NUREG/CR-5106
SAIC-88/3023

User's Guide for the TACT5 Computer Code

Prepared by D.B. West, H.E. Gilpin

Science Applications International Corporation

Prepared for
U.S. Nuclear Regulatory Commission

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
SPRINGFIELD, VA. 22161

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Manuscript Completed: May 1988
Date Published: June 1988

Prepared by
D.B. West, H.E. Gilpin

Science Applications International Corporation
1710 Goodridge Drive
P.O. Box 1303
McLean, VA 22102

Prepared for
Division of Radiation Protection and Emergency Preparedness
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555
NRC FIN D1763

NRC FORM 335 (2-84) NRCM 1102, 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

SEE INSTRUCTIONS ON THE REVERSE

1 REPORT NUMBER (Assigned by TIDC and Vol No., if any)
NUREG/CR-5106
SAIC-88/3023

2 TITLE AND SUBTITLE
User's Guide for the TACT5 Computer Code

3 LEAVE BLANK

4 DATE REPORT COMPLETED
MONTH: May YEAR: 1988

5 AUTHOR(S)
D.B. West, H.E. Gilpin

6 DATE REPORT ISSUED
MONTH: June YEAR: 1988

7 PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)
Science Applications International Corporation
1710 Goodridge Drive
McLean, VA 22102

8 PROJECT/TASK/WORK UNIT NUMBER
NRC-03-87-029 Task Order 007

9 FIN OR GRANT NUMBER
NRC FIN D-1763

10 SPONSORING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)
Division of Radiation Protection and Emergency Preparedness
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

11a TYPE OF REPORT
Computer Code

b PERIOD COVERED (Inclusive dates)

12 SUPPLEMENTARY NOTES

13 ABSTRACT (200 words or less)

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14 DOCUMENT ANALYSIS - a KEYWORDS/DESCRIPTORS

Accidents
BASIC
Containment
Containment systems
Doses
FORTRAN
Radiation Transport
Radiation Doses

b IDENTIFIERS/OPEN-ENDED TERMS

15 AVAILABILITY STATEMENT
Unlimited

16 SECURITY CLASSIFICATION
(This page) Unclassified
(This report) Unclassified

17 NUMBER OF PAGES

18 PRICE

☆U.S. GOVERNMENT PRINTING OFFICE:1988-202-292:80096

ABSTRACT

The TACT5 computer code, a successor to TACT III and earlier versions of TACT (an acronym for Transport of ACTivity), simulates the movement of radioactivity hypothetically released from a reactor core as it migrates through user-defined regions (nodes) of the containment, is immobilized by filters and sprays, and is released to the outside environment. The code has been modified to run on a personal computer (PC). The original PC version of TACT5 was developed and provided by Larry Bell of the NRC. A series of interactive BASIC preprocessor codes assists the user in compiling a nuclide input data file and a plant model data file. The plant model data file specifies a dynamic compartment model, which is represented by systems of ordinary differential equations with constant coefficients. The equations are solved explicitly by matrix transformation methods. A code run carries out the integration of these systems of equations over a succession of time intervals following reactor shutdown, with the interval boundaries corresponding to transitions of system parameter values which must be constant within each time interval. Outputs are shown for the end of each time interval and include the level of radioactivity in each node of the containment and in the environment, broken into isotopic groups that may be halogens, noble gases, sodium isotopes, solids, or plutonium isotopes. These categories may optionally be further subdivided into elemental, organic, and particulate forms. Radiation doses to reference individuals at the exclusion radius, the boundary of the low population zone, and, if selected, at a third receptor point, are generated by the code. Values of input parameters also are printed, and a summary is available at the user's option.

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The computer code TACT5 performs nodal dose transport calculations. It has evolved from the TACT code (Transport of ACTivity), which was originally developed by the Accident Evaluation Branch of NRC. Revisions and modifications of TACT resulted in several versions of the program culminating in TACT III, which was documented by ORNL in 1983 (NUREG/CR 3286). As a result, TACT III gained general acceptance for use in licensing actions. A need for a version of TACT that could be run quickly and easily in a PC environment has arisen. The NRC staff's Larry Bell developed TACT5 and its supporting preprocessors in response to this need. The ease of use and increased flexibility of this code has made it beneficial for NRC licensing actions. The intent of this document is to provide a user's guide and documentation so that the code can be used in a consistent manner for future licensing actions.

Installation of TACT5:

This section details the hardware/software requirements and steps involved in running TACT5 on a PC. A basic familiarity with the PC and the DOS environment is assumed. No programming experience is required to get TACT5 to run in its most often used form. Because of software license agreements, the code cannot be provided in a compiled, linked, ready to run form, resulting in the Ryan-McFarland RM/FORTRAN software requirement.

TACT5 requires the following minimum hardware:

IBM-PC/XT/AT or compatible
Hard disk with about 1 megabyte free (minimum of 500K)
256K memory
8087 or 80287 math coprocessor*
1 floppy drive
Printer (optional)

The following software also is required:

DOS 3.X
TACT5 diskette
RM/FORTRAN compiler version 2.3 or higher
BASICA (included in DOS)
A word processor capable of editing ASCII files (helpful, but not required).

---

* The 8087/80287 chips are highly recommended, but are not actually required. The FORTRAN source code for TACT5 can be compiled using libraries not requiring the presence of the math coprocessor. Refer to the RM/FORTRAN reference manual.

To install TACT5 on a hard disk, follow the procedure listed below. This procedure assumes RM/FORTRAN already has been installed in the root directory of the hard disk, as explained in the RM/FORTRAN manual. The TACT5 distribution disk should be placed in drive A. At this point, the following commands should be typed:

```
C:\                          switches to drive "C"
copy A:*.*                   copies all of the TACT5 distribution disk
                               to "C"
RMFORT TACT5                 compiles TACT5.FOR
RMFORT RILMAT                compiles RILMAT.FOR
PLINK86 FI TACT5, RILMAT     links TACT5.OBJ and RILMAT.OBJ
                               to create TACT5.EXE
```

This procedure will copy all of the files from the distribution disk onto the root directory of the hard disk, and compile, link, and create the executable file TACT5.EXE in the root directory.

It now will be possible to execute the two example problems included on the distribution disk. To execute these examples, type the following:

```
RUNTACT5
```

This begins execution of TACT5, and will prompt for an input file. Respond with:

```
EXAMPLE1.INP        (or EXAMPLE2.INP)
```

The program will then prompt for an output device. Respond with "CON" to send the output to the screen or "PRN" to send the output to a printer. Output produced will be identical to that shown in Appendices C and D, which correspond to examples 1 and 2.

1. INTRODUCTION

TACT5 is a FORTRAN code designed to model the possible transport of radionuclides through various compartments (nodes) of a reactor's containment and to the environment, and to report doses at two predefined locations and one user-defined location. TACT5 has the capability to model radionuclide removal processes such as filtration and containment sprays, and can treat both isotopic groups (i.e., halogens, nobles) and the various forms of the isotopic groups (i.e., elemental, organic, particulate) separately. The code can be used to calculate impacts on offsite dose and control room dose as a result of varying plant parameters such as containment spray effectiveness, filter efficiencies, ice condenser performance, or any other parameter modeled by the code.

TACT5 is a successor to TACT III, which was designed to run on a minicomputer. TACT5 incorporates several changes that were designed to make the program more responsive to the needs of the NRC. The ability to model daughter product buildup has been removed, since historically it never has been used and the code has been rewritten to run on a desktop PC rather than on a minicomputer. Several modifications to the format of the input and output data have been made to increase ease of use, and a BASIC preprocessor has been added, which greatly aids in the preparation of the input files that are required to execute the code. The mathematical treatment within the code has remained largely unchanged from earlier versions. The TACT5 source code has been modified to compile under RM/FORTRAN version 2.3, with a minimum of FORTRAN 77 extensions.

The code is designed to solve a system of ordinary differential equations that are set up by the user to represent the transport of mass between various compartments. Therefore, it is the responsibility of the user to design mathematical models that accurately describe the containment systems.

An input deck for TACT5 is broken into time-independent and time-dependent data. These two types of data are described in greater detail in Section 3. The time-dependent data are further divided into time steps,

with new time steps required only when a parameter value changes. Time zero normally is defined as the beginning of release from the coolant boundary. (A time delay can be introduced to model the time it takes for the reactor to shut down, in the time-independent input, if desired.) For each time step, only information that has changed from the previous time step needs to be input. TACT5 has no limit on the maximum number of time steps.

The general procedure to follow to execute a TACT5 run involves four steps. These steps are discussed in detail in Section 2. The first step in executing a TACT5 run is to create a nuclide file, or identify an existing nuclide file, containing information required by TACT5 for those nuclides of interest. The creation of a new nuclide file, if necessary, can be performed most easily and accurately using the TACT5ND preprocessor program. The second step is to design and define a model to represent the plant-specific case of interest. Use of the input forms contained in Appendix A is highly recommended when performing this step. A diagram that visually depicts the transfer paths between nodes also is helpful. The third step involves creating the model input data file, which is accomplished with the aid of TACT5MD, the preprocessor designed to assemble the model file. The fourth step is to execute the TACT5 code and generate the results.

Two examples are presented in Section 3.5 that outline each of these four steps. Although it is not important to understand fully the mathematical techniques used in TACT5, it is important to understand all of the input parameters, and when and how to use them. This document will provide a useful tutorial for TACT5 as well as a detailed reference source.

2. MATHEMATICAL DISCUSSION

The computational techniques used in TACT5 have remained virtually unchanged from those used in TACT III. The major exception is that the ability to model the transport of radionuclides independent of isotopic group, has been added. The ability to easily model daughter ingrowth due to decay of the fission products has been removed from TACT5. A programmer familiar with TACT5 and TACT III could put this capability back into the code; however, historically the effects of daughter products have not been included in NRC dose calculations. Therefore, this option has not been made readily available in the current version.

The discussion that follows provides a general description of how TACT5 computes doses. It provides a basic explanation of the code, which is extremely useful when attempting to construct a model of the containment, and in interpreting the values subsequently calculated by the codes. A detailed, rigorous description of the computational approach and underlying mathematics used by TACT5 is provided in NUREG/CR-3287, A Guide for the TACT III Computer Code (G.G. Killough et al. May 1983).

TACT5 computes doses to locations in the environment by solving a system of coupled, ordinary differential equations, which are set up by the user through the model description input. The differential equations are set up to track the production and removal of radionuclides through each node by performing a mass balance into and out of each node for each time step.

Sources of production of radionuclides in each node could only be from instantaneous or continuous release from the reactor core to the node, or from transport from any other node into the node. Sinks of radionuclides from a node include radioactive decay, containment spray removal, filtration, and leakage of radionuclides to other nodes or to the environment.

Given this information, a differential equation can easily be constructed relating the rates of production and removal of radionuclides in

each node. This system of differential equations is then put into matrix form and solved. This results in a calculation of the amount of a radionuclide (in curies) present in each node and the environment at the end of each time step. The curie contents then are reduced further by the X/Q values at the receptor points in the environment.

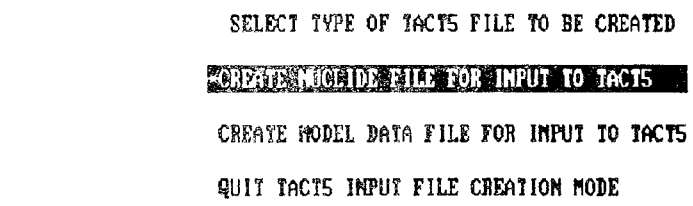
The number of curies of each nuclide at the dose evaluation point is multiplied by a dose conversion factor for the specific nuclide and for the organs of interest (and the breathing rate, if appropriate) to yield an organ dose in REM for each time step. The doses resulting from each nuclide then are summed to obtain a dose contribution for the time step and for each organ of interest. The organ doses then are summed over all the time steps, resulting in the final calculated dose to each organ of interest for the model.

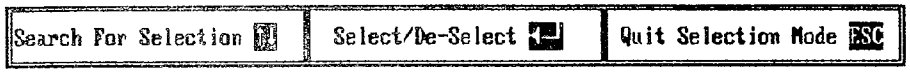
3. USER'S GUIDE FOR TACT5

3.1 OVERVIEW OF BASIC PREPROCESSOR CODES

The required input for execution of the TACT5 code may be characterized as either nuclear or plant model data. An interactive BASIC preprocessor code entitled TACT5MN is used to select the type of data the user wishes to prepare. TACT5MN transfers program control to one of two BASIC subprograms, either TACT5ND for the preparation of nuclear input data, or TACT5MD for the preparation of a plant model description, depending on the user's selection. Listings of the BASIC preprocessor codes are in Appendix F.

To initiate a run of TACT5MN, the user must first invoke BASIC from the disk operating system or already be in the BASIC environment. The commands to LOAD "TACT5MN.BAS" followed by RUN (or simply RUN "TACT5MN.BAS") must be entered. Immediately upon issuing the command to RUN "TACT5MN.BAS" the following menu will be displayed:





The first selection option, "CREATE NUCLIDE FILE FOR INPUT TO TACT5," will be highlighted with an inverse background/character color combination. Selecting this option will initiate the TACT5ND program. Selecting the second option, "CREATE MODEL DATA FILE FOR INPUT TO TACT5," will initiate the TACT5MD program. The last option is used to exit the preprocessor code.

Any one of the three options on this menu can be selected by pressing the carriage return or Enter key while the desired option is highlighted. The highlight is moved to other options with the up-arrow or down-arrow key. An option that has been selected is indicated by an asterisk (*), which appears immediately to the left of the option chosen, as shown by the highlighted option above. When the desired selection has been made, as indicated by an asterisk, the user implements the selection by pressing the ESC key. A selection may be changed before pressing the ESC key by simply moving the highlight to a new option and pressing the Enter key. The asterisk will move from the previous selection to the new selection.

The required keystrokes for moving the highlighted indicator from option to option, selecting or deselecting options, and implementing a selected option, are summarized in a graphic footnote that appears below the menu.

Discussions and detailed instructions, including sample screens, are presented below for preparation of nuclear input data and plant model input data files using the TACT5ND and TACT5MD programs, respectively.

3.2 PREPARATION OF NUCLEAR INPUT DATA

Input that is characterized as nuclear data is obtained from a combination of user input and permanent data files. The nuclear input data are prepared, properly formatted, and written to a data file by the BASIC program TACT5ND. The data that are handled by TACT5ND include:

- Organ dose conversion factors (DCFs) based on specific radioisotopes for any of various organs in which the user may wish to evaluate dose equivalents. Organ DCFs may be from either of two published sources: ICRP Publication 2 (ICRP 1959) or ICRP Publication 30 (ICRP 1979).

- Core inventory source terms for any of several isotopes. Radioisotopes for which data are available are grouped into the following categories: Halogens, Noble Gases, Solids, Sodiums, and Plutoniums.

Upon transfer of program control to TACT5ND from TACT5MN, the user will be requested to give a name to the nuclear data file that the program will proceed to create. The prompt will be as shown below:

```
ENTER NAME OF NUCLEAR DATA FILE TO BE CREATED
(INCLUDE OUTPUT DEVICE IN NAME eg. B:NUCDATA)

?
```

Following the input of the name of the file to be created, the user's responses to the following two queries determine the permanent source file from which organ and radioisotope data will be extracted to form the nuclear input data file. The first query is as follows:

```
Do you want to use the LWR Master Nuclide File (Y/N) ?
```

Two LWR Master Nuclide Files exist, one containing data from each of the two ICRP biological model source publications. The two files, MLWRICRP.02 and MLWRICRP.30, are shown in Appendix E. A "Y" response to the first query ensures that one of the two master files will be used. The user's response to the second query determines which of the two master files will be used. The second query is as follows:

```
Select Biological Model For
Dose Conversion Factors

 ICRP 2
 ICRP 30
```

Search For Selection ↑↓	Select/De-Select ↵	Enter Selection(s) ESC

If an "N" response is given to the first query, the user is asked to supply the name of the source nuclide file from which data will be extracted. The prompt for this case is as shown below:

```
Enter resident device and file name (eg. B:NUCLIDE.IN) ?
```

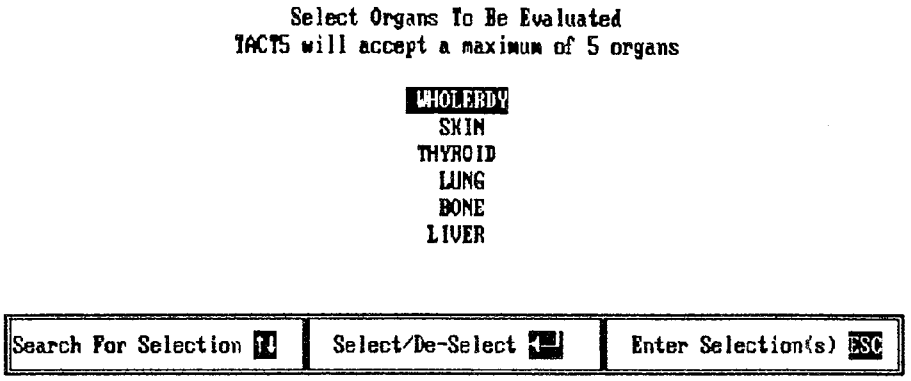
The file name supplied by the user must correspond to a nuclide file of the same type and format as the master nuclide files.

Having established the file that will be the source of nuclide data, TACT5ND then presents to the user a series of menus and queries to determine the data that will be written to the nuclear input data file. In general, the menus presented to obtain this information use the same highlighted selection/deselection process as the "SELECT TYPE OF TACT5 FILE TO BE CREATED" menu that is first encountered when running TACT5MN, with the exception that more than one choice (i.e., several organs) can be selected at one time. A selected option may be deselected by pressing the Enter key while the selected option is highlighted.

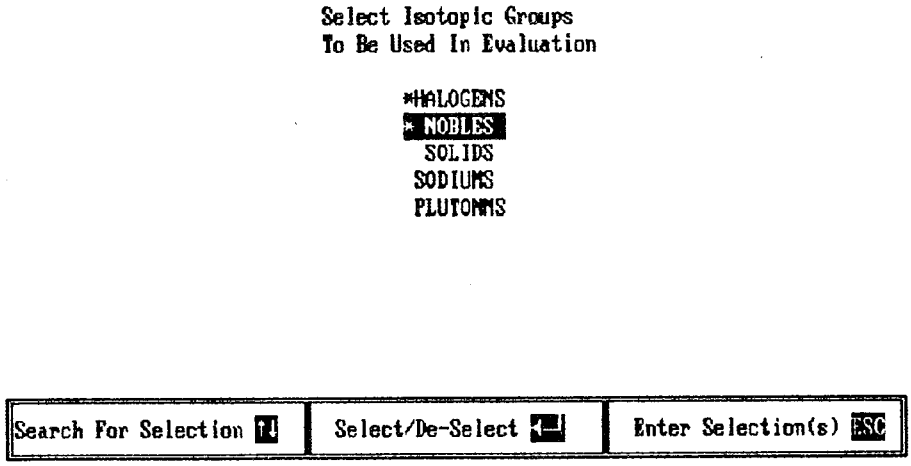
At this point, the writing of information to the nuclear input data file begins. If any mistakes are made in the process of answering queries or selecting items from menus in either of the BASIC preprocessor codes, it may not be possible to correct them once they have been entered. Inexperienced users may find it easier to exit the program and start over again. The program may be exited at any time by holding the CTRL key down and pressing BREAK. Before starting over, the user should type CLOSE followed by the ENTER key since exiting in mid-program may result in files being left open. Users who are more familiar with the required structure of the input data files will probably find it easier to make note of any errors made while running the BASIC preprocessor codes and correct the errors manually after completion of the preprocessor routine using an editor such as EDLIN. It is important to note that if one of the BASIC preprocessor codes is exited in mid-routine, it is not possible to resume file creation later at the point the user was before exiting; in other words, once the

user begins a run of either TACT5ND or TACT5MD from the TACT5MN menu, he must either complete it or abandon it and start over.

The first menu to appear allows the user to select up to five organs for which TACT5 will calculate dose equivalents. Since TACT5 allows a maximum of five organs, selecting more than five causes TACT5ND to display a warning and to return to the organ menu for reselection. As shown below, a reminder of the five-organ limit appears with the menu:



After the organs to be evaluated have been selected by highlighting them and pressing the Return key, striking the ESC key will accept these entries and display the following menu:



The user selects the isotopic groups, which include isotopes that are to be considered as contributing to calculated doses. If no isotopes of a given isotopic group are to be used by TACT5 to calculate doses, then that

isotopic group should not be selected. At least one isotope from a selected group must be selected. The sample screen above shows the selection of halogens and noble gases.

At this point and at various other times during execution of TACT5ND, a message will be displayed on the screen to indicate that the program is processing information.

For each of the isotopic groups selected, the program will ask if all isotopes of that group are to be used. For example, if the halogen group had been selected on the previous menu, the following will be displayed:

```
DO YOU WANT TO INCLUDE ALL OF THE ISOTOPES IN THE HALOGENS GROUP (Y/N) ?
```

If a "Y" response is entered, all isotopes of the given group for which data are included on the source nuclide file will be written to the nuclear input data file, and the above question will be repeated for the next isotopic group that had been selected. If an "N" response is entered, a list of all isotopes of the given group will be displayed, providing an opportunity for the user to select some or all of the displayed isotopes. The display would appear as shown below for the halogen group after the iodine isotopes were selected:

```
SELECT ISOTOPES TO BE UP-LOADED TO TACT V NUCLIDE INPUT FILE

  BR  82
  BR  83
  BR  84
  BR  85
* I  129
* I  131
* I  132
* I  133
* I  134
* I  135
* I  136

Search For Selection TAB | Select/De-Select SPACE | Enter Selection(s) ESC
```

Once the desired isotopes are selected, the program will continue with the next selected isotopic group, until all selected isotopic groups have been addressed.

When the routine described above has been completed for all selected isotopic groups, the program will display a summary of the characteristics of the nuclear input data file that has been created. The summary display is shown below:

```
THE NUCLIDE FILE 'NUCDATA'
HAS BEEN CREATED ON DEVICE C:
AND HAS THE FOLLOWING ATTRIBUTES:

NUMBER OF ORGANS ---------- 2

NUMBER OF ISOTOPIC GROUPS -- 2

NUMBER OF ISOTOPES -------- 20

STRIKE <-' TO CONTINUE
```

A sample nuclide file using two organs, selected halogen isotopes, and all noble gas isotopes, is shown in Appendix B.

Pressing the Enter key at this point returns program control to TACT5MN and the original menu, from which the user may select the option to create the plant model input data file, as described in the following section.

3.3 PREPARATION OF PLANT MODEL DESCRIPTION

The creation of a plant model input data file is significantly more involved than the creation of the nuclear input data file described previously. A fair amount of preparation generally is required of the user prior to initiating the TACT5MD program from the main TACT5MN menu. TACT5MD obtains all input from the user and from the nuclear input data file designated by the user. The designated file may or may not be the file just created. The plant model input data file is case-specific; a unique file is virtually always required for each run of TACT5. By comparison, the nuclear input data file described previously can be generic to many applications. The organ and nuclide data of interest are often the same, regardless of

plant- or case-specific parameters. Thus, a nuclear input data file initially created or already existing may be used for most TACT5 runs.

The data supplied by the user for the preparation of the plant model input data file consist of both time-independent and time-dependent data. Together, these data are interpreted by TACT5 as a simplified mathematical model of some of the physical characteristics of a nuclear power plant and the sequence of events occurring after a postulated reactor accident, including the release of radionuclides from the core and subsequent transfer between modeled compartments and to the environment.

Time-independent data processed by TACT5MD include:

- Rated thermal power output of reactor, in megawatts thermal
- Elapsed time between reactor shutdown and start of accident, in hours (0 if accident occurs during operation)
- Fraction of each isotopic group released to containment, and the fraction of the amount released that plates out for each group
- Proportional amount of each isotopic group represented by each of the three isotopic forms: elemental, organic, and particulate
- Volume of the compartments, or nodes, that partition the containment, in cubic feet.

Information pertaining to the sequence of events occurring after the start of an accident include:

- Parameters that determine
  - rates of exchange of air among the nodes
  - removal of radioactivity from the system (e.g., by filters and sprays)

- leakage of radioactivity to the outside environment

- Parameters related to individual exposure: breathing rates and dilution factors (X/Q)

To ensure that input is accomplished as efficiently and accurately as possible, it is recommended that all data be collected and organized on paper prior to initiating TACT5MD. A multi-page form has been developed for this purpose and is shown in Appendix A. A single page is required for time-independent data. Of the next two pages, the first is required for each time step, and the second is required for time steps during which any filter efficiency information changes from the previous time step.

Upon transfer of program control to TACT5MD from TACT5MN, the user will be asked to enter the name of the nuclear input data file to be used. This may be the file just created or any other nuclear input data file of the proper format.

```
ENTER NAME OF TACT5 NUCLIDE DATA FILE
(INCLUDE DEVICE NAME IN FILE NAME
 eg. B:NUCDATA)
```

The user then is asked to give a name to the plant model input data file about to be created. This prompt and the previous prompt contain reminders to include the device name followed by a colon (:) at the beginning of the file name.

```
ENTER NAME OF TACT5 MODEL DATA FILE
(INCLUDE DEVICE NAME IN FILE NAME
 eg. B:SEABROOK)
```

If no device name is specified, the default device will be used.

Title cards are input next. The title cards are transferred exactly as entered to the top of the output file. The following self-explanatory text appears just prior to the prompt for entering title cards:

```
You are allowed to enter a maximum of 50 title cards.
Each title card will be prompted by a < and entry is
made by striking ↵ after you have keyed in your text.
When you have entered your last title card, you enter
ESC to continue with your next TACT5 input parameter.

(STRIKE ANY KEY TO CONTINUE)
```

After the user reads this message and strikes any key, a blank screen will appear. As noted in the message above, the user must press ESC when finished with the entering of title cards; pressing Enter will simply result in a prompt for a new title card.

After title cards are entered, one or more print options are selected from the following menu:

```
        ENTER PRINT OPTION(S) (DEFAULT IS 1)

PRINT ACTIVITIES FOR EACH TIME STEP          1

PRINT DOSES FOR EACH TIME STEP

PRINT ACTIVITIES AND DOSES FOR EACH TIME STEP

PRINT SUMMARY FOR EACH TIME STEP

PRINT ALL OF THE ABOVE OPTIONS
```

A "1" appears to the right of each option, in turn. As the user proceeds down the list of options, he presses "Enter" for options he wishes to select, thereby causing the "1" to remain and output for that option to be printed when TACT5 is run, or he types "0" (to replace the "1") followed by the Enter key to suppress output for any option that is not desired.

The program then prompts for entry of the number of nodes; the number of dose evaluation points (e.g., Exclusion Area Boundary, Low Population Zone, or Control Room); the name of each node (up to eight characters are allowed for each node name); and the number of time steps. The sample screen below depicts the entry of this information.

```
ENTER THE FOLLOWING TACTS INPUT PARAMETERS

ENTER NUMBER OF NODES                    2
(MAXIMUM ALLOWED=4)

ENTER NUMBER OF DOSE EVALUATION POINTS   2
(MAXIMUM ALLOWED=3)

          NAME FOR NODE 1   Upr Cont

          NAME FOR NODE 2   Lwr Cont

     ENTER NUMBER OF TIME STEPS 7
```

For input of the next series of time-independent parameters, prompts are displayed on the screen, either for individual parameters or for a matrix of values, with "0.000E+00" appearing in turn where each value is to be entered. Cursor position for a value being entered is indicated by a differently shaded character in the entry field. After entry of a value, the zero figure appears where the next value will be entered. Each character of a value being typed in replaces (by printing over) each character of the zero figure in that position. Thus, even though any format is acceptable for values being entered, care must be taken when typing in a value that does not replace every character of the original zero figure. For example, if a value of 50 was entered by typing in a "5" and a "0", only the first zero and decimal point from the original zero figure would be replaced. Pressing "Enter" at this point would result in a value of 50,000 being read by the program. It is recommended that all values be entered in scientific notation, with the decimal point, "E", and sign on the exponent all positioned the same as the original zero figure to avoid this problem. The right-arrow and left-arrow keys may be used to position the cursor so as not to disturb any characters in the original zero figure that will remain the same in the entered value. The Enter key is used to move to the next entry field once a value correctly appears. No opportunity is provided to

correct a value once the Enter key has been struck. The following sample screens show the time-independent data entered in this manner:

```
                    ENTER THE FOLLOWING TACT5 INPUT PARAMETERS

                         ENTER POWER (Mwt) 0.000E+00

                    ENTER LAPSED TIME BETWEEN REACTOR
                    SHUTDOWN AND START OF ACCIDENT

                              CORE RELEASE FRACTION AND
                    INSTANTANEOUS PLATE OUT FACTOR BY ISOTOPIC GROUP

PARAMETER           HALOGENS     NOBLES
RELEASE FRACTION
PLATE OUT FACTOR

                              ISOTOPIC FORM BY ISOTOPIC GROUP

ISOTOPIC FORM       HALOGENS     NOBLES
  ELEM.
  ORG.
  PART.


                    ENTER THE FOLLOWING TACT5 INPUT PARAMETERS

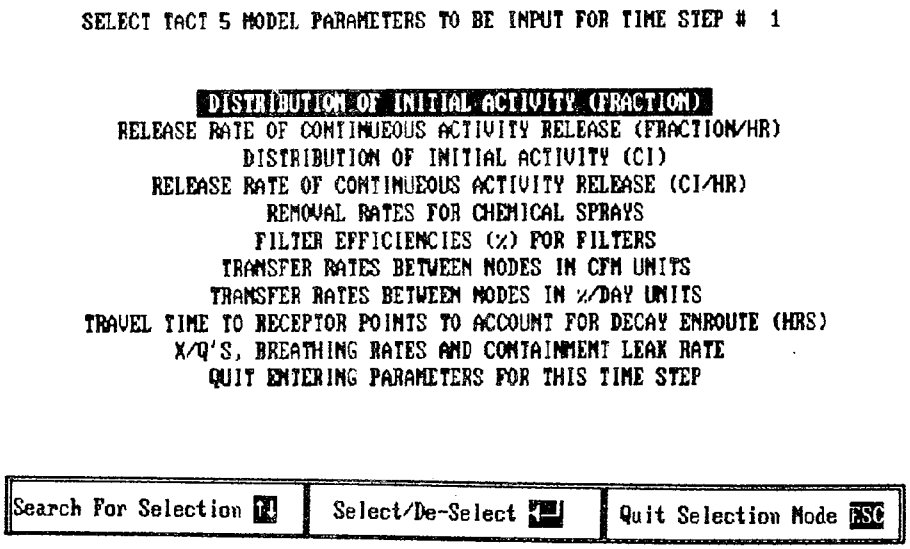
                              VOLUME OF NODES (FT**3)
                    Upr Cont     Lwr Cont
                    0.000E+00
```

At this point, entry of time-dependent data begins. For each time step, the program will prompt for the start and end times for the time step.

```
                    ENTER THE START TIME AND END TIME FOR TIME STEP #  1

                              START TIME (HRS)     END TIME (HRS)
                              0.000E+00
```

The following menu will then appear. The menu will reappear each time the entry sequence for a parameter or set of parameters has been completed.



When all desired data for a time step have been input, the last item, "QUIT ENTERING PARAMETERS FOR THIS TIME STEP," is selected. Entry of the start and end times for the next time step is prompted, and the menu again is displayed. This process continues until all data for all time steps have been entered. For any given time step, only the parameters that are new for that time step need to be entered (i.e., those parameters that were not previously entered or those that change at the beginning of that time step from previously entered values). In other words, entered parameters retain their values throughout the modeled accident until changed or "zeroed out" in subsequent time steps.

Each option on the menu above is addressed in the individual subsections below. A few of the options appear to differ from other options only by the units associated with the input parameters. Other, less apparent differences may exist, however. These differences are explained below.

3.3.1 Distribution of Initial Activity (Fraction)

This option allows the user to specify the amount of activity, in terms of the fraction of total activity released from the core and reduced by the plateout factor, that initially is distributed to each of the modeled nodes. The user may specify that the initial activity distribution is independent of isotopic group, in which case one set of input fractions will apply to all isotopes, or that the distribution may be different for each of the isotopic groups, in which case fractions are input separately. This choice is made by appropriately answering the following question:

```
DO YOU WANT THE INITIAL DISTRIBUTION TO
BE INDEPENDENT OF THE ISOTOPIC GROUPS (Y/N) ?
```

If an "N" response is given, the functions are entered matrix fashion, for each node, and for each isotopic group, as shown below:

```
ENTER INITIAL ACTIVITY IN EACH NODE FOR TIME STEP #  1

ISOTOPIC GROUP Upr Cont    Lwr Cont
  HALOGENS     0.000E+00   1.000E+00
  NOBLES       5.000E-01   5.000E-01
```

If a "Y" response is given, the fractions are entered once for each node. Although this option may be invoked for any time step, it is generally used only for the first time step.

3.3.2 Release Rate of Continuous Activity Release (Fraction/Hr)

This option may be used to model a continuous release of activity to the various nodes rather than the instantaneous release simulated by the first option. The continuous release is in terms of a fraction of the total activity available for release from the core per hour. As with the first option, the values of this parameter entered for each of the nodes may be the same for all isotopic groups or different for each group. Entry is also the same as with the first option.

3.3.3 Distribution of Initial Activity (CI)

This option is similar to the first option, except that instead of the distribution of initial activity being in terms of fractions of the total release, a specific number of curies released to each node may be entered.

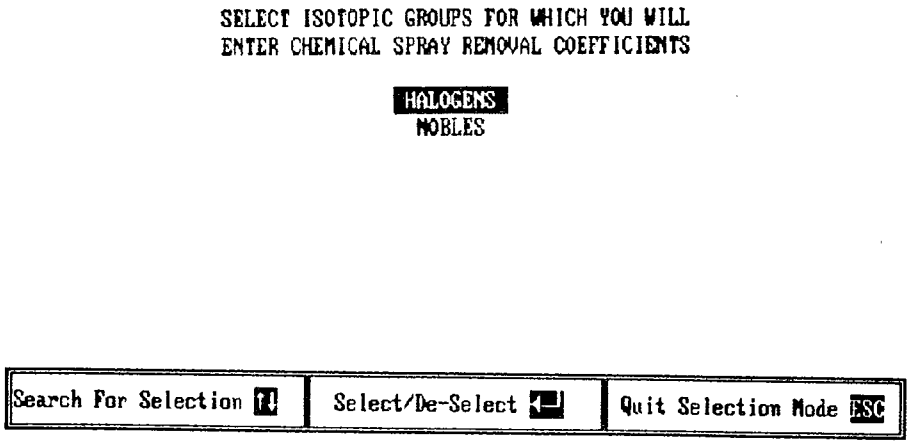
3.3.4 Release Rate of Continuous Activity Release (CI/HR)

This option is similar to the second option, except that instead of the release rate being in terms of a fraction of the total activity available for release per hour, a release rate in curies per hour may be entered for each node.

3.3.5 Removal Rates for Chemical Sprays

This option allows the user to model the effect of containment sprays on the released activity by entering removal rate coefficients. Containment spray removal rate coefficients have units of ($hour^{-1}$) and contribute to the total nonradioactive removal term.

Upon selecting this option from the main menu, the following sub-menu appears:



The selection options for this sub-menu will be the isotopic groups on the

nuclear input data file being used. Halogens are usually selected because they are heavily affected by sprays; noble gases usually are not selected because they are unaffected by sprays.

For each isotopic group selected, the removal rate coefficients for the elemental, organic, and particulate forms of that group are entered for each node, as shown in the following example:

```
ENTER CHEMICAL SPRAY REMOVAL RATES IN EACH NODE FOR TIME STEP # 1

REMOVAL COEFFICIENTS FOR HALOGENS

FORM NAME      Upr Cont    Lwr Cont
  ELEM.        1.700E+01   0.000E+00
  ORG.         0.000E+00   0.000E+00
  PART.        2.000E-01   0.000E+00
```

3.3.6 Filter Efficiencies (%) for Filters

This option is used to model the effect of filters on the concentration of appropriate isotopes. Values entered are filter efficiencies, expressed as percentages, for all internodal paths. The transfer rate of air to be filtered must be specified using the "TRANSFER RATES BETWEEN NODES IN CFM UNITS" option. No filtration occurs for transfers specified using the "TRANSFER RATES BETWEEN NODES IN %/DAY UNITS" option.

After selecting the filter efficiency option, the program will ask what isotopic groups are to be filtered. For each isotopic group selected, the program will prompt for the entry of filter efficiencies applicable to air transfers from each node to each node and to the environment. This matrix of values is input separately for the elemental, organic, and particulate forms of each selected isotopic group. The following is a sample filter

efficiency input matrix for the elemental form of the halogens isotopic group in a two-node containment.

```
ENTER FILTER EFFICIENCIES FOR EACH NODE FOR TIME STEP #  1

FILTER EFFICIENCIES FOR HALOGENS GROUP AND   ELEM. FORM

 FROM     TO  ENV.        Upr Cont    Lwr Cont
Upr Cont      9.500E+01   0.000E+00   9.500E+00
Lwr Cont      9.500E+01   9.500E+01   0.000E+00
```

3.3.7 Transfer Rates Between Nodes in CFM Units

This option is for the entry of air volume transfer rates from each node to each node and to the environment. Transfer rates are entered in units of cubic feet per minute (CFM). Selection of this entry option is made during the time step when the transfer mechanisms (e.g., fans) begin to operate. As noted previously, this option is associated with filtered flow rates, whereas the "TRANSFER RATES BETWEEN NODES IN %/DAY UNITS" option is not.

The program first asks if the initial distribution is to be independent of the isotopic groups. For each node, the user then is prompted for the entry of the transfer rates from that node to the environment and to each of the nodes, as shown in the following example:

```
ENTER TRANSFER RATES IN CFM FOR EACH NODE FOR TIME STEP #  1

 FROM     TO  ENV.        Upr Cont    Lwr Cont
Upr Cont      5.000E+00   0.000E+00   3.400E+03
Lwr Cont      5.000E+00   3.400E+03   0.000E+00
```

3.3.8 Transfer Rates Between Nodes in %/Day Units

This option is similar to the previous option in terms of entry format; however, the transfer rates entered with this option generally are associated with convective flow and are in units of %/day. Also, any filter

efficiencies entered are not applied to the transfer rates entered with this option. A general rule for convective flow is that whenever two nodal volumes are in contact with each other, twice the smaller nodal volume is exchanged between the two nodes per hour.

The transfer rates entered using the "...CFM UNITS" and "...%/DAY UNITS" options are independent and separate. Therefore, the total transfer rate between nodes or to the environment is the sum of the transfer rates entered using the two options, and it is this sum that TACT5 computes and uses. It is not correct, for example, to specify a transfer rate using the "CFM" option and to include that rate again in the "%/DAY" option. This would have the effect of doubling that transfer rate.

3.3.9 Travel Time to Receptor Points to Account for Decay Enroute (HRS)

This option represents a capability that was not available in TACT III. For each dose evaluation point (the number of dose evaluation points was entered as time-independent input), the time in hours required for the release to travel the distance to that dose evaluation point is entered. The entry format is straightforward, and the net effect of having a positive travel time is a reduced activity reaching the receptor point.

3.3.10 X/Qs, Breathing Rates and Containment Leak Rate

The dose-related parameters for the given time step are entered using this option. Dilution factors (X/Q) in seconds per cubic meters and breathing rates in cubic meters per second are entered for each dose evaluation point. The containment leak rate in %/day is entered after X/Qs and breathing rates. The containment leak rate being entered with this option does not eliminate the need to enter it with the "TRANSFER RATES BETWEEN NODES IN %/DAY UNITS" option described earlier.

A sample screen showing the entry of these parameters for three receptor points is shown below.

```
X/Q'S (SEC/M**3), BREATHING RATES (M**3/SEC), AND CONTAINMENT LEAK RATE (%/DAY)

  RECEPTOR   BREATHING    RECEPTOR   BREATHING
POINT 1 X/Q    RATE     POINT 2 X/Q    RATE
0.000E+00

                    CONTAINMENT LEAK
                      RATE (%/DAY)
```

Normally, the exclusion radius is taken as the first receptor point and the low population zone (LPZ) is taken as the second receptor point. Provision has been made to allow evaluation of a third receptor point of the user's choosing.

3.4 EXECUTION OF TACT5

At this point, both the nuclear and model data files should be complete and reside on either a floppy disk or the hard disk. Make certain that the DOS prompt is set to the device and subdirectory containing the TACT5 code. Begin execution by typing "RUNTACT5" at the DOS prompt. (This will execute a batch file with the command TACT5/R10000 in it.) The code will prompt for the name of the input file. Type in the device specifier (i.e., A:, B:, C:\subdir\...) and the name of the file containing the plant model input data.

The program will then respond by requesting where the output should be sent. Selecting either "LPT1" or "PRN" will send the output to a printer on LPTI (or other port, depending on the status of the MODE command). Selecting "CON" will scroll the output to the CRT screen. Optionally, a filename also could be entered here, and the output will be sent to a disk file in ASCII for future printing.

The code will then begin execution. Depending on the speed of the PC being used and the complexity of model, execution will take from seconds to several minutes. Error code #1008 may be reported during execution;

however, this should be ignored, since it means only that the numbers being calculated were below the numeric accuracy of the computer (which is approximately 1×10^{-40}), and will be reported as zero.

3.5 EXAMPLES

Output listings from two sample TACT5 runs, accompanied by brief descriptions of the output, are presented in Appendices C and D. Both runs are for hypothetical loss-of-coolant-accidents. The model for the first run used a simple one-node model with no fans or sprays. The model for the second run included four nodes, exfiltration fans operating for the first minute of the accident, and sprays operating from 10 minutes to 36.2 minutes into the accident. The input files are shown in Figures 3.1 and 3.3 respectively, which follow the line-by-line descriptions of the input files presented below.

Example 1:

Example 1 considers the simplest case for a TACT5 run. It represents a 2700 Mwt reactor with a single node containment for which no additional ESF features are modeled. A diagram depicting this model is shown in Figure 3.2. The fractions of nuclide groups and their breakdowns are representative of current NRC guidelines as outlined in Reg. Guide 1.3 and 1.4, and Standard Review Plan Chapter 15. Five time steps are modeled in which only the X/Qs, breathing rates, and containment leak rates change. Note that some lines (e.g., Line 2) or parts of lines are supplied by the program and not input directly by the user.

Example 1 (Figure 3.1 Input)

Line 1	C:NUCDATA	Name of nuclide file to use
Line 2	C:LTAPE, C:MTAPE C:NTAPE	Names of temporary files to hold blocks of data during program execution
Lines 3 and 4		Title (may be up to 50 lines)
Line 5	1,1,1,1,1	Print options (all were selected in this case)

Line 6	1	Number of nodes
	2	Number of dose evaluation points
Line 7	Contmt	Name of node
Line 8	5	Number of time steps
Line 9	2.7E3	(Mw_t) Reactor thermal power
	0	(hr.) Shutdown time
Line 10	0.25	Fraction of halogens released
	1.0	Fraction of noble gases released
Line 11	0	Fraction of halogens that plate out
	0	Fraction of noble gases that plate out
Line 12	0.955	Fraction of halogens that is elemental
	0.025	Fraction of halogens that is organic
	0.02	Fraction of halogens that is particulate
Line 13	1.0	Fraction of noble gases that is elemental
	0	Fraction of noble gases that is organic
	0	Fraction of noble gases that is particulate
Line 14	1.8E6	(ft^3) Volume of single containment node
Line 15	TIME INTERVAL	Time interval designation
	0,0,0,0	Not used for time interval designation
	2	Number of values to be read in
	0.000E+00	(hr.) Beginning of time step
	2.000E+00	(hr.) End of time step
Line 16	INITIAL FRACTION	Initial distribution in fraction(s) designation
	0,0,0,0	Not used in this case (initial distribution was to be independent of isotopic groups)
	1	Number of values to be read in
	1.0	Fraction (all in this case) of released activity to Node 1

Line 17	TRANSFER PERCENT	Transfer rate in %/day designation
	0,0,0,0	Not used
	1	Node from which transfer originates
	2	Number of values to be read in
	0.14	Percent transfer from Node 1 to environment
	0.0	Percent transfer from Node 1 to Node 1
Line 18	DOSE PARAMS	Dose parameters designation
	0,0,0,0	Not used
	5	Number of values to be read in
	3.7E-4	(sec/m^3) Dilution factor for exclusion radius
	3.47E-4	(m^3/sec) Breathing rate for exclusion radius
	1.9E-5	(sec/m^3) Dilution factor for low population zone
	3.47E-4	(m^3/sec) Breathing rate for low population zone
	0.14	(%/day) Containment leak rate
Line 19	TIME INTERVAL	Time interval designation
	0,0,0,0	Not used
	2	Number of values to be read in
	2.0	(hrs.) Beginning of second time step
	8.0	(hrs.) End of second time step

(remaining lines similar to above)

Example 2:

Example 2 represents a more complex model, in which four nodes are required to depict the transfer of nuclides inside containment and to the environment. A diagram showing the nodal inter-relationships is presented in Figure 3.4. This model is representative of a large BWR with a MARK III type containment. In this case, node 1 represents the drywell, node 2 the wetwell, node 3 the unsprayed region of the upper containment, and node 4

the sprayed upper containment. Sprays are assumed to operate from 10 to 36.2 minutes, and filters and fans transfer radionuclides between nodes, as explained below. Standard assumptions of breathing rate changes and X/Q value changes occur at 2, 8, 24, and 96 hours.

