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System Analysis and Risk Assessment System (SARA) Version 4.0

Reference Manual

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EG&G Idaho, Inc.

Prepared for
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ABSTRACT

This NUREG is the reference manual for the System Analysis and Risk Assessment (SARA) System Version 4.0, a microcomputer-based system used to analyze the safety issues of a family [i.e., a power plant, a manufacturing facility, any facility on which a probabilistic risk assessment (PRA) might be performed].

The SARA data base contains PRA data for the dominant accident sequences of a family and descriptive information about the family including event trees, fault trees, and system model diagrams. The number of facility data bases that can be accessed is limited only by the amount of disk storage available. To simulate changes to family systems, SARA users change the failure rates of initiating and basic events and/or modify the structure of the cut sets that make up the event trees, fault trees, and systems. The user then evaluates the effects of these changes through the recalculation of the resultant accident sequence probabilities and importance measures. The results are displayed in tables and graphs.

FIN No. L1429 - SARA, IRRAS and MAR-D Maintenance and User Support

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EXECUTIVE SUMMARY

The System Analysis and Risk Assessment (SARA) system provides the capability to examine the risk impact of a "family" [i.e., a power plant, a manufacturing facility, any facility on which a probabilistic risk assessment (PRA) might be performed] dealing with such items as regulatory issues, plant design, and operational changes. It is a flexible PRA tool that can be used in the evaluation and prioritization of physical and operational changes.

SARA is a computer program that is designed to access data generated by other programs. It contains no data, but can automatically access PRAs stored in the Models and Results Database (MAR-D). These PRAs could have been generated using the Integrated Reliability and Risk Analysis System (IRRAS) or loaded using the MAR-D program. MAR-D serves as a repository of models and results from completed PRAs, and has no analysis capabilities. SARA can select for analysis, any family database loaded in MAR-D. This data includes, event failure data, dominant accident sequences, descriptive information about the facility, event trees, fault trees, and plant system model diagrams.

Family modifications and accident scenarios are simulated by changing basic event probabilities, initiating event frequencies, and/or cut set structures. Accident sequences, total sequence frequencies, sequence uncertainty values, event importance measures, and facility end states are recalculated and the results of the calculations are displayed numerically and graphically. All data displays may be saved in disk files and/or sent to an attached hard copy device.

Each major function provided by SARA is discussed in the following paragraphs.

Select Family

The Select Family function allows the user to select for analysis a specific family from a library of families stored on disk. In addition it provides the means of copying SARA data base files between families.

Systems Analysis

The Systems Analysis function allows the user to modify basic event probabilities, cut set structures, uncertainty calculation parameters; and then recalculate system unavailabilities and importance measures. The results of the calculations are displayed in tables and graphs and may be compared to the base line data contained in the SARA data base.

Event Trees Analysis

The Event Tree Analysis function allows the user to modify basic event probabilities and sequence initiator frequencies, cut set structures, and uncertainty calculation parameters; and then recalculate core damage frequencies and importance measures. The results of the calculations are displayed in tables and graphs and may be compared to the base line data contained in the SARA data base.

Graphics Analysis

The Graphics Analysis function allows the user to view piping and instrumentation diagrams (P&IDs), fault tree and event tree diagrams, plus line and bar graphs of system, sequence, and end state plots. The diagrams may be sent to an attached Epson compatible printer, an HP LaserJet printer, or to an .HPP file.

Reports

The Reports function allows the user to print reports of the data contained in the SARA data base. Since user-generated data are also stored in the database, reports of this data may also be created. The reports may be sent to the screen, to an attached printer, or to a disk file for later editing and/or printing.

Modify Database

The Modify Database function allows the user to review and edit the base case or original data records contained in the SARA data base.

Utility Options

The Utility Options function allows the user to set system parameters, load and output data base records, and recover the data base index files if they have become corrupted.

FOREWORD

The U. S. Nuclear Regulatory Commission has developed a powerful suite of computer programs for the performance of Probabilistic Risk Assessments (PRAs). This suite of programs allows an analyst to perform many of the functions necessary to create, quantify, and evaluate the risk associated with a facility or process being analyzed. These programs include software to define the data base structure, to create, analyze, and quantify the data, and to display results and perform sensitivity analyses. The programs included in this suite are as follows: Models And Results Database (MAR-D) software, Integrated Reliability and Risk Analysis System (IRRAS) software, System Analysis and Risk Assessment (SARA) software, and Fault tree, Event tree, and P&ID (FEP) graphical editor software. Each of these programs performs a specific function in taking a PRA from the conceptual state all the way to publication.

MAR-D is a program that is used primarily for PRA data loading. This program defines a common relational database structure that is used by the entire suite of programs. This structure allows all of the software to access and manipulate data created by other software in the system without performing a lengthy conversion. Hence, data created by IRRAS is immediately available to SARA for sensitivity analysis. The MAR-D program also provides the facilities for loading and unloading of PRA data from the relational database structure used to store the data. A simple ASCII data format is used for interchange with other PRA software not included in NRC's suite of programs. This feature allows for compatibility with previously developed software systems and allows for maximum data interchange. Elements of this software are included with both IRRAS and SARA to allow these programs to load and unload data in the MAR-D format. Normally, the entire MAR-D software is used only by those performing a data loading function and is not required by the end user. Documentation for MAR-D, Version 4.0 is in draft form and will be finalized.

IRRAS is a program developed for the purpose of performing those functions necessary to create and analyze a complete PRA. This program includes functions to allow the user to create event trees and fault trees, to define accident sequences and basic event failure data, to solve system and accident sequence fault trees, to quantify cut sets, and to perform uncertainty analysis on the results. Also included in this program are features to allow the analyst to generate reports and displays that can be used to document the results of an analysis. Since this software is a very detailed technical tool, the user of this program should be familiar with PRA concepts and the methods used to perform these analyses. Although IRRAS has been designed to be user friendly and makes the process of performing a PRA easier, the complexity of this type of analysis requires a user with a more detailed understanding of PRA concepts than is required by other tools in this suite. The IRRAS 4.0 reference manual is available as NUREG/CR-5813, Volume 1. The IRRAS 4.0 tutorial, Volume 2,

is in preparation.

SARA is a program that allows the user to review the results of a PRA and to perform limited sensitivity analysis on these results. It is limited primarily to the extent that changes in the plant model can be accommodated by using the cut set editor. If other than simple changes are being simulated, then IRRAS should be used so that new cut sets can be accurately generated. This tool is intended to be used by a less technically-oriented user and does not require the level of understanding of PRA concepts required by IRRAS. With this program a user can review the information generated by a PRA analyst and compare the results to those generated by making limited modifications to the data in the PRA. Also included in this program is the ability to graphical display the information stored in the MAR-D database. This information includes event trees, fault trees, P&IDs and uncertainty distributions. The user of this program can gain a better understanding of the results of a PRA without getting into the details of the construction and analysis work behind the PRA. The SARA reference manual and tutorial are available as NUREG/CR-5303, Volumes 1 and 2, respectively.

FEP is a program developed to provide a common access to the suite of graphical tools developed for performing risk assessment. These tools include the graphical event tree, fault tree, and P&ID editors. The event tree and fault tree editors are available through IRRAS; however, the P&ID editor is only accessible through FEP. The event tree editor allows the analyst to construct and modify graphical event trees. The fault tree editor allows the user to construct and modify graphical fault trees. The P&ID editor allows the user to construct and modify plant drawings. These drawings can then be used to document the modeling used in a PRA. These editors are an integral part of a PRA. With the FEP tool, the user need not be concerned with the complexity of the IRRAS program if the need is only to generate one of these graphical displays. Documentation for FEP, Version 4.0 is in draft form and will be finalized.

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SYSTEM ANALYSIS AND RISK ASSESSMENT (SARA) SYSTEM VERSION 4.0 VOLUME 1 - REFERENCE MANUAL

1. INTRODUCTION

The System Analysis and Risk Assessment (SARA) system provides the capability to examine the safety impact of nuclear power plant regulatory issues and plant design and operational changes. It is a flexible probabilistic risk assessment (PRA) tool that the nuclear power plant analyst can use in the evaluation and prioritization of generic issues, and other applications using PRA core damage results.

Nuclear power plant modifications and accident scenarios are simulated by changing system cut sets, basic event probabilities or accident sequence initiator frequencies, and recalculating accident sequences, plant end states, and core damage frequencies. Results of the calculations are displayed numerically and graphically. Analysis can be done at several levels: a single event, a group of events, a system, a group of systems, a sequence, and a group of sequences. Only one family (plant) can be analyzed at a time.

This reference manual provides detailed information about SARA operations and general information about commands commonly used in each operation. To simulate changes to plant systems, you may change the failure rates of basic and initiating events in the plant systems models or change the cut sets to reflect a logic change in the systems. You may then evaluate the results of these changes through the calculation of the resultant core damage and accident sequence frequencies. Results are displayed in reports and graphs.

SARA contains two databases: the permanent or base case database and a parallel database that can be temporarily changed by the user. The modification of basic events and cut sets generate "change sets" and "alternate" cut sets that are saved in the data base. A change set consists of probability and/or class changes for a group of basic events. This allows the user to reproduce a particular scenario without repeating all of the data modifications. The base case data may be updated with the modified (current) data at any time.

Each operation is examined separately, and required actions and expected results are outlined. Appendices cover hardware and software requirements and data interchange formats.

1.1 SARA Internal Functions

The functions provided in SARA are described in the following paragraphs.

1.1.1 Select Family

A family is a group of models, such as those for a single plant, unit, or facility. SARA creates a directory for each family as it is added via the Modify Database option. A family model (data) is

accessed using the Select Family option. In Select Family, you may copy raw data or a data base file from another source into the current family directory. After you have selected a family, the family name is shown in the upper left corner of the subsequent screens. Selecting a family changes the current directory to the one created solely for that family data.

1.1.2 Systems Analysis

This portion of SARA allows you to evaluate different system scenarios. Basic event probabilities and system cut set configurations may be modified, requantified, recalculated, and the results displayed on the screen or directed to a printer or disk file. In addition, event importance measures may be calculated and displayed.

1.1.3 Event Tree Analysis

This portion of SARA allows you to evaluate different scenarios that involve the event trees. Basic event probabilities and sequence cut set configurations may be modified, requantified, recalculated, and the results displayed on the screen or directed to a printer or disk file. In addition, event importance measures and sequence uncertainty distributions may be calculated and displayed.

1.1.4 Graphics Analysis

This feature allows you to view piping and instrumentation diagrams (P&ID), and fault tree and event tree graphic diagrams. It also allows you to produce line plots and bar charts using system, sequence, or end state data contained in the data base.

1.1.5 Reports

The reporting functions provide the means to obtain summary or detailed reports about the data contained in the data base. The reports can be output to the screen (console), to a printer, or to a file.

1.1.6 Modify Database

This feature allows you to add, modify, or delete the base case data records for the selected family. It should be stressed that using this feature will change the base case data!

1.1.7 Utility Options

The Utility Options consist of three functions: Define Constants, MAR-D Interface, and Recover Database. The first option, Define Constants, is used to indicate system hardware configuration, set uncertainty and cut set defaults, and set fault tree and event tree graphics defaults.

The second option, MAR-D Interface, allows you to load raw data files into SARA and output

the data base records into files that conform to the MAR-D data formats (see Appendix B).

The third option, Recover Database, will rebuild the data and index files for each relation in the data base. This may be necessary if the data base has been corrupted in some way.

1.2 Invoking SARA

To activate SARA, change to the PRADATA.B1 directory, and type:

SARA

Figure 1 will appear. This disclaimer message will appear on the screen for a few seconds, followed by the SARA Main Menu shown in Figure 2.

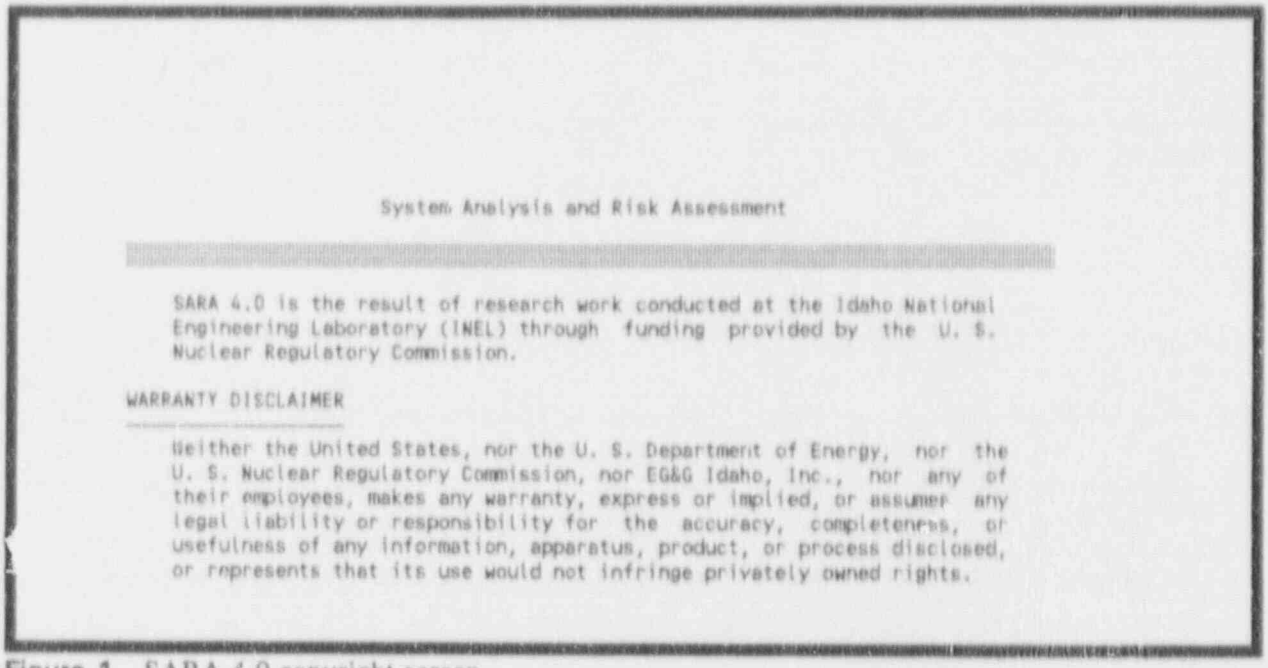


Figure 1. SARA 4.0 copyright screen.

NOTE: This document assumes the reader is familiar with PRA methods and terminology. This manual serves as a reference guide for the SARA user.

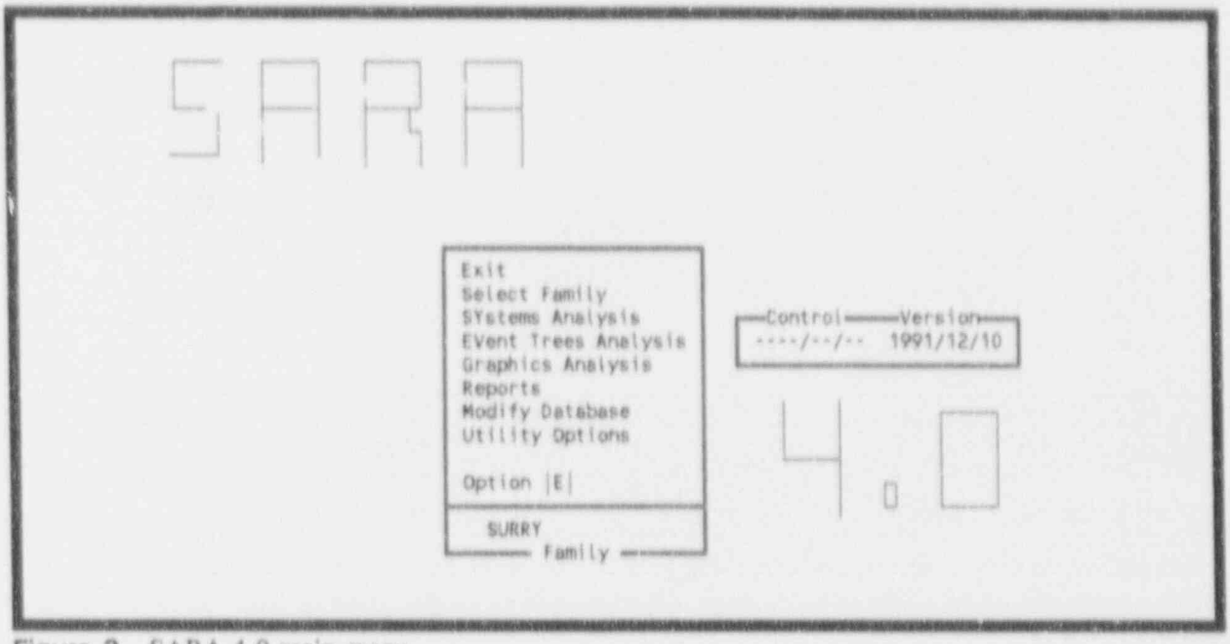


Figure 2. SARA 4.0 main menu.

1.3 Version Conflict

If you generated your data using the previous version of SARA and are logging-in for the first time using Version 4.0, the version conflict screen will appear (Figure 3).

You will need to rebuild the data files in order to access them using Version 4.0 software. At the prompt, enter a <Y> and press <Enter> to rebuild the relations for the current family. After the files have been rebuilt, you will be returned to the main menu. When you log-on to SARA from now on, this screen will not appear. You will proceed directly to the main menu.

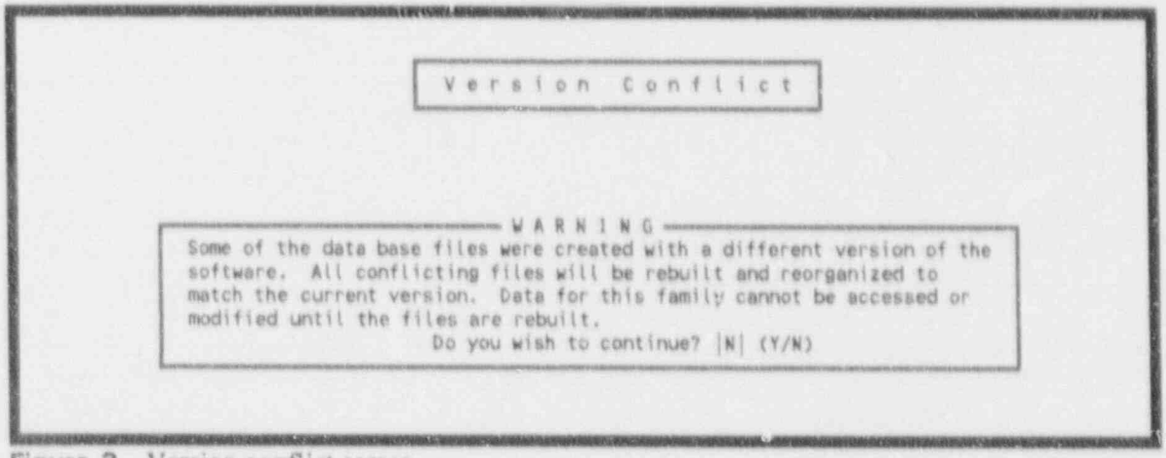


Figure 3. Version conflict screen.

2. SELECT FAMILY

This option allows you to select the family data set you wish to work with and provides the capability of copying raw (MAR-D) data files or SARA data base files into a specific family. A family is a group of models, such as those for a single plant, unit, or facility. When the family is successfully selected the name is shown in the upper left corner of the screen.

The current directory is the current family unless you select another family. SARA retains the last family you selected when you exited the program so when you enter SARA again the last family selected is the current family. The Select Family screen (Figure 4) lists all families in the SARA data base. The select family function provides four options: Exit, Select, Family Copy, and Copy. In addition, three function keys are available:

<Esc> Exits the Select Family module and returns you to the SARA main menu.

<F1> Displays on-line help messages.

<F5> Allows you to locate a specified family. When you press <F5> a blank line will appear on the screen. Enter all or part of the family name you wish to locate and press <Enter>. This feature will place the highlight on the located name. If the requested name is not found, then the next name in alphabetical order will be highlighted. This feature is especially useful when there are several screens of families to display.

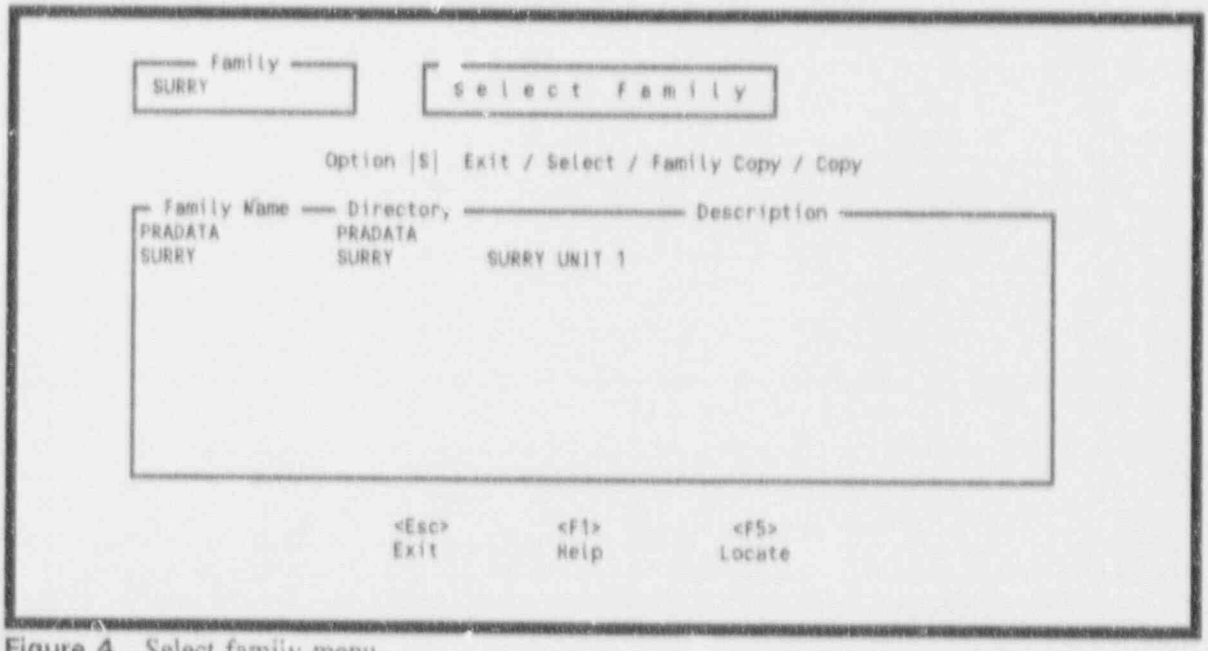


Figure 4. Select family menu.

2.1 Exit

Typing <E> in the option field and pressing <Enter>, or pressing <Esc> will return you to the SARA main menu.

2.2 Select

This option is used to select the family data files that will be accessed during subsequent SARA functions. To invoke the option, type <S> in the option field, highlight a family, and press <Enter>. If a family is not highlighted, the message **Position the cursor over the family to select** will be displayed. When a family is highlighted and selected, you will be returned to the SARA main menu where the selected family name will appear at the top of the menu. For later functions, the selected family name will appear in the box in the upper left corner of the screen. If for any reason the family cannot be selected, the message **Unable to select desired family** appears, the previously selected family will be retained, and you will be given another chance to select a family. If the highlighted family's data version does not match the current software version, the version update screen appears (Figure 5), and you will be asked if you want to rebuild the data. To select the family, the data must be rebuilt, so enter a <Y> to rebuild, and then select the desired family. If you type <N>, that family's data will not be rebuilt, that family will not be selected, the former selected family will be retained, and the message **Unable to select desired family** appears.

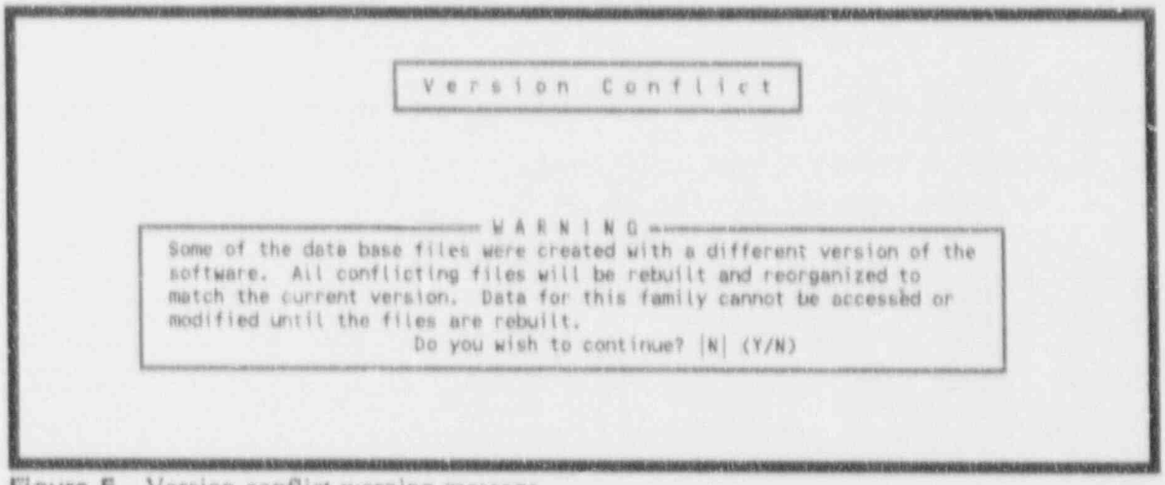


Figure 5. Version conflict warning message.

2.3 Family Copy

This option provides the means of copying data base files between families. If a family contains data that the user needs, this option allows them to copy all the data into a new family. Then the user can modify any of the data in the new family while keeping the original family data preserved. The family you are copying to should be empty. This option will overwrite all existing files. To invoke this option, type <F> in the option field, highlight a family, and press <Enter>. If no family has been highlighted, the message **Position the cursor over the family to copy from** appears at the bottom of the

screen. If this message appears, highlight a family and press <Enter>. The message **Position the cursor over the family to copy to** will then appear. Again, highlight a family and press <Enter>. All family data base files will be copied from the first family highlighted to the second family highlighted. When the files are copied, the message **Family successfully copied** appears.

2.4 Copy

This option provides the means of copying any file (raw data and/or a MAR-D file) into any family. If the user has a need for data that was generated using another application, this option provides the mechanism to copy such data into a family. To invoke this option, type <C> in the option field, highlight the family to copy to, and press <Enter>. If no family is highlighted, the message **Position the cursor over the family to copy to** is displayed at the bottom of the screen. If this message appears, highlight a family and press <Enter>. A new screen, File Copy (shown in Figure 6), requesting the path and file name of the source data being copied into the selected family is displayed. Specify the entire path of the data to be copied and press <Enter> (e.g., A:*.* or D:\RAWDATA\DEMO*.*). A confirmation message **File(s) successfully copied** is displayed when the files have been copied.

Entering an invalid path, a nonexistent file name, or pressing <Enter> without specifying a path results in the data not being located, and displays an error message **Unable to locate requested file(s)**. To return to the Select Family screen without copying a file, press <Esc>. The message **Copy attempt terminated at users's request** appears and the Select Family screen is redisplayed.

If you want to copy to a family that does not yet exist, you must first add the family. To add a family, see the Modify Data Base option. After you have added the family, you may return to the Select Family option and copy your data base into the new family.

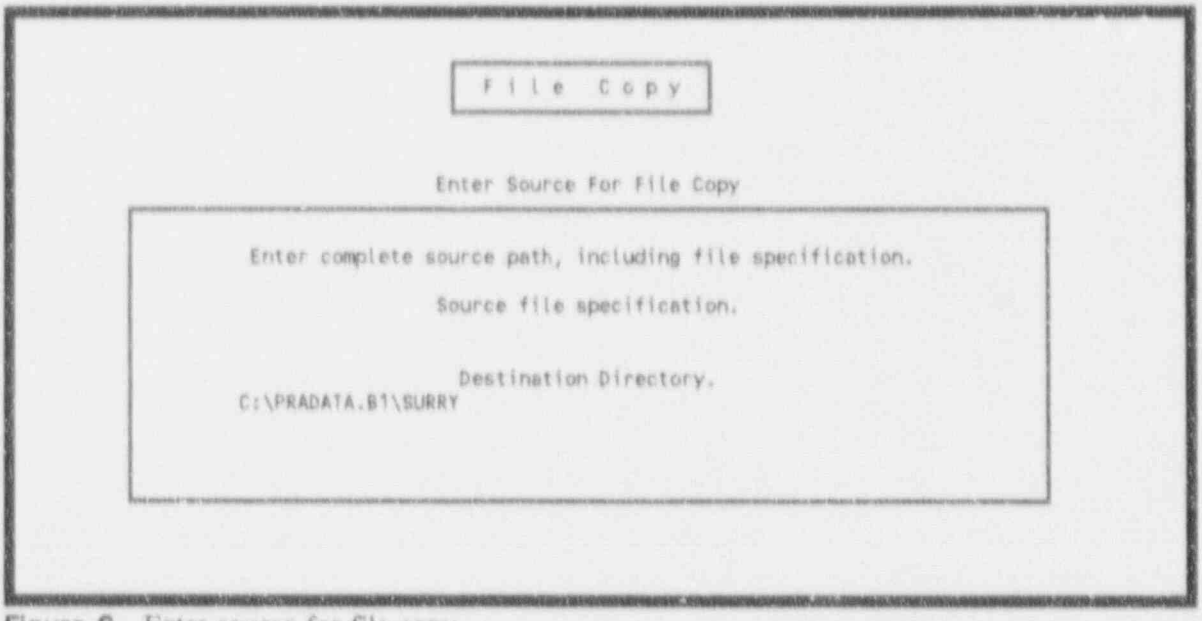


Figure 6. Enter source for file copy.

3. SYSTEMS ANALYSIS

To invoke the Systems Analysis option from the main menu, highlight SYstem Analysis or type <Y> in the option field and press <Enter>. The Systems Analysis option consists of the following four functions:

1. Modify Event Data includes adding, deleting, and modifying change sets. Change sets contain information about the probability/class changes that are to be applied to basic events during system analysis. Within a change set you may modify selected event probabilities, and reset those event probabilities to the base case values. In addition, you may perform a base case update that takes all current system data and makes it the new base case data. The original base case data are overwritten in this process. You may also add, modify, or delete user-defined histograms.

2. Analyze Systems includes updating the cut sets, quantifying the cut sets, running uncertainty analyses, and updating the base case.

3. Display Results presents the analyses in various report forms.

4. The Cut Set Editor provides the means to modify the system cut sets.

Keys you will frequently use include the following:

<Esc> Escape cancels your last choice and returns you to the previous screen.

<F1> Help briefly explains the function of a field and may show you examples of data entered.

<F2> Mark/Unmark tags items for use in the selected option.

<F3> Clear All Marked items removes the marks (*) from the listed items. If no items are marked, this option will mark all of the items.

<F4> Mark/Unmark range of items tags a large numbers of items more easily for processing.

<F5> Locate an item displays a blank field in the center of the screen, and a message **Please enter name to locate** will appear. The user should enter all or part of the name to be located and then press <Enter>. This feature will place the highlight on the located name. If the requested name is not found, then the next name in alphabetical order will be highlighted.

The System Analysis main menu is shown in Figure 7. The Systems Analysis options and their functions will be discussed in the following pages.

3.1 Exit

The System Analysis screen appears with Exit <E> as the default choice in the command line (see Figure 7). Press <Enter> or the <Esc> key to return to the SARA main menu.

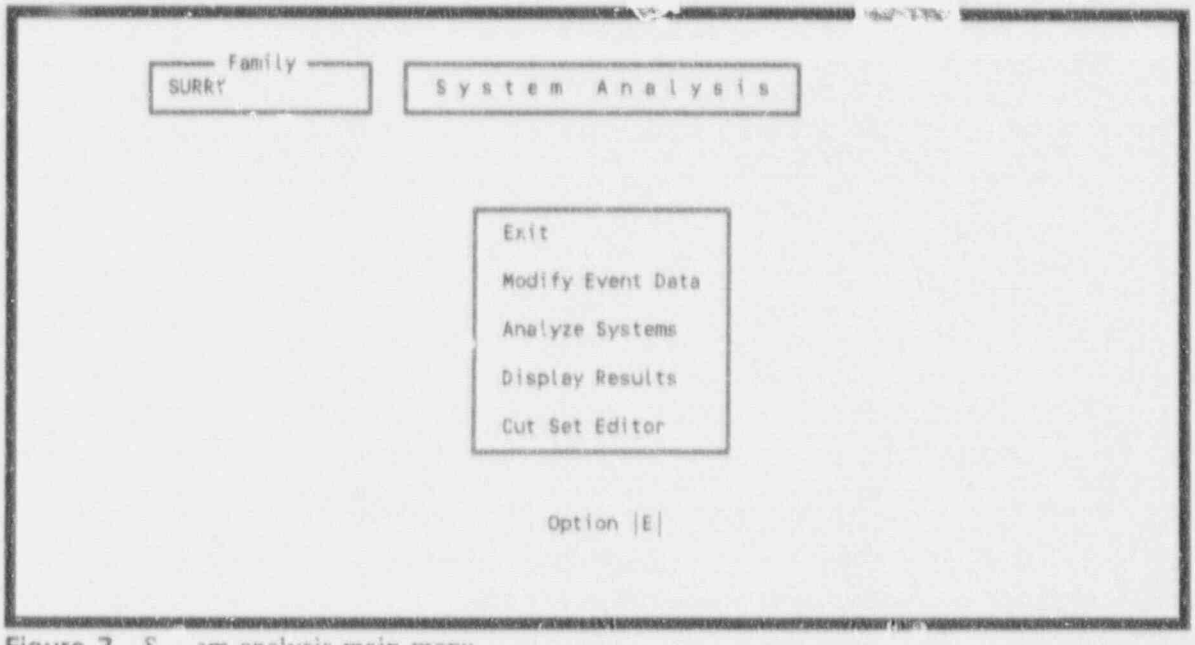


Figure 7. System analysis main menu.

3.2 Modify Event Data

The event data can be manipulated to examine the changes in the probabilities of plant accidents and accident sequence failures based on basic events. Events can be added, modified, and deleted. The probability of events occurring can be recalculated. You may generate change sets to be applied to the basic events for later propagation through the sequence cut sets. You may update the base case that will replace the present base case data with current data.

From the Modify Event Data option, the following operations may be performed: add, modify, or delete change sets; create and reset individual event probability changes; add a class probability change to a group of events; add, modify, or delete user-defined histograms; update the base case event data with the current case event data; generate new current case event data using the temporary modifications made to the marked change sets; and create reports that reflect the event modifications that currently exist within the data base.

Highlight Modify Event Data on the main menu or type a <M> to select this option and press <Enter>. The Change Sets screen shown in Figure 8 will be displayed. A change set is a set of sensitivity data modifications to be applied to the basic events. Change sets modify the current case basic event data. A change set consists of probability and/or class changes for a group of basic events. As shown in Figure 8, ten options are available. Each of these options is discussed in the following paragraphs.

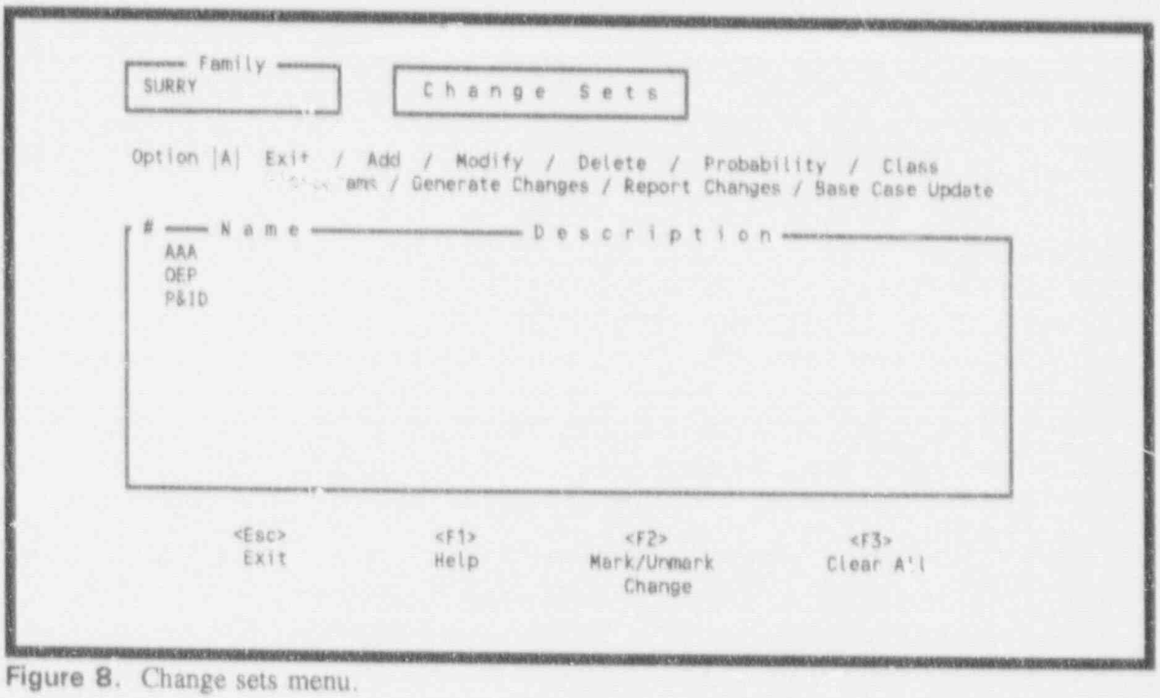


Figure 8. Change sets menu.

3.2.1 Exit

Type an <E> in the option field and press <Enter>, or press the <Esc> key to return to the SARA main menu.

3.2.2 Add

The Add function is used to add a change set name and description to the data base. You supply a name (up to 16 characters) and a description (up to 60 characters). To invoke the add function, type an <A> in the option field and press <Enter>. The Add Change Set screen shown in Figure 9 will be displayed. This screen is displayed with the <A> (Add) option as the default entry in the option field. The current date is supplied by the system, however, you may change it if you wish, by typing over the default date.

After entering the change set name (required) and description (optional) and pressing <Enter>, the message **New change record added** is displayed at the bottom of the screen and you are returned to the previous screen (Figure 10), where the newly added change set will be included. If the name you entered already exists, the message **Duplicate change record name - not added** is displayed at the bottom of the screen.

To exit the Add Change Set screen without entering a new change set, press <Esc> or move the cursor to the option field by pressing <Home>, type an <E> (for Exit), and press <Enter>.

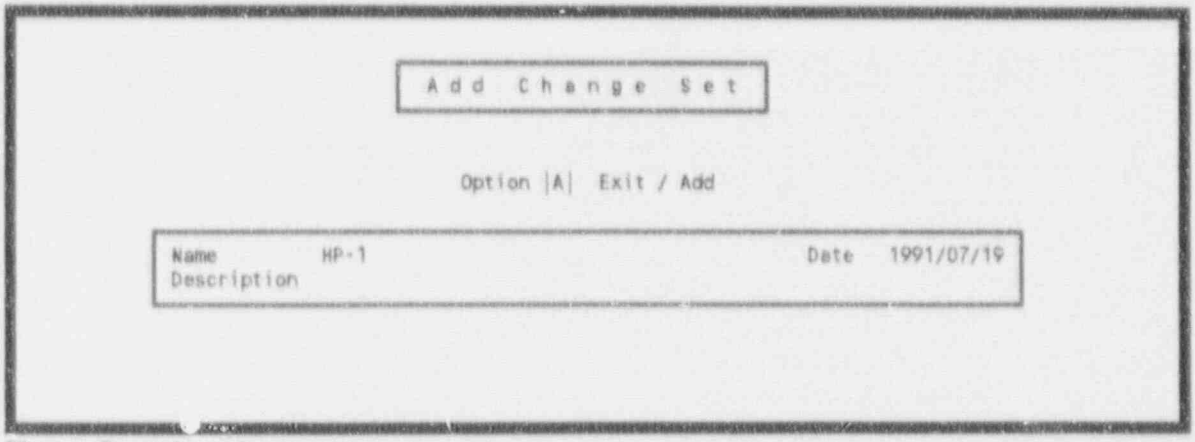


Figure 9. Add a change set.

