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CADET: A Decision Support System for Light Water Reactor Safety

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Prepared for
U.S. Nuclear Regulatory
Commission

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Abstract

CADET (Computer Aided DEcision Tool) is a decision support system for light water reactor safety which is designed for use on personal computers. As a decision support system, it provides a user-friendly data base program complemented with several computational capabilities. The data base component of the program provides users with pertinent data from a variety of sources. The computational portion of the program provides measures of consequence and risk, and a means for performing "what if" analyses with selected elements of the data base. Predictive capabilities incorporated into the present version of CADET include effects of time of containment failure, effects of containment leak rate, and influences of filtered venting on the outcome of accident sequences.

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1.0 INTRODUCTION

CADET (Computer Aided DEcision Tool) is a decision support system for light water reactor safety. As such, it provides users with pertinent information relevant to LWR source terms and consequences. This information is provided through a menu driven program and data base system which is operational on personnel computers. CADET is a stand-alone module which runs under MS or PC DOS. It is desirable to operate CADET on fixed disk systems, although operation on floppy based systems is possible.

CADET allows users to access the data base through a series of menus. Menu options provide for selection of the type of data to be displayed, the power plant for which data should be displayed, elements of the data base which should be searched, and selection of specialized computational options. Any time that data are displayed, the user may request CADET to display the source of that data.

This work was performed for the U. S. Nuclear Regulatory Commission under Task 19 of "Support Services for Research and Evaluation of Severe Accident Phenomena and Mitigation", contract No. NRC-04-84-127, and Task 2 of "Support Services for Evaluation of Severe Accident Phenomena", contract No. NRC-04-87-066.

2.0 SCOPE OF CADET

The primary function of CADET is to provide concise and pertinent information to users regarding light water reactor safety. To accomplish this successfully, CADET provides only summary information and references to the sources of that information. The use of summary information helps to prevent burdening the user with an overload of information which might compromise clarity and efficiency. References to the sources of the summary data are provided to enable the user to quickly access the original documents for a description of how the data were generated. This allows the user to explore specific elements of the analyses which are referenced and to assure comprehension of the summary data in their proper context. CADET also provides users with calculational extensions of the summary data reported, in the form of consequence measures and other processes relevant to source terms which are useful for what-if analyses. An important element of CADET is that it is operational on personal computers. Users are thereby able to access its data base and predictive capabilities in their offices as a complement to available references and other ongoing activities.

The data base in the current version of CADET contains summary data on analyses of five different specific light water power reactors. These are Grand Gulf, Peach Bottom, Sequoyah, Surry, and Zion. These plant types are a Mark III BWR, a Mark I BWR, an ice condenser design PWR, a subatmospheric design PWR, and a large dry containment design PWR respectively. Information in the data base includes calculated source terms, pressures, and temperatures. Also included are descriptions of each of the power plants and accident sequences.

Data in CADET are presented in tabular form and selected support information is presented as text. Selected data, at the users command through a menu option, can also be presented in graphical form. When instructed by the user, CADET will transfer information presented in the current display to a printer for production of a hard copy.

Information which CADET constructs from the data base includes measures of consequence and risk, influences of timing of containment failure, effects of containment leak rate, and influences of filtered venting on the outcome of accident sequences.

Menu selections which recall data directly from the CADET data base, and display that data in the form in which they were reported in the literature are:

Menu 1. Description of the data base.

Menu 2. Descriptions of selected plants.

Menus 3.1 through 3.6
Description and analyses of selected accident sequences and containment failure modes for selected plants.
- Menu 3.1 Description of accident sequence
- Menu 3.2 List key event times during the accident sequence
- Menu 3.3 List or plot containment pressure or temperature histories during the accident sequence.
- Menu 3.4 List or plot quantities of combustible or non-combustible gas suspended in the containment during the accident sequence.
- Menu 3.5 List core and primary system response.
- Menu 3.6 List containment response.

Menus 4.1 and 4.2
Analysis of source terms.
- Menu 4.1 Distributions of radionuclides in plants.
- Menu 4.2 Environmental release fractions.

Menu 7 Comparison of BMI-2104 data with IDCOR data.

Menu 8 Data base search.

Menu 9 Ranges of risk parameters.

Menu selections which use data stored in the CADET data base to provide the user with other information are:

Menus 4.3.1 through 4.4
- Menu 4.3.1 Off-site consequences for accident sequences.
- Menu 4.3.2 Principal contributors to off-site consequences.
- Menu 4.4 Risks associated with severe accidents.

Menus 5.1 and 5.2

Effects of containment failure time on the outcome of severe accidents.

- Menu 5.1.1 List environmental release fractions.
- Menu 5.1.2 List off-site consequences.
- Menu 5.2 Effect of leak rate on the outcome of severe accidents.

Menu 6.1 Effect of filtered venting.

- Menu 6.1.1 Environmental release fractions.
- Menu 6.1.2 Off-site consequences.

3.0 CADET DATA BASE

Five plants were selected for analysis of their performance and behavior during severe accident sequences. Performance characteristics include the results from these studies as well as principal plant features such as nominal power, primary system, containment geometry, and engineered safety feature characteristics for each installation.

Three pressurized water reactors (PWR's) and two boiling water reactors (BWR's) were selected as reference plant designs. Grand Gulf and Peach Bottom were selected as examples of BWR plants using a Mark III and Mark I containment design, respectively. Sequoyah, Surry, and Zion represented PWR's. Their design features used ice condenser, subatmospheric containment and large dry containment, respectively. Accident scenarios for each plant were selected on the basis of the potential importance as contributors to the risk profile of the associated plant. Table 1 gives a list of each plant along with its corresponding set of selected accident sequences.

3.1 Plant Data

A detailed description of each plant is provided in menu 2. This data base supplies such information as nominal operating power, reactor coolant system pressure, reactor core features and dimensions, fuel characteristics, and other physical parameters related to the plant design. Table 2 was printed by CADET. It illustrates an example of a CADET session in which the plant data for Peach Bottom has been retrieved on screen. Data are shown as displayed on the monitor. Additional data, not shown, can be viewed by scrolling the display vertically using the cursor control keys on the keyboard. In this example, about one quarter of the requested data are in the display window, which is limited by the number of lines of text which may be displayed on the monitor. Data for each plant were taken from BMI-2104 Volumes I through VI [1]. Appendix A contains a list of names of files containing plant-specific data.

Lower and upper bounds for each of the risk parameters considered in the NUREG-1150 draft report [2] are presented in menu 9. Table 3 lists those parameters.

3.2 Sequence Data

The greatest percentage of the CADET data base is composed of sequence-specific data. These data are located in individual files which comprise most of the CADET data base. Appendix A contains lists of all the data file names and the function for which each file is used. Results from each sequence analyzed in either BMI-2104 [1] or NUREG/CR-4624 [3] have been included in CADET's data base. A summary of the sequence-specific data available in CADET is provided in Table 4. All the data items listed in Table 4 are either directly taken from BMI-2104 or NUREG/CR-4624 or have been calculated from intermediate results given in one of these two series of reports (see Section 5).

Radionuclide release fraction results from the IDCOR [4] study are available for selected sequences. These data are used entirely in menus 7 and 8. A list of sequences for which IDCOR data is available is provided in Table 5. The IDCOR data is used by CADET primarily for the purposes of comparing the difference in results obtained for the same sequences under the varying assumptions incorporated in each study.

Table 1. Lists of Plants and Sequences Incorporated into CADET Data Base

Plant: **Grand Gulf**

Sequences:	TC - GAMMA'	S_2E - GAMMA'
	TB_1	TPI - GAMMA'
	TB_2	TQUV - GAMMA'
	TBS	TBR

Plant: **Peach Bottom**

Sequences:	AE - GAMMA'	TC_1
	TB_1	TC_2
	TB_2	TC_3
	TC - GAMMA'	TW - GAMMA'
		V

Plant: **Sequoyah**

Sequences:	S_2HF - GAMMMA	TML - GAMMA
	S_3HF_1 - GAMMA	TML - DELTA/EPSILON
	S_3HF_2 - GAMMA	TMLB' - GAMMA
	S_3HF_3 - GAMMA	TMLB' - DELTA
	TB	TMLU-SGTR
	TBA	

Plant: **Surry**

Sequences:	AB - BETA	S_2D - EPSILON
	AB - EPSILON	S_2D - GAMMA
	AB - GAMMA	TMLB' - DELTA
	AG	TMLB' - EPSILON
	S_1G	V
	S_2G	
	S_3G	

Plant: **Zion**

Sequences:	S_2D - EPSILON
	S_2DCr
	S_2D[illegible]irFir
	TMLB'- EPSILON
	TMLU

Table 2. Shown below is a sample of a CADET display of Plant Data. Additional data can be viewed on the screen by scrolling the display using the cursor control keys.

```
---------------Principal plant features for PEACH BOTTOM--------------
               Description of PEACH BOTTOM:
________________________________________________________________________
Weight Zircaloy in core:                144,382 lb (65,490 kg)
Weight other metal in core:              15,680 lb (7,112 kg)
Weight UO2 in core:                     351,440 lb (159,410 kg)
Weight of support structures
  included in debris:                   106,238 lb(48,188 kg)
Weight of bottom head:                  207,500 lb (94,120 kg)
Bottom head diameter:                   20.9 ft (6.4 m)
Bottom head thickness:                  0.576 ft (17.6 cm)

Containment Parameters
 ----------------------
  Number of compartments:  2
  Compartment 1:  Drywell
  Compartment 2:  Wetwell
              Free Volume          Initial Temperature      Initial Pressure
              -----------          -------------------      ----------------
            ft3          m3        F                 C      psia           MPa
           -----        ----      ---               ---    ------         -----
Drywell   159,000      4,503      100               37.8   14.7            0.1
WINDOW:CURSOR UP/DOWN/LEFT/RIGHT, F1=CONTINUE, F3=PREVIOUS MENU, F4=GENERAL MENU
                          FRAME 1 OF 1  CRTL-BRK & ALT-BRK OFF  F7=SWITCH FRAME
```

Table 3. Risk Parameters from NUREG/CR-1150 Study

Parameter	Units
Early Fatalities	yr^{-1}
Individual Risk	yr^{-1}
Latent Fatalities	yr^{-1}
Early Injuries	yr^{-1}
Population Dose	person-rem/r-yr
Offsite Costs	$/reactor-yr

Table 4. Summary of Sequence-Specific Data Available in CADET

Data Item	Menu*	Plants**
Accident Sequence Description.	3	All
Key Event Times During Sequence.	3	All
Containment Pressure Histories.	3	All
Containment Temperature Histories.	3	All
Mass of Combustible and Non-combustible Gases in Containment Following the Sequence.	3	All
Core and Primary System Response.	3	All
Containment Response.	3	All
Distribution of Radionuclides within the Plant Following the Accident Sequence.	4	All
Radionuclide Release Fraction within the PSP Following the Accident Sequence.	4-8	GG,PB
Radionuclide Release Fraction within the RCS Following the Accident Sequence.	4-8	All
Environmental Release Fractions of Radionuclides in Accident Sequence.	4-8	All
Data for Ex-Plant Consequence Analysis.	4	All
Ranges of Risk Parameters.	9	All

* Denotes those menus for which the associated data are used.

** Indicates for which plants the associated data items are available.

Table 5. IDCOR Data Base in CADET

Sequence	Plant
T_1QUV-GAMMA'	Grand Gulf
$T_2$3C-GAMMA'	Grand Gulf
T [illegible]	Grand Gulf
TW [illegible]	Peach Bottom
[illegible] case 1)	Peach Bottom
[illegible] chout seal LOCA)	Zion

4.0 CADET MENU ITEMS

CADET supports ten general menu items which are listed in Figure 1. Each time one of these menu items is selected, the program chains to the run module which corresponds to that specific item. For example: choosing menu item number 1 instructs CADET to chain to the run module named MENU1.RUN. This chaining process consists of reading the file from floppy diskette or hard disk storage into memory, initializing certain data blocks, and then beginning the program instructions in the run module. The file named CADET.RUN contains the run module for general menu item selection. In order to select a menu, either highlight the item ard strike the F1 key or enter the number of the item. If a number outside of the range of menu items is entered, such as -1 or some number greater than the total number of menu items, the program will simply ignore the entry until an item is selected using the F1 key or a valid number is entered.

Each menu item is described in detail in this section. Menus 1, 2 and 9 simply retrieve and summarize data and results without any intermediary computations. In addition to data retrieval and presentation, menu 3 also displays plots of temperature and pressure histories during a selected accident sequence as well as the mass of combustible and non-combustible gases as a function of time. Menus 4 through 7 allow the user to vary the conditions of a selected accident scenario and extrapolate from previous case studies in order to predict the consequences of the scenario under the constraint of the new conditions. Menu 8 contains a data base search algorithm which enables the user to search any combination of available plants and sequences for certain radionuclide release catagories.

4.1 Menu 1: Description of the Data Base

Menu 1 simply lists those items for which data are available. This menu contains four sub-menus, namely

1. List the plants, accident sequences and containment failure modes included in the data base.

2. List the radionuclide group structures used in the analysis.

3. List the measures of off-site consequence used in the analysis.

4. Return to general menu.

The list of plants and sequences in the data base is provided in Table 6. Table 7 contains a list of the elemental groups included in the database. In addition to this group structure, selected results are also given in terms of the WASH-1400 group structure. Finally, the measures of off-site consequences that can be used in the analyses are provided in Table 8.

General Menu

----

1. Description of the data base
2. Description of selected plants
3. Description and analysis of selected (accident sequence - containment failure mode) in selected plants
4. Analysis of source terms, consequences and risk for selected (accident sequence - containment failure mode)s in selected plants
5. Assessment of alternative containment failure modes
6. Assessment of plant design modifications
7. Comparison of BMI-2104 data with IDCOR data
8. Search options in the data base
9. Ranges of risk parameters
10. Terminate program

To make a selection move the cursor to highlight the item and press F1 or enter the number of the item.

Figure 1. General Menu Displayed by CADET

4.2 Menu 2: Description of Selected Plants

The information provided by menu 4.2 relates to principal plant features such as nominal power, primary system, containment geometry, and engineered safety feature characteristics for each plant. These data were used as inputs into the Source Term Code Package (STCP) [5] in order to obtain the results provided in CADET. An illustration of a CADET session where the plant description for Surry has been requested is provided in Table 2.

4.3 Menu 3: Description and Analysis of Sequences

The physical response of the reactor core and its contents (such as core temperature, pressure, mass of combustible gases) during key events in a hypothesized accident scenario are summarized and graphically displayed in menu 4.3. A list of the menu items is as follows:

1. Describe the accident sequence selected.
2. List the key event times during this sequence.
3. List or plot the containment pressure and temperature histories during this sequence.
4. List or plot the quantities of combustible and non-combustible gases suspended in the containment atmosphere during this sequence as a function of time.
5. List core and primary system response.
6. List containment response.
7. Select another plant or sequence.
8. Return to general menu.

Example output from a CADET session using menu 3 can be found in Appendix B.

Plots Generated by CADET

CADET displays plots for a number of parameters for the accident sequences. The list of plots is as follows:

1. Containment temperature history.
2. Containment pressure history.
3. Mass inventory of combustible and non-combustible gases in the containment.
4. Mass inventory plots of each of the combustible and non-combustible species, individually (includes H_2, CO, O_2, N_2, CO_2, and steam).

Since these plots show general trends in the data, they may not indicate transients. The source of the data should be consulted for a more detailed graphical description of the accident sequence. (The source of the data is readily displayed by depressing function key F9 on the keyboard.) Sample plots which can be printed by CADET are shown in Appendix B.

4.4 Menu 4: Analysis of Source Terms, Consequences, and Risk

Menu 4 provides the user with a variety of summary information relevant to source terms, consequences, and risk. These data are presented in the form of radionuclide distributions in the plant, environmental release fractions, off-site consequences, and risks associated with severe accidents. Algorithms used by CADET to calculate consequences are described in Section 5. Data which can be accessed through menu 4 are shown in the sample CADET session shown in Appendix B.

4.5 Menu 5: Assessment of Alternative Containment Failure Modes

CADET allows users to explore how alternative containment failure modes can affect the outcome of severe accidents. This is accomplished through provision for influences of containment failure time and containment leak rate.

4.5.1 Effects of containment failure time

Effects of containment failure time are calculated by CADET from the perspectives of release of selected species to the environment and influences on relative consequences.

4.5.1.1 Effects of containment failure time on environmental release fractions

Effects of containment failure time on environmental release fractions are estimated by CADET for selected plants and sequences. These calculations are performed using information from NAUA calculations and base case release data. Information from the NAUA calculations includes source rates to the containment for selected species as a function of time, airborne masses of species in the containment, and a decay constant for the removal of aerosols. The airborne masses of species in the containment are given as a function of time up to the calculated failure time of the containment for the base case. The decay constant for aerosol removal is taken as the constant observed just prior to containment failure. For the cases analyzed, decay was due to deposition on surfaces and gravitational settling. These data from NAUA calculations are stored in a file for use in these calculations as are the reported containment failure times and initial species inventories for selected base cases. This file is read by CADET when the user specifies the base case for which the containment failure time will be varied.

In these calculations, masses of species released to the environment at a failure time selected by the user are calculated as the sum of the total mass of airborne species in the containment at the selected failure time (T_f) and the source of species to the containment after the time of containment failure through termination of the accident. CADET performs these calculations in two different manners depending on whether the user selects a containment failure time which is before or after the containment failure time reported for the base case which is being examined. The difference between these calculations lies in the manner in which the masses of species airborne in the containment are estimated for the containment failure time selected by the user.

If the containment failure time selected by the user is before the containment failure time reported for the base case, CADET uses the airborne masses of species stored in the data file for the appropriate NAUA calculation. The actual value used is determined by interpolation of these data.

If the containment failure time selected by the user occurs after the containment failure time reported for the base case being examined, CADET estimates masses of species present in the containment through solution of the differential equation:

$$dM/dt = S - L * M$$

subject to the initial conditions that M is the mass of species in the containment just prior to the time of containment failure reported for the base case, S is the source rate of species the containment, and L is the decay constant for the airborne mass of aerosol in the containment at the time just prior to containment failure reported for the base case.

The release fractions estimated by CADET are determined by dividing the calculated masses released to the environment for each species by the initial inventory of that species.