Example 2 (Figure 3.3 Input)

Line 1	A:NUCDATA	Name of nuclide file to use
Line 2	A:LTAPE, A:MTAPE, A:NTAPE	Names of temporary files to hold blocks of data during program execution
Lines 3-6		Title information (may be up to 50 lines)
Line 7	0,0,0,1,0	Print options (summary option only was selected in this case)
Line 8	4	Number of nodes
	2	Number of dose evaluation points
Line 9	Unsp-Mx,...	Names of nodes
Line 10	8	Time steps
Line 11	4.1E3	(MW_t) reactor thermal power
Line 12	0.25	Fraction of halogens released
	1.0	Fraction of noble gases released
Line 13	0,0	Plateout fractions for halogens and nobles
Line 14	0.91	Fraction of halogens that is elemental
	0.04	Fraction of halogens that is organic
	0.05	Fraction of halogens that is particulate
Line 15	1.0	Fraction of noble gases that is elemental
	0	Fraction of noble gases that is organic
	0	Fraction of noble gases that is particulate
Line 16	1.25E5	(ft^3) volume of Node 1
	1.3E6	(ft^3) volume of Node 2
	3.5E4	(ft^3) volume of Node 3
	3.03E5	(ft^3) volume of Node 4

Line 17	TIME INTERVAL	Time interval designation
	0,0,0,0	Not used
	2	Number of values to be read in distribution in
	0.000E+00	(hrs.) Beginning of first time step
	1.670E-02	(hrs.) End of first time step
Line 18	INITIAL FRACTION	Initial distribution in fractions designation
	0,0,0,0	Not used
	4	Number of values to be read in
	0.0856	Fraction of release initially in Node 1
	0.8904	Fraction of release initially in Node 2
	0.024	Fraction of release initially in Node 3
	0.0	Fraction of release initially in Node 4
Line 19	FILTER EFF	Filter efficiency designation
	1	Signifies that filter efficiencies given are applicable to isotopic group 1 (halogens)
	1	Signifies that filter efficiencies given are applicable to form 1 (elemental) of halogens
	0	Not used
Line 19	1	Signifies that filter efficiencies given are for transfers from Node 1
	5	Number of values to be read in
	0.99	Filter efficiency for transfer to environment
	0,0,0,0	Filter efficiencies for transfers to Nodes 1, 2, 3, and 4
Lines 20-30		Similar to Line 19

Line 31	TRANSFER CFM	Transfer rate in cfm designation
	0,0,0	Not used
	1	Denotes transfer rates given are from Node 1
	5	Number of values to be read in
	0.233	Transfer rate to environment
	0,0,0,0	Transfer rates to Nodes 1, 2, 3, and 4
Lines 32-57		Similar to previous lines in this and first example
Line 58	REMOVAL RATE	Chemical spray removal coefficient designation
	1	Signifies removal coefficients given are applicable to isotopic group 1 (halogens)
	1	Signifies removal coefficients given are applicable to form 1 (elemental) of halogens
	0,0	Not used
	4	Number of values to be read in
	0	Removal coefficient for Node 1 (unsprayed region)
	4.6	Removal coefficient for Node 2
	0,0	Removal coefficients for Nodes 3 and 4 (unsprayed regions)

(remaining lines similar to previous lines in this and first example)

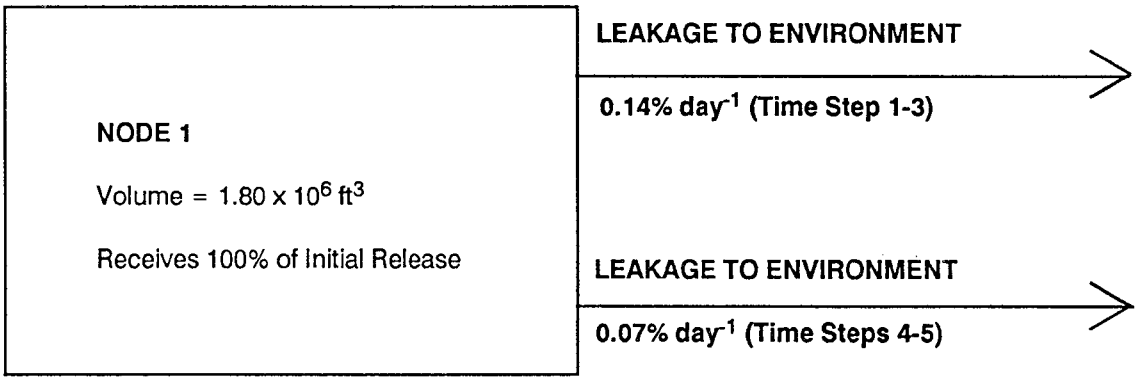
Note in the second example that filter efficiencies and transfer rates in cfm had to be "zeroed out" in Lines 41-52 and 53-56, respectively. The removal coefficient for elemental halogens was "zeroed out" in Line 62, while the removal coefficient for particulate halogens was re-specified as the same value in Line 64.

```
'C:NUCDATA
'C:LTAPE   ','C:MTAPE   ','C:NTAPE
'Sample Case - 1 Node Problem
'
 1, 1, 1, 1, 1
  1,  2
'Contmt  '
 5
 2.700E+03, 0.000E+00
 0.250E+00, 1.000E+00
 0.000E+00, 0.000E+00
 0.955E+00, 0.020E+00, 0.025E+00
 1.000E+00, 0.000E+00, 0.000E+00
 1.800E+06
'TIME INTERVAL   ',0,0,0,0,2, 0.000E+00, 2.000E+00
'INITIAL FRACTION',0,0,0,0,1, 1.000E+00
'TRANSFER PERCENT',0,0,0,1,2, 0.140E+00, 0.000E+00
'DOSE PARAMS     ',0,0,0,0,5, 3.700E-04, 3.470E-04, 1.900E-05, 3.470E-04, 0.140E+00
'TIME INTERVAL   ',0,0,0,0,2, 2.000E+00, 8.000E+00
'DOSE PARAMS     ',0,0,0,0,5, 0.000E+00, 3.470E-04, 1.900E-05, 3.470E-04, 0.140E+00
'TIME INTERVAL   ',0,0,0,0,2, 8.000E+00, 2.400E+01
'DOSE PARAMS     ',0,0,0,0,5, 0.000E+00, 1.750E-04, 9.700E-06, 1.750E-04, 0.140E+00
'TIME INTERVAL   ',0,0,0,0,2, 2.400E+01, 9.600E+01
'TRANSFER PERCENT',0,0,0,1,2, 0.070E+00, 0.000E+00
'DOSE PARAMS     ',0,0,0,0,5, 0.000E+00, 2.320E-04, 5.300E-06, 2.320E-04, 0.070E+00
'TIME INTERVAL   ',0,0,0,0,2, 9.600E+01, 7.200E+02
'DOSE PARAMS     ',0,0,0,0,5, 0.000E+00, 2.320E-04, 1.200E-06, 2.320E-04, 0.070E+00
'END             ',0,0,0,0,0, 0.000E+00, 0.000E+00
```

Input File for Example 1

Figure 3.1

Example 1



Nodal Diagram for Example 1

Figure 3.2

```
'A:NUCDATA                                                                    '
'A:LTAPE    ','A:MTAPE    ','A:NTAPE    '
'Sample Run - 4 Nodes                                                        '
'<                                                                           '
'4100 MWt BWR; 4 nodes; 8 time steps                                         '
'                                                                            '
 0, 0, 0, 1, 0
  4,  2
'Unsp-Mx ','Sprayed ','Unsprayd','Drywell '
 8
 4.100E+03, 0.000E+00
 2.500E-01, 1.000E+00
 0.000E+00, 0.000E+00
 9.100E-01, 4.000E-02, 5.000E-02
 1.000E+00, 0.000E+00, 0.000E+00
 1.250E+05, 1.300E+06, 3.500E+04, 3.030E+05
'TIME INTERVAL   ',0,0,0,0,2, 0.000E+00, 1.670E-02
'INITIAL FRACTION',0,0,0,0,4, 8.560E-02, 8.904E-01, 2.400E-02, 0.000E+00
'FILTER EFF      ',1,1,0,1,5, 9.900E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,1,0,2,5, 9.900E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,1,0,3,5, 9.900E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,1,0,4,5, 9.900E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,2,0,1,5, 9.900E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,2,0,2,5, 9.900E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,2,0,3,5, 9.900E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,2,0,4,5, 9.900E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,3,0,1,5, 9.900E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,3,0,2,5, 9.900E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,3,0,3,5, 9.900E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,3,0,4,5, 9.900E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'TRANSFER CFM    ',0,0,0,1,5, 2.330E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'TRANSFER CFM    ',0,0,0,2,5, 2.400E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'TRANSFER CFM    ',0,0,0,3,5, 6.120E-02, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'TRANSFER CFM    ',0,0,0,4,5, 1.100E-01, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'TRANSFER PERCENT',0,0,0,1,5, 0.000E+00, 0.000E+00, 4.800E+03, 0.000E+00, 9.697E+00
'TRANSFER PERCENT',0,0,0,2,5, 1.155E-02, 4.615E+02, 0.000E+00, 0.000E+00, 9.324E-01
'TRANSFER PERCENT',0,0,0,3,5, 8.050E-03, 0.000E+00, 0.000E+00, 0.000E+00, 3.463E+01
'TRANSFER PERCENT',0,0,0,4,5, 1.400E-03, 4.000E+00, 4.000E+00, 4.000E+00, 0.000E+00
'DOSE PARAMS     ',0,0,0,0,5, 6.900E-04, 3.470E-04, 3.000E-05, 3.470E-04, 2.100E-02
'TIME INTERVAL   ',0,0,0,0,2, 1.670E-02, 1.670E-01
'FILTER EFF      ',1,1,0,1,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,1,0,2,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,1,0,3,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,1,0,4,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,2,0,1,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,2,0,2,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,2,0,3,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,2,0,4,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,3,0,1,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,3,0,2,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'FILTER EFF      ',1,3,0,3,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
```

Input File for Example 2

Figure 3.3

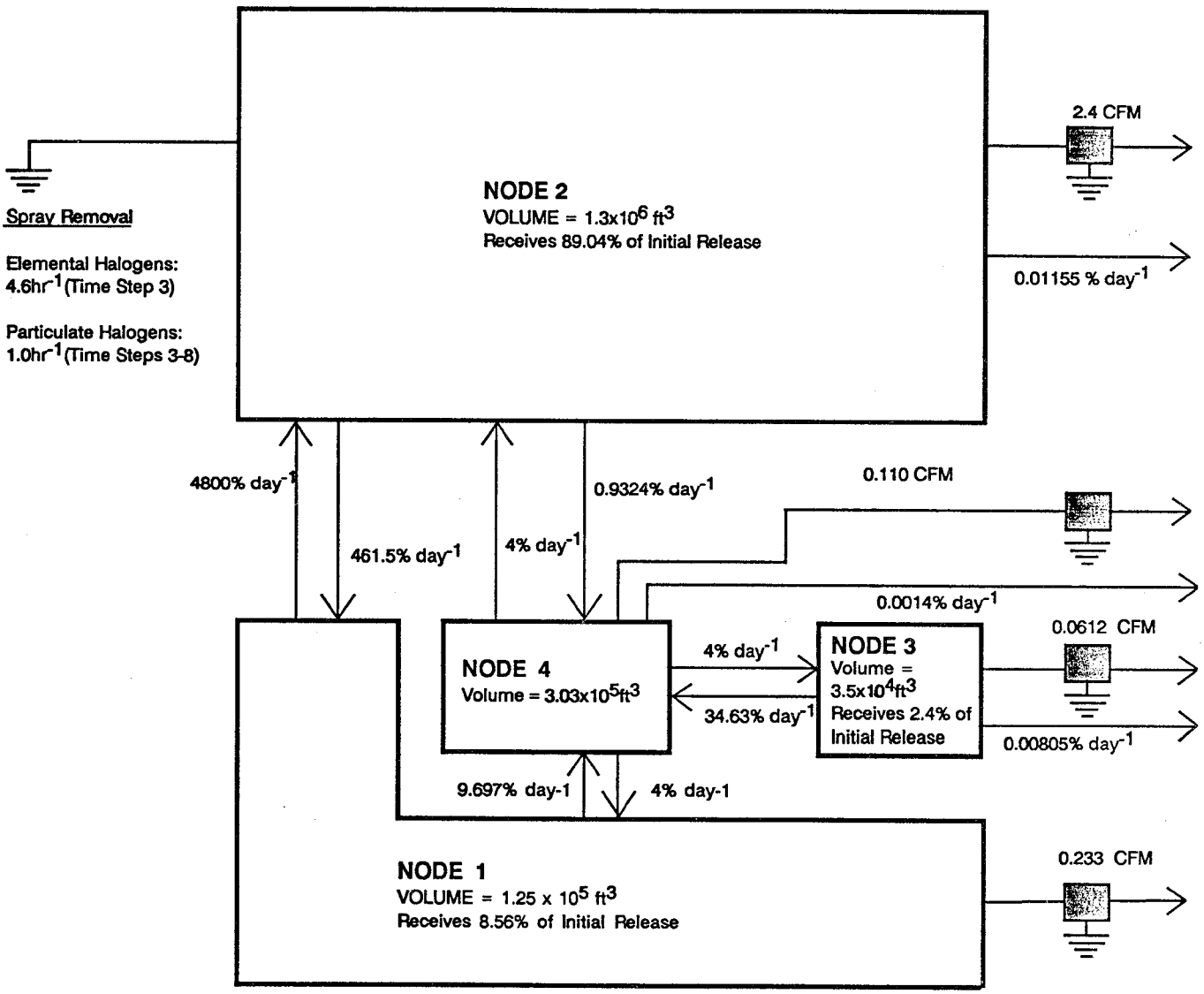
```
'FILTER EFF      ',1,3,0,4,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'TRANSFER CFM    ',0,0,0,1,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'TRANSFER CFM    ',0,0,0,2,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'TRANSFER CFM    ',0,0,0,3,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'TRANSFER CFM    ',0,0,0,4,5, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'TIME INTERVAL   ',0,0,0,0,2, 1.670E-01, 6.030E-01
'REMOVAL RATE    ',1,1,0,0,4, 0.000E+00, 4.600E+00, 0.000E+00, 0.000E+00
'REMOVAL RATE    ',1,2,0,0,4, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'REMOVAL RATE    ',1,3,0,0,4, 0.000E+00, 1.000E+00, 0.000E+00, 0.000E+00
'TIME INTERVAL   ',0,0,0,0,2, 6.030E-01, 2.000E+00
'REMOVAL RATE    ',1,1,0,0,4, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'REMOVAL RATE    ',1,2,0,0,4, 0.000E+00, 0.000E+00, 0.000E+00, 0.000E+00
'REMOVAL RATE    ',1,3,0,0,4, 0.000E+00, 1.000E+00, 0.000E+00, 0.000E+00
'TIME INTERVAL   ',0,0,0,0,2, 2.000E+00, 8.000E+00
'DOSE PARAMS     ',0,0,0,0,5, 0.000E+00, 3.470E-04, 3.000E-05, 3.470E-04, 2.100E-02
'TIME INTERVAL   ',0,0,0,0,2, 8.000E+00, 2.400E+01
'DOSE PARAMS     ',0,0,0,0,5, 0.000E+00, 1.750E-04, 2.000E-05, 1.750E-04, 2.100E-02
'TIME INTERVAL   ',0,0,0,0,2, 2.400E+01, 9.600E+01
'DOSE PARAMS     ',0,0,0,0,5, 0.000E+00, 2.320E-04, 8.400E-06, 2.320E-04, 2.100E-02
'TIME INTERVAL   ',0,0,0,0,2, 9.600E+01, 7.200E+02
'DOSE PARAMS     ',0,0,0,0,5, 0.000E+00, 2.320E-04, 2.400E-06, 2.320E-04, 2.100E-02
'END             ',0,0,0,0,0, 0.000E+00, 0.000E+00
```

Input File for Example 2

Figure 3.3 (continued)

Nodal Diagram for Example 2

Example 2



Filtered Transfer/Leakage (Time Step 1 only)

Unfiltered Transfer/Leakage (all Time Steps)

Figure 3.4

4. PROGRAMMER'S GUIDE FOR TACT5

This section contains information about the organization of the TACT5 program. It is directed to the programmer who needs to maintain or modify the code. Figure 4.1 depicts the relationships of the routines and the input/output files that are used. The variable name of each input/output unit is listed, along with the actual unit number listed in the program. Section 4.1 describes the functions of each routine. Section 4.2 defines the major variables in TACT5 and explains the logic of the program.

4.1 FUNCTIONAL DESCRIPTIONS OF THE TACT5 MODULES

MAIN - The MAIN program sets the system time and date and calls GETIN. GETIN then becomes responsible for the flow of information until the final results are printed, when control is passed back to MAIN, and the program is STOPped.

GETIN - The GETIN subroutine is responsible for reading and writing data files to the disk. GETIN also calls ACTDOS for each time step and SUMMRY after calculation of last time step. It is called from MAIN, and control is eventually passed back to end code execution.

ACTDOS - The ACTDOS subroutine calculates the activities in each node and the doses at the dose evaluation points at the end of every time step. It calls COEFF and MATRIX, which solve the system of equations. ACTDOS also calls ACTOUT and DOSOUT, which print activities and doses for each time step. Control is passed back to GETIN after each time step.

ACTOUT ACTOUT and DOSOUT print the resulting activities and doses **DOSOUT** (respectively) calculated for each time step by ACTDOS. Control is passed back to ACTDOS.

COEFF - In each time step, the subroutine COEFF is called by ACTDOS, to calculate the matrix C^m.

MATRIX - The purpose of subroutine MATRIX is to apply matrix analysis methods to solve systems of linear ordinary differential equations with constant coefficients and constant input functions. The first call of MATRIX occurs in subroutine GETIN to correct the instantaneous releases of radioactivity for any delay between shutdown time and the beginning of the current time step. The second call to MATRIX is from subroutine ACTDOS in order to calculate the activities in the nodes at the end of the current time step, given these activities at the beginning of the time step and releases to the nodes during the time step. Subroutine MATRIX determines the eigenvalues and eigenvectors of matrix C (for which we have used the mathematical notation C^m) by calling subroutines. If an error is detected in this sequence, an error message is printed and control is returned to the calling routine with an error code set. Otherwise, the program proceeds by determining whether there are any nonreal eigenvalues. If all eigenvalues are real, linear-equation solving, subroutines called by the Matrix are used to solve for vectors **Q** and **B**. The solutions are then used to compute $R_{sj}Z_j(t)$ in the real case or 2 $(R_{sj}Z_j(t))$ in the nonreal case. The terms are then summed over j to calculate activity levels at time t.

SIMQ,
RILMAT,
EIGQR,
DQRT - Subroutines which perform the mathematical solution to the series of differential equations.

SUMMRY - The subroutine SUMMRY reads the doses for each time step that were output to a temporary file by subroutine DOSE and prints a summary of both the input quantities and the doses for the exclusion radius, the low population zone, and the unprotected control room. For each time step, SUMMRY divides the doses according to whether they were received from iodines, noble gases, or solids.

4.2 PRINCIPAL VARIABLES

An alphabetical listing of important variables used in TACT5 is given below. Except where an indication to the contrary is given, variable names beginning in I - N are of type INTEGER*4, and all others are of type REAL*4.

AO(I,ISO) instantaneous release of nuclide ISO to node I at the beginning of the current time step. The units may be either Ci or the fraction of the amount of nuclide ISO that is available for release as airborne activity at shutdown time.

ACTY(I,ISO,ITYPE) current activity level (Ci) in node I for nuclide ISO of form ITYPE (ITYPE = 1, 2, or 3 corresponds to elemental, organic, or particulate form, respectively, if the nuclide is an iodine).

ACTYI(I,ISO,ITYPE) time-integrated activity (Ci h) in node I of nuclide ISO of form ITYPE. Integration is over the current time step.

ARELT(I,ISO,ITYPE) activity (Ci) of nuclide ISO and form ITYPE(ITYPE = 1, 2, or 3 for elemental, organic, or particulate form, respectively, if the nuclide is an iodine) released to the environment from node I during the current time step. When I = 1, the value is the release from the reactor core directly to the environment.

BR(JXQ) breathing rate ($m^3 s^{-1}$) for off-site individuals (JXQ = 1, 2 for the exclusion radius and the low population zone boundary, respectively) and control room operators (JXQ = 3).

DCF(K,ISO) dose conversion factor for nuclide ISO for organ number JORGN.

DECAY(ISO) radioactive decay-rate coefficient (h^{-1}) for nuclide ISO.

DOSET(JXQ,JORGN) thyroid dose (rem), for the current time step, for off-site individuals (JXQ = 1 and 2 for the exclusion radius and low population zone boundary, respectively) and control room operators (JXQ = 3), for organ number JORGN.

DOSE(JXQ,JORGN) whole-body dose (rem) for the current time step, for offsite individuals (JXQ = 1 and 2 for the exclusion radius and low population zone boundary, respectively) and control room operators (JXQ = 3), for organ JORGN (JORGN = 1,5).

FILTI
FILTN **(ITYPE,I,J)** filter efficiency for iodines of form
FILTS ITYPE (= 1, 2, or 3 for elemental,

organic, or particulate form, respectively), for noble gases, and for solids, moving from node I to node J; expressed as percent removed by filters.

FRACT(ITYPE) fraction of iodine available for release from the reactor core that is of form ITYPE (= 1, 2, or 3 for elemental, organic, or particulate form).

ICASE counter for the number of cases in a run. Each case consists of a complete analysis. Subroutine GETIN reads the data for all cases during a single call. The data for each case are written by GETIN on temporary data set NTAPE, labeled by the appropriate value of ICASE.

IDATA variable of subroutine INPUT. The value of IDATA is the sixth entry in each of the user's time-dependent data cards; its value indicates the number of data that are to be read from the card.

IDAY day of the month of the run.

IGROUP(ISO) indicator of which of five groups nuclide ISO belongs to.

IPRINT indicator of printing option set by the user's input.

ISOTOP - variable of subroutine GETIN. The value of INUM is the fourth entry in each of the user's time-dependent data cards.

ISTEP counter whose value is the number of the current time step.

IYEAR year of the run.

KEY - variable of subroutine GETIN. The value of KEY is the first entry in each of the user's time-dependent data cards. Its value identifies the function of the card's data. A card with "END" signals the end of the user's input cards.

LAMINI
LAMINN(ITYPE,I) **REAL*4** removal rate coefficients (h^{-1}) of
LAMINS

iodines, noble gases, and solids, respectively, from node I by the action of sprays.

LTAPE unit number of the data set containing the nuclide data base file (unformatted).

MTAPE unit number of a temporary data set that receives the calculated doses from subroutine ACTDOS at the completion of each time step. After completion of the last time step in a case, the data set is read by subroutine SUMMRY, which prints the information in accordance with the existing print option (see IPRINT).

NIN unit number of the user's input data set.

NISO total number of nuclides for the run.

NN the user-specified number of containment nodes in the model. The program increases this value by one to include the environment, which corresponds to node 1. Containment node I in the user's model then corresponds to index value I + 1 in the program.

NODES number of containment nodes specified by the user.

NOUT output device name.

NSTEP number of time steps for a case.

NTAPE unit number of a temporary data set that receives the user's data and specifications from subroutine and is read by subroutines.

PB(I,ISO,ITYPE) computed release rate of nuclide ISO and form ITYPE (= 1, 2, or 3 if the nuclide is an iodine of elemental, organic, or particulate form, respectively) from the reactor core to node I during the current time step. The units are $Ci(hr)^{-1}$. This quantity is computed in subroutine GETIN from the value of P(I<ISO) that is input by the user. The formulas are shown for two cases:

Case 1. P(I,ISO) specified as the fraction per hour of the available activity in the reactor core:

$$PB(I,ISO,ITYPE) = P(I,ISO)*S(ISO)*POWER*FAC2* \begin{matrix} RELFRI \\ RELFRN \\ RELFRS \end{matrix} * \begin{matrix} FRACT(ISO) \\ 1.0 \\ 1.0 \end{matrix}$$

where S(ISO) is the reactor source term ($CiMW_t^{-1}$) for nuclide ISO and POWER is the power output (Mw_t) of the reactor. The values of RELFRI, RELFRN, and RELFRS are the fractions of the release that are iodines, noble gases, and solids, respectively. If nuclide ISO is an iodine, FRACT(ITYPE) gives the fractional breakdown into elemental, organic, and particulate form. The factor FAC2 is essentially given by

```
FAC2 = (EXP(- DECAY(ISO)*(TSTEP1 - SDTIME))
   - EXP(- DECAY(ISO)*(TSTEP2 - SDTIME)))
     /((TSTEP2 - TSTEP1)*DECAY(ISO)),
```

where DECAY(ISO) = radioactive decay-rate coefficient of nuclide ISO(h^{-1}); TSTEP1 and TSTEP2 are the beginning and end times, respectively, of the current time step (h); and SDTIME is the time of shutdown (h), assumed $\leq$TSTEP1.

Case 2. P(I,ISO) specified as $Ci(hr)^{-1}$ of nuclide ISO:

$$PB(I,ISO,ITYPE) = P(I,ISO)*FAC2* \begin{cases} FRAC(ITYPE) & \text{for iodines} \\ 1.0 & \text{otherwise,} \end{cases}$$

where FAC2 and FRAC(ITYPE) have the same meanings as in Case 1.

PLTOUT plate-out factor for each isotopic group.

POWER power output of the reactor (Mw_t).

Q1(I,J) forced-flow transfer rate from node I to node J during the current time step ($ft^3\ min^{-1}$).

Q2(I,J) convective transfer rate from node I to node J during the current time step (% day^{-1}).

RELFRI
RELFRN
RELFRS fraction of released activity that is iodine, noble gas, and solid, respectively.

S(ISO) reactor source term for nuclide ISO ($CiMw_t^{-1}$).

SDTIME reactor shutdown time (hr).

TITLE(K)/CHARACTER *80 array of dimension 50 for storing the user's title or identifying phrase for the current case, to be printed on the output.

TSTEP1
TSTEP2 beginning and end, respectively, of the current time step (h).

URDOST(JXQ,JOR)
"unreduced" dose (rem) to thyroid or whole body,

respectively, for the current time step at location JXQ(= 1, 2, or 3 for the exclusion radius, the low population zone boundary, or the control room, respectively), summed over all nuclides in the release. The term "unreduced" refers to the fact that the calculation neglects radioactive decay of the nuclides from shutdown time to the current time step, and it neglects all removal processes, such as spraying and filtration.

VOL(I) volume (ft^3) of node I.

XISO(ISO)/CHARACTER *80 variable for the eight-character representation of the name of nuclide ISO.

XL leakage rate ($\%\ day^{-1}$) of activity from the primary containment, for calculation of the unreduced doses URDOST and URDOSE.

XQ(JXQ) dilution factor X/Q(sec/m^3) for location JXQ(= 1, 2, or 3 corresponding to the exclusion radius, the low population zone, and the control room, respectively.

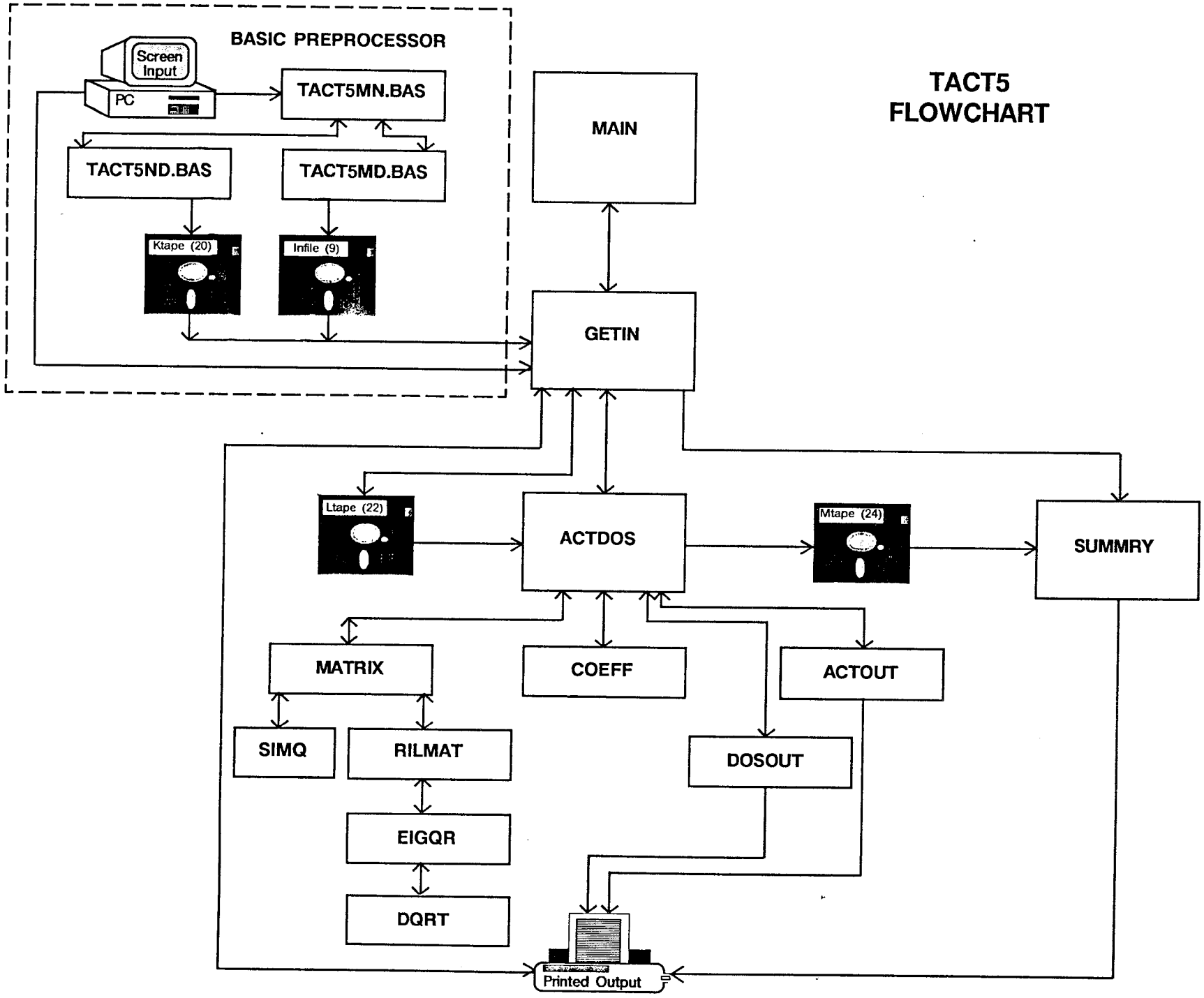

BASIC PREPROCESSOR
Screen Input
PC
TACT5MN.BAS
TACT5ND.BAS
TACT5MD.BAS
Ktape (20)
Infile (9)
TACT5
FLOWCHART
MAIN
GETIN
Ltape (22)
ACTDOS
Mtape (24)
SUMMRY
MATRIX
COEFF
ACTOUT
SIMQ
RILMAT
DOSOUT
EIGQR
DQRT
Printed Output

Figure 4.1

5. REFERENCES

Killough, G.G., et. al. 1983. A Guide for the TACT III Computer Code NUREG/CR-3287, ORNL/TM-8763; Division of Systems Integration, U.S. Nuclear Regulatory Commission.

U.S. Nuclear Regulatory Commission, "Division 1 Regulatory Guides, Power Reactors."

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ACKNOWLEDGEMENTS

We wish to acknowledge Larry Bell for his work in developing the original TACT5 code and for providing technical assistance in the production of this user's guide. We also wish to thank Charles Willis and Leta Brown for direction and guidance provided throughout the project.

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APPENDIX A

TACT5 DATA COLLECTIONS FORMS

TACT 5
TIME INDEPENDENT INPUT

Prepared by _____
Date _____
Page 1 of ____

Plant Name _____

Plant Type BWR ☐ PWR ☐

Power _____ MWtD

Drive Specification: A ☐ B ☐ C ☐ Nuclide File Name: _____

NODES

Node Number	Node Name	Node Volume (Ft^3)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
	Total Volume	_____ (for reference only; not an input to TACT 5)

Number of Dose Evaluation Points _____

Number of Time Steps _____ (complete after Time Dependent Input forms are completed, if necessary)

Lapsed Time Between Reactor Shutdown and Start of Accident (hours) _____

	Halogens	Nobles	Solids	Sodiums	Plutoniums
Release Fraction	_____	_____	_____	_____	_____
Plate-Out Fraction	_____	_____	_____	_____	_____
Composition					
- Elemental	_____	_____	_____	_____	_____
- Organic	_____	_____	_____	_____	_____
- Particulate	_____	_____	_____	_____	_____

Page____ of ____

Plant Name _____

TACT 5
TIME DEPENDENT INPUT

Time Step No. _____ Start Time (Hrs.) _____ End Time (Hrs.) _____

***Fill in only those blanks below for those values that have changed from the previous time step.*

INITIAL ACTIVITY DISTRIBUTION/CONTINUOUS ACTIVITY RELEASE RATE

(Fraction ☐ Fraction/Hr. ☐ Ci ☐ Ci/Hr.☐)

To Node	If Independent of Isotopic Groups	Halogens	Nobles	Solids	Sodiums	Plutoniums
		or				

SPRAY REMOVAL RATE COEFFICIENTS (HR. $^{-1}$)

Node	Halogens			Solids			Sodiums			Plutoniums		
	Elem.	Org.	Part.	Elem.	Org.	Part.	Elem.	Org.	Part.	Elem.	Org.	Part.

FILTERED TRANSFER RATES BETWEEN NODES (CFM)

**Include a Filter Efficiency Page

From Node	Environment	To Node			

UNFILTERED TRANSFER RATES BETWEEN NODES (%/DAY)

From Node	Environment	To Node			

TRAVEL TIME TO RECEPTOR POINTS (HRS.)

To Receptor Point:	1(Exclusion Radius)	2(Low Population Zone)	3(_____)
Travel Time:			

DOSE PARAMETERS

Containment Leak Rate (%/day) _____

	Receptor Pt. 1 (EAB)	Receptor Pt. 2 (LPZ)	Receptor Pt. 3 (_____)
Dilution Factor, χ/Q(sec/m^3)			
Breathing Rate (m^3/sec)			

Page_____ of _____

TACT 5
TIME DEPENDENT INPUT

Plant Name _____

Time Step No. _____

Isotopic Group(s) _____

** Complete this page if any values are different from previous time step.

FILTER EFFICIENCIES

From Node _____ To Node _____

Environment _____

Elem.						
Org.						
Part.						

APPENDIX B

SAMPLE NUCLIDE FILE

```
     2     2     3     0     1
WHOLEBDYTHYROID
HALOGENS NOBLES
  ELEM.   ORG.    PART.
  I  129
 1.294000E-15 0.0000000000
 3.020000E-03 5.542000E 06
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
     1     1     0     0     0     0     0
  I  131
 9.963996E-07 2.508000E+04
 8.719999E-02 1.485000E 06
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
     2     1     0     0     0     0     0
  I  132
 8.269001E-05 3.806000E+04
 5.137000E-01 5.353000E 04
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
     3     1     0     0     0     0     0
  I  133
 9.219000E-06 5.622000E+04
 1.551000E-01 3.970000E 05
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
     4     1     0     0     0     0     0
  I  134
 2.228000E-04 6.575000E+04
 5.327000E-01 2.537000E 04
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
     5     1     0     0     0     0     0
  I  135
 2.864000E-05 5.103000E+04
 4.217000E-01 1.235000E 05
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
     6     1     0     0     0     0     0
  I  136
 8.349001E-03 0.0000000000
 6.786000E-01 0.0
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
     7     1     0     0     0     0     0
  KR  83M
 1.035000E-04 4.152000E+03
 5.020000E-06 0.0
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
```

```
    8     2     0     0     0     0     0
 KR  85M
4.385000E-05 1.297000E+04
3.720000E-02 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
    9     2     0     0     0     0     0
 KR  85
2.042000E-09 4.102000E+02
5.250000E-04 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   10     2     0     0     0     0     0
 KR  87
1.519000E-04 2.335000E+04
1.870000E-01 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   11     2     0     0     0     0     0
 KR  88
6.875000E-05 3.200000E+04
4.640000E-01 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   12     2     0     0     0     0     0
 KR  89
3.630000E-03 3.979000E+04
5.250000E-01 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   13     2     0     0     0     0     0
 XE 131M
6.680000E-07 2.595000E+02
2.920000E-03 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   14     2     0     0     0     0     0
 XE 133M
3.490000E-06 1.384000E+03
8.000000E-03 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   15     2     0     0     0     0     0
 XE 133
1.522000E-06 5.622000E+04
9.330000E-03 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   16     2     0     0     0     0     0
 XE 135M
7.400000E-04 1.557000E+04
```

```
9.920000E-02 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   17     2     0     0     0     0     0
 XE 135
2.091999E-05 5.363000E+04
5.720000E-02 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   18     2     0     0     0     0     0
 XE 137
2.961000E-03 5.103000E+04
4.530000E-02 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   19     2     0     0     0     0     0
 XE 138
6.796001E-04 4.775000E+04
2.810000E-01 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   20     2     0     0     0     0     0
```

APPENDIX C

OUTPUT FOR EXAMPLE LOCA

- 2700 MW_t
- ONE NODE
- NO ENGINEERED SAFETY FEATURES

1

TACT V .
SEP 87 PC VERSION
NUCLEAR REGULATORY COMMISSION
ACCIDENT EVALUATION BRANCH
DATE 12/15/1987 TIME 12:27:31

MODEL SUMMARY FOR CASE 1

Sample Case - 1 Node Problem
1

TIME INDEPENDENT INPUT
CASE NUMBER 1

NODES	NSTEP
1	5

OUTPUT CONTROL PARAMETER

I	1	2	3	4	5
IPRINT(I)	1	1	1	1	1

NUMBER OF DOSE EVALUATION POINTS - 2

POWER (MWT)	REACTOR SHUTDOWN TIME (HRS)
2.700E+03	0.000E-01

FRACTION OF ACTIVITY RELEASED FROM CORE TO CONTAINMENT BY ISOTOPIC GROUP

HALOGENS	NOBLES
2.500E-01	1.000E+00

PLATEOUT FACTOR FOR ACTIVITY RELEASED FROM CORE TO CONTAINMENT BY ISOTOPIC GROUP

HALOGENS	NOBLES
0.000E-01	0.000E-01

FRACTION OF CORE INVENTORY AIRBORNE IN THE CONTAINMENT BY ISOTOPIC GROUP

HALOGENS	NOBLES
2.500E-01	1.000E+00

ISOTOPIC SPLIT BY GROUP

	ELEM.	ORG.	PART.
HALOGENS	9.550E-01	2.000E-02	2.500E-02
NOBLES	1.000E+00	0.000E-01	0.000E-01

VOLUME OF NODES (CU FT)

Contmt

1.800E+06

DATA FROM NUCLIDE FILE C:NUCDATA

ISOTOPE NAME	SPLIT	SOURCE (CI/MWT)	DOSE CONVERSION FACTORS WHOLEBDY	THYROID
I 129	ELEM.	0.00E-01	3.020E-03	5.542E+06
I 129	ORG.	0.00E-01	3.020E-03	5.542E+06
I 129	PART.	0.00E-01	3.020E-03	5.542E+06
I 131	ELEM.	2.40E+04	8.720E-02	1.485E+06
I 131	ORG.	5.02E+02	8.720E-02	1.485E+06
I 131	PART.	6.27E+02	8.720E-02	1.485E+06
I 132	ELEM.	3.63E+04	5.137E-01	5.353E+04
I 132	ORG.	7.61E+02	5.137E-01	5.353E+04
I 132	PART.	9.51E+02	5.137E-01	5.353E+04
I 133	ELEM.	5.37E+04	1.551E-01	3.970E+05
I 133	ORG.	1.12E+03	1.551E-01	3.970E+05
I 133	PART.	1.41E+03	1.551E-01	3.970E+05
I 134	ELEM.	6.28E+04	5.327E-01	2.537E+04
I 134	ORG.	1.31E+03	5.327E-01	2.537E+04
I 134	PART.	1.64E+03	5.327E-01	2.537E+04
I 135	ELEM.	4.87E+04	4.217E-01	1.235E+05
I 135	ORG.	1.02E+03	4.217E-01	1.235E+05
I 135	PART.	1.28E+03	4.217E-01	1.235E+05
I 136	ELEM.	0.00E-01	6.786E-01	0.000E-01
I 136	ORG.	0.00E-01	6.786E-01	0.000E-01
I 136	PART.	0.00E-01	6.786E-01	0.000E-01
KR 83M	ELEM.	4.15E+03	5.020E-06	0.000E-01
KR 85M	ELEM.	1.30E+04	3.720E-02	0.000E-01
KR 85	ELEM.	4.10E+02	5.250E-04	0.000E-01
KR 87	ELEM.	2.33E+04	1.870E-01	0.000E-01
KR 88	ELEM.	3.20E+04	4.640E-01	0.000E-01
KR 89	ELEM.	3.98E+04	5.250E-01	0.000E-01
XE 131M	ELEM.	2.59E+02	2.920E-03	0.000E-01
XE 133M	ELEM.	1.38E+03	8.000E-03	0.000E-01
XE 133	ELEM.	5.62E+04	9.330E-03	0.000E-01
XE 135M	ELEM.	1.56E+04	9.920E-02	0.000E-01
XE 135	ELEM.	5.36E+04	5.720E-02	0.000E-01
XE 137	ELEM.	5.10E+04	4.530E-02	0.000E-01
XE 138	ELEM.	4.77E+04	2.810E-01	0.000E-01

TIME DEPENDENT INPUT
CASE NUMBER 1

TIME INTERVAL		0	0	0	0	2	0.00000E-01	2.00000E+00
INITIAL FRACTION		0	0	0	0	1	1.00000E+00	
TRANSFER PERCENT		0	0	0	1	2	1.40000E-01	0.00000E-01
DOSE PARAMS		0	0	0	0	5	3.70000E-04	3.47000E-04
1.90000E-05	3.47000E-04		1.40000E-01					
TIME INTERVAL		0	0	0	0	2	2.00000E+00	8.00000E+00
DOSE PARAMS		0	0	0	0	5	0.00000E-01	3.47000E-04
1.90000E-05	3.47000E-04		1.40000E-01					
TIME INTERVAL		0	0	0	0	2	8.00000E+00	2.40000E+01
DOSE PARAMS		0	0	0	0	5	0.00000E-01	1.75000E-04
9.70000E-06	1.75000E-04		1.40000E-01					
TIME INTERVAL		0	0	0	0	2	2.40000E+01	9.60000E+01
TRANSFER PERCENT		0	0	0	1	2	7.00000E-02	0.00000E-01
DOSE PARAMS		0	0	0	0	5	0.00000E-01	2.32000E-04
5.30000E-06	2.32000E-04		7.00000E-02					
TIME INTERVAL		0	0	0	0	2	9.60000E+01	7.20000E+02
DOSE PARAMS		0	0	0	0	5	0.00000E-01	2.32000E-04
1.20000E-06	2.32000E-04		7.00000E-02					

ACTIVITIES (CI) AT END OF TIME STEP 1

CASE NUMBER 1

STEP START TIME AT 0.000E-01 (HRS) STEP END TIME AT 2.000E+00 (HRS)

ACTIVITY DISTRIBUTION IN THE NODES MODELED
BY CHEMICAL/PHYSICAL FORM AND GROUP

GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
HALOGENS	ELEM.	1.034E+08	9.877E+07	9.877E+07
	ORG.		2.068E+06	2.068E+06
	PART.		2.586E+06	2.586E+06
NOBLES	ELEM.	3.859E+08	3.859E+08	3.859E+08

ACTIVITY CONTRIBUTION TO THE ENVIRONMENT FROM EACH NODE MODELED
FOR THE PLANT BY CHEMICAL/PHYSICAL FORM AND GROUP

GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
HALOGENS	ELEM.	1.472E+04	1.406E+04	1.406E+04
	ORG.		2.944E+02	2.944E+02
	PART.		3.680E+02	3.680E+02
NOBLES	ELEM.	5.598E+04	5.598E+04	5.598E+04

ACTIVITY RELEASED TO ENVIRONMENT AND IN EACH NODE AT END OF... 2.000E+00 (HRS)

ISO	NAM	ENV.	Contmt
I	131	1.879E+03	1.605E+07
I	131	3.936E+01	3.361E+05
I	131	4.920E+01	4.202E+05
I	132	2.157E+03	1.353E+07
I	132	4.517E+01	2.833E+05
I	132	5.646E+01	3.541E+05
I	133	4.091E+03	3.391E+07
I	133	8.567E+01	7.101E+05
I	133	1.071E+02	8.877E+05
I	134	2.463E+03	8.521E+06
I	134	5.157E+01	1.784E+05
I	134	6.447E+01	2.231E+05
I	135	3.468E+03	2.676E+07
I	135	7.262E+01	5.605E+05
I	135	9.078E+01	7.006E+05
KR	83M	9.220E+02	5.320E+06
KR	85M	3.503E+03	2.554E+07
KR	85	1.292E+02	1.107E+06
KR	87	4.472E+03	2.112E+07
KR	88	7.950E+03	5.266E+07
KR	89	4.796E+02	4.790E-04
XE	131M	8.154E+01	6.972E+05
XE	133M	4.305E+02	3.644E+06
XE	133	1.761E+04	1.501E+08
XE	135M	9.160E+02	2.040E+05
XE	135	1.568E+04	1.245E+08
XE	137	7.540E+02	7.592E-02
XE	138	3.051E+03	9.666E+05

DOSES FOR TIME STEP 1
CASE NUMBER 1

STEP START TIME AT 0.000E-01 (HRS) STEP END TIME AT 2.000E+00 (HRS)

PERCENT OF DOSE CONTRIBUTION FROM EACH NODE
BY CHEMICAL/PHYSICAL FORM AND GROUP

ORGAN NAME	GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
WHOLEBDY	HALOGENS	ELEM.	4.134E+01	3.948E+01	3.948E+01
		ORG.		8.268E-01	8.268E-01
		PART.		1.033E+00	1.033E+00
	NOBLES	ELEM.	5.866E+01	5.866E+01	5.866E+01
THYROID	HALOGENS	ELEM.	1.000E+02	9.550E+01	9.550E+01
		ORG.		2.000E+00	2.000E+00
		PART.		2.500E+00	2.500E+00

EXCLUSION BOUNDARY

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	ACCUM.
WHOLEBDY	4.387E+00	4.387E+00	4.387E+00	4.387E+00
THYROID	6.750E+02	6.750E+02	6.750E+02	6.750E+02

LOW POPULATION ZONE

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	ACCUM.
WHOLEBDY	2.253E-01	2.253E-01	2.253E-01	2.253E-01
THYROID	3.466E+01	3.466E+01	3.466E+01	3.466E+01

OTHER X/Q

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	ACCUM.