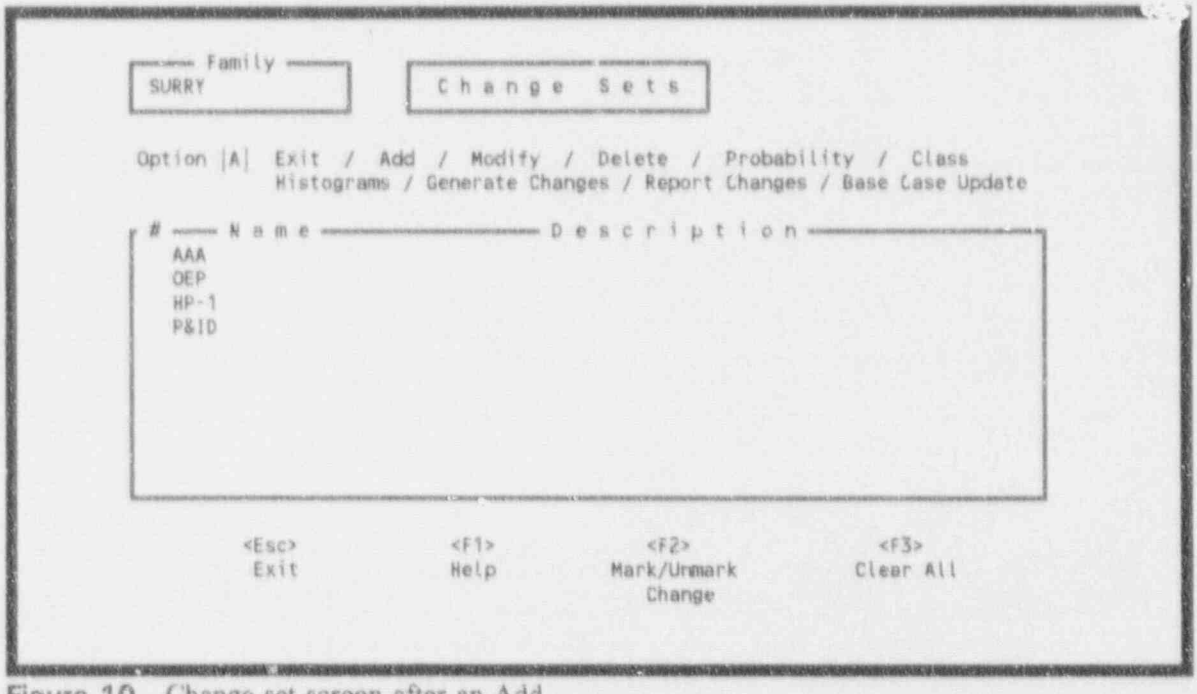


Figure 10. Change set screen after an Add.

3.2.3 Modify

This option allows you to modify the name, description, and/or date for an existing change set. To invoke this function, type an <M> in the option field, highlight the change set you want to modify, and press <Enter>. The Modify Change Set screen (shown in Figure 11) appears. If you did not highlight the change set to modify before pressing <Enter>, the message **Record must be highlighted first** appears.

Edit the name, description, and/or date and press <Enter> to execute the change. Use the <Tab> key to move the cursor from field to field. Upon pressing <Enter>, a confirmation message, **Record modified**, is displayed. To return to the Change Sets screen without modifying the change set, press <Esc> or move the cursor to the option field by pressing <Home>, typing an <E>, and

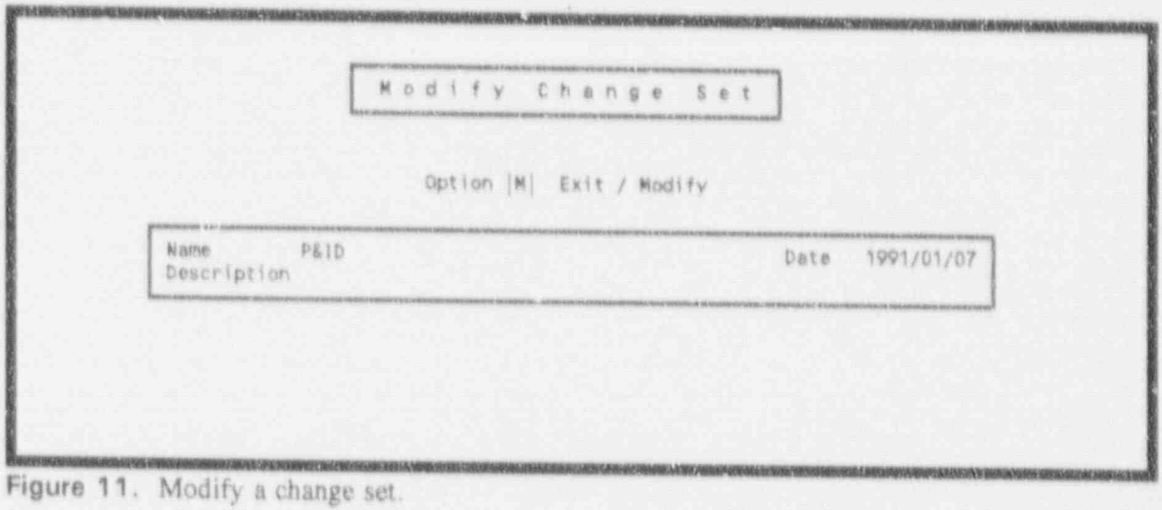


Figure 11. Modify a change set.

pressing <Enter>.

3.2.4 Delete

This function is used to remove a change set from the data base. To invoke this function, type a <D> in the option field, highlight the change set you want to delete, and press <Enter>. The Delete Change Set screen (see Figure 12) is displayed with an "E" (Exit) in the option field. To delete the change set, type a <D> and press <Enter>. You will be returned to the Change Sets screen, and the message **Change record deleted** is displayed.

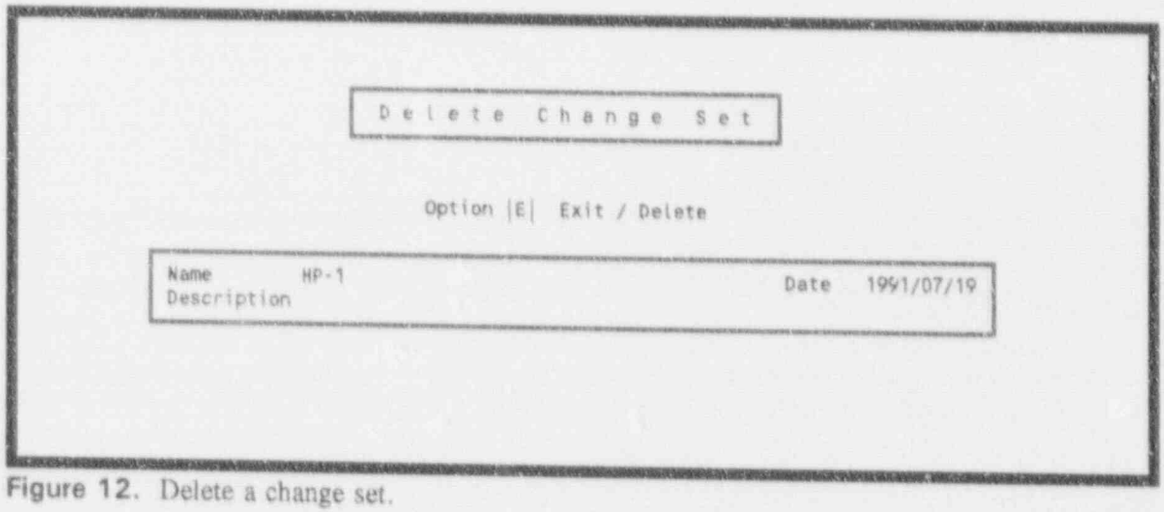


Figure 12. Delete a change set.

If you did not indicate the change set you wanted to delete before pressing <Enter>, the message **Record must be highlighted first** appears.

3.2.5 Probability

This function allows you the flexibility to experiment with setting different basic event failure and uncertainty data. These data values may be set for a single event or for a specified group of events. The function also provides a reset option to set data values back to the base case values. To invoke the Probability function, type a <P> in the option field, highlight a change set, and press <Enter>. If you press <Enter> without highlighting a change set, the message **A line must be highlighted** will be displayed. If you receive this message, highlight an event and press <Enter>. The Select Event screen (see Figure 13) appears with <P> (Probability) as the default option. The change set name is shown in the upper right corner in the Change Set box. Three options are available: Exit, Probability, and Reset probability to base.

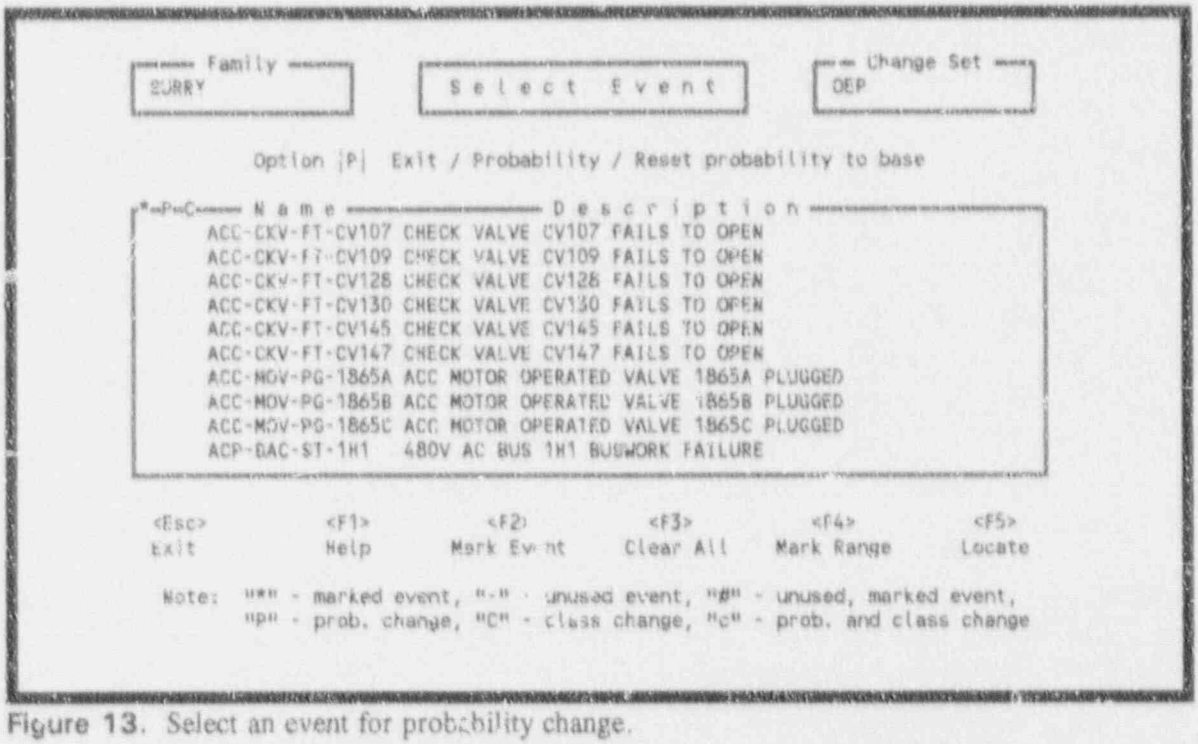


Figure 13. Select an event for probability change.

3.2.5.1 Exit. This option terminates the probability function and returns you to the Change Sets screen (Figure 8). To invoke this option, type an <E> in the option field and press <Enter>, or press the <Esc> key.

3.2.5.2 Probability. This function allows you to modify the current uncertainty and failure data values. This current data can then be applied to the specified events for use during event tree analysis. The changes applied to basic event data may be for a single event or a group of marked events.

To invoke this function, type a <P> in the option field, highlight an event or mark a group of events (using the <F2> and/or <F4> function keys) and press <Enter> (see Figure 14). If only a single event has been selected, then the Event Probability Changes screen (for a single event) will be

displayed (Figure 15). The display is divided into four data areas: Event Attributes, Uncertainty Data, Failure Data, Process Flag. The Event Attributes data display is for information only; no changes may be made to the data fields in this display. The Uncertainty Data/Failure Data areas display both the base case and current data values. You may change only the current data values. The Process Flag area is a one-character field that specifies if certain processes should take special note of the selected event. One of the following upper-case values can be input: 'S' (sensitivity analysis), 'X' (do not expand transfers), 'Y' (never expand transfers), and 'I' (always expand transfers).

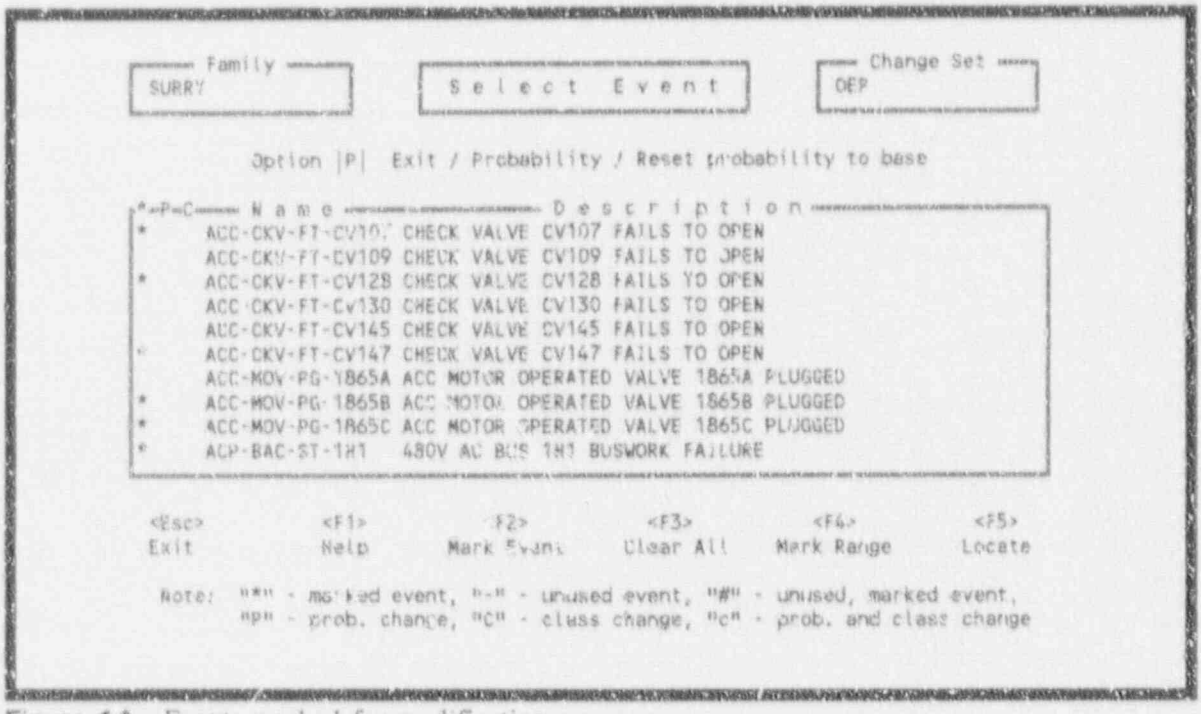


Figure 14. Events marked for modification.

When the Process Flag field is blank, the transfer associated with this event is expanded for failure references. For success references, the transfer is also expanded; however, the cut sets generated are removed from the failure cut sets using cut set matching. An "X" tells SARA that the basic event is to be used for failure references, but success references are to be treated the same as if the flag was blank. A "Y" indicates that a transfer is to be replaced with its basic event for failed references and the complement of the event is to be used for success references. An "I" causes SARA to treat the transfer as independent. Logic below this transfer is expanded for failure references, and for success references the complement of the logic is used.

If a group of events were marked (see Figure 14) using the <F2> and <F4> function keys, and the cursor was in the option field, then upon pressing <Enter> the Events Probability Changes screen (for a group of events) will be displayed (see Figure 16). This display is divided into three areas: Uncertainty Data, Failure Data, and Process Flag. As before, both the base case and current data values are shown. You may only change the current values. The changes entered on this screen will be applied to all marked events.

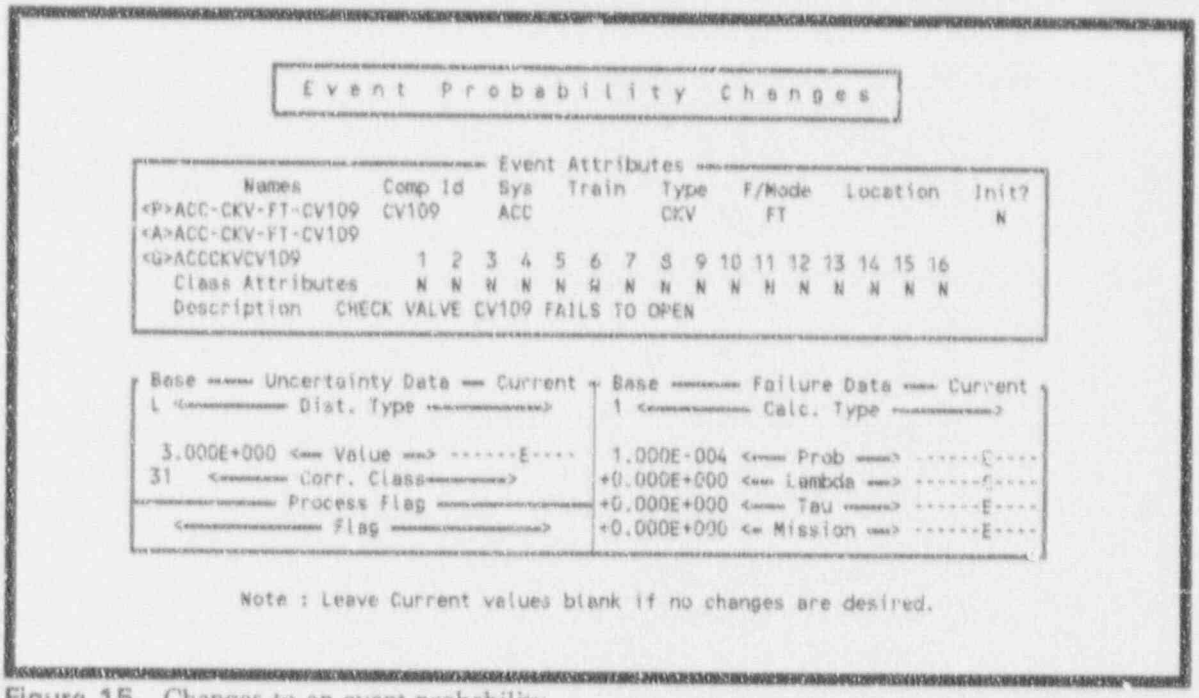


Figure 15. Changes to an event probability.

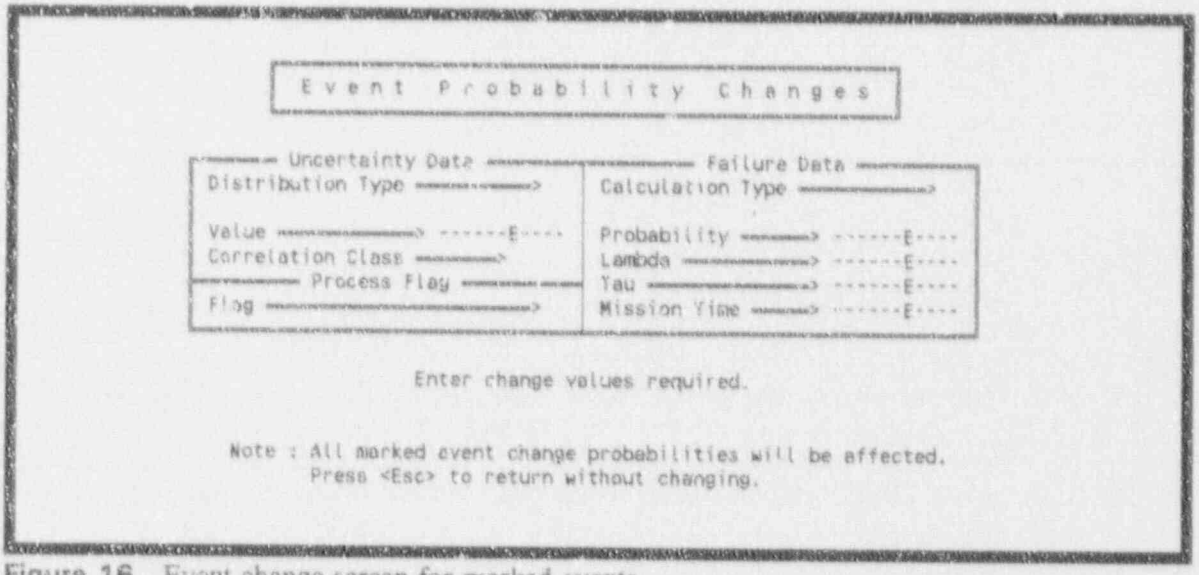


Figure 16. Event change screen for marked events.

The probability changes made are reflected on the Select Event display by showing a "P" to the left of the effected events. Probability changes have a higher priority than class changes. When both are applied to an event, the probability change will be used during fault tree/sequence analysis. This is indicated by flagging the affected events with a "P" and "c" as shown in Figure 17.

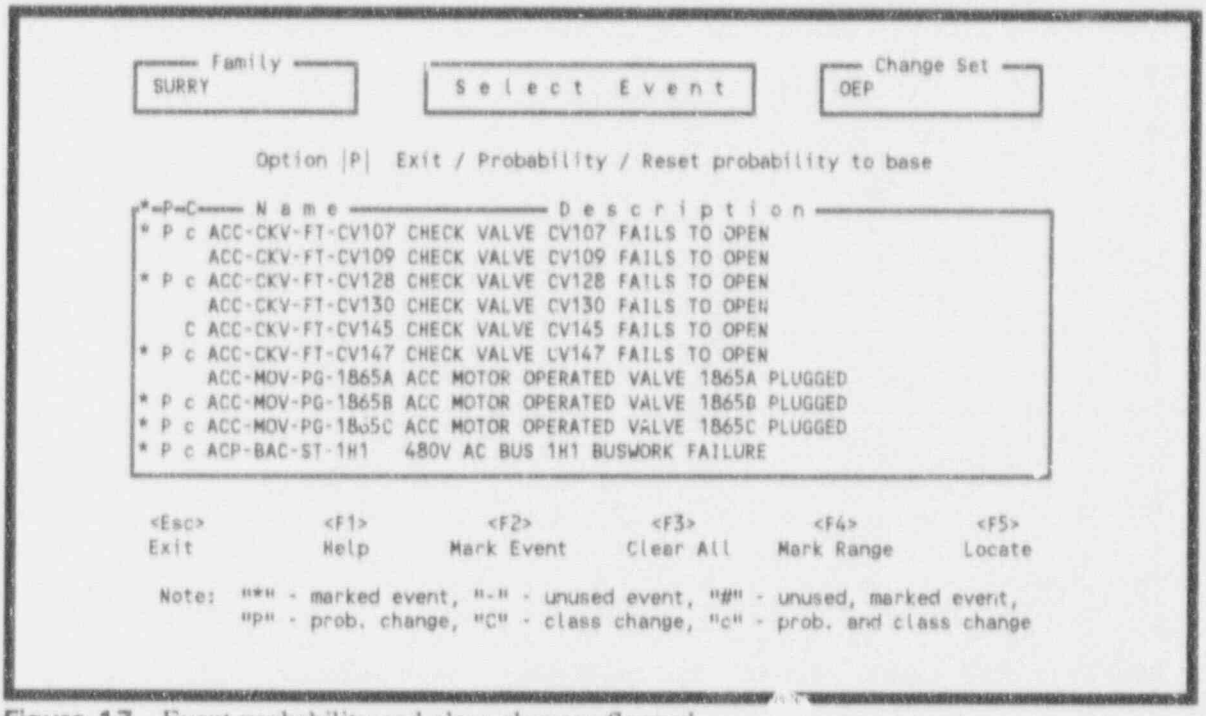


Figure 17. Event probability and class changes flagged.

On the Event Probability Changes display, help screens are supplied for all data entry fields. Pressing <F1> when the cursor is in any data entry field will cause a help screen to be displayed. Most of the help forms contain a data entry field at the bottom of the display. This field may be used to enter the desired data value, which will then be transferred into the proper data field upon exiting the help screen. Highlighting an item in the help form list will set the correct value in the data entry field.

Currently, there are seven predefined distribution types available. The predefined distribution types are normal, lognormal, beta, gamma, chi-squared, exponential, and uniform. In addition to these predefined distribution types, user-defined histograms may be used. The default distribution type is the lognormal. Figure 18 shows the help form associated with the distribution type field on the Event Probability Changes screen. From this help screen, help forms associated with each of the seven predefined distribution types are available. To view these distribution help forms, press the <F1> key while the cursor is positioned on the desired distribution type.

Correlation classes are used to account for data dependencies among like events in the data base. Correlation classes consist of four character upper-case values. A blank correlation class indicates that there are no data dependencies. When running the uncertainty analyses, the same sample value will be used for all basic events with the same correlation class.

In the Failure Data box the calculation type is a numerical reference to the calculation method to be used. There are 13 calculation types numbered 1 through 9, T, F, I, and S. When the cursor is positioned in the Calculation Type field, press <F1> for an explanation of these calculations. The help screen is shown in Figure 19.

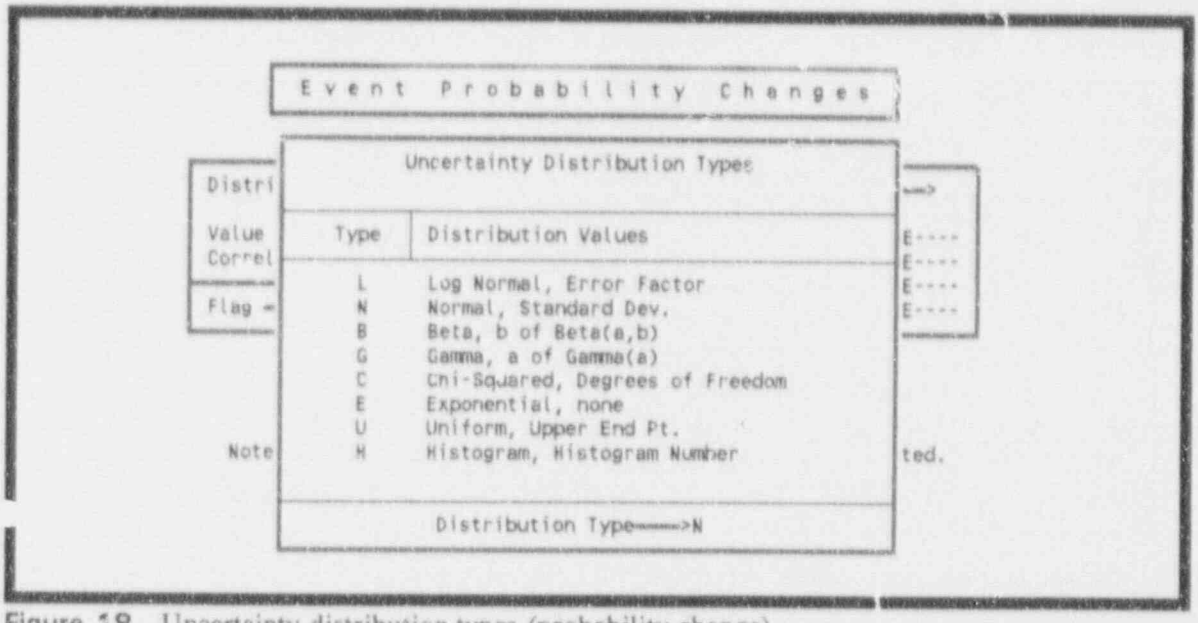


Figure 18. Uncertainty distribution types (probability change).

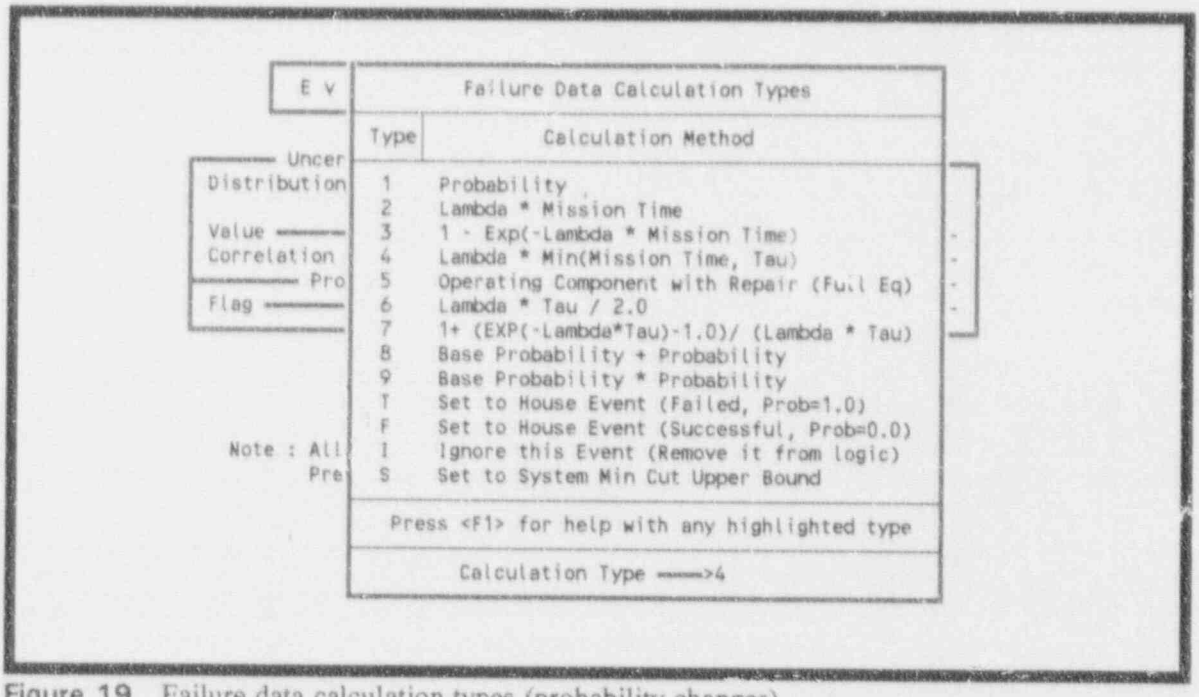


Figure 19. Failure data calculation types (probability changes).

The following symbols are used in the equations for calculating failure probability

P = failure probability of the basic event,
p = failure probability,
bp = base case failure probability,
L = failure rate per hour, input as lambda,
t_m = mission time expressed in hours, input as a default, and
T = average time to repair expressed in hours, input as tau.

An equation for each calculation type follows:

Calculation Type 1 P = p.

Calculation Type 2 $P = L * t_m$.

Calculation Type 3 $P = 1 - \text{Exp}(-L * t_m)$.

Calculation Type 4 $P = L * \text{Min}(t_m, T)$.

Calculation Type 5 $P = ([L * T] / [1 + \{L * T\}]) * (1 - \text{EXP}[-(L + 1 / T) * t_m])$.

Calculation Type 6 P = L * (T/2).

Calculation Type 7 P = 1 + (EXP[-L * T] - 1) / (L * T).

Calculation Type 8 P = bp + p.

Calculation Type 9 P = bp * p.

Calculation Type T P = 1.0 (House event - failed).

Calculation Type F P = 0.0 (house event - successful).

Calculation Type I P = 0.0 (ignore event).

Calculation Type S P = 0.0 (find a system with the same name and use its current mincut upperbound as the probability)

3.2.5.3 Reset Probability to Base. This option allows you to reset the probability changes (not class changes) for a selected event back to the base case values. You may reset probability changes for a single event, a group of events, or all events.

To reset the probability change for a single event, type an <R> (Reset probabilities) in the option field, highlight the desired event name and then press <Enter>. The message "**Reset HIGHLIGHTED probability change? (Y/N)**" is displayed at the bottom of the screen. To reset the probability back to the base case value enter <Y> for yes. To terminate the reset operation enter <N> for no.

To reset the probability changes for a group of events, mark the desired events using the F2 and/or F4 keys, type an <R> in the option field and press <Enter>. The message "**Reset ALL marked probability changes? (Y/N)**" is displayed at the bottom of the screen. Press <Y> to complete the reset operation, or <N> to terminate the reset operation.

To reset all event probabilities to the base case values, clear all existing marks with the F3 key, type an <R> in the option field and press <Enter>. The message "**Reset ALL probability changes? (Y/N)**" is displayed at the bottom of the screen. Press <Y> to perform the reset operation, or <N> to terminate the reset operation.

3.2.6 Class

This option allows you to change event data parameters for a specified grouping of events. To invoke this option, enter a <C> in the option field, highlight the desired change set, and press <Enter>. If you do not highlight a change set before pressing <Enter>, the message **An event change must be highlighted** will be displayed at the bottom of the screen. The screen display for this option is shown in Figure 20. All data fields in the four data areas are data entry fields. The event class is defined by entering data in the Event Attributes data fields. The more of these fields that are filled in the finer the class definition becomes.

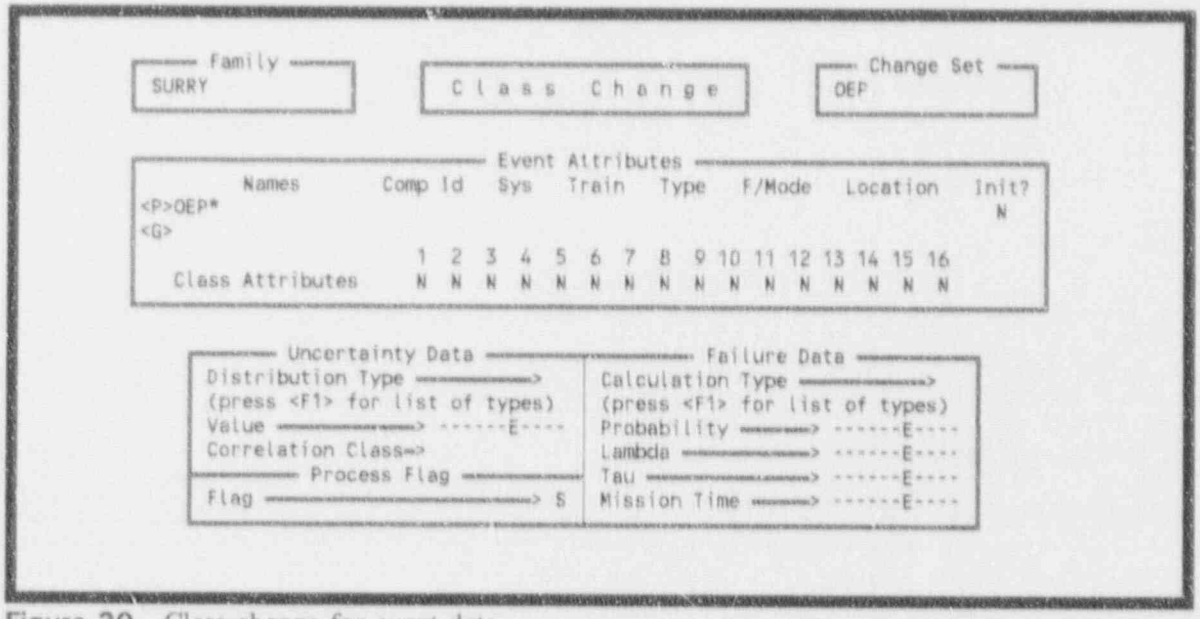


Figure 20. Class change for event data.

The class changes that you request are reflected on the Select Event display by showing a "C" to the left of the affected events (Figure 21) Probability changes have a higher priority than class changes. When both are applied to an event, the probability change will be used during event tree analysis. This is indicated by flagging the affected events with a "P" and "c" as shown in Figure 21.

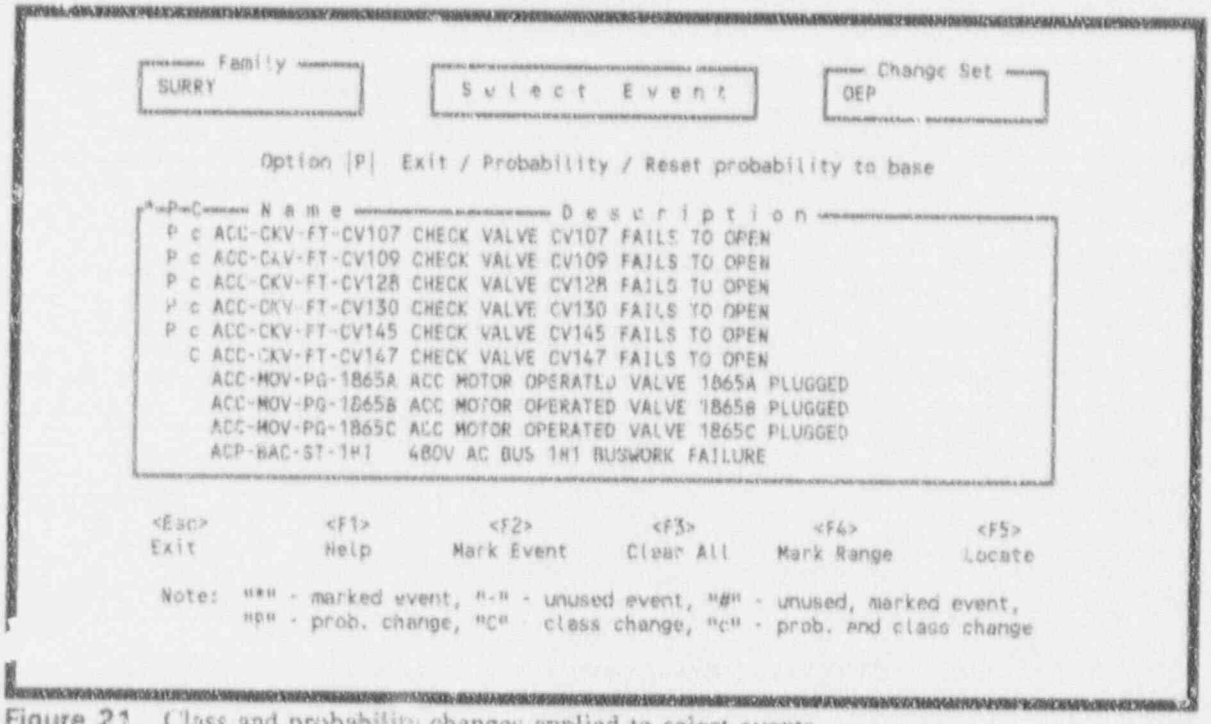


Figure 21. Class and probability changes applied to select events.

On the Class Change display, help screens are supplied for all data entry fields. Pressing <F1> when the cursor is in any data entry field will cause a help screen to be displayed. Figure 22 and Figure 23 show the help screens for Distribution Type and Calculation Type, respectively. Most of the help forms in this situation contain a data entry field at the bottom of the display. This field may be used to enter the desired data value, which will then be transferred into the proper data field upon exiting the help screen. Highlighting an item in the help form list will set the correct value in the data entry field.

3.2.7 Histograms

This option allows you to create, modify, and delete user-defined histograms. This is a useful option for allowing you to input your own uncertainty distribution for a variable that can not be expressed with one of the predefined distribution types. The Edit Histograms screen (Figure 24) displays the names of all currently existing histograms. A unique number is associated with each histogram and is listed on the Edit Histograms screen to the left of the histogram name. The format type is also provided. There are two format types: percentage format and range format. If the histogram was entered in a percent format, a "P" will be displayed in the type field. If the histogram was entered in a range format, an "R" will appear in the type field. To activate this option, type an <H> (Histograms) in the option field of the Change Sets screen and press <Enter>. Figure 24 will be displayed.

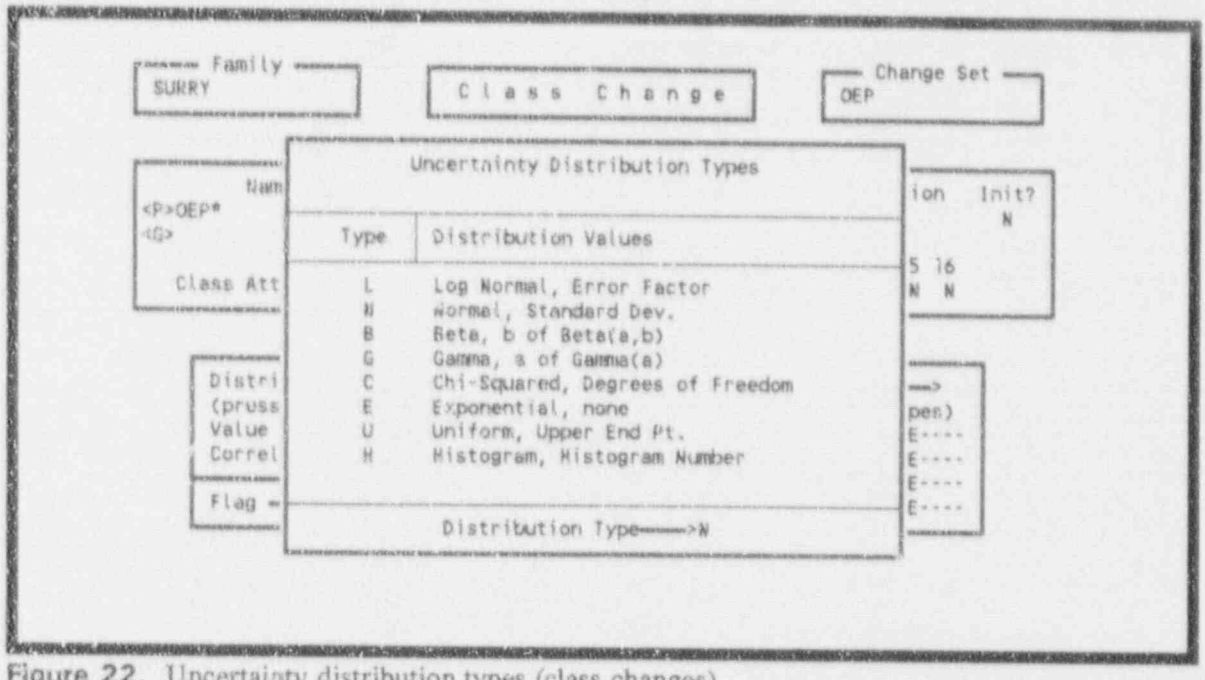


Figure 22. Uncertainty distribution types (class changes).