4.5.1.2 Effect of Containment Failure Time on Estimated Relative Off-Site Consequences

CADET estimates relative off-site consequences in a relative manner based on consequences per release fraction reported in NUREG/CR-1939 for the Zion plant. The estimated relative off-site consequences are given for man-rems, latent cancers, and land area interdicted. Early fatalities are from a paper by G. D. Kaiser [6].

4.5.2 Effects of containment leak rate on the outcome of severe accidents

The performance of the containment can be an important element in the response of a power plant to an accident sequence. To provide users with information on effects of containment integrity and performance on the outcome of severe accidents, results of selected analyses are reported in tabular fashion. Analyses reported were performed with the Source Term Code Package. Although this section does not exercise predictive capabilities per se, it does provide the user with information on how results reported for base case analyses can be affected when selected parameters of the analyses are changed. The base case analyses examined are:

TMLB' in Surry
TMLB' in Zion
TC-gamma in Peach Bottom
S_2E in Grand Gulf
TMLB' sequences in Sequoyah.

Each of these base case analyses was varied through incorporation of a six inch diameter opening in a selected portion of the containment which is assumed present from the beginning of the sequence. Some of the above base sequences were also examined with a pressure dependent containment leak area. In each case, CADET provides the user with a review of the accident sequence and effects of containment leak rate on radionuclide release fractions and relative consequences. Radionuclide release fractions are reported for CsI, CsOH, and Te species. Relative consequences are reported as man-rems, latent cancer fatalities, land area interdicted, and early fatalities.

Effects of containment leak rate for the Surry sequence were examined for two variations. In variation 1, the containment leak area is varied as a function of pressure (as described in CADET). In variation 2, a containment isolation failure is examined with a six inch diameter hole which is assumed to be present in the containment wall from the beginning of the accident sequence.

Influences of containment leak rate on the base Zion sequence were examined for three variations. In variations 1 and 2, the containment leak area is assumed to vary as a function of containment pressure for medium and high leak rates. A table of leak areas associated with containment pressures used in the calculations is shown in CADET. Variation 3 represents a containment isolation failure where a six inch diameter hole is assumed to be present in the containment wall from the beginning of the accident sequence.

Effects of containment leak rate on the outcome of the Peach Bottom sequence were examined through one variation. This was an assumed containment isolation failure modeled with a six inch diameter opening assumed to be present in the containment wall from the beginning of the accident sequence.

Influences of containment leak rate on the outcome of the base case sequence for Grand Gulf were examined for the case of containment isolation failure with a six inch diameter opening assumed to be present in the outer containment from the beginning of the accident sequence.

Effects of containment leak rate on the base Sequoyah sequences were examined through an assumed containment isolation failure. This was modeled with a six inch opening in the lower compartment of the ice condenser which was assumed to be present from the beginning of the accident sequence. Leakage through this opening was released to the secondary containment and then the environment. This differs from the base case analysis which takes no credit for the presence of the secondary containment.

4.6 Menu 6: Assessment of Plant Design Modifications

A variety of plant design modifications can be installed which will influence the response of a power plant to severe accident sequences. One such plant design modification is filtered venting which can be engineered to different designs and operated by different procedures. Different installations may thus show different levels of effectiveness. Detailed evaluation of filtered venting for a given plant and accident sequence would require an analysis with physical process and radionuclide behavior codes for a specific filtered vent design and a specified operating history. As an alternative, to support preliminary scoping studies, CADET provides a simple model which allows users to investigate possibilities for influences of containment filter vents on the outcome of severe accidents for selected plants and sequences. The model assumes that the volumetric release to the environment is the same with and without the filtered vent system in place. In the filtered venting process, radionuclides resident in the system during the venting process will be scrubbed by the filtered vent system. In CADET, the efficiency of this scrubbing process is determined by a decontamination factor (which must by definition be a value of one or greater) which is specified by the user. Furthermore, the CADET model applies this single decontamination factor to all radionuclide release groups. Effects of filtered venting are given for the release fractions of radionuclide groups to the environment and for relative off-site consequences (as described in section 5.1.2). Since a linear model is applied, CADET limits the magnitude of the decontamination factor which the user may input for analysis. For very large decontamination factors, a higher order description may be required to properly account for effects on the release of the radionuclide release groups.

4.7 Menu 7: Comparison of BMI-2104 Data with IDCOR Data

In Menu 7, CADET provides a comparison of analyses performed in two different studies for seven accident sequences which are deemed comparable. One group of analyses was performed by Battelle for the USNRC, as reported in BMI-2104, and the other was performed by various organizations sponsored by the nuclear industry under the IDCOR program.

Although objectives of the two studies are the same, specific elements of the analyses differ. These differences arise from a variety of sources such as selections of models to represent physical processes, computer codes selected for the analyses, and assumptions regarding the physical processes. Elements of the two studies which differ include core-melt progression, metal-water reactions, core-debris cooling, core-concrete interactions, and fission product transport through the containment.

4.8 Menu 8: Search Options in the Data Base

Menu 8 allows the user to search the data base using information regarding cesium, iodine, or tellurium. The user may search data for all sequences for all plants, or for all sequences in the data base associated with a single plant. Search options are provided to the user through four submenus.

4.9 Menu 9: Ranges of Risk Parameters

Menu 9 provides ranges of risk parameters for selected plants as opposed to the point estimates tabulated under other menu items. These data are extracted from (draft) NUREG-1150. Risk parameters reported are tabulated in Table 3.

4.10 Menu 10: Program Termination

Menu 10 allows the user to terminate the program and to return to DOS. A branch point is included which allows the user to return to the CADET session without exiting to DOS.

5.0 ESTIMATION OF CONSEQUENCES

Variations in such risk parameters as containment leak rate, containment failure time, and venting decontamination factor are evaluated in CADET in terms of their effects on off-site consequences. The radionuclide group structures used in the analyses are shown in Table 6 and the consequence measures are shown in Table 7. The consequences are measured in terms of

1. Man-rems
2. Latent Cancer Fatalities
3. Early Fatalities
4. Land Area Interdicted (square miles)

5.1 Computation of Man-rems, Latent Cancer Fatalities, and Land Interdicted

A number of core-meltdown scenarios for the Zion plant were analyzed in NUREG/CR-1989, ANALYSIS OF HYPOTHETICAL SEVERE CORE-DAMAGE ACCIDENTS FOR THE ZION PRESSURIZED-WATER REACTOR. In this analysis, specific accident sequences within the categories of loss of coolant accidents, transient initiated accidents, and containment by-pass accidents were evaluated in terms of consequences to the public. The transport, removal, and leakage of radioactive material in the containment atmosphere were calculated using the CORRAL computer code. Consequences for these accidents were computed by taking CORRAL release fractions and interpolating between CRAC2 benchmark data for high and low classes of release using demographic and meterological data for the Zion site. The CRAC2 results were in essence used to generate consequence-curve-fit constants for computing consequences as a function of release fractions for the various radionuclide groups.

The consequence estimates are computed using the linear equation

$$y=sx+b.$$

The use of the above equation in calculating consequence classes 1, 2 and 4 listed above is described below. In all cases, the constants s and b are the appropriate curve fit parameters generated by the CRAC2 benchmark runs for the particular consequence class.

Latent Cancer Fatalities

Variable y is the (natural) logarithm of the mean latent cancers per core fraction released in a given radionuclide group. The input variable x is the logarithm of the core fraction released in the group.

Mean Man-rem

Again x is the logarithm of the core fraction released in the group. Variable y represents the logarithm of the mean man-rems due to that particular group.

Land Area Interdicted

The variable x is the logarithm of the release fraction for the Cs-Rb radionuclide group **only**. The variable y represents the mean land area interdicted in square miles.

With the exception of land area interdicted, the total consequence due to any of the three classes listed above is the sum of the individual consequences due to each individual radionuclide group.

5.2 Calculation of Early Fatalities

The early fatality computations are based on analyses of CRAC2 results for noble gas, iodine, cesium, and tellurium only. These analyses are discussed in a paper THE IMPLICATIONS OF SOURCE TERM RESEARCH FOR EX-PLANT CONSEQUENCE MODELING, Geoffrey D. Kaiser, ANS topical meeting, Snowbird, Utah, July 15-19, 1984. This paper contains a graph of predicted mean early fatalities versus the average release fraction of the above listed fission products. The points on the graph were obtained from CRAC2 output by taking the conditional complementary cumulative distribution function for early fatalities and integrating under the curve. CADET uses the average release fraction to interpolate the predicted mean early fatalities from the graph in Kaiser's paper. Due to the varying assumptions in this study such as evacuation delay times, warning time, duration of the release and the population distribution, CADET presents the early fatalities in terms of a interval of values bounded below by results from the most favorable assumptions and likewise bounded above by results based on the most pessimistic assumptions.

Table 6. Elemental Group Structure Included in the Database

Group	Elements
1	Xe, Kr
2	I, Br
3	Cs, Rb
4	Te, Se, Sb
5	Ba, Sr

Table 7. Measures of Off-Site Consequences Used in the Analyses

Man-Rem
Latent Cancer Fatalities
Early Fatalities
Land Area Interdicted

6.0 Technical Description of CADET

CADET is a computer code written in BETTER BASIC. It consists of an operating shell named CADET.EXE along with ten run modules named CADET.RUN and MENU1.RUN through MENU9.RUN. The shell is essentially an executive batch file that manages such tasks as program flow, input and output procedures, and proper opening and closing of files. Each of the ten run modules run as child processes beneath the shell supplied by CADET.EXE. An example of a shell is DOS itself. Every program executed on the system is a child process of DOS. In addition to the operating shell, file CADET.EXE also contains all procedures and interrupt procedures which must remain memory resident throughout the duration of a CADET session. Once a CADET session is initiated via entering the command CADET, program control is transferred to the run module CADET.RUN. This run module now assumes the role of the main program module which in turn controls program flow to and from the remaining nine modules. Although none of run modules chain back to CADET.EXE, it is nonetheless necessary for CADET.EXE to be present at all times since it supports the runtime environment for each module.

CADET (version 2.1) offers several features not available in the earlier versions of the program. There have been many changes in the program logic as well as the addition of sophisticated interrupt procedures and error handling routines.

One new feature is the restructured and modularized source code. This task was performed, in part, to make use of procedures and interrupt procedures which will be described in section 8. Structuring and modular design are also important from the standpoint of code maintenance, benchmarking, and facilitates later work in terms of updates to the code and the addition of new capabilities.

Another new feature is the use of interrupt procedures in conjunction with the keyboard function keys. These new interrupt procedures are listed and briefly described in Table 8. A more in-depth discussion of their function is provided in section 8. An interrupt mechanism is a means by which normal program execution may be interrupted and a designated procedure can be activated. Once a particular interrupt procedure is activated, it stays in effect throughout program execution until it has been deactivated. The program polls for an active interrupt at the end of each executable line. If an interrupt is performed, program control is transferred to the interrupt procedure. Completion of the interrupt procedure results in program control returning to the next executable line immediately following the line in which the interrupt took place. The use of an interrupt procedure does not affect the execution of the current program line. For instance, when the user presses function key number 9, the screen is cleared and the name of the reference for the data currently in use is provided. At this point, the user is instructed to strike any key in order to continue. Doing so will return the program to the exact same screen and location where the interrupt was performed. In fact, the current screen is saved and returned at the end of all the interrupt procedures in CADET.

The CADET package contains many data files from which it reads in order to provide all the information associated with each of the menus. An error handling routine was added to CADET in order to aid the user in gaining access to the appropriate data files. Once a menu item requiring a data file is chosen, CADET first attempts to read the file from the default data location specified when the session is first begun or from the location designated during a subsequent default data location change (see Tables 9-17 in appendix A). If the appropriate file cannot be found at this location, an error message is displayed at the top of the screen. This message provides the name of the requested file along with the location at which it attempted to access the file (see Section 8.3 CADET File Access System).

Earlier versions of CADET were limited to listing the contents of data files no wider than 80 columns. Furthermore, when the user wished to review various portions of the file, they had to look at independent blocks of data at any given time. CADET 2.0 offers the capability to scroll through the data field either left and right or up and down. While scrolling up and down, the block of text above each column of numbers describing what the data is and the units of measurement remain at a fixed location in the screen while only the data itself scrolls up and down. On the other hand, using the left and right cursor keys causes the block of text to move along with the appropriate columns of data. Once the edge of a data field is reached (technically called a window in this case), a short "beep" is emitted and a message at the bottom of the screen informs the user which edge has been encountered.

Table 8. List and Brief Description of CADET Interrupt Procedures

Function Key*	Description of Procedure
8	Performs a page feed and prints the current screen using any online printer. (Note: graphics characters on the screen may appear different from their printed counter-parts)
9	Provides the references to the data in use by the current menu selection.
10	Permits the user to redefine the default location, i.e. the drive and full pathname where CADET should first attempt to access an input file.

* Designates the number of the function key to press in order to execute the associated interrupt procedure.

7.0 INSTALLATION

The installation procedure is only necessary if the user wishes to operate CADET from fixed disk. CADET will run most quickly and easily from the user's standpoint if all program segments, data files, and the operating shell for CADET are located in one directory on a fixed disk. This will alleviate the need for specifying any device or directory other than the default directory when CADET is accessing data files or chaining to other program segments. The files, of course, may be all placed in one directory or organized into various different sub-directories. Some users, for instance, may wish to store the program segments and operating shell in one sub-directory, the generic data files in another sub-directory, and store each plant-specific data file in a sub-directory corresponding to the name of the plant.

<u>Installation of All Files into One Directory</u>

1. Select the root directory on the fixed disk as the default directory. The prompt C:\> will appear on the monitor screen.

2. Enter the command MD CADET (assuming a directory named CADET does not already exist on the hard disk).

3. Enter the command CD CADET.

4. Place the diskette labelled "Program Files" containing the files CADET.EXE, CADET.RUN and MENU1.RUN through MENU9.RUN in floppy drive A.

5. Enter the command COPY A:*.*

6. Remove the diskette from drive A and repeat steps 4 and 5 for the diskettes labelled "Common Data", "Grand Gulf Data", "Peach Bottom Data", "Sequoyah Data", "Surry Data", and "Zion Data".

The user may, of course, adapt these installation procedures in any manner to suit personal preference, for example, by using different directory and sub-directory names. It is once again emphasized that the name of any data file or program segment must not be changed.

CADET Distribution Diskettes

Six distribution disks contain the various program segments and data files used by CADET. The diskette labelled "Program Files" contains the operating shell for CADET along with the various run modules that are used to generate the menu screens, display data, graphically plot data, analyze information, conduct specific searches, and perform calculations. The "Common Data" diskette contains data files which are read by menus 4 through 8 regardless of the plant and sequence currently being analyzed. Furthermore, the diskettes labelled "Grand Gulf Data", "Peach Bottom Data", "Sequoyah Data", "Surry Data", and "Zion Data" contain MARCH results for various accident sequences considered for each respective plant. The contents of each of the distribution diskettes are listed in Appendix C.

<u>Important</u>

Do not delete any of the files on the distribution diskettes or rename any files. Failure to comply with this warning will prevent CADET from working properly. It is strongly suggested that backup copies of each of the distribution diskettes be made and the original distribution diskettes be saved in case files are accidentally deleted.

<u>Software and Hardware Requirements</u>

CADET requires the use of a PC with a minimum of 640K of memory (RAM). In order to generate plots, a graphics adapter card must also be installed in the computer. Hard copy printout of plots requires a dot-matrix graphics printer and the DOS file GRAPHICS.COM. A color monitor is not required, however, it is recommended.

8.0 OPERATION

Operating CADET requires that the appropriate data files and program segments be available when requested. CADET can be run from either floppy disk drive or fixed disk systems. In most applications, however, CADET will require a number of different data files and program segments. Hence it is highly recommended that CADET be installed on a hard disk if possible. CADET will recognize only three different drive identifiers, namely A, B, and C. Furthermore, CADET is not limited to being run solely from floppy drive or hard disk. The program segments, for example, could be located on floppy drive while the data files may be on fixed disk or vice versa. The instructions below provide the sequence of steps needed to operate CADET either from floppy drive or fixed disk. CADET requires DOS 2.0 or higher as well as 640K of memory.

<u>8.1 Operation from Floppy Disk</u>

System Cold-Start

1. Turn on the computer and place the disk operating system (DOS) diskette in the computer's default disk drive or follow the normal boot up procedure for the system.

   <u>Note</u>: CADET requires DOS version <u>2.0 or higher.</u> A minimum of <u>640k of memory is also required.</u>

Load CADET

2. Once the boot-up procedure is complete, remove the DOS diskette and replace it with the diskette containing the program segment files.

3. Ensure that the prompt on the monitor matches the letter of the drive containing the program diskette.

Execute CADET

4. Enter the command "CADET", omitting the quotes. This initiates the default source drive selection.

5. The first screen will simply display the name CADET. Following this, CADET will ask the user to select the default drive on which the data files and program segments are located (see Appendix B). In this case, the user will need to select either drive A or B. Once this is finished, a CADET session begins.

3.2 Operation from Fixed Disk

Load CADET

1. Select the directory containing the program file CADET.EXE.

Execute CADET

2. Issue the command "CADET", omitting the quotes. This initiates the default data source selection.

3. The first screen will simply display the name CADET. Following this, CADET will ask the user to select the default drive on which the all program and data files are located (see the first figure in the sample CADET session shown in Appendix B). Once a drive has been selected , CADET will request the full path of directory names associated with the chosen device necessary to access the data. The path name entered may or may not begin with a back slash, depending on the user's preference. The end of the path name, however, may not end with a back slash, since in this case CADET assumes the last portion of the path name has been omitted, and the user will be prompted with an error message (see the second and third figures in the sample CADET session shown in Appendix B). Any illegal character will be ignored and a warning beep will be issued. After the directory and any associated sub-directory names have been provided, CADET displays the general menu and a session begins.

8.3 CADET File Access System

The beginning of a CADET session first prompts the user to specify a device (commonly termed drive) from which CADET will, by default, read each time it requests an input data file. The first figure in Appendix B (screens printed from a sample CADET session) depicts how the monitor screen appears when drive selection is requested. The choices for device are: A, B, or C. If devices A or B are selected, the program immediately proceeds to the general menu. On the other hand, if device C is selected, CADET will request the full path of directory names specifying where the default data are located on device C. Suppose, for example, one wished to use C:\CADET\COMDAT as the default data directory. This would require (1) selecting device C when the screen depicted in Appendix B appears, and (2) specifying the path name CADET\COMDAT when CADET asks for the name of the directory on device C in the following screen (see Appendix B).
The path-name can be entered and edited in the input window as follows:

1. Only alphanumeric characters and the underscore character "_" may be entered in the input window. Any other key strokes will be ignored.