ACTIVITIES (CI) AT END OF TIME STEP 2

CASE NUMBER 1

STEP START TIME AT 2.000E+00 (HRS) STEP END TIME AT 8.000E+00 (HRS)

ACTIVITY DISTRIBUTION IN THE NODES MODELED
BY CHEMICAL/PHYSICAL FORM AND GROUP

GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
HALOGENS	ELEM.	6.306E+07	6.023E+07	6.023E+07
	ORG.		1.261E+06	1.261E+06
	PART.		1.577E+06	1.577E+06
NOBLES	ELEM.	2.528E+08	2.528E+08	2.528E+08

ACTIVITY CONTRIBUTION TO THE ENVIRONMENT FROM EACH NODE MODELED
FOR THE PLANT BY CHEMICAL/PHYSICAL FORM AND GROUP

GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
HALOGENS	ELEM.	2.735E+04	2.612E+04	2.612E+04
	ORG.		5.470E+02	5.470E+02
	PART.		6.838E+02	6.838E+02
NOBLES	ELEM.	1.069E+05	1.069E+05	1.069E+05

ACTIVITY RELEASED TO ENVIRONMENT AND IN EACH NODE AT END OF... 8.000E+00 (HRS)

ISO	NAM	ENV.	Contmt
I	131	7.436E+03	1.570E+07
I	131	1.557E+02	3.288E+05
I	131	1.947E+02	4.111E+05
I	132	4.363E+03	2.266E+06
I	132	9.137E+01	4.746E+04
I	132	1.142E+02	5.933E+04
I	133	1.485E+04	2.778E+07
I	133	3.110E+02	5.817E+05
I	133	3.887E+02	7.271E+05
I	134	3.077E+03	6.923E+04
I	134	6.444E+01	1.450E+03
I	134	8.056E+01	1.812E+03
I	135	1.045E+04	1.441E+07
I	135	2.189E+02	3.018E+05
I	135	2.736E+02	3.773E+05
KR	83M	1.666E+03	5.687E+05
KR	85M	9.279E+03	9.900E+06
KR	85	5.167E+02	1.107E+06
KR	87	6.640E+03	7.935E+05
KR	88	1.755E+04	1.192E+07
KR	89	4.796E+02	0.000E-01
XE	131M	3.238E+02	6.870E+05
XE	133M	1.659E+03	3.378E+06
XE	133	6.929E+04	1.452E+08
XE	135M	9.205E+02	2.332E-02
XE	135	5.075E+04	7.923E+07
XE	137	7.540E+02	1.270E-29
XE	138	3.074E+03	4.073E-01

DOSES FOR TIME STEP 2
CASE NUMBER 1

STEP START TIME AT 2.000E+00 (HRS) STEP END TIME AT 8.000E+00 (HRS)

PERCENT OF DOSE CONTRIBUTION FROM EACH NODE
BY CHEMICAL/PHYSICAL FORM AND GROUP

ORGAN NAME	GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
WHOLEBDY	HALOGENS	ELEM.	4.754E+01	4.540E+01	4.540E+01
		ORG.		9.507E-01	9.507E-01
		PART.		1.188E+00	1.188E+00
	NOBLES	ELEM.	5.246E+01	5.246E+01	5.246E+01
THYROID	HALOGENS	ELEM.	1.000E+02	9.550E+01	9.550E+01
		ORG.		2.000E+00	2.000E+00
		PART.		2.500E+00	2.500E+00

EXCLUSION BOUNDARY

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	CALCULATED DOSE (REM) ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	UNREDUCED DOSE (REM) ACCUM.
WHOLEBDY	0.000E-01	4.387E+00	0.000E-01	4.387E+00
THYROID	0.000E-01	6.750E+02	0.000E-01	6.750E+02

LOW POPULATION ZONE

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	CALCULATED DOSE (REM) ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	UNREDUCED DOSE (REM) ACCUM.
WHOLEBDY	2.745E-01	4.998E-01	2.745E-01	4.998E-01
THYROID	9.333E+01	1.280E+02	9.333E+01	1.280E+02

OTHER X/Q

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	CALCULATED DOSE (REM) ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	UNREDUCED DOSE (REM) ACCUM.

ACTIVITIES (CI) AT END OF TIME STEP 3

CASE NUMBER 1

STEP START TIME AT 8.000E+00 (HRS) STEP END TIME AT 2.400E+01 (HRS)

ACTIVITY DISTRIBUTION IN THE NODES MODELED
BY CHEMICAL/PHYSICAL FORM AND GROUP

GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
HALOGENS	ELEM.	3.551E+07	3.392E+07	3.392E+07
	ORG.		7.103E+05	7.103E+05
	PART.		8.879E+05	8.879E+05
NOBLES	ELEM.	1.622E+08	1.622E+08	1.622E+08

ACTIVITY CONTRIBUTION TO THE ENVIRONMENT FROM EACH NODE MODELED
FOR THE PLANT BY CHEMICAL/PHYSICAL FORM AND GROUP

GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
HALOGENS	ELEM.	4.332E+04	4.137E+04	4.137E+04
	ORG.		8.664E+02	8.664E+02
	PART.		1.083E+03	1.083E+03
NOBLES	ELEM.	1.835E+05	1.835E+05	1.835E+05

ACTIVITY RELEASED TO ENVIRONMENT AND IN EACH NODE AT END OF... 2.400E+01 (HRS)

ISO	NAM	ENV.	Contmt
I	131	2.167E+04	1.481E+07
I	131	4.539E+02	3.102E+05
I	131	5.673E+02	3.878E+05
I	132	4.803E+03	1.934E+04
I	132	1.006E+02	4.050E+02
I	132	1.257E+02	5.062E+02
I	133	3.496E+04	1.632E+07
I	133	7.321E+02	3.417E+05
I	133	9.151E+02	4.272E+05
I	134	3.082E+03	1.847E-01
I	134	6.455E+01	3.868E-03
I	134	8.069E+01	4.835E-03
I	135	1.704E+04	2.766E+06
I	135	3.568E+02	5.793E+04
I	135	4.460E+02	7.241E+04
KR	83M	1.755E+03	1.463E+03
KR	85M	1.264E+04	7.912E+05
KR	85	1.549E+03	1.106E+06
KR	87	6.724E+03	1.257E+02
KR	88	2.031E+04	2.271E+05
KR	89	4.796E+02	0.000E-01
XE	131M	9.525E+02	6.604E+05
XE	133M	4.513E+03	2.760E+06
XE	133	1.990E+05	1.329E+08
XE	135M	9.205E+02	7.178E-21
XE	135	9.371E+04	2.372E+07
XE	137	7.540E+02	0.000E-01
XE	138	3.074E+03	4.065E-18

DOSES FOR TIME STEP 3
CASE NUMBER 1

STEP START TIME AT 8.000E+00 (HRS) STEP END TIME AT 2.400E+01 (HRS)

PERCENT OF DOSE CONTRIBUTION FROM EACH NODE
BY CHEMICAL/PHYSICAL FORM AND GROUP

ORGAN NAME	GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
WHOLEBDY	HALOGENS	ELEM.	6.014E+01	5.743E+01	5.743E+01
		ORG.		1.203E+00	1.203E+00
		PART.		1.503E+00	1.503E+00
	NOBLES	ELEM.	3.986E+01	3.986E+01	3.986E+01
THYROID	HALOGENS	ELEM.	1.000E+02	9.550E+01	9.550E+01
		ORG.		2.000E+00	2.000E+00
		PART.		2.500E+00	2.500E+00

EXCLUSION BOUNDARY

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	CALCULATED DOSE (REM) ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	UNREDUCED DOSE (REM) ACCUM.
WHOLEBDY	0.000E-01	4.387E+00	0.000E-01	4.387E+00
THYROID	0.000E-01	6.750E+02	0.000E-01	6.750E+02

LOW POPULATION ZONE

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	CALCULATED DOSE (REM) ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	UNREDUCED DOSE (REM) ACCUM.
WHOLEBDY	1.244E-01	6.242E-01	1.244E-01	6.242E-01
THYROID	5.325E+01	1.812E+02	5.325E+01	1.812E+02

OTHER X/Q

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	CALCULATED DOSE (REM) ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	UNREDUCED DOSE (REM) ACCUM.

ACTIVITIES (CI) AT END OF TIME STEP 4

CASE NUMBER 1

STEP START TIME AT 2.400E+01 (HRS) STEP END TIME AT 9.600E+01 (HRS)

ACTIVITY DISTRIBUTION IN THE NODES MODELED
BY CHEMICAL/PHYSICAL FORM AND GROUP

GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
HALOGENS	ELEM.	1.352E+07	1.291E+07	1.291E+07
	ORG.		2.704E+05	2.704E+05
	PART.		3.380E+05	3.380E+05
NOBLES	ELEM.	9.227E+07	9.227E+07	9.227E+07

ACTIVITY CONTRIBUTION TO THE ENVIRONMENT FROM EACH NODE MODELED
FOR THE PLANT BY CHEMICAL/PHYSICAL FORM AND GROUP

GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
HALOGENS	ELEM.	4.313E+04	4.119E+04	4.119E+04
	ORG.		8.626E+02	8.626E+02
	PART.		1.078E+03	1.078E+03
NOBLES	ELEM.	2.471E+05	2.471E+05	2.471E+05

ACTIVITY RELEASED TO ENVIRONMENT AND IN EACH NODE AT END OF... 9.600E+01 (HRS)

ISO	NAM	ENV.	Contmt
I	131	4.906E+04	1.142E+07
I	131	1.027E+03	2.391E+05
I	131	1.284E+03	2.989E+05
I	132	4.805E+03	9.487E-06
I	132	1.006E+02	1.987E-07
I	132	1.258E+02	2.484E-07
I	133	4.797E+04	1.493E+06
I	133	1.005E+03	3.126E+04
I	133	1.256E+03	3.908E+04
I	134	3.082E+03	1.532E-26
I	134	6.455E+01	3.208E-28
I	134	8.069E+01	4.009E-28
I	135	1.782E+04	1.648E+03
I	135	3.732E+02	3.451E+01
I	135	4.664E+02	4.314E+01
KR	83M	1.755E+03	3.263E-09
KR	85M	1.279E+04	9.146E+00
KR	85	3.868E+03	1.103E+06
KR	87	6.725E+03	9.980E-16
KR	88	2.033E+04	4.132E-03
KR	89	4.796E+02	0.000E-01
XE	131M	2.225E+03	5.543E+05
XE	133M	8.324E+03	1.115E+06
XE	133	4.294E+05	8.939E+07
XE	135M	9.205E+02	0.000E-01
XE	135	1.029E+05	1.046E+05
XE	137	7.540E+02	0.000E-01
XE	138	3.074E+03	0.000E-01

DOSES FOR TIME STEP 4
CASE NUMBER 1

STEP START TIME AT 2.400E+01 (HRS) STEP END TIME AT 9.600E+01 (HRS)

PERCENT OF DOSE CONTRIBUTION FROM EACH NODE
BY CHEMICAL/PHYSICAL FORM AND GROUP

ORGAN NAME	GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
WHOLEBDY	HALOGENS	ELEM.	6.454E+01	6.163E+01	6.163E+01
		ORG.		1.291E+00	1.291E+00
		PART.		1.613E+00	1.613E+00
	NOBLES	ELEM.	3.546E+01	3.546E+01	3.546E+01
THYROID	HALOGENS	ELEM.	1.000E+02	9.550E+01	9.550E+01
		ORG.		2.000E+00	2.000E+00
		PART.		2.500E+00	2.500E+00

EXCLUSION BOUNDARY

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	CALCULATED DOSE (REM) ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	UNREDUCED DOSE (REM) ACCUM.
WHOLEBDY	0.000E-01	4.387E+00	0.000E-01	4.387E+00
THYROID	0.000E-01	6.750E+02	0.000E-01	6.750E+02

LOW POPULATION ZONE

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	CALCULATED DOSE (REM) ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	UNREDUCED DOSE (REM) ACCUM.
WHOLEBDY	4.074E-02	6.649E-01	4.077E-02	6.649E-01
THYROID	5.914E+01	2.404E+02	5.918E+01	2.404E+02

OTHER X/Q

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	CALCULATED DOSE (REM) ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	UNREDUCED DOSE (REM) ACCUM.

ACTIVITIES (CI) AT END OF TIME STEP 5

CASE NUMBER 1

STEP START TIME AT 9.600E+01 (HRS) STEP END TIME AT 7.200E+02 (HRS)

ACTIVITY DISTRIBUTION IN THE NODES MODELED
BY CHEMICAL/PHYSICAL FORM AND GROUP

GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
HALOGENS	ELEM.	1.252E+06	1.196E+06	1.196E+06
	ORG.		2.504E+04	2.504E+04
	PART.		3.130E+04	3.130E+04
NOBLES	ELEM.	4.074E+06	4.074E+06	4.074E+06

ACTIVITY CONTRIBUTION TO THE ENVIRONMENT FROM EACH NODE MODELED
FOR THE PLANT BY CHEMICAL/PHYSICAL FORM AND GROUP

GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
HALOGENS	ELEM.	8.770E+04	8.375E+04	8.375E+04
	ORG.		1.754E+03	1.754E+03
	PART.		2.193E+03	2.193E+03
NOBLES	ELEM.	4.858E+05	4.858E+05	4.858E+05

ACTIVITY RELEASED TO ENVIRONMENT AND IN EACH NODE AT END OF... 7.200E+02 (HRS)

ISO	NAM	ENV.	Contmt
I	131	1.315E+05	1.196E+06
I	131	2.754E+03	2.504E+04
I	131	3.442E+03	3.130E+04
I	132	4.805E+03	0.000E-01
I	132	1.006E+02	0.000E-01
I	132	1.258E+02	0.000E-01
I	133	4.928E+04	1.486E-03
I	133	1.032E+03	3.112E-05
I	133	1.290E+03	3.890E-05
I	134	3.082E+03	0.000E-01
I	134	6.455E+01	0.000E-01
I	134	8.069E+01	0.000E-01
I	135	1.782E+04	1.853E-25
I	135	3.732E+02	3.881E-27
I	135	4.665E+02	4.851E-27
KR	83M	1.755E+03	0.000E-01
KR	85M	1.279E+04	0.000E-01
KR	85	2.371E+04	1.078E+06
KR	87	6.725E+03	0.000E-01
KR	88	2.033E+04	0.000E-01
KR	89	4.796E+02	0.000E-01
XE	131M	7.412E+03	1.214E+05
XE	133M	1.091E+04	4.309E+02
XE	133	8.875E+05	2.874E+06
XE	135M	9.205E+02	0.000E-01
XE	135	1.029E+05	3.998E-16
XE	137	7.540E+02	0.000E-01
XE	138	3.074E+03	0.000E-01

DOSES FOR TIME STEP 5
CASE NUMBER 1

STEP START TIME AT 9.600E+01 (HRS) STEP END TIME AT 7.200E+02 (HRS)

PERCENT OF DOSE CONTRIBUTION FROM EACH NODE
BY CHEMICAL/PHYSICAL FORM AND GROUP

ORGAN NAME	GROUP NAME	FORM NAME	TOTAL BY GROUP	TOTAL BY FORM	Contmt
WHOLEBDY	HALOGENS	ELEM.	6.417E+01	6.128E+01	6.128E+01
		ORG.		1.283E+00	1.283E+00
		PART.		1.604E+00	1.604E+00
	NOBLES	ELEM.	3.583E+01	3.583E+01	3.583E+01
THYROID	HALOGENS	ELEM.	1.000E+02	9.550E+01	9.550E+01
		ORG.		2.000E+00	2.000E+00
		PART.		2.500E+00	2.500E+00

EXCLUSION BOUNDARY

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	CALCULATED DOSE (REM) ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	UNREDUCED DOSE (REM) ACCUM.
WHOLEBDY	0.000E-01	4.387E+00	0.000E-01	4.387E+00
THYROID	0.000E-01	6.750E+02	0.000E-01	6.750E+02

LOW POPULATION ZONE

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	CALCULATED DOSE (REM) ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	UNREDUCED DOSE (REM) ACCUM.
WHOLEBDY	1.448E-02	6.794E-01	1.449E-02	6.794E-01
THYROID	3.584E+01	2.762E+02	3.587E+01	2.763E+02

OTHER X/Q

ORGAN NAME	CALCULATED DOSE (REM) FOR THIS TIME STEP	CALCULATED DOSE (REM) ACCUM.	UNREDUCED DOSE (REM) FOR THIS TIME STEP	UNREDUCED DOSE (REM) ACCUM.

SUMMARY OF OFF-SITE DOSES

Sample Case - 1 Node Problem

CALCULATION FOR WHOLEBDY DOSE (REMS)
SINGLE NODE CONTAINMENT WITH NO ESF

START TIME (HRS)	EXCLUSION RADIUS EACH STEP	EXCLUSION RADIUS ACCUM.	LOW POPULATION ZONE EACH STEP	LOW POPULATION ZONE ACCUM.	CONTROL ROOM EACH STEP	CONTROL ROOM ACCUM.
0.000E-01	4.387E+00	4.387E+00	2.253E-01	2.253E-01	0.000E-01	0.000E-01
2.000E+00	0.000E-01	4.387E+00	2.745E-01	4.998E-01	0.000E-01	0.000E-01
8.000E+00	0.000E-01	4.387E+00	1.244E-01	6.242E-01	0.000E-01	0.000E-01
2.400E+01	0.000E-01	4.387E+00	4.077E-02	6.649E-01	0.000E-01	0.000E-01
9.600E+01	0.000E-01	4.387E+00	1.449E-02	6.794E-01	0.000E-01	0.000E-01
	TOTAL	4.387E+00	TOTAL	6.794E-01	TOTAL	0.000E-01

CALCULATION FOR WHOLEBDY DOSE (REMS)
MULTI NODE CONTAINMENT WITH ESF

START TIME (HRS)	EXCLUSION RADIUS EACH STEP	EXCLUSION RADIUS ACCUM.	LOW POPULATION ZONE EACH STEP	LOW POPULATION ZONE ACCUM.	CONTROL ROOM EACH STEP	CONTROL ROOM ACCUM.
0.000E-01	4.387E+00	4.387E+00	2.253E-01	2.253E-01	0.000E-01	0.000E-01
2.000E+00	0.000E-01	4.387E+00	2.745E-01	4.998E-01	0.000E-01	0.000E-01
8.000E+00	0.000E-01	4.387E+00	1.244E-01	6.242E-01	0.000E-01	0.000E-01
2.400E+01	0.000E-01	4.387E+00	4.074E-02	6.649E-01	0.000E-01	0.000E-01
9.600E+01	0.000E-01	4.387E+00	1.448E-02	6.794E-01	0.000E-01	0.000E-01
	TOTAL	4.387E+00	TOTAL	6.794E-01	TOTAL	0.000E-01

SUMMARY OF OFF-SITE DOSES

Sample Case - 1 Node Problem

CALCULATION FOR THYROID DOSE (REMS)
SINGLE NODE CONTAINMENT WITH NO ESF

START TIME (HRS)	EXCLUSION RADIUS EACH STEP	EXCLUSION RADIUS ACCUM.	LOW POPULATION ZONE EACH STEP	LOW POPULATION ZONE ACCUM.	CONTROL ROOM EACH STEP	CONTROL ROOM ACCUM.
0.000E-01	6.750E+02	6.750E+02	3.466E+01	3.466E+01	0.000E-01	0.000E-01
2.000E+00	0.000E-01	6.750E+02	9.333E+01	1.280E+02	0.000E-01	0.000E-01
8.000E+00	0.000E-01	6.750E+02	5.325E+01	1.812E+02	0.000E-01	0.000E-01
2.400E+01	0.000E-01	6.750E+02	5.918E+01	2.404E+02	0.000E-01	0.000E-01
9.600E+01	0.000E-01	6.750E+02	3.587E+01	2.763E+02	0.000E-01	0.000E-01
	TOTAL	6.750E+02	TOTAL	2.763E+02	TOTAL	0.000E-01

CALCULATION FOR THYROID DOSE (REMS)
MULTI NODE CONTAINMENT WITH ESF

START TIME (HRS)	EXCLUSION RADIUS EACH STEP	EXCLUSION RADIUS ACCUM.	LOW POPULATION ZONE EACH STEP	LOW POPULATION ZONE ACCUM.	CONTROL ROOM EACH STEP	CONTROL ROOM ACCUM.
0.000E-01	6.750E+02	6.750E+02	3.466E+01	3.466E+01	0.000E-01	0.000E-01
2.000E+00	0.000E-01	6.750E+02	9.333E+01	1.280E+02	0.000E-01	0.000E-01
8.000E+00	0.000E-01	6.750E+02	5.325E+01	1.812E+02	0.000E-01	0.000E-01
2.400E+01	0.000E-01	6.750E+02	5.914E+01	2.404E+02	0.000E-01	0.000E-01
9.600E+01	0.000E-01	6.750E+02	3.584E+01	2.762E+02	0.000E-01	0.000E-01
	TOTAL	6.750E+02	TOTAL	2.762E+02	TOTAL	0.000E-01

1 NO MORE CASES

END OF EXECUTION

APPENDIX D

OUTPUT FOR EXAMPLE LOCA

- 4100 MW_t
- FOUR NODES
- FILTERS AND SPRAYS

This appendix contains the output listing from a sample TACT5 run. The input used to generate this run was outlined in Section 3 and Figure 3.3. As noted, the print option for the summary of each time step was selected for this listing.

The run consisted of a 4100 MW_t plant modeled with four nodes. Containment leakage to the environment was 0.021%/day throughout the accident. Values for dose parameters changed at 2, 8, 24, and 96 hours. Fans operated to filter leakage to the environment for the first minute. Sprays operated from 10 to 36.2 minutes into the accident. Isotope data were input from a standard nuclide data file incorporating iodines and noble gases.

The first page of the listing is a summary of all time-independent input. The second page summarizes all nuclide data from the nuclear input data file. Time-dependent input is shown beginning on the third page, followed by a summary of off-site doses tabulated over all time steps for each organ and for each dose receptor point. This off-site dose summary is as discussed in Appendix A for the first example.

1

TACT V
SEP 87 PC VERSION
NUCLEAR REGULATORY COMMISSION
ACCIDENT EVALUATION BRANCH
DATE 12/15/1987 TIME 12:18:56

MODEL SUMMARY FOR CASE 1

Sample Run - 4 Nodes
<
4100 MWt BWR; 4 nodes; 8 time steps
1

TIME INDEPENDENT INPUT
CASE NUMBER 1

NODES	NSTEP
4	8

OUTPUT CONTROL PARAMETER

I	1	2	3	4	5
IPRINT(I)	0	0	0	1	0

NUMBER OF DOSE EVALUATION POINTS - 2

POWER (MWT)	REACTOR SHUTDOWN TIME (HRS)
4.100E+03	0.000E-01

FRACTION OF ACTIVITY RELEASED FROM CORE TO CONTAINMENT BY ISOTOPIC GROUP

HALOGENS	NOBLES
2.500E-01	1.000E+00

PLATEOUT FACTOR FOR ACTIVITY RELEASED FROM CORE TO CONTAINMENT BY ISOTOPIC GROUP

HALOGENS	NOBLES
0.000E-01	0.000E-01

FRACTION OF CORE INVENTORY AIRBORNE IN THE CONTAINMENT BY ISOTOPIC GROUP

HALOGENS	NOBLES
2.500E-01	1.000E+00

ISOTOPIC SPLIT BY GROUP

	ELEM.	ORG.	PART.
HALOGENS	9.100E-01	4.000E-02	5.000E-02
NOBLES	1.000E+00	0.000E-01	0.000E-01

VOLUME OF NODES (CU FT)

Unsp-Mx	Sprayed	Unsprayd	Drywell
1.250E+05	1.300E+06	3.500E+04	3.030E+05

DATA FROM NUCLIDE FILE NUCDATA

ISOTOPE NAME	SPLIT	SOURCE (CI/MWT)	DOSE CONVERSION FACTORS WHOLEBDY	THYROID
I 129	ELEM.	0.00E-01	3.020E-03	5.542E+06
I 129	ORG.	0.00E-01	3.020E-03	5.542E+06
I 129	PART.	0.00E-01	3.020E-03	5.542E+06
I 131	ELEM.	2.28E+04	8.720E-02	1.485E+06
I 131	ORG.	1.00E+03	8.720E-02	1.485E+06
I 131	PART.	1.25E+03	8.720E-02	1.485E+06
I 132	ELEM.	3.46E+04	5.137E-01	5.353E+04
I 132	ORG.	1.52E+03	5.137E-01	5.353E+04
I 132	PART.	1.90E+03	5.137E-01	5.353E+04
I 133	ELEM.	5.12E+04	1.551E-01	3.970E+05
I 133	ORG.	2.25E+03	1.551E-01	3.970E+05
I 133	PART.	2.81E+03	1.551E-01	3.970E+05
I 134	ELEM.	5.98E+04	5.327E-01	2.537E+04
I 134	ORG.	2.63E+03	5.327E-01	2.537E+04
I 134	PART.	3.29E+03	5.327E-01	2.537E+04
I 135	ELEM.	4.64E+04	4.217E-01	1.235E+05
I 135	ORG.	2.04E+03	4.217E-01	1.235E+05
I 135	PART.	2.55E+03	4.217E-01	1.235E+05
I 136	ELEM.	0.00E-01	6.786E-01	0.000E-01
I 136	ORG.	0.00E-01	6.786E-01	0.000E-01
I 136	PART.	0.00E-01	6.786E-01	0.000E-01
KR 83M	ELEM.	4.15E+03	5.020E-06	0.000E-01
KR 85M	ELEM.	1.30E+04	3.720E-02	0.000E-01
KR 85	ELEM.	4.10E+02	5.250E-04	0.000E-01
KR 87	ELEM.	2.33E+04	1.870E-01	0.000E-01
KR 88	ELEM.	3.20E+04	4.640E-01	0.000E-01
KR 89	ELEM.	3.98E+04	5.250E-01	0.000E-01
XE 131M	ELEM.	2.59E+02	2.920E-03	0.000E-01
XE 133M	ELEM.	1.38E+03	8.000E-03	0.000E-01
XE 133	ELEM.	5.62E+04	9.330E-03	0.000E-01
XE 135M	ELEM.	1.56E+04	9.920E-02	0.000E-01
XE 135	ELEM.	5.36E+04	5.720E-02	0.000E-01
XE 137	ELEM.	5.10E+04	4.530E-02	0.000E-01
XE 138	ELEM.	4.77E+04	2.810E-01	0.000E-01

TIME DEPENDENT INPUT
CASE NUMBER 1

TIME INTERVAL	0	0	0	0	2	0.00000E-01	1.67000E-02
INITIAL FRACTION	0	0	0	0	4	8.56000E-02	8.90400E-01
2.40000E-02	0.00000E-01						
FILTER EFF	1	1	0	1	5	9.90000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
FILTER EFF	1	1	0	2	5	9.90000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
FILTER EFF	1	1	0	3	5	9.90000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
FILTER EFF	1	1	0	4	5	9.90000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
FILTER EFF	1	2	0	1	5	9.90000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
FILTER EFF	1	2	0	2	5	9.90000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
FILTER EFF	1	2	0	3	5	9.90000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
FILTER EFF	1	2	0	4	5	9.90000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
FILTER EFF	1	3	0	1	5	9.90000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
FILTER EFF	1	3	0	2	5	9.90000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
FILTER EFF	1	3	0	3	5	9.90000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
FILTER EFF	1	3	0	4	5	9.90000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
TRANSFER CFM	0	0	0	1	5	2.33000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
TRANSFER CFM	0	0	0	2	5	2.40000E+00	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
TRANSFER CFM	0	0	0	3	5	6.12000E-02	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
TRANSFER CFM	0	0	0	4	5	1.10000E-01	0.00000E-01
0.00000E-01	0.00000E-01	0.00000E-01					
TRANSFER PERCENT	0	0	0	1	5	0.00000E-01	0.00000E-01
4.80000E+03	0.00000E-01	9.69700E+00					
TRANSFER PERCENT	0	0	0	2	5	1.15500E-02	4.61500E+02
0.00000E-01	0.00000E-01	9.32400E-01					
TRANSFER PERCENT	0	0	0	3	5	8.05000E-03	0.00000E-01
0.00000E-01	0.00000E-01	3.46300E+01					
TRANSFER PERCENT	0	0	0	4	5	1.40000E-03	4.00000E+00
4.00000E+00	4.00000E+00	0.00000E-01					
DOSE PARAMS	0	0	0	0	5	6.90000E-04	3.47000E-04

```
 3.00000E-05   3.47000E-04   2.10000E-02
TIME INTERVAL          0    0    0    0    2   1.67000E-02   1.67000E-01
FILTER EFF             1    1    0    1    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
FILTER EFF             1    1    0    2    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
FILTER EFF             1    1    0    3    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
FILTER EFF             1    1    0    4    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
FILTER EFF             1    2    0    1    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
```

TIME DEPENDENT INPUT
CASE NUMBER 1

```
FILTER EFF             1    2    0    2    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
FILTER EFF             1    2    0    3    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
FILTER EFF             1    2    0    4    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
FILTER EFF             1    3    0    1    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
FILTER EFF             1    3    0    2    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
FILTER EFF             1    3    0    3    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
FILTER EFF             1    3    0    4    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
TRANSFER CFM           0    0    0    1    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
TRANSFER CFM           0    0    0    2    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
TRANSFER CFM           0    0    0    3    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
TRANSFER CFM           0    0    0    4    5   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01   0.00000E-01
TIME INTERVAL          0    0    0    0    2   1.67000E-01   6.03000E-01
REMOVAL RATE           1    1    0    0    4   0.00000E-01   4.60000E+00
 0.00000E-01   0.00000E-01
REMOVAL RATE           1    2    0    0    4   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01
REMOVAL RATE           1    3    0    0    4   0.00000E-01   1.00000E+00
 0.00000E-01   0.00000E-01
TIME INTERVAL          0    0    0    0    2   6.03000E-01   2.00000E+00
REMOVAL RATE           1    1    0    0    4   0.00000E-01   0.00000E-01
 0.00000E-01   0.00000E-01
REMOVAL RATE           1    2    0    0    4   0.00000E-01   0.00000E-01
```

```
 0.00000E-01   0.00000E-01
REMOVAL RATE          1    3    0    0    4   0.00000E-01   1.00000E+00
 0.00000E-01   0.00000E-01
TIME INTERVAL         0    0    0    0    2   2.00000E+00   8.00000E+00
DOSE PARAMS           0    0    0    0    5   0.00000E-01   3.47000E-04
 3.00000E-05   3.47000E-04   2.10000E-02
TIME INTERVAL         0    0    0    0    2   8.00000E+00   2.40000E+01
DOSE PARAMS           0    0    0    0    5   0.00000E-01   1.75000E-04
 2.00000E-05   1.75000E-04   2.10000E-02
TIME INTERVAL         0    0    0    0    2   2.40000E+01   9.60000E+01
DOSE PARAMS           0    0    0    0    5   0.00000E-01   2.32000E-04
 8.40000E-06   2.32000E-04   2.10000E-02
TIME INTERVAL         0    0    0    0    2   9.60000E+01   7.20000E+02
DOSE PARAMS           0    0    0    0    5   0.00000E-01   2.32000E-04
 2.40000E-06   2.32000E-04   2.10000E-02
```

SUMMARY OF OFF-SITE DOSES

Sample Run - 4 Nodes

CALCULATION FOR WHOLEBDY DOSE (REMS)
SINGLE NODE CONTAINMENT WITH NO ESF

START TIME (HRS)	EXCLUSION RADIUS EACH STEP	EXCLUSION RADIUS ACCUM.	LOW POPULATION ZONE EACH STEP	LOW POPULATION ZONE ACCUM.	CONTROL ROOM EACH STEP	CONTROL ROOM ACCUM.
0.000E-01	3.326E-02	3.326E-02	1.446E-03	1.446E-03	0.000E-01	0.000E-01
1.670E-02	2.380E-01	2.713E-01	1.035E-02	1.180E-02	0.000E-01	0.000E-01
1.670E-01	4.995E-01	7.708E-01	2.172E-02	3.351E-02	0.000E-01	0.000E-01
6.030E-01	1.093E+00	1.863E+00	4.751E-02	8.102E-02	0.000E-01	0.000E-01
2.000E+00	0.000E-01	1.863E+00	9.875E-02	1.798E-01	0.000E-01	0.000E-01
8.000E+00	0.000E-01	1.863E+00	5.847E-02	2.382E-01	0.000E-01	0.000E-01
2.400E+01	0.000E-01	1.863E+00	2.947E-02	2.677E-01	0.000E-01	0.000E-01
9.600E+01	0.000E-01	1.863E+00	1.327E-02	2.810E-01	0.000E-01	0.000E-01
	TOTAL	1.863E+00	TOTAL	2.810E-01	TOTAL	0.000E-01

CALCULATION FOR WHOLEBDY DOSE (REMS)
MULTI NODE CONTAINMENT WITH ESF

START TIME (HRS)	EXCLUSION RADIUS EACH STEP	EXCLUSION RADIUS ACCUM.	LOW POPULATION ZONE EACH STEP	LOW POPULATION ZONE ACCUM.	CONTROL ROOM EACH STEP	CONTROL ROOM ACCUM.
0.000E-01	4.364E-01	4.364E-01	1.897E-02	1.897E-02	0.000E-01	0.000E-01
1.670E-02	1.188E-01	5.551E-01	5.163E-03	2.414E-02	0.000E-01	0.000E-01
1.670E-01	1.989E-01	7.541E-01	8.648E-03	3.278E-02	0.000E-01	0.000E-01
6.030E-01	3.615E-01	1.116E+00	1.572E-02	4.850E-02	0.000E-01	0.000E-01
2.000E+00	0.000E-01	1.116E+00	3.119E-02	7.969E-02	0.000E-01	0.000E-01
8.000E+00	0.000E-01	1.116E+00	1.548E-02	9.517E-02	0.000E-01	0.000E-01
2.400E+01	0.000E-01	1.116E+00	7.115E-03	1.023E-01	0.000E-01	0.000E-01
9.600E+01	0.000E-01	1.116E+00	3.033E-03	1.053E-01	0.000E-01	0.000E-01
	TOTAL	1.116E+00	TOTAL	1.053E-01	TOTAL	0.000E-01

SUMMARY OF OFF-SITE DOSES

Sample Run - 4 Nodes

CALCULATION FOR THYROID DOSE (REMS)
SINGLE NODE CONTAINMENT WITH NO ESF

START TIME (HRS)	EXCLUSION RADIUS EACH STEP	EXCLUSION RADIUS ACCUM.	LOW POPULATION ZONE EACH STEP	LOW POPULATION ZONE ACCUM.	CONTROL ROOM EACH STEP	CONTROL ROOM ACCUM.
0.000E-01	2.494E+00	2.494E+00	1.084E-01	1.084E-01	0.000E-01	0.000E-01
1.670E-02	2.235E+01	2.485E+01	9.719E-01	1.080E+00	0.000E-01	0.000E-01
1.670E-01	6.398E+01	8.883E+01	2.782E+00	3.862E+00	0.000E-01	0.000E-01
6.030E-01	1.979E+02	2.867E+02	8.605E+00	1.247E+01	0.000E-01	0.000E-01
2.000E+00	0.000E-01	2.867E+02	3.357E+01	4.604E+01	0.000E-01	0.000E-01
8.000E+00	0.000E-01	2.867E+02	2.503E+01	7.107E+01	0.000E-01	0.000E-01
2.400E+01	0.000E-01	2.867E+02	4.278E+01	1.139E+02	0.000E-01	0.000E-01
9.600E+01	0.000E-01	2.867E+02	3.288E+01	1.467E+02	0.000E-01	0.000E-01
	TOTAL	2.867E+02	TOTAL	1.467E+02	TOTAL	0.000E-01

CALCULATION FOR THYROID DOSE (REMS)
MULTI NODE CONTAINMENT WITH ESF

START TIME (HRS)	EXCLUSION RADIUS EACH STEP	EXCLUSION RADIUS ACCUM.	LOW POPULATION ZONE EACH STEP	LOW POPULATION ZONE ACCUM.	CONTROL ROOM EACH STEP	CONTROL ROOM ACCUM.
0.000E-01	3.249E+01	3.249E+01	1.413E+00	1.413E+00	0.000E-01	0.000E-01
1.670E-02	1.115E+01	4.364E+01	4.849E-01	1.897E+00	0.000E-01	0.000E-01
1.670E-01	1.570E+01	5.934E+01	6.828E-01	2.580E+00	0.000E-01	0.000E-01
6.030E-01	2.342E+01	8.277E+01	1.018E+00	3.599E+00	0.000E-01	0.000E-01
2.000E+00	0.000E-01	8.277E+01	3.876E+00	7.474E+00	0.000E-01	0.000E-01
8.000E+00	0.000E-01	8.277E+01	2.828E+00	1.030E+01	0.000E-01	0.000E-01
2.400E+01	0.000E-01	8.277E+01	4.657E+00	1.496E+01	0.000E-01	0.000E-01
9.600E+01	0.000E-01	8.277E+01	3.379E+00	1.834E+01	0.000E-01	0.000E-01
	TOTAL	8.277E+01	TOTAL	1.834E+01	TOTAL	0.000E-01

1 NO MORE CASES

END OF EXECUTION

APPENDIX E

MASTER NUCLIDE FILE DATABASE LISTINGS

MLWRICRP.02

```
    5     6     3     0     0     1     1     1     1
WHOLEBDY  SKIN  THYROID   LUNG    BONE   LIVER
HALOGENS NOBLES  SOLIDS SODIUMS PLUTONMS
  ELEM.   ORG.    PART.
 NA  22
8.448000E-09 2.384000E-06
0.0          0.0          1.300000E 04 1.300000E 04 1.300000E 04 1.300000E 04
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
    1     4     0     0     0     0     0
 NA  24
1.273000E-05 1.429000E+00
0.0          0.0          1.278000E 03 1.278000E 03 1.278000E 03 1.280000E 03
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
    2     4     0     0     0     0     0
 GE  77
1.703000E-05 3.761000E+01
0.0          0.0          0.0          0.0          0.0          0.0000000000
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
    3     3     0     0     0     0     0
 SE  79
3.381000E-13 6.921000E-03
0.0          0.0          0.0          4.470000E 04 0.0          3.830000E 02
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
    4     3     0     0     0     0     0
 BR  82
5.456000E-06 6.905000E+01
0.0          0.0          0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
    5     1     0     0     0     0     0
 KR  83M
1.035000E-04 4.152000E+03
5.020000E-06 1.148000E-02 0.0          5.201000E-01 0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
    6     2     0     0     0     0     0
 BR  83
8.021000E-05 2.930000E+03
0.0          0.0          0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
    7     1     0     0     0     0     0
 BR  84
3.646000E-04 4.339000E+03
0.0          0.0          0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
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    8     1     0     0     0     0     0
 KR  85M
4.385000E-05 1.297000E+04
3.720000E-02 1.189000E-01 0.0          2.919000E 00 0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
    9     2     0     0     0     0     0
 KR  85
2.042000E-09 4.102000E+02
5.250000E-04 6.880999E-02 0.0          2.416000E 00 0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   10     2     0     0     0     0     0
 BR  85
3.850000E-03 4.923000E+03
0.0          0.0          0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   11     1     0     0     0     0     0
 RB  86
4.289000E-07 1.324000E+02
0.0          0.0          0.0          0.0          0.0          1.690000E 04
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   12     3     0     0     0     0     0
 KR  87
1.519000E-04 2.335000E+04
1.870000E-01 5.961000E-01 0.0          1.537000E 01 0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   13     2     0     0     0     0     0
 KR  88
6.875000E-05 3.200000E+04
4.640000E-01 6.627000E-01 0.0          3.136000E 01 0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   14     2     0     0     0     0     0
 RB  88
6.468000E-04 1.200000E+04
0.0          0.0          0.0          0.0          0.0          4.840000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   15     3     0     0     0     0     0
 KR  89
3.630000E-03 3.979000E+04
5.250000E-01 9.222200E-01 0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   16     2     0     0     0     0     0
 RB  89
3.629000E-03 1.538000E+04
```

```
0.0           0.0           0.0           0.0           0.0           3.200000E 01
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   17     3     0     0     0     0     0
 SR  89
1.588000E-07 1.552000E+04
0.0           0.0           0.0           1.749000E 05 3.801000E 04 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   18     3     0     0     0     0     0
 RB  90
3.982000E-03 1.335000E+04
0.0           0.0           0.0           0.0           0.0           0.0000000000
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   19     3     0     0     0     0     0
 SR  90
8.020999E-10 7.401000E+02
0.0           0.0           0.0           1.196000E 06 1.244000E 07 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   20     3     0     0     0     0     0
 Y   90
2.993000E-06 7.887000E+02
0.0           0.0           0.0           2.120000E+04 2.612000E 02 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   21     3     0     0     0     0     0
 SR  91
2.005001E-05 2.118000E+04
0.0           0.0           0.0           4.557000E 03 7.741000E 00 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   22     3     0     0     0     0     0
 Y   91M
2.292000E-04 1.230000E+04
0.0           0.0           0.0           2.402000E 02 3.264000E-02 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   23     3     0     0     0     0     0
 Y   91
1.383000E-07 2.121000E+04
0.0           0.0           0.0           2.130000E 05 5.781000E 04 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   24     3     0     0     0     0     0
 SR  92
7.292000E-05 2.508000E+04
0.0           0.0           0.0           2.061000E 03 8.431000E-01 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
```