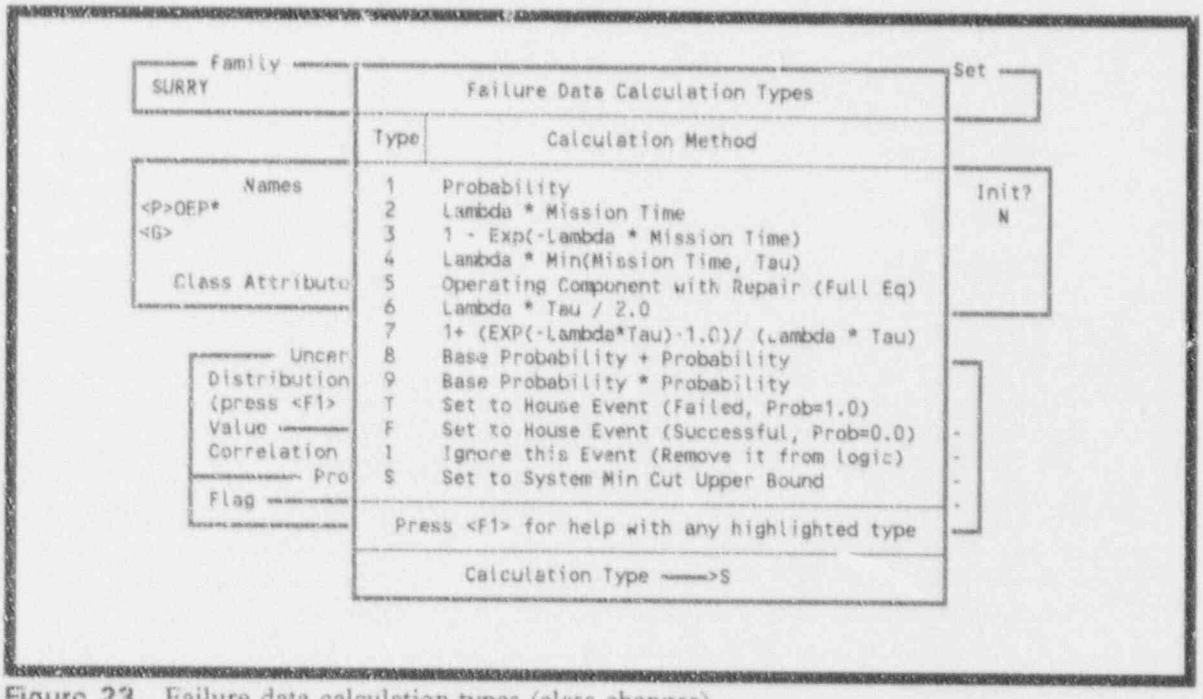


Figure 23. Failure data calculation types (class changes).

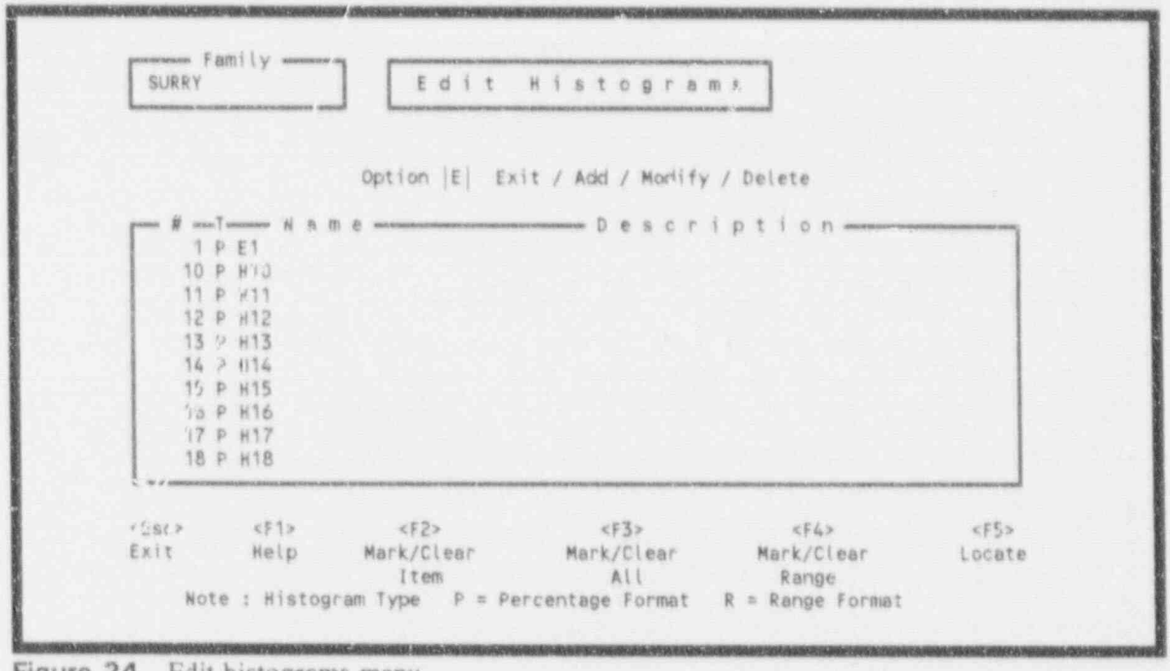


Figure 24. Edit histograms menu.

3.2.7.1 Exit. To return to the Change Sets screen, type an <E> (Exit) in the option field and press <Enter>, or press the <Esc> key.

3.2.7.2 Add Histograms. This option allows you to create a user-defined distribution type. To add a new histogram to the data base, type an <A> (Add) in the option field and press <Enter>. At this point, Figure 25 is displayed and you are given the choice of adding the histogram data in either a percentage format or in a range format.

If you wish to add a percentage histogram to the data base, enter a <P> (Percentage) in the option field. Entering a <P> in the option field will cause a Percentage Format Histogram screen to appear. On this screen you should type in a name and a description for the new histogram. Enter the percentages for the histogram along with the corresponding probabilities. Figure 26 demonstrates how to enter a percentage histogram, given that 15% of the data points have a probability of 0.04, 46% of the data points have a probability of 0.12, 36% of the data points have a probability of 0.02, and the remaining 3% of the data points have a probability of 0.8. The sum of the percentages entered must total 100% in order for the histogram to be accepted as a valid percentage histogram (Figure 27). In the upper right-hand area of the screen is a box that shows the current sum of the percentages that have been input and the remaining percentage needed to reach the 100% total.

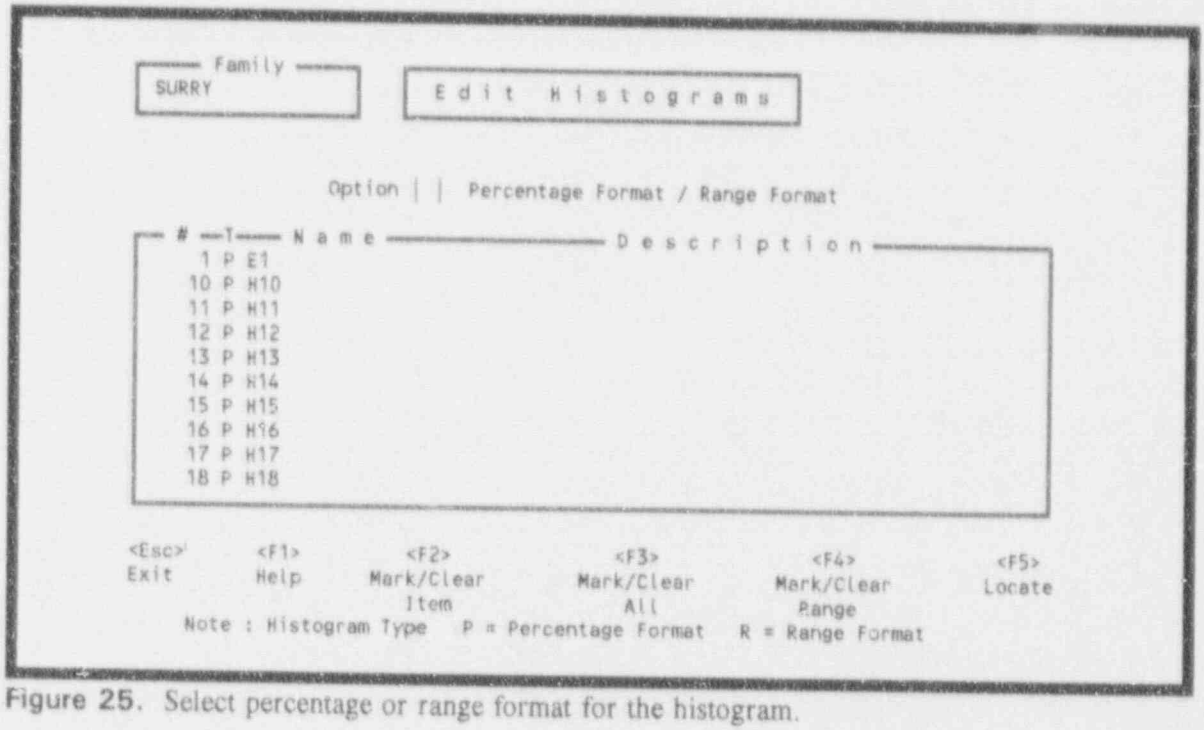


Figure 25. Select percentage or range format for the histogram.

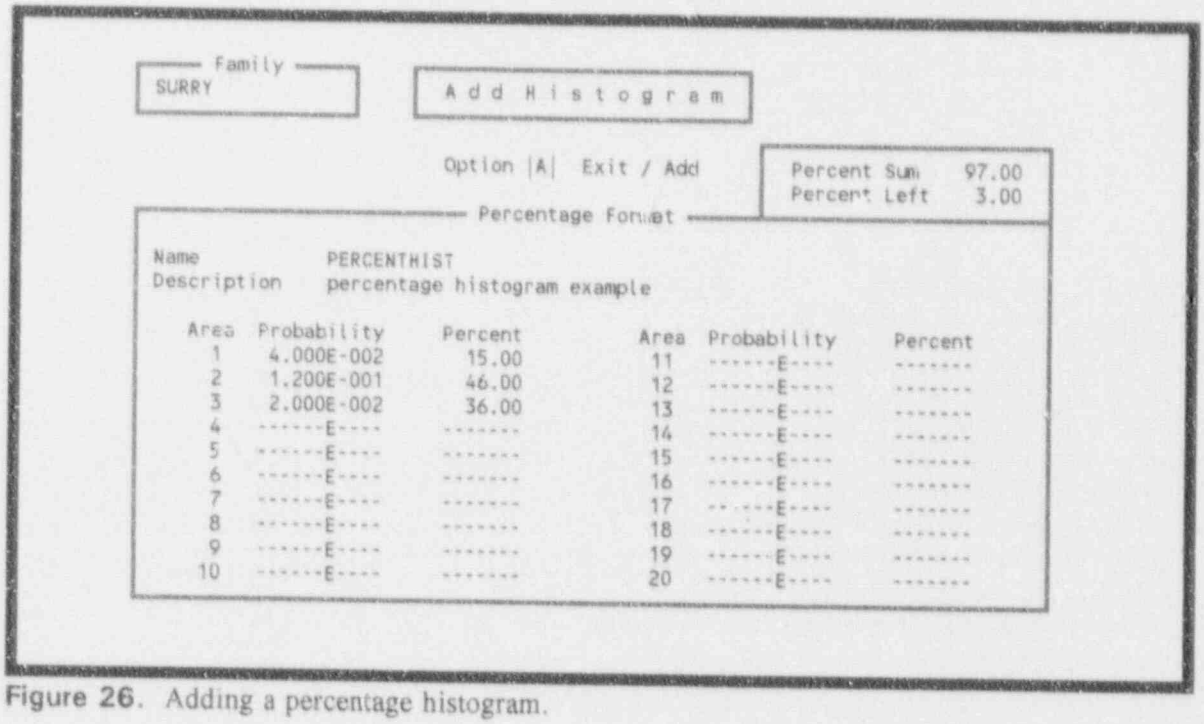


Figure 26. Adding a percentage histogram.

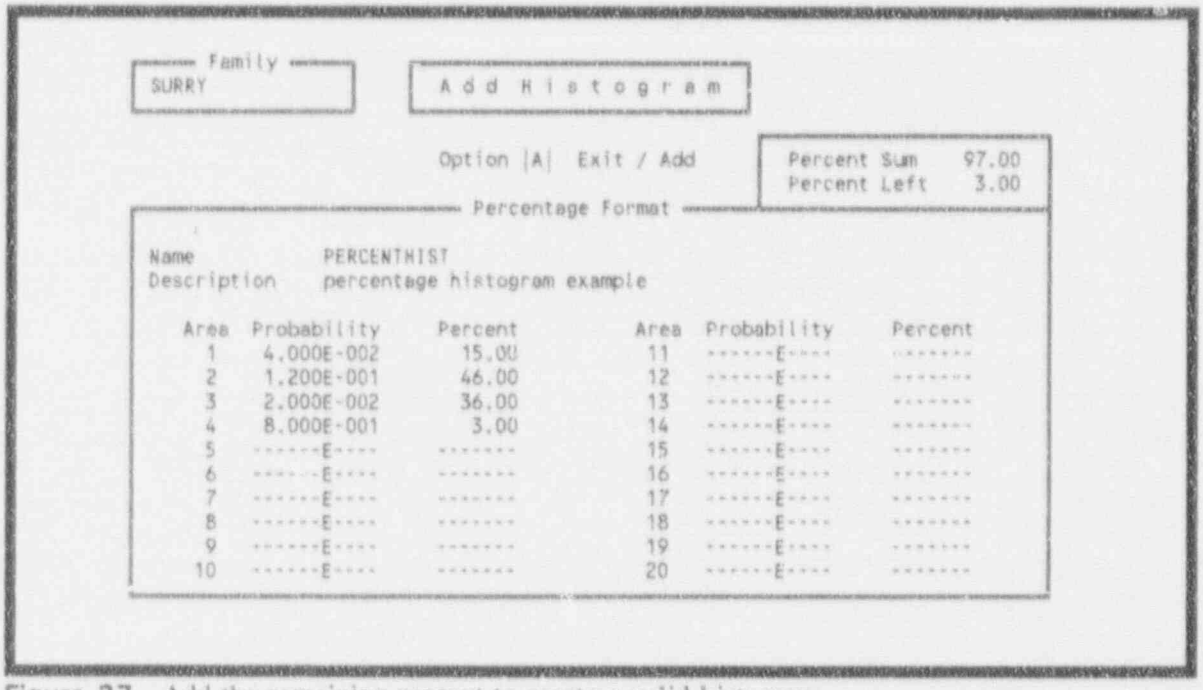


Figure 27. Add the remaining percent to create a valid histogram.

Another way to input a histogram is to use the range format. To add a range histogram to the data base, enter an <R> (Range) in the option field of the Add Histograms screen. This will bring up a Range Format Histogram screen (Figure 28). On this screen, type in a name and a description for the range histogram. Then, enter the starting probability point, the ending probability point, and the height associated with the first bin of the histogram. Next, for each successive bin of the histogram, an ending probability point and a height should be entered. There is a maximum of 20 bins allowed for each range histogram. Figure 28 is an example of inputting a range histogram whose data points lie on the closed interval of 0.0 and 1.0. The height associated with the data points on the sub-interval of 0.0 to 0.2 is 10.0 (Bin 1), the height for the sub-interval of 0.2 to 0.6 is 70.0 (Bin 2), the height for the sub-interval of 0.6 to 0.8 is 20.0 (Bin 3), and the height for the last sub-interval of 0.8 to 1.0 is 5.0 (Bin 4).

The code calculates the midpoint of each bin, finds the area of each bin, and normalizes each area so the sum of the areas equals 1.0. The midpoint is the probability for each bin and the normalized area corresponds to the percent in the Percent Histogram format. The basic event mean probability should correspond to the mean of the histogram.

Once you have typed in the histogram data, enter an <A> in the option field and press <Enter> to save the newly created histogram. However, if you wish to exit the Add process without saving the new histogram, enter an <E> in the option field and press <Enter>, or press the <Esc> key.

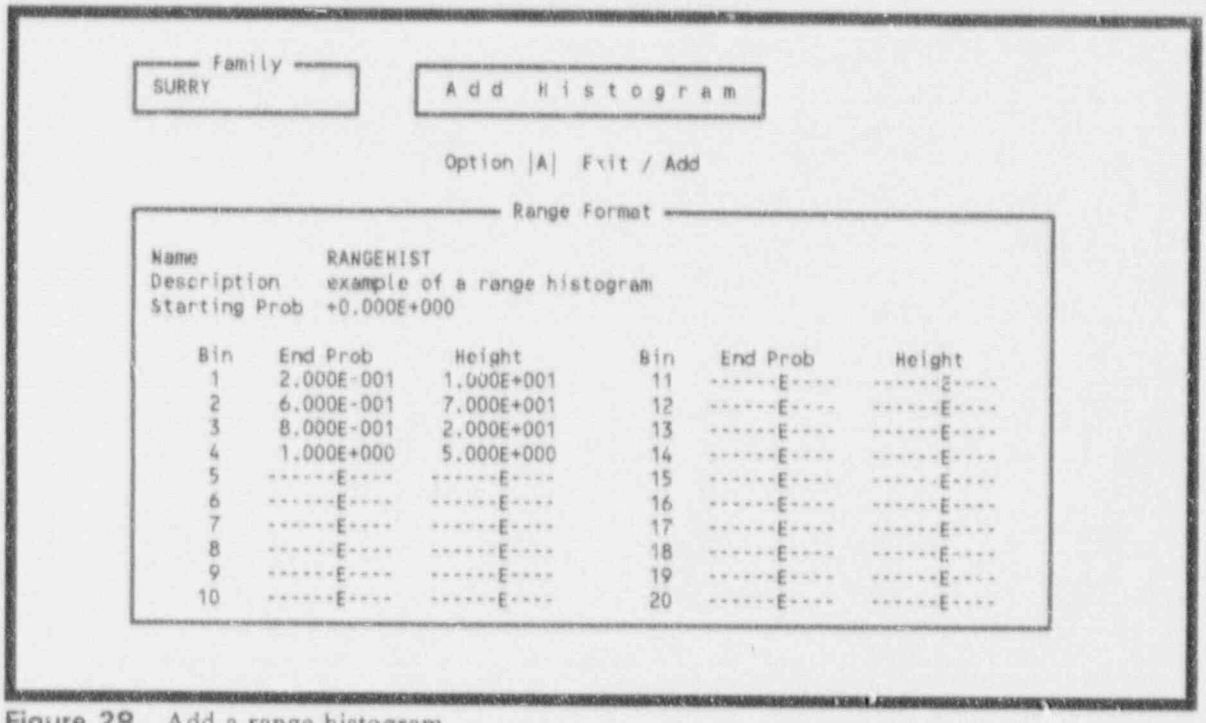


Figure 28. Add a range histogram.

3.2.7.3 Modify Histograms. To modify a currently existing histogram, type an <M> (Modify) in the option field of the Edit Histograms screen, highlight the desired histogram, and press <Enter>.

If you selected to modify a percentage histogram, then the histogram data will be displayed in percentage format. You may make modifications to the histogram's name, description, or any of the probabilities or percentages. Remember, the percentages must total 100% before it will be accepted as a valid percentage histogram. Figure 29 demonstrates the screen for modifying histograms in percentage format.

If you selected to modify a range histogram, then the histogram data will be displayed in range format. You may change the histogram's name, description, and any of the bin's starting points, ending points, or probabilities. Figure 30 demonstrates the screen for modifying histograms in range format.

If you wish to save the modifications made to the selected histogram, type an <M> (Modify) in the option field of the Modify Histograms screen and press <Enter>. If you wish to exit this screen without modifying the histogram, enter an <E> in the option field and press <Enter>, or press the <Esc> key.

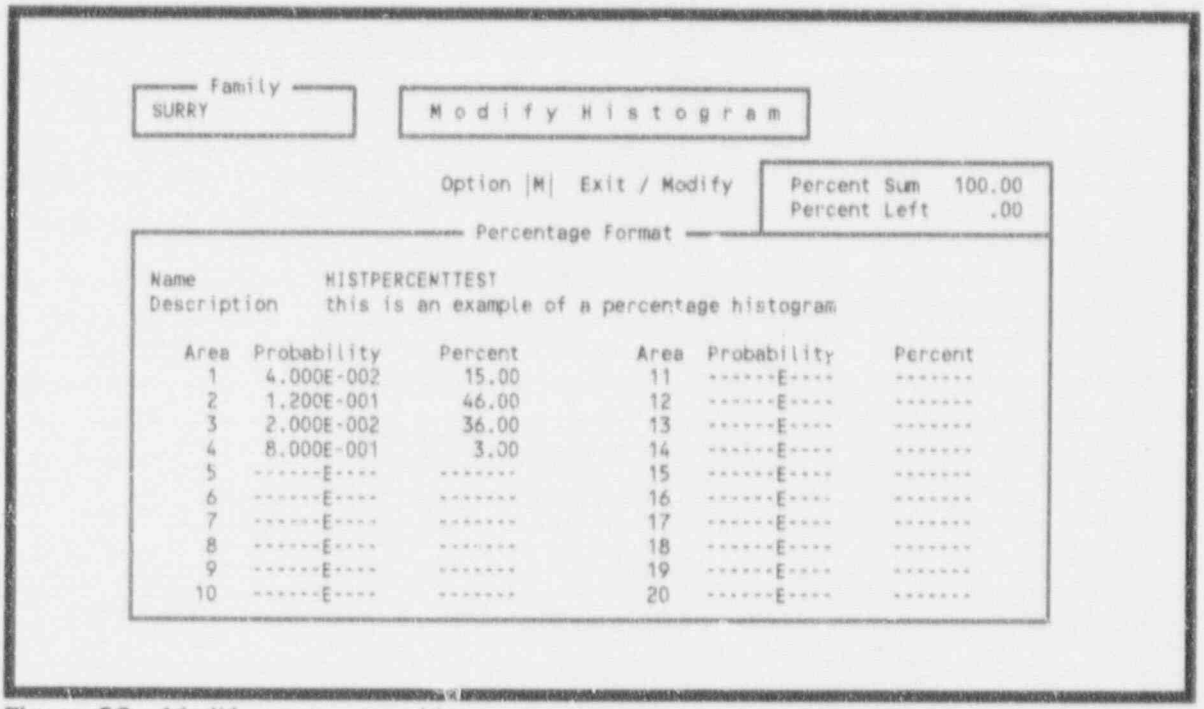


Figure 29. Modify a percentage histogram.

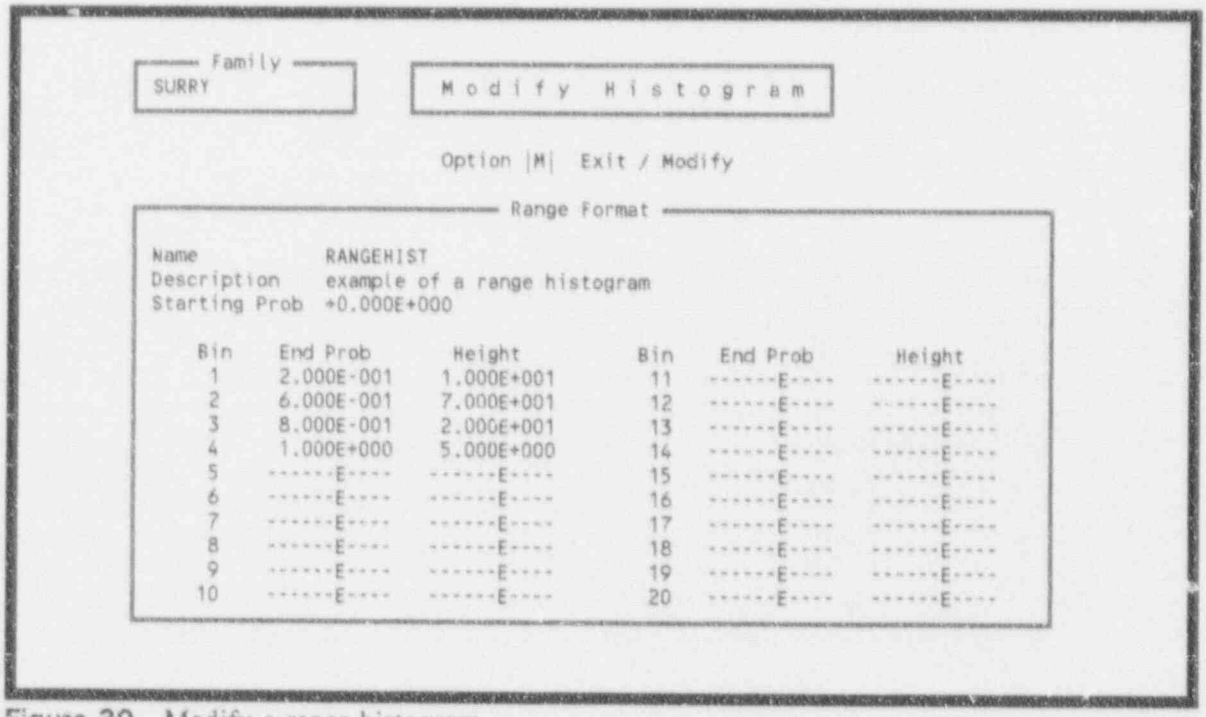


Figure 30. Modify a range histogram.

3.2.7.4 Delete Histograms. To delete an existing histogram from the data base, type a <D> (Delete) in the option field of the Edit Histograms screen, highlight the histogram to be deleted, and press <Enter>.

This action will result in displaying the selected histogram in the appropriate format on the Delete Histograms screen. To delete the histogram, type a <D> (Delete) in the option field and press <Enter>. To exit the Delete Histograms screen without deleting the histogram, press the <Esc> key or enter an <E> (Exit) in the option field and press <Enter>. Figure 31 and Figure 32 show examples of the Delete Histograms screen for percentage histograms and range histograms, respectively.

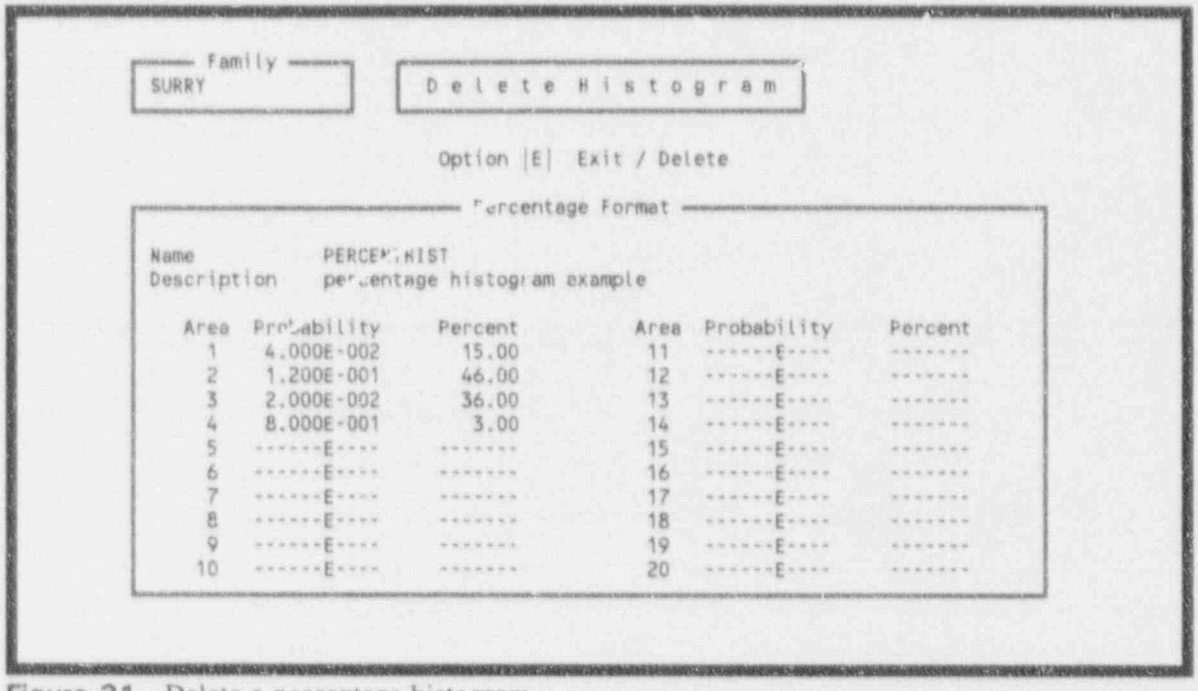


Figure 31. Delete a percentage histogram.

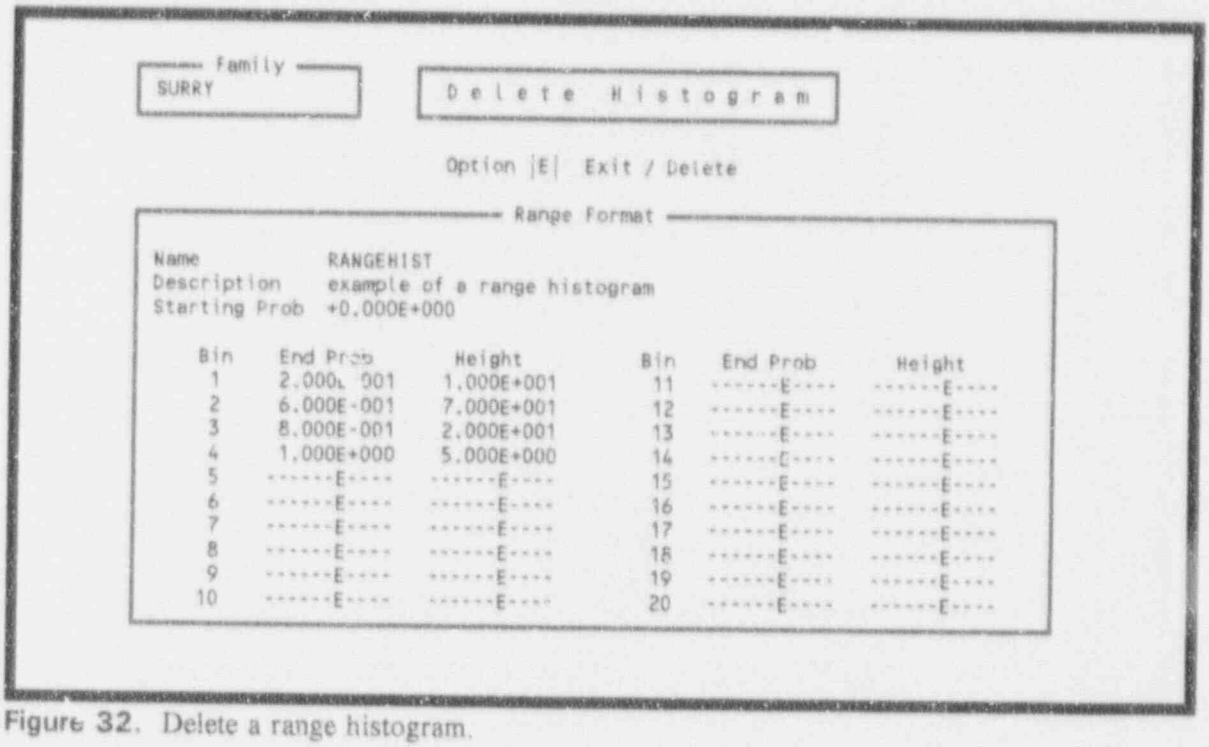


Figure 32. Delete a range histogram.

3.2.8 Generate Changes

This option applies the event data modifications specified by the selected change sets to the basic event data file. This option must be executed prior to any data analysis if you wish the change set modifications to be reflected in the analysis results. The Generate Changes option creates new current event data, which is used when a user wishes to run an uncertainty analysis on a selected sequence.

To activate this function, type <G> (Generate Changes) in the option field, use the function key <F2> to mark the change sets to be used during the generation process, and then press <Enter>. Upon pressing <Enter>, the default mission time and propagate event failure flag are displayed at the bottom of the screen (Figure 33). If you do not wish to change the mission time, press <Enter>. **New event data has been generated with changes** is displayed when the changes are successfully generated. If no changes were made, the message **New event data has been generated (no changes)** is displayed at the bottom of the Change Sets screen.

If the propagate event failure flag is set to 'Y' and if an event is failed (i.e., set to house event "T"), then any event with the same "system" and train attribute is set to "T" also. Any event with the same group name is also set to "T." This is a repetitive process. That is, if an event is set to house event "T" because it matches the system and train, any event in the same group will be set to house event "T."

This option transfers the temporary values for the basic events marked with either a probability change or a class change in the marked change set to the current event data values. If an event in the change set has both a class change and a probability change associated with it, the probability change

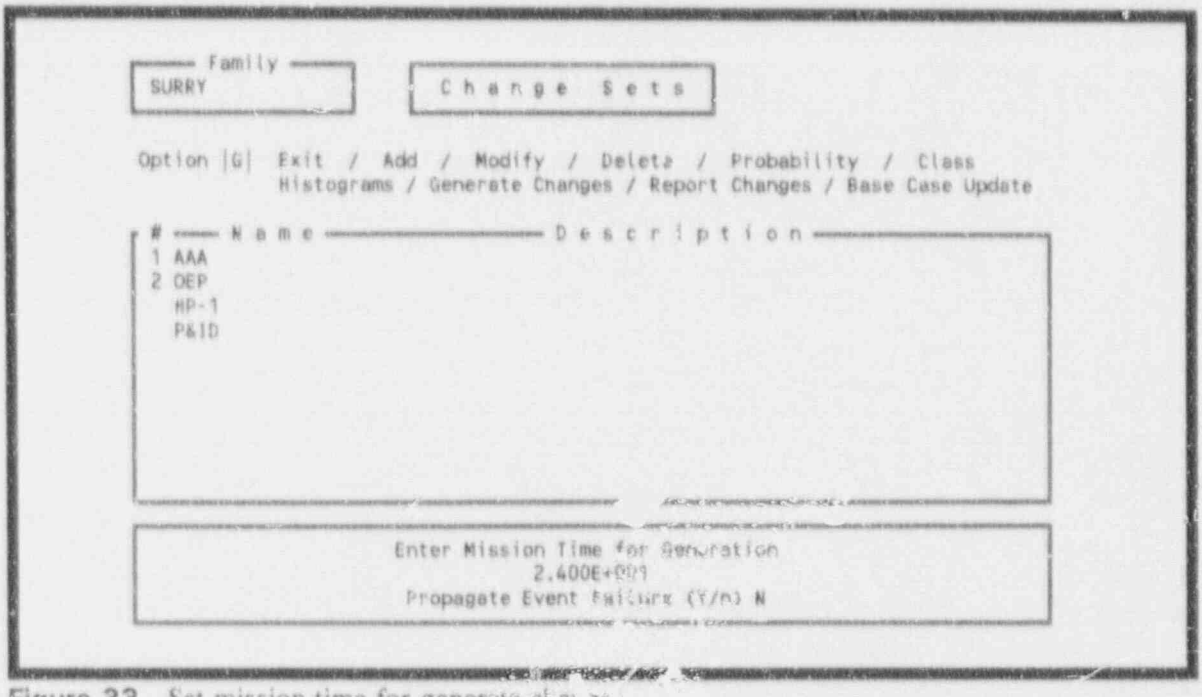


Figure 33. Set mission time for generate changes.

takes precedence over the class change when generating new current case event data values. If the event does not have an associated probability change or class change, then the current case event data values will be set equal to the base case data for the event.

If you select the Generate Changes option without marking any of the change sets, then the current case data will be initialized to the base case data.

If more than one change set is marked when you enter the Generate Changes option, then the probability and class changes in the change sets marked with the highest number will take precedence over any changes from lower numbered change sets.

For example, three change sets (CS) are marked and Event A has both a probability change and a class change associated with it in CS 2. Event B has a probability change in CS 1, and a class change in CS 3. Event C has only a class change in CS 1. Event D has no probability changes or class changes associated with it in any of the three marked change sets. The outcome of the Generate Changes option on these three marked change sets would be as follows:

The current case data for event A would be set to the temporary values associated with the probability change in CS 2. (Probability changes take precedence over class changes when they occur for the same event within the same change set.)

The current case data for event B would be set equal to the temporary values associated with the class change in CS 3. (The probability or class change in higher numbered change sets take precedence over changes in lower numbered change sets.)

The current case data for event C would be set to the temporary values associated with the class

change in CS 1.

The current case data for event D would be set to the base case values for event D. (There were no probability changes or class changes made to event D in any of the marked change sets.)

3.2.9 Report Changes

This option allows you to create reports that reflect the event modifications that currently exist within the data base. There are three report types: Unaffected Events, Affected Events, and All Events (see Figure 34). Each of the report types may be sorted by event name, ascending probability, or change sets. In addition, a report may be routed to the console, an attached printer, or a disk file. When a report is routed to the printer or a disk file, the data will be echoed on the console.

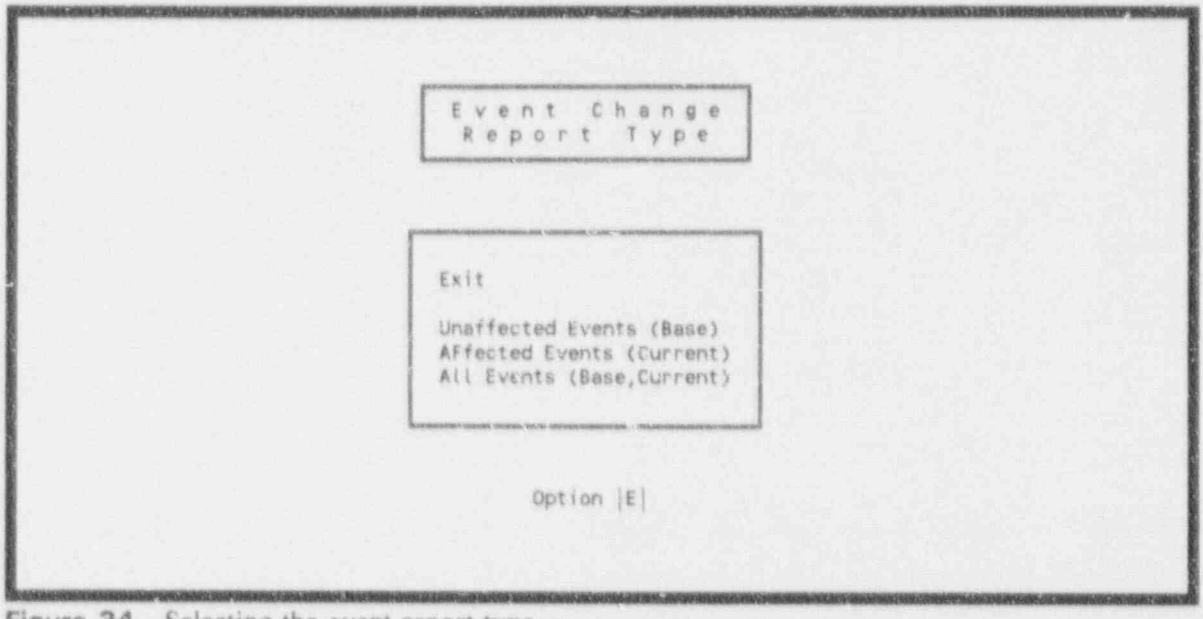


Figure 34. Selecting the event report type.

3.2.9.1 Exit. This option returns you to the Change Sets screen. To invoke the option, type <E> in the option field and press <Enter>, or press <Esc>.

3.2.9.2 Unaffected Events (Base). This option allows you to generate a report of the events that are not affected by any of the change sets that currently exist in the data base. To invoke this option, type <U> in the option field and press <Enter>. The sort selection menu will be displayed, allowing you to sort the data by event name, ascending probability, or change set (see Figure 35).

After the sorting method has been selected, you are asked to specify the routing of the report (Figure 36).