2. The cursor appears directly beneath the column into which the next character will be entered.

3. Blanks may not be embedded in the path-name. The placement of the cursor is automatically controlled in order to ensure this rule is observed.

4. The cursor may be positioned to the left or right by use of the left and right cursor keys, respectively.

5. Use the delete key (Del) in order to delete the character directly above the cursor. The path-name is automatically shifted one column to the left, starting from the location of the cursor and finishing at the end of the character string.

6. To insert text before a certain character, position the cursor directly beneath that character and begin typing in the desired text.

7. Use the back-space key to delete the character immediately before the cursor. The cursor is repositioned one column to the left.

8. The escape key deletes the entire entry and places the cursor at the beginning of the entry field.

9. To position the cursor to the beginning of the path name, strike the Home key.

10. Place the cursor at the end of the path name by striking the End key.

11. The Ctrl-End keystroke sequence deletes all text from the cursor position to the end of the line.

12. Press the Enter key, once the path-name is correct, in order to proceed with program execution. The location of the cursor at this step is of no consequence.

13. If the path-name is incorrect, the path name is displayed on the lower portion of the screen with arrows pointing to the portions of the path-name that are incorrect. At this time the user may edit the path-name string and re-enter it.

Each time CADET requests an input file, it will look first for the file on the default device (and in the default directory if one was specified). If the file cannot be found, an error message will appear on the screen. This message will provide the name of the file along with the name of the device from which it attempted to read the file. The options available to the user at this point depend on what particular menu item was last selected when CADET attempted file access. In any case, however, the user will always be permitted to attempt file access as many times as desired. If the user chooses to try again, CADET will bring up the same screens it used for default drive selection with the exception that the name of the missing file is given in the screen used for device selection. If device C is selected, the screen used for directory selection will appear along with the full path-name used in the previous file access attempt. Entering a carriage return at this point will leave the path-name unchanged. Striking any key with the exception of the enter key will clear the entry line, re-initialize the temporary path-name, and permit entry of a new, temporary path-name.

The user may change the default drive and/or directory designation at any point during a CADET session by pressing function key number 10 (F10). This action calls an interrupt procedure which executes the same set of selection screens as described above. This feature is advantageous if the user has been using data located exclusively on one device or directory and wishes to subsequently use a number of data files on another device or directory.

The other options available to the user consist of a combination of: (1) cancel the request and go back to the previous menu, (2) cancel the request and return to the general menu, or (3) terminate execution. The available selection from this list of options just described, as mentioned above, depends on the current menu at the time file access was attempted.

8.4 Hard Copy Output

Two types of hard copy output during a CADET session can be obtained. Striking function key number eight (F8) will issue a form feed command to the online printer and print the contents of the current screen. If the computer is not connected to a printer which is turned on, the program will issue an error message and provide the user with the option of either resubmitting the print command or resuming program execution. On the other hand, if one strikes the PrtSc key while holding down on the Ctrl key, all screen output from that instant until the next Ctrl-PrtSc key stroke is issued will also be routed to the online printer.

If hard copy output of graphs is desired, the user must first run the DOS utility graphics program before running CADET. In order to do this, have DOS defined in the path or go to the sub-directory which contains DOS. Enter "graphics" (without quotes) to run the graphics program. Now enter "cadet", and proceed with the CADET session as usual. Plots printed by CADET are shown in appendix B under menu item 3.4.

Printed output characters, however, may not appear the same as they are represented on the screen. The most noteworthy example of this is the frames for each individual menu. Each frame is constructed from a non-standard set of characters that cannot be represented on most printers. These non-standard characters will be printed as letters or other standard symbols, the identity of which may vary among various types of printers. The Talaris laser printer or a dot-matrix graphics printer are known to print all characters in the same manner in which they are represented on the monitor screen.

8.5 Changing the Default Data Location

The default device (and directory if device C is selected) may be changed at any point in a CADET session by striking function key number 10 (F10). This command brings up the screens used for specifying the default device and directory as described in Section 8.3. If device C is chosen, the directory selection screen will appear along with the name of the current default directory in the entry window. Simply striking the enter key at this point will leave the default directory unchanged. Striking any key other than the enter key will clear the directory entry window, and permit entry of the new full path name for the default directory.

8.6 Reference Requests

The data used for the tables, plots and analyses performed by CADET are extracted from NUREG reports, as well as various STCP [5] and IDCOR [4] calculations, and other sources as referenced by CADET. At any time during a CADET session, the user may request the reference for any data or information used during the most recent menu selection by striking function key number 9 (F9). This command will clear the screen and provide the reference from which the data or information was extracted. If no specific reference is available or the user issues this command at a level of menu selection that does not require any input data, then CADET will simply report that no reference is available. Striking any key while the reference listing screen is present will return the screen and the program pointer for CADET back to the location before the F9 key was pressed.

8.7 Selection of Menu Items

The general menu consists of ten elements as shown on the sixth figure in Appendix B. This menu simply provides a list of the general categories of questions the user may ask. Menu items are selected by positioning the highlight bar over the desired item using the cursor up and down keys and pressing function key 1, or by entering the number of the item.

9.0 REFERENCES

1. J. A. Gieseke, et. al., "Radionuclide Release Under Specific LWR Accident Conditions", Volumes I-VI, BMI-2104, Battelle Columbus Laboratories, Columbus, OH (July 1987).

2. U.S. Nuclear Regulatory Commission, "Reactor Risk Reference Document", NUREG-1150 (draft), (February 1987).

3. R. S. Denning, et. al., "Radionuclide Release Calculations for Selected Severe Accident Scenarios", Volumes 1-5, NUREG/CR-4624, BMI-2139 (1986).

4. "IDCOR Technical Summary Report- Nuclear Power Plant Response to Severe Accidents" by Technology for Energy Corp., One Energy Center, Pellissippi Parkway, Knoxville, Tennessee (November 1987).

5. R. S. Denning, et. al., "Verification Test Calculations for the Source Term Code Package", NUREG/CR-4656, BMI-2140 (July 1986).

6. G. D. Kaiser, "Implications of Source Term Research for Ex-plant Consequence Model" presented at the ANS Topical Meeting on Fission Product Behavior and Source Term Research, Snow Bird, Utah, July 15-19, 1984.

APPENDIX A

CADET DATA FILES

Table 9. CADET Data Files Associated with Sequoyah

Filename	Menu	Sequence
SQSSH31.DAT	3.1	S2HF
SQS2H32.DAT	3.2	S_2HF
SQS3B31.DAT	3.1	S_3B
SQS3B32.DAT	3.2	S_3B
SQS3B33.DAT	3.3	S_3B
SQS3B35.DAT	3.5	S_3B
SQS3B36.DAT	3.2	S_3B
SQS3H31.DAT	3.1	S3H
SQS3H32.DAT	3.2	S_3H
SQSFG31.DAT	3.1	S_2HF - GAMMA
SQSFG32.DAT	3.2	S_2HF - GAMMA
SQSFG33.DAT	3.3	S_2HF - GAMMA
SQSFG34.DAT	3.4	S_2HF - GAMMA
SQSFG35.DAT	3.5	S_2HF - GAMMA
SQSFG36.DAT	3.6	S_2HF - GAMMA
SQSFG41.DAT	4.1	S_2HF - GAMMA
SQSH131.DAT	3.1	S_3HF_1
SQSH132.DAT	3.2	S_3HF_1
SQSH133.DAT	3.3	S_3HF_1
SQSH134.DAT	3.4	S_3HF_1
SQSH135.DAT	3.5	S_3HF_1
SQSH136.DAT	3.6	S_3HF_1
SQSH141.DAT	4.1	S3HF1
SQSH231.DAT	3.1	S_3HF2
SQSH232.DAT	3.2	S_3HF2
SQSH233.DAT	3.3	S_3HF2
SQSH235.DAT	3.5	S_3HF2
SQSH236.DAT	3.6	S_3HF2
SQSH241.DAT	4.1	S3HF2
SQSH331.DAT	3.1	S_3HF_3
SQSH332.DAT	3.2	S_3HF_3
SQSH333.DAT	3.3	S_3HF_3
SQSH335.DAT	3.5	S_3HF_3
SQSH336.DAT	3.6	S_3HF_3
SQSH341.DAT	4.1	S3HF3

Table 9. (Continued)

Filename	Menu	Sequence
SQTB520.DAT	5.2	TMLB' GAMMA AND
SQTB521.DAT	5.21	TMLB' DELTA/EPSI ON
SQTBA31.DAT	3.1	TBA
SQTBA32.DAT	3.2	TBA
SQTBA33.DAT	3.3	TBA
SQTBA34.DAT	3.4	TBA
SQTBA35.DAT	3.5	TBA
SQTBA36.DAT	3.6	TBA
SQTBA41.DAT	4.1	TBA
SQTBD31.DAT	3.1	TMLB' - DELTA
SQTBD32.DAT	3.2	TMLB' - DELTA
SQTBD33.DAT	3.3	TMLB' - DELTA
SQTBD34.DAT	3.4	TMLB' - DELTA
SQTBD35.DAT	3.4	TMLB' - DELTA
SQTBD36.DAT	3.6	TMLB' - DELTA
SQTBD41.DAT	4.1	TMLB' - DELTA
SQTBG31.DAT	3.1	TMLB' - GAMMA
SQTBG32.DAT	3.2	TMLB' - GAMMA
SQTBG33.DAT	3.3	TMLB' - GAMMA
SQTBG34.DAT	3.4	TMLB' - GAMMA
SQTBG35.DAT	3.4	TMLB' - GAMMA
SQTBG36.DAT	3.4	TMLB' - GAMMA
SQTBG41.DAT	4.1	TMLB' - GAMMA
SQTLD31.DAT	3.1	TML - DELTA
SQTLD32.DAT	3.2	TML - DELTA
SQTLD33.DAT	3.3	TML - DELTA
SQTLD34.DAT	3.4	TML - DELTA
SQTLD35.DAT	3.5	TML - DELTA
SQTLD36.DAT	3.6	TML - DELTA
SQTLD41.DAT	4.1	TML - DELTA

Table 9. (Continued)

Filename	Menu	Sequence
SQTLG31.DAT	3.1	TML - GAMMA
SQTLG32.DAT	3.2	TML - GAMMA
SQTLG33.DAT	3.3	TML - GAMMA
SQTLG34.DAT	3.4	TML - GAMMA
SQTLG35.DAT	3.5	TML - GAMMA
SQTLG36.DAT	3.6	TML - GAMMA
SQTLG41.DAT	4.1	TML - GAMMA
SQTMU31.DAT	3.1	TMLU -SGTR
SQTMU32.DAT	3.2	TMLU -SGTR
SQTMU35.DAT	3.5	TMLU -SGTR

Table 10. CADET Data Files Associated with Zion

Filename	Menu	Sequence
ZISD131.DAT	3.1	S_2DCF_1
ZISD132.DAT	3.2	S_2DCF_1
ZISD133.DAT	3.3	S_2DCF_1
ZISD134.DAT	3.4	S_2DCF_1
ZISD135.DAT	3.5	S_2DCF_1
ZISD136.DAT	3.6	S_2DCF_1
ZISD141.DAT	4.1	S_2DCF_1
ZISD231.DAT	3.1	S_2DCF_2
ZISD232.DAT	3.2	S_2DCF_2
ZISD233.DAT	3.3	S_2DCF_2
ZISD234.DAT	3.4	S_2DCF_2
ZISD235.DAT	3.5	S_2DCF_2
ZISD236.DAT	3.6	S_2DCF_2
ZISD241.DAT	4.1	S_2DCF_2
ZISDE31.DAT	3.1	S_2D - EPSILON
ZISDE32.DAT	3.2	S_2D - EPSILON
ZISDE33.DAT	3.3	S_2D - EPSILON
ZISDE34.DAT	3.4	S_2D - EPSILON
ZISDE35.DAT	3.5	S_2D - EPSILON
ZISDE36.DAT	3.6	S_2D - EPSILON
ZISDE41.DAT	4.1	S_2D - EPSILON
ZISDR31.DAT	3.1	S_2DCR
ZISDR32.DAT	3.2	S_2DCR
ZISDR33.DAT	3.3	S_2DCR
ZISDR34.DAT	3.4	S_2DCR
ZISDR35.DAT	3.5	S_2DCR
ZISDR36.DAT	3.6	S_2DCR
ZISDR41.DAT	4.1	S_2SCR
ZITBE31.DAT	3.1	TMLB' - EPSILON
ZITBE32.DAT	3.2	TMLB' - EPSILON
ZITBE33.DAT	3.3	TMLB' - EPSILON
ZITBE34.DAT	3.4	TMLB' - EPSILON
ZITBE35.DAT	3.5	TMLB' - EPSILON
ZITBE36.DAT	3.6	TMLB' - EPSILON
ZITBE41.DAT	4.1	TMLB' - EPSILON
ZITBE51.DAT	5.1	TMLB' - EPSILON
ZITB520.DAT	5.2	TMLB' - EPSILON
ZITB521.DAT	5.21	TMLB' - EPSILON

Table 10. (Continued)

Filename	Menu	Sequence
ZITMU31.DAT	3.1	TMLU
ZITMU32.DAT	3.2	TMLU
ZITMU33.DAT	3.3	TMLU
ZITMU34.DAT	3.4	TMLU
ZITMU35.DAT	3.5	TMLU
ZITMU36.DAT	3.6	TMLU
ZITMU41.DAT	4.1	TMLU

Table 11. CADET Data Files Associated with Peach Bottom

Filename	Menu	Sequence
PBAEG31.DAT	3.1	AE - GAMMA'
PBAEG32.DAT	3.2	AE - GAMMA'
PBAEG33.DAT	3.3	AE - GAMMA'
PBAEG34.DAT	3.4	AE - GAMMA'
PBAEG35.DAT	3.5	AE - GAMMA'
PBAEG36.DAT	3.6	AE - GAMMA'
PBAEG41.DAT	4.1	AE - GAMMA'
PBTB131.DAT	3.1	TB_1
PBTB132.DAT	3.2	TB_1
PBTB133.DAT	3.3	TB_1
PBTB135.DAT	3.5	TB_1
PBTB136.DAT	3.6	TB_1
PBTB141.DAT	4.1	TB1
PBTBG31.DAT	3.1	TB_1 - GAMMA'
PBTBG32.DAT	3.2	TB_1 - GAMMA'
PBTBG33.DAT	3.3	TB_1 - GAMMA'
PBTBG34.DAT	3.5	TB_1 - GAMMA'
PBTBG36.DAT	3.6	TB_1 - GAMMA'
PBTBG41.DAT	4.1	TB_1 - GAMMA'
PBTC131.DAT	3.1	TC_1
PBTC132.DAT	3.2	TC_1
PBTC133.DAT	3.3	TC_1
PBTC135.DAT	3.5	TC_1
PBTC136.DAT	3.6	TC_1
PBTC141.DAT	4.1	TC1
PBTC231.DAT	3.1	TC_2
PBTC232.DAT	3.2	TC_2
PBTC233.DAT	3.3	TC_2
PBTC235.DAT	3.5	TC_2
PBTC236.DAT	3.6	TC_2
PBTC241.DAT	4.1	TC2
PBTC331.DAT	3.1	TC_3
PBTC332.DAT	3.2	TC_3
PBTC333.DAT	3.3	TC_3
PBTC335.DAT	3.5	TC_3
PBTC336.DAT	3.6	TC_3
PBTC341.DAT	4.1	TC3

Table 11. (Continued)

Filename	Menu	Sequence
PBTCG31.DAT	3.1	TC - GAMMA'
PBTCG32.DAT	3.2	TC - GAMMA'
PBTCG33.DAT	3.3	TC - GAMMA'
PBTCG34.DAT	3.4	TC - GAMMA'
PBTCG35.DAT	3.5	TC - GAMMA'
PBTCG36.DAT	3.6	TC - GAMMA'
PBTCG41.DAT	4.1	TC - GAMMA'
PBTC520.DAT	5.2	TC - GAMMA'
PBTC521.DAT	5.21	TC - GAMMA'
PBTWG31.DAT	3.1	TW - GAMMA'
PBTWG32.DAT	3.2	TW - GAMMA'
PBTWG33.DAT	3.3	TW - GAMMA'
PBTWG34.DAT	3.4	TW - GAMMA'
PBTWG35.DAT	3.5	TW - GAMMA'
PBTWG36.DAT	3.6	TW - GAMMA'
PBTWG41.DAT	4.1	TW - GAMMA'
PBVVV31.DAT	3.1	V
PBVVV32.DAT	3.2	V
PBVVV33.DAT	3.3	V
PBVVV35.DAT	3.5	V
PBVVV36.DAT	3.6	V
PBVVV41.DAT	4.1	V

Table 12. CADET Data Files Associated with Surry

Filename	Menu	Sequence
SUABB31.DAT	3.1	AB - BETA
SUABB32.DAT	3.2	AB - BETA
SUABB33.DAT	3.3	AB - BETA
SUABB34.DAT	3.4	AB - BETA
SUABB35.DAT	3.5	AB - BETA
SUABB36.DAT	3.6	AB - BETA
SUABB41.DAT	4.1	AB - BETA
SUABE31.DAT	3.1	AB - EPSILON
SUABE32.DAT	3.2	AB - EPSILON
SUABE33.DAT	3.3	AB - EPSILON
SUABE34.DAT	3.4	AB - EPSILON
SUABE[illegible]DAT	3.5	AB - EPSILON
SUABE3[illegible].DAT	3.6	AB - EPSILON
SUABE41.DAT	4.1	AB - EPSILON
SUABE51.DAT	5.1	AB - EPSILON
SUABG31.DAT	3.1	AB - GAMMA
SUABG32.DAT	3.2	AB - GAMMA
SUABG33.DAT	3.3	AB - GAMMA
SUABG34.DAT	3.4	AB - GAMMA
SUABG35.DAT	3.5	AB - GAMMA
SUABG36.DAT	3.6	AB - GAMMA
SUABG41.DAT	4.1	AB - GAMMA
SUAG31.DAT	3.1	AG
SUAG32.DAT	3.2	AG
SUAG33.DAT	3.3	AG
SUAG34.DAT	3.4	AG
SUAG35.DAT	3.5	AG
SUAG36.DAT	3.6	AG
SUAG41.DAT	4.1	AG
SUSDE31.DAT	3.1	S_2D - EPSILON
SUSDE32.DAT	3.2	S_2D - EPSILON
SUSDE33.DAT	3.3	S_2D - EPSILON
SUSDE34.DAT	3.4	S_2D - EPSILON
SUSDE35.DAT	3.5	S_2D - EPSILON
SUSDE36.DAT	3.6	S_2D - EPSILON
SUSDE41.DAT	4.1	S_2D - EPSILON
SUSDE51.DAT	5.1	S_2D - EPSILON