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   25     3     0     0     0     0     0
 Y   92
5.346999E-05 2.535000E+04
0.0           0.0           0.0           1.961000E 03 1.292000E 00 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   26     3     0     0     0     0     0
 SR  93
1.444000E-03 3.017000E+04
0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   27     3     0     0     0     0     0
 Y   93
1.909000E-05 3.163000E+04
0.0           0.0           0.0           6.062000E 03 1.182000E 01 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   28     3     0     0     0     0     0
 ZR  93
2.006000E-14 2.459000E-02
0.0           0.0           0.0           2.129000E 04 5.223000E 04 2.920000E 03
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   29     3     0     0     0     0     0
 ZR  95
1.267000E-07 3.858000E+04
0.0           0.0           0.0           2.214000E 05 1.339000E 04 4.300000E 03
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   30     3     0     0     0     0     0
 NB  95
2.292000E-07 3.842000E+04
0.0           0.0           0.0           6.311000E 04 1.758000E 03 9.770000E 02
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   31     3     0     0     0     0     0
 ZR  97
1.129000E-05 4.197000E+04
0.0           0.0           0.0           9.839000E 03 1.214000E 01 2.450000E 00
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   32     3     0     0     0     0     0
 NB  97M
1.155000E-02 3.987000E+04
0.0           0.0           0.0           0.0           0.0           0.0000000000
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   33     3     0     0     0     0     0
 NB  97
1.573000E-04 4.235000E+04
```

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0.0           0.0           0.0           2.995000E 02 2.777000E-02 7.030000E-03
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   34     3     0     0     0     0     0
 MO  99
2.874000E-06 4.886000E+04
0.0           0.0           0.0           1.140000E 04 0.0           1.510000E 03
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   35     3     0     0     0     0     0
 TC  99M
3.183000E-05 4.278000E+04
0.0           0.0           0.0           9.546001E 01 1.287000E-04 3.640000E-04
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   36     3     0     0     0     0     0
 TC  99
1.042000E-13 2.534000E-01
0.0           0.0           0.0           1.011000E 05 3.132001E 01 4.640000E 01
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   37     3     0     0     0     0     0
 TC 101
8.250000E-04 5.188000E+04
0.0           0.0           0.0           4.985001E 01 5.215000E-06 7.520000E-06
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   38     3     0     0     0     0     0
 RU 103
2.025000E-07 5.381000E+04
0.0           0.0           0.0           6.312000E 04 1.906000E 02 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   39     3     0     0     0     0     0
 RU 105
4.221000E-05 4.051000E+04
0.0           0.0           0.0           1.375000E 03 9.877002E-02 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   40     3     0     0     0     0     0
 RU 106
2.197000E-08 2.270000E+04
0.0           0.0           0.0           1.174000E 06 8.643000E 03 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   41     3     0     0     0     0     0
 RH 106
2.310000E-02 2.272000E+04
0.0           0.0           0.0           0.0           0.0           0.0000000000
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
```

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   42     3     0     0     0     0     0
 PD 107
3.139000E-15 3.975000E-03
0.0          0.0          0.0          9.472000E 03 0.0          8.270000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   43     3     0     0     0     0     0
 RH 109
1.925000E-04 1.223000E+04
0.0          0.0          0.0          0.0          0.0          0.0000000000
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   44     3     0     0     0     0     0
 PD 109
1.407000E-05 1.277000E+04
0.0          0.0          0.0          1.852000E 03 0.0          4.630000E-01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   45     3     0     0     0     0     0
 AG 111
1.069000E-06 3.159000E+03
0.0          0.0          0.0          2.333000E 04 4.253000E 01 1.780000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   46     3     0     0     0     0     0
 IN 115M
4.220000E-05 9.015000E+02
0.0          0.0          1.114000E 01 0.0          5.888000E 01 0.0000000000
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   47     3     0     0     0     0     0
 SN 123
2.750000E-04 1.832000E+02
0.0          0.0          5.665000E 02 2.878000E 05 3.015000E 04 6.670000E 02
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   48     3     0     0     0     0     0
 SN 125
8.443000E-07 5.698000E+02
0.0          0.0          2.588000E 01 7.367000E 04 1.162000E 03 3.120000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   49     3     0     0     0     0     0
 SB 125
9.158001E-09 6.103000E+02
0.0          0.0          6.747000E 00 2.175000E 05 6.665000E 03 7.440000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   50     3     0     0     0     0     0
 TE 125M
1.383000E-07 1.253000E+02
```

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0.0           0.0           1.313000E 02 3.919000E 04 4.268000E 02 1.980000E 02
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   51     3     0     0     0     0     0
 SB 126
6.416000E-07 9.707000E+01
0.0           0.0           2.746000E 00 9.569000E 04 4.497000E 02 9.130000E 00
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   52     3     0     0     0     0     0
 SB 127
2.069000E-06 4.527000E+03
0.0           0.0           3.968000E-01 2.048000E 04 3.299001E 01 7.220000E-01
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   53     3     0     0     0     0     0
 TE 127M
7.637999E-08 6.114000E+02
0.0           0.0           4.110000E 02 1.200000E 05 1.575000E 03 7.210000E 02
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   54     3     0     0     0     0     0
 TE 127
2.055999E-05 4.501000E+03
0.0           0.0           1.325000E-01 8.137000E 02 1.754000E-01 8.030000E-02
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   55     3     0     0     0     0     0
 I  129
1.294000E-15 0.0000000000
3.020000E-03 2.435000E-02 5.542000E 06 0.0          2.476000E 03 2.110000E 03
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   56     1     0     0     0     0     0
 TE 129M
2.359000E-07 1.668000E+03
0.0           0.0           4.297000E 02 1.448000E 05 1.219000E 03 5.840000E 02
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   57     3     0     0     0     0     0
 TE 129
1.573000E-04 1.111000E+04
0.0           0.0           4.872002E-03 2.418000E 02 6.219000E-03 2.990000E-03
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   58     3     0     0     0     0     0
 I  131
9.963996E-07 2.508000E+04
8.719999E-02 1.655000E-01 1.485000E 06 0.0          3.149000E 03 4.470000E 03
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
```

```
   59     1     0     0     0     0     0
 XE 131M
6.680000E-07 2.595000E+02
2.920000E-03 3.995000E-02 0.0          1.400000E+00 0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   60     2     0     0     0     0     0
 TE 131
4.620000E-04 2.741000E+04
0.0          0.0          1.170000E-03 1.740000E+02 1.390000E-03 7.440000E-04
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   61     3     0     0     0     0     0
 TE 131M
6.416000E-06 4.800000E+03
0.0          0.0          6.879000E 00 1.823000E 04 8.743000E 00 5.450000E 00
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   62     3     0     0     0     0     0
 I  132
8.269001E-05 3.806000E+04
5.137000E-01 7.927000E-01 5.353000E 04 0.0          1.447000E 02 4.070000E 02
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   63     1     0     0     0     0     0
 TE 132
2.506000E-06 4.115000E+04
0.0          0.0          2.366000E 01 3.598000E 04 3.253000E 01 2.690000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   64     3     0     0     0     0     0
 I  133
9.219000E-06 5.622000E+04
1.551000E-01 3.120000E-01 3.970000E 05 0.0          1.077000E 03 1.850000E 03
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   65     1     0     0     0     0     0
 XE 133M
3.490000E-06 1.384000E+03
8.000000E-03 5.391000E-02 0.0          1.890000E+00 0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   66     2     0     0     0     0     0
 XE 133
1.522000E-06 5.622000E+04
9.330000E-03 5.454000E-02 0.0          1.573000E 00 0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   67     2     0     0     0     0     0
 TE 133M
2.310000E-04 1.789000E+04
```

```
0.0           0.0           6.269000E-03 5.506001E 02 7.243998E-03 5.400000E-03
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   68     3     0     0     0     0     0
 I  134
2.228000E-04 6.575000E+04
5.327000E-01 8.593000E-01 2.537000E 04 0.0          8.047000E 01 2.160000E 02
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   69     1     0     0     0     0     0
 TE 134
2.750000E-04 3.999000E+04
0.0           0.0           3.437000E-03 4.377000E 02 3.843000E-03 3.220000E-03
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   70     3     0     0     0     0     0
 CS 134
9.551002E-09 1.019000E+03
0.0           0.0           0.0          1.216000E 04 4.662000E 04 1.060000E 05
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   71     3     0     0     0     0     0
 I  135
2.864000E-05 5.103000E+04
4.217000E-01 5.803000E-01 1.235000E 05 0.0          3.353999E 02 8.730000E 02
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   72     1     0     0     0     0     0
 XE 135M
7.400000E-04 1.557000E+04
9.920000E-02 1.484000E-01 0.0          2.231000E 00 0.0          0.0
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   73     2     0     0     0     0     0
 XE 135
2.091999E-05 5.363000E+04
5.720000E-02 1.620000E-01 0.0          4.061000E 00 0.0          0.0
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   74     2     0     0     0     0     0
 CS 135
7.293001E-15 2.909000E-02
0.0           0.0           0.0          1.566000E 03 1.459000E 04 1.290000E 04
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   75     3     0     0     0     0     0
 I  136
8.349001E-03 0.0000000000
6.786000E-01 1.300000E+00 0.0          0.0          0.0          0.0000000000
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
```

```
   76     1     0     0     0     0     0
 CS 136
6.160000E-07 1.667000E+03
0.0          0.0          0.0          1.500000E 03 4.879000E 03 1.830000E 04
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   77     3     0     0     0     0     0
 XE 137
2.961000E-03 5.103000E+04
4.530000E-02 5.676000E-01 0.0          1.748000E 01 0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   78     2     0     0     0     0     0
 CS 137
7.292000E-10 1.907000E+03
0.0          0.0          0.0          9.400000E 03 5.977000E 04 7.760000E 04
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   79     3     0     0     0     0     0
 BA 137M
4.528999E-03 1.811000E+03
0.0          0.0          0.0          0.0          0.0          0.0000000000
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   80     3     0     0     0     0     0
 XE 138
6.796001E-04 4.775000E+04
2.810000E-01 4.249000E-01 0.0          2.445000E 01 0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   81     2     0     0     0     0     0
 CS 138
3.587001E-04 4.878000E+04
0.0          0.0          0.0          6.066000E 00 4.137000E 01 7.760000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   82     3     0     0     0     0     0
 CS 139
1.216000E-03 4.478000E+04
0.0          0.0          0.0          2.837000E 00 2.557001E 01 3.630000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   83     3     0     0     0     0     0
 BA 139
1.393000E-04 4.604000E+04
0.0          0.0          0.0          4.697000E 02 1.167000E-01 8.320000E-05
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   84     3     0     0     0     0     0
 BA 140
6.266000E-07 4.274000E+04
```

```
0.0           0.0           0.0           1.587000E 05 4.884000E 03 6.130000E 00
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   85     3     0     0     0     0     0
 LA 140
4.774000E-06 4.342000E+04
0.0           0.0           0.0           1.701000E 04 4.300999E 01 2.170000E 01
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   86     3     0     0     0     0     0
 BA 141
6.416000E-04 4.345000E+04
0.0           0.0           0.0           2.419000E 02 1.247000E-02 9.410000E-06
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   87     3     0     0     0     0     0
 LA 141
4.935999E-05 4.371000E+04
0.0           0.0           0.0           1.345000E 03 5.342000E-01 1.660000E-01
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   88     3     0     0     0     0     0
 CE 141
2.506000E-07 4.387000E+04
0.0           0.0           0.0           4.517000E 04 2.494000E 03 1.690000E 03
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   89     3     0     0     0     0     0
 BA 142
1.050000E-03 3.762000E+04
0.0           0.0           0.0           1.487000E 02 3.294000E-03 3.380000E-06
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   90     3     0     0     0     0     0
 LA 142
1.255000E-04 3.883000E+04
0.0           0.0           0.0           7.907000E 02 8.535999E-02 3.880000E-02
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   91     3     0     0     0     0     0
 CE 143
6.030000E-06 3.552000E+04
0.0           0.0           0.0           9.972000E 03 2.334000E 01 1.720000E 01
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   92     3     0     0     0     0     0
 PR 143
5.854000E-07 3.467000E+04
0.0           0.0           0.0           3.506000E 04 1.168000E 03 4.690000E 02
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
```

```
   93     3     0     0     0     0     0
 CE 144
2.766000E-08 2.294000E+04
0.0           0.0           0.0           9.716000E 05 4.286000E 05 1.790000E 05
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   94     3     0     0     0     0     0
 PR 144
6.676000E-04 2.302000E+04
0.0           0.0           0.0           1.272000E 02 3.763000E-03 1.560000E-03
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   95     3     0     0     0     0     0
 ND 147
7.098000E-07 1.733000E+04
0.0           0.0           0.0           2.759000E 04 6.592000E 02 7.620000E 02
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   96     3     0     0     0     0     0
 PM 147
8.718001E-09 4.881000E+03
0.0           0.0           0.0           6.602000E 04 8.368000E 04 7.870000E 03
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   97     3     0     0     0     0     0
 ND 149
9.664999E-05 1.121000E+04
0.0           0.0           0.0           0.0          3.676001E 02 0.0000000000
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   98     3     0     0     0     0     0
 PM 149
3.625000E-06 1.122000E+04
0.0           0.0           0.0           7.206000E 03 3.439000E 01 4.870000E 00
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   99     3     0     0     0     0     0
 PM 151
6.875000E-06 6.828000E+03
0.0           0.0           0.0           3.939000E 03 8.496000E 00 1.420000E 00
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  100     3     0     0     0     0     0
 SM 151
2.168000E-10 7.226000E+01
0.0           0.0           0.0           4.454000E 04 8.589000E 04 1.480000E 04
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  101     3     0     0     0     0     0
 EU 155
1.292000E-08 2.973000E+02
```

```
0.0           0.0           0.0           9.463000E 04 1.005000E 05 1.430000E 04
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  102     3     0     0     0     0     0
 EU 156
5.347000E-07 1.575000E+03
0.0           0.0           0.0           8.556000E 04 1.927000E 03 1.480000E 03
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  103     3     0     0     0     0     0
 GD 159
1.069000E-05 3.083000E+02
0.0           0.0           0.0           0.0          6.478000E 02 0.0000000000
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  104     3     0     0     0     0     0
 U  235
3.095999E-17 9.169000E-05
0.0           0.0           0.0           4.896000E 07 1.001000E 07 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  105     3     0     0     0     0     0
 U  237
1.188000E-06 3.456000E+03
0.0           0.0           0.0           1.020000E 04 3.673000E 01 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  106     3     0     0     0     0     0
 NP 237
1.027000E-14 2.150000E-03
0.0           0.0           0.0           5.215000E 07 1.693000E 09 1.470000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  107     3     0     0     0     0     0
 PU 238
2.431000E-10 2.775000E+01
0.0           0.0           0.0           1.825000E 08 2.737000E 09 3.870000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  108     5     0     0     0     0     0
 NP 238
3.819000E-06 7.741000E+02
0.0           0.0           0.0           1.016000E 04 2.962000E 02 8.000000E 00
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  109     3     0     0     0     0     0
 PU 239
9.012000E-13 1.227000E+02
0.0           0.0           0.0           1.716000E 08 3.188000E 09 4.310000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
```

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  110     5     0     0     0     0     0
 U  239
4.916000E-04 8.928000E+05
0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  111     3     0     0     0     0     0
 NP 239
3.442000E-06 8.293000E+05
0.0           0.0           0.0           4.702000E 03 2.866000E 01 2.820000E 00
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  112     3     0     0     0     0     0
 PU 240
3.342000E-12 7.235000E+01
0.0           0.0           0.0           1.716000E 08 3.183000E 09 4.300000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  113     5     0     0     0     0     0
 PU 241
1.671000E-09 3.779000E+03
0.0           0.0           0.0           1.517000E 05 6.407000E 07 3.280000E 06
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  114     5     0     0     0     0     0
 AM 241
4.803000E-11 1.571000E+01
0.0           0.0           0.0           6.062000E 07 1.013000E 09 3.590000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  115     3     0     0     0     0     0
 PU 242
5.812001E-14 2.110000E-02
0.0           0.0           0.0           1.651000E 08 2.954000E 09 4.150000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  116     5     0     0     0     0     0
 CM 242
4.936000E-08 9.018000E+02
0.0           0.0           0.0           3.923000E 07 1.483000E 07 1.510000E 07
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  117     3     0     0     0     0     0
 AM 242M
1.432000E-10 1.457000E+00
0.0           0.0           0.0           2.443000E 07 1.019000E 09 3.460000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  118     3     0     0     0     0     0
 CM 243
6.855001E-10 3.528000E-01
```

```
0.0           0.0           0.0           6.312000E 07 7.856000E 08 2.970000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  119     3     0     0     0     0     0
 AM 243
2.766000E-12 5.306000E-02
0.0           0.0           0.0           5.747000E 07 1.013000E 09 3.470000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  120     3     0     0     0     0     0
 CM 244
1.248000E-09 1.497000E+00
0.0           0.0           0.0           6.062000E 07 5.904000E 08 2.540000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  121     3     0     0     0     0     0
 AM 244
4.431000E-04 3.186000E+00
0.0           0.0           0.0           0.0          2.985000E 03 0.0000000000
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  122     3     0     0     0     0     0
```

MLWRICRP.30

```
    5     6     3     0     0     1     1     1     1
WHOLEBDY  SKIN  THYROID   LUNG    BONE   LIVER
HALOGENS NOBLES  SOLIDS SODIUMS PLUTONMS
  ELEM.   ORG.    PART.
 NA  22
 8.448000E-09 2.384000E-06
 0.0          0.0          1.300000E 04 1.300000E 04 1.300000E 04 1.300000E 04
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
    1     4     0     0     0     0     0
 NA  24
 1.273000E-05 1.429000E+00
 0.0          0.0          1.278000E 03 1.278000E 03 1.278000E 03 1.280000E 03
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
    2     4     0     0     0     0     0
 GE  77
 1.703000E-05 3.761000E+01
 0.0          0.0          0.0          0.0          0.0          0.0000000000
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
    3     3     0     0     0     0     0
 SE  79
 3.381000E-13 6.921000E-03
 0.0          0.0          0.0          4.470000E 04 0.0          3.830000E 02
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
    4     3     0     0     0     0     0
 BR  82
 5.456000E-06 6.905000E+01
 0.0          0.0          0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
    5     1     0     0     0     0     0
 KR  83M
 1.035000E-04 4.152000E+03
 1.270000E-05 0.000000E+00 0.000000E+00 5.201000E-01 0.000000E+00 0.0
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
    6     2     0     0     0     0     0
 BR  83
 8.021000E-05 2.930000E+03
 0.0          0.0          0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
    7     1     0     0     0     0     0
 BR  84
 3.646000E-04 4.339000E+03
 0.0          0.0          0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
 0.0          0.0          0.0          0.0
```

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    8     1     0     0     0     0     0
KR  85M
4.385000E-05 1.297000E+04
2.310000E-02 4.970000E-02 0.000000E+00 2.919000E 00 0.000000E+00 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
    9     2     0     0     0     0     0
KR  85
2.042000E-09 4.102000E+02
3.310000E-04 4.840000E-02 0.000000E+00 2.416000E 00 0.000000E+00 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   10     2     0     0     0     0     0
BR  85
3.850000E-03 4.923000E+03
0.0          0.0          0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   11     1     0     0     0     0     0
RB  86
4.289000E-07 1.324000E+02
0.0          0.0          0.0          0.0          0.0          1.690000E 04
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   12     3     0     0     0     0     0
KR  87
1.519000E-04 2.335000E+04
1.330000E-01 3.360000E-01 0.000000E+00 1.537000E 01 0.000000E+00 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   13     2     0     0     0     0     0
KR  88
6.875000E-05 3.200000E+04
3.380000E-01 7.760000E-02 0.000000E+00 3.136000E 01 0.000000E+00 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   14     2     0     0     0     0     0
RB  88
6.468000E-04 1.200000E+04
0.0          0.0          0.0          0.0          0.0          4.840000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   15     3     0     0     0     0     0
KR  89
3.630000E-03 3.979000E+04
3.030000E-01 3.470000E-01 0.000000E+00 0.000000E+00 0.000000E+00 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   16     2     0     0     0     0     0
RB  89
3.629000E-03 1.538000E+04
```

```
0.0           0.0           0.0           0.0           0.0           3.200000E 01
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   17     3     0     0     0     0     0
SR  89
1.588000E-07 1.552000E+04
0.0           0.0           0.0           1.749000E 05 3.801000E 04 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   18     3     0     0     0     0     0
RB  90
3.982000E-03 1.335000E+04
0.0           0.0           0.0           0.0           0.0           0.0000000000
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   19     3     0     0     0     0     0
SR  90
8.020999E-10 7.401000E+02
0.0           0.0           0.0           1.196000E 06 1.244000E 07 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   20     3     0     0     0     0     0
Y   90
2.993000E-06 7.887000E+02
0.0           0.0           0.0           2.120000E+04 2.612000E 02 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   21     3     0     0     0     0     0
SR  91
2.005001E-05 2.118000E+04
0.0           0.0           0.0           4.557000E 03 7.741000E 00 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   22     3     0     0     0     0     0
Y   91M
2.292000E-04 1.230000E+04
0.0           0.0           0.0           2.402000E 02 3.264000E-02 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   23     3     0     0     0     0     0
Y   91
1.383000E-07 2.121000E+04
0.0           0.0           0.0           2.130000E 05 5.781000E 04 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   24     3     0     0     0     0     0
SR  92
7.292000E-05 2.508000E+04
0.0           0.0           0.0           2.061000E 03 8.431000E-01 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
```

```
   25     3     0     0     0     0     0
Y   92
5.346999E-05 2.535000E+04
0.0           0.0           0.0           1.961000E 03 1.292000E 00 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   26     3     0     0     0     0     0
SR  93
1.444000E-03 3.017000E+04
0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   27     3     0     0     0     0     0
Y   93
1.909000E-05 3.163000E+04
0.0           0.0           0.0           6.062000E 03 1.182000E 01 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   28     3     0     0     0     0     0
ZR  93
2.006000E-14 2.459000E-02
0.0           0.0           0.0           2.129000E 04 5.223000E 04 2.920000E 03
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   29     3     0     0     0     0     0
ZR  95
1.267000E-07 3.858000E+04
0.0           0.0           0.0           2.214000E 05 1.339000E 04 4.300000E 03
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   30     3     0     0     0     0     0
NB  95
2.292000E-07 3.842000E+04
0.0           0.0           0.0           6.311000E 04 1.758000E 03 9.770000E 02
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   31     3     0     0     0     0     0
ZR  97
1.129000E-05 4.197000E+04
0.0           0.0           0.0           9.839000E 03 1.214000E 01 2.450000E 00
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   32     3     0     0     0     0     0
NB  97M
1.155000E-02 3.987000E+04
0.0           0.0           0.0           0.0           0.0           0.0000000000
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   33     3     0     0     0     0     0
NB  97
1.573000E-04 4.235000E+04
```

```
0.0           0.0           0.0           2.995000E 02 2.777000E-02 7.030000E-03
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   34     3     0     0     0     0     0
MO  99
2.874000E-06 4.886000E+04
0.0           0.0           0.0           1.140000E 04 0.0           1.510000E 03
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   35     3     0     0     0     0     0
TC  99M
3.183000E-05 4.278000E+04
0.0           0.0           0.0           9.546001E 01 1.287000E-04 3.640000E-04
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   36     3     0     0     0     0     0
TC  99
1.042000E-13 2.534000E-01
0.0           0.0           0.0           1.011000E 05 3.132001E 01 4.640000E 01
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   37     3     0     0     0     0     0
TC 101
8.250000E-04 5.188000E+04
0.0           0.0           0.0           4.985001E 01 5.215000E-06 7.520000E-06
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   38     3     0     0     0     0     0
RU 103
2.025000E-07 5.381000E+04
0.0           0.0           0.0           6.312000E 04 1.906000E 02 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   39     3     0     0     0     0     0
RU 105
4.221000E-05 4.051000E+04
0.0           0.0           0.0           1.375000E 03 9.877002E-02 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   40     3     0     0     0     0     0
RU 106
2.197000E-08 2.270000E+04
0.0           0.0           0.0           1.174000E 06 8.643000E 03 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
   41     3     0     0     0     0     0
RH 106
2.310000E-02 2.272000E+04
0.0           0.0           0.0           0.0           0.0           0.0000000000
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
```

```
   42     3     0     0     0     0     0
PD 107
3.139000E-15 3.975000E-03
0.0          0.0          0.0          9.472000E 03 0.0          8.270000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   43     3     0     0     0     0     0
RH 109
1.925000E-04 1.223000E+04
0.0          0.0          0.0          0.0          0.0          0.0000000000
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   44     3     0     0     0     0     0
PD 109
1.407000E-05 1.277000E+04
0.0          0.0          0.0          1.852000E 03 0.0          4.630000E-01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   45     3     0     0     0     0     0
AG 111
1.069000E-06 3.159000E+03
0.0          0.0          0.0          2.333000E 04 4.253000E 01 1.780000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   46     3     0     0     0     0     0
IN 115M
4.220000E-05 9.015000E+02
0.0          0.0          1.114000E 01 0.0          5.888000E 01 0.0000000000
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   47     3     0     0     0     0     0
SN 123
2.750000E-04 1.832000E+02
0.0          0.0          5.665000E 02 2.878000E 05 3.015000E 04 6.670000E 02
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   48     3     0     0     0     0     0
SN 125
8.443000E-07 5.698000E+02
0.0          0.0          2.588000E 01 7.367000E 04 1.162000E 03 3.120000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   49     3     0     0     0     0     0
SB 125
9.158001E-09 6.103000E+02
0.0          0.0          6.747000E 00 2.175000E 05 6.665000E 03 7.440000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   50     3     0     0     0     0     0
TE 125M
1.383000E-07 1.253000E+02
```

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0.0           0.0           1.313000E 02 3.919000E 04 4.268000E 02 1.980000E 02
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   51     3     0     0     0     0     0
SB 126
6.416000E-07 9.707000E+01
0.0           0.0           2.746000E 00 9.569000E 04 4.497000E 02 9.130000E 00
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   52     3     0     0     0     0     0
SB 127
2.069000E-06 4.527000E+03
0.0           0.0           3.968000E-01 2.048000E 04 3.299001E 01 7.220000E-01
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   53     3     0     0     0     0     0
TE 127M
7.637999E-08 6.114000E+02
0.0           0.0           4.110000E 02 1.200000E 05 1.575000E 03 7.210000E 02
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   54     3     0     0     0     0     0
TE 127
2.055999E-05 4.501000E+03
0.0           0.0           1.325000E-01 8.137000E 02 1.754000E-01 8.030000E-02
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   55     3     0     0     0     0     0
I  129
1.294000E-15 0.0000000000
3.020000E-03 2.435000E-02 5.542000E 06 0.0          2.476000E 03 2.110000E 03
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   56     1     0     0     0     0     0
TE 129M
2.359000E-07 1.668000E+03
0.0           0.0           4.297000E 02 1.448000E 05 1.219000E 03 5.840000E 02
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   57     3     0     0     0     0     0
TE 129
1.573000E-04 1.111000E+04
0.0           0.0           4.872002E-03 2.418000E 02 6.219000E-03 2.990000E-03
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   58     3     0     0     0     0     0
I  131
9.963996E-07 2.508000E+04
5.590000E-02 3.070000E-02 1.100000E 06 0.000000E+00 3.149000E 03 4.470000E 03
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
```

```
   59     1     0     0     0     0     0
XE 131M
6.680000E-07 2.595000E+02
1.250000E-03 1.330000E-02 0.000000E+00 1.400000E+00 0.000000E+00 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   60     2     0     0     0     0     0
TE 131
4.620000E-04 2.741000E+04
0.0          0.0          1.170000E-03 1.740000E+02 1.390000E-03 7.440000E-04
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   61     3     0     0     0     0     0
TE 131M
6.416000E-06 4.800000E+03
0.0          0.0          6.879000E 00 1.823000E 04 8.743000E 00 5.450000E 00
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   62     3     0     0     0     0     0
I  132
8.269001E-05 3.806000E+04
3.550000E-01 1.100000E-01 6.300000E+03 0.000000E+00 1.447000E+02 4.070000E 02
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   63     1     0     0     0     0     0
TE 132
2.506000E-06 4.115000E+04
0.0          0.0          2.366000E 01 3.598000E 04 3.253000E 01 2.690000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   64     3     0     0     0     0     0
I  133
9.219000E-06 5.622000E+04
9.110000E-02 8.900000E-02 1.800000E+05 0.000000E+00 1.077000E+03 1.850000E 03
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   65     1     0     0     0     0     0
XE 133M
3.490000E-06 1.384000E+03
4.290000E-03 2.960000E-02 0.000000E+00 1.890000E+00 0.000000E+00 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   66     2     0     0     0     0     0
XE 133
1.522000E-06 5.622000E+04
4.960000E-03 9.670000E-03 0.000000E+00 1.573000E+00 0.000000E+00 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   67     2     0     0     0     0     0
TE 133M
2.310000E-04 1.789000E+04
```

```
0.0           0.0           6.269000E-03 5.506001E 02 7.243998E-03 5.400000E-03
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   68     3     0     0     0     0     0
I  134
2.228000E-04 6.575000E+04
4.110000E-01 1.420000E-01 1.100000E 03 0.000000E+00 8.047000E+01 2.160000E 02
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   69     1     0     0     0     0     0
TE 134
2.750000E-04 3.999000E+04
0.0           0.0           3.437000E-03 4.377000E 02 3.843000E-03 3.220000E-03
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   70     3     0     0     0     0     0
CS 134
9.551002E-09 1.019000E+03
0.0           0.0           0.0          1.216000E 04 4.662000E 04 1.060000E 05
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   71     3     0     0     0     0     0
I  135
2.864000E-05 5.103000E+04
2.490000E-01 7.860000E-02 3.100000E+04 0.000000E+00 3.353999E+02 8.730000E 02
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   72     1     0     0     0     0     0
XE 135M
7.400000E-04 1.557000E+04
6.370000E-02 2.140000E-02 0.000000E+00 2.231000E 00 0.000000E+00 0.0
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   73     2     0     0     0     0     0
XE 135
2.091999E-05 5.363000E+04
3.590000E-02 6.320000E-02 0.000000E+00 4.061000E 00 0.000000E+00 0.0
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   74     2     0     0     0     0     0
CS 135
7.293001E-15 2.909000E-02
0.0           0.0           0.0          1.566000E 03 1.459000E 04 1.290000E 04
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
   75     3     0     0     0     0     0
I  136
8.349001E-03 0.0000000000
6.786000E-01 1.300000E+00 0.0          0.0          0.0          0.0000000000
0.0           0.0           0.0          0.0
0.0           0.0           0.0          0.0
```

```
   76     1     0     0     0     0     0
CS 136
6.160000E-07 1.667000E+03
0.0          0.0          0.0          1.500000E 03 4.879000E 03 1.830000E 04
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   77     3     0     0     0     0     0
XE 137
2.961000E-03 5.103000E+04
2.830000E-02 4.590000E-01 0.000000E+00 1.748000E 01 0.000000E+00 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   78     2     0     0     0     0     0
CS 137
7.292000E-10 1.907000E+03
0.0          0.0          0.0          9.400000E 03 5.977000E 04 7.760000E 04
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   79     3     0     0     0     0     0
BA 137M
4.528999E-03 1.811000E+03
0.0          0.0          0.0          0.0          0.0          0.0000000000
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   80     3     0     0     0     0     0
XE 138
6.796001E-04 4.775000E+04
1.870000E-01 1.470000E-01 0.000000E+00 2.445000E 01 0.000000E+00 0.0
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   81     2     0     0     0     0     0
CS 138
3.587001E-04 4.878000E+04
0.0          0.0          0.0          6.066000E 00 4.137000E 01 7.760000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   82     3     0     0     0     0     0
CS 139
1.216000E-03 4.478000E+04
0.0          0.0          0.0          2.837000E 00 2.557001E 01 3.630000E 01
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   83     3     0     0     0     0     0
BA 139
1.393000E-04 4.604000E+04
0.0          0.0          0.0          4.697000E 02 1.167000E-01 8.320000E-05
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   84     3     0     0     0     0     0
BA 140
6.266000E-07 4.274000E+04
```

```
0.0             0.0             0.0             1.587000E 05 4.884000E 03 6.130000E 00
0.0             0.0             0.0             0.0
0.0             0.0             0.0             0.0
   85     3     0     0     0     0     0
LA 140
4.774000E-06 4.342000E+04
0.0             0.0             0.0             1.701000E 04 4.300999E 01 2.170000E 01
0.0             0.0             0.0             0.0
0.0             0.0             0.0             0.0
   86     3     0     0     0     0     0
BA 141
6.416000E-04 4.345000E+04
0.0             0.0             0.0             2.419000E 02 1.247000E-02 9.410000E-06
0.0             0.0             0.0             0.0
0.0             0.0             0.0             0.0
   87     3     0     0     0     0     0
LA 141
4.935999E-05 4.371000E+04
0.0             0.0             0.0             1.345000E 03 5.342000E-01 1.660000E-01
0.0             0.0             0.0             0.0
0.0             0.0             0.0             0.0
   88     3     0     0     0     0     0
CE 141
2.506000E-07 4.387000E+04
0.0             0.0             0.0             4.517000E 04 2.494000E 03 1.690000E 03
0.0             0.0             0.0             0.0
0.0             0.0             0.0             0.0
   89     3     0     0     0     0     0
BA 142
1.050000E-03 3.762000E+04
0.0             0.0             0.0             1.487000E 02 3.294000E-03 3.380000E-06
0.0             0.0             0.0             0.0
0.0             0.0             0.0             0.0
   90     3     0     0     0     0     0
LA 142
1.255000E-04 3.883000E+04
0.0             0.0             0.0             7.907000E 02 8.535999E-02 3.880000E-02
0.0             0.0             0.0             0.0
0.0             0.0             0.0             0.0
   91     3     0     0     0     0     0
CE 143
6.030000E-06 3.552000E+04
0.0             0.0             0.0             9.972000E 03 2.334000E 01 1.720000E 01
0.0             0.0             0.0             0.0
0.0             0.0             0.0             0.0
   92     3     0     0     0     0     0
PR 143
5.854000E-07 3.467000E+04
0.0             0.0             0.0             3.506000E 04 1.168000E 03 4.690000E 02
0.0             0.0             0.0             0.0
0.0             0.0             0.0             0.0
```

```
   93     3     0     0     0     0     0
CE 144
2.766000E-08 2.294000E+04
0.0          0.0          0.0          9.716000E 05 4.286000E 05 1.790000E 05
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   94     3     0     0     0     0     0
PR 144
6.676000E-04 2.302000E+04
0.0          0.0          0.0          1.272000E 02 3.763000E-03 1.560000E-03
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   95     3     0     0     0     0     0
ND 147
7.098000E-07 1.733000E+04
0.0          0.0          0.0          2.759000E 04 6.592000E 02 7.620000E 02
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   96     3     0     0     0     0     0
PM 147
8.718001E-09 4.881000E+03
0.0          0.0          0.0          6.602000E 04 8.368000E 04 7.870000E 03
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   97     3     0     0     0     0     0
ND 149
9.664999E-05 1.121000E+04
0.0          0.0          0.0          0.0          3.676001E 02 0.0000000000
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   98     3     0     0     0     0     0
PM 149
3.625000E-06 1.122000E+04
0.0          0.0          0.0          7.206000E 03 3.439000E 01 4.870000E 00
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
   99     3     0     0     0     0     0
PM 151
6.875000E-06 6.828000E+03
0.0          0.0          0.0          3.939000E 03 8.496000E 00 1.420000E 00
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
  100     3     0     0     0     0     0
SM 151
2.168000E-10 7.226000E+01
0.0          0.0          0.0          4.454000E 04 8.589000E 04 1.480000E 04
0.0          0.0          0.0          0.0
0.0          0.0          0.0          0.0
  101     3     0     0     0     0     0
EU 155
1.292000E-08 2.973000E+02
```

```
0.0           0.0           0.0           9.463000E 04 1.005000E 05 1.430000E 04
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  102     3     0     0     0     0     0
EU 156
5.347000E-07 1.575000E+03
0.0           0.0           0.0           8.556000E 04 1.927000E 03 1.480000E 03
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  103     3     0     0     0     0     0
GD 159
1.069000E-05 3.083000E+02
0.0           0.0           0.0           0.0          6.478000E 02 0.0000000000
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  104     3     0     0     0     0     0
U  235
3.095999E-17 9.169000E-05
0.0           0.0           0.0           4.896000E 07 1.001000E 07 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  105     3     0     0     0     0     0
U  237
1.188000E-06 3.456000E+03
0.0           0.0           0.0           1.020000E 04 3.673000E 01 0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  106     3     0     0     0     0     0
NP 237
1.027000E-14 2.150000E-03
0.0           0.0           0.0           5.215000E 07 1.693000E 09 1.470000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  107     3     0     0     0     0     0
PU 238
2.431000E-10 2.775000E+01
0.0           0.0           0.0           1.825000E 08 2.737000E 09 3.870000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  108     5     0     0     0     0     0
NP 238
3.819000E-06 7.741000E+02
0.0           0.0           0.0           1.016000E 04 2.962000E 02 8.000000E 00
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  109     3     0     0     0     0     0
PU 239
9.012000E-13 1.227000E+02
0.0           0.0           0.0           1.716000E 08 3.188000E 09 4.310000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
```

```
  110     5     0     0     0     0     0
U  239
4.916000E-04 8.928000E+05
0.0           0.0           0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  111     3     0     0     0     0     0
NP 239
3.442000E-06 8.293000E+05
0.0           0.0           0.0           4.702000E 03 2.866000E 01 2.820000E 00
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  112     3     0     0     0     0     0
PU 240
3.342000E-12 7.235000E+01
0.0           0.0           0.0           1.716000E 08 3.183000E 09 4.300000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  113     5     0     0     0     0     0
PU 241
1.671000E-09 3.779000E+03
0.0           0.0           0.0           1.517000E 05 6.407000E 07 3.280000E 06
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  114     5     0     0     0     0     0
AM 241
4.803000E-11 1.571000E+01
0.0           0.0           0.0           6.062000E 07 1.013000E 09 3.590000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  115     3     0     0     0     0     0
PU 242
5.812001E-14 2.110000E-02
0.0           0.0           0.0           1.651000E 08 2.954000E 09 4.150000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  116     5     0     0     0     0     0
CM 242
4.936000E-08 9.018000E+02
0.0           0.0           0.0           3.923000E 07 1.483000E 07 1.510000E 07
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  117     3     0     0     0     0     0
AM 242M
1.432000E-10 1.457000E+00
0.0           0.0           0.0           2.443000E 07 1.019000E 09 3.460000E 08
0.0           0.0           0.0           0.0
0.0           0.0           0.0           0.0
  118     3     0     0     0     0     0
CM 243
6.855001E-10 3.528000E-01
```

```
0.0             0.0             0.0             6.312000E 07 7.856000E 08 2.970000E 08
0.0             0.0             0.0             0.0
0.0             0.0             0.0             0.0
  119     3     0     0     0     0     0
AM 243
2.766000E-12 5.306000E-02
0.0             0.0             0.0             5.747000E 07 1.013000E 09 3.470000E 08
0.0             0.0             0.0             0.0
0.0             0.0             0.0             0.0
  120     3     0     0     0     0     0
CM 244
1.248000E-09 1.497000E+00
0.0             0.0             0.0             6.062000E 07 5.904000E 08 2.540000E 08
0.0             0.0             0.0             0.0
0.0             0.0             0.0             0.0
  121     3     0     0     0     0     0
AM 244
4.431000E-04 3.186000E+00
0.0             0.0             0.0             0.0          2.985000E 03 0.0000000000
0.0             0.0             0.0             0.0
0.0             0.0             0.0             0.0
  122     3     0     0     0     0     0
```

APPENDIX F

BASIC PREPROCESSOR CODE LISTINGS

TACT5MN.BAS

```
10 DIM P$(3)
20 CLS
30 CLOSE
40 KEY OFF
50 GOTO 640
60 REM
70 REM SUB-PROGRAM TO DISPLAY AND SELECT SINGLE COLUMN OPTIONS
80 REM
90 REM
100 REM DISPLAY HELP FOOTER ON SELECTION SCREEN
110 REM
120 LOCATE 21,1:PRINT CHR$(201);:FOR J9=1 TO 25:PRINT CHR$(205);:NEXT J9:PRINT CHR$(203)
130 LOCATE 22,1:PRINT CHR$(186):LOCATE 22,27:PRINT CHR$(186):LOCATE 22,53:PRINT CHR$(186
140 LOCATE 23,1:PRINT CHR$(200);:FOR J9=1 TO 25:PRINT CHR$(205);:NEXT J9:PRINT CHR$(202)
150 LOCATE 22,2:PRINT "Search For Selection ";:COLOR 0,7:PRINT CHR$(24);CHR$(25):COLOR 7
160 LOCATE 22,30:PRINT "Select/De-Select ";:COLOR 0,7:PRINT CHR$(17);CHR$(196);CHR$(217)
170 LOCATE 22,55:PRINT "Quit Selection Mode ";:COLOR 0,7:PRINT "ESC":COLOR 7,0
180 REM
190 REM DISPLAY AND SELECT OPTIONS ON SCREEN FOR SINGLE COLUMN SELECTION
200 REM
210 ROW=SROW
220 LOCATE ROW,COL(KKEY):COLOR 0,7:PRINT P$(KKEY):COLOR 7,0
230 A$=INKEY$
240 IF LEN(A$)=0 THEN 230
250 REM   CHECK FOR KEY STRIKE
260 IF LEN(A$)=2 THEN 470
270 IF LEN(A$)=1 AND ASC(A$)<>13 AND ASC(A$)<>27 THEN 230
280 IF ASC(A$)=13 GOTO 310
290 CLS
300 RETURN
310 IF M=1 GOTO 400
320 FOR KSEL=1 TO KEYMAX
330 IF KSEL=KKEY THEN 370
340 IF MID$(P$(KSEL),1,1)=" " THEN 370
350 MID$(P$(KSEL),1,1)=" "
360 LOCATE (ROWMIN+(KSEL-1)*2),COL(KSEL):PRINT P$(KSEL)
370 NEXT KSEL
380 MID$(P$(KKEY),1,1)="*"
390 GOTO 460
400 IF MID$(P$(KKEY),1,1)<>" " THEN 440
410 MID$(P$(KKEY),1,1)="*"
420 ISELCT(KKEY)=1
430 GOTO 460
440 MID$(P$(KKEY),1,1)=" "
450 ISELCT(KKEY)=0
460 LOCATE ROW,COL(KKEY):COLOR 0,7:PRINT P$(KKEY):COLOR 7,0
470 C=ASC(RIGHT$(A$,1))
480 LOCATE ROW,COL(KKEY):PRINT P$(KKEY)
490 IF C=72 THEN ROW=ROW-2:KKEY=KKEY-1
500 IF C=80 THEN ROW=ROW+2:KKEY=KKEY+1
510 REM  CHANGE SELECTION
520 IF (ROW<ROWMIN) THEN ROW=ROWMAX:KKEY=KEYMAX
530 IF (ROW>ROWMAX) THEN ROW=ROWMIN:KKEY=KEYMIN
540 LOCATE ROW,COL(KKEY):COLOR 0,7:PRINT  P$(KKEY):COLOR 7,0
550 GOTO 230
```