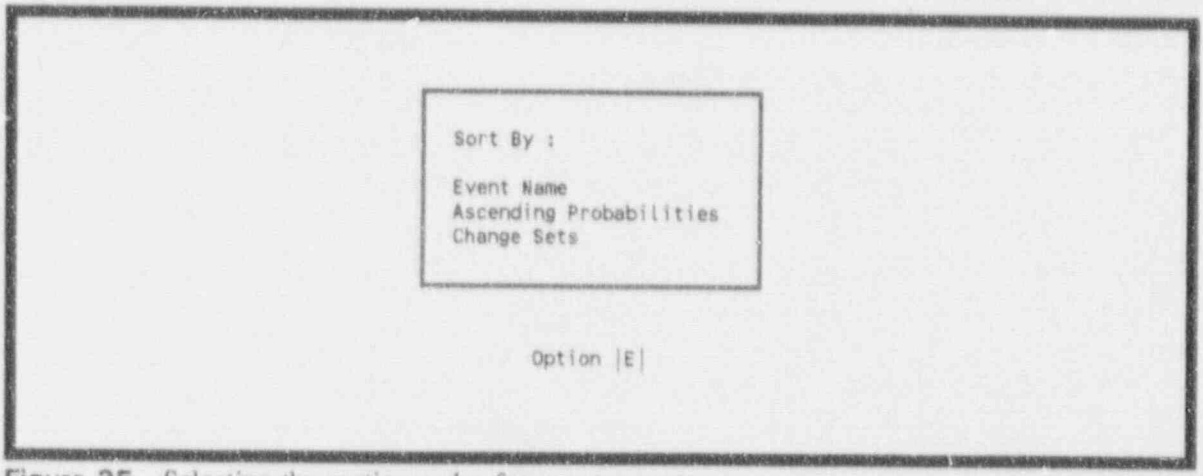


Figure 35. Selecting the sorting order for event reports.

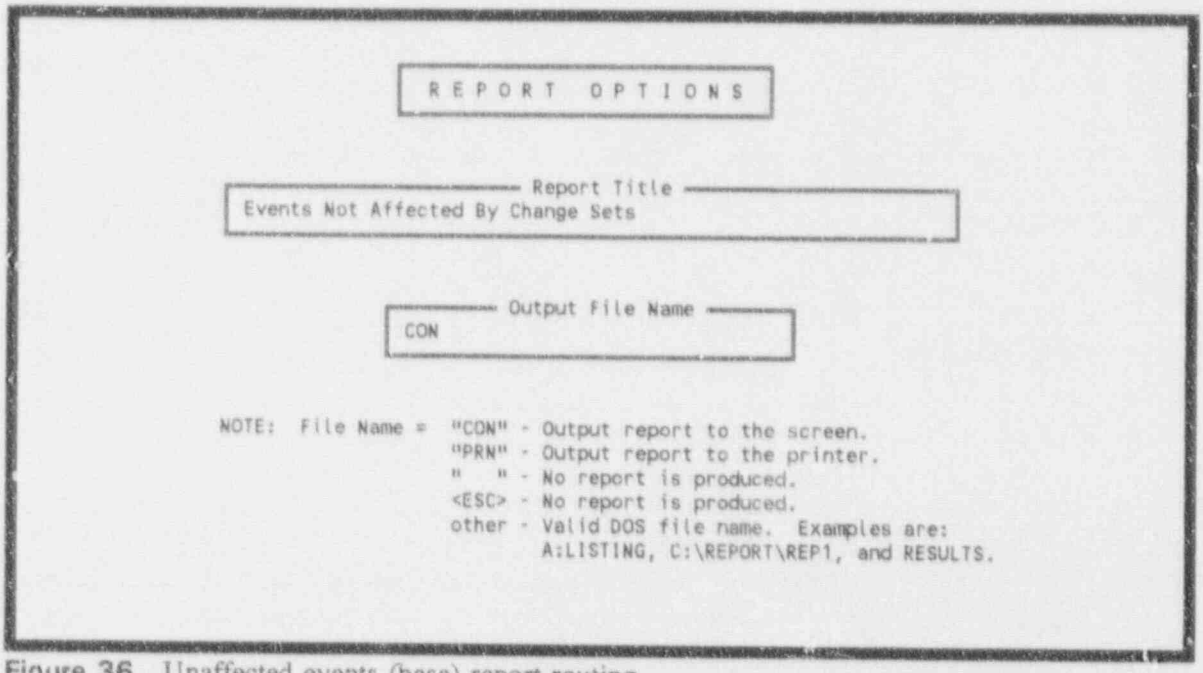


Figure 36. Unaffected events (base) report routing.

3.2.9.3 AFfected Events (Current). This option allows you to generate a report of the events that are affected by the change sets that currently exist in the data base. To invoke the option, type <F> in the option field and press <Enter>. The sort selection menu will be presented allowing you to sort the data by event name, ascending probability, or change set (Figure 35).

After the sorting method has been selected, you are asked to specify the routing of the report (see Figure 36).

3.2.9.4 All Events (Base, Current). This option allows you to generate a report of all of the events in the data base. The report will indicate the events affected by a change set. To invoke the option, type <A> in the option field and press <Enter>. The sort selection menu will be presented allowing you to sort the data by event name, ascending probability, or change set (Figure 35).

After the sorting method has been selected, you are asked to specify the routing of the report (see Figure 36).

3.2.10 Base Case Update

This option allows you to overwrite the base case data values stored in the data base with the current (temporary) data values for each basic event. After executing this option, the original base case data are no longer available.

To invoke this option, type <B> (Base Case Update) in the option field, mark the desired change set(s) and press <Enter>. A confirmation screen (Figure 37) will appear to ensure you wish to update the base case values with the temporary data values from the marked change set(s). To terminate the process type an <N> in the option field and press <Enter>. To initiate the update process, type a <Y> in the option field and press <Enter>. Upon pressing <Enter>, the default mission time is displayed at the bottom of the screen (Figure 38). If you do not wish to change the mission time press <Enter>.

WARNING: When you respond with a <Y> on the warning screen, you will overwrite the base case.

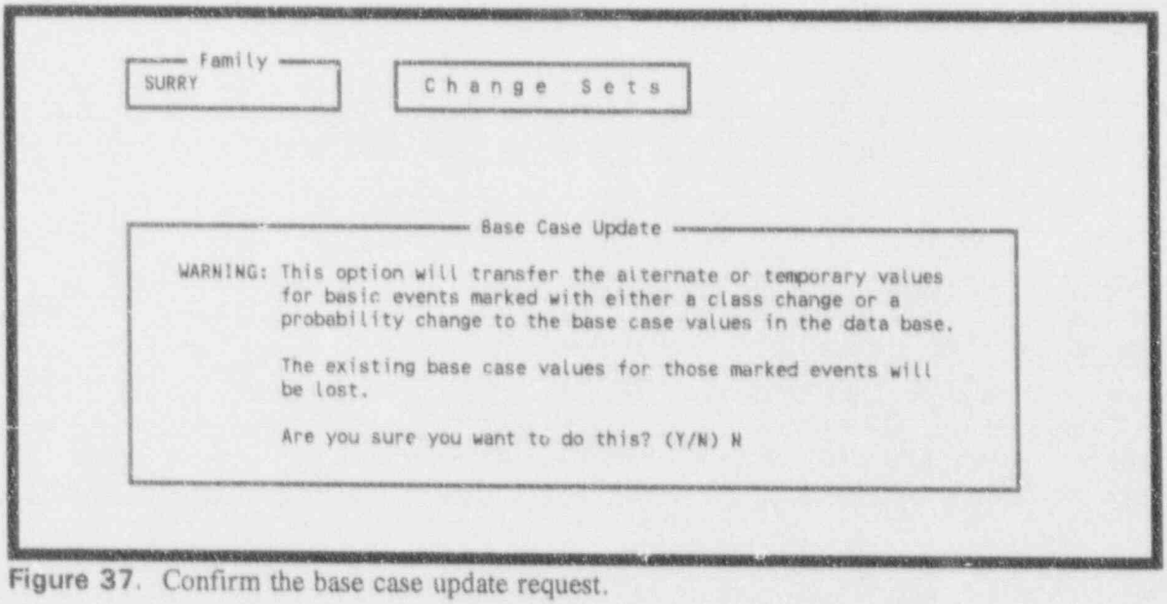


Figure 37. Confirm the base case update request.

In order to run a base case update at least one change set must be marked. This option transfers the temporary values for the basic events marked with either a probability change or a class change in a change set to the base case values. The existing base case values will be lost. Any event in the change set that does not have either a class change or a probability change associated with it will maintain its existing base case data. Upon completion of the base case update, the message **Base case events have been updated with changed values** will appear at the bottom of the screen.

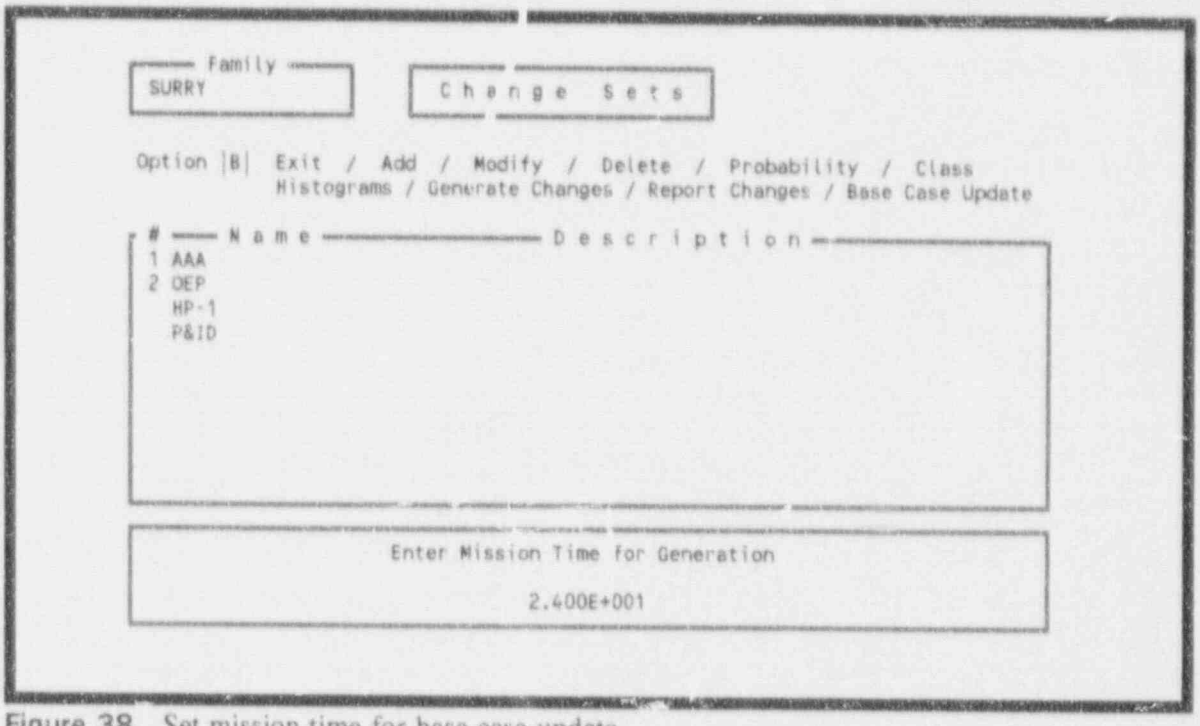


Figure 38. Set mission time for base case update.

If an event in a marked change set has both a class change and a probability change associated with it, the probability change takes precedence and will be used to update the base case values.

If more than one change set has been marked and is being used in the base case update, then the probability and class changes in the highest numbered change set take precedence over changes from lower numbered change sets. For example, if Event A has a probability change associated with it in Change Set 1, and a class change associated with it in Change Set 2, then the class change from Change Set 2 would override the probability change from Change Set 1.

3.3 Analyze Systems

This option provides the means to recalculate system values after events and/or cut sets have been modified. To invoke the option, highlight Analyze Systems or type <A> in the option field, and press <Enter>. Figure 39 shows the main screen for system analysis function and lists the systems defined for the current family. The letters c, q, and u (in any combination) may precede a system name and are defined as follows:

c - flags the system as having cut sets that must be recalculated
q - flags the system as having cut sets that must be requantified
u - flags the system as needing uncertainty distributions recalculated

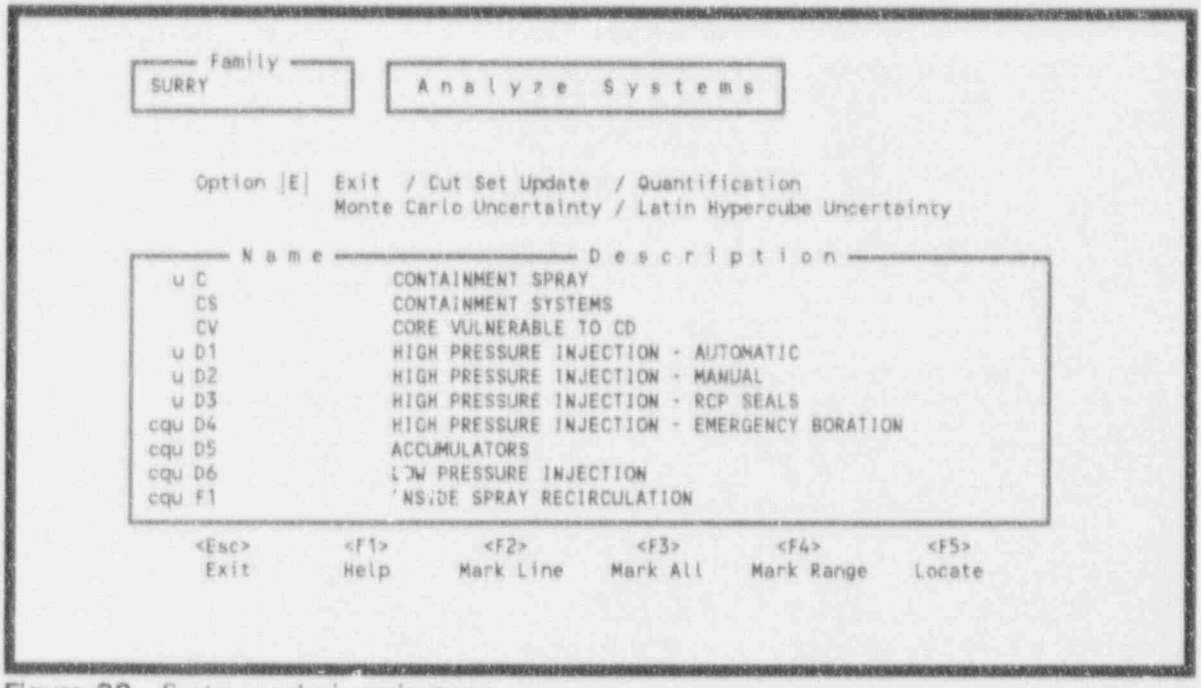


Figure 39. System analysis main menu.

Once these functions have been executed the corresponding letter is removed from the display. The options available from the Analyze Systems screen are Exit, Cut Set Update, Quantification, Monte Carlo Uncertainty and Latin Hypercube Uncertainty.

3.3.1 Exit

To return to the System Analysis menu, type an <E> in option field and press <Enter>, or press the <Esc> key.

3.3.2 Cut Set Update

This option will update the alternate cut sets for a selected system based on cut set generation cutoff values. You are given the opportunity to specify several cut set generation cutoff values that will be used to determine if a cut set is to be retained or discarded from the selected system. You are also given the choice of using either the base case cut sets or the alternate case cut sets as the starting set of cut sets to be updated. The updated version of the cut sets will be saved as the new alternate cut sets for the system.

You are given the ability to update the alternate cut sets for a selected system, the alternate cut sets for a group of systems, or the alternate cut sets for all of the systems within the current family. To invoke the Cut Set Update process for a single selected system, type <C> in the option field, highlight the desired system, and press <Enter>. To invoke this process for a group of systems, mark the desired systems using the function keys (F2, F3, or F4), type a <C> in the option field and press <Enter>. To invoke this option for all systems in the current family, clear all marked entries with the

F3 key, type <C> in the option field and press <Enter>. A message **Process all records? (Y/N)** will appear at the bottom of the screen. Type a <Y> to continue the Cut Set Update for all of the systems, or type an <N> to discontinue the update for all systems.

Whether you are updating alternate cut sets for a single system, a group of systems, or for all systems the Cut Set Generation Cutoff Values screen shown in Figure 40 will be displayed. You may change any of the data fields on this screen. The default values that appear on this screen may be reset to new values by selecting Utility Options on the main menu and then invoking Define Constants option (Section 8.2).

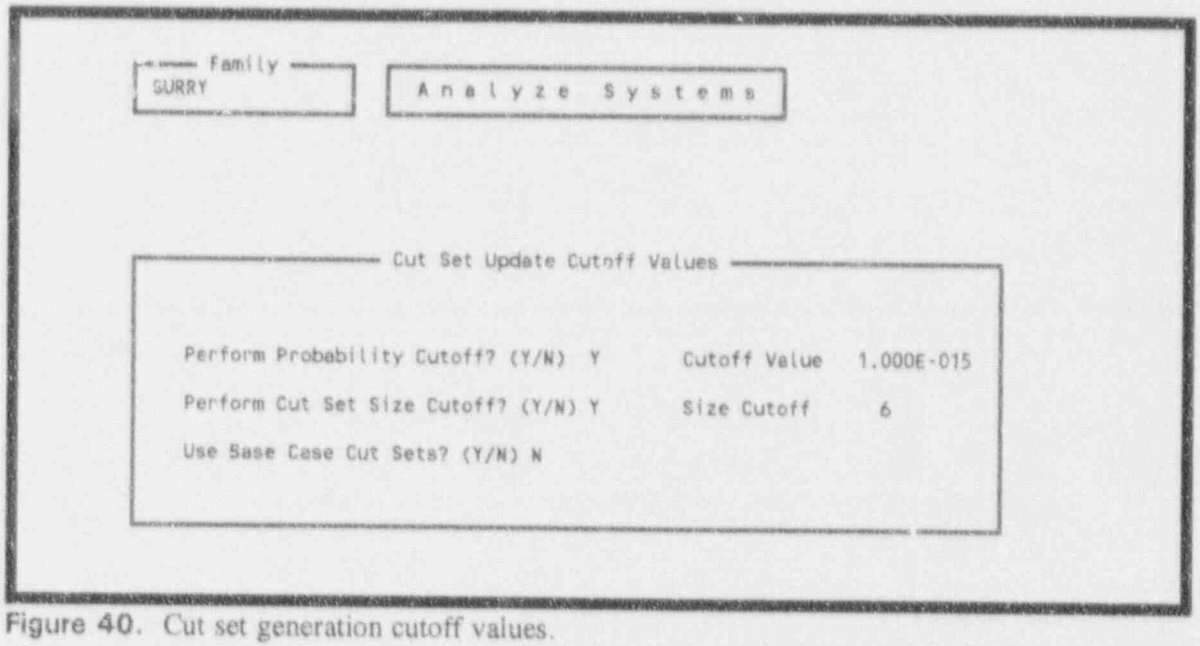


Figure 40. Cut set generation cutoff values.

If you type a <Y> in the Perform Probability Cutoff field, then only the cut sets whose product for all of its event probabilities is greater than or equal to the value in the Cutoff Value field will be kept. All other cut sets will be removed from alternate case cut sets for that system. If you type an <N> in this field, then the probability for the cut set will not be relevant for determining if the cut set should be retained or discarded.

If you type a <Y> in the Perform Cut Set Size Cutoff field, then only the cut sets whose number of events is less than or equal to the value in the Size Cutoff field will be kept in the alternate case cut sets for that system. All other cut sets will be removed. If you type an <N> in this field, then the number of events in a cut set is irrelevant for determining if the cut set should be retained or discarded.

If you enter a <Y> in the Use Base Case Cut Sets field, then the base case cut sets will be used as the cut sets to be updated and then stored in the alternate case cut sets. However, if an <N> was entered in this field, the alternate cut sets will be used as the cut sets to be updated and then resaved in the alternate case cut sets.

During processing the screen shown in Figure 41 is displayed and updated as the calculations proceed. Upon completion of the cut set update, the results are displayed as shown in Figure 42.

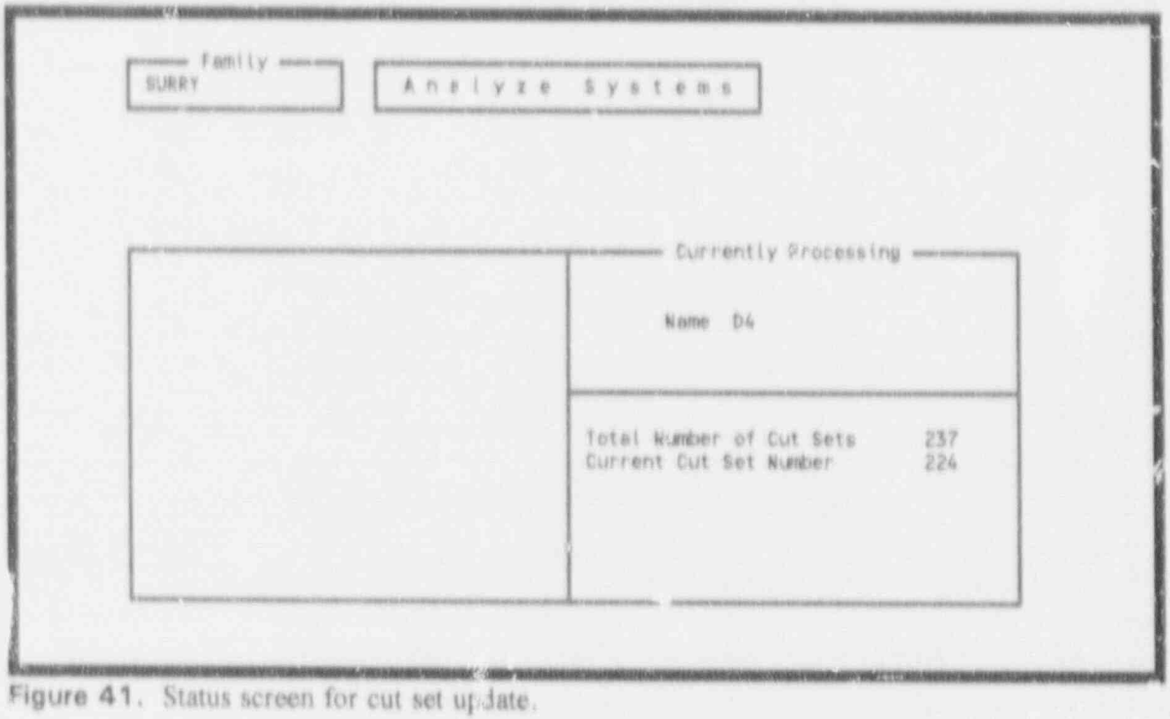


Figure 41. Status screen for cut set update.

The cut set update flag 'c' will then be removed from every system on the Analyze Systems screen in which the cut set update process has been performed. If an error of some kind occurs during the update process then the message **Error in Cut Set analysis** will be displayed at the bottom of the screen. Once the cut sets are updated, they are also automatically quantified and the appropriate "q" flag is cleared.

3.3.3 Quantification

The quantification process will calculate a new minimum cut set upper bound for the system cut sets using the current data values (event change sets and alternate case cut sets). The new minimum cut set upper bound is saved with the alternate case cut sets for the selected system.

You are given the ability to requantify the alternate cut sets for a selected system, for a group of systems, or for all of the systems within the current family. To invoke the Quantification process for a single selected system, type <Q> Quantification in the option field of the Analyze Systems screen, highlight the desired system, and press <Enter>. To invoke this procers for a group of systems, mark the desired systems using the function keys F2, F3, or F4, type a <Q> in the option field and press <Enter>. To invoke this option for all systems in the current family, type <Q> in the option field and press <Enter>. A message **Process all records (Y/N)?** will appear at the bottom of the screen. Type a <Y> to continue the Quantification process for all of the systems, or type an <N> to

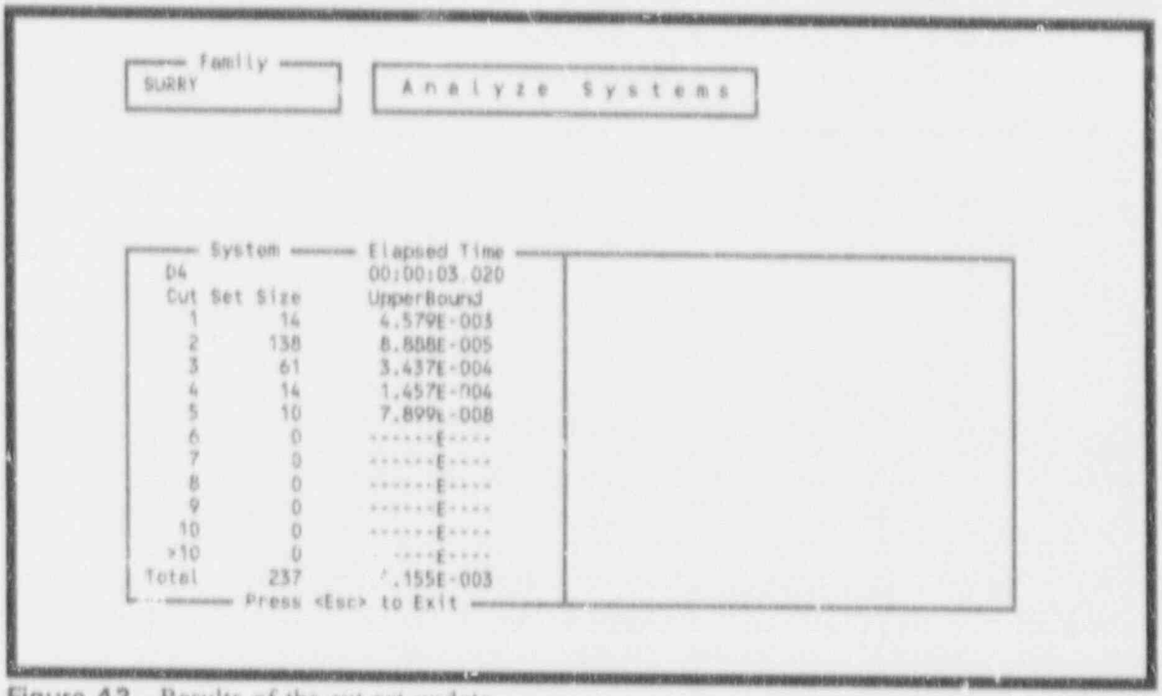


Figure 42. Results of the cut set update.

discontinue this process.

During processing, the message **Quantification in progress** appears at the bottom of the screen. If an error occurs then the message **Error quantifying cut sets** will be displayed at the bottom of the screen.

Upon completion of the quantification process, the results are displayed as shown in Figure 43. The requantify flag 'q' will then be removed from every system on the Analyze Systems screen for which the quantification process has been performed.

3.3.4 Uncertainty Analysis

This function allows you to run an uncertainty analysis on a system using one of the two sampling techniques provided. The two sampling techniques are the Monte Carlo simulation technique and the Latin Hypercube simulation technique.

To use the Monte Carlo sampling technique to obtain an uncertainty analysis for a system or a group of systems, you must type an <M> in the option field of the Analyze Systems screen and press <Enter>. However, if you wish to use the Latin Hypercube sampling technique, then type an <L> in the option field and press <Enter>.

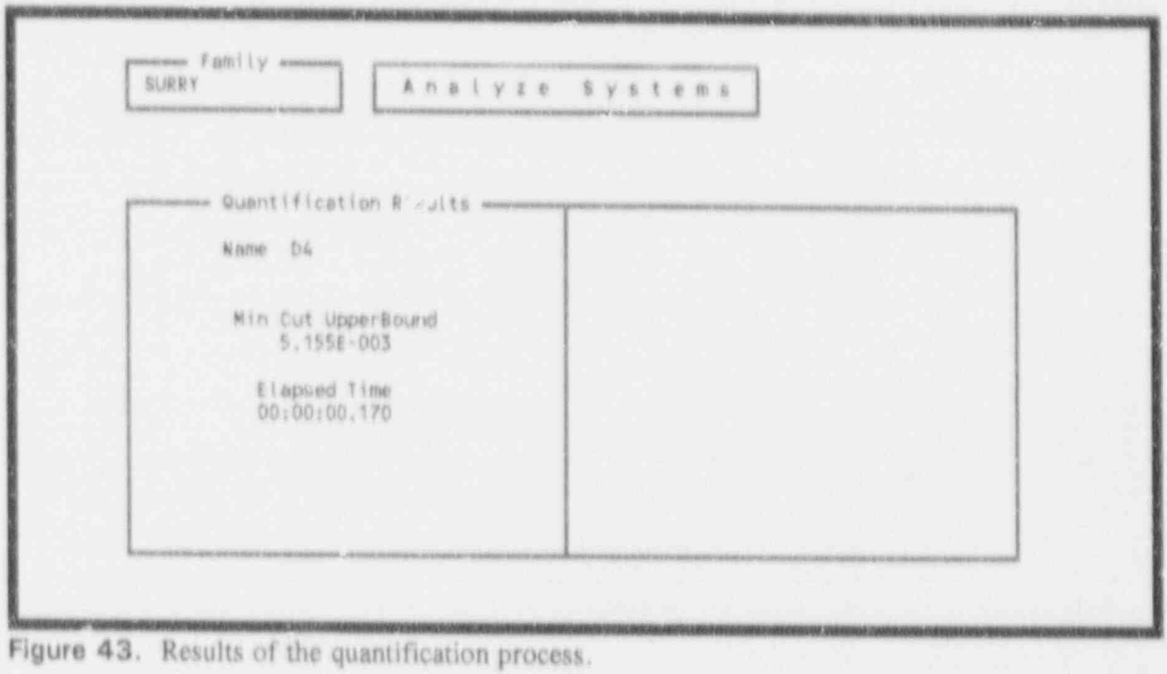


Figure 43. Results of the quantification process.

You are given the option of running an uncertainty analysis on the alternate cut sets for either a single system, for a group of systems, or for all of the systems within the current family. To invoke this process for a single selected system, type <L> or <M> (Latin Hypercube / Monte Carlo) in the option field, highlight the desired system, and press <Enter>. To invoke this process for a group of systems, mark the desired systems using <F2>, <F3>, and <F4>, type an <L> or <M> in the option field and press <Enter>. To invoke this process for all systems in the current family, type <L> or <M> in the option field and press <Enter>. A message **Process all records? (Y/N)** will appear at the bottom of the screen. Type a <Y> to continue the uncertainty analysis for all of the systems, or type an <N> to discontinue the analysis.

Once the sampling technique for the uncertainty analysis has been selected and the desired system(s) selected, the Uncertainty Calculation Values screen will be displayed (Figure 44 for Monte Carlo sampling and Figure 45 for Latin Hypercube sampling). This screen prompts the user to enter the number of samples to be generated during the simulation and the initial value of the seed for the random number generator. A default seed value may be provided for the random seed field. You may use this value or enter a new value for the seed. To obtain a random seed from the system clock, you must enter a zero in this field. A default value will be supplied in the field for the number of samples. You may use this value or enter another value. You may change the default values for both the number of samples and the random seed in the Utility Options, Define Constants suboption.

When using the Monte Carlo sampling technique for the uncertainty analysis, if the number of samples entered is less than ten, then the number of samples will be increased to ten before the uncertainty analysis process will continue. Any number of samples greater than or equal to ten will be allowed, but a number of at least 1000 is probably a better value for improving the reliability of the Monte Carlo results.

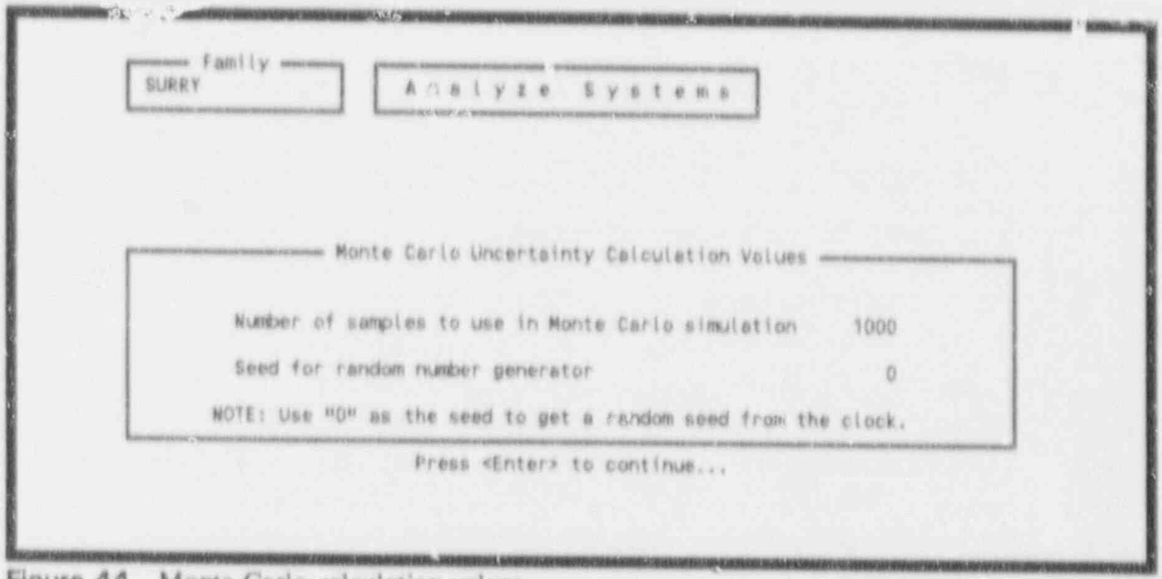


Figure 44. Monte Carlo calculation values.

When using the Latin Hypercube Sampling (LHS) technique, if the number of samples entered is less than twice the total number of unique events in the system, then the number of samples will be increased to two times the total number of unique events before the analysis will continue. The LHS technique gives its best results if the number of samples is at least twice the total number of unique events.

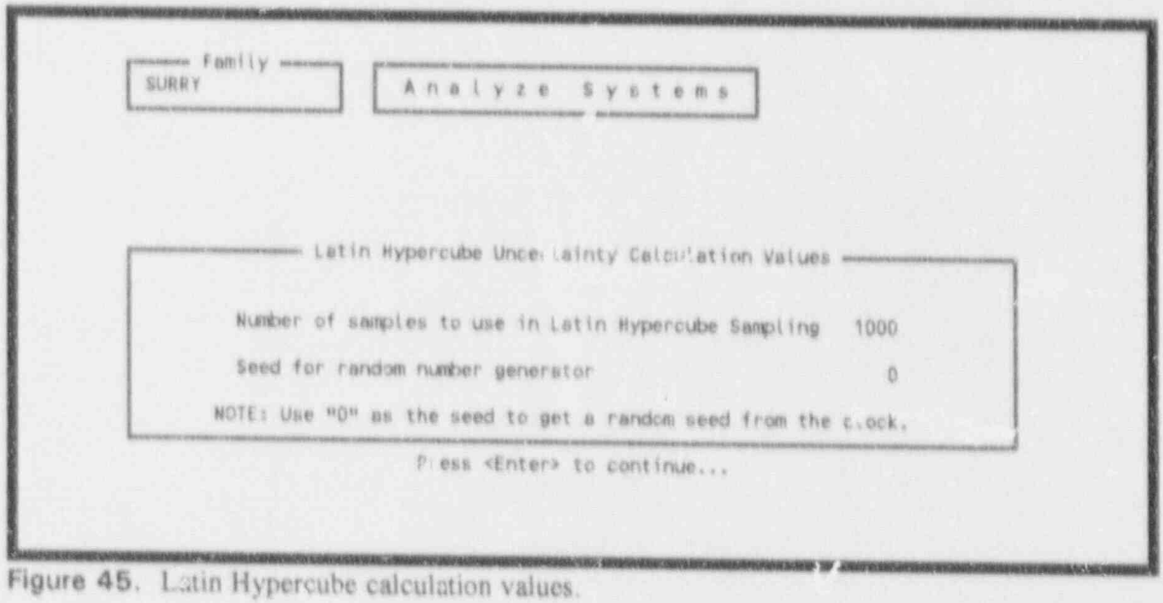


Figure 45. Latin Hypercube calculation values.

Once the number of samples has been accepted and a seed obtained from the system clock (if necessary), checks will be run to ensure the events with the same correlation classes have consistent failure data, uncertainty data, and distribution types. If any events with inconsistencies are found, an

error message will be displayed and the uncertainty analysis process will be terminated so that the inconsistent values may be corrected.

If an error of some type occurs during the uncertainty analysis process, the process is terminated and the message **Error in Uncertainty analysis** is displayed at the bottom of the Analyze Systems screen.

If all of the events successfully pass the correlation class checks, then the distribution parameters for the events will be checked to ensure that they are valid. If any of the parameters are invalid, error messages will be displayed and the process will be terminated so the distribution parameters may be corrected by the user.

After both of these checks have been passed, a point estimate will be calculated for the selected system. At this point the samples for each event will be generated using the selected sampling technique, either Monte Carlo Sampling technique or the Latin Hypercube Sampling technique. The uncertainty analysis function provides you with eight different distribution types for both of the two sampling techniques. The distributions types include normal, lognormal, beta, gamma, chi-squared, exponential, uniform and the user-defined histograms.

During processing the current status screen will be displayed and updated as the samples are generated. Figure 46 illustrates the current status screen for the Monte Carlo sampling technique. When the requested number of samples has been generated or the user has terminated the process of generating the samples by pressing the <Esc> key, statistical information will be calculated using the generated samples. A sample mean, median, and standard deviation will be calculated for the selected system. Coefficients of skewness and kurtosis, and quantile values will also be calculated for the system. This data will be saved in the database for the selected system.

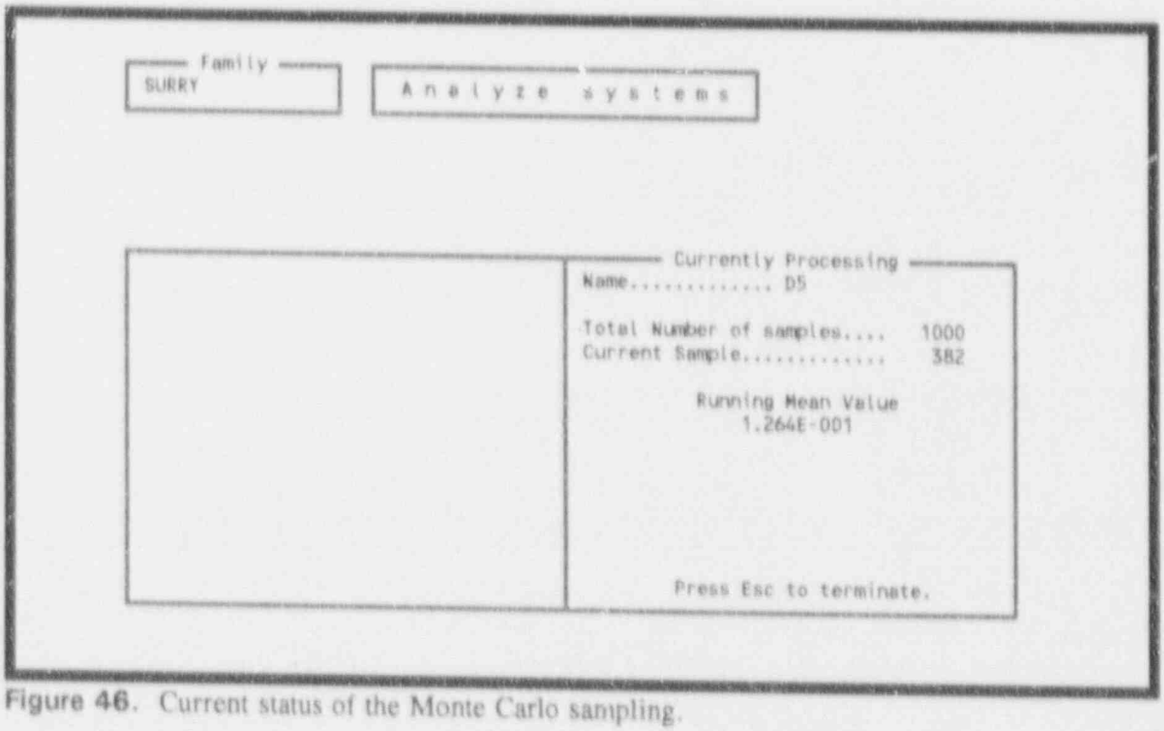


Figure 46. Current status of the Monte Carlo sampling.

Upon completion of these calculations, the following values will be displayed on the Uncertainty Results screen for viewing: the system name, random seed used, the number of samples generated in this process, the total number of events and cut sets in the system being processed, the point estimate, the mean, the median, the 5th and 95th percentile values, the minimum and maximum generated sample values, the standard deviation, the skewness and kurtosis, and the time involved to perform the analysis. Figure 47 illustrates the Uncertainty Results screen for the Monte Carlo sampling technique.