Table 12. (Continued)

Filename	Menu	Sequence
SUSDG31.DAT	3.1	S_2D - GAMMA
SUSDG32.DAT	3.2	S_2D - GAMMA
SUSDG33.DAT	3.3	S_2D - GAMMA
SUSDG34.DAT	3.4	S_2D - GAMMA
SUSDG35.DAT	3.5	S_2D - GAMMA
SUSDG36.DAT	3.6	S_2D - GAMMA
SUSDG41.DAT	4.1	S_2D - GAMMA
SUTBD31.DAT	3.1	TMLB' - DELTA
SUTBD32.DAT	3.2	TMLB' - DELTA
SUTBD33.DAT	3.3	TMLB' - DELTA
SUTBD34.DAT	3.4	TMLB' - DELTA
SUTBD35.DAT	3.5	TMLB' - DELTA
SUTBD36.DAT	3.6	TMLB' - DELTA
SUTBD41.DAT	4.1	TMLB' - DELTA
SUTB520.DAT	5.2	TMLB' - DELTA
SUTB521.DAT	5.21	TMLB' - DELTA
SUTBE31.DAT	3.1	TMLB' - EPSILON
SUTBE32.DAT	3.2	TMLB' - EPSILON
SUTBE33.DAT	3.3	TMLB' - EPSILON
SUTBE34.DAT	3.4	TMLB' - EPSILON
SUTBE35.DAT	3.5	TMLB' - EPSILON
SUTBE36.DAT	3.6	TMLB' - EPSILON
SUTBE41.DAT	4.1	TMLB' - EPSILON
SUTBE51.DAT	5.1	TMLB' - EPSILON
SUVVV31.DAT	3.1	V
SUVVV32.DAT	3.2	V
SUVVV33.DAT	3.3	V
SUVVV34.DAT	3.4	V
SUVVV35.DAT	3.5	V
SUVVV36.DAT	3.6	V
SUVVV41.DAT	4.1	V

Table 12. CADET Data Files Associated with Grand Gulf

Filename	Menu	Sequence
GGSEG31.DAT	3.1	S_2E - GAMMA'
GGSEG32.DAT	3.2	S_2E - GAMMA'
GGSEG33.DAT	3.3	S_2E - GAMMA'
GGSEG34.DAT	3.4	S_2E - GAMMA'
GGSEG35.DAT	3.5	S_2E - GAMMA'
GGSEG36.DAT	3.6	S_2E - GAMMA'
GGSEG41.DAT	4.1	S_2E - GAMMA'
GGSE520.DAT	5.2	S_2E - GAMMA'
GGSE521.DAT	5.21	S_2E - GAMMA'
GGTB131.DAT	3.1	TB_1
GGTB132.DAT	3.2	TB_1
GGTB133.DAT	3.3	TB_1
GGTB135.DAT	3.5	TB_1
GGTB136.DAT	3.6	TB_1
GGTB141.DAT	4.1	TB1
GGTB231.DAT	3.1	TB_2
GGTB232.DAT	3.2	TB_2
GGTB233.DAT	3.3	TB_2
GGTB234.DAT	3.4	TB_2
GGTB235.DAT	3.5	TB_2
GGTB236.DAT	3.6	TB_2
GGTB241.DAT	4.1	TB2
GGTBR31.DAT	3.1	TBR
GGTBR32.DAT	3.2	TBR
GGTBR33.DAT	3.3	TBR
GGTBR34.DAT	3.4	TBR
GGTBR35.DAT	3.5	TBR
GGTBR36.DAT	3.6	TBR
GGTBR41.DAT	4.1	TBR
GGTBS31.DAT	3.1	TBS
GGTBS32.DAT	3.2	TBS
GGTBS33.DAT	3.3	TBS
GGTBS34.DAT	3.4	TBS
GGTBS35.DAT	3.5	TBS
GGTBS36.DAT	3.6	TBS
GGTBS41.DAT	4.1	TBS

Table 13. (Continued)

Filename	Menu	Sequence
GGTC31.DAT	3.1	TC
GGTC32.DAT	3.2	TC
GGTC33.DAT	3.3	TC
GGTC34.DAT	3.4	TC
GGTC35.DAT	3.5	TC
GGTC36.DAT	3.6	TC
GGTC41.DAT	4.1	TC
GGTCG31.DAT	3.1	TC - GAMMA'
GGTCG32.DAT	3.2	TC - GAMMA'
GGTCG33.DAT	3.3	TC - GAMMA'
GGTCG35.DAT	3.5	TC - GAMMA'
GGTCG36.DAT	3.6	TC - GAMMA'
GGTCG41.DAT	4.1	TC - GAMMA'
GGTIG31.DAT	3.1	TPI - GAMMA'
GGTCG32.DAT	3.2	TPI - GAMMA'
GGTIG33.DAT	3.3	TPI - GAMMA'
GGTIG35.DAT	3.5	TPI - GAMMA'
GGTIG36.DAT	3.6	TPI - GAMMA'
GGTIG41.DAT	4.1	TPI - GAMMA'
GGTVG31.DAT	3.1	TQUV - GAMMA'
GGTVG32.DAT	3.2	TQUV - GAMMA'
GGTVG33.DAT	3.3	TQUV - GAMMA'
GGTVG35.DAT	3.5	TQUV - GAMMA'
GGTVG36.DAT	3.6	TQUV - GAMMA'
GGTVG41.DAT	4.1	TQUV - GAMMA'

Table 14. CADET Data Files Associated with Multiple Menu Items.

Filename	Description
BMIPSPCF.DAT	Radionuclide inventory release fractions in the pressure suppression pool for sequences analyzed in the BMI study.
BMIRCSCF.DAT	Radionuclide inventory release fractions in the reactor coolant system for sequences analyzed in the BMI study.
IDCORRF.DAT	Environmental radionuclide release fractions for sequences analyzed in the IDCOR study.
IDPSPCF.DAT	Radionuclide inventory release fractions in the pressure suppression pool for sequences analyzed in the IDCOR study.
IDRCSCF.DAT	Radionuclide inventory release fractions in the reactor coolant system for sequences analyzed in the IDCOR study.
PLANT.DAT	File containing the names of all sequences and failure modes in the BMI study, and the names of all data files used by menu 3.
PLOT.DAT	Scale factors for the plotting routine in menu 3.
RELFRC.DAT	Environmental radionuclide release fractions for various sequences in the BMI study.

Table 15. CADET Data Files Containing Principle Plant Features Data.

Filename	Plant
GRANDG.DAT	Grand Gulf
PEACHB.DAT	Peach Bottom
SEQUOYAH.DAT	Sequoyah
SURRY.DAT	Surry
ZION.DAT	Zion

Table 16. CADET Data Files Containing Event Sequence Names for Associated Plants.

Filename	Plant
GRAN.SAM	Grand Gulf
PEAC.SAM	Peach Bottom
SEQU.SAM	Sequoyah
SURR.SAM	Surry
ZION.SAM	Zion

Table 17. CADET Data Files Containing NUREG/CR-1150 Risk Parameter Results.

Filename	Plant
GRAND.RKP	Grand Gulf
PEACH.RKP	Peach Bottom
SEQUOYAH.RKP	Sequoyah
SURRY.RKP	Surry
ZION.RKP	Zion

APPENDIX B

A SAMPLE SESSION WITH CADET

CADET

SELECT THE DEFAULT DRIVE FOR LOCATION OF DATA FILES:

1. DRIVE A
2. DRIVE B
3. DRIVE C

To make a selection move the cursor to highlight the item and press F1 or enter the number of the item.

ENTER PATHNAME OF DIRECTORY ON DEVICE C:

```
ENTER PATHNAME OF DIRECTORY ON DEVICE C:

cadet\newprog
```

CADET (Computer Aided Decision Tool) was developed at Battelle-Columbus.

It answers questions about radionuclide source terms for severe core damage accidents in light water reactors. For further information the user may consult the user's manual; "CADET: A Decision Support System for Light Water Reactor Safety", By Stephen L. Nicolosi and David J. Hesse, NUREG/CR-4857.

Version 2.1 August - 1987

PRESS ANY KEY TO CONTINUE

FEW QUICK NOTES:

1. ANYTIME YOU WANT TO MAKE A PRINTED COPY OF WHAT YOU SEE ON THE SCREEN, MAKE SURE YOUR PRINTER IS ON LINE AND PRESS F8.
   (Please refer to the user's guide to get hard copies of plots)

2. PRESS F9 TO LIST THE REFERENCE FOR THE DATA OR INFORMATION YOU ARE CURRENTLY USING.

3. PRESS F10 TO CHANGE THE DEFAULT DRIVE AND DIRECTORY.

4. THE DATABASE FOR CADET IS CURRENT THROUGH FEBRUARY, 1987.

5. DATA USED IN CADET, UNLESS OTHERWISE SPECIFIED, ARE FROM BMI-2104.

PRESS ANY KEY TO START THE INTERACTIVE SESSION WITH CADET

General Menu

1. Description of the data base
2. Description of selected plants
3. Description and analysis of selected (accident sequence - containment failure mode)s in selected plants
4. Analysis of source terms, consequences and risk for selected (accident sequence - containment failure mode)s in selected plants
5. Assessment of alternative containment failure modes
6. Assessment of plant design modifications
7. Comparison of BMI-2104 data with IDCOR data
8. Search options in the data base
9. Ranges of risk parameters
10. Terminate program

To make a selection move the cursor to highlight the item and press F1 or enter the number of the item.

1.0 Description of the data base

1.1 List the plants, accident sequences and containment failure modes included in the data base.
1.2 List the radionuclide group structures used in the analysis
1.3 List the measures of off-site consequences used in the analysis.
1.4 Return to General Menu

To make a selection move the cursor to highlight the item and press F1 or enter the number of the item.

1.1 Plants, accident sequences and containment failure modes in the data base.

Plants included in the database are:

1. SURRY
2. ZION
3. PEACH BOTTOM
4. GRAND GULF
5. SEQUOYAH

F1=SELECT AND CONTINUE, F3=PREVIOUS MENU, F4=GENERAL MENU
To make a selection move the cursor to highlight the item and press F1 or enter the number of the item.

For the plant SURRY the (accident sequence - containment failure mode)s analyzed are:

1 AB - EPSILON
2 AB - GAMMA
3 AB - BETA
4 S2D - EPSILON
5 S2D - GAMMA
6 V -
7 TMLB' - EPSILON
8 TMLB' - DELTA
9 AG -

F1=CONTINUE, F3=PREVIOUS MENU, F4=GENERAL MENU

1.2 Elemental groups included in the database are:

CsI

CsOH

Te

Aerosol (includes all aerosols except CsI, CsOH and Te)

Some results are also given in WASH-1400 group structure.

Group	Elements
1	Xe,Kr
2	I,Br
3	Cs,Rb
4	Te,Se,Sb
5	Ba,Sr

F1= CONTINUE,   F4= GENERAL MENU

1.3 Measures of off-site consequence that can be used in the analyses are:

Man-Rem

Latent cancer fatalities

Early fatalities

Land area interdicted

F1= CONTINUE,   F4= GENERAL MENU

2.0 Description of selected plants

Available plants are:

1. SURRY
2. ZION
3. PEACH BOTTOM
4. GRAND GULF
5. SEQUOYAH

F1=SELECT AND CONTINUE, F3=PREVIOUS MENU, F4=GENERAL MENU
To make a selection move the cursor to highlight the item and press F1 or enter the number of the item.

---------------Principal plant features for SURRY---------------

Nominal power	2,441 MW(t)	(8.331E+06 Btu/hr)
Initial Primary Pressure	2280 psia	(15.7 MPa)
Initial water mass in the primary	423,200 lb	(192,000 kg)
Reactor coolant system volume	10,370 ft3	(293.7 m3)
Pressurizer volume	1,336 ft3	(37.83 m3)
Containment volume	1.80E+06 ft3	(5.10E+04 m3)
Initial temperature in containment	100.0 F	(37.78 C)
Initial pressure in containment	10.0 psia	(6.89E+04 Pa)
Core		
Equivalent diameter	119.7 in.	(3.04 m)
Active height	144.0 in.	(3.658 m)
Total cross sectional area	78.3 ft2	(7.27 m2
No. of fuel assemblies	157	
Rods per assembly	204	
Weight	226,200 lb	(102,700 kg)
UO2	175,600 lb	(79,820 kg)
Zircaloy	36,300 lb	(16,500 kg)
Misc.	14,300 lb	(6,500 kg)
No. of control assemblies	53	
Rods per assembly	20	

WINDOW:CURSOR UP/DOWN/LEFT/RIGHT, F1=CONTINUE, F3=PREVIOUS MENU, F4=GENERAL MENU
FRAME 1 OF 1 CRTL-BRK & ALT-BRK OFF F7=SWITCH FRAME

PEACH BOTTOM TC - GAMMA'

Sequence frequency =6.00E-07
Failure mode prob. =NOT AVAILABLE
Product of the two prob's =NOT AVAILABLE

3.1 Describe the accident sequence shown above.
3.2 List the key event times during this sequence.
3.3 List or plot the containment pressure and temperature histories during this sequence.
3.4 List or plot the quantities of combustible and non-combustible gases suspended in the containment atmosphere during this sequence as a function of time.
3.5 List core and primary system response
3.6 List containment response
3.7 Return to 3.0 to select a different plant or sequence.
3.8 Return to the General Menu.

F1=SHOW LISTING OF THE DATA, F2=PLOT THE DATA

PEACH BOTTOM TC - GAMMA'

Sequence frequency =6.00E-07
Failure mode prob. =NOT AVAILABLE
Product of the two prob's =NOT AVAILABLE

Mass of Gases in Containment During TC-GAMMA' Sequence in PEACH BOTTOM
Volume of Containment: Compartment 1 (Drywell) = 1.59E+5 ft3
Compartment 2 (Wetwell) = 1.19E+5 ft3
No Combustion takes place.
Containment fails at 58.1 minutes.
Combustible Gases (lbs)

	H2		CO		O2	
Time, min.	1	2	1	2	1	2
124.6	3.42+01	2.03+01	0.0	0.0	0.0	0.0
126.6	3.77+02	1.93+02	0.0	0.0	0.0	0.0
137.6	1.63+00	3.53-01	0.0	0.0	0.0	0.0
150.1	2.85-02	3.68-02	0.0	0.0	0.0	0.0
215.2	6.09-03	3.32-03	0.0	0.0	0.0	0.0

WINDOW:CURSOR UP/DOWN/LEFT/RIGHT, F1=CONTINUE, F3=PREVIOUS MENU, F4=GENERAL MENU
FRAME 1 OF 2 CRTL-BRK & ALT-BRK OFF F7=SWITCH FRAME

PEACH BOTTOM TC - GAMMA'

Sequence frequency =6.00E-07
Failure mode prob. =NOT AVAILABLE
Product of the two prob's =NOT AVAILABLE

PEACH BOTTOM TC-GAMMA':
F1= Plot gas masses in Drywell
F2= Plot gas masses in Wetwell
F3= Previous Menu, F4= General Menu

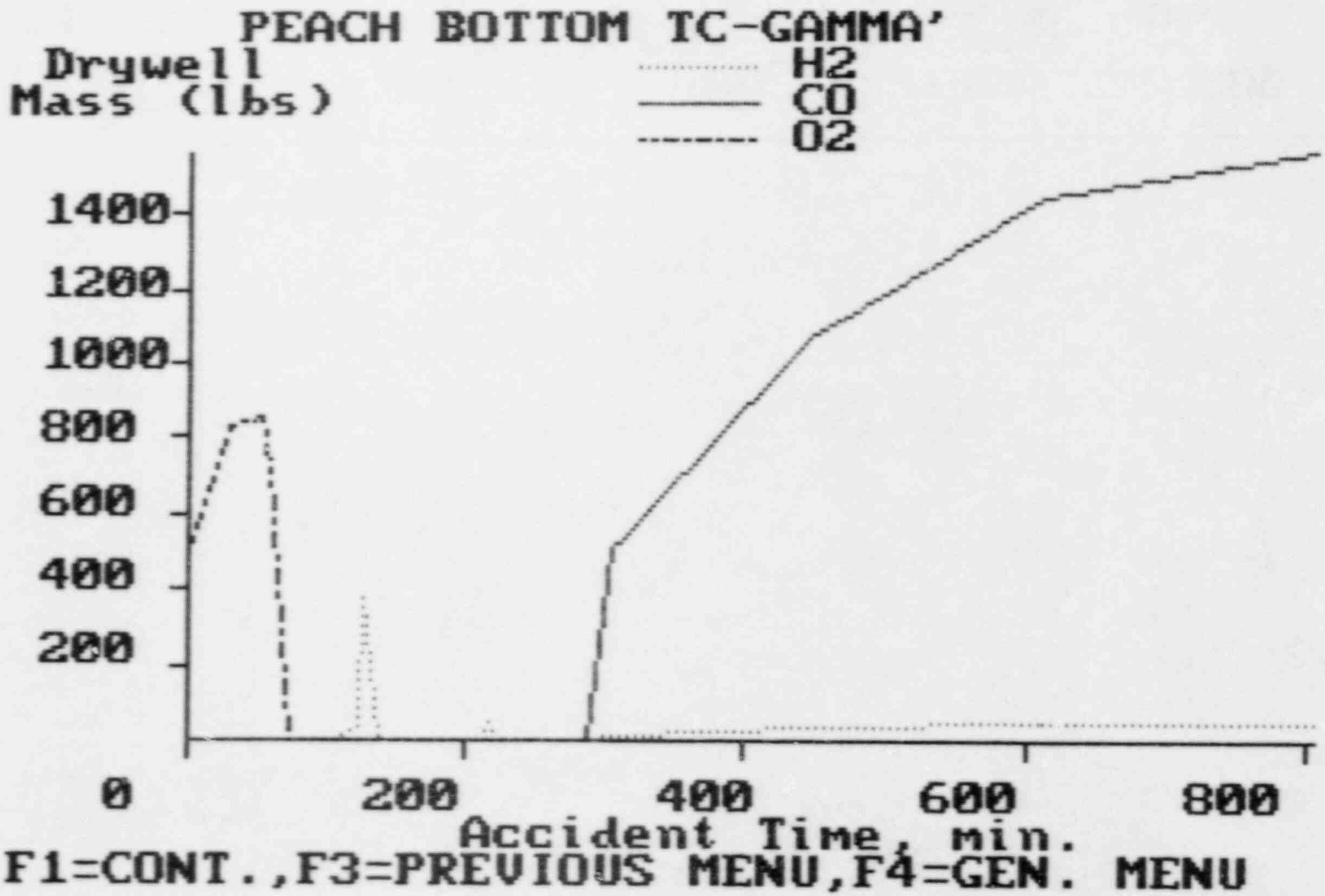
PEACH BOTTOM TC - GAMMA'