```
560 REM
570 REM DISPLAY AND SELECT EXECUTION MODE FOR TACT V PROGRAM
580 REM TACT5ND.BAS ALLOWS USER TO GENERATE TACT V NUCLIDE FILE
590 REM TACT5MD.BAS ALLOWS USER TO GENERATE TACT V MODEL DATA FILE
600 REM THIRD OPTION RETURNS CONTROL TO AUTOEXEC.BAT FILE WHICH
610 REM CALL THE TACT V PROGRAM AND RUNS WITH THE DATA GENERATED
620 REM BY THE PREVIOUS TWO MODES
630 REM
640 P$(1)=" CREATE NUCLIDE FILE FOR INPUT TO TACT5   "
650 P$(2)=" CREATE MODEL DATA FILE FOR INPUT TO TACT5"
660 P$(3)=" QUIT TACT5 INPUT FILE CREATION MODE      "
670 CLS
680 LOCATE 5,21:COLOR 1,0:PRINT "SELECT TYPE OF TACT5 FILE TO BE CREATED":COLOR 7,0
690 LOCATE 7,19:PRINT P$(1):LOCATE 9,19:PRINT P$(2):LOCATE 11,19:PRINT P$(3)
700 ROWMIN=7:ROWMAX=11:KEYMIN=1:KEYMAX=3:SROW=7:COL(1)=19:COL(2)=19:COL(3)=19:KKEY=1:M=0
710 IF MID$(P$(1),1,1)="*" THEN CHAIN "TACT5ND.BAS"
720 IF MID$(P$(2),1,1)="*" THEN CHAIN "TACT5MD.BAS"
730 IF MID$(P$(3),1,1)="*" THEN CLS:SYSTEM
740 GOTO 20
750 END
```

TACT5ND.BAS

```
10 DIM P$(120)
20 REM
30 REM AT THIS STEP IN THE PROGRAM, ENTER THE NAME OF THE NUCLIDE
 FILE
40  REM TO BE GENERATED AND THEN BRANCH TO SELECT  INPUT  NUCLIDE
 FILE
50 REM
60 CLS
70  LOCATE  8,13:PRINT  "ENTER NAME OF NUCLEAR DATA  FILE  TO  BE
 CREATED"
80  LOCATE  9,13:PRINT  "(INCLUDE  OUTPUT  DEVICE  IN  NAME   eg.
 B:NUCDATA)"
90 LOCATE 11,32:INPUT "";F1$
100 CLS
110 CLOSE
120 KEY OFF
130 GOTO 980
140 REM
150  REM  SUB-PROGRAM FOR DISPLAYING HELP FOOTER  ON  SCREEN  FOR
 SELECTION
160 REM SCREENS
170 REM
180   LOCATE   21,1:PRINT   CHR$(201);:FOR   J9=1   TO   25:PRINT
 CHR$(205);:NEXT   J9:PRINT   CHR$(203);:FOR  J9=1   TO   25:PRINT
 CHR$(205);:NEXT   J9:PRINT   CHR$(203);:FOR  J9=1   TO   25:PRINT
 CHR$(205);:NEXT J9:PRINT CHR$(187)
190     LOCATE    22,1:PRINT     CHR$(186):LOCATE     22,27:PRINT
 CHR$(186):LOCATE    22,53:PRINT   CHR$(186):LOCATE    22,79:PRINT
 CHR$(186)
200   LOCATE   23,1:PRINT   CHR$(200);:FOR   J9=1   TO   25:PRINT
 CHR$(205);:NEXT   J9:PRINT   CHR$(202);:FOR  J9=1   TO   25:PRINT
 CHR$(205);:NEXT   J9:PRINT   CHR$(202);:FOR  J9=1   TO   25:PRINT
 CHR$(205);:NEXT J9:PRINT CHR$(188)
210  LOCATE 22,2:PRINT "Search For Selection  ";:COLOR  0,7:PRINT
 CHR$(24);CHR$(25):COLOR 7,0
220  LOCATE  22,30:PRINT  "Select/De-Select  ";:COLOR   0,7:PRINT
 CHR$(17);CHR$(196);CHR$(217):COLOR 7,0
230  LOCATE 22,55:PRINT " Enter Selection(s)  ";:COLOR  0,7:PRINT
 "ESC":COLOR 7,0
240 RETURN
250 REM
260 REM SUB-PROGRAM TO DISPLAY AND SELECT INPUT OPTIONS ON SCREEN
 FOR
270 REM SINGLE COLUMN SELECTIONS
280 REM
290 ROW=SROW
300 LOCATE ROW,COL(KKEY):COLOR 0,7:PRINT P$(KKEY):COLOR 7,0
310 A$=INKEY$
320 IF LEN(A$)=0 THEN 310
330 REM   CHECK FOR KEY STRIKE
340 IF LEN(A$)=2 THEN 550
350 IF LEN(A$)=1 AND ASC(A$)<>13 AND ASC(A$)<>27 THEN 310
360 IF ASC(A$)=13 GOTO 390
370 CLS
380 RETURN
```

```
390 IF M=1 GOTO 480
400 FOR KSEL=1 TO KEYMAX
410 IF KSEL=KKEY THEN 450
420 IF MID$(P$(KSEL),1,1)=" " THEN 450
430 MID$(P$(KSEL),1,1)=" "
440 LOCATE (ROWMIN+(KSEL-1)),COL(KSEL):PRINT P$(KSEL)
450 NEXT KSEL
460 MID$(P$(KKEY),1,1)="*"
470 GOTO 540
480 IF MID$(P$(KKEY),1,1)<>" " THEN 520
490 MID$(P$(KKEY),1,1)="*"
500 ISELCT(KKEY)=1
510 GOTO 540
520 MID$(P$(KKEY),1,1)=" "
530 ISELCT(KKEY)=0
540 LOCATE ROW,COL(KKEY):COLOR 0,7:PRINT P$(KKEY):COLOR 7,0
550 C=ASC(RIGHT$(A$,1))
560 LOCATE ROW,COL(KKEY):PRINT P$(KKEY)
570 IF C=72 THEN ROW=ROW-1:KKEY=KKEY-1
580 IF C=80 THEN ROW=ROW+1:KKEY=KKEY+1
590 REM  CHANGE SELECTION
600 IF (ROW<ROWMIN) THEN ROW=ROWMAX:KKEY=KEYMAX
610 IF (ROW>ROWMAX) THEN ROW=ROWMIN:KKEY=KEYMIN
620 LOCATE ROW,COL(KKEY):COLOR 0,7:PRINT  P$(KKEY):COLOR 7,0
630 GOTO 310
640 REM
650 REM SUB-PROGRAM TO DISPLAY AND SELECT INPUT OPTIONS ON SCREEN
 FOR
660 REM MULTI-COLUMN SELECTIONS
670 REM
680 ROW=SROW:COL=SCOL
690 LOCATE ROW,COL:COLOR 0,7:PRINT P$(KKEY):COLOR 7,0
700 A$=INKEY$
710 IF LEN(A$)=0 THEN 700
720 REM   CHECK FOR KEY STRIKE
730 IF LEN(A$)=2 THEN 830
740 IF LEN(A$)=1 AND ASC(A$)<>13 AND ASC(A$)<>27 THEN 700
750 IF ASC(A$)<>27 GOTO 780
760 CLS
770 RETURN
780 IF MID$(P$(KKEY),1,1)<>" " THEN 810
790 MID$(P$(KKEY),1,1)="*"
800 GOTO 820
810 MID$(P$(KKEY),1,1)=" "
820 LOCATE ROW,COL:COLOR 0,7:PRINT P$(KKEY):COLOR 7,0
830 C=ASC(RIGHT$(A$,1))
840 LOCATE ROW,COL:PRINT P$(KKEY)
850 IF C=72 THEN ROW=ROW-1:KKEY=KKEY-1
860 IF C=80 THEN ROW=ROW+1:KKEY=KKEY+1
870 REM  CHANGE SELECTION
880 IF (ROW<ROWMIN AND J<>1) THEN  J=J-1:ROW=ROWMAX(J):COL=10*(J-
 1)+1
890      IF      (ROW>ROWMAX(J)      AND      J<>JCOL)       THEN
 J=J+1:ROW=ROWMIN:COL=10*(J-1)+1
900 IF (ROW<ROWMIN AND J=1) THEN  J=JCOL:ROW=ROWMAX(J):COL=10*(J-
```

```
 1)+1:KKEY=JMAX
910       IF      (ROW>ROWMAX(J)      AND      J=JCOL)       THEN
 J=1:ROW=ROWMIN:COL=1:KKEY=1
920 LOCATE ROW,COL:COLOR 0,7:PRINT  P$(KKEY):COLOR 7,0
930 GOTO 700
940 REM
950 REM SELECT NUCLIDE INPUT FILE AND BIOLOGICAL MODEL TO BE USED
 FOR
960 REM DOSE COMPUTATIONS
970 REM
980 LOCATE 10,13:INPUT "Do you want to use the LWR Master Nuclide
 File (Y/N) ";A$
990 CLS
1000 IF A$<>"Y" AND A$<>"y" THEN GOTO 1110
1010 F$="MLWRICRP."
1020 P$(1)=" ICRP 2 ":P$(2)=" ICRP 30 "
1030 CLS
1040  LOCATE  7,27:PRINT  "Select  Biological  Model  For":LOCATE
 8,29:PRINT "Dose Conversion Factors"
1050 LOCATE 10,37:PRINT P$(1):LOCATE 11,37:PRINT P$(2)
1060   ROWMIN=10:ROWMAX=11:KEYMIN=1:KEYMAX=2:COL(1)=37:COL(2)=37:
 SROW=10:KKEY=1:M=0:GOSUB  180
1070 GOSUB 290
1080 IF MID$(P$(1),1,1)="*" THEN LET F$=F$+"02":GOTO 1120
1090 IF MID$(P$(2),1,1)="*" THEN LET F$=F$+"30":GOTO 1120
1100 GOTO 1030
1110 LOCATE 10,7:INPUT "Enter resident device and file name  (eg.
 B:NUCLIDE.IN) ";F$
1120 CLS
1130 REM
1140  REM OPEN TEMPORARY FILE TO HOLD SELECTED NUCLIDE  DATA  AND
 INPUT
1150 REM HEADER CARDS FROM INPUT NUCLIDE FILE
1160 REM
1170 F2$=MID$(F1$,1,2)+"TEMP.DAT"
1180 OPEN F$ FOR INPUT AS #1
1190 OPEN F1$ FOR OUTPUT AS #2
1200 LINE INPUT #1,X1$
1210 IGRP1=VAL(MID$(X1$,6,1))
1220 IORG1=VAL(MID$(X1$,12,1))
1230 LINE INPUT #1,X2$
1240 FOR I=1 TO IORG1
1250 P$(I)=" "+MID$(X2$,(I-1)*8+1,8)
1260 ISELCT(I)=0
1270 NEXT I
1280 CLS
1290 REM
1300  REM  PRINT  ORGAN SCREEN AND SELECT ORGANS TO  BE  USED  IN
 COMPUTATION
1310 REM OF DOSES
1320 REM
1330 LOCATE 7,26:PRINT "Select Organs To Be Evaluated"
1340 LOCATE 8,21:PRINT "TACT5 will accept a maximum of 5 organs"
1350 ROW=10
1360 FOR I=1 TO IORG1
```

```
1370 LOCATE ROW,36:PRINT P$(I)
1380 COL(I)=36
1390 ROW=ROW+1
1400 NEXT I
1410 ROWMIN=10:ROWMAX=ROWMIN+IORG1-1:KEYMIN=1:KEYMAX=IORG1:
 SROW=10: KKEY=1:M=1:GOSUB 180
1420 GOSUB 290
1430 K2=0
1440 FOR I=1 TO IORG1
1450 ISEL2(I)=ISELCT(I)
1460 IF ISEL2(I)<>0 THEN LET K2=K2+1
1470 NEXT I
1480 IF K2=0 THEN 1280
1490 IF K2<6 THEN GOTO 1560
1500 LOCATE 10,25: PRINT "You have selected too many organs."
1510 LOCATE 11,15: PRINT "TACT5 will allow a maximum of 5  organs
 to be evaluated."
1520 LOCATE 12,19: PRINT "You will need to de-select at least one
 organ."
1530  LOCATE 15,16: PRINT "(Press any key to return to the  organ
 selection menu)"
1540 A$=INKEY$: IF A$="" THEN 1540
1550 GOTO 1280
1560 LINE INPUT #1,X3$
1570 FOR I=1 TO IGRP1
1580 P$(I)=" "+MID$(X3$,(I-1)*8+1,8)
1590 ISELCT(I)=0
1600 NEXT I
1610 CLS
1620 REM
1630  REM PRINT ISOTOPIC GROUP SCREEN AND SELECT ISOTOPIC  GROUPS
 TO
1640 REM BE USED IN DOSE COMPUTATION
1650 REM
1660 LOCATE 7,29:PRINT "Select Isotopic Groups":LOCATE 8,29:PRINT
 "To Be Used In Evaluation"
1670 ROW=10
1680 FOR I=1 TO IGRP1
1690 LOCATE ROW,36:PRINT P$(I)
1700 COL(I)=36
1710 ROW=ROW+1
1720 NEXT I
1730 ROWMIN=10:ROWMAX=ROWMIN+IGRP1-1:KEYMIN=1:KEYMAX=IGRP1
 :SROW=10:KKEY=1:M=1:GOSUB 180
1740 GOSUB 290
1750 REM
1760 REM CREATE HEADER CARDS FOR THE TACT5 NUCLIDE FILE AND STORE
 THEM
1770 REM ONTO THE TEMPORARY FILE
1780 REM
1790 K1=0
1800 FOR I=1 TO IGRP1
1810 ISEL1(I)=ISELCT(I)
1820 IF ISEL1(I)<>0 THEN LET K1=K1+1
1830 NEXT I
```

```
1840 IF K1=0 THEN 1610
1850 MID$(X1$,5,2)=STR$(K1)
1860 MID$(X1$,11,2)=STR$(K2)
1870 K3=0
1880 FOR I=1 TO IORG1
1890 IF ISEL2(I)=0 THEN 1920
1900 K3=K3+1
1910 MID$(X1$,(K3+2)*6+1,6)=MID$(X1$,(I+2)*6+1,6)
1920 IF K3<>I THEN MID$(X1$,(I+2)*6+1,6)="      "
1930 NEXT I
1940 PRINT #2,X1$
1950 K3=0
1960 FOR I=1 TO IORG1
1970 IF ISEL2(I)=0 THEN 2000
1980 K3=K3+1
1990 MID$(X2$,(K3-1)*8+1,8)=MID$(X2$,(I-1)*8+1,8)
2000 IF K3<>I THEN MID$(X2$,(I-1)*8+1,8)="        "
2010 NEXT I
2020 PRINT #2,X2$
2030 K3=0
2040 FOR I=1 TO IGRP1
2050 IF ISEL1(I)=0 THEN 2080
2060 K3=K3+1
2070                              MID$(X3$,(K3-1)*8+1,8)=MID$(X3$,(I-
 1)*8+1,8):GRPNEW$(K3)=MID$(X3$,(I-1)*8+1,8)
2080 IF K3<>I THEN MID$(X3$,(I-1)*8+1,8)="        "
2090 NEXT I
2100 PRINT #2,X3$
2110 LINE INPUT #1,X4$
2120 PRINT #2,X4$
2130 CLOSE #2
2140 REM
2150 REM RETRIEVE ISOTOPIC DATA FROM THE INPUT FILE AND STORE  IT
 ONTO THE
2160 REM TEMPORARY FILE FOR THOSE ISOTOPES TO BE USED IN THE DOSE
 COMPUTATION
2170 REM
2180 LOCATE 10,34:COLOR 0,7:PRINT "PLEASE WAIT!":COLOR 7,0
2190 LOCATE 12,29:COLOR 0,7:PRINT "SORTING DATA FOR REVIEW":COLOR
 7,0
2200 OPEN F2$ FOR OUTPUT AS #2
2210 IF EOF(1) GOTO 2450
2220 LINE INPUT #1,CARD$(1)
2230 LINE INPUT #1,CARD$(2)
2240 LINE INPUT #1,CARD$(3)
2250 LINE INPUT #1,CARD$(4)
2260 LINE INPUT #1,CARD$(5)
2270 LINE INPUT #1,CARD$(6)
2280 K3=0
2290 FOR I=1 TO IGRP1
2300 IF ISEL1(I)=0 THEN 2430
2310 K3=K3+1
2320 IF I<>VAL(MID$(CARD$(6),8,6)) THEN 2430
2330 MID$(CARD$(6),11,2)=STR$(K3)
2340 K3=0
```

```
2350 FOR J=1 TO IORG1
2360 IF ISEL2(J)=0 THEN 2390
2370 K3=K3+1
2380 MID$(CARD$(3),(K3-1)*13+1,13)=MID$(CARD$(3),(J-1)*13+1,13)
2390 IF J<>K3 THEN MID$(CARD$(3),(J-1)*13+1,13)="             "
2400 NEXT J
2410 PRINT #2,CARD$(1):PRINT #2,CARD$(2):PRINT  #2,CARD$(3):PRINT
 #2,CARD$(4):PRINT #2,CARD$(5):PRINT #2,CARD$(6)
2420 GOTO 2440
2430 NEXT I
2440 GOTO 2210
2450 CLOSE
2460 CLS
2470 REM
2480  REM  DETERMINE IF ALL ISOTOPES IN  EACH  SELECTED  ISOTOPIC
 GROUP ARE TO BE
2490  REM USED. IF NOT, THEN PRINT ISOTOPE SELECTION  SCREEN  AND
 SELECT THOSE
2500  REM ISOTOPES FROM THE ISOTOPIC GROUP DISPLAYED THAT ARE  TO
 BE USED IN
2510 REM THE DOSE COMPUTATION
2520 REM
2530 K3=0
2540 FOR I=1 TO K1
2550  LOCATE  10,5:PRINT  "DO  YOU WANT TO  INCLUDE  ALL  OF  THE
 ISOTOPES IN THE ";MID$(GRPNEW$(I),1,8):LOCATE 10,65:INPUT  "GROUP
 (Y/N) ";A$
2560 CLS
2570 IF A$<>"Y" AND A$<>"y" THEN 2790
2580   LOCATE  8,33:COLOR  0,7:PRINT  "  PLEASE   WAIT!   ":COLOR
 7,0:LOCATE  10,27:COLOR  0,7:PRINT  "  OFF-LOADING  ALL  ISOTOPES
 ":COLOR    7,0:LOCATE    12,29:COLOR   0,7:PRINT   "    IN    THE
 ";MID$(GRPNEW$(I),1,8);" GROUP ":COLOR 7,0
2590  LOCATE 14,31:COLOR 0,7:PRINT " TO THE NUCLIDE FILE  ":COLOR
 7,0
2600 OPEN F2$ FOR INPUT AS #1
2610 OPEN F1$ FOR APPEND AS #2
2620 IF EOF(1) GOTO 2760
2630 LINE INPUT #1,CARD$(1)
2640 LINE INPUT #1,CARD$(2)
2650 LINE INPUT #1,CARD$(3)
2660 LINE INPUT #1,CARD$(4)
2670 LINE INPUT #1,CARD$(5)
2680 LINE INPUT #1,CARD$(6)
2690 IF I<>VAL(MID$(CARD$(6),7,6)) THEN 2620
2700 K3=K3+1
2710 IF K3<10 THEN MID$(CARD$(6),5,2)=STR$(K3)
2720 IF K3>9 AND K3<100 THEN MID$(CARD$(6),4,3)=STR$(K3)
2730 IF K3>99 THEN MID$(CARD$(6),3,4)=STR$(K3)
2740 PRINT #2,CARD$(1):PRINT #2,CARD$(2):PRINT  #2,CARD$(3):PRINT
 #2,CARD$(4):PRINT #2,CARD$(5):PRINT #2,CARD$(6)
2750 GOTO 2620
2760 CLOSE
2770 CLS
2780 GOTO 3390
```

```
2790 OPEN F2$ FOR INPUT AS #1
2800 J=0
2810 IF EOF(1) GOTO 2920
2820 LINE INPUT #1,CARD$(1)
2830 LINE INPUT #1,CARD$(2)
2840 LINE INPUT #1,CARD$(3)
2850 LINE INPUT #1,CARD$(4)
2860 LINE INPUT #1,CARD$(5)
2870 LINE INPUT #1,CARD$(6)
2880 IF I<>VAL(MID$(CARD$(6),7,6)) THEN 2810
2890 J=J+1
2900 P$(J)=" "+MID$(CARD$(1),1,9)
2910 GOTO 2810
2920 CLOSE
2930 JMAX=J
2940 JCOL=INT(JMAX/18)
2950 IF JCOL*18<JMAX THEN JCOL=JCOL+1
2960 ROWMIN=3
2970 FOR J=1 TO JCOL
2980 IF J<JCOL THEN ROWMAX(J)=20
2990 IF J=JCOL THEN ROWMAX(J)=JMAX-(JCOL-1)*18+2
3000 NEXT J
3010 LOCATE 1,1:COLOR 1,0:PRINT "SELECT ISOTOPES TO BE  UP-LOADED
 TO TACT V NUCLIDE INPUT FILE ":COLOR 7,0
3020 KKEY=1
3030 FOR J=1 TO JCOL
3040 COL=(J-1)*10+1
3050 ROW=ROWMIN
3060 LOCATE ROW,COL:PRINT P$(KKEY)
3070 ROW=ROW+1
3080 KKEY=KKEY+1
3090 IF ROW<=ROWMAX(J) THEN 3060
3100 NEXT J
3110 SROW=3:SCOL=1:KKEY=1:J=1:M=1:GOSUB 180
3120 GOSUB 680
3130   LOCATE  8,33:COLOR  0,7:PRINT  "  PLEASE   WAIT!   ":COLOR
 7,0:LOCATE 10,25:COLOR 0,7:PRINT " OFF-LOADING SELECTED  ISOTOPES
 ":COLOR    7,0:LOCATE    12,29:COLOR   0,7:PRINT   "    IN    THE
 ";MID$(GRPNEW$(I),1,8);" GROUP ":COLOR 7,0
3140  LOCATE 14,26:COLOR 0,7:PRINT " TO THE TACT V  NUCLIDE  FILE
 ":COLOR 7,0
3150 KSTART=K3
3160 OPEN F2$ FOR INPUT AS #1
3170 OPEN F1$ FOR APPEND AS #2
3180 IF EOF(1) GOTO 3360
3190 LINE INPUT #1,CARD$(1)
3200 LINE INPUT #1,CARD$(2)
3210 LINE INPUT #1,CARD$(3)
3220 LINE INPUT #1,CARD$(4)
3230 LINE INPUT #1,CARD$(5)
3240 LINE INPUT #1,CARD$(6)
3250 IF I<>VAL(MID$(CARD$(6),7,6)) THEN 3180
3260 FOR J=1 TO JMAX
3270            IF            MID$(P$(J),1,1)="*"             AND
 MID$(P$(J),2,9)=MID$(CARD$(1),1,9) THEN 3290
```

```
3280 GOTO 3340
3290 K3=K3+1
3300 IF K3<10 THEN MID$(CARD$(6),5,2)=STR$(K3)
3310 IF K3>9 AND K3<100 THEN MID$(CARD$(6),4,3)=STR$(K3)
3320 IF K3>99 THEN MID$(CARD$(6),3,4)=STR$(K3)
3330 PRINT #2,CARD$(1):PRINT #2,CARD$(2):PRINT  #2,CARD$(3):PRINT
 #2,CARD$(4):PRINT #2,CARD$(5):PRINT #2,CARD$(6)
3340 NEXT J
3350 GOTO 3180
3360 CLOSE
3370 CLS
3380 IF K3=KSTART THEN 2550
3390 NEXT I
3400 KILL F2$
3410 CLS
3420 LOCATE 8,25:PRINT "THE NUCLIDE FILE '";MID$(F1$,3);"'"
3430   LOCATE   9,25:PRINT   "HAS   BEEN   CREATED   ON    DEVICE
 ";MID$(F1$,1,2)
3440 LOCATE 10,25:PRINT "AND HAS THE FOLLOWING ATTRIBUTES:"
3450 LOCATE 12,25:PRINT "NUMBER OF ORGANS ------------ ";K2
3460 LOCATE 14,25:PRINT "NUMBER OF ISOTOPIC GROUPS --- ";K1
3470 LOCATE 16,25:PRINT "NUMBER OF ISOTOPES ---------- ";K3
3480    LOCATE    20,30:PRINT    "STRIKE    ";:COLOR    0,7:PRINT
 CHR$(17);CHR$(196);CHR$(217);:COLOR 7,0:PRINT " TO CONTINUE"
3490 A$=INKEY$
3500 IF LEN(A$)=0 THEN 3490
3510 CHAIN "tact5mn.bas"
3520 END
```

TACT5MD.BAS

```
10 DIM P$(60),COLL(60),Q$(60),FRACT(5,3),ISELCT(60)
20 CLS
30 CLOSE
40 KEY OFF
50 GOTO 860
60 REM
70  REM  SUB-PROGRAM  USED TO ENTER DATA IN  RESPONSE  TO  SCREEN
 PROMPTS
80 REM
90 LOCATE ROW,COL:PRINT Z$
100 SSAVE$=Z$
110 LOCATE ROW,COL:COLOR 1,0:PRINT  MID$(Z$,COL-COLMIN+1,1):COLOR
 7,0:LOCATE ROW,COL
120 A$=INKEY$
130 IF LEN(A$)=0 THEN 120
140 IF LEN(A$)=2 THEN 190
150 IF ASC(A$)=13 THEN III%=0:GOTO 290
160 IF ASC(A$)=27 THEN III%=1:GOTO 290
170 IF ASC(A$)=8 THEN 220
180 GOTO 240
190   IF   ASC(RIGHT$(A$,1))=75  AND   COL>COLMIN   THEN   LOCATE
 ROW,COL:PRINT MID$(Z$,COL-COLMIN+1,1):COL=COL-1
200   IF   ASC(RIGHT$(A$,1))=77  AND   COL<COLMAX   THEN   LOCATE
 ROW,COL:PRINT MID$(Z$,COL-COLMIN+1,1):COL=COL+1
210 GOTO 110
220  IF  COL>COLMIN THEN  LOCATE  ROW,COL:PRINT  MID$(SSAVE$,COL-
 COLMIN+1,1):MID$(Z$,COL-COLMIN+1,1)=MID$(SSAVE$,COL-
 COLMIN+1,1):COL=COL-1
230 GOTO 110
240 LOCATE ROW,COL:PRINT MID$(A$,1,1)
250 MID$(Z$,COL-COLMIN+1,1)=MID$(A$,1,1)
260 LOCATE ROW,COL:PRINT MID$(A$,1,1)
270 IF COL<COLMAX THEN COL=COL+1
280 GOTO 110
290 LOCATE ROW,COLMIN:PRINT Z$:RETURN
300 REM
310  REM SUB-PROGRAM TO DISPLAY AND SELECT OPTIONS ON THE  SCREEN
 FOR
320 REM MULTI-COLUMN OR SINGLE COLUMN OPTIONS
330 REM
340 REM
350 REM DISPLAY HELP FOOTER ON SELECTION SCREENS
360 REM
370 LOCATE 21,1:PRINT CHR$(201);:FOR J9=1 TO 25:PRINT
 CHR$(205);:NEXT J9:PRINT CHR$(203);:FOR J9=1 TO 25:PRINT
 CHR$(205);:NEXT J9:PRINT CHR$(203);:FOR J9=1 TO 25:PRINT
 CHR$(205);:NEXT J9:PRINT CHR$(187)
380 LOCATE 22,1:PRINT CHR$(186):LOCATE 22,27:PRINT
 CHR$(186):LOCATE 22,53:PRINT CHR$(186):LOCATE 22,79:PRINT
 CHR$(186)
390 LOCATE 23,1:PRINT CHR$(200);:FOR J9=1 TO 25:PRINT
```

```
 CHR$(205);:NEXT J9:PRINT CHR$(202);:FOR J9=1 TO 25:PRINT
 CHR$(205);:NEXT J9:PRINT CHR$(202);:FOR J9=1 TO 25:PRINT
 CHR$(205);:NEXT J9:PRINT CHR$(188)
400 LOCATE 22,2:PRINT "Search For Selection ";:COLOR 0,7:PRINT
 CHR$(24);CHR$(25):COLOR 7,0
410 LOCATE 22,30:PRINT "Select/De-Select ";:COLOR 0,7:PRINT
 CHR$(17);CHR$(196);CHR$(217):COLOR 7,0
420  LOCATE 22,55:PRINT "Quit Selection Mode  ";:COLOR  0,7:PRINT
 "ESC":COLOR 7,0
430 REM
440 REM DISPLAY AND SELECT OPTIONS ON THE SCREEN FOR MULTI-COLUMN
 OR SINGLE
450 REM COLUMN OPTIONS
460 REM
470 ROW=SROW
480 LOCATE ROW,COLL(KKEY):COLOR 0,7:PRINT P$(KKEY):COLOR 7,0
490 A$=INKEY$
500 IF LEN(A$)=0 THEN 490
510 REM   CHECK FOR KEY STRIKE
520 IF LEN(A$)=2 THEN 730
530 IF LEN(A$)=1 AND ASC(A$)<>13 AND ASC(A$)<>27 THEN 490

540 IF ASC(A$)=13 GOTO 570
550 CLS
560 RETURN
570 IF M=1 GOTO 660
580 FOR KSEL=1 TO KEYMAX
590 IF KSEL=KKEY THEN 630
600 IF MID$(P$(KSEL),1,1)=" " THEN 630
610 MID$(P$(KSEL),1,1)=" "
620 LOCATE (ROWMIN+KSEL-1),COLL(KSEL):PRINT P$(KSEL)
630 NEXT KSEL
640 MID$(P$(KKEY),1,1)="*"
650 GOTO 720
660 IF MID$(P$(KKEY),1,1)<>" " THEN 700
670 MID$(P$(KKEY),1,1)="*"
680 ISELCT(KKEY)=1
690 GOTO 720
700 MID$(P$(KKEY),1,1)=" "
710 ISELCT(KKEY)=0
720 LOCATE ROW,COLL(KKEY):COLOR 0,7:PRINT P$(KKEY):COLOR 7,0
730 C=ASC(RIGHT$(A$,1))
740 LOCATE ROW,COLL(KKEY):PRINT P$(KKEY)
750 IF C=72 THEN ROW=ROW-1:KKEY=KKEY-1
760 IF C=80 THEN ROW=ROW+1:KKEY=KKEY+1
770 REM  CHANGE SELECTION
780 IF (ROW<ROWMIN) THEN ROW=ROWMAX:KKEY=KEYMAX
790 IF (ROW>ROWMAX) THEN ROW=ROWMIN:KKEY=KEYMIN
800 LOCATE ROW,COLL(KKEY):COLOR 0,7:PRINT  P$(KKEY):COLOR 7,0
810 GOTO 490
820 REM
```

```
830 REM INITIALIZING DATA AND OFF-LOADING NUCLEAR DATA TO BE USED
 IN
840 REM SCREEN SELECTIONS
850 REM
860 BLNK$="
870 LOCATE 8,1:PRINT "ENTER NAME OF TACT5 NUCLIDE DATA FILE "
880 LOCATE 9,1:PRINT "(INCLUDE DEVICE NAME IN FILE NAME"
890 LOCATE 10,1:PRINT " eg. B:NUCDATA)
900 LOCATE 8,40:INPUT "",F0$
910 CLS
920 LOCATE 8,1:PRINT "ENTER NAME OF TACT5 MODEL DATA FILE "
930 LOCATE 9,1:PRINT "(INCLUDE DEVICE NAME IN FILE NAME"
940 LOCATE 10,1:PRINT " eg. B:SEABROOK)"
950 LOCATE 8,37:INPUT "",F1$
960 CLS
970 LOCATE 10,33:COLOR 1,0:PRINT " PLEASE WAIT! ":COLOR
 7,0:LOCATE 12,27:COLOR 1,0:PRINT " OFF-LOADING NUCLEAR DATA
 ":COLOR 7,0
980 OPEN F0$ FOR INPUT AS #1
990 LINE INPUT #1,CARD$
1000 JGRP%=VAL(MID$(CARD$,1,6))
1010 LINE INPUT #1,CARD$
1020 LINE INPUT #1,CARD$
1030 FOR J%=1 TO JGRP%
1040 GRPNAM$(J%)=MID$(CARD$,(J%-1)*8+1,8)
1050 NEXT J%
1060 LINE INPUT #1,CARD$
1070 FOR J%=1 TO 3
1080 FRMNAM$(J%)=MID$(CARD$,(J%-1)*8+1,8)
1090 NEXT J%
1100 ISOMAX%=1
1110 IF EOF(1) THEN 1210
1120 LINE INPUT #1,CARD$
1130 Q$(ISOMAX%)=" "+MID$(CARD$,1,8)
1140 LINE INPUT #1,CARD$
1150 LINE INPUT #1,CARD$
1160 LINE INPUT #1,CARD$
1170 LINE INPUT #1,CARD$
1180 LINE INPUT #1,CARD$:Q$(ISOMAX%)=Q$(ISOMAX%)+MID$(CARD$,7,6)
1190 ISOMAX%=ISOMAX%+1
1200 GOTO 1110
1210 ISOMAX%=ISOMAX%-1
1220 CLOSE
1230 OPEN F1$ FOR OUTPUT AS #1
1240 KTAPE$=CHR$(39)+F0$+MID$(BLNK$,1,80-LEN(F0$))+CHR$(39)
1250 MTAPE$=MID$(F0$,1,2)+"MTAPE    ":LTAPE$=MID$(F0$,1,2)+"LTAPE
 ":NTAPE$=MID$(F0$,1,2)+"NTAPE
 ":X$=CHR$(39)+LTAPE$+CHR$(39)+CHR$(44)+CHR$(39)+MTAPE$+CHR$(39)
 +CHR$(44)+CHR$(39)+NTAPE$+CHR$(39):X$=X$+MID$(BLNK$,1,80-LEN(X$))
1260 PRINT #1,KTAPE$
1270 PRINT #1,X$
```

```
1280 CLS
1290 REM
1300 REM ENTER TIME INDEPENDENT TACT V MODEL DATA
1310 REM
1320 X$=""
1330 LOCATE 9,13:PRINT "You are allowed to enter a maximum of  50
 title cards."
1340  LOCATE 10,13:PRINT "Each title card will be prompted  by  a
 ";:COLOR 1,0:PRINT "<";:COLOR 7,0:PRINT " and entry is"
1350  LOCATE  11,13:PRINT "made by  striking  ";:COLOR  0,7:PRINT
 CHR$(17);CHR$(196);CHR$(217);:COLOR  7,0:PRINT " after  you  have
 keyed in your text."
1360  LOCATE 12,13:PRINT "When you have entered your  last  title
 card,  you  enter  ":LOCATE  13,13:COLOR  0,7:PRINT  "ESC";:COLOR
 7,0:PRINT " to continue with your next TACT5 input parameter."
1370 LOCATE 16,26:PRINT "(STRIKE ANY KEY TO CONTINUE)"
1380 A$=INKEY$
1390 IF LEN(A$)=0 THEN 1380
1400 CLS
1410 LOCATE 1,35:COLOR 0,7:PRINT "TITLE CARDS":COLOR 7,0
1420 BLNK$="
 "
1430 ROW=2:I%=0
1440  COLMIN=1:COLMAX=78:COL=COLMIN:Z$="<"+MID$(BLNK$,1,77):GOSUB
 90
1450 IF II1%=1 THEN 1550
1460 X$=CHR$(39)+Z$+CHR$(39)
1470 PRINT #1,X$
1480 I%=I%+1
1490 ROW=ROW+1
1500 IF ROW<=23 THEN 1540
1510 LOCATE 1,1:PRINT BLNK$;
1520 LOCATE 1,35:COLOR 0,7:PRINT "TITLE CARDS";:COLOR 7,0
1530 ROW=23
1540 IF I<51 THEN 1440
1550 X$=CHR$(39)+MID$(BLNK$,1,78)+CHR$(39)
1560 PRINT #1,X$
1570 X$=""
1580 CLS
1590 FOR J=1 TO 5
1600 IPRINT(J)=1
1610 NEXT J
1620 LOCATE 5,22:COLOR 1,0:PRINT "ENTER PRINT OPTION(S) (DEFAULT
 IS 1)":COLOR 7,0
1630 LOCATE 7,17:PRINT "PRINT ACTIVITIES FOR EACH TIME STEP
 "
1640 LOCATE 9,17:PRINT "PRINT DOSES FOR EACH TIME STEP
 "
1650 LOCATE 11,17:PRINT "PRINT ACTIVITIES AND DOSES FOR EACH TIME
 STEP "
1660 LOCATE 13,17:PRINT "PRINT SUMMARY FOR EACH TIME STEP
```

```
 "
1670 LOCATE 15,17:PRINT "PRINT ALL OF THE ABOVE OPTIONS
 "
1680 X$=""
1690 FOR J%=1 TO 5
1700 ROW=(J%-1)*2+7:COL=64:COLMIN=64:COLMAX=64:Z$="1"
1710 GOSUB 90
1720 IF J%<>5 THEN X$=X$+" "+Z$+CHR$(44)
1730 IF J%=5 THEN X$=X$+" "+Z$
1740 NEXT J%
1750 PRINT #1,X$
1760 X$=""
1770 CLS
1780 LOCATE 2,19:COLOR 1,0:PRINT "ENTER THE FOLLOWING TACT5 INPUT
 PARAMETERS":COLOR 7,0
1790 X$=""
1800 LOCATE 4,20:PRINT "ENTER NUMBER OF NODES                    "
1810 LOCATE 5,20:PRINT "(MAXIMUM ALLOWED=4)"
1820 LOCATE 7,20:PRINT "ENTER NUMBER OF DOSE EVALUATION POINTS "
1830 LOCATE 8,20:PRINT "(MAXIMUM ALLOWED=3)"
1840 ROW=4:COL=60:COLMIN=60:COLMAX=60:Z$=" ":GOSUB 90
1850 NODES%=VAL(Z$)
1860 X$=" "+STR$(NODES%)+CHR$(44)
1870 ROW=7:COL=60:COLMIN=60:COLMAX=60:Z$=" ":GOSUB 90
1880 NXQ%=VAL(Z$)
1890 X$=X$+" "+STR$(NXQ%)
1900 PRINT #1,X$
1910 X$=""
1920 FOR J%=1 TO NODES%
1930 ROW=(J%-1)*2+10
1940 LOCATE ROW,31:PRINT "NAME FOR NODE ";MID$(STR$(J%),2,1)
1950 NEXT J%
1960 FOR J%=1 TO NODES%
1970              ROW=(J%-1)*2+10:COL=49:COLMIN=49:COLMAX=56:Z$="
 ":GOSUB 90
1980 NODNAM$(J%)=Z$
1990                IF                J%<>NODES%                THEN
 X$=X$+CHR$(39)+MID$(NODNAM$(J%),1,8)+CHR$(39)+CHR$(44)
2000                IF                J%=NODES%                 THEN
 X$=X$+CHR$(39)+MID$(NODNAM$(J%),1,8)+CHR$(39)
2010 NEXT J%
2020 PRINT #1,X$
2030 X$=""
2040 ROW=2*NODES%+10
2050 LOCATE ROW,25:PRINT "ENTER NUMBER OF TIME STEPS "
2060 COL=52:COLMIN=52:COLMAX=54:Z$="   ":GOSUB 90
2070 NSTEP%=VAL(Z$)
2080 X$=STR$(NSTEP%)
2090 PRINT #1,X$
2100 CLS
2110 X$=""
```

```
2120 LOCATE 2,19:COLOR 1,0:PRINT "ENTER THE FOLLOWING TACT5 INPUT
 PARAMETERS":COLOR 7,0
2130 LOCATE 4,25:COLOR 1,0:PRINT "ENTER POWER (Mwt)":COLOR 7,0
2140 LOCATE 6,17:PRINT "ENTER LAPSED TIME BETWEEN REACTOR"
2150   LOCATE  7,17:COLOR  1,0:PRINT  "SHUTDOWN  AND  START  OF
 ACCIDENT":COLOR 7,0
2160   LOCATE   9,28:COLOR  1,0:PRINT  "CORE  RELEASE  FRACTION
 AND":COLOR 7,0
2170 LOCATE 10,16:COLOR 1,0:PRINT "INSTANTANEOUS PLATE OUT FACTOR
 BY ISOTOPIC GROUP":COLOR 7,0
2180 LOCATE 12,1:COLOR 1,0:PRINT "PARAMETER":COLOR 7,0
2190 FOR J%=1 TO JGRP%
2200 COL=(J%-1)*12+20
2210 LOCATE 12,COL:COLOR 1,0:PRINT GRPNAM$(J%):COLOR 7,0
2220 NEXT J%
2230 LOCATE 13,1:PRINT "RELEASE FRACTION"
2240 LOCATE 14,1:PRINT "PLATE OUT FACTOR"
2250  LOCATE  16,25:COLOR 1,0:PRINT "ISOTOPIC  FORM  BY  ISOTOPIC
 GROUP":COLOR 7,0
2260 LOCATE 18,1:COLOR 1,0:PRINT "ISOTOPIC FORM":COLOR 7,0
2270 FOR J%=1 TO JGRP%
2280 COL=(J%-1)*12+20
2290 LOCATE 18,COL:COLOR 1,0:PRINT GRPNAM$(J%):COLOR 7,0
2300 NEXT J%
2310     LOCATE    19,1:PRINT    FRMNAM$(1):LOCATE     20,1:PRINT
 FRMNAM$(2):LOCATE 21,1:PRINT FRMNAM$(3)
2320 ROW=4:COL=43:COLMIN=43:COLMAX=51:Z$="0.000E+00":GOSUB 90
2330 POWER$=" "+Z$
2340 X$=POWER$+CHR$(44)
2350 ROW=7:COL=51:COLMIN=51:COLMAX=59:Z$="0.000E+00":GOSUB 90
2360 SDTIME$=" "+Z$
2370 X$=X$+SDTIME$
2380 PRINT #1,X$
2390 X$=""
2400 FOR J%=1 TO JGRP%
2410                          ROW=13:COLMIN=(J%-1)*12+20:COLMAX=(J%-
 1)*12+28:COL=COLMIN:Z$="0.000E+00":GOSUB 90
2420 RELF$(J%)=" "+Z$
2430 IF J%<JGRP% THEN X$=X$+RELF$(J%)+CHR$(44)
2440 IF J%=JGRP% THEN X$=X$+RELF$(J%)
2450 NEXT J%
2460 PRINT #1,X$
2470 X$=""
2480 FOR J%=1 TO JGRP%
2490 ROW=14:COLMIN=(J%-1)*12+20:COLMAX=(J%-1)*12+28:COL=
 COLMIN:Z$="0.000E+00":GOSUB 90
2500 PLTOUT$(J%)=" "+Z$
2510 IF J%<JGRP% THEN X$=X$+PLTOUT$(J%)+CHR$(44)
2520 IF J%=JGRP% THEN X$=X$+PLTOUT$(J%)
2530 NEXT J%
2540 PRINT #1,X$
```