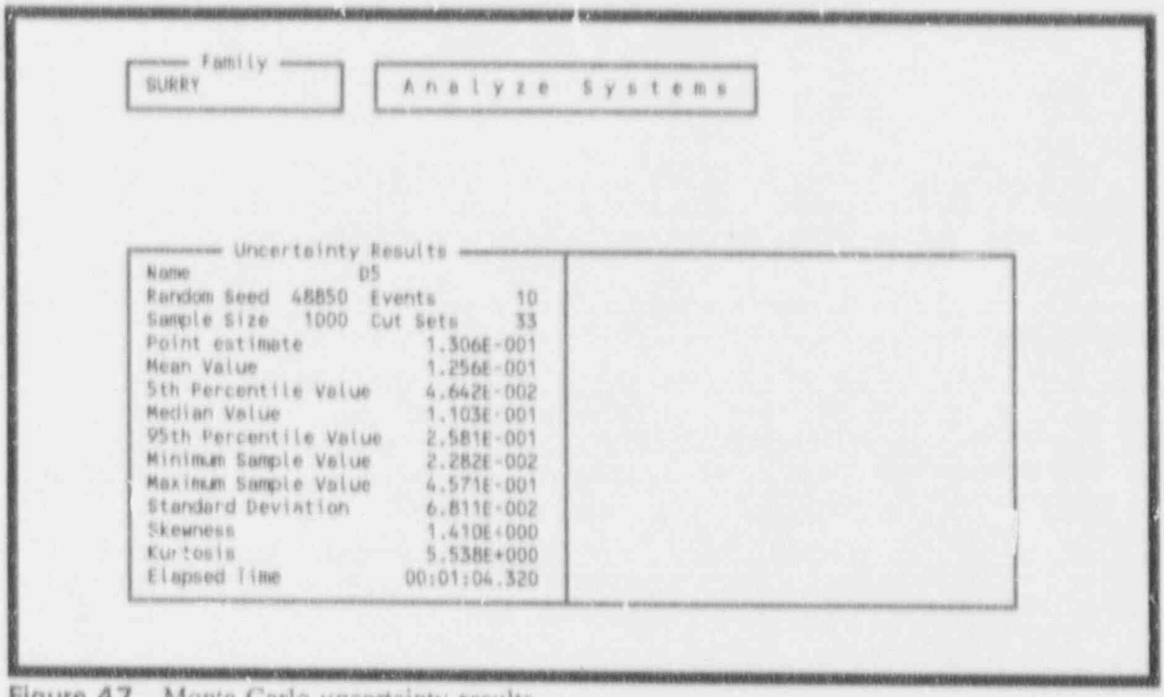


Figure 47. Monte Carlo uncertainty results.

If only one system was selected (highlighted) for the uncertainty analysis process, then you will need to press <Enter> to return to the Analyze Systems screen from the Uncertainty Results screen. However, if more than one system is being processed, the Uncertainty Results screen will be displayed for each system, and when all of the selected systems have processed, you will automatically be returned to the Analyze Systems screen.

3.4 Display Results

3.4.1 Display System Results

To display the results of your system analysis, highlight Display Results or type <D> on the System Analysis screen and press <Enter>. The System Display screen will be displayed showing a list of the systems contained in the data base (Figure 48). The following options are available: Exit, Report, Cutsets, Uncertainty, and Importance Measures.

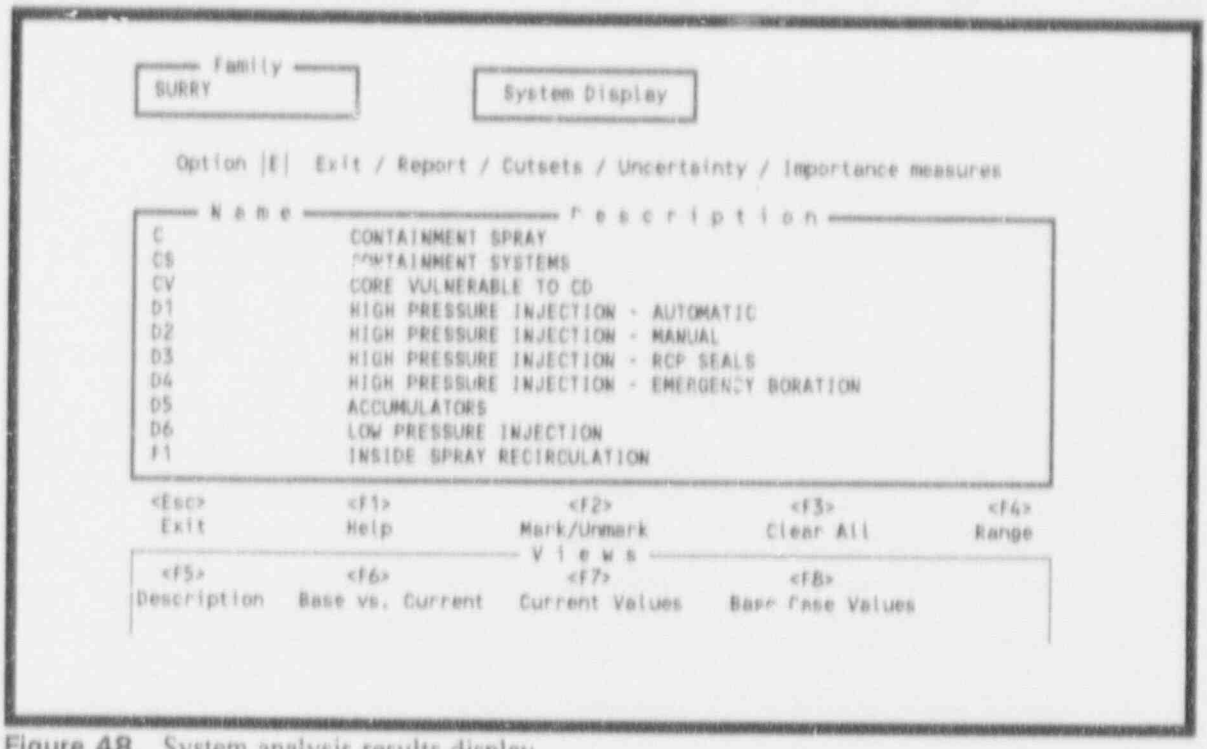


Figure 48. System analysis results display.

Some additional functions appear at the bottom of the System Display screen. These functions (which correspond to the <Esc> and function keys) operate in the same manner whenever they appear at the bottom of a display.

<Esc> Returns to the previous screen.
<F1> Displays a general help screen.
<F2> Marks or unmarks a single item in the display list
<F3> Clears all marked items, or if none are marked then sets all items to marked.
<F4> Marks a range of items.
<F5> Displays a list showing name and description (default view as shown in Figure 48).
<F6> Displays a list showing name, base case, and current frequency values.
<F7> Displays a list showing name and current frequency values.
<F8> Displays a list showing name and base frequency values.

Selecting one of the view options, in this case <F6>, will change the display as shown in Figure 49.

3.4.1.1 Exit. This option terminates the process and returns you to the previous screen. To invoke the option, type <E> in the option field and press <Enter>, or press the <Esc> key.

3.4.1.2 Report. The Report option allows you to generate a report of the data displayed on the screen. The report may be displayed on the console, sent to an attached printer, or saved in a disk file

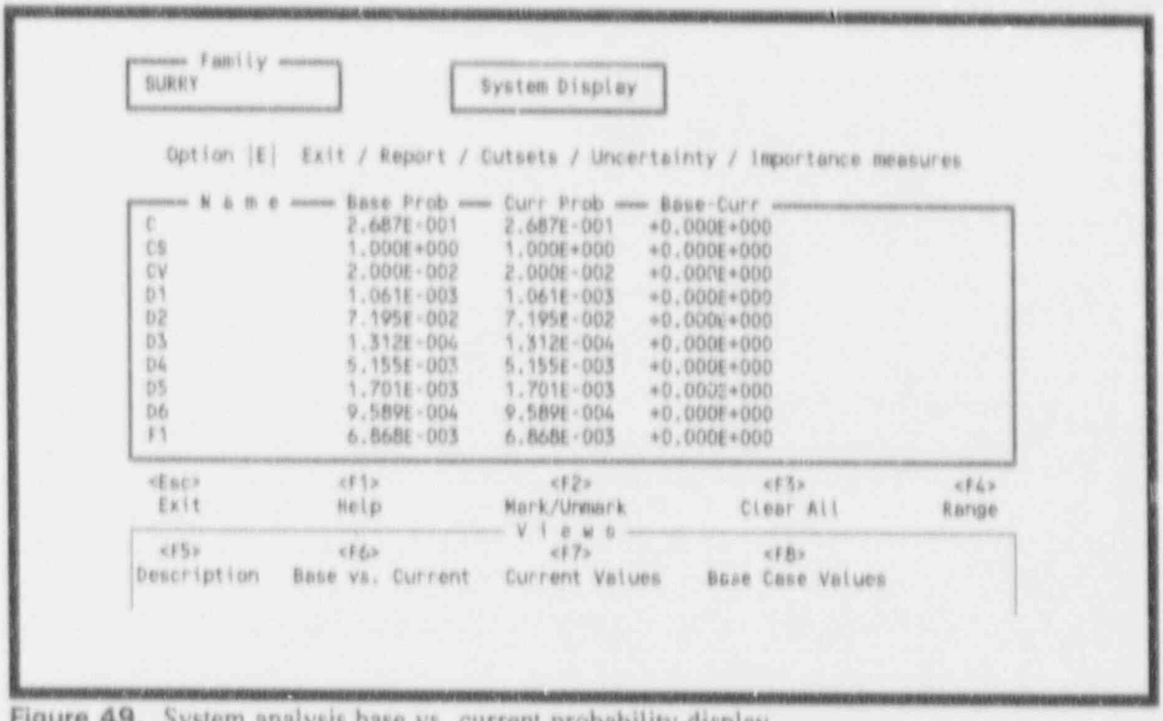


Figure 49. System analysis base vs. current probability display.

for later processing.

To invoke this option, type <R> in the option field and press <Enter>. Upon pressing <Enter>, the screen shown in Figure 50 is displayed. This screen shows a default title and file name, which you may change to match your needs.

3.4.1.3 Cutsets. This option displays the system cut sets (Figure 51), their percent of contribution to the system, frequency, and the event names that make up the cut sets. The system minimum upper bound, the number of cut sets that make up the system, the current partition upper bound, the percentage that the partition contributes to the system, and the number of cut sets in the partition are displayed at the bottom of the screen.

3.4.1.3.1 Exit—This option terminates the process and returns you to the previous screen. To invoke this option, type <E> and press <Enter>, or press <Esc>.

3.4.1.3.2 Partition—The partition option allows you to redefine a system as a subset of the original cut sets. This is accomplished by defining a set of events to be used to determine whether a cut set belongs to a partition. The functions available to perform this task are: Exit, Include, EXclude, Complement, Reset, and View Events.

To invoke this option, type <P>, highlight a system, and press <Enter>. This will bring up the screen shown in Figure 52.

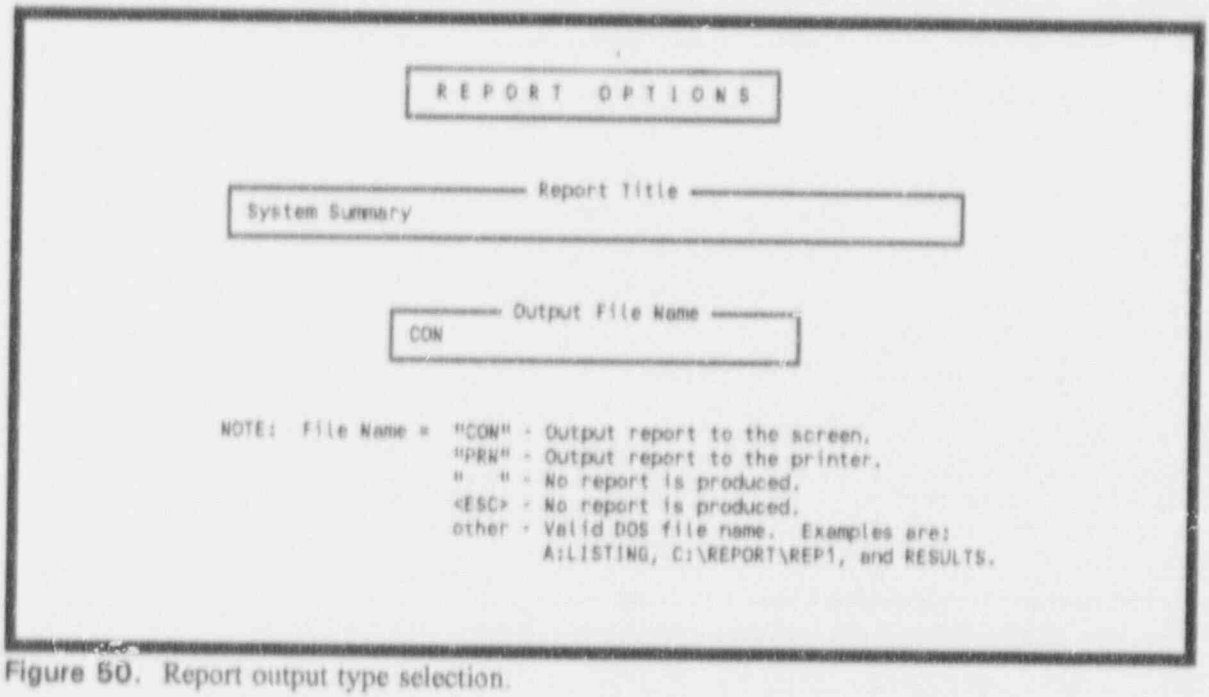


Figure 50. Report output type selection.

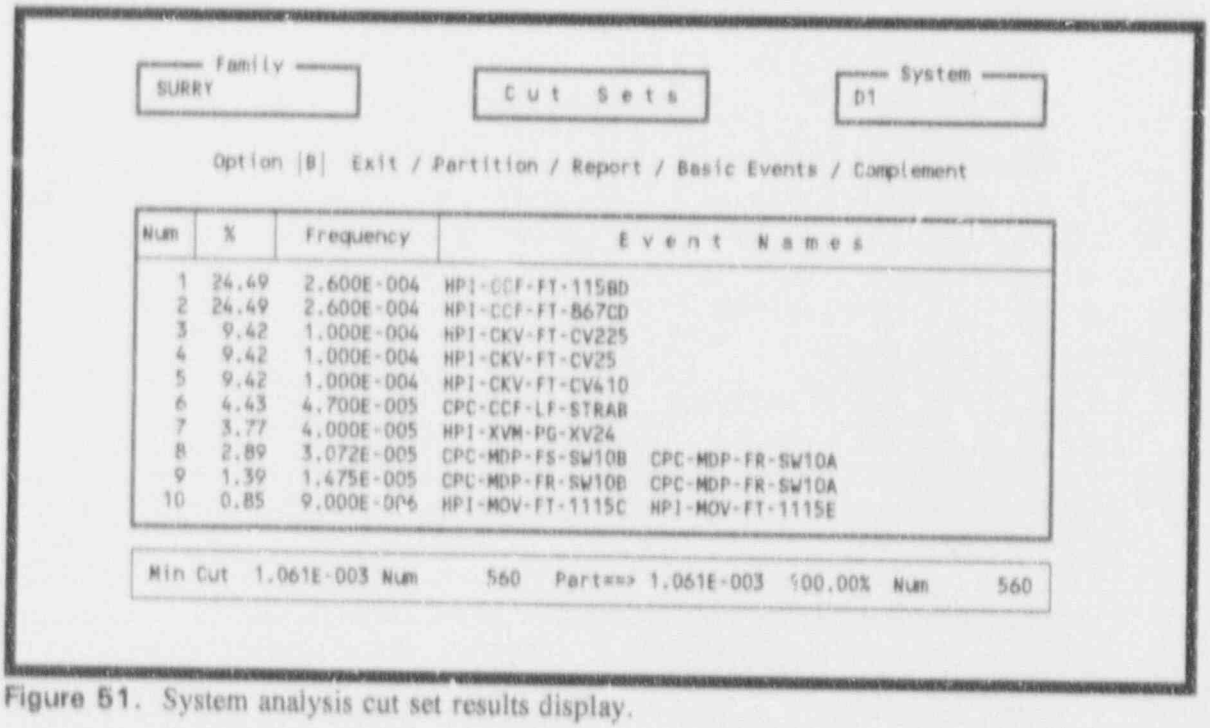


Figure 51. System analysis cut set results display.

Exit: This option terminates the process and returns you to the previous screen. To invoke this option, type <E> and press <Enter>, or press <Esc>.

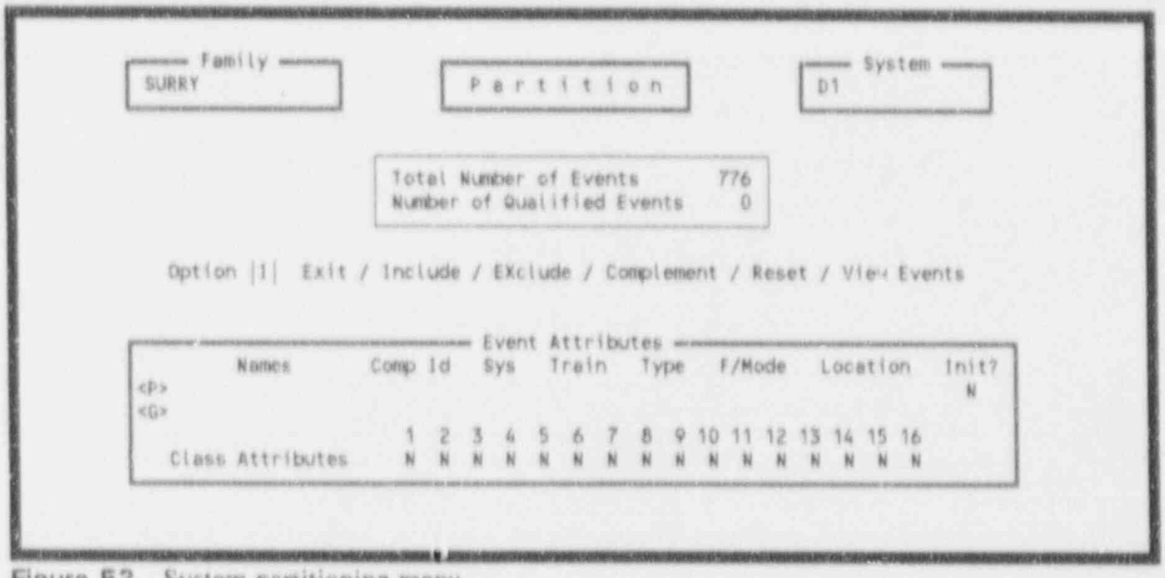


Figure 52. System partitioning menu.

Include: To establish a partition via this option, type <I> in the option field, then fill in the entry fields on the screen that are to be used to qualify the events that may be used in the new partition and press <Enter>. The application proceeds to qualify the events and when complete will update the Number of Qualified Events field that appears at the top of the screen. In this case, qualified events are those events that contain the included attributes. Returning to the Cut Sets screen via the Exit option, you will see that the system cut set list contains only those cut sets that are made up of qualified events. Figure 53 was the result of specifying the event name "HPI-CKV-FT-CV410" for the "Include" option. If the system cut sets do not contain any of the qualified events, then the message **No cutsets qualify** is displayed at the bottom of the screen.

EXclude: To establish a partition via this option, type <X> in the option field, then fill in the entry fields on the screen that are to be used to remove events from the list of qualified events. The application proceeds to remove the events. When complete, the Number of Qualified Events field that appears at the top of the screen will be updated accordingly. Returning to the Cut Sets screen via the Exit option you will see that the system cut set list contains only those cut sets that are made up of qualified events. Figure 54 was the result of specifying the event name "HPI-CKV-FT-CV410" for the "EXclude" option. If the system cut sets do not contain any of the qualified events, then the message **No cutsets qualify** is displayed at the bottom of the screen.

Complement: To establish a partition via this option, type <C> in the option field, and press <Enter>. This causes all currently qualified events to be disqualified, and all unqualified events to become the set of qualified events. The Number of Qualified Events field at the top of the screen will change accordingly. Returning to the Cut Sets screen via the Exit option you will see that the system cut set list contains only those cut sets that are made up of qualified events. If the system cut sets do not contain any of the qualified events then the message **No cutsets qualify** is displayed at the bottom of the screen.

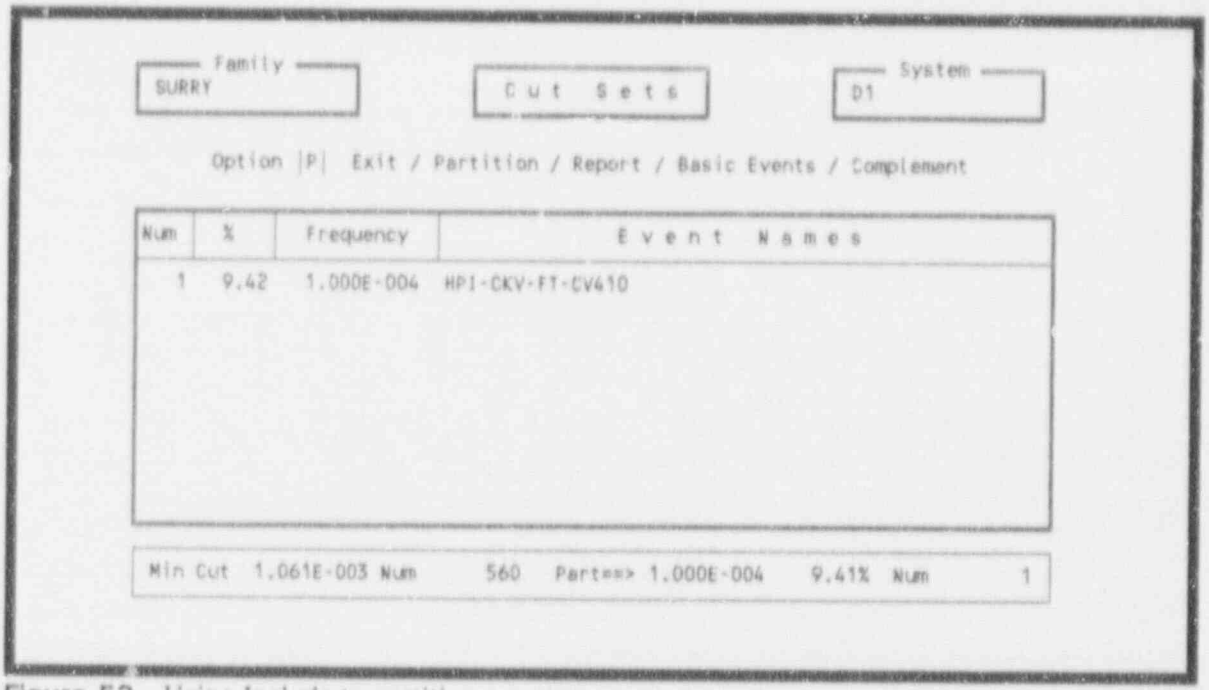


Figure 53. Using Include to partition a system.

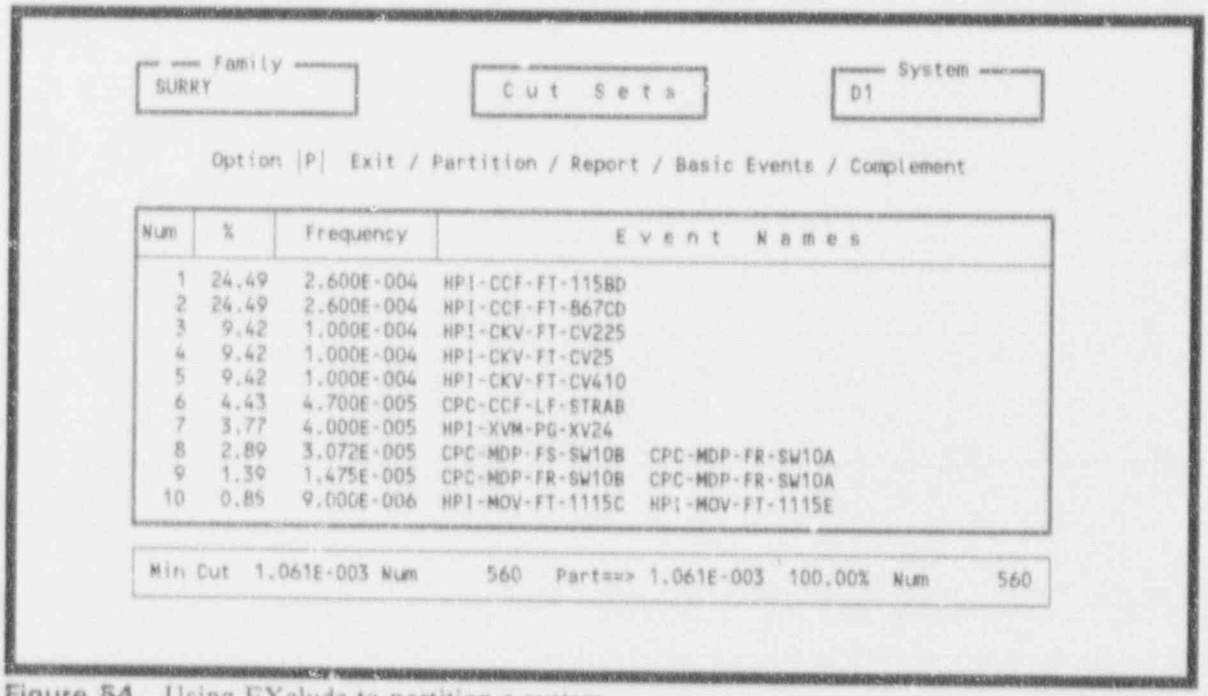


Figure 54. Using EXclude to partition a system.

Reset: This option sets all family events to qualified. This, of course, removes all partitioning from the current system cut sets. To activate this option, type <R> in the option field and press <Enter>. (Assume the partition shown in Figure 53). Type <R> in the option field and press <Enter>. The original cut set list is the result, as shown in Figure 51.

View Events: This option displays the list of family events and allows you to mark those events that are to be considered qualified events (Figure 55). To activate this option, type <V> in the option field, and press <Enter>. Mark the events, using <F2>, <F3>, or <F4> keys, that are considered qualified and press <Enter>. You will be returned to the Partition screen where the number of qualified events will be updated accordingly (Figure 56). If the system cut sets do not contain any of the qualified events, then the message **No cutsets qualify** is displayed at the bottom of the screen.

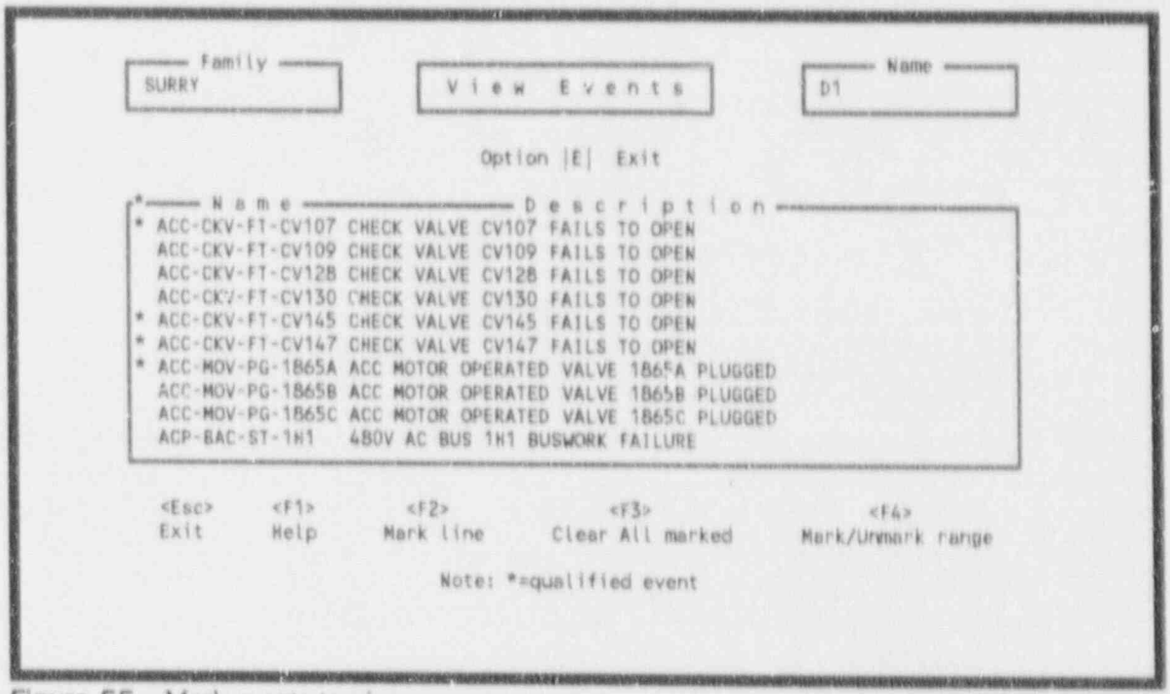


Figure 55. Mark events to view.

3.4.1.3.3 Report—The Report option allows you to generate a report of the data that is displayed on the screen. The report may be displayed on the console, sent to an attached printer, or saved in a disk file for later processing (Figure 57).

To invoke this option, type <R> in the option field, and press <Enter>. Upon pressing <Enter>, the screen shown in Figure 57 is displayed. This screen shows a default title and file name. You may change these defaults to meet your needs.

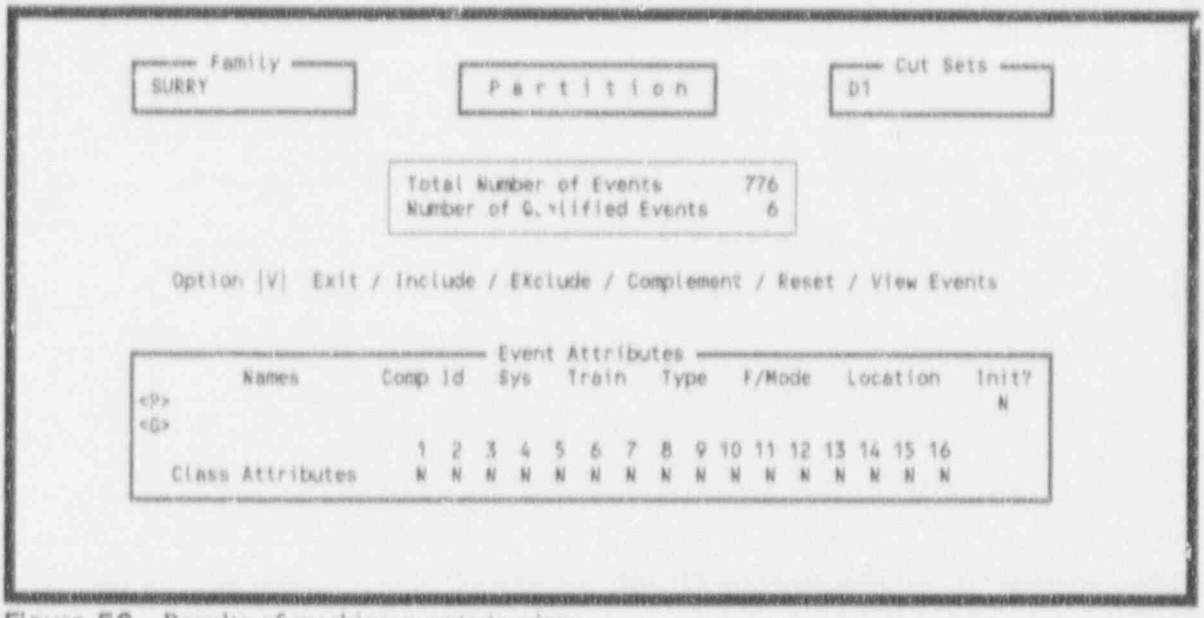


Figure 56. Results of marking events to view.

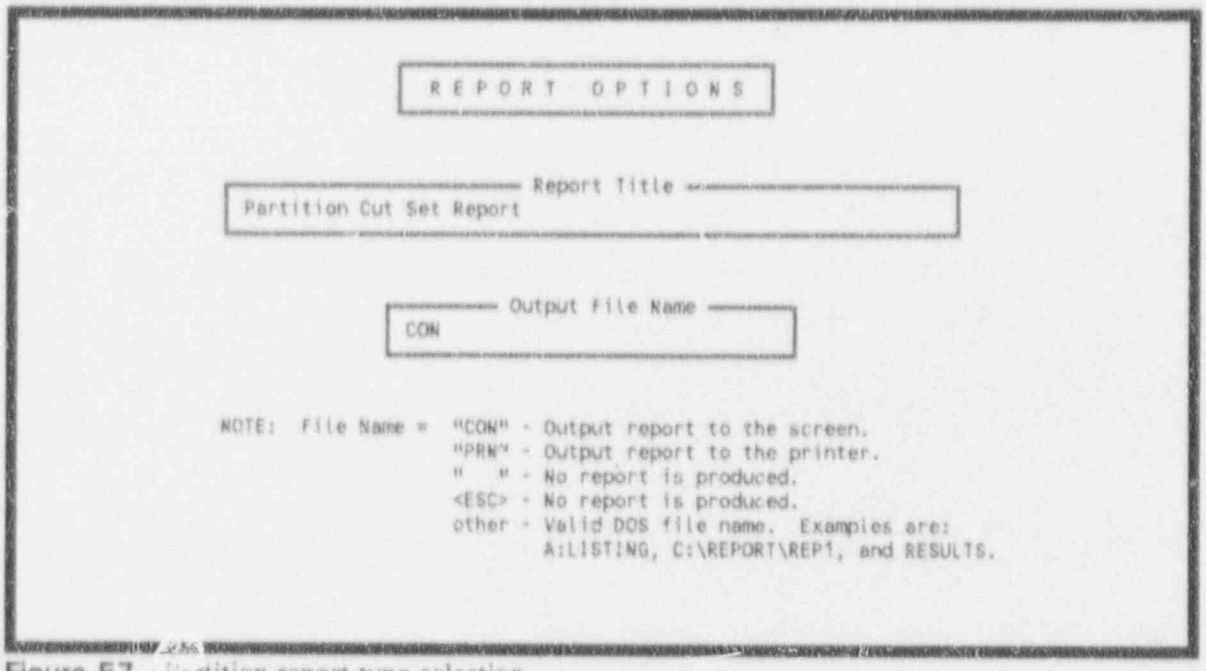


Figure 57. Partition report type selection.

3.4.1.3.4 Basic Events—The Basic Event option provides the following detailed information about the events that make up a cut set: name, description, probability, component ID, system, component type, failure mode, and location (Figure 58). To invoke this option, type <B> in the option field, highlight a cut set, and press <Enter>.

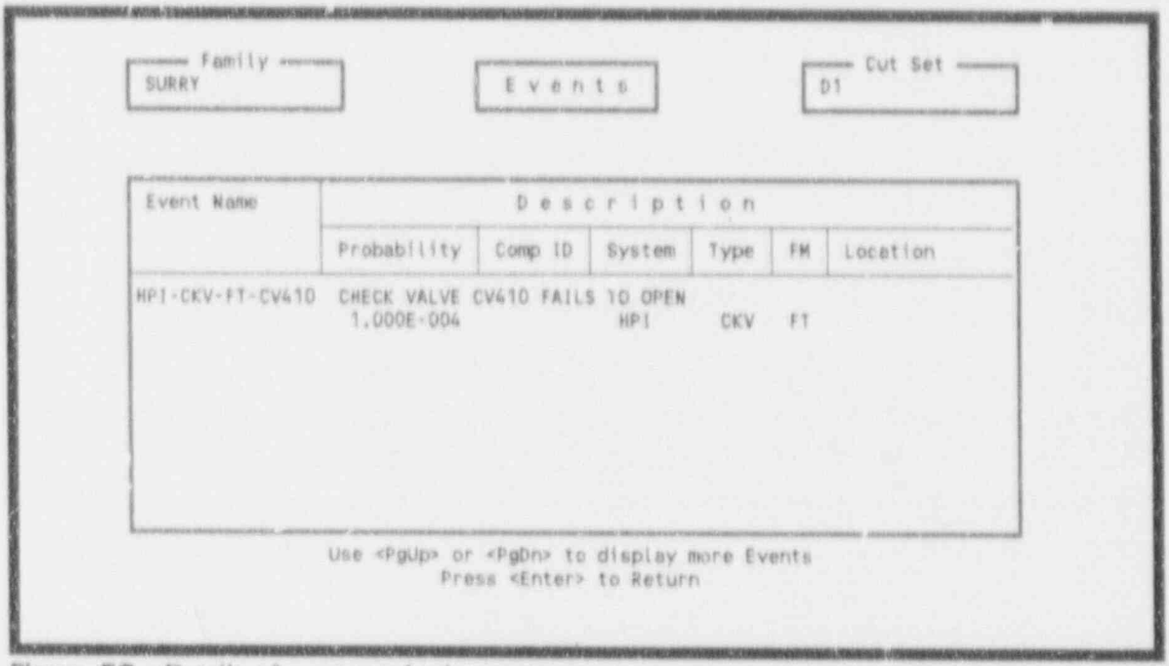


Figure 58. Details of a cut sets basic events.

3.4.1.3.5 Complement—The Complement option operates on the current system partition. Its function is to set all currently qualified cut sets to unqualified. This allows you to split a system into two partitions and then switch between the two partitions to view the results. To invoke this option, type <C> in the option field, and press <Enter>. (Assume the partition shown in Figure 53). Type <C> and press <Enter>. The resulting display is shown in Figure 54.

3.4.1.4 Uncertainty. The Uncertainty option displays the distribution and confidence limits of a system for both base and current data values. These values were calculated using either the Latin Hypercube simulation technique or the Monte Carlo simulation technique. To invoke this option, type <U> (Uncertainty) in the option field of the System Display screen, highlight the desired system, and press <Enter>. Figure 59 shows the base and current case uncertainty data for a selected system.

From this screen you may either return to the System Display screen or view the quantile values associated with the current case data or the base case data. To return to the System Display screen, type an <E> (Exit) in the option field and press <Enter>, or press the <Esc> key. To view the quantile values for the current case type a <C> in the option field and press <Enter>. A screen showing the quantile values will appear, (Figure 60). To return to the previous screen press <Enter>. If you wish to view base case quantile values, type a <B> in the option field and press <Enter>.

Family: SURRY | UNCERTAINTY DATA | System: C

Option |C| Exit / Current Quantile Values / Base Quantile Values

Base

Mean	4.699E-004	Median	4.237E-004	Mincut	2.687E-001
Std. Dev	1.212E-004	Skewness	1.657E+000	Kurtosis	4.822E+000
5th %	3.654E-004	Minimum	3.654E-004	Seed	53990
95th %	7.919E-004	Maximum	7.919E-004	Samples	15

Size Cutoff 6 Probability Cutoff 1.000E-015

Current

Mean	4.699E-004	Median	4.237E-004	Mincut	2.687E-001
Std. Dev	1.212E-004	Skewness	1.657E+000	Kurtosis	4.822E+000
5th %	3.654E-004	Minimum	3.654E-004	Seed	53990
95th %	7.919E-004	Maximum	7.919E-004	Samples	15

Size Cutoff 6 Probability Cutoff 1.000E-015

Figure 59. Uncertainty data display.

Distribution Quantile Level (in per cent)	95% Confidence Interval On Quantile Level in % (+/-)	Quantile Value	CURRENT CASE 95% Confidence Interval on Quantile Lower Bound	Upper Bound
0.5	6.9	3.6546E-004	3.6546E-004	3.6546E-004
1.0	8.4	3.6546E-004	3.6546E-004	3.6546E-004
2.5	11.2	3.6546E-004	3.6546E-004	3.7003E-004
5.0	14.4	3.6546E-004	3.6546E-004	3.7021E-004
10.0	18.5	3.7003E-004	3.6546E-004	3.9247E-004
20.0	23.6	3.9247E-004	3.6546E-004	4.2324E-004
25.0	25.2	3.9247E-004	3.6546E-004	4.2375E-004
30.0	26.5	3.9301E-004	3.7003E-004	4.2375E-004
40.0	28.1	4.2324E-004	3.7021E-004	4.6749E-004
50.0	28.6	4.2375E-004	3.9247E-004	4.9533E-004
60.0	28.1	4.6749E-004	4.0875E-004	4.9592E-004
70.0	26.5	4.9265E-004	4.2375E-004	6.9206E-004
75.0	25.2	4.9533E-004	4.2375E-004	7.9197E-004
80.0	23.6	4.9592E-004	4.6644E-004	7.9197E-004
90.0	18.5	6.9206E-004	4.9533E-004	7.9197E-004
95.0	14.4	7.9197E-004	4.9592E-004	7.9197E-004
97.5	11.2	7.9197E-004	6.9206E-004	7.9197E-004
99.0	8.4	7.9197E-004	7.9197E-004	7.9197E-004
99.5	6.9	7.9197E-004	7.9197E-004	7.9197E-004

Figure 60. Quantile values display.