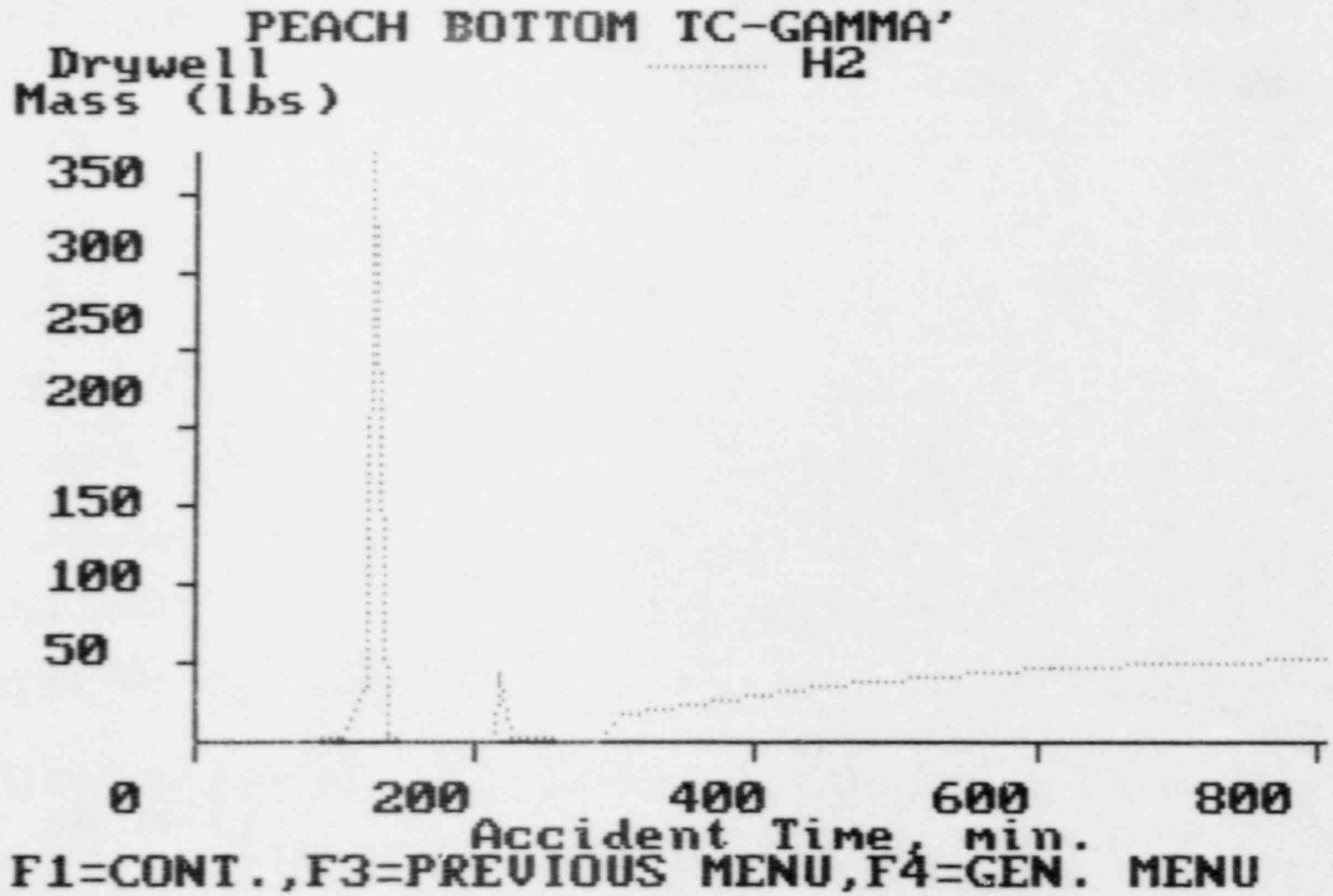
Sequence frequency =6.00E-07
Failure mode prob. =NOT AVAILABLE
Product of the two prob's =NOT AVAILABLE

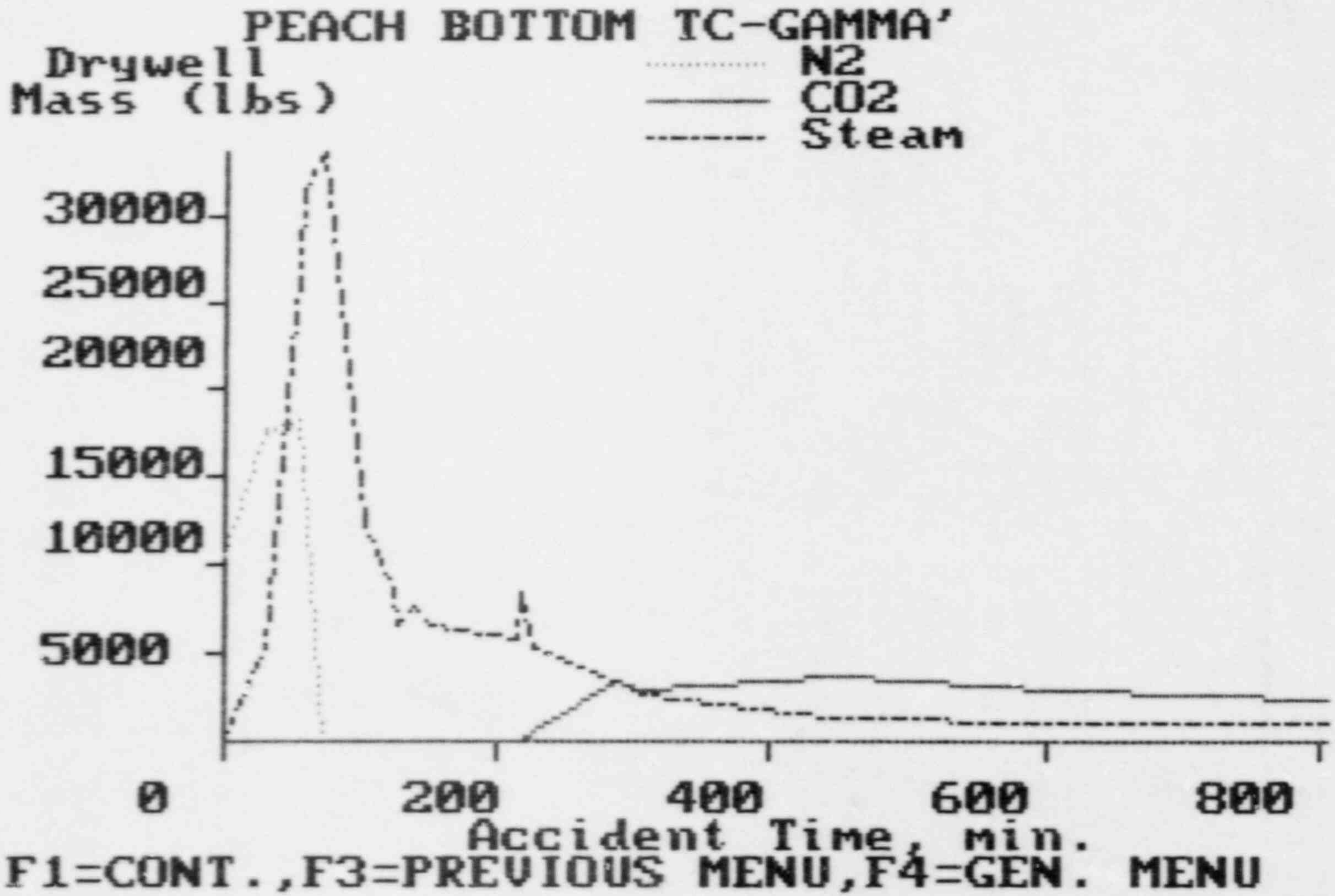
3.4 Combustible and non-combustible gases in the Drywell

1. Plot all combustible gas masses (H_2, CO and O_2).
2. Plot hydrogen mass only.
3. Plot carbon monoxide mass only.
4. Plot all non-combustible gas masses (N_2, CO_2 and Steam).
5. Plot steam mass only.
6. Plot carbon dioxide mass only.
7. Return to previous menu
8. Return to the general menu

To make a selection move the cursor to highlight the item and press F1 or enter the number of the item.


PEACH BOTTOM TC-GAMMA'
Drywell
Mass (lbs)
H2
CO
O2
1400
1200
1000
800
600
400
200
0
200
400
600
800
Accident Time, min.
F1=CONT.,F3=PREVIOUS MENU,F4=GEN. MENU


PEACH BOTTOM TC-GAMMA'
Drywell
H2
Mass (lbs)
350
300
250
200
150
100
50
0
200
400
600
800
Accident Time, min.
F1=CONT.,F3=PREVIOUS MENU,F4=GEN. MENU


PEACH BOTTOM TC-GAMMA'
Drywell
Mass (lbs)
N2
CO2
Steam
30000
25000
20000
15000
10000
5000
0
200
400
600
800
Accident Time, min.
F1=CONT.,F3=PREVIOUS MENU,F4=GEN. MENU

PEACH BOTTOM TC - GAMMA'

Sequence frequency =6.00E-07
Failure mode prob. =NOT AVAILABLE
Product of the two prob's =NOT AVAILABLE

CORE AND PRIMARY SYSTEM RESPONSE

Accident Event	Time, minutes	Primary System Pressure, psia	Primary System Water Inventory, lbm	Average Core Temp., F	Peak Core Temp., F	Fraction Core Melted
Core Uncover	73.0	1200	1.97E+05	682	802	0.
Start Melt	93.6	1149	1.75E+05	1461	4130	0.00
Start Slump	124.6	1124	1.575E+05	3400	4499	0.53
Bottom Head Dry	136.6	1126	1150	2401	4130	0.50
Core Collapse	178.9	1120	982.6	3073	4130	0.67
Bottom Head Fail	216.6	1120	2.39E+04	3517	--	--

WINDOW:CURSOR UP/DOWN/LEFT/RIGHT, F1=CONTINUE, F3=PREVIOUS MENU, F4=GENERAL MENU
FRAME 1 OF 1 CRTL-BRK & ALT-BRK OFF F7=SWITCH FRAME

1 REFERENCE SEQUENCE FREQUENCY DATA

2 REFERENCE FAILURE MODE PROBABILITY

3 REFERENCE OTHER DATA OR RESULTS DISPLAYS

Highlight desired item and press F1 key

The sequence frequency data was taken from -

A. M. Kolaczkowski, et al. Interim Report on Accident Sequence Likelihood Reassessment (Accident Sequence Evaluation Program) Sandia National Laboratories, Albuquerque, NM (February 1983)

PRESS ANY KEY TO CONTINUE

The failure mode probability data was taken from -

P. Cybulskis, Battelle-Columbus, Columbus, Ohio
(Private communication)

PRESS ANY KEY TO CONTINUE

The data currently being displayed or analyzed
was taken from

BMI-2104, VOL. 2

STRIKE ANY KEY TO RETURN TO THE PREVIOUS SCREEN...

PEACH BOTTOM TC - GAMMA'

Sequence frequency =6.00E-07
Failure mode prob. =NOT AVAILABLE
Product of the two prob's =NOT AVAILABLE

CONTAINMENT RESPONSE

Accident Event	Time, minutes	Compartment Pressure, psia 1	Compartment Pressure, psia 2	Compartment Temp., F 1	Compartment Temp., F 2	Supp. Pool Temp., F	Reactor Cavity Water Mass, lbm	Reactor Cavity Water Temp., F
Core Uncover	73.0	89.7	89.7	320	320	326	2.41E+04	207
Start Melt	93.6	48.8	48.8	280	288	275	2.41E+04	207
Start Slump	124.6	21.8	21.8	230	244	229	2.41E+04	207
Bottom Head Dry	136.6	25.9	25.9	242	260	236	2.41E+04	207
Core Collapse	178.9	15.0	15.0	270	255	213	2.41E+04	207

WINDOW:CURSOR UP/DOWN/LEFT/RIGHT, F1=CONTINUE, F3=PREVIOUS MENU, F4=GENERAL MENU
FRAME 1 OF 1 CRTL-BRK & ALT-BRK OFF F7=SWITCH FRAME

4. Analysis of source terms,consequences and risk in severe accidents

4.1 Distributions of radionuclides within the plants following severe accident sequences (plant Z,sequence Y,failure mode M).
4.2 Environmental release fractions of radionuclides in severe accident sequences (plant Z,sequence Y,failure mode M).
4.3 Off-site consequences of severe accident sequences (plant Z,sequence Y, failure mode M)
    4.3.1 Rank the contribution of groups of radionuclides to consequence C
4.4 Risks associated with severe accident sequences (plant Z, sequence Y, failure mode M).
4.5 Show data for ex-plant consequence analysis
4.6 Return to General Menu

To make a selection move the cursor to highlight the item and press F1 or enter the number of the item.

PEACH BOTTOM TC - GAMMA'

Sequence frequency =6.00E-07
Failure mode prob. =NOT AVAILABLE
Product of the two prob's =NOT AVAILABLE

PEACH BOTTOM TC-GAMMA'

Locational Distribution of Species at 20 Hours into the Accident

Group	Fraction of Core Inventory						Initial Core Inventory (kg)
	RCS	Pool	Wetwell	Drywell	Melt	Environment	
CsI	0.23	0.60	1.4E-7	2.3E-2	0	0.16	34.1
CsOH	0.51	0.33	7.5E-8	2.3E-2	0	0.14	213.0
Te	0.35	7.5E-4	1.5E-10	3.3E-2	0.14	0.48	34.8
Sr	0.19	5.1E-2	9.3E-9	2.2E-2	0.35	0.39	168.0
Ru	5.4E-2	9.7E-3	1.8E-9	3.5E-4	0.93	1.9E-3	584.0
La	4.5E-3	8.1E-4	1.2E-10	9.2E-4	0.98	1.8E-2	2612.0

WINDOW:CURSOR UP/DOWN/LEFT/RIGHT, F1=CONTINUE, F3=PREVIOUS MENU, F4=GENERAL MENU
FRAME 1 OF 1 CRTL-BRK & ALT-BRK OFF F7=SWITCH FRAME

The release fractions are given for the following sets:

Set A

CsI (same as I alone)
CsOH
Cs alone
Te
Aerosols (all aerosols except CsI,CsOH and Te)

Set B

WASH-1400 group no.	Elements included
1	Xe,Kr
2	I
3	Cs,Rb
4	Te
5	Ba,Sr
6	Ru,Mo,Pd,Rh,Tc
7	La,Nd,Eu,Y,Ce,Zr,Pr,Pm,Sm,Pu,Nb
8	Non-fission group(Fe,UO2,Zr,Sn,Ag,Cd,In)

Move cursor to highlight the radionuclide group selected and press F1

PEACH BOTTOM TC - GAMMA'

Sequence frequency =6.00E-07
Failure mode prob. =NOT AVAILABLE
Product of the two prob's =NOT AVAILABLE

The environmental release fractions (fraction of core inventory released) from plant PEACH BOTTOM after the completion of TC-GAMMA' accident are:

CsI (same as I alone)	.16
CsOH	.14
Cs alone	.162
Te	.48
Aerosols (all except CsI,CsOH and Te)	not available.

If you would like to see the source of this information please press F2, otherwise press F1 to continue

PEACH BOTTOM TC - GAMMA'

Sequence frequency =6.00E-07
Failure mode prob. =NOT AVAILABLE
Product of the two prob's =NOT AVAILABLE

The environmental release fractions (fraction of core inventory released) from plant PEACH BOTTOM after the completion of TC-GAMMA' accident are:

Xe,Kr	1 (assumed)
I	.16
Cs,Rb	.162
Te	.48
Ba,Sr	.39
Ru,Mo,Pd,Rh,Tc	.0013
La,Nd,Eu,Y,Ce,Zr,Pr,Pm,Sm,Pu,Np,Nb	.0031
Non-fission group (Fe,UO2,Zr,Sn,Ag,Cd,I	not available.

If you would like to see the source of this information please press F2, otherwise press F1 to continue

PEACH BOTTOM TC - GAMMA'

Sequence frequency =6.00E-07
Failure mode prob. =NOT AVAILABLE
Product of the two prob's =NOT AVAILABLE

4.3 Off-site consequences of severe accidents.

The mean consequences of the accident sequence TC failure mode GAMMA' in plant PEACH BOTTOM are:

8.97300E+07 Man-rems.

These consequences are due to Xe, Kr, I, Cs and Te alone.
Release fractions for other radionuclides are not available for this sequence

4.44319E+03 Latent cancers.

These consequences are due to Xe, Kr, I, Cs and Te alone.
Release fractions for other radionuclides are not available for this sequence

between 1.00000E+00 and 4.11800E+03 Early fatalities.

These consequences are due to Xe, Kr, I, Cs and Te alone.
Release fractions for other radionuclides are not available for this sequence

2.01566E+01 Land area interdicted(square miles).

F1=CONTINUE, F2=LIST THE SOURCE OF THIS INFORMATION
F3=EXPLAIN HOW THE CONSEQUENCES ARE CALCULATED

The radionuclide release fractions are from BMI-2104 or NUREG/CR-4624.

The consequences (all except the early fatalities) are calculated by multiplying the radionuclide release fractions with the consequence coefficients (in units of consequence per release fraction per radionuclide group) given in F. E. Haskin, J. L. Darby and W. B. Murfin, 'Analysis of Hypothetical Severe Core Damage Accidents for the Zion Pressurized Water Reactor', NUREG/CR-1989, SAND81-0504 (October 1982)

The early fatalities are calculated by interpolation based on curves given in a paper by G. D. Kaiser, 'The Implications of Source Term Research for Ex-plant Consequence Modeling', presented at the ANS Topical meeting on Fission Product Behavior and Source Term Research in Snowbird, Utah, July 15-19,1984. In this paper plots of mean number of early fatalities as a function of average I, Cs and Te release fractions are presented. These plots, according to the author, are based on data obtained from previous PRA studies and consequence analysis calculations. Therefore the data is not specific to any one reactor or emergency procedures, but somewhat generic in nature. Consequently there is a large spread in the data. This spread is indicated in this code as the lower and upper bounds to the early fatality numbers.