```
2550 X$=""
2560 FOR J%=1 TO JGRP%
2570 ROW=19:COLMIN=(J%-1)*12+20:COLMAX=(J%-1)*12+28
2580 FOR I%=1 TO 3
2590 COL=COLMIN:Z$="0.000E+00":GOSUB 90
2600 FORM$(I%)=" "+Z$
2610 FRACT(J%,I%)=VAL(FORM$(I%))
2620 IF I%<3 THEN X$=X$+FORM$(I%)+CHR$(44)
2630 IF I%=3 THEN X$=X$+FORM$(I%)
2640 ROW=ROW+1
2650 NEXT I%
2660 PRINT #1,X$
2670 X$=""
2680 NEXT J%
2690 CLS
2700 LOCATE 2,19:COLOR 1,0:PRINT "ENTER THE FOLLOWING TACT5 INPUT
 PARAMETERS":COLOR 7,0
2710 LOCATE 4,29:COLOR 1,0:PRINT "VOLUME OF NODES  (FT**3)":COLOR
 7,0
2720 FOR J%=1 TO NODES%
2730 COL=(J%-1)*12+20
2740 LOCATE 5,COL:PRINT NODNAM$(J%)
2750 NEXT J%
2760 FOR J%=1 TO NODES%
2770                          ROW=6:COLMIN=(J%-1)*12+20:COLMAX=(J%-
 1)*12+28:COL=COLMIN:Z$="0.000E+00":GOSUB 90
2780 VOL$(J%)=" "+Z$
2790 IF J%<NODES% THEN X$=X$+VOL$(J%)+CHR$(44)
2800 IF J%=NODES% THEN X$=X$+VOL$(J%)
2810 NEXT J%
2820 PRINT #1,X$
2830 X$=""
2840 REM
2850 REM ENTER TACT V TIME DEPENDENT DATA
2860 REM
2870 FOR ISTEP%=1 TO NSTEP%
2880 CLS
2890  LOCATE 8,12:COLOR 1,0:PRINT "ENTER THE START TIME  AND  END
 TIME FOR TIME STEP # ";ISTEP%:COLOR 7,0
2900  LOCATE  10,23:COLOR  1,0:PRINT  "START  TIME   (HRS)":COLOR
 7,0:LOCATE 10,44:COLOR 1,0:PRINT "END TIME (HRS)":COLOR 7,0
2910 X$=CHR$(39)+"TIME INTERVAL   "+CHR$(39)+",0,0,0,0,2,"
2920 ROW=11:COL=23:COLMIN=23:COLMAX=31:Z$="0.000E+00":GOSUB 90
2930 START$=" "+Z$
2940 X$=X$+START$+CHR$(44)
2950 ROW=11:COL=44:COLMIN=44:COLMAX=52:Z$="0.000E+00":GOSUB 90
2960 ENDTIM$=" "+Z$
2970 X$=X$+ENDTIM$
2980 PRINT #1,X$
2990 X$=""
3000 CLS
```

```
3010  P$(1)=" DISTRIBUTION OF INITIAL ACTIVITY (FRACTION)
 ":COLL(1)=18
3020  P$(2)=" RELEASE RATE OF CONTINUEOUS ACTIVITY RELEASE
 (FRACTION/HR) ":COLL(2)=10
3030 P$(3)=" DISTRIBUTION OF INITIAL ACTIVITY (CI) ":COLL(3)=21
3040 P$(4)=" RELEASE RATE OF CONTINUEOUS ACTIVITY RELEASE (CI/HR)
 ":COLL(4)=13
3050 P$(5)=" REMOVAL RATES FOR CHEMICAL SPRAYS ":COLL(5)=23
3060 P$(6)=" FILTER EFFICIENCIES (%) FOR FILTERS ":COLL(6)=22
3070  P$(7)=" TRANSFER RATES BETWEEN NODES IN CFM UNITS
 ":COLL(7)=19
3080  P$(8)=" TRANSFER RATES BETWEEN NODES IN %/DAY UNITS
 ":COLL(8)=18
3090 P$(9)=" TRAVEL TIME TO RECEPTOR POINTS TO ACCOUNT FOR DECAY
 ENROUTE (HRS) ":COLL(9)=7
3100  P$(10)=" X/Q'S, BREATHING RATES AND CONTAINMENT LEAK RATE
 ":COLL(10)=15
3110  P$(11)=" QUIT ENTERING PARAMETERS FOR THIS TIME STEP
 ":COLL(11)=18
3120  CLS:LOCATE 1,8:COLOR 1,0:PRINT "SELECT TACT 5 MODEL
 PARAMETERS TO BE INPUT FOR TIME STEP # ";ISTEP%:COLOR 7,0:FOR
 J%=1 TO 11:LOCATE J%+3,COLL(J%):PRINT P$(J%):NEXT J%
3130 ROWMIN=4:ROWMAX=14:KEYMIN=1:KEYMAX=11:SROW=4:KKEY=1:M=0:GOSUB 370
3140 FOR J%=1 TO 11
3150 IF MID$(P$(J%),1,1)="*" THEN 3180
3160 NEXT J%
3170 GOTO 3010
3180 K%=J%
3190 ON K% GOTO
3200,3200,3580,3580,4060,4350,4700,4700,5160,5300,5480
3200 CLS
3210 ON K% GOTO 3220,3250
3220 LOCATE 10,18:PRINT "DO YOU WANT THE INITIAL DISTRIBUTION TO"
3230  LOCATE 11,18:INPUT "BE INDEPENDENT OF THE ISOTOPIC GROUPS
 (Y/N) ";A$
3240 GOTO 3270
3250 LOCATE 10,20:PRINT "DO YOU WANT THE RELEASE RATE TO BE"
3260 LOCATE 11,20:INPUT "INDEPENDENT OF THE ISOTOPIC GROUPS (Y/N)
 ";A$
3270 CLS
3280  IF K%=1 THEN LOCATE 5,12:COLOR 1,0:PRINT "ENTER INITIAL
 ACTIVITY IN EACH NODE FOR TIME STEP # ";ISTEP%:COLOR 7,0
3290 IF K%=2 THEN LOCATE 5,14:COLOR 1,0:PRINT "ENTER RELEASE RATE
 IN EACH NODE FOR TIME STEP # ";ISTEP%:COLOR 7,0
3300 IF A$<>"Y" AND A$<>"y" THEN 3420
3310  LOCATE 7,16:FOR J%=1 TO NODES%:LOCATE 7,(J%-1)*12+17:COLOR
 1,0:PRINT NODNAM$(J%):COLOR 7,0:NEXT J%
3320        IF       K%=1        THEN        X$=CHR$(39)+"INITIAL
 FRACTION"+CHR$(39)+CHR$(44)+"0,0,0,0,"+MID$(STR$(NODES%),2,1)+CHR$(44)
3330        IF       K%=2        THEN        X$=CHR$(39)+"RELEASE
 FRACTION"+CHR$(39)+CHR$(44)+"0,0,0,0,"+MID$(STR$(NODES%),2,1)+CHR$(44)
```

```
3340 FOR J%=1 TO NODES%
3350    ROW=8:COLMIN=(J%-1)*12+17:COLMAX=(J%-1)*12+25:COL=COLMIN:
 Z$="0.000E+00":GOSUB 90
3360 IF J%<>NODES% THEN X$=X$+" "+Z$+CHR$(44)
3370 IF J%=NODES% THEN X$=X$+" "+Z$
3380 NEXT J%
3390 PRINT #1,X$
3400 X$=""
3410 GOTO 2990
3420 LOCATE 7,2:COLOR 1,0:PRINT "ISOTOPIC GROUP":COLOR 7,0:LOCATE
 7,16:FOR J%=1 TO NODES%:LOCATE 7,(J%-1)*12+17:COLOR 1,0:PRINT
 NODNAM$(J%):COLOR 7,0:NEXT J%
3430 ROW=8
3440 FOR JO%=1 TO JGRP%
3450 IF K%=1 THEN X$=CHR$(39)+"INITIAL
 FRACTION"+CHR$(39)+CHR$(44)
 +MID$(STR$(JO%),2,1)+CHR$(44)+"0,0,0,"+MID$(STR$(NODES%),2,1)+CHR$(44)
3460 IF K%=2 THEN X$=CHR$(39)+"RELEASE
 FRACTION"+CHR$(39)+CHR$(44)+MID$(STR$(JO%),2,1)+CHR$(44)+"0,0,0,"
 +MID$(STR$(NODES%),2,1)+CHR$(44)
3470 LOCATE ROW,5:PRINT GRPNAM$(JO%)
3480 FOR J%=1 TO NODES%
3490       COLMIN=(J%-1)*12+17:COLMAX=(J%-1)*12+25:COL=COLMIN:Z$=
 "0.000E+00":GOSUB 90
3500 IF J%<>NODES% THEN X$=X$+" "+Z$+CHR$(44)
3510 IF J%=NODES% THEN X$=X$+" "+Z$
3520 NEXT J%
3530 PRINT #1,X$
3540 X$=""
3550 ROW=ROW+1
3560 NEXT JO%
3570 GOTO 2990
3580 CLS
3590 FOR J%=1 TO ISOMAX%
3600 P$(J%)=MID$(Q$(J%),1,9):COLL(J%)=36
3610 NEXT J%
3620  IF K%=3 THEN LOCATE 1,10:COLOR 1,0:PRINT  "SELECT  ISOTOPES
 FOR WHICH YOU WANT TO ENTER DISTRIBUTION (CI)":COLOR 7,0
3630 IF K%=4 THEN LOCATE 1,8:COLOR 1,0:PRINT "SELECT ISOTOPES FOR
 WHICH YOU WANT TO ENTER RELEASE RATES (CI/HR)":COLOR 7,0
3640 J1%=1
3650 ROW=3
3660 FOR J%=1 TO ISOMAX%
3670 LOCATE ROW,36:PRINT P$(J%)
3680 ROW=ROW+1
3690 IF ROW<21 AND J%<>ISOMAX% THEN 3780
3700 J2%=J%
3710 IF J2%-J1%+1=18 THEN 3750
3720 LOCATE ROW,1:PRINT MID$(BLNK$,1,79)
3730 ROW=ROW+1
3740 IF ROW<21 THEN 3720
```

```
3750   ROWMIN=3:ROWMAX=J2%-J1%+3:KEYMIN=J1%:KEYMAX=J2%:M=1:SROW=3
 :KKEY=J1%:GOSUB 370
3760 J1%=J2%+1
3770 ROW=3
3780 NEXT J%
3790 CLS
3800 IF K%=3 THEN LOCATE 1,9:COLOR 1,0:PRINT "ENTER  DISTRIBUTION
 (CI) FOR EACH ISOTOPE AND FORM IN EACH NODE":COLOR 7,0
3810 IF K%=4 THEN LOCATE 1,8:COLOR 1,0:PRINT "ENTER RELEASE  RATE
 (CI/HR) FOR EACH ISOTOPE AND FORM IN EACH NODE":COLOR 7,0
3820  LOCATE  3,8:COLOR  1,0:PRINT  "ISOTOPE  ":COLOR  7,0:LOCATE
 3,17:COLOR   1,0:PRINT   "   FORM   ":COLOR   7,0:FOR   J%=1   TO
 NODES%:LOCATE   3,(J%-1)*12+26:COLOR   1,0:PRINT    NODNAM$(J%);"
 ":COLOR 7,0:NEXT J%
3830 ROW=4
3840 K0%=1
3850 FOR J0%=1 TO ISOMAX%
3860 FOR J1%=1 TO 3
3870 J5%=VAL(MID$(Q$(J0%),10,6))
3880 IF FRACT(J5%,J1%)=0 THEN 4030
3890 IF MID$(P$(J0%),1,1)<>"*" THEN 4010
3900  LOCATE  ROW,8:PRINT  MID$(P$(J0%),2,8):LOCATE  ROW,17:PRINT
 FRMNAM$(J1%)
3910     IF     K%=3     THEN     X$=CHR$(39)+"INITIAL     CURIES
 "+CHR$(39)+CHR$(44)+"0,0,"+MID$(STR$(K0%),2,LEN(STR$(K0%))-
 1)+CHR$(44)+"0,"+MID$(STR$(NODES%),2,1)
3920     IF     K%=4     THEN     X$=CHR$(39)+"RELEASE     CURIES
 "+CHR$(39)+CHR$(44)+"0,0,"+MID$(STR$(K0%),2,LEN(STR$(K0%))-
 1)+CHR$(44)+"0,"+MID$(STR$(NODES%),2,1)
3930 FOR J2%=1 TO NODES%
3940 COLMIN=(J2%-1)*12+26:COLMAX=COLMIN+8:COL=COLMIN:GOSUB 90
3950 IF II1%=1 THEN LOCATE ROW,1:PRINT MID$(BLNK$,1,79):GOTO 4010
3960 X$=X$+CHR$(44)+" "+Z$
3970 NEXT J2%
3980 PRINT #1,X$
3990 X$=""
4000 ROW=ROW+1
4010 K0%=K0%+1
4020 IF K0%>60 THEN 4050
4030 NEXT J1%
4040 NEXT J0%
4050 GOTO 2990
4060 CLS
4070 FOR J%=1 TO JGRP%
4080 P$(J%)=" "+GRPNAM$(J%)+" "
4090 COLL(J%)=35
4100 NEXT J%
4110  LOCATE  3,20:PRINT "SELECT ISOTOPIC GROUPS  FOR  WHICH  YOU
 WILL":LOCATE  4,20:COLOR 1,0:PRINT "ENTER CHEMICAL SPRAY  REMOVAL
 COEFFICIENTS":COLOR 7,0
4120 FOR J%=1 TO JGRP%
```

```
4130 LOCATE (J%-1)+6,COLL(J%):PRINT P$(J%)
4140 NEXT J%
4150 ROWMIN=6:ROWMAX=JGRP%+5:KEYMIN=1:KEYMAX=JGRP%:KKEY=1:
 SROW=6:M=1:GOSUB 370
4160 FOR J0%=1 TO JGRP%
4170 IF MID$(P$(J0%),1,1)<>"*" THEN 4330
4180  LOCATE  2,6:COLOR 1,0:PRINT "ENTER CHEMICAL  SPRAY  REMOVAL
 RATES IN EACH NODE FOR TIME STEP # ";ISTEP%:COLOR 7,0
4190  LOCATE  4,24:COLOR  1,0:PRINT  "REMOVAL  COEFFICIENTS   FOR
 ";GRPNAM$(J0%):COLOR 7,0
4200  LOCATE  6,2:COLOR 1,0:PRINT  "FORM  NAME":COLOR  7,0:LOCATE
 6,16:FOR  J%=1  TO NODES%:LOCATE  6,(J%-1)*12+17:COLOR  1,0:PRINT
 NODNAM$(J%):COLOR 7,0:NEXT J%
4210 FOR J1%=1 TO 3
4220 X$=CHR$(39)+"REMOVAL RATE    "+CHR$(39)+CHR$(44)+MID$
 (STR$(J0%),2,1)+CHR$(44)+MID$(STR$(J1%),2,1)+CHR$(44)+"0,0,"+
 MID$(STR$(NODES%),2,1)+CHR$(44)
4230 LOCATE J1%+6,2:PRINT FRMNAM$(J1%)
4240 FOR J%=1 TO NODES%
4250 ROW=J1%+6:COLMIN=(J%-1)*12+17:COLMAX=(J%-1)*12+25:COL=
 COLMIN:Z$="0.000E+00":GOSUB 90
4260 IF J%<>NODES% THEN X$=X$+" "+Z$+CHR$(44)
4270 IF J%=NODES% THEN X$=X$+" "+Z$
4280 NEXT J%
4290 PRINT #1,X$
4300 X$=""
4310 NEXT J1%
4320 CLS
4330 NEXT J0%
4340 GOTO 2990
4350 CLS
4360 ON K%-5 GOTO 4370,4710,4740
4370 CLS
4380 FOR J%=1 TO JGRP%
4390 P$(J%)=" "+GRPNAM$(J%)+" "
4400 COLL(J%)=35
4410 NEXT J%
4420 LOCATE 3,23:PRINT "SELECT ISOTOPIC GROUPS FOR  WHICH":LOCATE
 4,23:COLOR  1,0:PRINT "YOU WILL ENTER FILTER  EFFICIENCIES":COLOR
 7,0
4430 FOR J%=1 TO JGRP%
4440 LOCATE (J%-1)+6,COLL(J%):PRINT P$(J%)
4450 NEXT J%
4460 ROWMIN=6:ROWMAX=JGRP%+5:KEYMIN=1:KEYMAX=JGRP%:KKEY=1:
SROW=6:M=1:GOSUB 370
4470 CLS
4480 FOR J2%=1 TO JGRP%
4490 IF MID$(P$(J2%),1,1)<>"*" THEN 4680
4500 FOR J1%=1 TO 3
4510   LOCATE  5,10:COLOR  1,0:PRINT  "FILTER  EFFICIENCIES   FOR
 ";GRPNAM$(J2%);" GROUP AND ";FRMNAM$(J1%);" FORM":COLOR 7,0
```

```
4520  LOCATE 3,10:COLOR 1,0:PRINT "ENTER FILTER EFFICIENCIES  FOR
 EACH NODE FOR TIME STEP # ";ISTEP%:COLOR 7,0
4530  LOCATE  7,4:COLOR  1,0:PRINT "   FROM   ":COLOR  7,0:LOCATE
 7,12:PRINT "  TO  ":COLOR 1,0:LOCATE 7,18:PRINT "ENV.     ":COLOR
 7,0:FOR  J%=1  TO  NODES%:LOCATE  7,(J%-1)*12+30:COLOR  1,0:PRINT
 NODNAM$(J%):COLOR 7,0:NEXT J%
4540 FOR J0%=1 TO NODES%
4550 X$=CHR$(39)+"FILTER EFF       "+CHR$(39)+CHR$(44)+MID$(STR$
 (J2%),2,1)+CHR$(44)+MID$(STR$(J1%),2,1)+CHR$(44)+"0,"+MID$(STR$
 (J0%),2,1)+CHR$(44)+MID$(STR$(NODES%+1),2,1)+CHR$(44)
4560 ROW=(J0%-1)+8
4570 LOCATE ROW,5:PRINT NODNAM$(J0%)
4580 FOR J%=1 TO NODES%+1
4590 COLMIN=(J%-1)*12+18:COLMAX=(J%-1)*12+26:COL=COLMIN:Z$=
 "0.000E+00":GOSUB 90
4600 IF J%<>NODES%+1 THEN X$=X$+" "+Z$+CHR$(44)
4610 IF J%=NODES%+1 THEN X$=X$+" "+Z$
4620 NEXT J%
4630 PRINT #1,X$
4640 X$=""
4650 NEXT J0%
4660 CLS
4670 NEXT J1%
4680 NEXT J2%
4690 GOTO 2990
4700 CLS
4710 LOCATE 10,18:PRINT "DO YOU WANT THE INITIAL DISTRIBUTION TO"
4720  LOCATE 11,18:INPUT "BE INDEPENDENT OF THE  ISOTOPIC  GROUPS
 (Y/N) ";A$
4730 GOTO 4760
4740 LOCATE 10,20:PRINT "DO YOU WANT THE RELEASE RATE TO BE"
4750 LOCATE 11,20:INPUT "INDEPENDENT OF THE ISOTOPIC GROUPS (Y/N)
 ";A$
4760 CLS
4770 IF A$<>"Y" AND A$<>"y" THEN 4960
4780  IF  K%=7 THEN LOCATE 3,9:COLOR  1,0:PRINT  "ENTER  TRANSFER
 RATES IN CFM FOR EACH NODE FOR TIME STEP # ";ISTEP%:COLOR 7,0
4790  IF  K%=8 THEN LOCATE 3,3:COLOR  1,0:PRINT  "ENTER  TRANSFER
 RATES  IN  PERCENT  PER  DAY  FOR  EACH  NODE  FOR  TIME  STEP  #
 ";ISTEP%:COLOR 7,0
4800  LOCATE  7,4:COLOR  1,0:PRINT "   FROM   ":COLOR  7,0:LOCATE
 7,12:PRINT "  TO  ":COLOR 1,0:LOCATE 7,18:PRINT "ENV.     ":COLOR
 7,0:FOR  J%=1  TO  NODES%:LOCATE  7,(J%-1)*12+30:COLOR  1,0:PRINT
 NODNAM$(J%):COLOR 7,0:NEXT J%
4810 ROW=8
4820 FOR J0%=1 TO NODES%
4830 IF K%=7 THEN X$=CHR$(39)+"TRANSFER CFM
 "+CHR$(39)+CHR$(44)+"0,0,0,"+MID$(STR$(J0%),2,1)+CHR$(44)+MID$
 (STR$(NODES%+1),2,1)+CHR$(44)
4840 IF K%=8 THEN X$=CHR$(39)+"TRANSFER PERCENT"+CHR$(39)+CHR$(44)
 +"0,0,0,"+MID$(STR$(J0%),2,1)+CHR$(44)+MID$(STR$(NODES%+1),2,1)
```

```
 +CHR$(44)
4850 ROW=(J0%-1)+8
4860 LOCATE ROW,5:PRINT NODNAM$(J0%)
4870 FOR J%=1 TO NODES%+1
4880 COLMIN=(J%-1)*12+18:COLMAX=(J%-1)*12+26:COL=COLMIN:Z$=
 "0.000E+00":GOSUB 90
4890 IF J%<>NODES%+1 THEN X$=X$+" "+Z$+CHR$(44)
4900 IF J%=NODES%+1 THEN X$=X$+" "+Z$
4910 NEXT J%
4920 PRINT #1,X$
4930 X$=""
4940 NEXT J0%
4950 GOTO 2990
4960 CLS
4970 FOR J1%=1 TO JGRP%
4980  IF  K%=7 THEN LOCATE 3,9:COLOR  1,0:PRINT  "ENTER  TRANSFER
 RATES IN CFM FOR EACH NODE FOR TIME STEP # ";ISTEP%:COLOR 7,0
4990  IF  K%=8 THEN LOCATE 3,3:COLOR  1,0:PRINT  "ENTER  TRANSFER
 RATES  IN  PERCENT  PER  DAY  FOR  EACH  NODE  FOR  TIME  STEP  #
 ";ISTEP%:COLOR 7,0
5000  LOCATE  7,4:COLOR  1,0:PRINT "   FROM   ":COLOR  7,0:LOCATE
 7,12:PRINT "  TO  ":COLOR 1,0:LOCATE 7,18:PRINT "ENV.     ":COLOR
 7,0:FOR  J%=1  TO  NODES%:LOCATE  7,(J%-1)*12+30:COLOR  1,0:PRINT
 NODNAM$(J%):COLOR 7,0:NEXT J%
5010 FOR J0%=1 TO NODES%
5020      IF     K%=7     THEN     X$=CHR$(39)+"TRANSFER      CFM
 "+CHR$(39)+CHR$(44)+MID$(STR$(J1%),2,1)+CHR$(44)+"0,0,"+MID$
 (STR$(J0%),2,1)+CHR$(44)+MID$(STR$(NODES%+1),2,1)+CHR$(44)
5030 IF K%=8 THEN X$=CHR$(39)+"TRANSFER  PERCENT"+CHR$(39)+CHR$
 (44)+MID$(STR$(J1%),2,1)+CHR$(44)+"0,0,"+MID$(STR$(J0%),2,1)+
 CHR$(44)+MID$(STR$(NODES%+1),2,1)+CHR$(44)
5040 ROW=(J0%-1)+8
5050 LOCATE ROW,5:PRINT NODNAM$(J0%)
5060 FOR J%=1 TO NODES%+1
5070 COLMIN=(J%-1)*12+18:COLMAX=(J%-1)*12+26:COL=COLMIN:Z$=
 "0.000E+00":GOSUB 90
5080 IF J%<>NODES%+1 THEN X$=X$+" "+Z$+CHR$(44)
5090 IF J%=NODES%+1 THEN X$=X$+" "+Z$
5100 NEXT J%
5110 PRINT #1,X$
5120 X$=""
5130 NEXT J0%
5140 NEXT J1%
5150 GOTO 2990
5160 CLS
5170 LOCATE 5,10:COLOR 1,0:PRINT "TRAVEL TIME FROM RELEASE  POINT
 TO RECEPTOR POINT (HRS)":COLOR 7,0
5180   COL1=(80-12*NXQ%)/2:FOR   J%=1   TO   NXQ%:LOCATE   7,(J%-
 1)*12+COL1:PRINT "  RECEPTOR  ":NEXT J%
5190  FOR J%=1 TO NXQ%:LOCATE 8,(J%-1)*12+COL1:COLOR 1,0:PRINT  "
 POINT ";MID$(STR$(J%),2,1);" ":COLOR 7,0:NEXT J%
```

```
5200 X$=CHR$(39)+"TRAVEL TIME
 "+CHR$(39)+CHR$(44)+"0,0,0,0,"+MID$(STR$(NXQ%),2,1)+CHR$(44)
5210 FOR J%=1 TO NXQ%
5220 ROW=9:COLMIN=(J%-1)*12+COL1:COL=COLMIN:COLMAX=COLMIN+8:Z$=
 "0.000E+00":GOSUB 90
5230 IF J%<>NXQ% THEN X$=X$+" "+Z$+CHR$(44)
5240 IF J%=NXQ% THEN X$=X$+" "+Z$
5250 NEXT J%
5260 PRINT #1,X$
5270 CLS
5280 X$=""
5290 GOTO 2990
5300 CLS
5310  LOCATE  5,1:COLOR 1,0:PRINT  "X/Q'S  (SEC/M**3),  BREATHING
 RATES (M**3/SEC), AND CONTAINMENT LEAK RATE (%/DAY)":COLOR 7,0
5320   COL1=(80-24*NXQ%)/2:FOR   J%=1   TO   NXQ%:LOCATE   7,(J%-
 1)*24+COL1:PRINT "  RECEPTOR  ":LOCATE  7,(J%-1)*24+COL1+12:PRINT
 " BREATHING  ":NEXT J%
5330  FOR  J%=1 TO NXQ%:LOCATE  8,(J%-1)*24+COL1:COLOR  1,0:PRINT
 "POINT   ";MID$(STR$(J%),2,1);"  X/Q":COLOR   7,0:LOCATE   8,(J%-
 1)*24+COL1+12:COLOR 1,0:PRINT "    RATE   ":COLOR 7,0:NEXT J%
5340  LOCATE  11,32:PRINT "CONTAINMENT  LEAK":LOCATE  12,32:COLOR
 1,0:PRINT "  RATE (%/DAY)  ":COLOR 7,0
5350 X$=CHR$(39)+"DOSE PARAMS     "+CHR$(39)+CHR$(44)+"0,0,0,0,"
 +MID$(STR$(2*NXQ%+1),2,1)+CHR$(44)
5360 FOR J%=1 TO NXQ%
5370 ROW=9:COLMIN=(J%-1)*24+COL1:COL=COLMIN:COLMAX=COLMIN+8:Z$=
 "0.000E+00":GOSUB 90
5380 X$=X$+" "+Z$+CHR$(44)
5390 ROW=9:COLMIN=(J%-1)*24+COL1+12:COL=COLMIN:COLMAX=COLMIN+8:
 Z$="0.000E+00":GOSUB 90
5400 X$=X$+" "+Z$+CHR$(44)
5410 NEXT J%
5420 ROW=13:COL=35:COLMIN=35:COLMAX=43:Z$="0.000E+00":GOSUB 90
5430 X$=X$+" "+Z$
5440 PRINT #1,X$
5450 CLS
5460 X$=""
5470 GOTO 2990
5480 NEXT ISTEP%
5490 X$=CHR$(39)+"END             "+CHR$(39)+CHR$(44)+"0,0,0,0,0,
 0.000E+00, 0.000E+00"
5500 PRINT #1,X$
5510 PRINT #1,BLNK$
5520 CLOSE
5530 CHAIN "TACT5MN.BAS"
5540 END
```

APPENDIX G

TACT5 AND RILMAT SOURCE CODE LISTINGS

```
C  ************************************************************
C  *                                                          *
C  *             *** PROGRAM TACT5.FOR ***                    *
C  *                                                          *
C  * A NODAL DOSE CALCULATION PROGRAM                         *
C  *                                                          *
C  * MODIFIED 9/23/87 BY SCIENCE APPLICATIONS INTERNATIONAL   *
C  * CORPORATION FOR THE US NUCLEAR REGULATORY COMMISSION     *
C  *                                                          *
C  *                                                          *
C  * R/M FORTRAN VERSION                                      *
C  * REQUIRES ROUTINES FOUND IN RILMAT.FOR TO BE COMPILED     *
C  * AND LINKED IN CONJUNCTION WITH THIS FILE.                *
C  *                                                          *
C  * THIS VERSION REQUIRES A /R10000 EXTENSION AT RUNTIME     *
C  * TO PROVIDE ENOUGH BUFFERED IO FOR UNFORMATTED WRITES.    *
C  *                                                          *
C  ************************************************************
C
C  The next 19 lines have been commented out.
C
C  DATTIM.FOR program - To access the date and time:

C       INTERFACE TO SUBROUTINE TIME (N,STR)
C       CHARACTER*10 STR [NEAR,REFERENCE]
C       INTEGER*2 N [VALUE]
C       END
C       INTERFACE TO SUBROUTINE DATE (N,STR)
C        CHARACTER*10 STR [NEAR,REFERENCE]
C       INTEGER*2 N [VALUE]
C       END
C$STORAGE:4
C      PROGRAM MAIN
C
C              PROGRAM TO CALL GETIN AND SUBSEQUENT ROUTINES
C
C
C  CALL DATE AND TIME (NOTE THAT THE STRING LENGTH IS PASSED
C  AS THE FIRST ARGUMENT)
C
C
      INTEGER*2 YEAR,MONTH,DAY,HOUR,MINUTE,SECOND,HD
      COMMON / SYSTIME / YEAR,MONTH,DAY,HOUR,MINUTE,SECOND
      CALL GETDAT (YEAR,MONTH,DAY)
      CALL GETTIM (HOUR,MINUTE,SECOND,HD)
      CALL GETIN
      STOP
      END
C
C
C
```

```
      SUBROUTINE GETIN
      CHARACTER*8 ORGNAM(5)
      CHARACTER*8 GRPNAM(5)
      CHARACTER*8 TYPNAM(3)
      CHARACTER*8 NODNAM(5)
      CHARACTER*80 KTAPE
      CHARACTER*10 LTAPE
      CHARACTER*10 NTAPE
      CHARACTER*10 MTAPE
      CHARACTER*80 TITLE(50)
      CHARACTER*80 BLNK80
      CHARACTER*8 BLNK8
      CHARACTER*16 CODES(12)
      CHARACTER*16 KEY
      CHARACTER*8 XISO(60)
      CHARACTER*8 Z1
      LOGICAL ERR
      CHARACTER*20 INFILE
      CHARACTER*20 OUTFIL
      CHARACTER CH,FF
      INTEGER*2 YEAR,MONTH,DAY,HOUR,MINUTE,SECOND,HD
      COMMON / DATA1 / ORGNAM,GRPNAM,TYPNAM,NODNAM,KTAPE,LTAPE,
     *                 NTAPE,MTAPE,BLNK8,BLNK80,TITLE,XISO
      COMMON / DATA2 / ICASE,NSTEP,ISTEP,NODES,NXQ,NISO,JORGN,
     *                 JTYPE,JGROUP,NIN,NOUT,
     *                 IPRINT(5),IGROUP(60),INDEXO(5),ISWTCH(10),
     *                 ITYPE(60),IISO(60)
      COMMON / DATA3 / POWER,SDTIME,RELFR(5),PLTOUT(5),FRACT(5,3),
     *                 DECAY(60),DCF(5,60),S(60),TSTEP1,TSTEP2,
     *                 XE(60),XQ(3),BR(3),TTRAVL(3),
     *                 AO(5,60),PB(5,60),VOL(5),XLAMIN(5,60),
     *                 Q1(5,5,60),Q2(5,5,60),FILT(5,5,60)
      COMMON / SYSTIME / YEAR,MONTH,DAY,HOUR,MINUTE,SECOND,FF
      DIMENSION ZORG(5),X(5),GCHAIN(4),RELFC(5),YDECAY(4),JPRNT(4)
C
C          SET DEFAULT VALUES
C
      DATA CODES / 'TIME INTERVAL   ','INITIAL FRACTION',
     *             'RELEASE FRACTION','INITIAL CURIES  ',
     *             'RELEASE CURIES  ','REMOVAL RATE    ',
     *             'FILTER EFF      ','TRANSFER CFM    ',
     *             'TRANSFER PERCENT','TRAVEL TIME     ',
     *             'DOSE PARAMS     ','END             '
     *           /
      BLNK8='        '
      BLNK80='
     *                    '
      KTAPE=BLNK80
      LTAPE= '         '
      MTAPE= '         '
      NTAPE= '         '
```

```
      ICASE=0
      NIN=9
      NOUT=12
      FF=CHAR(12)
      NODNAM(1)= '  ENV. '
      CH=CHAR(27)
C
C             INPUT NAME OF INPUT AND OUTPUT DEVICES AND/OR FILES
C
      WRITE(*,'(1X,2A\)') CH,'[2J'
      WRITE (*,*) 'Enter the name of the TACT5 input data file.'
      WRITE (*,*) 'Use 20 characters or less, and include a'
      WRITE (*,*) 'device specifier if required.'
      WRITE (*,*) 'Example- B:DATA.DAT'
      WRITE (*,*) ' '
      WRITE (*,*) 'Input file =>'
      READ(*,'(1A20)') INFILE
      WRITE(*,'(1X,2A\)') CH,'[2J'
      WRITE(*,*) ' '
      WRITE (*,*) 'Enter the desired destination of the TACT5'
      WRITE (*,*) 'program output.  The choices are:'
      WRITE (*,*) ' '
      WRITE (*,*) '  CON          --> Output to screen (console)'
      WRITE (*,*) '  LPT1         --> Output to printer'
      WRITE (*,*) '  PRN          --> Output to printer'
      WRITE (*,*) '  filename     --> Output to disk file'
      WRITE (*,*)' '
      WRITE (*,*) 'Output device =>'
      READ(*,'(1A20)') OUTFIL
      WRITE(*,'(1X,2A\)') CH,'[2J'
    5 IF(ICASE.EQ.0) GOTO 7
      CLOSE(22,STATUS='KEEP')
      CALL ACTDOS(ERR)
      IF(ERR) GOTO 407
      IF (IPRINT(4).EQ.1.OR.IPRINT(5).EQ.1)CALL SUMMRY
    7 NISO=0
      JGROUP=0
      JORGN=0
      JTYPE=0
      ERR=.FALSE.
      DO 10 J=1,5
       ORGNAM(J)=BLNK8
       GRPNAM(J)=BLNK8
       IF (J.LE.3)TYPNAM(J)=BLNK8
   10  CONTINUE
      DO 25 J=1,60
       XISO(J)=BLNK8
       DECAY(J)=0
       S(J)=0
       XE(J)=0
       IISO(J)=0
```

```
      IGROUP(J)=0
      ITYPE(J)=0
    DO 20 I=1,5
    DCF(I,J)=0
20  CONTINUE
25  CONTINUE
    DO 35 J=1,5
    RELFR(J)=0
    PLTOUT(J)=0
    INDEXO(J)=0
    ISWTCH(J)=1
    ISWTCH(J+5)=1
    DO 30 I=1,3
    FRACT(J,I)=0
30  CONTINUE
35  CONTINUE
    ISTEP=0
    NSTEP=0
    NODES=0
    TSTEP1=0
    TSTEP2=0
    POWER=0
    SDTIME=0
    XL=0
    DO 40 J=1,50
    TITLE(J)=BLNK80
40  CONTINUE
    DO 45 J=1,5
    IPRINT(J)=0
45  CONTINUE
    DO 50 J=1,3
    XQ(J)=0
    BR(J)=0
    TTRAVL(J)=0
50  CONTINUE
    DO 60 J=1,60
    DO 55 I=1,5
    AO(I,J)=0
    PB(I,J)=0
55  CONTINUE
60  CONTINUE
    DO 75 J=1,5
    IF(J.NE.1) NODNAM(J)=BLNK8
    VOL(J)=0
    DO 70 I=1,60
    XLAMIN(J,I)=0
    DO 65 K=1,5
    Q1(J,K,I)=0
    Q2(J,K,I)=0
    FILT(J,K,I)=0
65  CONTINUE
```

```
   70 CONTINUE
   75 CONTINUE
C
C              INITIALIZE CASE NUMBER
C
   76 ICASE=ICASE+1
      IF (ICASE.GT.1)GOTO 79
C
C              READ IN NAME OF KTAPE
C
      OPEN (NIN,FILE=INFILE,STATUS='OLD',ACCESS='SEQUENTIAL',
     *FORM='FORMATTED')
      OPEN (NOUT,FILE=OUTFIL)
      READ(NIN,*,END=390) KTAPE
      READ(NIN,*,END=390)LTAPE,MTAPE,NTAPE
C
C              READ IN TITLE CARDS
C
   79 I=1

   80 READ (NIN,*,END=415) TITLE(I)
      IF (TITLE(I).EQ.BLNK80)GOTO 95
      I=I+1
      IF (I.LE.50)GOTO 80

C
C               PRINT ERROR MESSAGE--TITLE CARDS EXCEED 50
C
      WRITE (NOUT,90)
   90 FORMAT(30X,33H**********ERROR MESSAGE**********//
     *       31X,32HNUMBER OF TITLE CARDS EXCEEDS 50//
     *       31X,30HCHECK YOUR INPUT FOR ERRORS!!!//)
      STOP
   95 ITITLE=I-1
C
C               WRITE OUT TITLE PAGE
C
      WRITE(NOUT,97) MONTH,DAY,YEAR,HOUR,MINUTE,SECOND,
     *               ICASE,(TITLE(I),I=1,ITITLE)
   97 FORMAT(1H1,34X,7HTACT  V/31X,17HSEP 87 PC VERSION/25X,
     *29HNUCLEAR REGULATORY COMMISSION/27X,
     *26HACCIDENT EVALUATION BRANCH/24X,'DATE  ',I2,'/',I2,
     *'/',I4,4X,'TIME  ',I2,':',I2,':',I2//
     *26X,23HMODEL SUMMARY FOR CASE ,I4//(1X,A80))
C
C               READ IN HEADERS FROM KTAPE
C
      OPEN (20,FILE=KTAPE,STATUS='OLD',ACCESS='SEQUENTIAL',
     *FORM='FORMATTED')
      READ (20,100,END=400) JGROUP,JORGN,JTYPE,(INDEXO(I),I=1,JORGN)
  100 FORMAT (13I6)
```

```
      READ (20,105,END=400)(ORGNAM(I),I=1,JORGN)
      READ (20,105,END=400)(GRPNAM(I),I=1,JGROUP)
      READ (20,105,END=400)(TYPNAM(I),I=1,JTYPE)
  105 FORMAT (10A8)
C
C               READ IN TIME INDEPENDENT INPUT
C
      READ (NIN,*,END=390) (IPRINT(I),I=1,5)
      READ (NIN,*,END=390) NODES,NXQ
      READ(NIN,*,END=390)(NODNAM(I+1),I=1,NODES)
      READ (NIN,*,END=390) NSTEP
      READ (NIN, *, END=390) POWER, SDTIME
      READ (NIN, *,END=390)  (RELFR (I),I=1,JGROUP)
      READ (NIN, *,END=390)  (PLTOUT(I),I=1,JGROUP)
      DO 110 J=1,JGROUP
      READ(NIN, *,END=390)(FRACT(J,I),I=1,JTYPE)
  110 CONTINUE
      VOL(1)=1.
      READ (NIN, *,END=390)(VOL(I+1),I=1,NODES)
C
C              WRITE OUT TIME INDEPENDENT INPUT
C
      WRITE(NOUT,120) ICASE,
     *                NODES,NSTEP,(IPRINT(I),I=1,5),NXQ
  120 FORMAT (1H1,29X,22HTIME INDEPENDENT INPUT/
     *           32X,11HCASE NUMBER,I4
     *           ///34X,5HNODES,2X,5HNSTEP/30X,2I7//28X,
     *           24HOUTPUT CONTROL PARAMETER/25X,
     *           30HI        1    2    3    4    5/21X,
     *           9HIPRINT(I),5I5//21X,35HNUMBER OF DOSE EVALUATION POINT
     *S - ,I3)
      WRITE (NOUT,125)  POWER,SDTIME
  125 FORMAT(// 19X,42HPOWER (MWT)    REACTOR SHUTDOWN TIME (HRS)/ 20X,
     * 1P1E10.3, 13X, 1P1E10.3)
      WRITE (NOUT,130)(GRPNAM(I),I=1,JGROUP)
  130 FORMAT (// 4X,40HFRACTION OF ACTIVITY RELEASED FROM CORE ,
     *        32HTO CONTAINMENT BY ISOTOPIC GROUP/(4X,5(6X,A8)))
      WRITE (NOUT,135)(RELFR(I),I=1,JGROUP)
  135 FORMAT((5X,5(4X,1P1E10.3)))
      WRITE (NOUT,140)(GRPNAM(I),I=1,JGROUP)
  140 FORMAT(// 18X,43HPLATEOUT FACTOR FOR ACTIVITY RELEASED FROM /
     *       21X,37HCORE TO CONTAINMENT BY ISOTOPIC GROUP/
     *       (4X,5(6X,A8)))
      WRITE(NOUT,145)(PLTOUT(I),I=1,JGROUP)
  145 FORMAT (5X,5(4X,1P1E10.3))
      DO 150 I=1,JGROUP
         RELFC(I)=RELFR(I)*(1.0-PLTOUT(I))
  150 CONTINUE
      WRITE(NOUT,155)(GRPNAM(I),I=1,JGROUP)
  155 FORMAT(//4X,43HFRACTION OF CORE INVENTORY AIRBORNE IN THE ,
```

```
     *      29HCONTAINMENT BY ISOTOPIC GROUP/(4X,5(6X,A8)))

      WRITE(NOUT,160)(RELFC(I),I=1,JGROUP)
  160 FORMAT(4X,5(4X,1P1E10.3))
      WRITE (NOUT,165)(TYPNAM(I),I=1,3)
  165 FORMAT(//28X,23HISOTOPIC SPLIT BY GROUP/
     *       16X,3(6X,A8))
      DO 170 J=1,JGROUP
         WRITE (NOUT,175) GRPNAM(J),(FRACT(J,I), I=1,3)
  170 CONTINUE
  175 FORMAT (6X,A8,1X,3(4X,1P1E10.3))
      WRITE (NOUT,176) (NODNAM(I+1),I=1,NODES)
  176 FORMAT(//28X,23HVOLUME OF NODES (CU FT)/(5X,5(6X,A8)))
      WRITE(NOUT,177)(VOL(I+1),I=1,NODES)
  177 FORMAT (6X,5(4X,1P1E10.3))
      ILINE=0
      WRITE (NOUT,*)FF
      WRITE(NOUT,178)KTAPE,(ORGNAM(I),I=1,5)
  178 FORMAT(1X,10X,23HDATA FROM NUCLIDE FILE ,A80//
     *1X,7HISOTOPE,10X,6HSOURCE,19X,23HDOSE CONVERSION FACTORS/
     *2X,4HNAME,4X,5HSPLIT,2X,8H(CI/MWT),1X,
     *5(2X,A8))
      NISO=0
  179 READ(20,180,END=207)Z1
  180 FORMAT(1X,A8)
      READ(20,185,END=400) Z2,ZSOUR
      READ(20,185,END=400) (ZORG(I),I=1,JORGN)
      READ(20,185,END=400) (GCHAIN(I),I=1,4)
      READ(20,185,END=400) (YDECAY(I),I=1,4)
  185 FORMAT(1P6E13.6)
      READ(20,190,END=400) I1,I2,KCHAIN,(JPRNT(I),I=1,4)
  190 FORMAT (7I6)
      DO 205 J=1,JTYPE
      IF (FRACT(I2,J).EQ.0.0)GOTO 205
      NISO=NISO+1
      IF (NISO.GT.60) GOTO 207
      IISO(NISO)=I1
      IGROUP(NISO)=I2
      ITYPE(NISO)=J
      XISO(NISO)=Z1
      DECAY(NISO)=Z2*3600.
      S(NISO)=ZSOUR*FRACT(I2,J)
      DO 195 K=1,JORGN
      DCF(K,NISO)=ZORG(K)
  195 CONTINUE
      WRITE(NOUT,203)XISO(NISO),TYPNAM(J)(3:8),
     *               S(NISO),(DCF(K,NISO),K=1,JORGN)
  203 FORMAT(1X,A8,1X,A5,1X,1P1E9.2,5(1X,1P1E10.3))
      ILINE=ILINE+1
      IF (ILINE.GT.55)ILINE=0
      IF (ILINE.EQ.0)WRITE(NOUT,178) KTAPE,(ORGNAM(I),I=1,5)
```