3.4.1.5 Importance. This option calculates and displays the following three important measures for each event in the selected system:

- Fussell-Vesely importance - an indication of the percentage of the minimal cut set upper bound contributed by the basic event.
- Risk Reduction Ratio - an indication of how much the minimal cut set upper bound would decrease if the basic event was made perfect (never fail).
- Risk Increase Ratio - an indication of how much the minimal cut set upper bound would increase if the basic event was always failed.

If the Intervals flag is set in the Constants menu, the Birnbaum measures (the partial derivative), the Risk Reduction Interval, and the Risk Increase Interval will be displayed.

To invoke this option, type <1> in the option field, highlight a system, and press <Enter>. By default, when the importance measures are first displayed they are sorted, high to low, on Fussell-Vesely (Figure 61).

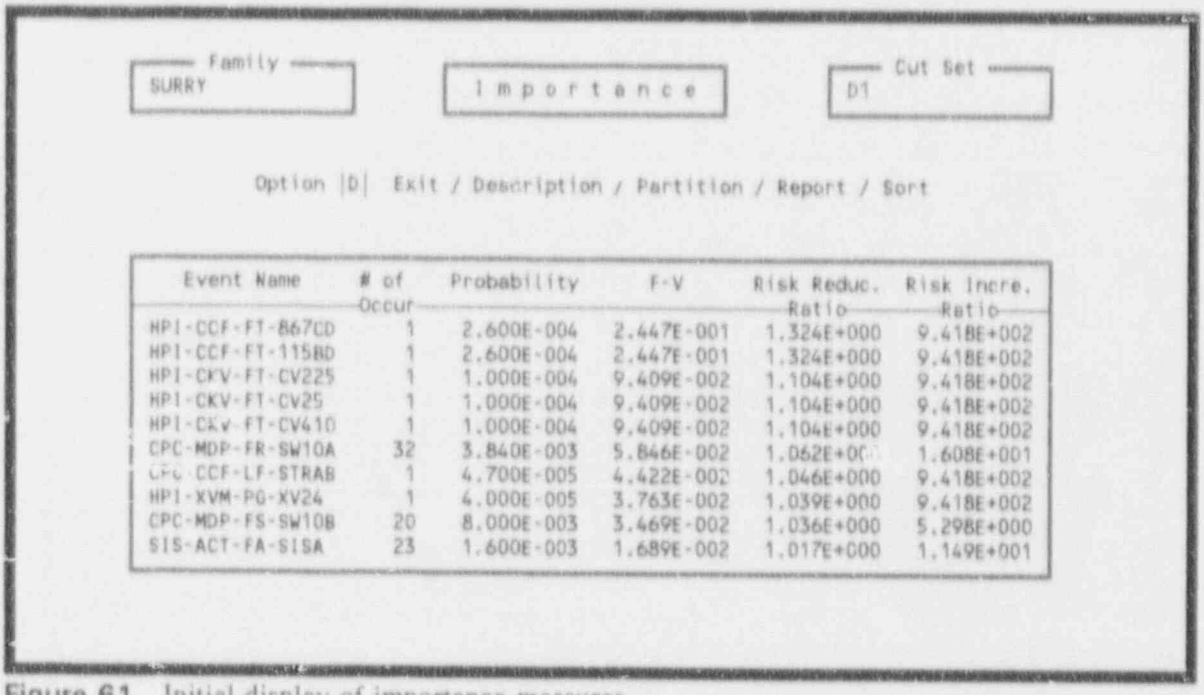


Figure 61. Initial display of importance measures.

3.4.1.5.1 Exit—Returns to the System Display.

3.4.1.5.2 Description—Displays the full description of the highlighted event at the bottom of the screen. To invoke this option, enter a <D>, highlight the desired event, and press <Enter>. If no event is highlighted, the message **An event must be selected first** is displayed.

3.4.1.5.3 Partition—This option invokes the same process as described in Section 3.4.1.3.2, except the effect is to limit which events are displayed/reported.

3.4.1.5.4 Report—This option invokes the same process as described in Section 3.4.1.3.3.

3.4.1.5.5 Sort—When you invoke this option, Figure 62 will be displayed. As shown, the data can be sorted by the following: Name, Occurrence, Probability, F-V, Reduction, and Increase.

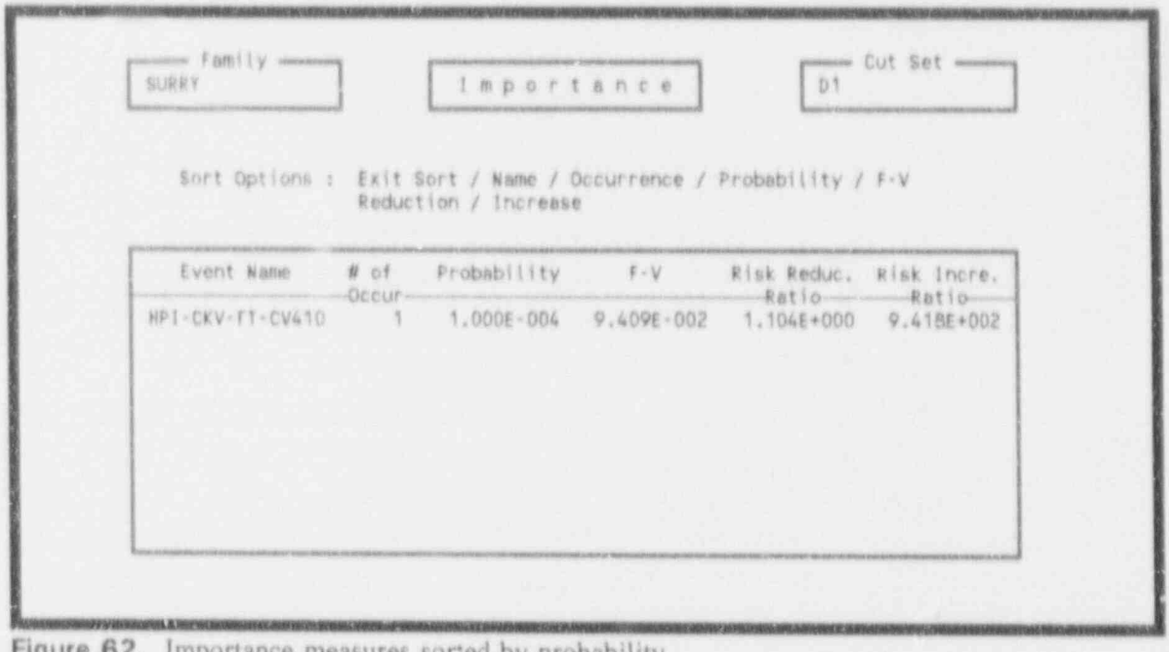


Figure 62. Importance measures sorted by probability.

3.5 Cut Set Editor

The cut set editor provides you with the means to edit the base case/alternate system cut sets. SARA provides room for two sets of cut sets in the data base: base case and alternate, or current case. Whenever SARA creates cut sets, they are stored in the current case location. The user may save a set of cut sets to the base case location by performing a Base Case Update. The user can choose to edit either base case or alternate cut sets; however, the results are always stored in the alternate case location.

Any event name entered during cut set editing may be preceded by a "/" to indicate that it is to be treated as a complemented event. The probability of a complemented event is 1 - the failure probability.

To invoke this option, highlight Cut Set Editor or type <C> in the option field and press <Enter>. Figure 63 shows the Cutset Editor screen listing the system names and descriptions. Whether the system has associated base case cut sets and/or alternate cut sets is indicated by the letter B and A preceding the system name. To edit the base case cut set, select <B>, highlight a system showing a letter B, and press <Enter>. Likewise, to edit an alternate cut set select <A>, highlight a system showing a letter A, and press <Enter>. If a system name is not flagged with a B or A it may still be edited.

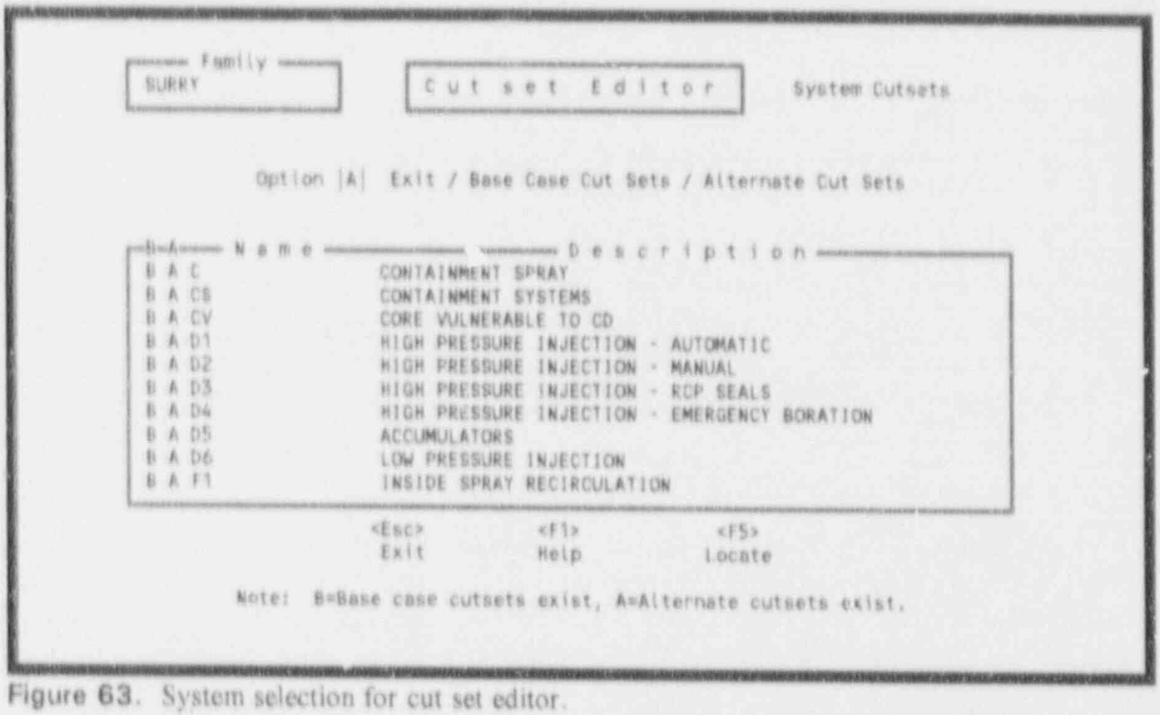


Figure 63. System selection for cut set editor.

In any case, a screen similar to the one shown in Figure 64 is displayed. This screen shows 14 editing options that are activated by a single key stroke. The 14 options include: Exit, Add, Modify, Delete, Locate, Next, Previous, Search, Options, Insert Event, Replace Events, Copy Cutset and Replace Events, Undo, and Find and Delete Cut Set. The Add, Modify, and Delete functions will perform their function on either the entire cut set or on a single event in a cut set depending upon where the cursor is positioned at the time the key to activate the function is pressed. If the cursor is in the first column of the screen, then the function will be performed on the entire cut set. However, if the cursor is in one of the other four columns, then the function will be performed on the event where the cursor is positioned.

To move the cursor about the editing window, use the keyboard cursor pad. The arrow keys move one field in each respective direction. The <Home> key places the cursor in the upper right corner of the window. The <PgUp> key moves the window up one page (12 lines). The <PgDn> key moves the window down one page. <Ctrl-PgUp> and <Ctrl-PgDn> moves to the top and bottom of the file. Pressing the function key <F1> toggles between two cut set editor screens. One screen shows the editing options and the other shows the available cursor movements.

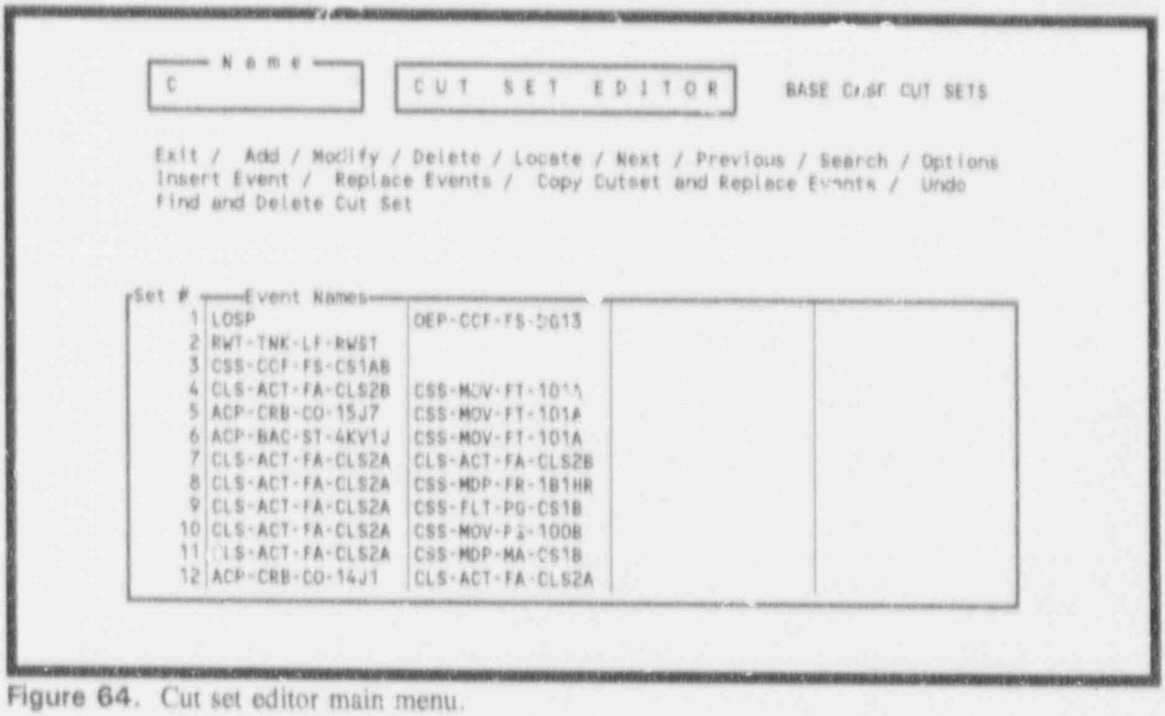


Figure 64. Cut set editor main menu.

3.5.1 Exit

This option returns you to the Cutset Editor screen (Figure 63). After pressing <E> (Exit) you are asked if the changes are to be saved or discarded (Figure 65). If the changes are saved, the sequence and plant frequencies must be recalculated to reflect the new cut set configurations.

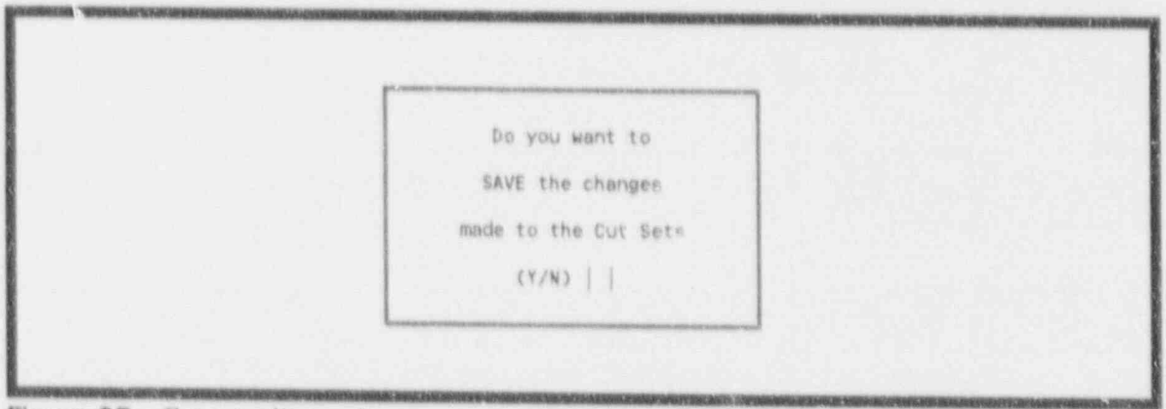


Figure 65. Cut set editor exit screen.

3.5.2 Add

This option allows you to add a cut set to a system or an event to a cut set. To add a new cut set, move the cursor into the set number column and press <A>. The cut set display is cleared, and the cursor is placed in the event name column (Figure 66). The event names that make up the cut set may be entered using the <Tab> key to move between fields, and the <Enter> key to end the addition. The window is then updated and the cursor is positioned on the new cut set (Figure 67). The <Insert> key also invokes the Add option.

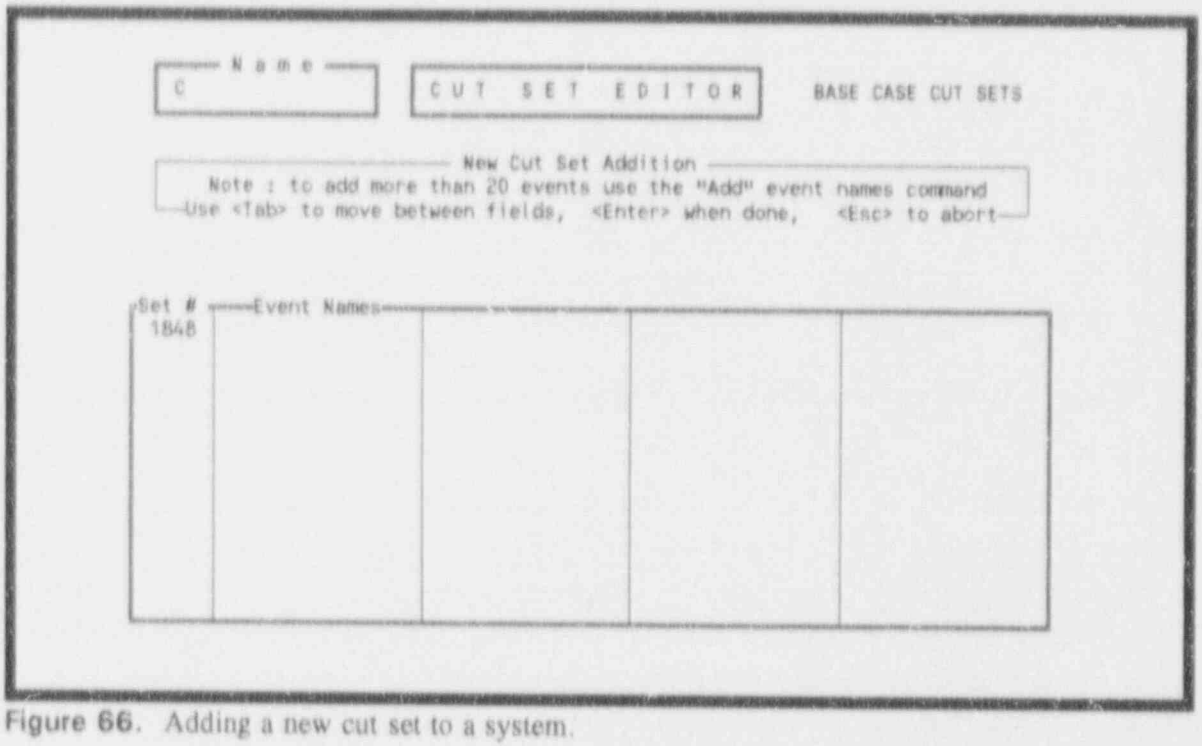


Figure 66. Adding a new cut set to a system.

To add an event to a cut set place the cursor in the row of the cut set you wish the event to be in, press <A>, and enter the event name. Figure 68 shows the editor screen ready to add an event name. Figure 69 shows the results of adding a new event.

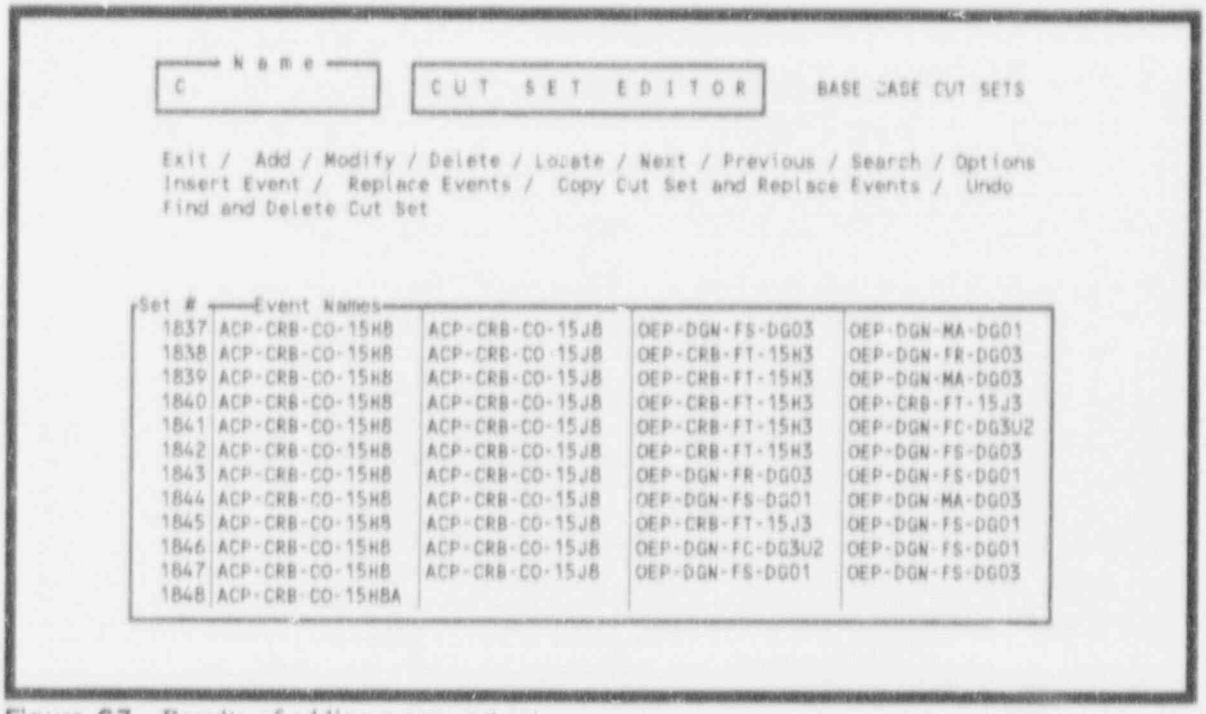


Figure 67. Results of adding a new cut set.

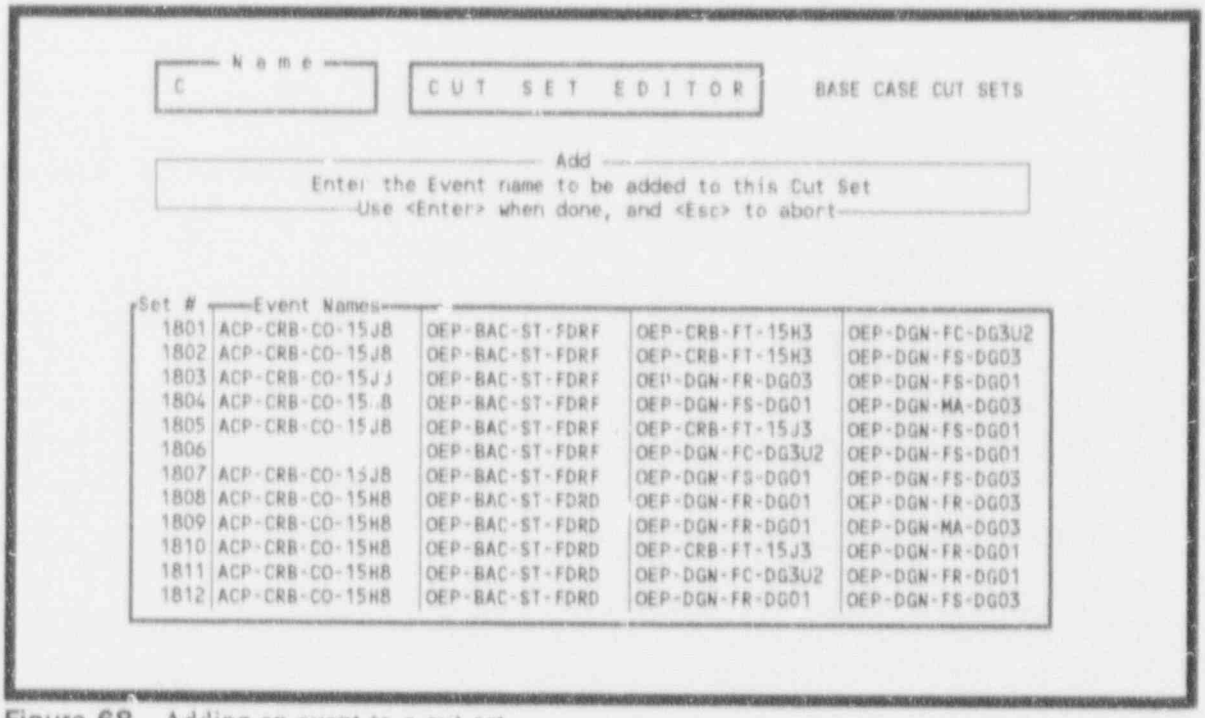


Figure 68. Adding an event to a cut set.

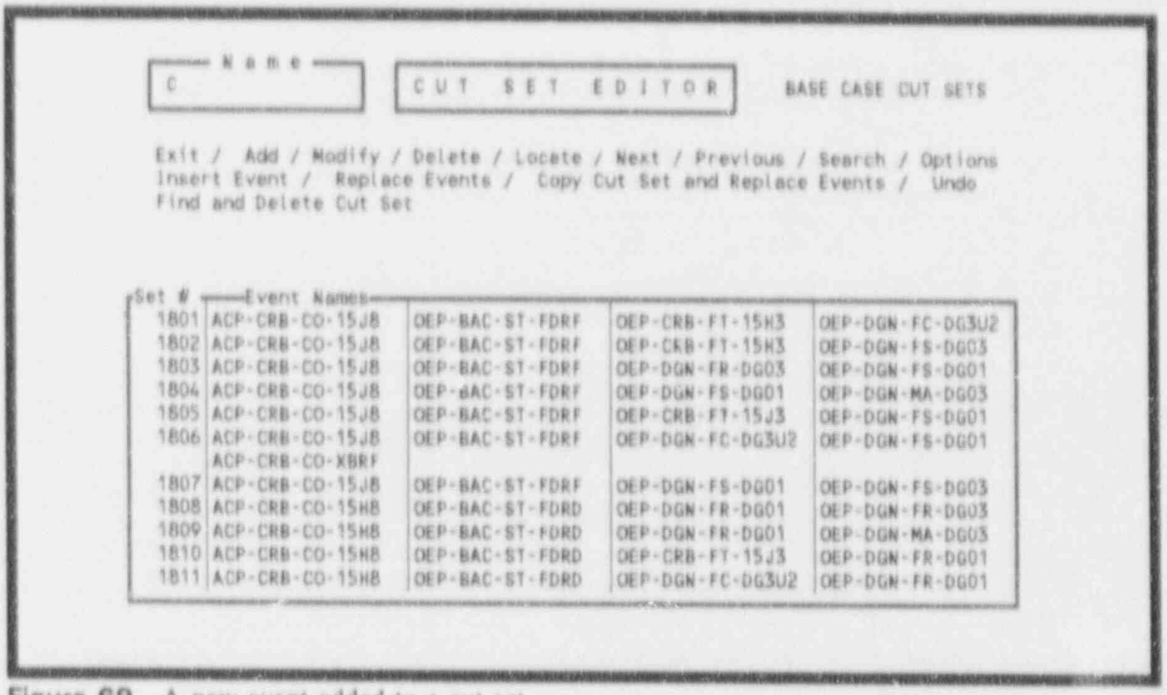


Figure 69. A new event added to a cut set.

3.5.3 Modify

To modify events of an entire cut set, place the cursor in the first column of the screen and press the <M> key. This will display a screen containing the first 20 events (if available) of the cut set to be modified (Figure 70). After making modifications to the events of the cut set, press <Enter> to save the modifications or press <Esc> to abort the modification process.

To change a single event in a cut set, position the cursor on the desired event and press the <M> key. This will display the Change Event Name screen (Figure 71) to allow you to modify the current event. When modifying an event, you may use all of the alphanumeric keys, in addition to the <Ins> and <Del> keys.

3.5.4 Delete

This option allows you to delete an entire cut set or an individual event. Placing the cursor on a cut set number and pressing <D> causes the entire cut set to be deleted. If the cursor is placed on an event name, the event at that location only is deleted from the cut set.

When the delete option is invoked, the option list on the display is replaced by a veto menu. For deletions, the Veto option is always turned on unless you specifically turn it off. The veto options function as follows:

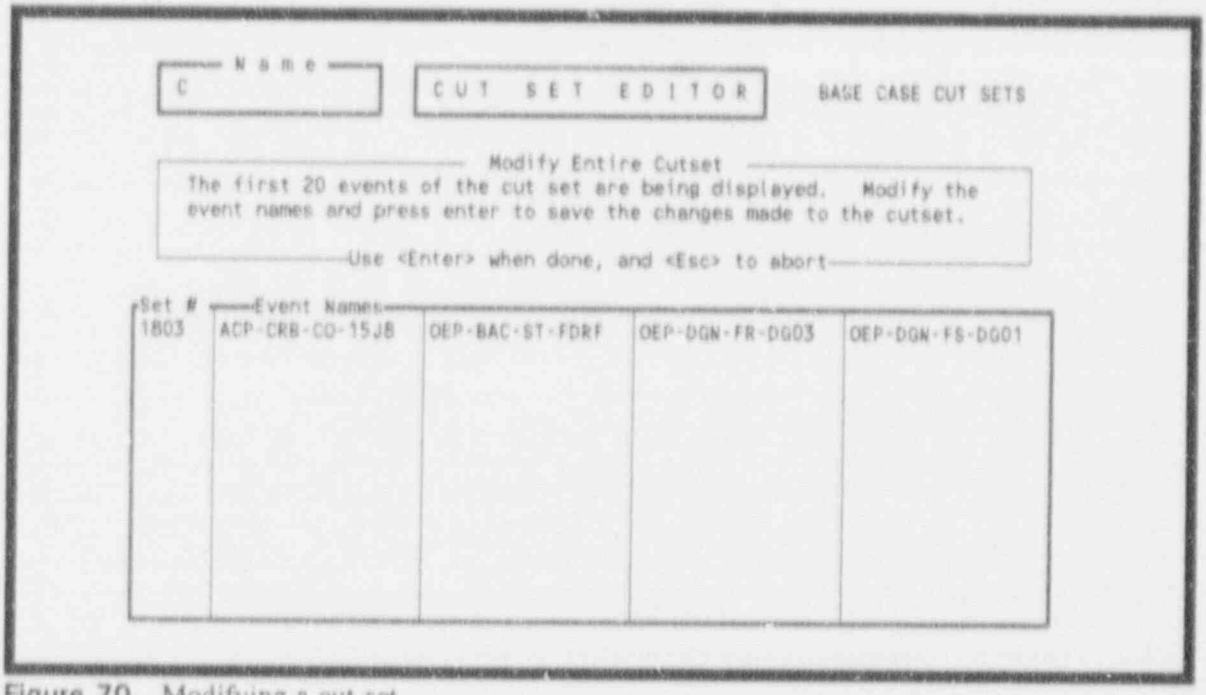


Figure 70. Modifying a cut set.

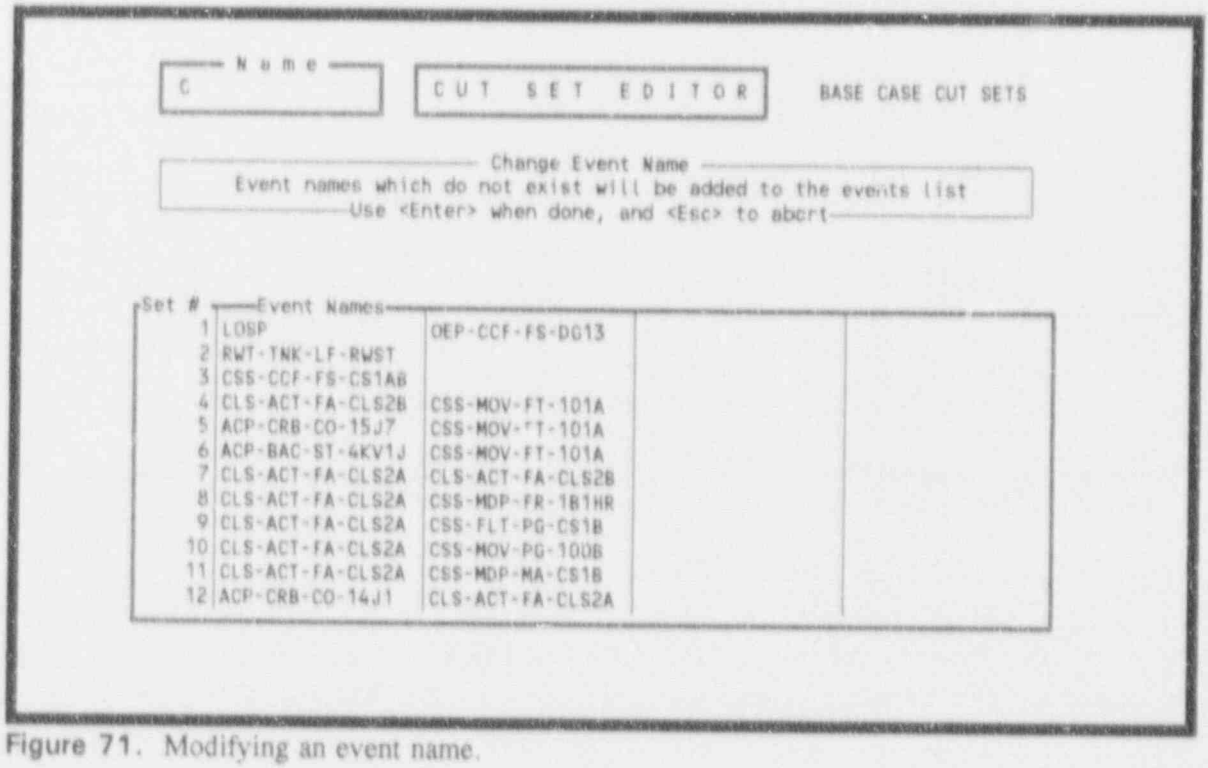


Figure 71. Modifying an event name.

Stop. Typing <S> aborts the delete operation for the highlighted cut set or event.

Continue the process. Typing <C> and pressing <Enter> results in deleting a cut set or event.

3.5.5 Locate

The locate option allows you to search the list of all existing events and the list of all the newly added events for events that meet the desired search criteria. Events that meet the desired search criteria are considered to be qualified events. You are then able to locate the first occurrence of one of these qualified events from the current set of cut sets.

To invoke this option, press the <L> key. This will display the locate menu (Figure 72). From this screen, the following four options are available: Exit, Locate, Next, and Previous. The number of unique events that exist in the current set of cut sets is listed on this screen, along with the number of currently qualified events.

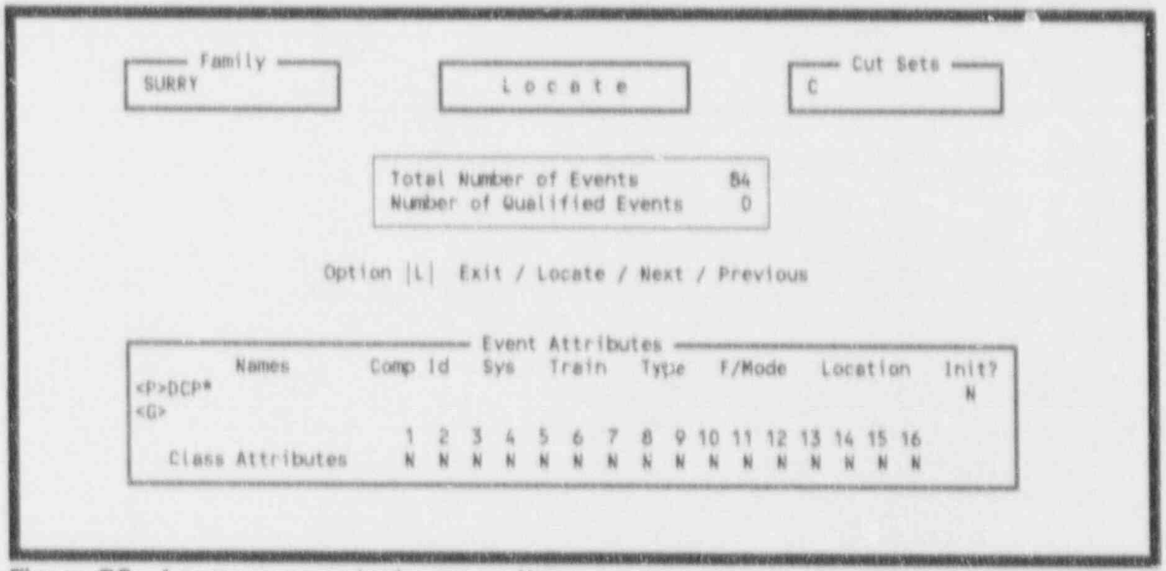


Figure 72. Locate an event in the cut set list.

3.5.5.1 Exit. If the locate function has been performed and an event name exists in the name field of this screen, then upon entering an <E> in the option field, the cursor will be placed on the first occurrence of that event name within the current set of cut sets. If the event does not exist within the current cut sets, then a message stating the event was not found will be displayed.

If the locate function has not been performed then entering an <E> in the option field will simply terminate the locate function. Locate may also be terminated by pressing the <Esc> key.

3.5.5.2 Locate. This option searches the list of all existing events and the list of all newly added events for events that meet the desired search criteria. This option allows wild card search characters for the two name fields on the screen. A question mark (?) matches any single character in its specified position, and an asterisk (*) matches a character string of any length. This option will use any of the filled event attribute fields on the screen as search criteria. Any events that meet the selected search criteria are considered to be qualified events. The number of currently qualified events will then be updated on the screen. The first qualified event will be displayed on the screen (see Figure 73).

NOTE: It is possible for an event to be a qualified event and still not exist in the current set of cut sets, because the entire data base is searched in the qualification process.

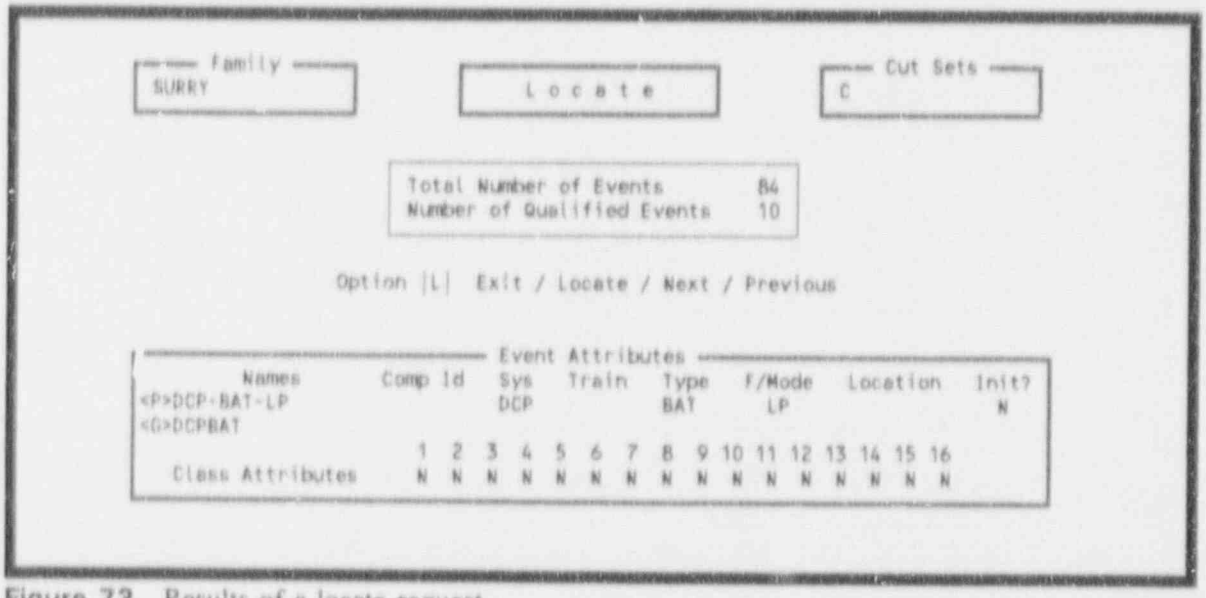


Figure 73. Results of a locate request.

3.5.5.3 Next. This option will display the next qualified event from the list of qualified events.

3.5.5.4 Previous. This option will display the previous qualified event from the list of qualified events.

3.5.6 Next

This option allows you to go to the next occurrence of the event name that was specified in the locate option. To invoke the option, type <N>.