MORE EXPLANATION...F1= CONTINUE, F3= PREVIOUS MENU, F4= GENERAL MENU.

The other consequence numbers (man-rems, latent cancers and land area interdicted) are based on data that is specific to the Zion site and on some specific assumptions regarding the emergency response procedures for that site. Therefore the absolute numbers for these consequences would be reasonably accurate for the Zion plant but may or may not be for the other plants. These numbers would still be useful, however, if one wanted to get a feeling for their magnitude or wanted to see how different sequences in a single plant compare to one another.

END OF EXPLANATION...F1= CONTINUE, F2=REVIEW, F3= PREVIOUS MENU, F4= GENERAL MENU.

PRESS F1 To Show the principal contributors to mean consequences
PRESS F2 To return to menu 4.3, Consequences of severe accidents
PRESS F3 To Return to Menu 4.0, Analysis of source terms, consequences, and risks in severe accidents
PRESS F4 To Return to the General Menu

PEACH BOTTOM TC - GAMMA'

Sequence frequency =6.00E-07
Failure mode prob. =NOT AVAILABLE
Product of the two prob's =NOT AVAILABLE

The principal contributors to consequences of the accident sequence TC failure mode GAMMA' in plant PEACH BOTTOM are:

Element	Percent contribution		
	Man-rem	Latent Cancers	Land Area Interdicted (square miles)
Xe-Kr	0.16	0.20	0.00
I-Br	1.37	2.09	0.00
Cs-Rb	74.02	71.12	100.00
Te	0.86	3.37	0.00
Ba	20.43	19.40	0.00
Ru	0.16	0.40	0.00
La	3.01	3.43	0.00

F1=CONTINUE, F2=SELECT ANOTHER PLANT OR SEQUENCE
F3=PREVIOUS MENU, F4=GENERAL MENU

The radionuclide release fractions are from BMI-2104 or NUREG/CR-4624. The consequences per release fraction for man-rems, latent cancers and land area interdicted are for the Zion plant and are taken from NUREG/CR-1989.

The mean number of early fatalities are from a paper by Geoffrey D. Kaiser ''Implications of Source Terms Research for Ex-plant Consequence Model''

Presented at ANS Topical Meeting on Fission Product Behavior and Source Term Research in Snowbird, Utah, July 15-19, 1984.

The core melt probability is taken from the ASEP study. (Note: At the time this data was inserted into this code ,August 1985, ASEP was in the process of revising the core melt frequencies. New frequencies will be incorporated into the code as they become available.)

Containment failure probability is from NUREG-0956. As of August 1985, it is available for the SURRY plant only.

PRESS F1 To Show the principal contributors to mean consequences
PRESS F2 To return to menu 4.3, Consequences of severe accidents
PRESS F3 To Return to Menu 4.0, Analysis of source terms, consequences, and risks in severe accidents
PRESS F4 To Return to the General Menu

4.4 Risks associated with severe accidents

The risks associated with AB-EPSILON accident in plant SURRY are:

5.0226E-05 Man-rems per year.
3.1117E-09 Latent cancers per year.
less than 3.0000E-11 Early fatalities per year.
0.0000E+00 Land area interdicted(square miles) per year.

Note: The release of radionuclides is to the ground below the containment. In calculating the risk given above, no credit has been taken for decontamination of radionuclides in the ground before they are released to the atmosphere.

If you would like to see the source of this information please press F2, otherwise press F1 to continue

The radionuclide release fractions are from BMI-2104 or NUREG/CR-4624. The consequences per release fraction for man-rems, latent cancers and land area interdicted are for the Zion plant and are taken from NUREG/CR-1989.

The mean number of early fatalities are from a paper by Geoffrey D. Kaiser ''Implications of Source Terms Research for Ex-plant Consequence Model''

Presented at ANS Topical Meeting on Fission Product Behavior and Source Term Research in Snowbird, Utah, July 15-19, 1984.

The core melt probability is taken from the ASEP study. (Note: At the time this data was inserted into this code ,August 1985, ASEP was in the process of revising the core melt frequencies. New frequencies will be incorporated into the code as they become available.)

Containment failure probability is from NUREG-0956. As of August 1985, it is available for the SURRY plant only.

F1=CONTINUE,   F2=SELECT ANOTHER PLANT OR SEQUENCE
F3=PREVIOUS MENU, F4=GENERAL MENU

4.5 Data For Ex-plant Consequence Analysis

Information not available for this sequence at this time.

PRESS ANY KEY TO CONTINUE

4.5 Data For Ex-plant Consequence Analysis

Height of release	10.0 meters
Duration of release	30.0 minutes
Energy of release	1.60E+09 btu

PRESS ANY KEY TO CONTINUE

5. Assessment of Alternative Containment Failure Modes

5.1 Effect of containment failure time on the outcome of severe accidents (time T, sequence Y, failure mode M, plant Z)
5.2 Effect of leak rate after failure on the outcome of severe accidents
5.3 Return to General Menu

To make a selection move the cursor to highlight the item and press F1 or enter the number of the item.

```
I DO NOT HAVE THE FILE FOR MENU 5.1 FOR SURRY V-
PLEASE SELECT A DIFFERENT PLANT OR SEQUENCE
PRESS ANY KEY TO CONTINUE
```

1 AB - EPSILON
2 AB - GAMMA
3 AB - BETA
4 S2D - EPSILON
5 S2D - GAMMA
6 V -
7 TMLB' - EPSILON
8 TMLB' - DELTA
9 AG -

For this plant, I can vary the containment failure time for the AB-EPSILON, S2D-EPSILON and TMLB'-EPSILON sequences only.
Please select one of them.
To make a selection move the cursor to highlight the item and press F1
Press F3 to return to menu 5.0 ... F4 to return to the main menu

5.1 Effect of containment failure time on the outcome of severe accidents.

The base case is:
PLANT: SURRY
ACCIDENT SEQUENCE: AB
CONTAINMENT FAILURE MODE: EPSILON

Containment does not fail in the base case
Please enter the new containment failure time in minutes :

5.1 Effect of containment failure time on the outcome of severe accidents.

```
          The base case is:
                     PLANT:  SURRY
        ACCIDENT SEQUENCE:  AB
 CONTAINMENT FAILURE MODE:  EPSILON
```

```
     Containment does not fail in the base case
Please enter the new containment failure time in minutes : 50

    The containment failure time has to be greater than  28.1  minutes
```

5.1 Effect of containment failure time on the outcome of severe accidents.

The base case is:
PLANT: SURRY
ACCIDENT SEQUENCE: AB
CONTAINMENT FAILURE MODE: EPSILON

Assumed containment failure time is 50 minutes

5.1.1 List the estimated environmental release fractions of radionuclides.
5.1.2 List the off-site consequences and compare them to the base case.
5.1.3 Return to Menu 5.1.

Move cursor to highlight the item selected and press F1

Estimated radionuclide release fractions in SURRY AB EPSILON for 50 min. containment failure time.

Radionuclide group	Release fraction	Base Case release fraction
Noble gas	1.0(assumed)	1.0(assumed)
I	8.14E-01	4.80E-05
Cs	7.21E-01	4.70E-05
Te	4.45E-01	4.00E-05
Ba	2.39E-01	4.90E-05
Ru	1.12E-03	1.70E-07
La	2.52E-02	6.20E-06

If you would like to see the source of this information please press F2, otherwise press F1 to continue

The radionuclide release fractions are from BMI-2104 or NUREG/CR-4624.

The core melt probability is taken from the ASEP study. (Note: At the time this data was inserted into this code ,August 1985, ASEP was in the process of revising the core melt frequencies. New frequencies will be incorporated into the code as they become available.)

Containment failure probability is from NUREG-0956. As of August 1985, it is available for the SURRY plant only.

F1=CONTINUE
F2=EXPLAIN HOW THE RELEASE FRACTIONS FOR THE ALTERNATE CASE ARE CALCULATED

The release fractions for the base case are from BMI-2104.

The release fractions for the alternate containment failure time case are calcu..:d as follows:

1.) The following data were extracted from the NAUA code run which had been used to generate the results for the base case in BMI-2104:

a) The source rate of individual species into the containment as a function of time

b) Airborne mass of individual species in the containment as a function of time upto the containment failure time

c) Decay constant for aerosol removal from the containment atmosphere just before the containment failed. (in the cases analyzed decay was due to the surface deposition and gravitational settlinag only)

These data plus the core inventories of individual species and the containment failure time in the base case were stored in a file. This file is read by CADET automatically when the user selects to vary the containment failure time for the base case contained in it

MORE EXPLANATION...F1=CONTINUE, F3=SKIP THE REST, F4=GENERAL MENU

2.) The mass of individual species released to the environment if the containment failed at a user selected time Tf is calculated as the sum of the airborne mass of a species in the containment at time Tf plus the total source of that species into the containment between Tf and TS, where TS is the time the source into the containment is cut off. If Tf is less than TFAIL, where TFAIL is the containment failure time in the base case, then the airborne mass of a species at Tf is obtained directly from the NAUA code results by interpolation. If however, Tf is greater than TFAIL, then the airborne mass is calculated by solving the following differential equation:

dM/dt=S-L*M

with the initial condition M(t=TFAIL)= airborne mass of the species just before the containment failed in the base case. S is the source rate of the species into the containment, and L is the decay constant for the airborne mass of aerosols just before the containment failed in the base case.

3.) The release fractions are then calculated by simply dividing the released mass of species by their respective core inventories.

END OF EXPLANATION...F1=CONTINUE, F2=REVIEW, F3=PREVIOUS MENU
F4=GENERAL MENU

5.1.2

SURRY AB EPSILON
Containment Failure time = 50 min.

Mean Consequence type	Estimated Consequence This case	Base case	Percent change
Man-Rems	3.36E+08	1.67E+05	20.06E+04
Latent cancer fatalities	1.65E+04	1.04E+01	15.86E+04
Land area interdicted (square miles)	1.07E+02	0.00E+00	Indeterm.
Early fatalities	16.0-8840.0	less than 0.1	

If you would like to see the source of this information please press F2, otherwise press F1 to continue

The radionuclide release fractions are from BMI-2104 or NUREG/CR-4624. The consequences per release fraction for man-rems, latent cancers and land area interdicted are for the Zion plant and are taken from NUREG/CR-1989.

The mean number of early fatalities are from a paper by Geoffrey D. Kaiser ''Implications of Source Terms Research for Ex-plant Consequence Model''

Presented at ANS Topical Meeting on Fission Product Behavior and Source Term Research in Snowbird, Utah, July 15-19, 1984.

The core melt probability is taken from the ASEP study. (Note: At the time this data was inserted into this code ,August 1985, ASEP was in the process of revising the core melt frequencies. New frequencies will be incorporated into the code as they become available.)

Containment failure probability is from NUREG-0956. As of August 1985, it is available for the SURRY plant only.

F1=SELECT NEW CONTAINMENT FAILURE TIME, F2=SELECT ANOTHER PLANT OR SEQUENCE
F3=PREVIOUS MENU, F4=GENERAL MENU

Effect of leak rate after failure on the outcome of severe accidents.

Due to lack of data in this area the scope of this question is limited to the following sequences and plants. (Unless otherwise stated all radionuclide release fractions given in this section of the code is from an informal report entitled 'Source Term Predictions for Various Containment Failure Assumptions' to U.S. NRC by J. A. Gieseke, et. al at Battelle Columous Laboratories, dated August 29,1984.)

1. TMLB' in SURRY
2. TMLB' in ZION
3. TC in PEACH BOTTOM
4. S2E in GRAND GULF
5. TMLB' in SEQUOYAH

To make a selection move the cursor to highlight the item and press F1 or enter the number of the item.

Descriptions of the base case TMLB' in SURRY and the variations to it will be given below:

Press F1 to continue
Press F2 to skip case descriptions

Descriptions of the base case and the variations are given below:

base case: TMLB'-DELTA in SURRY (as given in volume V of BMI-2104)

~ usual TMLB' sequence except the containment fails early due to rapid steam generation from the interaction of core debris with accumulator water in reactor cavity.

~ Main event times are:

Event	Time,minutes
Steam Generator Dry	67.5
Core Uncover	95.5
Start Melt	118.3
Core Slump	146.3
Core Collapse	148.0
Bottom Head Fail	152.8
Containment Fail	152.9
Reactor Cavity Dry	177.2
Start Concrete Attack	254.2
End Calculation	1073.4

F1=CONTINUE, F2=REVIEW, F3=PREVIOUS MENU, F4=GENERAL MENU

~ Variation 1 to TMLB'-DELTA in SURRY

~ Leak rate is dependent on the containment pressure. This corresponds to the high leak case for SURRY TMLB' as postulated by the containment Performance Working Group. The pressure dependent leak area for this case is:

Pressure, Psia	Leak area, in2
9.9	1.00
32.9	1.50
56.9	1.80
105.3	11.00

F1=CONTINUE, F2=REVIEW, F3=PREVIOUS MENU, F4=GENERAL MENU

~ Variation 2 to TMLB'-DELTA in SURRY

~ Containment isolation failure. A six inch hole is assumed in the containment wall from the beginning of the accident.

F1=CONTINUE, F2=REVIEW, F3=PREVIOUS MENU, F4=GENERAL MENU

5.2 Effect of leak rate after failure on the outcome of the accident:
TMLB' in SURRY

1. Show radionuclide release fractions
2. Show Consequences
3. Show Risk
4. Review the descriptions
5. Select another plant and sequence
6. Return to menu 5.0

To make a selection move the cursor to highlight the item and press F1 or enter the number of the item.

Radionuclide Release Fractions for TMLB' in SURRY and its variations:

Effect of Leak rate on Fraction of Core inventory released to the environment

Species	Base Case TMLB'-DELTA	High Leak Rate	Isolation Failure
CsI	4.60E-02	1.90E-03	2.20E-02
CsOH	3.90E-02	1.10E-03	1.30E-02
Te	1.10E-01	1.20E-02	1.10E-01

If you would like to see the source of this information please press F2, otherwise press F1 to continue

Effect of Leak Rate on Ex-plant Consequences for TMLB' in SURRY and its variations:

	Base Case TMLB'-DELTA	High Leak Rate	Isolation Failure
Man-rems	1.04E+09	1.03E+09	1.03E+09
Latent Cancer Fatalities	6.57E+04	6.49E+04	6.52E+04
Land area interdicted (square miles)	3.98E+00	5.07E-02	1.10E+00
Early fatalities	0.00E+00	0.00E+00	0.00E+00

If you would like to see the source of this information please press F2, otherwise press F1 to continue

Effect of Leak Rate on Mean Risk

AT THIS TIME WE ARE UNABLE TO ASSIGN PROBABILITIES TO CONTAINMENT FAILURES WITH VARYING LEAK RATES. THEREFORE WE CAN NOT LIST ANY RISK NUMBERS HERE. THIS TABLE WILL BE FILLED IN LATER WHEN SUCH PROBABILITIES BECOME AVAILABLE

F1=RETURN TO MENU 5.2, F2=SELECT ANOTHER PLANT AND SEQUENCE
F3=RETURN TO MENU 5.0, F4=RETURN TO GENERAL MENU

6. Assessment of Plant Design Modifications

There are many plant design modifications which can affect the outcome of severe accidents. Within the constraints of this project we can not study them in great detail. We will only illustrate here the types of questions that can be answered by using the filtered venting of the containment as an example.

The containment can be vented either at a constant pressure or it can be vented down to atmospheric pressure after it reaches a certain pressure. The vents can be opened and closed periodically. To analyze these situations properly, a physical process code (such as MARCH) and subsequently a radionuclide behavior code (such as NAUA) would need to be run for each case with proper values assigned to the filter decontamination factors of radinuclides. Here we will assume that the environmental volumetric release rates are the same with or without the filtered venting. In filtered venting the radionuclides will be scrubbed by filters enroute to the environment based on a decontamination factor input by the user. A single DF will be used for all radionuclides.

PRESS ANY KEY TO CONTINUE

6.1 Effect of filtered venting on the outcome of severe accidents. The base case is:

PLANT: SURRY
ACCIDENT SEQUENCE: AB
CONTAINMENT FAILURE MODE: EPSILON

Please enter the decontamination factor to use (between 1 and 100): 20

6.1 Effect of filtered venting on the outcome of severe accidents.
The base case is:

PLANT: SURRY
ACCIDENT SEQUENCE: AB
CONTAINMENT FAILURE MODE: EPSILON

Assumed decontamination factor is 20

6.1.1 List the estimated environmental release fractions of radionuclides.
6.1.2 List the off-site consequences and compare them to the base case.
6.1.3 Return to menu 6.1.
6.1.4 Return to general menu.

Move cursor to highlight the item selected and press F1

Effect of filtered venting on radionuclide release fractions
The sequence is AB-EPSILON in SURRY
Assumed filter DF is 20

Radionuclide group	Release fraction	Base Case release fraction
Noble gas	1.0(assumed)	1.0(assumed)
I	2.40E-06	4.80E-05
Cs	2.35E-06	4.70E-05
Te	2.00E-06	4.00E-05
Ba	2.45E-06	4.90E-05
Ru	8.50E-09	1.70E-07
La	3.10E-07	6.20E-06

If you would like to see the source of this information please press F2, otherwise press F1 to continue

The radionuclide release fractions are from BMI-2104 or NUREG/CR-4624.
The core melt probability is taken from the ASEP study. (Note: At the time this data was inserted into this code ,August 1985, ASEP was in the process of revising the core melt frequencies. New frequencies will be incorporated into the code as they become available.)
Containment failure probability is from NUREG-0956. As of August 1985, it is available for the SURRY plant only.

F1=CONTINUE, F2=SELECT NEW FILTER DF
F3=SELECT ANOTHER PLANT OR SEQUENCE, F4=GENERAL MENU

Effect of filtered venting on consequences
The sequence is AB-EPSILON in SURRY
Assumed filter DF is 20

Mean Consequence type	Estimated Consequence This case	Base case	Percent change
Man-Rems	1.41E+05	1.67E+05	-1.56E+01
Latent cancer fatalities	9.07E+00	1.04E+01	-1.26E+01
Land area interdicted (square miles)	0.00E+00	0.00E+00	00.00E+00
Early fatalities	less than 0.1	less than 0.1	

If you would like to see the source of this information please press F2, otherwise press F1 to continue

The radionuclide release fractions are from BMI-2104 or NUREG/CR-4624. The consequences per release fraction for man-rems, latent cancers and land area interdicted are for the Zion plant and are taken from NUREG/CR-1989.