```
  205 CONTINUE
      GOTO 179
  207 CLOSE(20,STATUS='KEEP')
C
C  ************************
C             WRITE FILE LTAPE FOR TIME INDEPENDENT DATA
C
  208 OPEN (22,FILE=LTAPE,STATUS='UNKNOWN',ACCESS='SEQUENTIAL',
     *FORM='UNFORMATTED')
      WRITE (22) ICASE,NSTEP,NODES,NXQ,TITLE,POWER,SDTIME,
     *      RELFR,PLTOUT,FRACT,YEAR,MONTH,DAY,HOUR,MINUTE,
     *      SECOND,JGROUP,JTYPE,JORGN,
     *      INDEXO,GRPNAM,TYPNAM,ORGNAM,IPRINT,NISO,XISO,DECAY,S,
     *      IGROUP,ITYPE,DCF,VOL
      WRITE (NOUT,*) FF
      WRITE (NOUT,209) ICASE
  209 FORMAT(//30X,20HTIME DEPENDENT INPUT/32X,11HCASE NUMBER ,I4//)
      ILINE=0
  210 ISET=0
      LOWEST=1
      LIMIT=2
      READ(NIN,*,END=390) KEY,NGROUP,NTYPE,ISOTOP,INODE,IDATA,
     *                    (X(I),I=1,IDATA)
      IF (KEY.EQ.CODES(12))GOTO 270
      IF (IDATA.GT.0) GOTO 225
      WRITE (NOUT,220) KEY,NGROUP,NTYPE,ISOTOP,INODE,IDATA,
     *                 (X(I),I=LOWEST,LIMIT)
  220 FORMAT (//1X,35HTHE FOLLOWING DATA CARD IS IN ERROR//1X,
     *       38HCORRECT THE CARD AND RERUN PROGRAM!!!!//3X,
     *       A16,2X,5I5,1P2E14.5)
      STOP
  225 IF (IDATA.LE.LIMIT) LIMIT=IDATA
      WRITE (NOUT,230) KEY,NGROUP,NTYPE,ISOTOP,INODE,IDATA,
     *                 (X(I),I=LOWEST,LIMIT)
  230 FORMAT(3X,A16,2X,5I5,1P2E14.5 )
      ILINE=ILINE+1
      IF(ILINE.GT.55)ILINE=0
      IF (ILINE.EQ.0)WRITE(NOUT,209) ICASE
  235 IF ( IDATA.EQ.LIMIT)GOTO 250
      LOWEST=LIMIT+1
      LIMIT=IDATA
      WRITE(NOUT,245) (X(II),II=LOWEST,LIMIT)
  245 FORMAT(1X,1P6E14.5)
      ILINE=ILINE+1
      IF (ILINE.GT.55)ILINE=0
      IF (ILINE.EQ.0)WRITE(NOUT,209) ICASE
      GOTO235
C
C             IDENTIFY TYPE OF DATA CARD
C'
  250 DO 255 I=1,11
```

```
      IF (KEY.EQ.CODES(I))GOTO 265
  255 CONTINUE
      LOWEST=1
      IF (LIMIT.LT.2)LIMIT=LOWEST
      IF (LIMIT.GT.2) LIMIT=2
      WRITE (NOUT,260) KEY,NGROUP,NTYPE,ISOTOP,INODE,IDATA,
     *                 (X(I),I=LOWEST,LIMIT)
  260 FORMAT (//1X,15HWRONG DATA TYPE//1X,
     *        39HCORRECT DATA TYPE AND RERUN PROGRAM!!!!//3X,
     *        A16,2X,5I5,1P2E14.5)
      STOP
  265 ISET=I
      IF(ISET.GT.1)ISWTCH(ISET-1)=1
C
C
C               PERFORM MULTI - WAY BRANCH
C
      IF(ISET.EQ.1)GOTO 270
      IF (ISET.LT.10)GOTO 280
      GOTO 365
  270 IF (ISTEP.EQ.0) GOTO 275
C
C               SET TIME DEPENDENT INPUT DATA TO FILE LTAPE
C
      WRITE(22)ISTEP,ISWTCH,TSTEP1,TSTEP2
      IF((ISWTCH(1).EQ.1).OR.(ISWTCH(3).EQ.1))WRITE(22) ((AO(I,J)
     *,I=1,NODES+1),J=1,NISO)
      IF((ISWTCH(2).EQ.1).OR.(ISWTCH(4).EQ.1))WRITE(22) ((PB(I,J)
     *,I=1,NODES+1),J=1,NISO)
      IF(ISWTCH(5).EQ.1)WRITE(22) ((XLAMIN(I,J),I=1,NODES+1),J=1,NISO)
      IF(ISWTCH(6).EQ.1)WRITE(22) (((FILT(I,J,K),I=1,NODES+1)
     *,J=1,NODES+1),K=1,NISO)
      IF(ISWTCH(7).EQ.1)WRITE(22) (((Q1(I,J,K),I=1,NODES+1)
     *,J=1,NODES+1),K=1,NISO)
      IF(ISWTCH(8).EQ.1)WRITE(22) (((Q2(I,J,K),I=1,NODES+1)
     *,J=1,NODES+1),K=1,NISO)
      IF(ISWTCH(9).EQ.1)WRITE(22) TTRAVL
      IF(ISWTCH(10).EQ.1)WRITE(22) XQ,BR,XL
      DO 272 I=1,10
      ISWTCH(I)=0
  272 CONTINUE
      DO 273 J=1,5
      DO 273 I=1,60
      AO(J,I)=0
  273 CONTINUE
      IF(ISTEP.EQ.NSTEP)GOTO 5
C
C               SET TIME INTERVAL SCHEDULE
C
  275 ISTEP=ISTEP+1
      TSTEP1=X(1)
```

```
      TSTEP2=X(2)
      GOTO 210
  280 DO 360 ITH=1,NISO
      IF (NGROUP.EQ.0)GOTO 285
      IF (NGROUP.NE.IGROUP(ITH))GOTO 360
  285 IF (NTYPE.EQ.0)GOTO 290
      IF (NTYPE.NE.ITYPE(ITH))GOTO 360
  290 IF (ISOTOP.EQ.0)GOTO 295
      IF (ISOTOP.NE.IISO(ITH))GOTO 360
  295 GOTO (297,297,297,297,320,330,340,350),ISET-1
  297    AO(I,ITH)=0.0
         FAC1=1.0
         XLAM1=DECAY(ITH)*(TSTEP1-SDTIME)
         IF(TSTEP1.LE.SDTIME)GOTO 300
         IF(XLAM1.LE.150.0) FAC1=EXP(-XLAM1)
         IF(XLAM1.GT.150.) FAC1=0.
  300    FAC2=1.0
         XLAM2=DECAY (ITH)*(TSTEP2-TSTEP1)
         IF (TSTEP2.LE.SDTIME)GOTO 310
         IF ((XLAM1.LE.150.).AND.(XLAM2.LE.150.))GOTO 305
         IF (XLAM1.GT.150.)FAC2=0.
         IF ((XLAM1.LE.150.).AND.(XLAM2.GT.150.))FAC2=EXP(-XLAM1)/XLAM2
         GOTO 310
  305    IF ((1.-EXP(-XLAM2)).GT.0.00000001)FAC2=EXP(-XLAM1)*
     *        (1.-EXP(-XLAM2))/XLAM2
         IF(((1.-EXP(-XLAM2)).LE.0.00000001))FAC2=EXP(-XLAM1)*
     *        (1.-XLAM2/2.)
C
  310 DO 315 I=1,IDATA
C
C      INPUT INITIAL ACTIVITY IN FRACTION OR TIMED RELEASE ACTIVITY IN
C      FRACTION PER HOUR FOR THIS TIME STEP
C
       IF(ISET.EQ.2)
     *          AO(I+1,ITH)=X(I)*S(ITH)*POWER*FAC1*
     *                RELFR(IGROUP(ITH))*(1.0-PLTOUT(IGROUP(ITH)))
       IF ( ISET.EQ.3)
     *          PB(I+1,ITH)=X(I)*S(ITH)*POWER*FAC2*
     *               (1.0-PLTOUT(IGROUP(ITH)))
C
C      INPUT INITIAL ACTIVITY IN CURIES OR TIMED RELEASE ACTIVITY IN
C      CURIES PER HOUR
C
       IF((ISET.EQ.4).AND.(((NGROUP.EQ.0).AND.(NTYPE.EQ.0))
     *.OR.((NGROUP.NE.0).AND.(NTYPE.EQ.0)).OR.((NGROUP.EQ.0)
     *.AND.(NTYPE.NE.0))))
     *     AO(I+1,ITH)=X(I)*FAC1*FRACT(IGROUP(ITH),ITYPE(ITH))
       IF((ISET.EQ.4).AND.(NGROUP.NE.0).AND.(NTYPE.NE.0))
     *     AO(I+1,ITH)=X(I)*FAC1
       IF((ISET.EQ.5).AND.(((NGROUP.EQ.0).AND.(NTYPE.EQ.0))
     * .OR.((NGROUP.NE.0).AND.(NTYPE.EQ.0)).OR.((NGROUP.EQ.0)
```

```
     * .AND.(NTYPE.NE.0))))
     *       PB(I+1,ITH)=X(I)*FAC1*FRACT(IGROUP(ITH),ITYPE(ITH))
      IF((ISET.EQ.5).AND.(NGROUP.NE.0).AND.(NTYPE.NE.0))
     *      PB(I+1,ITH)=X(I)*FAC1
  315 CONTINUE
      GOTO 360
C
C           REMOVAL COEFFICIENTS (1/HR)
C
  320  XLAMIN(1,ITH)=0.0
       DO 325 I=1,IDATA
          XLAMIN(I+1,ITH)=X(I)
  325 CONTINUE
      GOTO 360
C
C           FILTER EFFICIENCIES (%)
C
  330 DO 335 I=1,IDATA
          FILT(I,1,ITH)=0.0
          FILT(I,INODE+1,ITH)=X(I)
  335 CONTINUE
      GOTO 360
C
C           TRANSFER RATES (CFM)
  340  DO 345 I=1,IDATA
          Q1(I,1,ITH)=0.0
           Q1(I,INODE+1,ITH)=X(I)
  345 CONTINUE
      GOTO 360
C
C           TRANSFER RATES (% PER DAY)
C
  350 DO 355 I=1,IDATA
           Q2(I,1,ITH)=0.0
           Q2(I,INODE+1,ITH)=X(I)
  355 CONTINUE
  360 CONTINUE
      GOTO 210
  365 IF (ISET.EQ.10)GOTO 370
      IF (ISET.EQ.11)GOTO 380
C
C        INPUT OF TRAVEL TIME FROM CONTAINMENT TO RECEPTOR TO ACCOUNT FOR
C        DECAY ENROUTE
C
  370 DO 375 I=1,IDATA
           TTRAVL(I)=X(I)
  375 CONTINUE
      GOTO 210
C
C        INPUT OF DOSE PARAMETERS FOR THIS TIME STEP
C
```

```
380 DO 385 I=1,NXQ
    XQ(I)=X(2*I-1)
    BR(I)=X(2*I)
385 CONTINUE
    XL=X(IDATA)


    GOTO 210
390 WRITE (NOUT,395)
395 FORMAT(//1X,32HERROR IN READING INPUT DATA FILE//1X,
   *       30HCHECK INPUT DATA AND TRY AGAIN//)
397 CLOSE(20,STATUS='KEEP')
    CLOSE(22,STATUS='DELETE')
    GOTO 410
400 WRITE(NOUT,405)KTAPE
405 FORMAT(//1X,29HERROR IN READING NUCLIDE FILE//1X,
   *       13HFILE NAME IS ,A10//1X,
   *       25HREVIEW FILE AND TRY AGAIN//)
    GOTO 397
407 WRITE(NOUT,408)
408 FORMAT(//1X,'ERROR ENCOUNTERED IN SUB MATRIX'//
   *1X,'COEFF OR SOURCE TERMS NOT ACCEPTABLE'//)
    GOTO 7
410 RETURN
415 WRITE(NOUT,420)
420 FORMAT(1H1,1X,'NO MORE CASES'//1X,
   *'END OF EXECUTION'//)
    CLOSE(22,STATUS='DELETE')
    CLOSE(24,STATUS='DELETE')
    CLOSE(NIN,STATUS='KEEP')
    CLOSE(NOUT,STATUS='KEEP')
    GOTO 410
    END
    SUBROUTINE ACTDOS(ERR)
    CHARACTER*8 ORGNAM(5)
    CHARACTER*8 GRPNAM(5)
    CHARACTER*8 TYPNAM(3)
    CHARACTER*8 NODNAM(5)
    CHARACTER*80 KTAPE
    CHARACTER*10 LTAPE
    CHARACTER*10 NTAPE
    CHARACTER*10 MTAPE
    CHARACTER*8 BLNK8
    CHARACTER*8 XISO(60)
    CHARACTER*80 TITLE(50)
    CHARACTER*80 BLNK80
    CHARACTER FF
    DOUBLE PRECISION  AA, A1, B, CC, CCC, EI, ER, Z
    LOGICAL ERR
    INTEGER*2 YEAR,MONTH,DAY,HOUR,MINUTE,SECOND
    COMMON / DATA1 / ORGNAM,GRPNAM,TYPNAM,NODNAM,KTAPE,LTAPE,
```

```
     *                  NTAPE,MTAPE,BLNK8,BLNK80,TITLE,XISO
      COMMON / DATA2 / ICASE,NSTEP,ISTEP,NODES,NXQ,NISO,JORGN,
     *                  JTYPE,JGROUP,NIN,NOUT,
     *                  IPRINT(5),IGROUP(60),INDEXO(5),ISWTCH(10),
     *                  ITYPE(60),IISO(60)
      COMMON / DATA3 / POWER,SDTIME,RELFR(5),PLTOUT(5),FRACT(5,3),
     *                  DECAY(60),DCF(5,60),S(60),TSTEP1,TSTEP2,
     *                  XE(60),XQ(3),BR(3),TTRAVL(3),
     *                  AO(5,60),PB(5,60),VOL(5),XLAMIN(5,60),
     *                  Q1(5,5,60),Q2(5,5,60),FILT(5,5,60)
      COMMON / DATA4 / DOSE(3,5),DOSET(3,5),URDOSE(3,5),SUMX(60),
     *                  URDOST(3,5),ACTY(5,60),ACTYI(5,60),
     *                  AIRELT(5,60)
      COMMON / SYSTIME / YEAR,MONTH,DAY,HOUR,MINUTE,SECOND,FF
      DIMENSION AA(5),A1(5),B(5),CC(5,5),CCC(5,5),EI(5),
     *          ER(5),Z(25),AI(5),A2(5),C(5,5)
C
C     INPUT TIME INDEPENDENT DATA FROM LTAPE
C
      OPEN(22,FILE=LTAPE,STATUS='OLD',ACCESS='SEQUENTIAL',
     *FORM='UNFORMATTED')
      OPEN(24,FILE=MTAPE,STATUS='UNKNOWN',ACCESS='SEQUENTIAL',
     *FORM='UNFORMATTED')
   10 READ(22,END=1000)ICASE,NSTEP,NODES,NXQ,TITLE,POWER,SDTIME,RELFR,
     *               PLTOUT,FRACT,YEAR,MONTH,DAY,HOUR,MINUTE,
     *               SECOND,JGROUP,JTYPE,JORGN,INDEXO,
     *               GRPNAM,TYPNAM,ORGNAM,IPRINT,NISO,XISO,DECAY,
     *               S,IGROUP,ITYPE,DCF,VOL
      WRITE(24)ICASE,NSTEP,NODES,NXQ,TITLE,POWER,SDTIME,RELFR,
     *         PLTOUT,FRACT,YEAR,MONTH,DAY,HOUR,MINUTE,
     *         SECOND,JGROUP,JTYPE,JORGN,INDEXO,
     *         GRPNAM,TYPNAM,ORGNAM,IPRINT,NISO,XISO,DECAY,
     *         S,IGROUP,ITYPE,DCF,VOL
      NN = NODES + 1
C
C              INITIALIZE ACTIVITY VARIABLES
C
      DO 20 I=1,60
      SUMX(I)=0.0
      DO 20 J=1,5
            AO    (J,I) = 0.0
            PB    (J,I) = 0.0
            ACTY  (J,I) = 0.0
            ACTYI (J,I) = 0.0
            AIRELT(J,I) = 0.0
   20 CONTINUE
C
C              CYCLE THRU ALL TIME STEPS FOR THIS CURRENT CASE.
C
   25 READ(22,END=1000) ISTEP,ISWTCH,TSTEP1,TSTEP2
      IF((ISWTCH(1).EQ.1).OR.(ISWTCH(3).EQ.1))READ(22,END=1000)
```

```
     *((AO(I,J),I=1,NN),J=1,NISO)
      IF((ISWTCH(2).EQ.1).OR.(ISWTCH(4).EQ.1))READ(22,END=1000)
     *((PB(I,J),I=1,NN),J=1,NISO)
      IF(ISWTCH(5).EQ.1)READ(22,END=1000) ((XLAMIN(I,J),I=1,NN),
     *J=1,NISO)
      IF(ISWTCH(6).EQ.1)READ(22,END=1000) (((FILT(I,J,K),I=1,NN),
     *J=1,NN),K=1,NISO)
      IF(ISWTCH(7).EQ.1)READ(22,END=1000) (((Q1(I,J,K),I=1,NN),
     *J=1,NN),K=1,NISO)
      IF(ISWTCH(8).EQ.1)READ(22,END=1000) (((Q2(I,J,K),I=1,NN),
     *J=1,NN),K=1,NISO)
      IF(ISWTCH(9).EQ.1)READ(22,END=1000) TTRAVL
      IF(ISWTCH(10).EQ.1)READ(22,END=1000) XQ,BR,XL
      DO 27 I=1,10
      ISWTCH(I)=0
   27 CONTINUE
      DO 30 JXQ=1,NXQ
      DO 30 IORG=1,JORGN
            DOSE(JXQ,IORG) = 0.0
            URDOSE(JXQ,IORG) = 0.0
            IF( ISTEP .NE. 1 )  GOTO 30
            DOSET(JXQ,IORG) = 0.0
            URDOST(JXQ,IORG) = 0.0
   30 CONTINUE
         DT = TSTEP2 - TSTEP1
C
C              INITIALIZE ACTIVITIES FOR ALL ISOTOPES WITHIN THE BLOCK.
C
         DO 50 ITH=1,NISO
            XE(ITH) = 1.0
         DO 50 I=1,NN
               ACTY(I,ITH) = ACTY(I,ITH) + AO(I,ITH)
               AIRELT(I,ITH) = 0.0
               AO(I,ITH)=0.0
   50    CONTINUE
C
         DO 60 I=1,NN
            AA(I)=0.D0
            A1(I)=0.D0
            B(I)=0.D0
            EI(I)=0.D0
            ER(I)=0.D0
            AI(I)=0.
            A2(I)=0.
         DO 60 J=1,NN
               CC(I,J)=0.D0
               CCC(I,J)=0.D0
   60    CONTINUE
C
C
C              COMPUTE ACTIVITIES FOR ALL ISOTOPES WITHIN THE BLOCK.
```

```
C
      DO 140 ITH = 1,NISO
         NGROUP = IGROUP(ITH)
         NTYPE = ITYPE(ITH)
         SUMALL = 0.0
         PUMALL=0.0
         DO   70 NTH = 1,NN
            SUMALL = SUMALL + ACTY(NTH,ITH)
            PUMALL=PUMALL+PB(NTH,ITH)
 70      CONTINUE
         IF( SUMALL .EQ. 0.0 .AND. PUMALL .EQ. 0.0 )  GOTO 140
C
      CALL COEFF (C,ITH,NN,5)
C
         DO 100 I = 1,NN
            A1(I) = DBLE(ACTY(I,ITH) )
            B (I) = DBLE(-PB (I,ITH) )
 100     CONTINUE
C
         DO 110 I = 1,NN
            IF( A1(I) .NE. 0.0  .OR.  B(I) .NE. 0.0 )   GOTO 120
 110     CONTINUE
         GOTO 140
C
 120     IFLAG=0
         CALL MATRIX( NOUT,NN, 5, C, CC, CCC, A1, AA, ER, EI, B,
     *           Z, DT, A2, AI,IFLAG,ERR)
         IF(ERR)RETURN
C
         DO 130 I = 2,NN
            IF( A2(I) .LE. 1.0E-30 )  A2(I) = 0.0
            ACTY(I,ITH) = A2(I)
            ACTYI(I,ITH) = AI(I)
            IF( ACTY(I,ITH) .LE. 1.0E-30 )  ACTY(I,ITH) = 0.0
         IF(IFLAG.EQ.1)GOTO 130
            AIRELT(1,ITH) = AIRELT(1,ITH) + ACTYI(I,ITH)*C(1,I)
            AIRELT(I,ITH) = ACTYI(I,ITH)*C(1,I)
 130     CONTINUE
C
         ACTY(1,ITH) = A2(1)
         ACTYI(1,ITH) = AI(1)
         SUMX(ITH) = SUMX(ITH) + AIRELT(1,ITH)
 140  CONTINUE
C
C           COMPUTE DOSES FROM ACTIVITIES.
C
      DO 280 JXQ = 1,NXQ
         IF( XQ(JXQ) .EQ. 0.0 )   GOTO 280
         DO 270 IORG = 1,JORGN
            DO 150 ITH = 1,NISO
               THING = DECAY(ITH)*TTRAVL(JXQ)
```

```
                  THING = ABS(THING)
                  XE(ITH) = EXP(-THING)
                  AIRELT(1,ITH) = AIRELT(1,ITH)*XE(ITH)
                  DOSE(JXQ,IORG) = DOSE(JXQ,IORG) + XQ(JXQ)*
     *                 AIRELT(1,ITH)*DCF(IORG,ITH)
 150           CONTINUE
               IF( INDEXO(IORG) .EQ. 1 )
     *              DOSE(JXQ,IORG) = DOSE(JXQ,IORG) * BR(JXQ)
               DOSET(JXQ,IORG)=DOSET(JXQ,IORG)+DOSE(JXQ,IORG)
 160           IF( XL .EQ. 0.0 )   GOTO 270
C
            DO 260 ITH = 1,NISO
               NGROUP = IGROUP(ITH)
               NTYPE = ITYPE(ITH)
C
               XLAM = DECAY(ITH) + XL/2400.0
               E1 = ABS( XLAM*TSTEP1 )
               E2 = ABS( XLAM*DT)
 230           IF( E1 .GT. 150.0 )   GOTO 260
               IF( E2 .GT. 150.0 )   GOTO 240
               AIO = S(ITH)*POWER*RELFR(NGROUP)*(1.0-PLTOUT(NGROUP))*
     *              EXP(-E1)*(1.0-EXP(-E2))*XE(ITH) / XLAM
               GOTO 250
 240           AIO = S(ITH)*POWER*RELFR(NGROUP)*(1.0-PLTOUT(NGROUP))*
     *              EXP(-E1)*XE(ITH) / XLAM
 250           URDOSE(JXQ,IORG) = URDOSE(JXQ,IORG) + AIO*XQ(JXQ) *
     *              DCF(IORG,ITH)*XL / 2400.0
 260        CONTINUE
               IF( INDEXO(IORG) .EQ. 1 )
     *              URDOSE(JXQ,IORG) = URDOSE(JXQ,IORG) * BR(JXQ)
               URDOST(JXQ,IORG)=URDOST(JXQ,IORG)+URDOSE(JXQ,IORG)
 270        CONTINUE
 280     CONTINUE
      WRITE(24) (SUMX(I),I=1,NISO),((ACTY(I,J),I=1,NN),J=1,NISO),
     *((AIRELT(I,J),I=1,NN),J=1,NISO),((ACTYI(I,J),I=1,NN),J=1,NISO),
     *((DOSE(I,J),I=1,NXQ),J=1,JORGN),((DOSET(I,J),I=1,NXQ),J=1,JORGN),
     *((URDOSE(I,J),I=1,NXQ),J=1,JORGN),((URDOST(I,J),I=1,NXQ),
     *J=1,JORGN),ISTEP,TSTEP1,TSTEP2
      IF((IPRINT(1).NE.0).OR.(IPRINT(3).NE.0).OR.(IPRINT(5).NE.0))CALL
     * ACTOUT
      IF((IPRINT(2).NE.0).OR.(IPRINT(3).NE.0).OR.(IPRINT(5).NE.0))CALL
     * DOSOUT
      IF (ISTEP.LT.NSTEP) GOTO 25
 1000 CLOSE(22,STATUS='KEEP')
      CLOSE(24,STATUS='KEEP')
      RETURN
      END
        SUBROUTINE COEFF (C,ITH,NN,MM)
C
C   THIS ROUTINE SETS UP THE COEFFICIENTS OF THE MATRIX OF SIMULT. EQNS.
C
```

```
      COMMON / DATA3 / POWER,SDTIME,RELFR(5),PLTOUT(5),FRACT(5,3),
     *                 DECAY(60),DCF(5,60),S(60),TSTEP1,TSTEP2,
     *                 XE(60),XQ(3),BR(3),TTRAVL(3),
     *                 AO(5,60),PB(5,60),VOL(5),XLAMIN(5,60),
     *                 Q1(5,5,60),Q2(5,5,60),FILT(5,5,60)
      DIMENSION C(MM,MM)
         DO 102 I=1,NN
         DO 100 J = 1,NN
            C(I,J) = 0.0
            IF(VOL(J) .EQ. 0.0 )   GOTO 100
            C(I,J) = Q1(I,J,ITH)*60.0*(1.0-FILT(I,J,ITH) / 100.0) /
     *           VOL(J) + Q2(I,J,ITH) / 2400.0
  100 CONTINUE
      WW=0.0
         DO 101 J = 1,NN
            IF( I .EQ. J )   GOTO 101
            WW = WW + Q1(J,I,ITH)*60.0 +
     *           Q2(J,I,ITH)*VOL(I) / 2400.0
 101     CONTINUE
C
         SUM = WW / VOL(I)
         C(I,I) = -(XLAMIN(I,ITH) + Q1(I,I,ITH)*0.60*
     *           FILT(I,I,ITH) / VOL(I)) - SUM - DECAY(ITH)
 102  CONTINUE
C
C   ADJUST REMOVAL COEFF. OF NODE 1 (ENVIRONS) TO DISTINGUISH IT FROM
C   A SECOND ISOLATED NODE.(NOTE, SYSTEM WITH 2 IDENTICAL NODES
C   IS UNSOLVABLE)
C
      C(1,1)=C(1,1)-C(1,1)*1.0E-06
      RETURN
      END
      SUBROUTINE ACTOUT
      CHARACTER*8 ORGNAM(5)
      CHARACTER*8 GRPNAM(5)
      CHARACTER*8 TYPNAM(3)
      CHARACTER*8 NODNAM(5)
      CHARACTER*80 KTAPE
      CHARACTER*10 LTAPE
      CHARACTER*10 NTAPE
      CHARACTER*10 MTAPE
      CHARACTER*80 TITLE(50)
      CHARACTER*80 BLNK80
      CHARACTER*8 BLNK8
      CHARACTER*8 XISO(60)
      CHARACTER FF
      INTEGER*2 YEAR,MONTH,DAY,HOUR,MINUTE,SECOND
      COMMON / DATA1 / ORGNAM,GRPNAM,TYPNAM,NODNAM,KTAPE,LTAPE,
     *                 NTAPE,MTAPE,BLNK8,BLNK80,TITLE,XISO
      COMMON / DATA2 / ICASE,NSTEP,ISTEP,NODES,NXQ,NISO,JORGN,
     *                 JTYPE,JGROUP,NIN,NOUT,
```

```
     *                  IPRINT(5),IGROUP(60),INDEXO(5),ISWTCH(10),
     *                  ITYPE(60),IISO(60)
      COMMON / DATA3 / POWER,SDTIME,RELFR(5),PLTOUT(5),FRACT(5,3),
     *                  DECAY(60),DCF(5,60),S(60),TSTEP1,TSTEP2,
     *                  XE(60),XQ(3),BR(3),TTRAVL(3),
     *                  AO(5,60),PB(5,60),VOL(5),XLAMIN(5,60),
     *                  Q1(5,5,60),Q2(5,5,60),FILT(5,5,60)
      COMMON / DATA4 / DOSE(3,5),DOSET(3,5),URDOSE(3,5),SUMX(60),
     *                  URDOST(3,5),ACTY(5,60),ACTYI(5,60),
     *                  AIRELT(5,60)
      COMMON / SYSTIME / YEAR,MONTH,DAY,HOUR,MINUTE,SECOND,FF
      DIMENSION ZORG(5),X(5),GCHAIN(4),RELFC(5),YDECAY(4),JPRNT(4),
     *          ASUMO(5),ASUM1(5,3,5),JJA(5),ASUM2(3,5),BSUMO(5),
     *          BSUM1(5,3,5),BSUM2(3,5),JJB(5)
      NN = NODES + 1
C
C              INITIALIZE SUMS OF ACTIVITIES
C
         DO 103 I = 1,5
            ASUMO(I) = 0.0
            JJA(I) = 0
            DO 103 K = 1,3
               ASUM2(K,I) = 0.0
               DO 103 L = 1,5
                  ASUM1(L,K,I) = 0.0
 103     CONTINUE
C
C              ACCUMULATE SUMS OF ACTIVITIES FOR ALL
C              ISOTOPES IN CURRENT BLOCK
C
 104     DO 105 ITH = 1,NISO
            I = IGROUP(ITH)
            K = ITYPE(ITH)
            IF( JJA(I) .LT. K )   JJA(I) = K
            DO 105 L = 1,NODES
               ASUMO(I) = ASUMO(I) + ACTY(L+1,ITH)
               ASUM1(L,K,I) = ASUM1(L,K,I) + ACTY(L+1,ITH)
               ASUM2(K,I) = ASUM2(K,I) + ACTY(L+1,ITH)
 105     CONTINUE
C
C              PRINT SUMS OF ACTIVITIES
C
         WRITE (NOUT,*) FF
         WRITE(NOUT, 1002)  ISTEP,ICASE,
     *         TSTEP1, TSTEP2
         LINES  = 8
 1042    WRITE(NOUT, 1003)(NODNAM(II+1),II=1,4)
         LINES = LINES + 4
         DO 107 I = 1,JGROUP
            JMAX = JJA(I)
            KK=0
```

```
C
            DO 106 K = 1,JMAX
            IF(ASUM2(K,I).EQ.0)GOTO 106
            IF( KK .EQ. 0 )  LINES = LINES + 2
          IF( KK.EQ.0)WRITE(NOUT, 1005)GRPNAM(I),TYPNAM(K),
     *           ASUM0(I),ASUM2(K,I),(ASUM1(L,K,I),L=1,NODES)
C
            IF( KK .EQ. 1 )  LINES = LINES + 1
            IF( KK.EQ.1)   WRITE(NOUT, 1006) TYPNAM(K),
     *           ASUM2(K,I),(ASUM1(L,K,I),L=1,NODES)
            KK=1
 106        CONTINUE
 107      CONTINUE
  58     DO 109 I = 1,5
            BSUM0(I) = 0.0
            JJA(I) = 0
            DO 109 K = 1,3
               BSUM2(K,I) = 0.0
               DO 109 L = 1,5
                  BSUM1(L,K,I) = 0.0
 109      CONTINUE
C
C              ACCUMULATE SUMS OF RELEASED FOR ALL
C              ISOTOPES IN CURRENT BLOCK
C
 110      DO 111 ITH = 1,NISO
            I = IGROUP(ITH)
            K = ITYPE(ITH)
            IF( JJA(I) .LT. K )   JJA(I) = K
            DO 111 L = 1,NODES
               BSUM0(I) = BSUM0(I) + AIRELT(L+1,ITH)
               BSUM1(L,K,I) = BSUM1(L,K,I) + AIRELT(L+1,ITH)
               BSUM2(K,I) = BSUM2(K,I) + AIRELT(L+1,ITH)
 111      CONTINUE
C
C              PRINT SUMS OF RELEASED
C
          IF( LINES .LE. 45 )  GOTO 1112
            WRITE(NOUT, 1007)
            LINES = 0
C
 1112    WRITE(NOUT, 1004)(NODNAM(II+1),II=1,4)
C
          DO 113 I = 1,JGROUP
            JMAX = JJA(I)
            KK=0
            DO 112 K = 1,JMAX
            IF(BSUM2(K,I).EQ.0)GOTO 112
            IF( KK .EQ. 0 )  LINES = LINES + 2
          IF( KK.EQ.0)WRITE(NOUT, 1005)GRPNAM(I),TYPNAM(K),
     *           BSUM0(I),BSUM2(K,I),(BSUM1(L,K,I),L=1,NODES)
```

```
C
            IF( KK .EQ. 1 )  LINES = LINES + 1
            IF( KK.EQ.1)   WRITE(NOUT, 1006) TYPNAM(K),
     *           BSUM2(K,I),(BSUM1(L,K,I),L=1,NODES)
            KK=1
 112        CONTINUE
 113     CONTINUE
C
 114     CONTINUE
C
C
      WRITE (NOUT,*) FF
      WRITE(NOUT, 1007)
      LINES = 3
 1142  WRITE(NOUT, 1000)TSTEP2,(NODNAM(II),II=1,5)
      DO 117 ITH=1,NISO
         DO 115 K = 1,NODES
            IF( ACTY(K+1,ITH) .NE. 0.0 )  GOTO 116
 115     CONTINUE
         IF( SUMX(ITH) .EQ. 0 )  GOTO 117
 116     WRITE(NOUT, 1001)  XISO(ITH), SUMX(ITH),
     *        (ACTY(K+1,ITH), K = 1,NODES)
         IF( LINES .LT. 56 )  GOTO 117
            WRITE(NOUT, 1007)
            LINES = 0
 117  CONTINUE
 118                    RETURN
C
C
C
 1000 FORMAT(1X,37HACTIVITY RELEASED TO ENVIRONMENT AND ,
     *     25HIN EACH NODE AT END OF..., 1P1E10.3,7H  (HRS)//
     *     1X,8HISO NAM ,1X,5(1X,A8,1X))
 1001 FORMAT(1X, A8, 1X,5(1P1E10.3))
 1002 FORMAT(21X,35HACTIVITIES (CI) AT END OF TIME STEP,I3/
     *     /33X,11HCASE NUMBER,I3//
     *     4X,18HSTEP START TIME AT,1P1E10.3,2X,5H(HRS),4X,
     *     16HSTEP END TIME AT,1P1E10.3,2X,5H(HRS))
 1003 FORMAT(///18X,43HACTIVITY DISTRIBUTION IN THE NODES MODELED / ,
     *     22X,35HBY CHEMICAL/PHYSICAL FORM AND GROUP
     *     // 1X,5HGROUP,8X,4HFORM,3X,8HTOTAL BY,2X,8HTOTAL BY,
     *     1X,4(1X,A8,1X)/1X,4HNAME,9X,4HNAME,5X,5HGROUP,5X,
     *     4HFORM,3X,4(1X,A8,1X))
 1004 FORMAT(///8X,45HACTIVITY CONTRIBUTION TO THE ENVIRONMENT FROM,
     *     18H EACH NODE MODELED/,
     *     15X,50H FOR THE PLANT BY CHEMICAL/PHYSICAL FORM AND GROUP
     *     // 1X,5HGROUP,8X,4HFORM,3X,8HTOTAL BY,2X,8HTOTAL BY,
     *     2X,4(1X,A8,1X)/1X,4HNAME,9X,4HNAME,5X,5HGROUP,5X,
     *     4HFORM,3X,4(1X,A8,1X))
 1005 FORMAT(2X,A8,2X,A8,1P6E10.3)
 1006 FORMAT(12X,A8,10X,1P5E10.3)
```

```
 1007 FORMAT(1X)
      END
C
C     *************** DOSOUT *****************
C
      SUBROUTINE DOSOUT
      CHARACTER*8 ORGNAM(5)
      CHARACTER*8 GRPNAM(5)
      CHARACTER*8 TYPNAM(3)
      CHARACTER*8 NODNAM(5)
      CHARACTER*80 KTAPE
      CHARACTER*10 LTAPE
      CHARACTER*10 NTAPE
      CHARACTER*10 MTAPE
      CHARACTER*80 TITLE(50)
      CHARACTER*80 BLNK80
      CHARACTER*8 BLNK8
      CHARACTER*8 XISO(60)
      CHARACTER FF
      INTEGER*2 YEAR,MONTH,DAY,HOUR,MINUTE,SECOND
      COMMON / DATA1 / ORGNAM,GRPNAM,TYPNAM,NODNAM,KTAPE,LTAPE,
     *                 NTAPE,MTAPE,BLNK8,BLNK80,TITLE,XISO
      COMMON / DATA2 / ICASE,NSTEP,ISTEP,NODES,NXQ,NISO,JORGN,
     *                 JTYPE,JGROUP,NIN,NOUT,
     *                 IPRINT(5),IGROUP(60),INDEXO(5),ISWTCH(10),
     *                 ITYPE(60),IISO(60)
      COMMON / DATA3 / POWER,SDTIME,RELFR(5),PLTOUT(5),FRACT(5,3),
     *                 DECAY(60),DCF(5,60),S(60),TSTEP1,TSTEP2,
     *                 XE(60),XQ(3),BR(3),TTRAVL(3),
     *                 AO(5,60),PB(5,60),VOL(5),XLAMIN(5,60),
     *                 Q1(5,5,60),Q2(5,5,60),FILT(5,5,60)
      COMMON / DATA4 / DOSE(3,5),DOSET(3,5),URDOSE(3,5),SUMX(60),
     *                 URDOST(3,5),ACTY(5,60),ACTYI(5,60),
     *                 AIRELT(5,60)
      COMMON / SYSTIME / YEAR,MONTH,DAY,HOUR,MINUTE,SECOND,FF
      DIMENSION DSUMO(5),DSUM1(5,15,5),DSUM2(3,5,5),
     *          DSUM3(5,5),JJD(5)
C
C              INITIALIZE CONVERTED SUMS
C
         NN=NODES+1
         DO 103 J = 1, JORGN
            DSUMO(J) = 0.0
 103     CONTINUE
C
         DO 104 I = 1,JGROUP
            JJD(I) = 0
            DO 104 J = 1,JORGN
               DSUM3(J,I) = 0.0
               DO 104 K = 1,3
                  JKMIX = K + (J-1)*3
```

```
                  DSUM2(K,J,I) = 0.0
                  DO 104 L = 1,NN
                     DSUM1(L,JKMIX,I) = 0.0
 104      CONTINUE
C
C               ACCUMULATE CONVERTED SUMS FOR ALL ISOTPES IN BLOCK
C
 105      DO 106 ITH = 1,NISO
             DO 106 J = 1,JORGN
                DSUM0(J) = DSUM0(J) + AIRELT(1,ITH)*DCF(J,ITH)
                I = IGROUP(ITH)
                K = ITYPE(ITH)
                IF( JJD(I) .LT. K )   JJD(I) = K
                JKMIX = K + (J-1)*3
                DO 106 L = 1,NODES
                   DSUM1(L,JKMIX,I) = DSUM1(L,JKMIX,I) +
     *                   AIRELT(L+1,ITH)*DCF(J,ITH)
 106      CONTINUE
C
C               PRINT CONVERTED SUMS
C
C
          DO 107 I = 1,JGROUP
             JMAX = JJD(I)
             DO 107 J = 1,JORGN
                DO 107 K = 1,JMAX
                JKMIX = K + (J-1)*3
                DO 107 L = 1,NODES
                   IF( DSUM0(J) .NE. 0.0 )
     *                 DSUM1(L,JKMIX,I) = 100.0*DSUM1(L,JKMIX,I)/DSUM0(J)
                   DSUM2(K,J,I) = DSUM2(K,J,I) + DSUM1(L,JKMIX,I)
                   DSUM3(J,I) = DSUM3(J,I) + DSUM1(L,JKMIX,I)
 107      CONTINUE
C
          IMAX=JGROUP
 108      LINES=14
C
          DO 109 I=1,IMAX
             JMAX=JJD(I)
             DO 109 J=1,JMAX
                LINES=LINES+JORGN
 109      CONTINUE
C
          IF(LINES.LE.55)GO TO 110
          IMAX=IMAX-1
          GO TO 108
 110      ILINE=0
C
 1102     DO 112 J=1,JORGN
          ITEST1=0
          DO 112 I = 1,JGROUP
```

```
         ITEST2=0
            JMAX = JJD(I)
               DO 112 K = 1,JMAX
                  JKMIX = K + (J-1)*3
                  IF(DSUM2(K,J,I).EQ.0.)GOTO 112
                  IF(DSUM3(J,I).EQ.0.)GOTO 112
                  IF( ILINE .NE. 0  .AND.  ILINE .LT. LINES )  GOTO 111
                  WRITE (NOUT,*) FF
                  WRITE(NOUT, 1000)  ISTEP,
     *                 ICASE, TSTEP1, TSTEP2
          WRITE(NOUT, 1001)(NODNAM(II+1),II = 1,4)
                  ILINE = 14
 111       IF(ITEST1.NE.0) GOTO 1111
                WRITE(NOUT, 1002)
     *          ORGNAM(J),GRPNAM(I),TYPNAM(K),DSUM3(J,I),DSUM2(K,J,I),
     *              (DSUM1(L,JKMIX,I),L=1,NODES)
       ITEST1=1
        ITEST2=1
       GOTO 11111
1111              IF(ITEST2.NE.0)GOTO 11110
                     WRITE(NOUT,1003)
     *               GRPNAM(I),TYPNAM(K),DSUM3(J,I),DSUM2(K,J,I),
     *               (DSUM1(L,JKMIX,I),L=1,NODES)
        ITEST2=1
       GOTO 11111
11110             IF(ITEST1.NE.0.AND.ITEST2.NE.0)WRITE(NOUT, 1004)
     *               TYPNAM(K),DSUM2(K,J,I),(DSUM1(L,JKMIX,I),
     *          L=1,NODES)
11111   ILINE=ILINE+1
 112      CONTINUE
C
C
       WRITE (NOUT,*) FF
C
 114   IF ((LINES+JORGN+6) .GT. 58) THEN
         WRITE (NOUT,*) FF
         WRITE (NOUT,1000) ISTEP,ICASE,
     *       TSTEP1,TSTEP2
       ENDIF
       DO 200 M=1,3
         IF (M .EQ. 1) THEN
           WRITE(NOUT,1005)
         ELSE IF (M .EQ. 2) THEN
           WRITE(NOUT,1007)
         ELSE
           WRITE (NOUT,1008)
         END IF
         WRITE (NOUT,1009)
         DO 115 I=1,JORGN
           IF ((DOSET(M,I).EQ.0.).AND.(URDOST(M,I).EQ.0.)) GOTO 115
           WRITE (NOUT,1006)ORGNAM(I),DOSE(M,I),DOSET(M,I),
```