3.5.7 Previous

This option allows you to go back to the previous occurrence of the event name specified in the locate option. To invoke the option, type <P>.

3.5.8 Search

This option provides a fast locate feature for a single event name. As each letter of the event name is typed the cut set list is scanned for the first occurrence of the letter. To invoke the option, type <S>, which will replace the option list with the search request on the screen display (Figure 74). The search starts with the top cut set of the current display. Type the desired event name and press <Enter>. The cursor will be positioned on the first occurrence of the requested event. At this point, <N> (Next) and <P> (Previous) will allow you to move through the cut set list positioning the cursor on the next or previous occurrence of the requested event name.

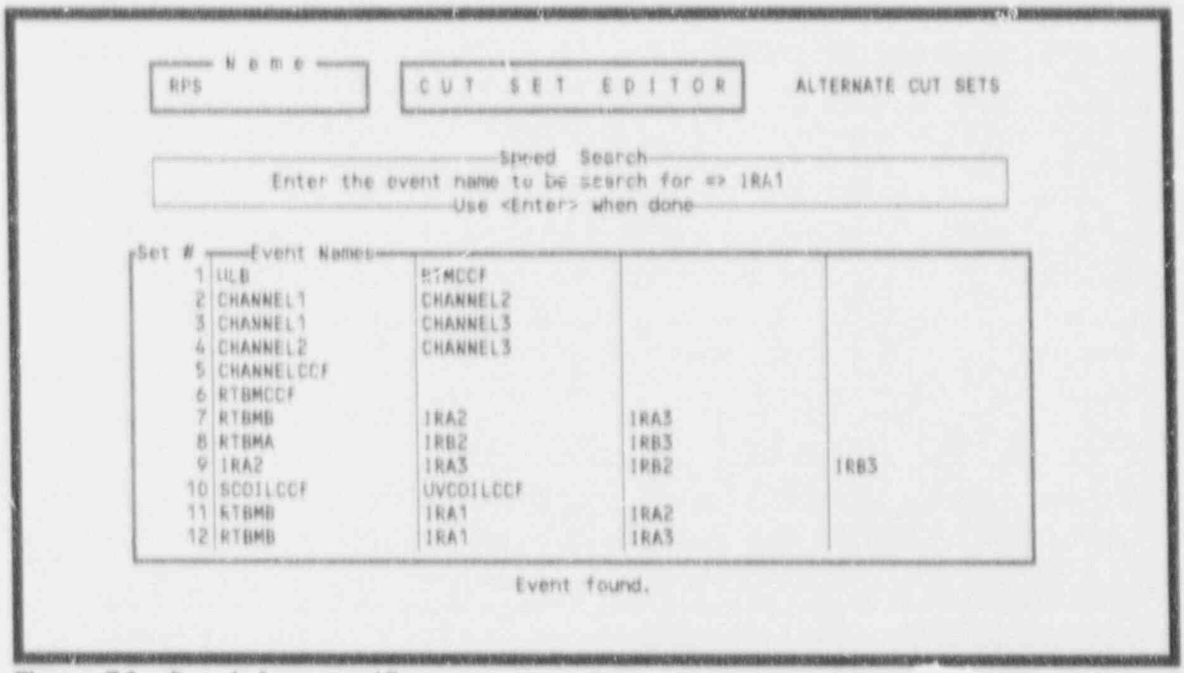


Figure 74. Search for a specific event.

3.5.9 Options

The Options command provides the capability of setting Cut Set Editor defaults. To invoke this option, type <O>. The normal option list will be replaced with the "default" option list on the screen display (Figure 75). The default options are:

- Range - This option sets the maximum number of cut sets with the specified string that will be located. Range is used by the Replace, Insert, Copy and Replace, and Find and Delete commands. By default, Range is set to 9999.

- Veto - Veto tells each operation to ask again if you wish to modify the cut set data. By default, this is turned off.

- Delete Veto - Functions the same as Veto. However, it applies only to the Delete command. By default, this is turned on.

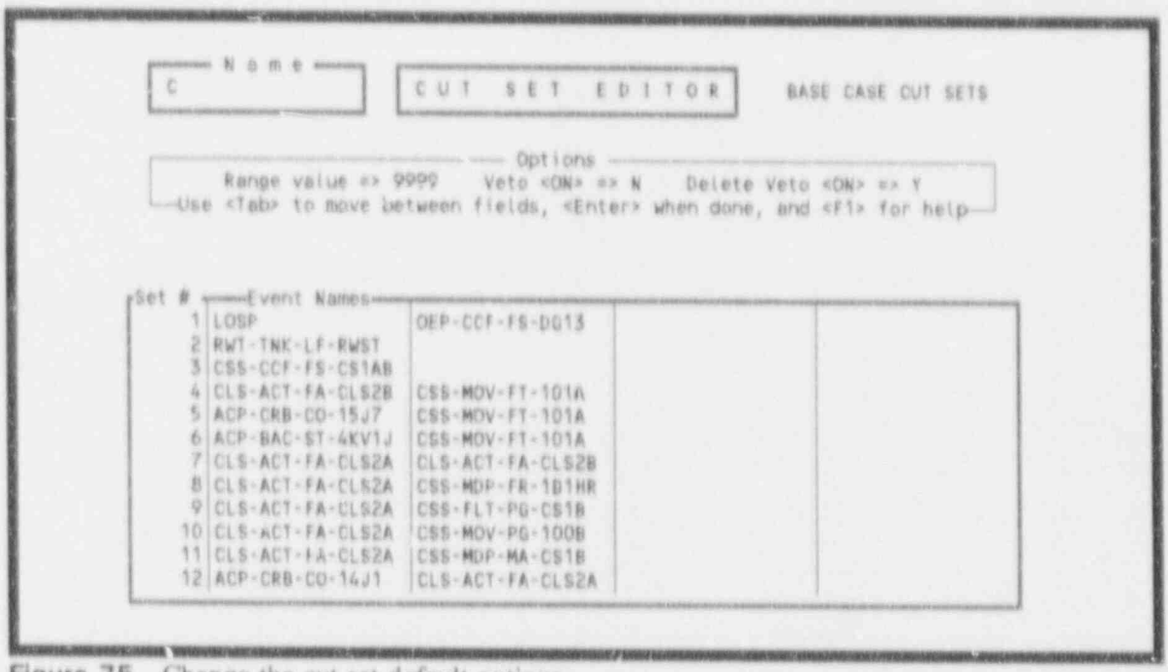


Figure 75. Change the cut set default options.

3.5.10 Insert Event

This option allows you to execute a global insertion of an event. You specify a search string consisting of up to five event names and the name of the event to be inserted. In all cut sets containing the "search string" the specified event to be inserted will be added. The search starts with the cut set at the top of the current display. To invoke this option, type <I>. The option list will be replaced on the screen with the Find/Insert request as shown in Figure 76.

3.5.11 Replace Events

This option allows you to specify a search string and replace every occurrence of that string with a specified event name. The search string may consist of up to five event names. The replacement is a global function in that all occurrences of the search string will be replaced by the specified event name. The replacement event name may be left blank, which will delete all occurrences of the search string from the cut set list. The search starts with the cut set at the top of the current display. To invoke the option, type <R>. The option list on the screen will be replaced with the Find/Replace request (Figure 77).

3.5.12 Copy Cutset and Replace Events

This option allows you to search for cut sets containing a specific string, copy the cut sets (minus the events specified in the search string), and add a specific event to the new cut set. You may specify up to five event names as a search string. If the event name to be added is left blank, the process is terminated. The search starts with the cut set at the top of the current display. To invoke this option, type <C>. The option list on the display will be replaced with the Copy/Replace request (Figure 78).

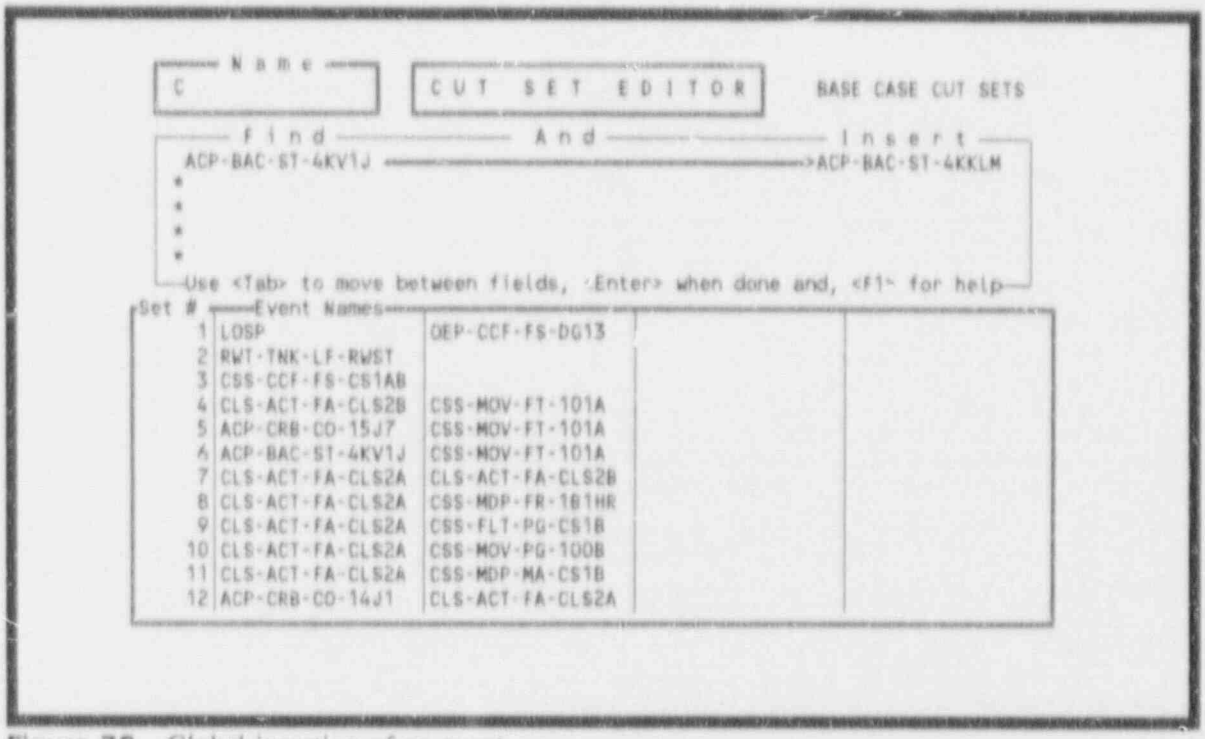


Figure 76. Global insertion of an event.

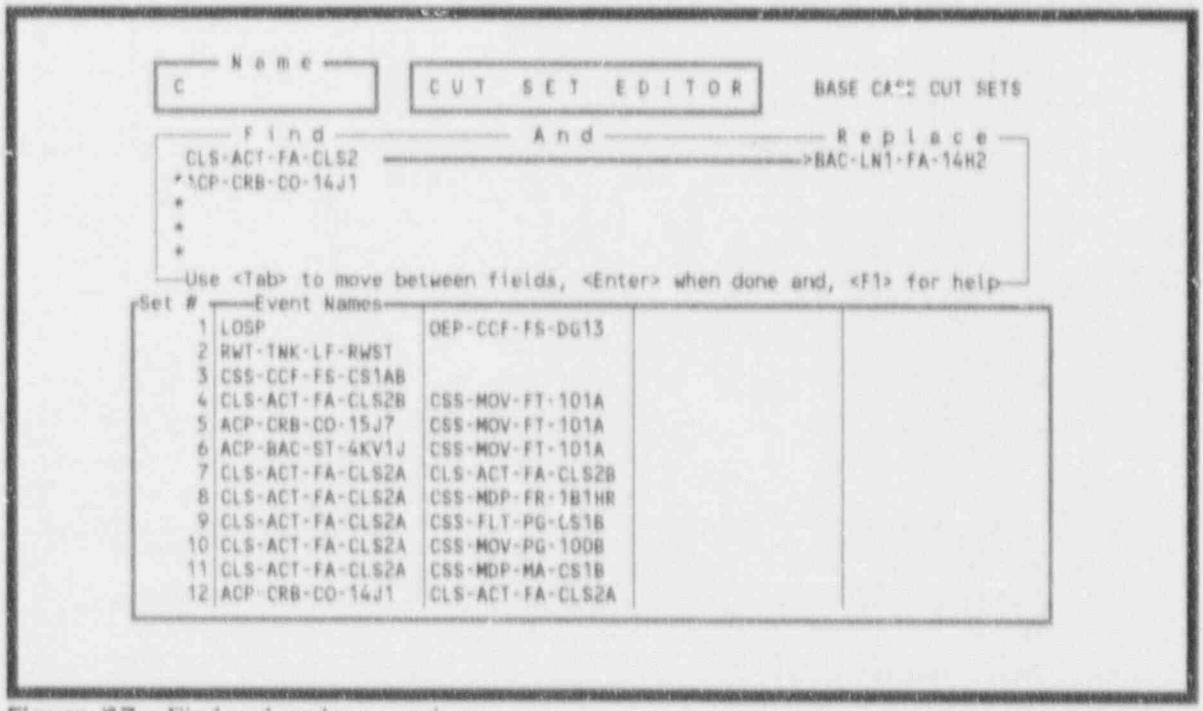


Figure 77. Find and replace a string.

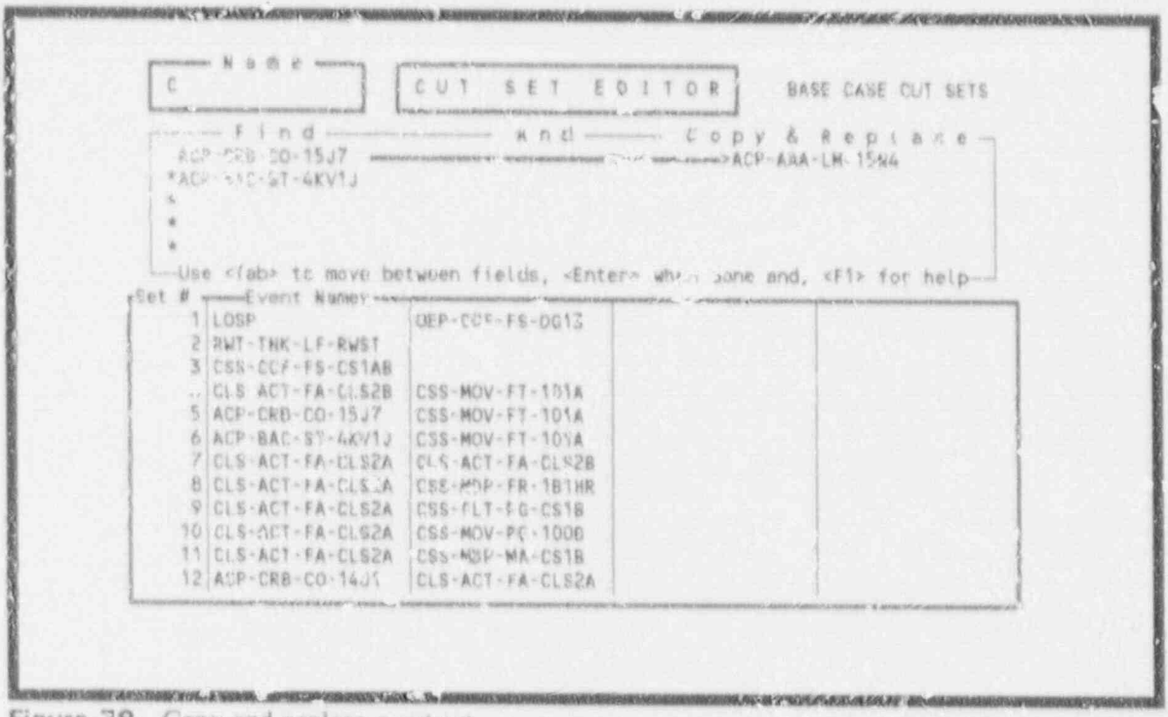


Figure 78. Copy and replace a cut set.

3.5.13 Undo

This option allows you to recover the last item deleted. The item may be an entire cut set or a single event. A deletion may be undone only if the Undo Delete command is used immediately after the deletion has occurred. To invoke the option, type <U>.

3.5.14 Find and Delete Cut Set

This option allows you to delete all cut sets that contain a specified string. You may specify up to five event names as a search string. The search begins at the cut set at the top of the current display. To invoke this option, type <F>. The option list will be replaced with the find and delete request (Figure 79).

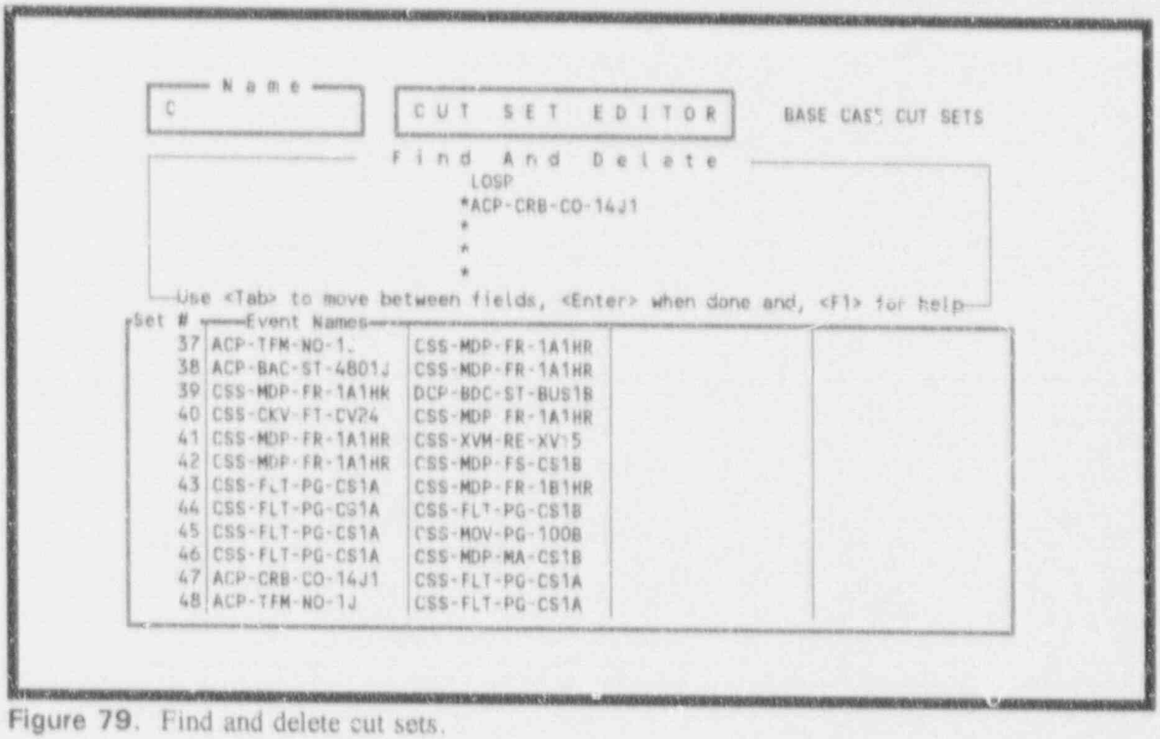


Figure 79. Find and delete cut sets.

4. EVENT TREE ANALYSIS

To invoke the Event Tree Analysis option from the main menu, highlight EVent Tree Analysis or type <V> in the option field and press <Enter>. The Event Tree Analysis option consists of the following four functions:

1. Modify Event Data includes adding, deleting, and modifying change sets. Change sets contain information about the probability/class changes that are to be applied to basic events during event tree analysis. Within a change set you may modify selected event probabilities, and reset those event probabilities to the base case values. In addition, you may perform a base case update that takes all current event tree data and makes it the new base case data. The original base case values are overwritten in this process. You may also add, modify, or delete user-defined histograms.

2. Analyze Event Trees includes updating the cut sets, quantifying the cut sets, running uncertainty analyses, and updating the base case.

3. Display Results presents the analyses in various report forms.

4. The Cut Set Editor provides the means to modify the event tree cut sets.

Keys that you will frequently use include:

<Esc>	Escape cancels your last choice and returns you to the previous screen.
<F1>	Help briefly explains the function of a field and may show you examples of data entered.
<F2>	Mark/Unmark tags items for use in the selected option.
<F3>	Clear All Marked events removes the marks (*) from the listed items. If no items are marked, this option will mark all of the items.
<F4>	Mark/Unmark range of items to more easily tag large numbers of items for processing.
<F5>	Locate an item displays a blank field in the center of the screen, and a message **Please enter name to locate** appears. The user should enter all or part of the name to be located and then press <Enter>. This feature will place the highlight on the located name. If the required name is not found, then the next name in alphabetical order will be highlighted.

The Event Tree Analysis main menu is shown in Figure 80. The Event Tree Analysis options and their functions are discussed in the following pages.

4.1 Exit

The Event Tree Analysis screen appears with Exit <E> as the default choice in the command line (see Figure 80). Press <Enter> to return to the SARA main menu.

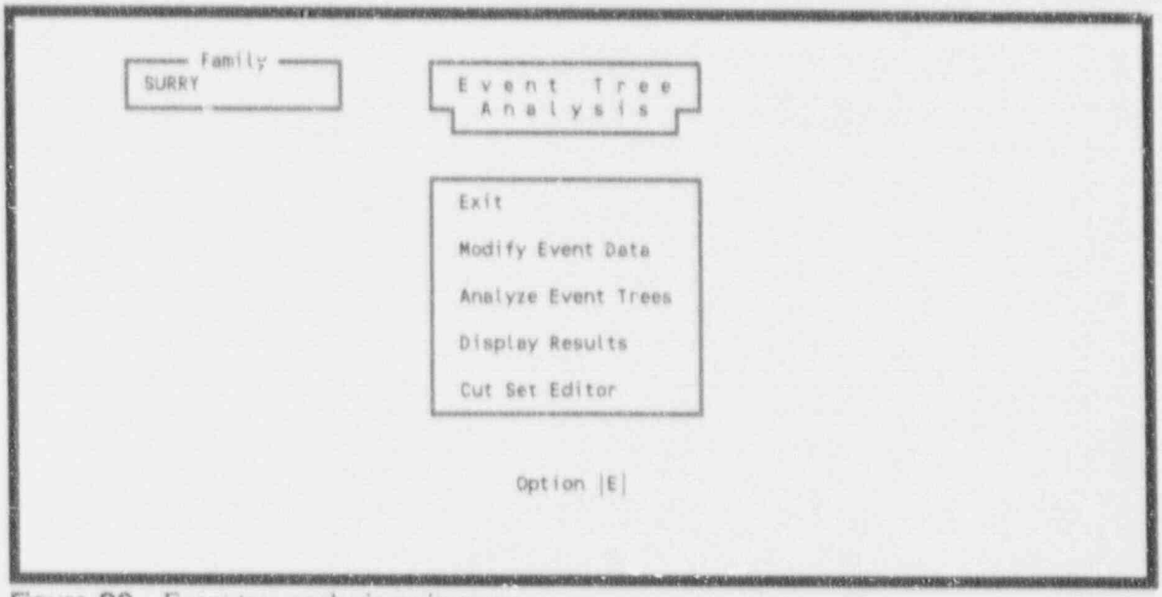


Figure 80. Event tree analysis main menu.

4.2 Modify Event Data

This option operates the same as the Modify Event Data option discussed in Section 3.2. Refer to that section for a detailed discussion.

4.3 Analyze Event Trees

This option provides the means to recalculate sequence values after events and/or cut sets have been modified. To invoke this option, highlight Analyze Event Trees or type <A> in the option field, and press <Enter>. Figure 81 shows the main screen for event tree analysis that lists the sequences defined for the current family. The letters c, q, and u (in any combination) may precede a sequence name and are defined as follows:

c - flags the sequence as having cut sets that must be recalculated
q - flags the sequence as having cut sets that must be requantified
u - flags the sequence as needing uncertainty distributions recalculated

Once these functions have been executed the corresponding letter is removed from the display. The options available to analyze event trees are Exit, Cut Set Update, Quantification, and Uncertainty Analysis. You have the choice of using either the Monte Carlo sampling technique or the Latin Hypercube sampling technique for running the uncertainty analysis process.

4.3.1 Exit

To return to the Event Tree Analysis screen, type an <E> in option field and press <Enter>,

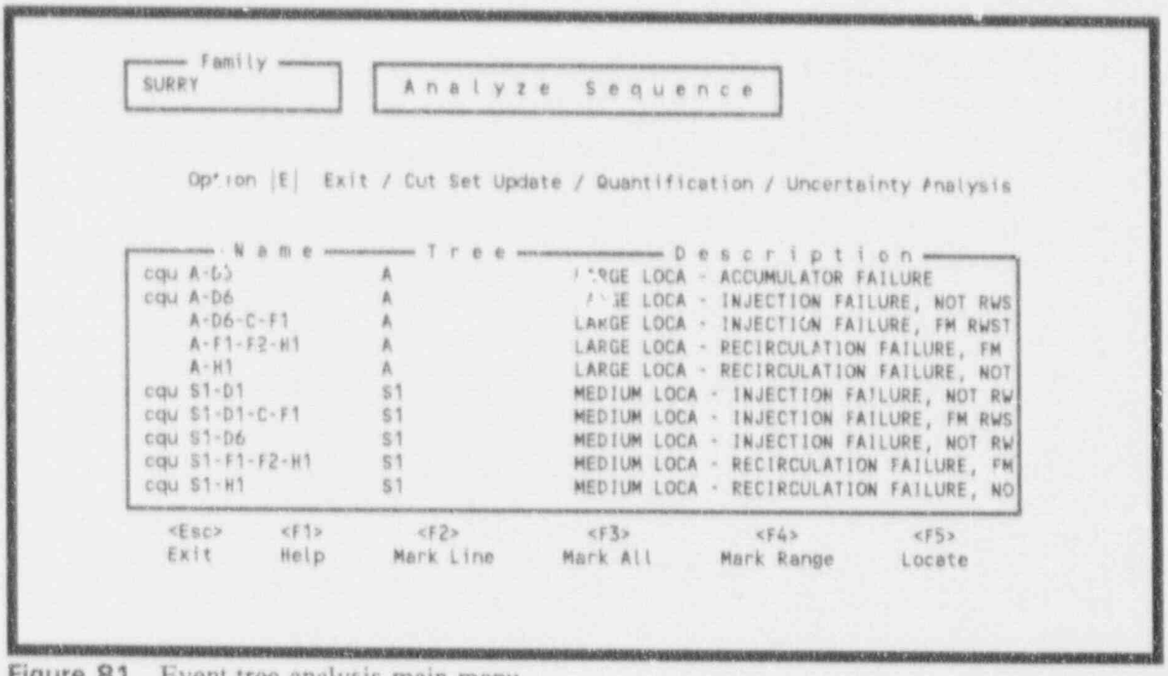


Figure 81. Event tree analysis main menu.

or press the <Esc> key.

4.3.2 Cut Set Update

This option will update alternate cut sets for a selected sequence based on cut set generation cutoff values. You are given the opportunity to specify several cut set generation cutoff values that will be used to determine if a cut set is to be retained or discarded from the selected sequence. You are also given the choice of using either the base case cut sets or the alternate case cut sets as the starting set of cut sets to be updated. The updated version of the cut sets will be saved as the new alternate cut sets for the sequence.

You are given the ability to update the alternate cut sets for a selected sequence, the alternate cut sets for a group of sequences, or the alternate cut sets for all of the sequences within the current family. To invoke the Cut Set Update process for a single selected sequence, type <C> in the option field, highlight the desired sequence, and press <Enter>. To invoke this process for a group of sequences, mark the desired sequences using the function keys F2, F3, and F4, type a <C> in the option field and press <Enter>. To invoke this option for all sequences in the current family, clear all marked entries with the F3 key, type <C> in the option field and press <Enter>. A message **Process all entries? (Y/N)** will appear at the bottom of the screen. Type a <Y> to continue the Cut Set Update for all of the sequences, or type an <N> to discontinue the update for all sequences.

Whether you are updating alternate cut sets for a single sequence, a group of sequences, or for all sequences the Cut Set Generation Cutoff Values screen shown in Figure 82 will be displayed. You may change any of the data fields on this screen. The default values that appear on this screen may be reset to new values by selecting Utility Options on the SARA main menu and then invoking the Define

Constants option (Section 8.2).

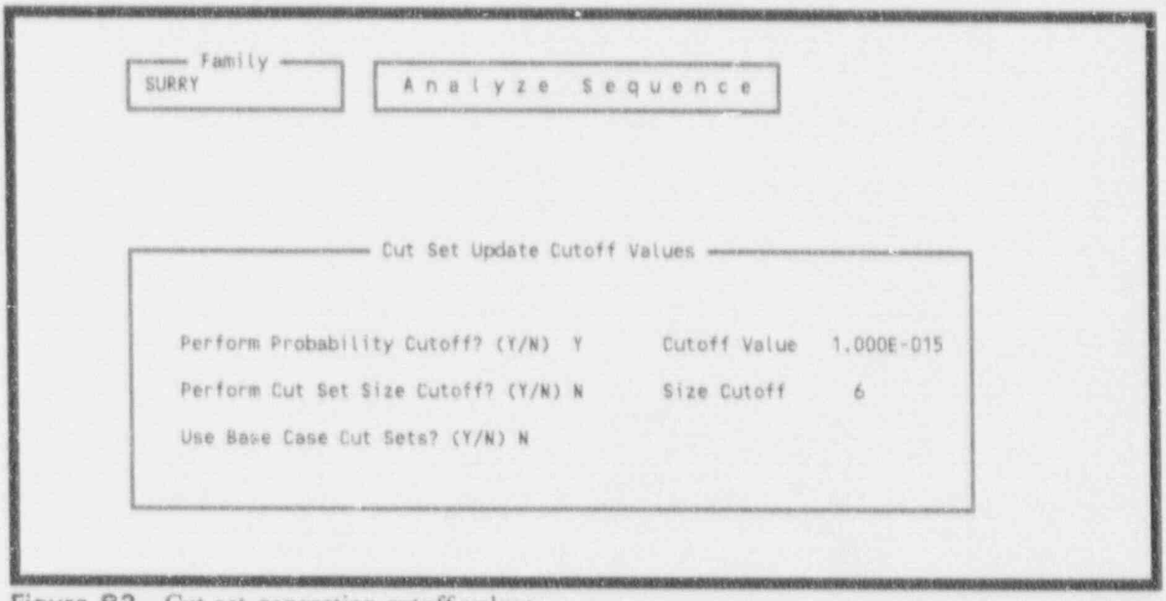


Figure 82. Cut set generation cutoff values.

If you type a <Y> in the Perform Probability Cutoff field, then only the cut sets whose product for all of its event probabilities is greater than or equal to the value in the Cutoff Value field will be kept. All other cut sets will be removed from alternate case cut sets for that sequence. If you type an <N> in this field, then the probability for the cut set will not be relevant for determining if the cut set should be retained or discarded.

If you type a <Y> in the Perform Cut Set Size Cutoff field, then only the cut sets whose number of events is less than or equal to the value in the Size Cutoff field will be kept in the alternate case cut sets for that sequence. All other cut sets will be removed. If you type an <N> in this field, then the number of events in a cut set will be irrelevant for determining if the cut set should be retained or discarded.

If you enter a <Y> in the Use Base Case Cut Sets field, then the base case cut sets will be used as the cut sets to be updated and then stored in the alternate case cut sets. However, if an <N> was entered in this field, the alternate cut sets will be used as the cut sets to be updated and then resaved in the alternate case cut sets.

During processing the screen shown in Figure 83 is displayed and updated as the calculations proceed. Upon completion of the cut set update, the results are displayed as shown in Figure 84.

The cut set update flag 'c' will then be removed from every sequence on the Analyze Sequence screen in which the cut set update process has been performed. If an error of some kind occurs during the update process then the message **Error in Cut Set analysis** will be displayed at the bottom of the screen. Once the cut sets are updated, they are also automatically quantified and the appropriate "q" flag is cleared.

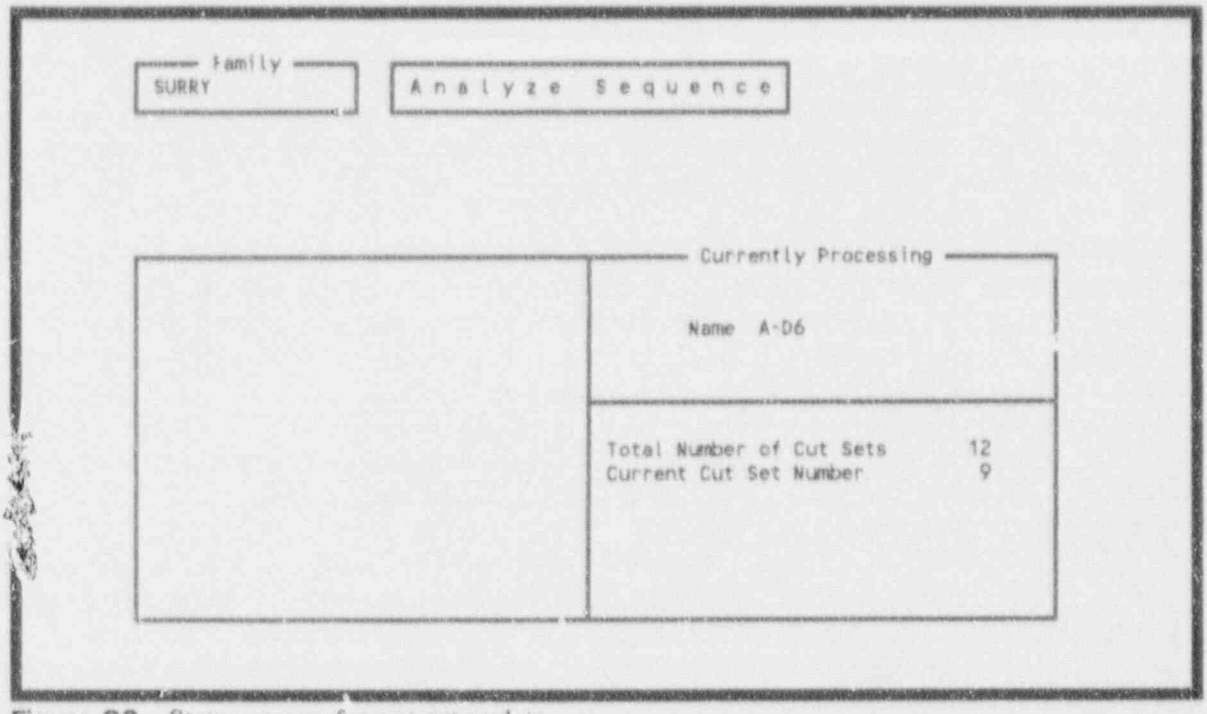


Figure 83. Status screen for cut set update.

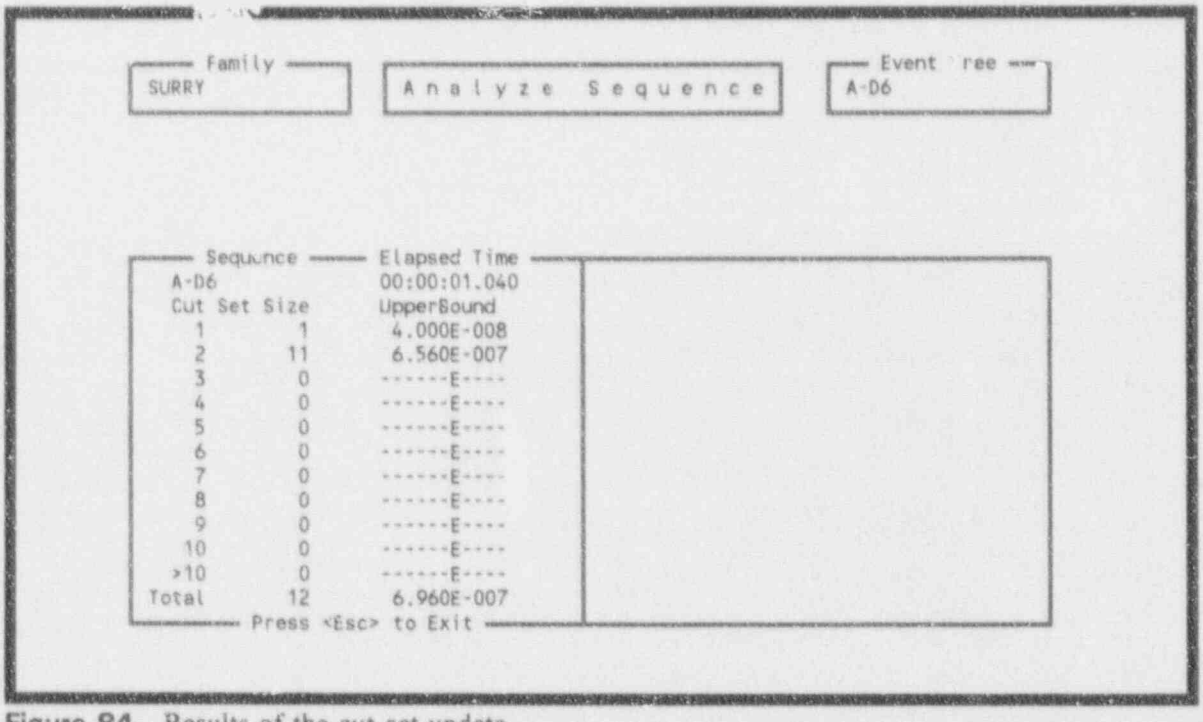


Figure 84. Results of the cut set update.

4.3.3 Quantification

The quantification process will calculate a new minimum cut set upper bound for the sequence cut sets using the current data values (event change sets and alternate cut sets). The new minimum cut set upper bound is saved with the alternate case cut sets for the selected sequence.

You are given the ability to requantify the alternate cut sets for a selected sequence, for a group of sequences, or for all of the sequences within the current family. To invoke the Quantification process for a single selected sequence, type <Q> (Quantification) in the option field of the Analyze Sequences screen, highlight the desired sequence, and press <Enter>. To invoke this process for a group of sequences, mark the desired sequences using the function keys F2, F3, and F4, type a <Q> in the option field and press <Enter>. To invoke this option for all sequences in the current family, type <Q> in the option field and press <Enter>. A message **Process all records (Y/N)?** will appear at the bottom of the screen. Type a <Y> to continue the Quantification process for all of the sequences, or type an <N> to discontinue this process.

During processing, the message **Quantification in progress** appears at the bottom of the screen. If an error occurs, the message **Error quantifying cut sets** will be displayed at the bottom of the screen.

Upon completion of the quantification process, the results are displayed as shown in Figure 85. The requantify flag 'q' will then be removed from every sequence on the Analyze Sequence screen for which the quantification process has been performed.

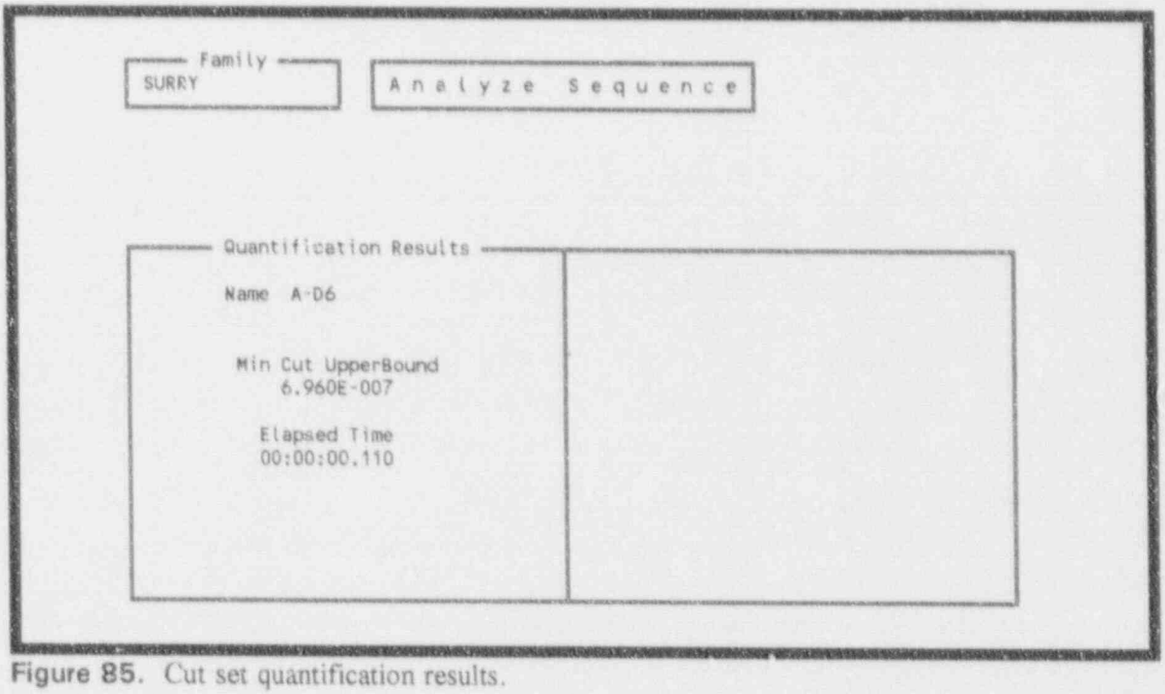


Figure 85. Cut set quantification results.