The mean number of early fatalities are from a paper by Geoffrey D. Kaiser ''Implications of Source Terms Research for Ex-plant Consequence Model''

Presented at ANS Topical Meeting on Fission Product Behavior and Source Term Research in Snowbird, Utah, July 15-19, 1984.

The core melt probability is taken from the ASEP study. (Note: At the time this data was inserted into this code ,August 1985, ASEP was in the process of revising the core melt frequencies. New frequencies will be incorporated into the code as they become available.)

Containment failure probability is from NUREG-0956. As of August 1985, it is available for the SURRY plant only.

F1=CONTINUE, F2=SELECT NEW FILTER DF
F3=SELECT ANOTHER PLANT OR SEQUENCE, F4=GENERAL MENU

7.0 COMPARISON OF BMI-2104 AND IDCOR DATA

THERE IS AN IMPORTANT MESSAGE THAT YOU SHOULD BE AWARE OF BEFORE YOU CONTINUE WITH THIS SECTION. IF YOU HAVE ALREADY READ IT PRESS F1 TO GO AROUND IT, OTHERWISE PRESS F2.

7.0 COMPARISON OF BMI-2104 AND IDCOR DATA

In this section of the code an attempt is being made to compare the results from two different studies, namely the NRC study performed by Battelle Columbus Laboratories and reported in BMI-2104 and IDCOR study performed by various organizations and funded by the nuclear industry. Even though the objectives of the two studies were the same, the tools each used to achieve those objectives were different. i.e. different set of computer codes were used in each study. The mathematical models to account for physical processes such as core melt progression, metal-water reactions, core debris cooling, core-concrete interactions, fission product transport through containment were considerably different in the two sets of codes. Therefore even though an accident may be initiated the same way, it may progress quite differently and the results may be quite different in the two studies. The purpose here is to highlight the differences in the results obtained in the two studies.

PRESS ANY KEY TO CONTINUE

The BMI-2104 and IDCOR Sequences that are believed to be comparable are:

	PLANT	BMI-2104 Sequence Designation	IDCOR Sequence Designation
1.	ZION	TMLB'-EPSILON	TMLB'-DELTA(WITHOUT SEAL LOCA)
2.	PEACH BOTTOM	TW-GAMMA'	TW-GAMMA
3.	PEACH BOTTOM	TC-GAMMA'	TC-GAMMA(CASE 1)
4.	GRAND GULF	TQUV-GAMMA'	T1QUV-GAMMA'
5.	GRAND GULF	TC-GAMMA'	T23C-GAMMA'
6.	GRAND GULF	TPI-GAMMA'	T23QW-GAMMA'
7.	SEQUOYAH	TMLB'-DELTA	T1B3MLB13-DELTA

Please highlight selection and press F1 or press number desired

THE SEQUENCES TO BE COMPARED ARE:

PLANT	BMI-2104	IDCOR
ZION	TMLB'-EPSILON	TMLB'-DELTA(WITHOUT SEAL LOCA)

1. Compare the radionuclide release fractions.
2. Compare consequences.

HIGHLIGHT SELECTION AND PRESS F1 OR ENTER DESIRED NUMBER

COMPARING THE RELEASE FRACTIONS

The sequences being compared are:

PLANT	BMI-2104	IDCOR
ZION	TMLB'-EPSILON	TMLB'-DELTA(WITHOUT SEAL LOCA)

--------------------Release Fraction--------------------

Radionuclide group	BMI-2104	IDCOR
Noble gas	1	1
I,Br	.0000019	.002
Cs,Rb	.0000021	.002
Te,Sb	8.4E-05	2.0E-05
Sr,Ba	3.1E-05	1.0E-05
Ru,Mo	4.1E-07	1.0E-05
La, ...	3.1E-07	Not available

If you would like to see the source of this information please press F2, otherwise press F1 to continue

The radionuclide release fractions are from BMI-2104 or NUREG/CR-4624.

The core melt probability is taken from the ASEP study. (Note: At the time this data was inserted into this code ,August 1985, ASEP was in the process of revising the core melt frequencies. New frequencies will be incorporated into the code as they become available.)

Containment failure probability is from NUREG-0956. As of August 1985, it is available for the SURRY plant only.

F1=CONTINUE
F3=COMPARE ANOTHER SEQUENCE
F4=GO TO GENERAL MENU

COMPARING THE CONSEQUENCES

The sequences being compared are:

PLANT	BMI-2104	IDCOR
ZION	TMLB'-EPSILON	TMLB'-DELTA(WITHOUT SEAL LOCA)

--------------------Consequences----------------------

Consequence type	BMI-2104	IDCOR
Man-rem	142781.8	977002
Latent Cancers	9.157553	49.33334
Early fatalities	less than .1	less than .1
Land area interdicted (Square miles)	0	.1108613

If you would like to see the source of this information please press F2. otherwise press F1 to continue

The radionuclide release fractions are from BMI-2104 or NUREG/CR-4624. The consequences per release fraction for man-rems, latent cancers and land area interdicted are for the Zion plant and are taken from NUREG/CR-1939.

The mean number of early fatalities are from a paper by Geoffrey D. Kaiser ''Implications of Source Terms Research for Ex-plant Consequence Model''

Presented at ANS Topical Meeting on Fission Product Behavior and Source Term Research in Snowbird, Utah, July 15-19, 1984.

The core melt probability is taken from the ASEP study. (Note: At the time this data was inserted into this code ,August 1985, ASEP was in the process of revising the core melt frequencies. New frequencies will be incorporated into the code as they become available.)

Containment failure probability is from NUREG-0956. As of August 1985, it is available for the SURRY plant only.

F1=CONTINUE
F3=COMPARE ANOTHER SEQUENCE
F4=GO TO GENERAL MENU

REFERENCES FOR MENU 7

The IDCOR data is a compilation of various studies performed by the nuclear industry and hence no one reference can be cited.

The information for the BMI-2104 accident sequences was taken from the following documents:

BMI-2104, Radionuclide Release Under Specific LWR Accident Conditions, (July 1984).

Vol. 2 - Peach Bottom Vol. 4 - Sequoyah Vol. 6 - Zion
Vol. 3 - Grand Gulf Vol. 5 - Surry

PRESS ANY KEY TO CONTINUE

8.0 Database Search Options -- Searching across all sequences in all plants.

```
1. Search across all sequences
   in all plants.

2. Search across the sequences
   in a single plant.

                                        1
```

```
Searching across all sequences
   in all plants
1. Search in Environmental
   release fraction
2. Search in Fraction of Core
   Inventory (FOCI) in Reactor
   Coolant System (RCS)
3. Search in FOCI in Pressure Sup-
   pression Pool (PSP) of BWR's   2
```

```
Searching across all sequences
   in all plants
Searching in environmental
   release fraction
1. Search for Iodine
2. Search for Cesium
3. Search for Tellurium

                                        3
```

```
Identify plant and sequence with:
1. greatest Iodine environmental
   release fraction
2. Iodine environmental
   release fraction greater than X
3. least Iodine environmental
   release fraction
4. Iodine environmental
   release fraction less than X   4
```

ENTER MENU NUMBER FOR CHANGE OR PRESS F1 TO CONTINUE -- F5=HELP

For any selection menus, press the number of the desired option or make selection by highlighting the desired option and pressing F1. Use the up and down arrow keys of the key pad for highlighting.

For screens with multiple menus, the active menu is the one with a blinking yellow number in the lower right corner. From the multiple menu screens, pressing F4 sends the program back to the general menu. and pressing F3 sends it back to the first menu of the multiple menu screen.

PRESS ANY KEY TO CONTINUE

8.0 Database Search Options -- Searching across all sequences in all plants.

1. Search across all sequences in all plants. 2. Search across the sequences in a single plant. 1	Searching across all sequences in all plants 1. Search in Environmental release fraction 2. Search in Fraction of Core Inventory (FOCI) in Reactor Coolant System (RCS) 3. Search in FOCI in Pressure Suppression Pool (PSP) of BWR's 2
Searching across all sequences in all plants Searching in environmental release fraction 1. Search for Iodine 2. Search for Cesium 3. Search for Tellurium 3	Identify plant and sequence with: 1. greatest Iodine environmental release fraction 2. Iodine environmental release fraction greater than X 3. least Iodine environmental release fraction 4. Iodine environmental release fraction less than X 4

ENTER THE VALUE OF X .3

Searched across all sequences in all plants. The plants and the sequences with Iodine environmental release fraction greater than .3 are listed below.

Plant	sequence	Iodine environmental release fraction	Source of Data
SURRY	AG	58.00E-02	BMI-2139
PEACH BOTTOM	V	46.00E-02	BMI-2139
SURRY	V	41.00E-02	BMI-2104
PEACH BOTTOM	AE-GAMMA'	32.00E-02	BMI-2104

SEARCH COMPLETE -- F1=CONTINUE, F3=SELECT NEW OPTIONS , F4=MAIN MENU

REFERENCES FOR MENU 8

The references for Menu 8 are provided along-side the associated sequence(s) listed on the screen once a data base search has been completed for a given set of menu selections. The IDCOR data is a compilation of various studies performed by the nuclear industry and hence no one reference can be cited.

The BMI reports cited are as follows:

BMI-2104, Radionuclide Release Under Specific LWR Accident Conditions, (July 1984).

Vol. 2 - Peach Bottom	Vol. 4 - Sequoyah	Vol. 6 - Zion
Vol. 3 - Grand Gulf	Vol. 5 - Surry	

BMI-2139, Radionuclide Release Calculations for Selected Severe Accident Scenarios, NUREG/CR-4624 (July 1986).

Vol. 1 - Peach Bottom	Vol. 3 - Surry	Vol. 5 - Zion
Vol. 2 - Sequoyah	Vol. 4 - Grand Gulf	

PRESS ANY KEY TO CONTINUE

8.0 Database Search Options

1. Search across all sequences in all plants.

2. Search across the sequences in a single plant.

1

CURRENT MENU INDICATED BY BLINKING NUMBER ---F1=CONTINUE, F5=HELP

8.0 Database Search Options -- Searching across sequences in SURRY.

Available plants are:	Searching across sequences in SURRY
1. SURRY 2. ZION 3. PEACH BOTTOM 4. GRAND GULF 5. SEQUOYAH	1. Search in Environmental release fraction 2. Search in Fraction of Core Inventory (FOCI) in Reactor Coolant System (RCS)
1	2

CURRENT MENU INDICATED BY BLINKING NUMBER ---F1=CONTINUE, F5=HELP

8.0 Database Search Options -- Searching across sequences in SURRY.

```
Available plants are:

  1. SURRY
  2. ZION
  3. PEACH BOTTOM
  4. GRAND GULF
  5. SEQUOYAH
                                        1
```

```
Searching across sequences in
   SURRY
1. Search in Environmental
   release fraction
2. Search in Fraction of Core
   Inventory (FOCI) in Reactor
   Coolant System (RCS)
                                        2
```

```
Searching across sequences
   in SURRY
Searching in fraction of core
   inventory in RCS
1. Search for Iodine
2. Search for Cesium
3. Search for Tellurium
                                        3
```

CURRENT MENU INDICATED BY BLINKING NUMBER ---F1=CONTINUE, F5=HELP

8.0 Database Search Options -- Searching across sequences in SURRY.

<table>
<tr>
<td>Available plants are:

1. SURRY
2. ZION
3. PEACH BOTTOM
4. GRAND GULF
5. SEQUOYAH
1</td>
<td>Searching across sequences in SURRY
1. Search in Environmental release fraction
2. Search in Fraction of Core Inventory (FOCI) in Reactor Coolant System (RCS)
2</td>
</tr>
<tr>
<td>Searching across sequences in SURRY
Searching in fraction of core inventory in RCS
1. Search for Iodine
2. Search for Cesium
3. Search for Tellurium
3</td>
<td>Identify sequence with:
1. greatest Iodine fraction of core inventory in RCS
2. Iodine fraction of core inventory in RCS greater than X
3. least Iodine fraction of core inventory in RCS
4. Iodine fraction of core inventory in RCS less than X 4</td>
</tr>
</table>

ENTER MENU NUMBER FOR CHANGE OR PRESS F1 TO CONTINUE -- F5=HELP

8.0 Database Search Options -- Searching across sequences in SURRY.

1. Search across all sequences in all plants.

2. Search across the sequences in a single plant.

1

Searching across sequences in SURRY

1. Search in Environmental release fraction
2. Search in Fraction of Core Inventory (FOCI) in Reactor Coolant System (RCS)

2

Searching across sequences in SURRY

Searching in fraction of core inventory in RCS

1. Search for Iodine
2. Search for Cesium
3. Search for Tellurium

3

Identify sequence with:

1. greatest Iodine fraction of core inventory in RCS
2. Iodine fraction of core inventory in RCS greater than X
3. least Iodine fraction of core inventory in RCS
4. Iodine fraction of core inventory in RCS less than X

4

ENTER THE VALUE OF X .5

Searched across sequences in SURRY. The sequences with Iodine fraction of core inventory in RCS greater than .5 are listed below.

Sequence	Iodine fraction of core inventory in RCS	Source of Data
TMLB'-EPSILON	85.00E-02	BMI-2104
TMLB'-DELTA	76.00E-02	BMI-2104
S2D-EPSILON	74.00E-02	BMI-2104

SEARCH COMPLETE -- F1=CONTINUE, F3=SELECT NEW OPTIONS , F4=MAIN MENU

9.0 Ranges of Risk Parameters to the Public.

1. SURRY
2. ZION
3. PEACH BOTTOM
4. GRAND GULF
5. SEQUOYAH

F1=SELECT AND CONTINUE, F3=PREVIOUS MENU, F4=GENERAL MENU
To make a selection move the cursor to highlight the item and press F1
or enter the number of the item.

---------------- Ranges of Risk Parameters ----------------

Ranges of Risk Parameters for GRAND GULF

Risk Measure *	Lower Bound	Upper Bound
Early Fatalities (/r-yr)	1.4E-8	6.5E-6
Individual Risk of Early Fatality (/r-yr)	3.1E-10	5.5E-8
Latent Cancer Fatalities (/r-yr)	1.4E-3	5.2E-2
Early Injuries (/r-yr)	2.6E-7	3.6E-5
Population Dose Within 50 Miles (person-rem/r-yr)	2	89
Offsite Costs ($/r-yr)	730	26900

* (r-yr) = reactor year of operation.

WINDOW:CURSOR UP/DOWN/LEFT/RIGHT, F1=CONTINUE, F3=PREVIOUS MENU, F4=GENERAL MENU
FRAME 1 OF 1 CRTL-BRK & ALT-BRK OFF F7=SWITCH FRAME

The data currently being displayed was taken from

NUREG/1150, Append. B, pg. 36

STRIKE ANY KEY TO RETURN TO THE PREVIOUS SCREEN...

APPENDIX C

CONTENTS OF EACH DISTRIBUTION DISKETTE

```
CADET     EXE    183680   9-30-87  12:49p
CADET     RUN      5750   9-25-87  12:50p
MENU1     RUN      6968   9-25-87  12:52p
MENU2     RUN      3954   9-25-87  12:58p
MENU3     RUN     28462   9-25-87   7:25p
MENU4     RUN     26456   9-25-87   1:10p
MENU5     RUN     31162   9-25-87   1:16p
MENU6     RUN     12170   9-25-87   1:19p
MENU8     RUN     26366   9-25-87   4:12p
MENU9     RUN      3976   9-25-87   4:27p
MENU7     RUN     14142   9-25-87   1:22p
        11 File(s)     16384 bytes free
```

Cadet Runtime Files

```
BMIPSPCF DAT       847   9-04-87   6:12p
BMIRCSCF DAT      1871   9-04-87   6:11p
IDCORRF  DAT       589   9-04-87   5:17p
IDPSPCF  DAT       314   9-04-87   5:18p
IDRCSCF  DAT       404   9-04-87   5:18p
PLOT     DAT       329   4-26-85   5:06p
RELFRC   DAT      4673   9-18-87   1:48p
RISKPARM DAT      1408   1-26-87   6:46p
PLANT    DAT      3930   9-18-87  11:54a
        9 File(s)    344064 bytes free
```