```
     *          URDOSE(M,I),URDOST(M,I)
 115    CONTINUE
 200  CONTINUE
                        RETURN
C
C
C
 1000 FORMAT(29X, 19HDOSES FOR TIME STEP, I3/
     *  33X,11HCASE NUMBER,I3//4X,18HSTEP START TIME AT,
     *  1P1E10.3,2X,5H(HRS),4X,16HSTEP END TIME AT,1P1E10.3,2X,5H(HRS))
 1001 FORMAT(///18X,43HPERCENT OF DOSE CONTRIBUTION FROM EACH NODE/
     *22X,35HBY CHEMICAL/PHYSICAL FORM AND GROUP// 2X,5HORGAN,5X,
     *5HGROUP,6X,4HFORM,3X,8HTOTAL BY,2X,8HTOTAL BY,1X,4(1X,A8,1X)/
     *3X,4HNAME,6X,4HNAME,6X,4HNAME,5X,5HGROUP,5X,4HFORM,3X,
     *4(1X,A8,1X))
 1002 FORMAT(/1X,A8,2X,A8,2X,A8,1P6E10.3)
 1003 FORMAT(/11X,A8,2X,A8,1P6E10.3)
 1004 FORMAT(21X,A8,10X,1P5E10.3)
 1005 FORMAT(/26X,18HEXCLUSION BOUNDARY)
 1006 FORMAT(1X,A8,1X,1P2E10.3,2X,1P2E10.3)
 1007 FORMAT(/25X,19HLOW POPULATION ZONE)
 1008 FORMAT (/30X,9HOTHER X/Q)
 1009 FORMAT(1X,5HORGAN,11X,10HCALCULATED,13X,9HUNREDUCED/
     *       1X,4HNAME,12X,10HDOSE (REM),13X,10HDOSE (REM)/
     *       11X,39HFOR THIS   ACCUM.     FOR THIS   ACCUM./
     *       11X,9HTIME STEP,13X,9HTIME STEP)
      END
      SUBROUTINE SUMMRY
      CHARACTER*8 ORGNAM(5)
      CHARACTER*8 GRPNAM(5)
      CHARACTER*8 TYPNAM(3)
      CHARACTER*8 NODNAM(5)
      CHARACTER*80 KTAPE
      CHARACTER*10 LTAPE
      CHARACTER*10 NTAPE
      CHARACTER*10 MTAPE
      CHARACTER*80 TITLE(50)
      CHARACTER*80 BLNK80
      CHARACTER*8 BLNK8
      CHARACTER*8 XISO(60)
      CHARACTER FF
      INTEGER*2 YEAR,MONTH,DAY,HOUR,MINUTE,SECOND
      COMMON / DATA1 / ORGNAM,GRPNAM,TYPNAM,NODNAM,KTAPE,LTAPE,
     *                 NTAPE,MTAPE,BLNK8,BLNK80,TITLE,XISO
      COMMON / DATA2 / ICASE,NSTEP,ISTEP,NODES,NXQ,NISO,JORGN,
     *                 JTYPE,JGROUP,NIN,NOUT,
     *                 IPRINT(5),IGROUP(60),INDEXO(5),ISWTCH(10),
     *                 ITYPE(60),IISO(60)
      COMMON / DATA3 / POWER,SDTIME,RELFR(5),PLTOUT(5),FRACT(5,3),
     *                 DECAY(60),DCF(5,60),S(60),TSTEP1,TSTEP2,
     *                 XE(60),XQ(3),BR(3),TTRAVL(3),
```

```
     *                AO(5,60),PB(5,60),VOL(5),XLAMIN(5,60),
     *                Q1(5,5,60),Q2(5,5,60),FILT(5,5,60)
      COMMON / DATA4 / DOSE(3,5),DOSET(3,5),URDOSE(3,5),SUMX(60),
     *                URDOST(3,5),ACTY(5,60),ACTYI(5,60),
     *                AIRELT(5,60)
      COMMON / SYSTIME / YEAR,MONTH,DAY,HOUR,MINUTE,SECOND,FF
      OPEN(24,FILE=MTAPE,STATUS='OLD',ACCESS='SEQUENTIAL',
     *FORM='UNFORMATTED')
C
C
C
 152  ITEST = 1
      DO 158 IJ=1,JORGN
      WRITE (NOUT,*)FF
      WRITE(NOUT,1010) IJ,TITLE(1)
         REWIND 24
      READ(24,END=155)ICASE,NSTEP,NODES,NXQ,TITLE,POWER,SDTIME,RELFR,
     *          PLTOUT,FRACT,YEAR,MONTH,DAY,HOUR,MINUTE,
     *          SECOND,JGROUP,JTYPE,JORGN,INDEXO,
     *          GRPNAM,TYPNAM,ORGNAM,IPRINT,NISO,XISO,DECAY,
     *          S,IGROUP,ITYPE,DCF,VOL
      NN=NODES+1
         ITEST =1
C
 153     CONTINUE
      READ(24,END=155) (SUMX(I),I=1,NISO),((ACTY(I,J),I=1,NN),J=1,NISO),
     *((AIRELT(I,J),I=1,NN),J=1,NISO),((ACTYI(I,J),I=1,NN),J=1,NISO),
     *((DOSE(I,J),I=1,NXQ),J=1,JORGN),((DOSET(I,J),I=1,NXQ),J=1,JORGN),
     *((URDOSE(I,J),I=1,NXQ),J=1,JORGN),((URDOST(I,J),I=1,NXQ),
     *J=1,JORGN),ISTEP,TSTEP1,TSTEP2
C
         IF(ITEST.EQ.1)WRITE(NOUT, 1013)ORGNAM(IJ)
         IF(ITEST .EQ.1)WRITE(NOUT, 1012)
C
         IF( ITEST .EQ. 1 )   WRITE(NOUT, 1014)
 154     WRITE(NOUT, 1043)   TSTEP1,
     *        URDOSE(1,IJ), URDOST(1,IJ), URDOSE(2,IJ), URDOST(2,IJ),
     *URDOSE(3,IJ),URDOST(3,IJ)
         IF( ISTEP .EQ. NSTEP )   WRITE(NOUT, 1015)
     *        URDOST(1,IJ), URDOST(2,IJ),URDOST(3,IJ)
         IF(ISTEP .EQ. NSTEP) GO TO 155
         ITEST=0
         GO TO 153
 155     CONTINUE
         REWIND 24
      READ(24,END=155)ICASE,NSTEP,NODES,NXQ,TITLE,POWER,SDTIME,RELFR,
     *          PLTOUT,FRACT,YEAR,MONTH,DAY,HOUR,MINUTE,
     *          SECOND,JGROUP,JTYPE,JORGN,INDEXO,
     *          GRPNAM,TYPNAM,ORGNAM,IPRINT,NISO,XISO,DECAY,
     *          S,IGROUP,ITYPE,DCF,VOL
      NN=NODES+1
```

```
          ITEST=1
C
 156      CONTINUE
       READ(24,END=155) (SUMX(I),I=1,NISO),((ACTY(I,J),I=1,NN),J=1,NISO),
      *((AIRELT(I,J),I=1,NN),J=1,NISO),((ACTYI(I,J),I=1,NN),J=1,NISO),
      *((DOSE(I,J),I=1,NXQ),J=1,JORGN),((DOSET(I,J),I=1,NXQ),J=1,JORGN),
      *((URDOSE(I,J),I=1,NXQ),J=1,JORGN),((URDOST(I,J),I=1,NXQ),
      *J=1,JORGN),ISTEP,TSTEP1,TSTEP2
          IF( ITEST .EQ. 1 )   WRITE(NOUT, 1013)   ORGNAM(IJ)
          IF( ITEST .EQ. 1 )   WRITE(NOUT, 1011)
          IF( ITEST .EQ. 1 )   WRITE(NOUT, 1014)
C
          ITEST = 0
 157      WRITE(NOUT, 1043)   TSTEP1,
      *        DOSE(1,IJ), DOSET(1,IJ), DOSE(2,IJ), DOSET(2,IJ),
      *DOSE(3,IJ),DOSET(3,IJ)
          IF( ISTEP .EQ. NSTEP )   WRITE(NOUT, 1015)
      *DOSET(1,IJ),DOSET(2,IJ),DOSET(3,IJ)
          IF(ISTEP .EQ. NSTEP)GO TO 158
          GO TO 156
 158   CONTINUE
       CLOSE (24,STATUS='KEEP')
                          RETURN
C
C
C
 1010 FORMAT(1X/70X,5HPAGE ,I1//27X,25HSUMMARY OF OFF-SITE DOSES/
      *       /1X,A80)
 1011 FORMAT(24X,31HMULTI NODE CONTAINMENT WITH ESF)
 1012 FORMAT(22X,35HSINGLE NODE CONTAINMENT WITH NO ESF)
 1013 FORMAT(22X,15HCALCULATION FOR,1X,A8,1X,11HDOSE (REMS))
 1014 FORMAT(1X,5HSTART,10X,16HEXCLUSION RADIUS,4X,
      *19HLOW POPULATION ZONE,8X,12HCONTROL ROOM/1X,4HTIME,8X,
      *4HEACH,7X,6HACCUM.,5X,4HEACH,7X,6HACCUM.,5X,4HEACH,
      *7X,6HACCUM./1X,5H(HRS),7X,4HSTEP,18X,4HSTEP,
      *18X,4HSTEP)
 1015 FORMAT(18X,5HTOTAL,1P1E10.3,7X,5HTOTAL,1P1E10.3,7X,5HTOTAL,
      *1P1E10.3//)
 1043 FORMAT( 7(1X, 1P1E10.3) )
       END
       SUBROUTINE MATRIX(IO,N,M,C,CC,DD,AO,AA,EI,ER,B,STRING,DT,A,AI,IFLA
      >G,ERR)
C*************************************************************************
C  THIS SUBROUTINE IS CALLED FROM 'ACT' TO SOLVE THE SET OF SIMULTANEOUS
C EQUATIONS THAT REPRESENT THE TRANSPORT AND REMOVAL OF ACTIVITY
C FROM OR BETWEEN NODES.  'MATRIX' AND THE SUBROUTINES
C IT CALLS, DIRECTLY OR INDIRECTLY, ('RILMAT,' 'DQRT,' 'EIGQR,'
C AND 'SIMQ'), CAN BE CONSIDERED A SEPERATE UNIT THAT INTERFACE
C WITH THE OTHER SUBROUTINES ONLY THROUGH THE CALL OF 'MATRIX' FROM
C 'ACT'.  THE MEANING OF THE ARGUMENTS IS AS FOLLOWS:
C   IO . . . . .NUMBER OF THE OUTPUT DEVICE
```

```
C   N. . . . . .NUMBER OF NODES, PLUS ONE, FOR THIS RUN
C   M. . . . . .MAXIMUM NUMBER OF NODES THIS VERSION CAN ACCEPT
C   C. . . . . .THE COEFFICIENT MATRIX CALCULATED BY 'COEFF'
C   CC . . . . .DOUBLE PRECISION OF C
C   DD . . . . .OUTPUT ARGUMENT, IMAGINARY COMPONENTS OF THE EIGENVECTORS
C   AO . . . . .INPUT ARGUMENT, ACTIVITY IN NODES AT START OF TIME STEP
C   AA . . . . .INTERNAL ARGUMENT
C   EI . . . . .OUTPUT ARGUMENT, THE IMAGINARY PART OF THE EIGENVALUES
C   ER . . . . .OUTPUT ARGUMENT, THE REAL PART OF THE EIGEN VALUES
C   B. . . . . .INPUT ARGUMENT, THE VECTOR CONTAINING THE CONSTANT PARTS
C                 OF THE EQUATIONS
C   STRING . . .INTERNAL ARGUMENT, THE MATRIX C LINEARLIZED TO A VECTOR
C   DT . . . . .INPUT ARGUMENT, THE DURATION OF THE TIME STEP
C   A. . . . . .OUTPUT ARGUMENT, THE ACTIVITY IN NODES AT THE END OF THE
C                 TIME STEPS
C   AI . . . . .OUTPUT ARGUMENT, THE INTEGRATED ACTIVITY IN NODES AT THE
C                 END OF THE TIME STEP
C   IFLG . . . .INPUT/OUTPUT ARGUMENT, A SWITCH SET TO 1 IF MATRIX IS
C                 DIAGONAL
C   ERR. . . . .OUTPUT ARGUMENT, A SWITCH SET IF A SOLUTION CANNOT BE FOUND
C*************************************************************************
      DIMENSION C(M,M),CC(M,M),DD(M,M),AO(M),AA(M),A(M),AI(M),ER(M),EI(M
     1),B(M),STRING(25)
      DOUBLE PRECISION CC, DD, ER, EI, T, EXPN,AA,AO,B,STRING,SUMA,SUMAI
      LOGICAL ERR
C
C   CHECK FOR ALL-ZERO ACTIVITY VECTOR
      ASUM = 0.
      BSUM=0.
      DO 1 I = 1, N
      BSUM=BSUM+B(I)
    1 ASUM = ASUM + AO(I)
      IF (ASUM.GT.0.)GO TO 3
      IF (BSUM.NE.0.)GO TO 3
      DO 2 I = 1, N
      A(I) = 0.
      AI(I) = 0.
    2 CONTINUE
      RETURN
    3 DO 15 J = 1, N
      DO 15 I = 1, N
      CC(I,J) = DBLE(C(I,J))
      IJ = (J-1) * N + I
      STRING(IJ) = DBLE(C(I,J))
   15 CONTINUE
      T = DBLE(DT)
C
C   CHECK IF C(I,J) IS A DIAGONAL MATRIX
      CSUM = 0.
      DO 4 I = 1, N
      DO 4 J = 1, N
```

```
      IF (I .EQ. J) GO TO 4
      CSUM = CSUM + C(I,J)
    4 CONTINUE
      IF (CSUM .GT. 0.) GO TO 10
      IFLAG=1
      DO 5 I = 1, N
      IF(DABS(CC(I,I)).LE.1.E-06)CC(I,I)=-(1.E-06)/T
      A(I)=SNGL(AO(I)*DEXP(CC(I,I)*T)+(B(I)/CC(I,I))*(1.-DEXP(CC(I,I)*T)
     >))
      AI(I)=SNGL((AO(I)/CC(I,I))*(DEXP(CC(I,I)*T)-1.)+(B(I)/CC(I,I))*(T-
     >(DEXP(CC(I,I)*T)-1.)/CC(I,I)))
    5 CONTINUE
      RETURN
C
C   DETERMINE PARTICULAR SOLUTION FROM EQUILIBRIUM CONDITION
   10 CALL SIMQ(STRING,B,N,KS)
      IF(KS .NE. 0) GO TO 9
C
C   OBTAIN EIGENVALUES AND EIGENVECTORS OF THE
C   COEFFICIENT MATRIX C
      IPRINT = 0
      CALL RILMAT(CC,DD,ER,EI,N,M,IPRINT,NCAL)
C
C   CHECK THE NUMBER OF EIGENVALUES
      IF (NCAL .LT. N) GO TO 99
C
C   CHECK FOR IMAGINARY VALUES
      SUMI = 0.
      DO 20 I = 1, N
      SUMI = SUMI + EI(I)
      DO 20 J = 1, N
      SUMI = SUMI + DD(I,J)
   20 CONTINUE
      IF (SUMI .NE. 0.) GO TO 999
C
C   NORMALIZE EIGENVECTORS TO INITIAL CONDITIONS
   30 CONTINUE
      DO 35 J = 1, N
      AA(J) = AO(J) - B(J)
      DO 35 I = 1, N
      IJ = (J-1) * N + I
      STRING(IJ) = CC(I,J)
   35 CONTINUE
      CALL SIMQ(STRING,AA,N,KS)
      IF (KS .NE. 0) GO TO 9999
C
C   CALCULATE ACTIVITIES AND INTEGRATED ACTIVITIES
      DO 41 I = 1, N
      SUMA = B(I)
      SUMAI = B(I) * DT
      DO 40 J = 1, N
```

```
      EXPN = 0.
      IF((ER(J)*T).LE.-150.)GO TO 39
      EXPN = DEXP(ER(J)*T)
   39 CONTINUE
      SUMA = SUMA + AA(J)*CC(I,J)*EXPN
      SUMAI = SUMAI + AA(J)*CC(I,J)*(EXPN - 1.0)/ER(J)
   40 CONTINUE
      A(I)=SNGL(SUMA)
      AI(I)=SNGL(SUMAI)
   41 CONTINUE
C
      RETURN
C
C   ERROR MESSAGES
    9 WRITE(IO,600)
      IF(N.LE.10)GO TO 92
      WRITE(IO,400) ((C(I,J),J=1,N), I=1,N)
      GO TO 90
   92 DO 91 I=1,N
   91 WRITE(IO,400)(C(I,J),J=1,N)
   90 WRITE(IO,700)
      WRITE(IO,400) (B(I), I=1,N)
      ERR = .TRUE.
      RETURN
   99 WRITE(IO,100) NCAL
      ERR = .TRUE.
      RETURN
  999 WRITE(IO,200)
      WRITE(IO,400) (EI(I), I=1,N)
      WRITE(IO,500)
      IF(N.LE.10)GO TO 992
      WRITE(IO,400) ((DD(I,J), J=1,N), I=1,N)
      GO TO 9993
  992 DO 991 I=1,N
  991 WRITE(IO,400)(DD(I,J),J=1,N)
      WRITE(IO,101)
      GO TO 30
 9999 WRITE(IO,300)
      ERR = .TRUE.
      IF(N.LE.10)GO TO 9992
      WRITE(IO,400) ((C(I,J),J=1,N), I=1,N)
      GO TO 9993
 9992 DO 9991 I=1,N
 9991 WRITE(IO,400)(C(I,J),J=1,N)
 9993 RETURN
  100 FORMAT(1H1,30X,'...ERROR IN SUBROUTINE MATRIX...',//,
     1       10X,'DEGENERATE SET OF EIGENVALUES',//,
     2       10X,'THE NUMBER OF EIGENVALUES GENERATED IS',I3)
  101 FORMAT(1H1)
  200 FORMAT(1H1,30X,'...WARNING...'//,10X,'IN SUBROUTINE ',
     1       'MATRIX, THE EIGENVALUES OR EIGENVECTORS HAVE ',
```

```
     2       'IMAGINARY COMPONENTS',//,10X,
     3       'CONTINUE CALCULATION WITH REAL PARTS',//,10X,
     4       'THE IMAGINARY COMPONENTS OF THE EIGENVALUES ARE',/)
300  FORMAT(1H1,30X,'...ERROR IN SUBROUTINE MATRIX...',//,10X,
     1       'SINGULAR SET OF SOLUTIONS RETURNED FROM ',
     2       'SUBROUTINE SIMQ',//,10X,'NORMALIZATION OF ',
     3       'EIGENVECTORS NOT POSSIBLE.', //, 1X,
     4       'THE COEFFICIENT MATRIX IS',//)
400  FORMAT(10E12.3)
500  FORMAT(1H1,10X,'THE IMAGINARY COMPONENTS OF THE EIGENVECTORS ',
     1       'ARE',/)
600  FORMAT(1H1,10X,'...ERROR IN SUBROUTINE MATRIX...',//,10X,
     1       'CALCULATION OF PARTICULAR SOLUTION FAILED',//,10X,
     2       'THE COEFFICIENT MATRIX IS',/)
700  FORMAT(1HO,10X,'THE SOURCE TERMS ARE',/)
      END
```

```
C
      SUBROUTINE RILMAT(A,H,ROOTR,ROOTI,M,ID,IP,NCAL)
C  PROGRAM AUTHORS  MISS JANE COPE AND MISS
C   DUNPHEY
C  FORMERLY WITH
C  COMPUTING TECHNOLOGY CENTER, UNION CARBIDE CORP., NUCLEAR DIV.,
C  OAK RIDGE, TENN.
C
      REAL*8 A(ID,ID), H(ID,ID),HLR(30,30),HLI(30, 30),
     > ROOTR(ID ),ROOTI(ID),VECTR(30),VECTI(30),RTR(30), MULTR(30),
     > MULTI(30),ABIG, ABS1,RI,SUM,VTI,BIG,TEMPI, VTR,EPS,TEMPR,TEMP,RR
      LOGICALINTH(30),TWICE
      INTEGERINT(30),R,RP1,RP2
      IRET = 1
      N=M
      IF (N-2) 20,20,50
   20 IF (IRET.EQ.0) GO TO 40
      DO 30I=1,N
         DO 30J=1,N
   30       H(I,J)=A(I,J)
   40 CALL EIGQR (A, M, ROOTR, ROOTI, IP, ID, NCAL)
      GO TO 190
C
C     REDUCE MATRIX A TO UPPER HESSENBERG FORM
C
   50 NM2=N-2
      DO 160R=1,NM2
         RP1=R+1
         RP2=R+2
         ABIG=0.D0
         INT(R)=RP1
         DO 60I=RP1,N
            ABS1=DABS(A(I,R))
            IF (ABS1.LE.ABIG) GO TO 60
            INT(R)=I
            ABIG=ABS1
   60       CONTINUE
         INTER=INT(R)
         IF (ABIG.EQ.0.D0) GO TO 160
         IF (INTER.EQ.RP1) GO TO 90
         DO 70I=R,N
            TEMP=A(RP1,I)
            A(RP1,I)=A(INTER,I)
   70       A(INTER,I)=TEMP
         DO 80I=1,N
            TEMP=A(I,RP1)
            A(I,RP1)=A(I,INTER)
   80       A(I,INTER)=TEMP
   90    DO 100I=RP2,N
            MULTR(I)=A(I,R)/A(RP1,R)
  100       A(I,R)=MULTR(I)
```

```
      DO 120I=1,RP1
         TEMP=0.D0
         DO 110J=RP2,N
  110       TEMP=TEMP+A(I,J)*MULTR(J)
  120    A(I,RP1)=A(I,RP1)+TEMP
      DO 140I=RP2,N
         TEMP=0.D0
         DO 130J=RP2,N
  130       TEMP=TEMP+A(I,J)*MULTR(J)
  140    A(I,RP1)=A(I,RP1)+TEMP-MULTR(I)*A(RP1,RP1)
      DO 150I=RP2,N
         DO 150J=RP2,N
  150       A(I,J)=A(I,J)-MULTR(I)*A(RP1,J)
  160 CONTINUE
      IF (IRET.EQ.0) GO TO 180
C     SAVE A IN H
      DO 170I=1,N
         DO 170J=1,N
  170       H(I,J)=A(I,J)
C
C     CALCULATE EIGENVALUES
C
  180 CALL EIGQR (A, M, ROOTR, ROOTI, IP,ID, NCAL)
  190 IF (NCAL.EQ.0.OR.IRET.EQ.0) GO TO 510
C
C     CALCULATE VECTORS
C
      EPS=0.D0
      DO 200 I=1,N
  200    EPS=EPS+DABS(H(1,I))
      DO 220 I=2,N
         SUM=0.D0
         IM1=I-1
         DO 210J=IM1,N
  210       SUM=SUM+DABS(A(I,J))
  220    IF (SUM.GT.EPS) EPS=SUM
      EPS=DSQRT(DBLE(FLOAT(N)))*EPS*1.D-19
      IF (EPS.EQ.0.D0) EPS=1.D-19
      N=M
      NM1=N-1
      ITAG1=0
      ITAG2=0
      NMT = NCAL
  230 DO 470 L = 1,NCAL
         LMT=L-ITAG1
         DO 250I=1,N
            DO 240J=1,N
               HLR(I,J)=H(I,J)
  240          HLI(I,J)=0.D0
            HLR(I,I)=HLR(I,I)-ROOTR(L)
  250       HLI(I,I)=-1.D0*ROOTI(L)
```

```
      DO 290I=1,NM1
         MULTR(I)=0.D0
         MULTI(I)=0.D0
         INTH(I)=.FALSE.
         IP1=I+1
         IF ((HLR(I+1,I))**2+(HLI(I+1,I))**2.LE.(HLR(I,I))**2+(HLI(I,
     >       I))**2) GO TO 270
         INTH(I)=.TRUE.
         DO 260J=1,N
            TEMPR=HLR(I+1,J)
            TEMPI=HLI(I+1,J)
            HLR(I+1,J)=HLR(I,J)
            HLI(I+1,J)=HLI(I,J)
            HLR(I,J)=TEMPR
260         HLI(I,J)=TEMPI
270      IF (HLR(I,I).EQ.0.D0.AND.HLI(I,I).EQ.0.D0) GO TO 290
         MULTR(I)=-(HLR(I+1,I)*HLR(I,I)+HLI(I+1,I)*HLI(I, I))/(HLR(I,
     >        I) **2+HLI(I,I)**2)
         MULTI(I)=(HLR(I+1,I)*HLI(I,I)-HLI(I+1,I)*HLR(I, I))/(HLR(I,
     >       I) **2+HLI(I,I)**2)
         DO 280J=IP1,N
            TEMPR=HLR(I+1,J)+MULTR(I)*HLR(I,J)-MULTI(I)* HLI(I,J)
            TEMPI=HLI(I+1,J)+MULTR(I)*HLI(I,J)+MULTI(I)* HLR(I,J)
            HLR(I+1,J)=TEMPR
280         HLI(I+1,J)=TEMPI
290      CONTINUE
      DO 300I=1,N
         VECTR(I)=1.D0
300      VECTI(I)=0.D0
      TWICE=.FALSE.
310   IF (HLR(N,N).EQ.0.D0.AND.HLI(N,N).EQ.0.D0) HLR(N,N) =EPS
      TEMPR=(VECTR(N)*HLR(N,N)+VECTI(N)*HLI(N,N))/(HLR(N, N)**2 +
     >  HLI(N,N)**2)
      TEMPI=(VECTI(N)*HLR(N,N)-VECTR(N)*HLI(N,N))/(HLR(N, N)** 2+
     >  HLI(N,N)**2)
      VECTR(N)=TEMPR
      VECTI(N)=TEMPI
      DO 330I=1,NM1
         K=N-I
         DO 320J=K,NM1
            TEMPR=VECTR(K)-HLR(K,J+1)*VECTR(J+1)+HLI(K,J+ 1)*VECTI(J+
     >        1)
            TEMPI=VECTI(K)-HLR(K,J+1)*VECTI(J+1)-HLI(K,J+ 1)*VECTR(J+
     >        1)
            VECTR(K)=TEMPR
320         VECTI(K)=TEMPI
         IF (HLR(K,K).EQ.0.D0.AND.HLI(K,K).EQ.0.D0) HLR(K,K)=EPS
         TEMPR=(VECTR(K)*HLR(K,K)+VECTI(K)*HLI(K,K))/ (HLR(K,K)**2+
     >       HLI(K,K)**2)
         TEMPI=(VECTI(K)*HLR(K,K)-VECTR(K)*HLI(K,K))/ (HLR(K,K)**2+
     >       HLI(K,K)**2)
```

```
            VECTR(K)=TEMPR
  330       VECTI(K)=TEMPI
          BIG=0.D0
          DO 340I=1,N
            SUM=DABS(VECTR(I))+DABS(VECTI(I))
  340       IF (SUM.GT.BIG) BIG=SUM
          DO 350I=1,N
            VECTR(I)=VECTR(I)/BIG
  350       VECTI(I)=VECTI(I)/BIG
          IF (TWICE) GO TO 380
          DO 370I=1,NM1
            IF (.NOT.INTH(I)) GO TO 360
            TEMPR=VECTR(I)
            TEMPI=VECTI(I)
            VECTR(I)=VECTR(I+1)
            VECTI(I)=VECTI(I+1)
            VECTR(I+1)=TEMPR
            VECTI(I+1)=TEMPI
  360       VTR=VECTR(I+1)+MULTR(I)*VECTR(I)-MULTI(I)* VECTI(I)
            VTI=VECTI(I)+MULTI(I)*VECTR(I)+MULTR(I)*VECTI(I)
            VECTR(I+1)=VTR
  370       VECTI(I+1)=VTI
          TWICE=.TRUE.
          GO TO 310
  380     IF (N.EQ.2) GO TO 410
          NM2=N-2
          DO 400I=1,NM2
            N1I=N-1-I
            NI1=N-I+1
            DO 390J=NI1,N
              VECTR(J)=H(J,N1I)*VECTR(N1I+1)+VECTR(J)
  390         VECTI(J)=H(J,N1I)*VECTI(N1I+1)+VECTI(J)
            INDEX=INT(N1I)
            TEMPR=VECTR(N1I+1)
            TEMPI=VECTI(N1I+1)
            VECTR(N1I+1)=VECTR(INDEX)
            VECTI(N1I+1)=VECTI(INDEX)
            VECTR(INDEX)=TEMPR
  400       VECTI(INDEX)=TEMPI
  410     DO 420I=1,N
            IF (VECTI(I).NE.0.D0) GO TO 430
  420       CONTINUE
          GO TO 450
  430     ITAG1=ITAG1+1
          IF (VECTI(I).LT.0.D0) GO TO 470
          ITAG2=ITAG2+1
          NMT = NCAL-2*ITAG2
C     ITAG1 TELLS HOW MANY COMPLEX VECTORS, ITAG2 HOW MANY STORED IN A
          DO 440I=1,N
            A(I,NMT+1)=VECTR(I)
            A(I,NMT+2)=VECTI(I)
```

```
  440       CONTINUE
            RTR(NMT+1)=ROOTR(L)
            RTR(NMT+2)=ROOTI(L)
            GO TO 470
  450       DO 460I=1,N
               A(I,LMT)=VECTR(I)
  460       CONTINUE
            RTR(LMT)=ROOTR(L)
  470       CONTINUE
C        PUT REAL PARTS OF EIGENVECTORS IN A, IMAGINARY PARTS IN H
         DO 480 I=1,N
            DO 480JJ=1,NMT
               ROOTR(JJ)=RTR(JJ)
               ROOTI(JJ)=0.D0
  480       H(I,JJ)=0.D0
         NMTP1=NMT+1
         NM1 = NCAL - 1
         DO 490I=1,N
            DO 490J=NMTP1,NM1,2
               ROOTI(J)=-RTR(J+1)
         IF (NMT.EQ.NCAL) GO TO 510
               ROOTI(J+1)=RTR(J+1)
               H(I,J)=-A(I,J+1)
  490       H(I,J+1)=A(I,J+1)
         DO 500 I=1,N
            DO 500 J=NMTP1,NM1,2
               ROOTR(J)=RTR(J)
               ROOTR(J+1)=ROOTR(J)
  500       A(I,J+1)=A(I,J)
  510 RETURN
         END
         SUBROUTINE DQRT(A,N,R,SIG,D,ID)
         DOUBLE PRECISION A(ID,ID),PSI(2),G(3),SIG,DEN,XK,AL, C,D,E,R,GMAX,
        >  G1,G2
         N1=N-1
         IA=N-2
         IP=IA
         IF (N-3) 410,50,10
   10 DO 40J=3,N1
            J1=N-J
            IF (DABS(A(J1+1,J1))-D) 50,50,20
   20       DEN=A(J1+1,J1+1)*(A(J1+1,J1+1)-SIG)+A(J1+1,J1+2)* A(J1+2, J1+1)
     >        +R
            IF (DEN) 30,40,30
   30       IF (DABS(A(J1+1,J1)*A(J1+2,J1+1)*(DABS(A(J1+1,J1+1)+A(J1+2,J1+
     >       2)-SIG)+DABS(A(J1+3,J1+2)))/DEN)-D) 50,50,40
   40       IP=J1
   50 DO 60J=1,IP
            J1=IP-J+1
            IF (DABS(A(J1+1,J1))-D) 70,70,60
   60       IQ=J1
```

```
 70 DO 400I=IP,N1
       IF (I-IP) 90,80,90
 80    G(1)=A(IP,IP)*(A(IP,IP)-SIG)+A(IP,IP+1)*A(IP+1,IP)+ R
       G(2)=A(IP+1,IP)*(A(IP,IP)+A(IP+1,IP+1)-SIG)
       G(3)=A(IP+1,IP)*A(IP+2,IP+1)
       A(IP+2,IP)=0.D0
       GO TO 120
 90    G(1)=A(I,I-1)
       G(2)=A(I+1,I-1)
       IF (I-IA) 100,100,110
100    G(3)=A(I+2,I-1)
       GO TO 120
110    G(3)=0.D0
120    CONTINUE
       IF (G(1).EQ.0.D0.AND.G(2).EQ.0.D0.AND.G(3).EQ.0.D0) GO TO 190
       GMAX = G(1)
       IF (DABS(G(2)).GT.DABS(GMAX)) GO TO 130
       G1 = G(2)
       GO TO 140
130    GMAX = G(2)
       G1 = G(1)
140    IF (DABS(G(3)).GT.DABS(GMAX)) GO TO 150
       G2 = G(3)
       GO TO 160
150    G2 = GMAX
       GMAX = G(3)
160    CONTINUE
       XK = DABS(GMAX)*DSQRT( (G1/GMAX)**2 + (G2/GMAX)**2 + 1.D0)
       IF (G(1).GE.0.D0) GO TO 170
       XK = -XK
170    CONTINUE
       IF (XK) 180,200,180
180    AL=G(1)/XK+1.D0
       PSI(1)=G(2)/(G(1)+XK)
       PSI(2)=G(3)/(G(1)+XK)
       GO TO 210
190    XK = 0.D0
200    AL=2.D0
       PSI(1)=0.D0
       PSI(2)=0.D0
210    IF (I-IQ) 220,250,220
220    IF (I-IP) 240,230,240
230    A(I,I-1)=-A(I,I-1)
       GO TO 250
240    A(I,I-1)=-XK
250    DO 300J=I,N
          IF (I-IA) 260,260,270
260       C=PSI(2)*A(I+2,J)
          GO TO 280
270       C=0.0
280       E=AL*(A(I,J)+PSI(1)*A(I+1,J)+C)
```

```
            A(I,J)=A(I,J)-E
            A(I+1,J)=A(I+1,J)-PSI(1)*E
            IF (I-IA) 290,290,300
  290       A(I+2,J)=A(I+2,J)-PSI(2)*E
  300       CONTINUE
          IF (I-IA) 310,310,320
  310     L=I+2
          GO TO 330
  320     L=N
  330     DO 380J=IQ,L
            IF (I-IA) 340,340,350
  340       C=PSI(2)*A(J,I+2)
            GO TO 360
  350       C=0.0
  360       E=AL*(A(J,I)+PSI(1)*A(J,I+1)+C)
            A(J,I)=A(J,I)-E
            A(J,I+1)=A(J,I+1)-PSI(1)*E
            IF (I-IA) 370,370,380
  370       A(J,I+2)=A(J,I+2)-PSI(2)*E
  380       CONTINUE
          IF (I-N+3) 390,390,400
  390     E=AL*PSI(2)*A(I+3,I+2)
          A(I+3,I)=-E
          A(I+3,I+1)=-PSI(1)*E
          A(I+3,I+2)=A(I+3,I+2)-PSI(2)*E
  400     CONTINUE
  410   RETURN
        END
        SUBROUTINE EIGQR (A,M,ROOTR,ROOTI,IPRNT,ID, NCAL)
C  PROGRAM AUTHORS  MISS JANE COPE AND MISS JANE DUNPHEY
C  COMPUTING TECHNOLOGY CENTER, UNION CARBIDE CORP., NUCLEAR DIV.,
C  OAK RIDGE, TENN. MODIFICATION OF SHARE 3006.01.
C
C       PROGRAM TO CALL DOUBLE PRECISION QR TRANSFORMATION
C
        DOUBLE PRECISION A(ID,ID)
        DOUBLE PRECISION ROOTR(ID),ROOTI(ID),AA,B,C,DD,E,F,G, H,R,SIG,X,S,
       >  ZERO,XNN,XN2,Z1,Z2,VQ,SQ,D
        N=M
        NCAL = N
        IF (IPRNT) 10,20,10
    10  WRITE(6,10000)
    20  ZERO=0.D0
        JJ=1
    30  XNN=0.D0
        XN2=0.D0
        AA=0.D0
        B=0.D0
        C=0.D0
        DD=0.D0
        R=0.D0
```

```
      SIG=0.D0
      ITER=0
   40 IF (N-2) 50,90,100
   50 IF (IPRNT) 60,70,60
   60 WRITE(6,10100)A(1,1)
   70 ROOTR(1)=A(1,1)
      ROOTI(1)=0.D0
   80 RETURN
   90 JJ=-1
  100 X=(A(N-1,N-1)-A(N,N))**2
      S=4.D0*A(N,N-1)*A(N-1,N)
      ITER=ITER+1
      IF (X.EQ.0.D0.OR.DABS(S/X).GT.1.D-16) GO TO 150
  110 IF (DABS(A(N-1,N-1))-DABS(A(N,N))) 130,130,120
  120 E=A(N-1,N-1)
      G=A(N,N)
      GO TO 140
  130 G=A(N-1,N-1)
      E=A(N,N)
  140 F=0.D0
      H=0.D0
      GO TO 200
  150 S=X+S
      X=A(N-1,N-1)+A(N,N)
      IF (S) 190,160,160
  160 SQ=DSQRT(S)
      F=0.D0
      H=0.D0
      IF (X) 170,170,180
  170 E=(X-SQ)/2.0D0
      G=(X+SQ)/2.0D0
      GO TO 200
  180 G=(X-SQ)/2.0D0
      E=(X+SQ)/2.0D0
      GO TO 200
  190 F=DSQRT(-S)/2.0D0
      E=X/2.0D0
      G=E
      H=-F
  200 CONTINUE
      IF (JJ) 220,210,210
  210 D=1.0D-17*(DABS(G)+F)
      IF (DABS(A(N-1,N-2)).GT.D) GO TO 250
  220 IF (IPRNT) 230,240,230
  230 WRITE(6,10100)E,F,ITER
      WRITE(6,10100)G,H
  240 ROOTR(N)=E
      ROOTI(N)=F
      ROOTR(N-1)=G
      ROOTI(N-1)=H
      N=N-2
```

```
    IF (JJ) 80,30,30
250 IF (DABS(A(N,N-1)).GT.1.0D-17*DABS(A(N,N))) GO TO 290
260 IF (IPRNT) 270,280,270
270 WRITE(6,10100)A(N,N),ZERO,ITER
280 ROOTR(N)=A(N,N)
    ROOTI(N)=0.D0
    N=N-1
    GO TO 30
290 IF (DABS(DABS(XNN/A(N,N-1))-1.D0)-1.D-13) 310,310,300
300 IF (DABS(DABS(XN2/A(N-1,N-2))-1.D0)-1.D-13) 310,310,400
310 VQ=DABS(A(N,N-1))-DABS(A(N-1,N-2))
    IF (ITER-15) 450,320,350
320 IF (VQ) 330,330,340
330 R=A(N-1,N-2)**2*1.D0
    SIG=2.D0*A(N-1,N-2)
    GO TO 500
340 R=A(N,N-1)**2
    SIG=2.D0*A(N,N-1)
    GO TO 500
350 IF (VQ) 380,380,360
360 IF (IPRNT) 370,240,370
370 WRITE(6,10200)A(N-1,N-2)
    GO TO 230
380 IF (IPRNT) 390,280,390
390 WRITE(6,10200)A(N,N-1)
    GO TO 270
400 IF (ITER.LE.50) GO TO 420
    NCAL = M - N
    MNC = M - NCAL + 1
    DO 410 K = 1,NCAL
       II = MNC + K - 1
       ROOTR(K) = ROOTR(II)
410    ROOTI(K) = ROOTI(II)
    GO TO 80
420 IF (ITER.GT.5) GO TO 450
430 Z1= (E-AA)**2+(F-B)**2 - 0.25D0*(E*E + F*F)
    Z2= (G-C)**2+(H-DD)**2 - 0.25D0*(G*G + H*H)
    IF (Z1) 440,440,470
440 IF (Z2) 450,450,460
450 R=E*G-F*H
    SIG=E+G
    GO TO 500
460 R=E*E
    SIG=E+E
    GO TO 500
470 IF (Z2) 480,480,490
480 R=G*G
    SIG=G+G
    GO TO 500
490 R=0.D0
    SIG=0.D0
```

```
  500 XNN=A(N,N-1)
      XN2=A(N-1,N-2)
      CALL DQRT(A,N,R,SIG,D,ID)
      AA=E
      B=F
      C=G
      DD=H
      GO TO 100
10000 FORMAT(////1X,9HREAL PART,14X,14HIMAGINARY PART,26X,
     > 13HTAKEN AS ZERO,6X,4HITER//)
10100 FORMAT(1X,D23.16,3X,D23.16,26X,I3)
10200 FORMAT(64X,D23.16)
      END
      SUBROUTINE SIMQ(A,B,N,KS)
      IMPLICIT REAL*8 (A-H,O-Z)
C
C   THIS IS THE STANDARD IBM ROUTINE SIMQ, AS DESCRIBED IN
C   IBM MANUAL GH20-0166-5 (SCIENTIFIC SUBROUTINE PACKAGE)
C           METHOD OF SOLUTION IS BY ELIMINATION USING LARGEST PIVOTAL
C           DIVISOR. EACH STAGE OF ELIMINATION CONSISTS OF INTERCHANGING
C           ROWS WHEN NECESSARY TO AVOID DIVISION BY ZERO OR SMALL
C           ELEMENTS.
C           THE FORWARD SOLUTION TO OBTAIN VARIABLE N IS DONE IN
C           N STAGES. THE BACK SOLUTION FOR THE OTHER VARIABLES IS
C           CALCULATED BY SUCCESSIVE SUBSTITUTIONS. FINAL SOLUTION
C           VALUES ARE DEVELOPED IN VECTOR B, WITH VARIABLE 1 IN B(1),
C           VARIABLE 2 IN B(2),....., VARIABLE N IN B(N).
C           IF NO PIVOT CAN BE FOUND EXCEEDING A TOLERANCE OF 0.0,
C           THE MATRIX IS CONSIDERED SINGULAR AND KS IS SET TO 1. THIS
C           TOLERANCE CAN BE MODIFIED BY REPLACING THE FIRST STATEMENT.
C
C     .....................................................................
C
      DIMENSION A(1),B(1)
C
C        FORWARD SOLUTION
C
      TOL = 1.0D-50
      KS=0
      JJ=-N
      DO 65 J=1,N
      JY=J+1
      JJ=JJ+N+1
      BIGA=0
      IT=JJ-J
      DO 30 I=J,N
C
C        SEARCH FOR MAXIMUM COEFFICIENT IN COLUMN
C
      IJ=IT+I
      IF(DABS(BIGA)-DABS(A(IJ))) 20,30,30
```

```
   20 BIGA=A(IJ)
      IMAX=I
   30 CONTINUE
C
C        TEST FOR PIVOT LESS THAN TOLERANCE (SINGULAR MATRIX)
C
      IF(DABS(BIGA)-TOL) 35,35,40
   35 KS=1
      RETURN
C
C        INTERCHANGE ROWS IF NECESSARY
C
   40 I1=J+N*(J-2)
      IT=IMAX-J
      DO 50 K=J,N
      I1=I1+N
      I2=I1+IT
      SAVE=A(I1)
      A(I1)=A(I2)
      A(I2)=SAVE
C
C        DIVIDE EQUATION BY LEADING COEFFICIENT
C
   50 A(I1)=A(I1)/BIGA
      SAVE=B(IMAX)
      B(IMAX)=B(J)
      B(J)=SAVE/BIGA
C
C        ELIMINATE NEXT VARIABLE
C
      IF(J-N) 55,70,55
   55 IQS=N*(J-1)
      DO 65 IX=JY,N
      IXJ=IQS+IX
      IT=J-IX
      DO 60 JX=JY,N
      IXJX=N*(JX-1)+IX
      JJX=IXJX+IT
   60 A(IXJX)=A(IXJX)-(A(IXJ)*A(JJX))
   65 B(IX)=B(IX)-(B(J)*A(IXJ))
C
C        BACK SOLUTION
C
   70 NY=N-1
      IT=N*N
      DO 80 J=1,NY
      IA=IT-J
      IB=N-J
      IC=N
      DO 80 K=1,J
      B(IB)=B(IB)-A(IA)*B(IC)
```

```
      IA=IA-N
   80 IC=IC-1
      RETURN
      END
```

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