Common Data Files

GGSEG34	DAT	6770	9-18-87	5:19p
GGTB134	DAT	11819	9-18-87	5:20p
GGTB234	DAT	11678	9-18-87	5:21p
GGTBS34	DAT	10418	9-18-87	5:21p
GGTBR34	DAT	10418	9-18-87	5:22p
GGSE520	DAT	2048	5-08-85	9:16p
GGSE521	DAT	276	9-22-87	6:01p
GGSEG31	DAT	1536	1-26-87	6:58p
GGSEG35	DAT	1280	1-26-87	6:57p
GGSEG36	DAT	1536	1-26-87	6:58p
GGTB131	DAT	768	1-26-87	7:07p
GGTB132	DAT	1408	12-31-86	10:54a
GGTB135	DAT	1920	1-26-87	6:58p
GGTB136	DAT	2048	1-26-87	6:59p
GGTB231	DAT	1024	1-26-87	7:21p
GGTB232	DAT	1408	12-31-86	10:48a
GGTB235	DAT	1792	1-26-87	7:08p
GGTB236	DAT	2304	1-26-87	7:08p
GGTBR31	DAT	1024	1-26-87	7:32p
GGTBR32	DAT	1408	12-31-86	11:01a
GGTBR35	DAT	1920	1-26-87	7:16p
GGTBR36	DAT	2432	1-26-87	7:16p
GGTBS31	DAT	1152	1-26-87	7:32p
GGTBS32	DAT	1280	12-31-86	11:03a
GGTBS35	DAT	1920	1-26-87	7:22p
GGTBS36	DAT	2304	1-26-87	7:22p
GGTC31	DAT	896	1-26-87	7:31p
GGTC35	DAT	1792	1-26-87	7:26p
GGTC36	DAT	2048	1-26-87	7:26p
GGTCG31	DAT	1536	1-26-87	7:36p
GGTCG32	DAT	1536	4-06-85	5:57p
GGTCG35	DAT	1536	1-26-87	7:35p
GGTIG31	DAT	1536	1-26-87	7:37p
GGTIG32	DAT	1536	4-06-85	7:01p
GGTIG35	DAT	1536	1-26-87	7:36p
GGTIG36	DAT	2048	1-26-87	7:37p
GGTVG31	DAT	1536	1-26-87	7:39p
GGTVG35	DAT	1536	1-26-87	7:38p
GGSEG32	DAT	1428	5-11-87	3:48p
GGSEG41	DAT	1327	5-11-87	3:50p
GGTVG32	DAT	1437	5-11-87	3:57p
GGTCG36	DAT	1803	9-08-87	9:49p
GGTC32	DAT	1320	9-08-87	9:46p
GGTCG41	DAT	874	9-08-87	9:50p
GGTIG41	DAT	874	9-08-87	9:51p
GGTVG36	DAT	2008	9-08-87	9:52p
GGTVG41	DAT	876	9-08-87	9:53p
GRAND	RKP	925	9-08-87	3:24p
GGTC34	DAT	11519	9-18-87	5:22p
GGTCG34	DAT	4603	9-18-87	5:23p
GGTIG34	DAT	3737	9-18-87	5:23p
GGTVG34	DAT	5624	9-18-87	5:25p
GGTB133	DAT	1419	9-18-87	5:26p
GGSEG33	DAT	2640	9-18-87	5:27p
GGTB233	DAT	1492	9-18-87	5:28p
GGTBR33	DAT	1653	9-18-87	5:28p
GGTBS33	DAT	1579	9-18-87	5:29p
GGTC33	DAT	1420	9-18-87	5:29p
GGTCG33	DAT	1992	9-18-87	5:29p
GGTVG33	DAT	2428	9-18-87	5:30p
GGTIG33	DAT	2271	9-18-87	5:31p
GRAN	SAM	128	1-27-87	3:49a
GRANDG	DAT	3903	9-08-87	9:53p
GGTC41	DAT	1692	9-22-87	11:47a
GGTBS41	DAT	1691	9-22-87	11:53a
GGTB141	DAT	1516	9-22-87	12:07p
GGTBR41	DAT	1693	9-22-87	11:55a
GGTB241	DAT	1514	9-22-87	12:21p

68 File(s)   161792 bytes free

Grand Gulf Files

PEACHB	DAT	3584	4-14-85	3:46p
PBAEG31	DAT	1536	1-26-87	9:33p
PBAEG32	DAT	1536	4-11-85	4:26p
PBAEG33	DAT	1550	9-08-87	9:55p
PBAEG34	DAT	4832	9-08-87	9:54p
PBAEG35	DAT	1536	1-26-87	9:31p
PBAEG36	DAT	2176	1-26-87	9:33p
PBAEG41	DAT	1099	9-08-87	8:06p
PBTB131	DAT	261	9-18-87	11:15a
PBTB132	DAT	1280	12-29-86	7:42p
PBTB135	DAT	1664	1-26-87	9:46p
PBTB136	DAT	1892	8-31-87	4:33p
PBTB231	DAT	381	9-02-87	9:46a
PBTB232	DAT	1812	9-08-87	1:57p
PBTBG31	DAT	1536	1-26-87	9:49p
PBTBG32	DAT	1536	2-18-86	10:38a
PBTBG33	DAT	2944	1-09-87	5:48p
PBTBG34	DAT	1536	2-18-86	10:50a
PBTBG35	DAT	1536	1-26-87	9:48p
PBTBG36	DAT	2048	1-26-87	9:49p
PBTBG41	DAT	1536	3-25-86	11:18a
PBTC131	DAT	512	1-26-87	9:57p
PBTC132	DAT	1810	9-08-87	8:08p
PBTC135	DAT	1792	1-26-87	9:55p
PBTC136	DAT	2176	1-26-87	9:57p
PBTC231	DAT	232	9-02-87	9:55a
PBTC232	DAT	1522	9-08-87	9:57p
PBTC235	DAT	1536	1-26-87	10:01p
PBTC236	DAT	2176	1-26-87	10:02p
PBTC331	DAT	382	9-02-87	9:50a
PBTC332	DAT	1536	12-30-86	7:03p
PBTC520	DAT	1792	5-08-85	9:05p
PBTC521	DAT	246	9-22-87	6:01p
PBTCG31	DAT	393	8-31-87	2:24p
PBTCG32	DAT	1536	4-11-85	3:52p
PBTCG33	DAT	1909	8-30-87	4:17p
PBTCG34	DAT	4329	9-08-87	3:30p
PBTCG35	DAT	1184	8-31-87	2:23p
PBTCG41	DAT	1100	9-08-87	9:58p
PBTWG31	DAT	397	8-31-87	2:28p
PBTWG32	DAT	1536	4-11-85	4:08p
PBTWG33	DAT	1710	9-08-87	9:59p
PBTWG34	DAT	3550	9-08-87	3:30p
PBTWG35	DAT	1169	8-31-87	2:27p
PBTWG41	DAT	1098	9-26-87	1:14p
PBVVV31	DAT	313	9-02-87	9:55a
PBVVV32	DAT	1931	9-08-87	8:09p
PEAC	SAM	86	9-18-87	11:54a
PBTB233	DAT	1171	9-19-87	11:49a
PBTC233	DAT	1223	9-19-87	11:49a
PBVVV33	DAT	1090	9-19-87	11:50a
PBTC333	DAT	1233	9-19-87	11:50a
PBTC133	DAT	1233	9-19-87	11:51a
PBTB241	DAT	1496	9-22-87	10:17a
PBTB133	DAT	1165	9-18-87	11:25a
PBTC335	DAT	1541	8-31-87	2:12p
PBTB236	DAT	1798	8-31-87	2:55p
PBTB235	DAT	1442	8-31-87	2:55p
PBTC336	DAT	2014	8-31-87	2:13p
PBTCG36	DAT	1799	9-08-87	8:10p
PBTWG36	DAT	1492	9-08-87	8:11p
PBVVV36	DAT	1782	9-08-87	10:00p
PBVVV35	DAT	1436	9-08-87	10:00p
PEACH	RKP	926	9-08-87	3:23p
PBTC141	DAT	1496	9-22-87	9:54a
PBTC241	DAT	1496	9-22-87	10:00a
PBTC341	DAT	1496	9-22-87	10:08a
PBVVV41	DAT	1495	9-22-87	10:15a
PBTB141	DAT	1496	9-22-87	10:36a

69 File(s)   218112 bytes free

Peach Bottom Files

SQTBA34	DAT	13894	9-19-87	12:17p
SQSH134	DAT	10842	9-19-87	12:19p
SQSH234	DAT	10840	9-19-87	12:20p
SQSH135	DAT	1333	9-08-87	9:02p
SQSH136	DAT	2237	9-08-87	9:03p
SQS3B36	DAT	2048	1-26-87	5:29p
SQSH233	DAT	1748	9-08-87	9:03p
SQSFG31	DAT	1408	1-26-87	4:32p
SQSH332	DAT	1628	9-08-87	9:05p
SQSH333	DAT	1455	9-08-87	9:05p
SQSH335	DAT	1333	9-08-87	9:05p
SQSFG41	DAT	898	9-26-87	1:13p
SQSH131	DAT	896	1-26-87	4:44p
SQSH336	DAT	1842	9-08-87	9:05p
SQSH133	DAT	2047	9-08-87	8:58p
SQSH231	DAT	896	1-26-87	4:50p
SQTBA32	DAT	1442	9-08-87	9:06p
SQSH235	DAT	1536	1-26-87	4:49p
SQSH236	DAT	2432	1-26-87	5:32p
SQSH331	DAT	1152	1-26-87	4:53p
SQTB520	DAT	2176	5-08-85	9:11p
SQTB521	DAT	401	9-22-87	6:02p
SQTBA31	DAT	896	1-26-87	5:01p
SQTBD31	DAT	1792	1-26-87	5:03p
SQTBD32	DAT	1536	1-01-80	2:32a
SQTBG31	DAT	1536	1-26-87	5:05p
SQTBG32	DAT	1536	5-22-85	2:38p
SQTLD31	DAT	1792	1-26-87	5:06p
SQTLG31	DAT	1792	1-26-87	5:08p
SQTMU31	DAT	1024	1-26-87	5:16p
SQSFG33	DAT	2553	8-30-87	4:58p
SQTBA33	DAT	1819	9-08-87	9:06p
SQS2H32	DAT	2304	8-30-87	5:03p
SQS3B31	DAT	444	9-02-87	11:05a
SQS3H31	DAT	775	9-02-87	11:12a
SQS2H31	DAT	493	9-02-87	11:12a
SQTBD33	DAT	1971	9-05-87	2:53p
SQTBG33	DAT	2990	9-05-87	2:54p
SQTLD33	DAT	2664	9-05-87	2:55p
SQTLG33	DAT	1584	9-05-87	2:56p

SQSH232	DAT	1870	9-08-87	8:48p
SQS3B32	DAT	1041	9-08-87	8:49p
SQS3B33	DAT	1381	9-08-87	8:50p
SQS3B35	DAT	1333	9-08-87	8:50p
SQS3H32	DAT	1583	9-08-87	8:50p
SQSFG32	DAT	1607	9-08-87	8:51p
SQSFG34	DAT	5588	9-08-87	8:52p
SQSFG35	DAT	1095	9-08-87	8:52p
SQSFG36	DAT	1727	9-08-87	8:52p
SQSH132	DAT	1870	9-08-87	8:53p
SQTBA35	DAT	1548	9-08-87	9:07p
SQTBA36	DAT	2421	9-08-87	9:08p
SQTBD34	DAT	4457	9-08-87	9:08p
SQTBD35	DAT	1092	9-08-87	9:09p
SQTBD36	DAT	1276	9-08-87	9:09p
SQTBD41	DAT	902	9-08-87	9:09p
SQTBG34	DAT	6657	9-08-87	9:10p
SQTBG35	DAT	1094	9-08-87	9:10p
SQTBG36	DAT	1846	9-08-87	9:11p
SQTBG41	DAT	902	9-08-87	9:11p
SQTLD32	DAT	1611	9-08-87	9:12p
SQTLD34	DAT	6514	9-08-87	9:13p
SQTLD35	DAT	1093	9-08-87	9:13p
SQTLD36	DAT	1743	9-08-87	9:13p
SQTLD41	DAT	914	9-08-87	9:14p
SQTLG32	DAT	1194	9-08-87	9:14p
SQTLG34	DAT	3715	9-08-87	9:15p
SQTLG35	DAT	1093	9-08-87	9:15p
SQTLG36	DAT	1404	9-08-87	9:15p
SQTLG41	DAT	900	9-08-87	9:16p
SQTMU32	DAT	1141	9-08-87	9:16p
SQTMU35	DAT	1407	9-08-87	9:16p
SEQU	SAM	145	9-18-87	10:44a
SEQUOYAH	DAT	3741	9-08-87	4:08p
SEQUOYAH	RKP	924	9-08-87	3:24p
SQSH141	DAT	1644	9-22-87	10:42a
SQSH241	DAT	1642	9-22-87	10:49a
SQSH341	DAT	1642	9-22-87	10:58a
SQTBA41	DAT	1641	9-22-87	11:18a

79 File(s)   155648 bytes free

Sequoyah Files

SUAG32	DAT	873	9-09-87	7:25p
SUABE35	DAT	1116	8-30-87	6:26p
SUABB41	DAT	912	9-26-87	1:17p
SUAG31	DAT	281	8-31-87	3:55p
SUABE32	DAT	1280	12-26-86	3:33p
SUAG34	DAT	14253	9-09-87	12:42p
SUABE51	DAT	2727	9-06-87	6:50p
SUABB33	DAT	2098	5-26-87	5:41p
SUABG41	DAT	832	9-26-87	1:16p
SUABE31	DAT	693	8-30-87	6:26p
SURR	SAM	128	1-27-87	3:43a
SUAG33	DAT	1408	3-30-87	6:34p
SUABE33	DAT	1545	5-26-87	5:42p
SUSDE51	DAT	1932	9-06-87	6:52p
SUABG33	DAT	1199	5-26-87	5:43p
SUTB520	DAT	1920	4-17-85	5:06p
SUTB521	DAT	470	9-22-87	5:51p
SUABB35	DAT	1106	8-31-87	3:47p
SUABB36	DAT	1222	8-31-87	3:47p
SUTBE51	DAT	2983	9-06-87	6:34p
SUSDE33	DAT	1547	5-26-87	5:44p
SUSDG33	DAT	2048	5-26-87	5:45p
SUABB31	DAT	833	8-31-87	3:47p
SUSDG34	DAT	2764	5-26-87	3:46p
SUABG34	DAT	2342	5-26-87	3:47p
SUABE34	DAT	2468	5-26-87	3:48p
SUSDE34	DAT	2324	5-26-87	3:50p
SUVVV34	DAT	3524	5-26-87	5:12p
SUTBD33	DAT	1408	5-26-87	5:49p
SUTBE33	DAT	1920	5-26-87	5:54p
SUABG32	DAT	1001	8-30-87	5:23p
SUABG35	DAT	1094	8-30-87	5:30p
SUABG31	DAT	804	8-30-87	5:30p
SUAG36	DAT	1955	8-30-87	5:32p
SUAG35	DAT	1447	8-30-87	5:32p
SUSDE35	DAT	1028	8-30-87	5:47p
SUSDE31	DAT	551	8-30-87	5:48p
SUSDG35	DAT	1028	8-30-87	5:55p
SUSDG36	DAT	1699	8-30-87	5:56p
SUSDG31	DAT	535	8-30-87	5:56p

SUVVV35	DAT	1018	8-31-87	3:50p
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SUTBD31	DAT	752	8-30-87	6:04p
SUTBE35	DAT	1025	8-30-87	6:05p
SUTBE36	DAT	1505	8-30-87	6:07p
SUTBE31	DAT	994	8-30-87	6:10p
SUVVV31	DAT	630	8-31-87	3:51p
SURRY	RKP	1381	9-04-87	9:26a
SUABB32	DAT	849	9-08-87	9:18p
SUABB34	DAT	5307	9-08-87	9:19p
SUABE36	DAT	1339	9-08-87	9:20p
SUABE41	DAT	968	9-08-87	9:22p
SUABG36	DAT	1314	9-08-87	9:22p
SURRY	DAT	4125	9-08-87	9:23p
SUSDE32	DAT	1187	9-08-87	9:24p
SUSDE36	DAT	1624	9-08-87	9:25p
SUSDE41	DAT	913	9-08-87	9:26p
SUSDG32	DAT	1208	9-08-87	9:26p
SUSDG41	DAT	1057	9-08-87	9:28p
SUTBD32	DAT	844	9-08-87	9:28p
SUTBD34	DAT	2128	9-08-87	9:29p
SUTBD35	DAT	1027	9-08-87	9:29p
SUTBD41	DAT	1058	9-08-87	9:30p
SUTBE32	DAT	832	9-08-87	9:30p
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SUTBE41	DAT	908	9-08-87	9:32p
SUVVV32	DAT	913	9-08-87	9:33p
SUVVV33	DAT	2989	9-09-87	6:18p
SUVVV36	DAT	1245	9-08-87	9:35p
SUVVV41	DAT	1226	9-08-87	9:36p
SUAG41	DAT	1354	9-22-87	12:21p

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Surry Files

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ZISD234	DAT	7910	9-08-87	8:32p
ZION	DAT	3912	9-08-87	8:32p
ZION	SAM	128	1-27-87	3:47a
ZISD131	DAT	768	1-26-87	9:07p
ZISD132	DAT	1536	12-29-86	3:13p
ZISD135	DAT	1792	1-26-87	9:06p
ZISD136	DAT	1920	1-26-87	9:07p
ZISD231	DAT	640	1-26-87	9:11p
ZISD232	DAT	1280	12-13-86	3:12p
ZISD235	DAT	1792	1-26-87	9:10p
ZISD236	DAT	1792	1-26-87	9:11p
ZISDE31	DAT	1536	1-26-87	9:12p
ZISDE32	DAT	1171	9-08-87	8:35p
ZISDR34	DAT	8878	9-08-87	8:29p
ZISDE34	DAT	1925	9-08-87	8:28p
ZISDE35	DAT	1536	1-26-87	9:11p
ZISDE36	DAT	1606	9-08-87	8:35p
ZISDE41	DAT	854	9-08-87	8:33p
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ZISDR32	DAT	1536	12-13-86	3:08p
ZISDR35	DAT	1792	1-26-87	9:17p
ZISDR36	DAT	2100	5-05-87	3:34p
ZITB520	DAT	2176	4-20-85	6:44p
ZITB521	DAT	519	9-22-87	5:55p
ZITBE31	DAT	927	5-05-87	4:01p
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ZITBE34	DAT	1319	9-05-87	3:03p
ZITBE35	DAT	1536	1-26-87	9:19p
ZITBE36	DAT	1536	1-26-87	9:19p
ZITBE41	DAT	854	9-08-87	8:41p
ZITBE51	DAT	2702	9-06-87	7:17p
ZITMU31	DAT	768	1-26-87	9:25p
ZITMU32	DAT	1536	12-13-86	3:13p
ZITMU35	DAT	1792	1-26-87	9:24p
ZITMU36	DAT	2304	1-26-87	9:25p
ZTU1T2	DAT	9216	10-21-86	5:39p
ZITMU34	DAT	10387	9-08-87	8:44p
ZISDE33	DAT	1640	9-08-87	8:43p
ZITMU33	DAT	1518	9-08-87	8:43p
ZISD133	DAT	1219	9-08-87	8:42p
ZISD233	DAT	1155	9-08-87	8:42p
ZISDR33	DAT	1369	9-08-87	8:42p
ZION	RKP	921	9-16-87	1:39p
ZISDR41	DAT	1352	9-22-87	12:34p
ZISD141	DAT	1351	9-22-87	12:38p
ZITMU41	DAT	1350	9-22-87	12:43p
ZISD241	DAT	1351	9-22-87	12:43p

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13. ABSTRACT (200 words or less)

CADET (Computer Aided DEcision Tool) is a decision support system for light water reactor safety which is designed for use on personal computers. As a decision support system, it provides a user-friendly data base program complemented with several computational capabilities. The data base component of the program provides users with pertinent data from a variety of sources. The computational portion of the program provides measures of consequence and risk, and a means for performing "what if" analyses with selected elements of the data base. Predictive capabilities incorporated into the present version of CADET include effects of time of containment failure, effects of containment leak rate, and influences of filtered venting on the outcome of accident sequences.

14. DOCUMENT ANALYSIS - a. KEYWORDS/DESCRIPTORS
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