4.3.4 Uncertainty Analysis

This option allows you to run a single uncertainty analysis for a sequence or an overall uncertainty analysis for a group of sequences. When you enter a <U> and press <Enter>, Figure 86 is displayed. As shown, the four types of overall uncertainty analyses available are: an analysis for a single sequence, a group of marked sequences, an analysis for all sequences having a particular end state, or an analysis for all sequences within the current family.

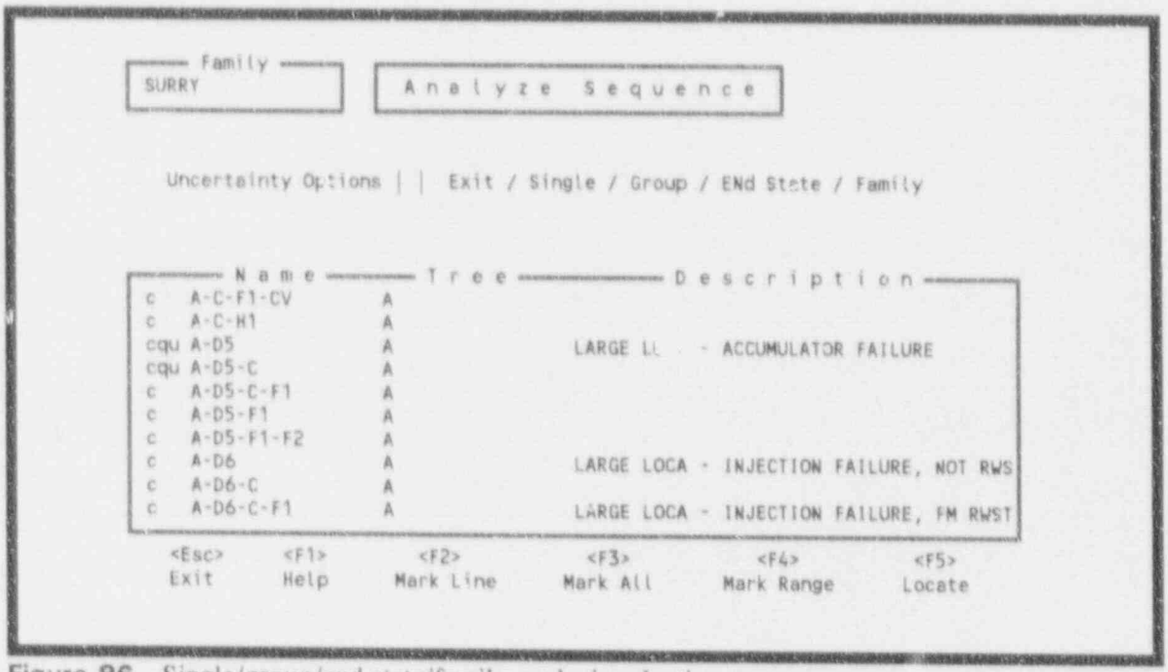


Figure 86. Single/group/end state/family analysis selection screen.

There are two different sampling techniques provided to the user for generating the samples which will be used in the uncertainty analysis calculations. The two sampling techniques are the Monte Carlo simulation technique and the Latin Hypercube simulation technique.

4.3.4.1 Exit. This option terminates the uncertainty analysis process and returns you to the Analyze Sequence screen. To invoke this option enter an <E> in the option field and press <Enter>, or press the <Esc> key.

4.3.4.2 Single. To generate a single uncertainty analysis, enter an <S> in the option field. The Sequence Uncertainty menu will be displayed (Figure 87). From this menu you may run a single uncertainty analysis for either a single highlighted sequence, for a group of marked sequences, or for all of the sequences within the current family.

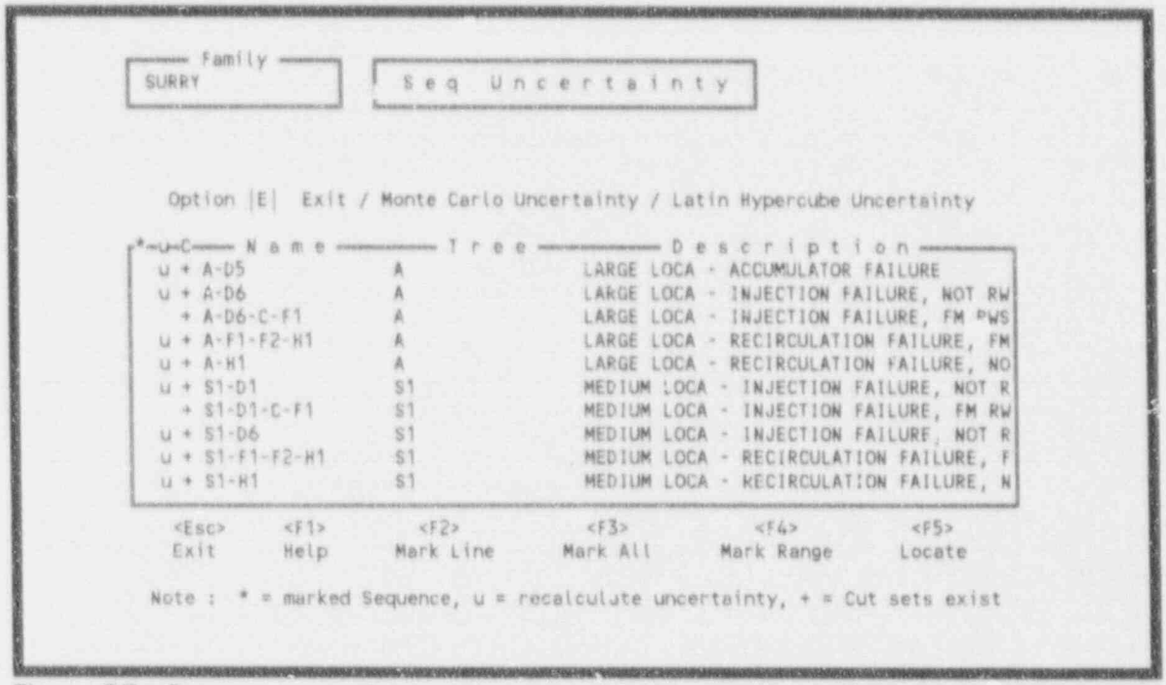


Figure 87. Sequence uncertainty menu.

To invoke the uncertainty analysis process for a single selected sequence type <L> or <M> (Latin Hypercube / Monte Carlo) in the option field, highlight the desired sequence, and press <Enter>. To invoke this process for a group of sequences, mark the desired sequences using the function keys F2, F3, and F4, type an <L> or <M> in the option field and press <Enter>. To invoke this process for all sequences in the current family, clear all marked sequences and then type an <L> or <M> in the option field and press <Enter>. A message **Process all entries? (Y/N)** will appear at the bottom of the screen. Type a <Y> to continue the uncertainty analysis for all of the sequences, or type an <N> to terminate the analysis.

When you have entered the desired sampling technique for the uncertainty analysis, the Uncertainty Calculation Values screen will be displayed (Figure 88 for Monte Carlo calculation values). This screen prompts you to enter the number of samples to be generated during the simulation and the initial value of the seed for the random number generator. A default seed value for the random seed may be provided. You may use this value or enter a new value for the seed. To obtain a random seed from the system clock, enter a zero in this field. There will also be a default value in the field for the number of samples. You may use this value or enter another value. You may change the default values for both the number of samples and the random seed in the Utility Options, Define Constants suboption.

When using the Monte Carlo sampling technique for the uncertainty analysis, if the number of samples entered is less than ten, then the number of samples will be increased to ten before the uncertainty analysis process will continue. Any number of samples greater than or equal to ten will be allowed, but a number of at least 1000 is probably a better value for improving the reliability of the Monte Carlo results.

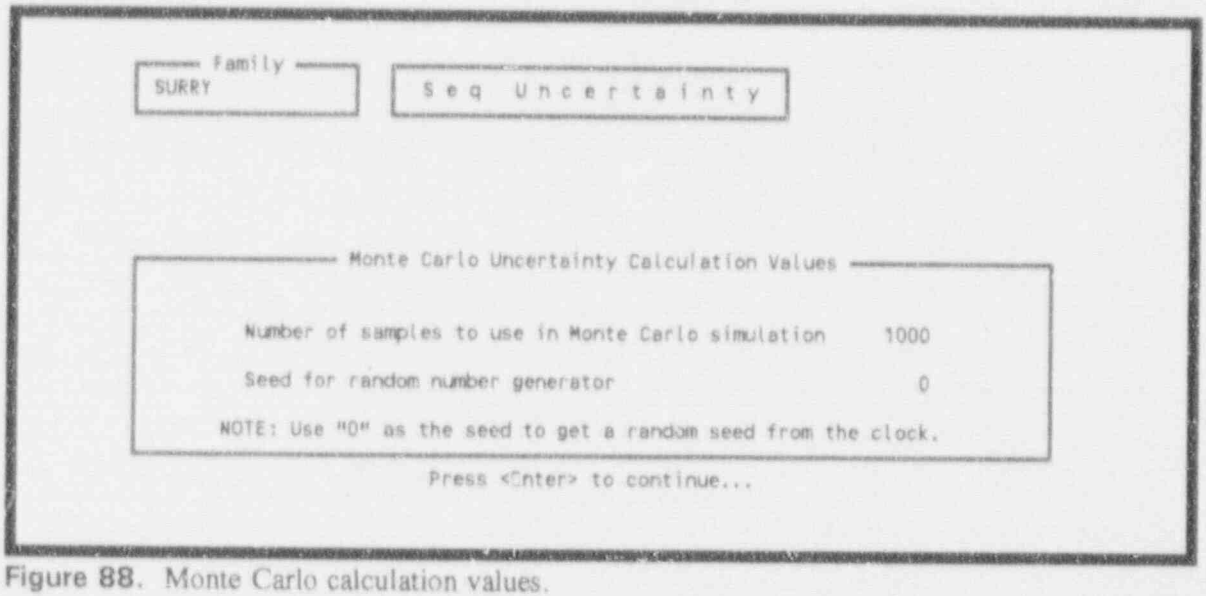


Figure 88. Monte Carlo calculation values.

When using the Latin Hypercube sampling (LHS) technique, if the number of samples entered is less than twice the total number of unique events in the sequence, then the number of samples will be increased to two times the total number of unique events before the analysis will continue. The LHS technique gives its best results if the number of samples is at least twice the total number of unique events.

Once the number of samples has been accepted and a seed obtained from the system clock if necessary, checks will be run to ensure the events with the same correlation classes have consistent failure data, uncertainty data, and distribution types. If any events with inconsistencies exist, an error message will be displayed and the uncertainty analysis process will be terminated so that the inconsistent values may be corrected.

If an error of some type occurs during the uncertainty analysis process, the process is terminated and the message **Error in Uncertainty analysis** is displayed at the bottom of the Analyze Sequence screen. If all of the events successfully pass the correlation class checks, then the distribution parameters for the events will be checked to ensure that they are valid. If any of the parameters are invalid, error messages will be displayed and the process will be terminated so the distribution parameters may be corrected by the user.

After both of these checks have been passed, a point estimate will be calculated for the selected sequence. At this point the samples for each event will be generated using the selected sampling technique, either Monte Carlo Sampling technique or the Latin Hypercube Sampling technique. The uncertainty analysis function provides the user with eight different distribution types for both of the two sampling techniques. The distribution types include Normal, Lognormal, Beta, Gamma, Chi-Squared, Exponential, Uniform and the user-defined histograms.

During processing the current status screen will be displayed and updated as the samples are generated. Figure 89 illustrates the current status screen for the Monte Carlo sampling technique. When the requested number of samples has been generated or the user has terminated the process of generating the samples by pressing the <Esc> key, statistical information will be calculated using the generated

samples. A sample mean, median, and standard deviation will be calculated for the selected sequence. Coefficients of skewness and kurtosis, and quantile values will also be calculated for the sequence. This data will be saved in the data base for the selected sequence.

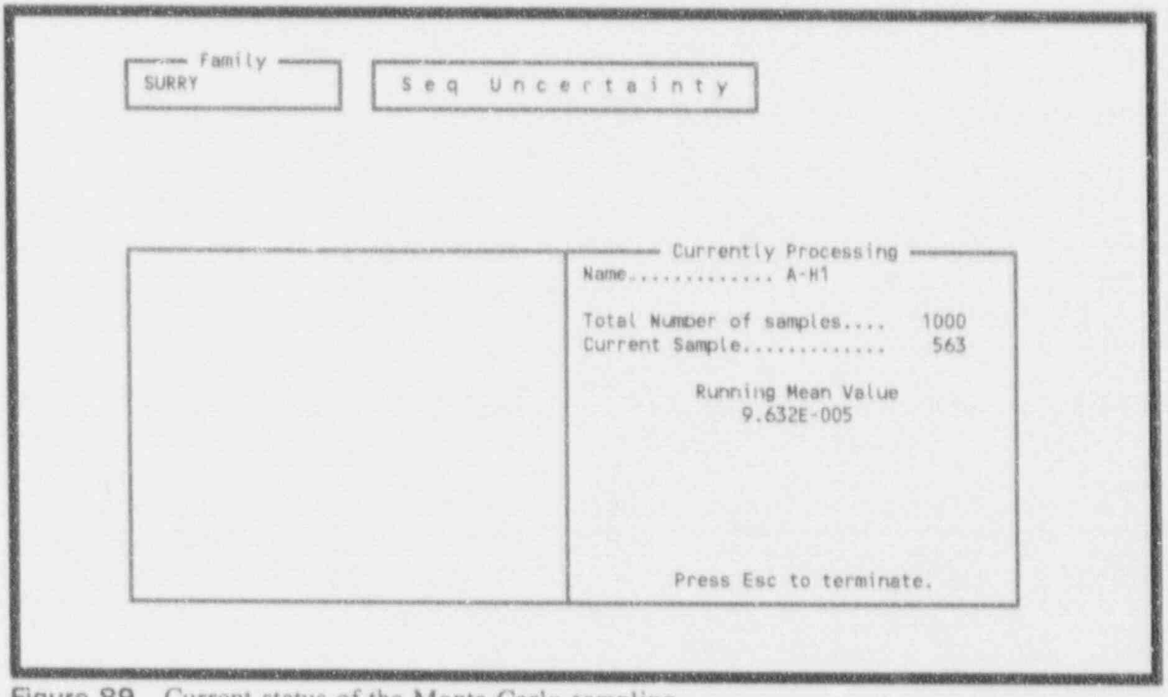


Figure 89. Current status of the Monte Carlo sampling.

Upon completion of these calculations, the following values will be displayed on the Uncertainty Results screen for viewing: the sequence name, random seed used, the number of samples generated in this process, the total number of events and cut sets in the sequence being processed, the point estimate, the mean, the median, the 5th and 95th percentile values, the minimum and maximum generated sample values, the standard deviation, the skewness and kurtosis, and the time involved to perform the analysis. Figure 90 illustrates the Uncertainty Results screen for the Monte Carlo sampling technique.

If only one sequence was selected (highlighted) for the uncertainty analysis process, then you will need to press <Enter> to return to the Analyze Sequence screen from the Uncertainty Results screen. However, if more than one sequence is being processed, the Uncertainty Results screen will be displayed for each sequence, and when all of the selected sequences have been processed you will be returned automatically to the Analyze Sequence screen.

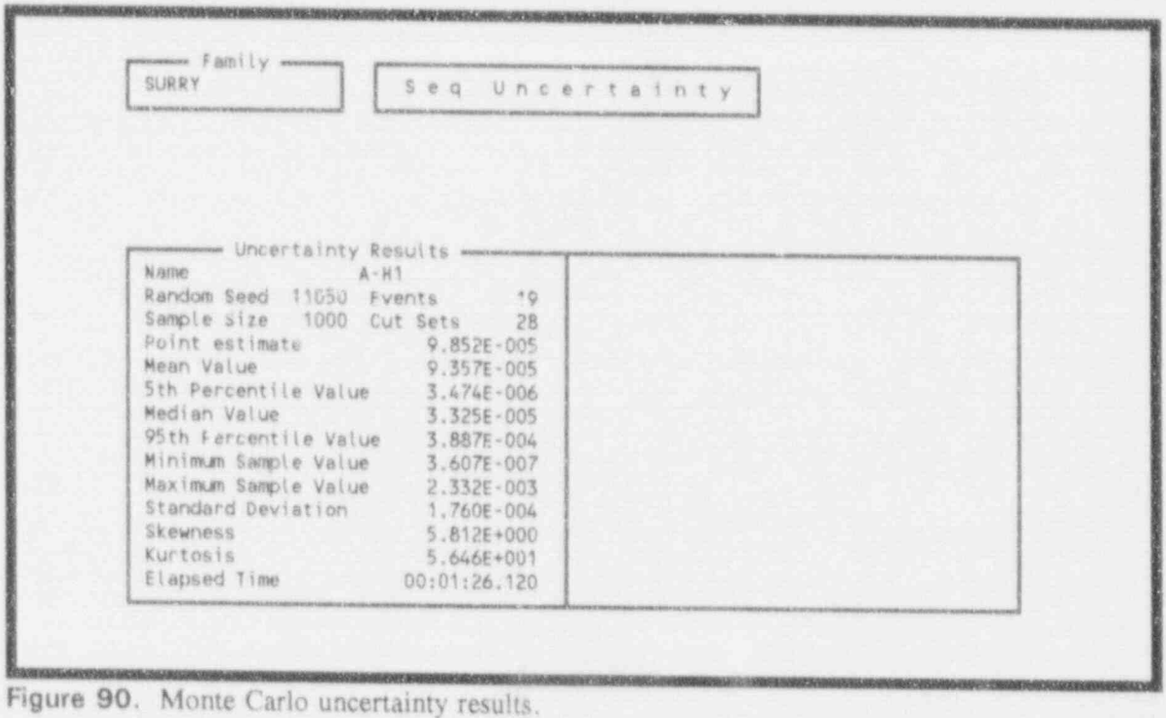


Figure 90. Monte Carlo uncertainty results.

4.3.4.3 Group. To generate an overall uncertainty analysis for a group of sequences, enter a <G> in the option field. The Group Uncertainty menu will be displayed (Figure 91).

To invoke the overall uncertainty analysis process for a single group of sequences, type <L> or <M> (Latin Hypercube / Monte Carlo) in the option field, and press <Enter>. To invoke the process for a group of sequences, mark the desired groups using the function keys <F2>, <F3>, and <F4>, type an <L> or <M> in the option field, and press <Enter>. To invoke this process for all groups, clear all marked groups and then type an <L> or <M> in the option field and press <Enter>. A message **Process all entries? <Y/N>** will appear at the bottom of the screen. Type a <Y> to continue the uncertainty analysis for all groups, or type an <N> to terminate the analysis.

When you have entered the desired sampling technique for the uncertainty analysis, the Uncertainty Calculation Values screen will be displayed. This screen is similar to the one shown in Figure 88 (refer to Section 4.3.4.2 for details). Once you have entered valid values for the uncertainty calculations, the uncertainty analysis process will begin. During processing the current group status screen will be displayed and updated as the samples are generated. Twenty-five samples will be generated at a time, before the status screen will be updated with a new calculated mean value. Figure 92 illustrates the current group status screen for the Monte Carlo sampling technique. When the requested number of samples has been generated or the user has terminated the process of generating the samples by pressing the <Esc> key, statistical information will be calculated using the generated samples. A sample mean, median, and standard deviation will be calculated for the entire group of sequences. Coefficients of skewness, kurtosis, and quantile values will also be calculated for the group.

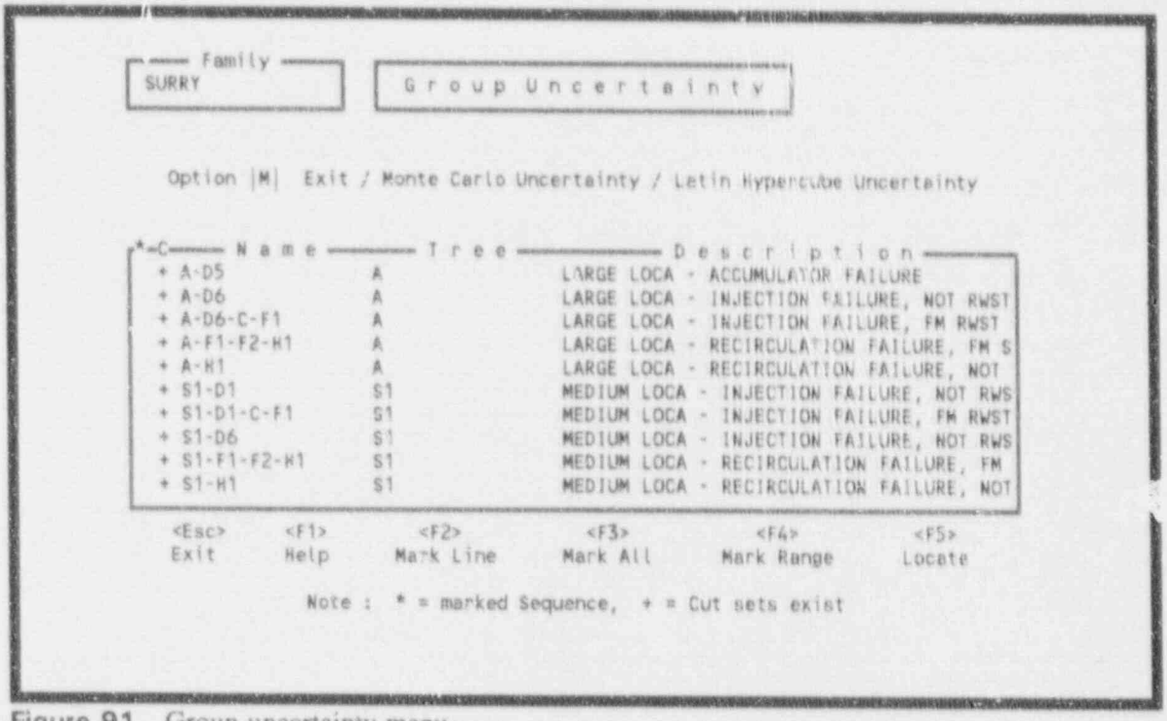


Figure 91. Group uncertainty menu.

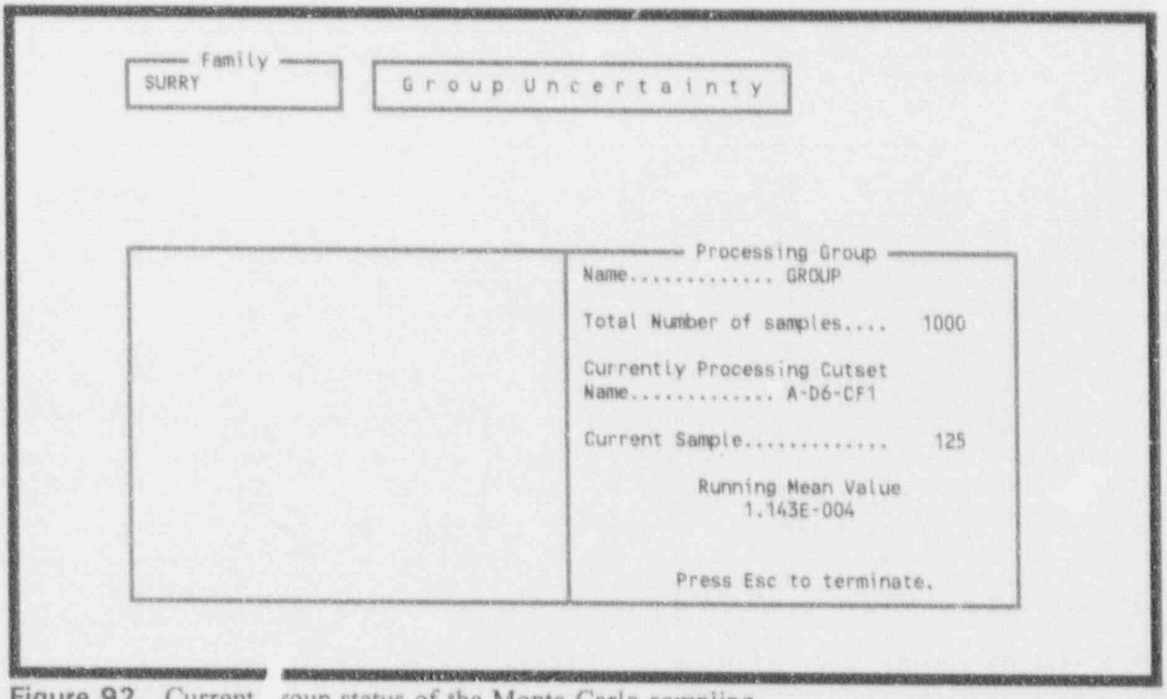


Figure 92. Current roup status of the Monte Carlo sampling.

Upon completion of these calculations, the following values will be displayed on the Uncertainty Results screen for viewing: the group name, random seed used, the number of samples generated in this process, the total number of events and cut sets in the group of sequences being processed, the point estimate, the mean, the median, the 5th and 95th percentile values, the minimum and maximum generated sample values, the standard deviation, the skewness and kurtosis, and the time involved to perform the analysis. The results of overall uncertainty analysis for a group of sequences is not stored in the data base. Figure 93 illustrates the group Uncertainty Results screen for the Monte Carlo sampling technique.

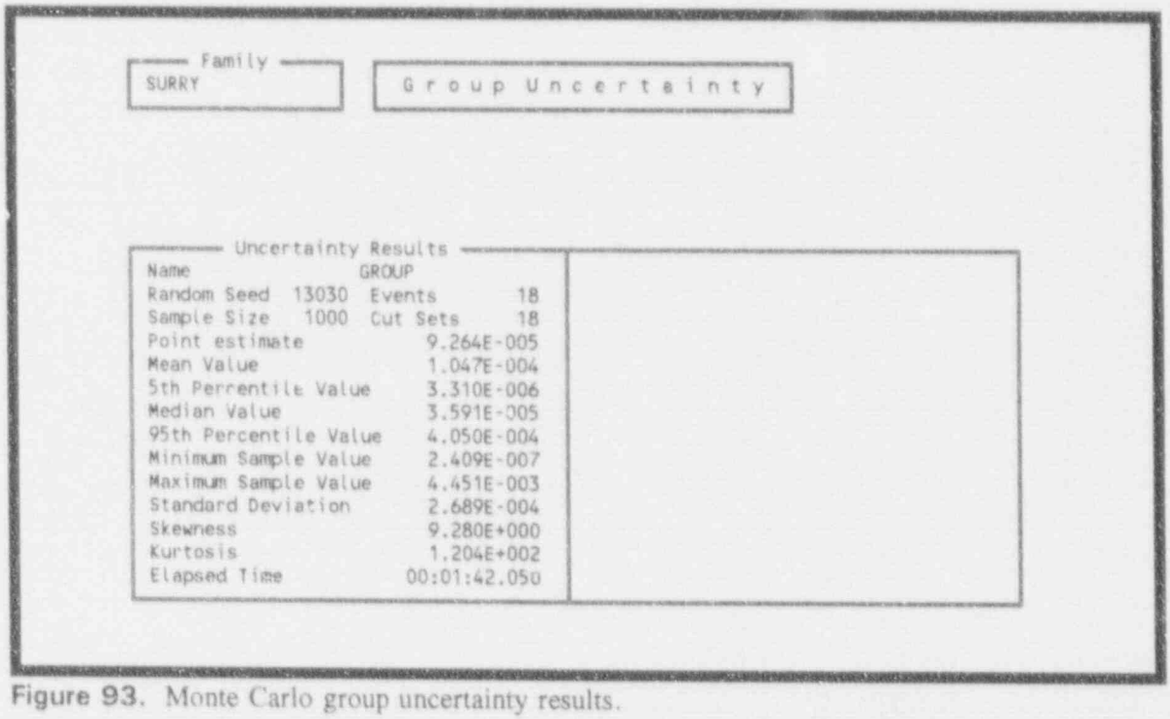


Figure 93. Monte Carlo group uncertainty results.

4.3.4.4 ENd State. To generate an overall uncertainty analysis for all of the sequences within a selected end state, enter an <N> in the option field. The End State Uncertainty menu will be displayed (Figure 94). From this menu, mark the sequences that will make up the group using the F2, F3, and F4 function keys. From this menu you may run an overall uncertainty analysis for either a single highlighted end state, for a group of marked end states, or for all of the end states within the current family.

To invoke the uncertainty analysis process for a single selected end state type <L> or <M> (Latin Hypercube / Monte Carlo) in the option field, highlight the desired end state, and press <Enter>. To invoke this process for a group of end states, mark the desired end states using the function keys F2, F3, and F4, type an <L> or <M> in the option field and press <Enter>. To invoke this process for all the end states in the current family, clear all marked sequences and then type an <L> or <M> in the option field and press <Enter>. A message **Process all entries? (Y/N)** will appear at the bottom of the screen. Type a <Y> to continue the uncertainty analysis for all of the end states, or type an <N> to terminate the analysis.

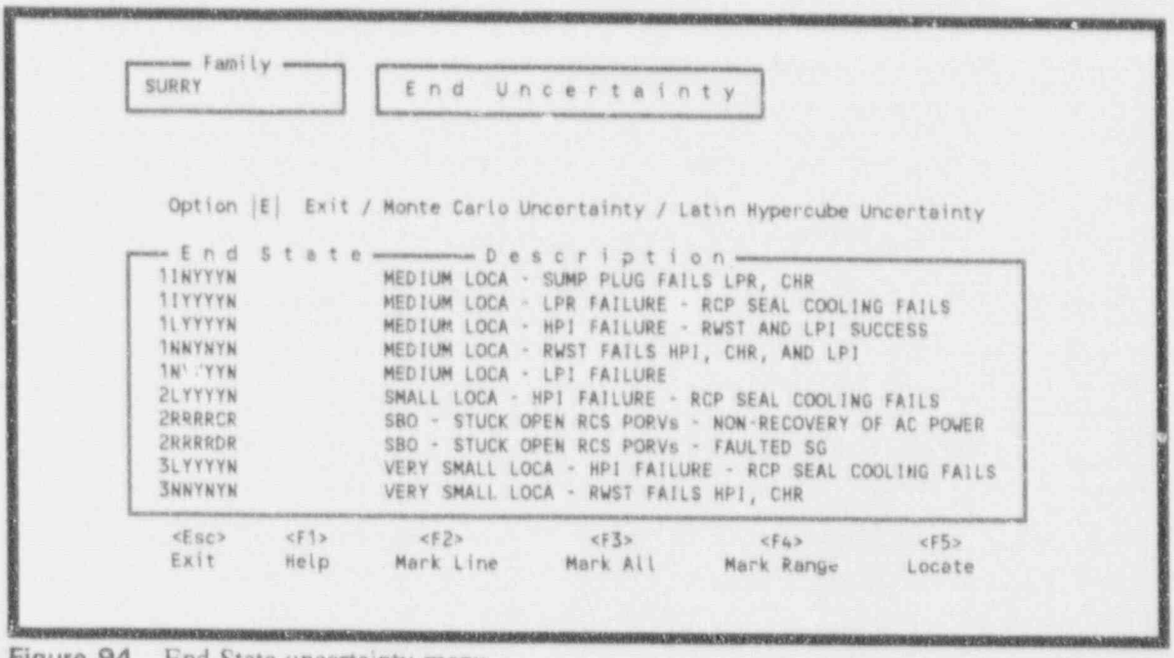


Figure 94. End State uncertainty menu.

When you have entered the desired sampling technique for the uncertainty analysis, the Uncertainty Calculation Values screen (see Figure 88) will be displayed. Once you have entered valid values for the uncertainty calculations, the uncertainty analysis process will begin. During processing the current End State status screen will be displayed and updated as the samples are generated.

Twenty-five samples will be generated at a time, before the status screen will be updated with a new calculated mean value. Figure 95 illustrate the current End State status screen for the Latin Hypercube sampling technique. When the requested number of samples has been generated or the user has terminated the process of generating the samples by pressing the <Esc> key, statistical information will be calculated using the generated samples. A sample mean, median, and standard deviation will be calculated for the entire group of sequences within the current end state. Coefficients of skewness and kurtosis, and quantile values will also be calculated for the end state. This data will be saved in the data base for the current end state.

Upon completion of these calculations, the following values will be displayed on the Uncertainty Results screen for viewing: the end state name, random seed used, the number of samples generated in this process, the total number of events and cut sets in the end state being processed, the point estimate, the mean, the median, the 5th and 95th percentile values, the minimum and maximum generated sample values, the standard deviation, the skewness and kurtosis, and the time involved to perform the analysis. Figure 96 illustrates the End State Uncertainty Results screens for the Latin Hypercube sampling technique.

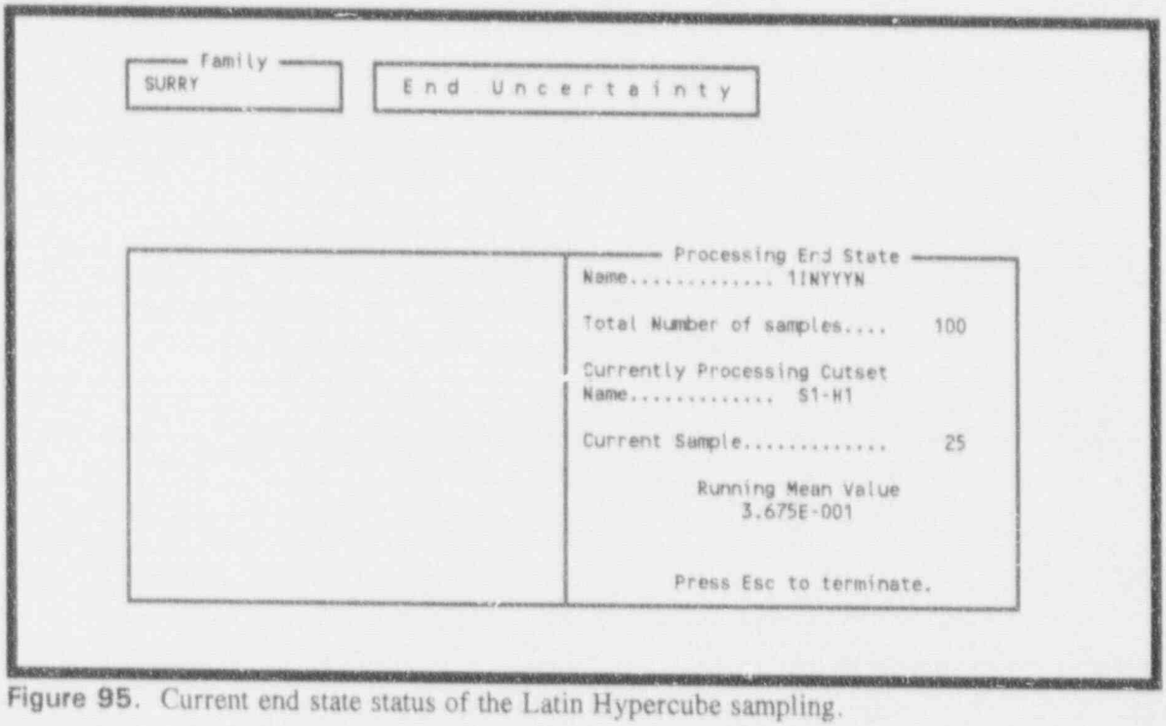


Figure 95. Current end state status of the Latin Hypercube sampling.

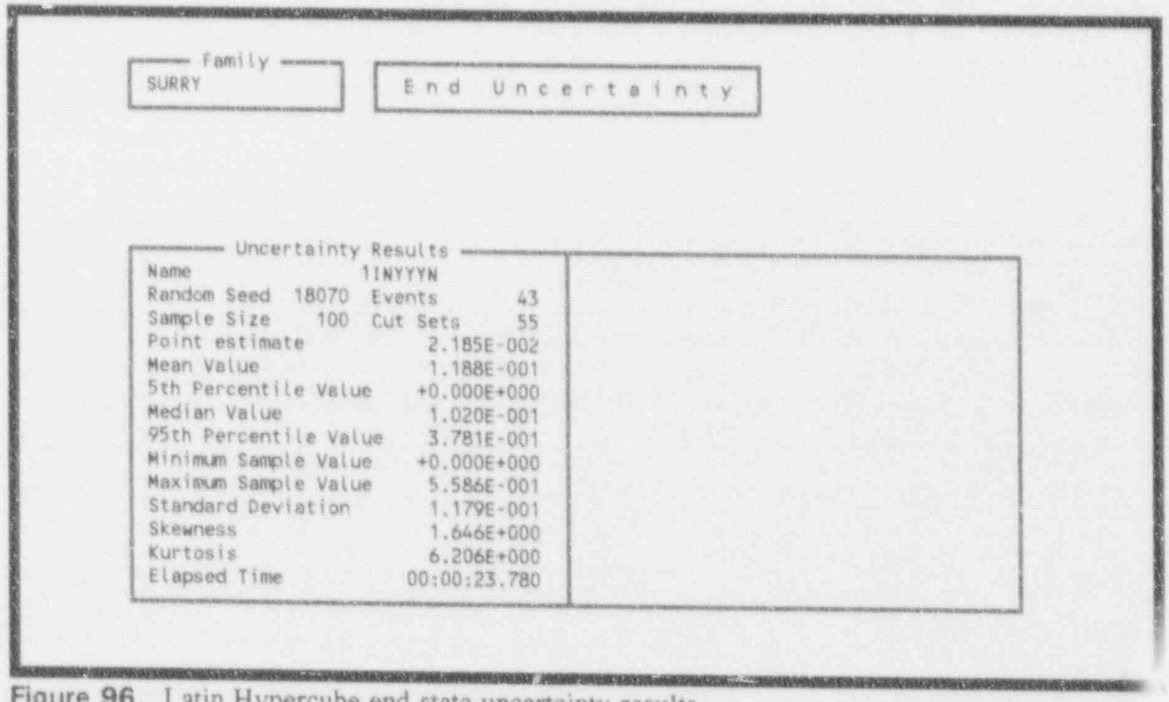


Figure 96. Latin Hypercube end state uncertainty results.

If only one end state was selected (highlighted) for the overall uncertainty analysis process, press <Enter> to return to the Analyze Sequence screen from the Uncertainty Results screen. However, if more than one end state is being processed, the Uncertainty Results screen will be displayed for each end state, and when all of the selected End States have been processed you will automatically be returned to the Analyze Sequence screen.

4.3.4.5 Family. To generate an overall uncertainty analysis for all of the sequences within the current family, enter an <F> in the option field. The Family Uncertainty menu will be displayed (Figure 97). From this menu, you select the type of uncertainty analysis to be performed on the family (Monte Carlo or Latin Hypercube).

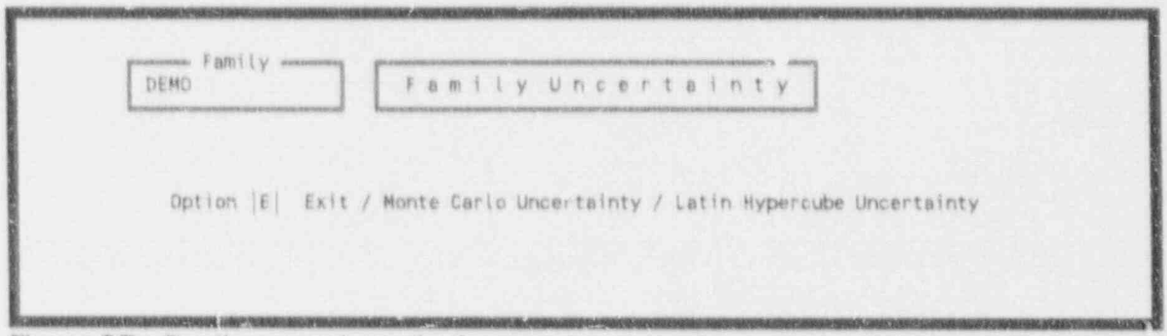


Figure 97. Family uncertainty selection menu.

When you have entered the desired sampling technique for the uncertainty analysis, the Uncertainty Calculation Values screen (Figure 88) will be displayed. Once you have entered valid values for the uncertainty calculation, the uncertainty analysis process will begin. During processing, the current family status screen will be displayed and updated as the samples are generated.

Twenty-five samples will be generated at a time before the status screen will be updated with a new calculated mean value. Figure 98 illustrates the current family status screen for the Latin Hypercube sampling technique. When the requested number of samples has been generated or the user has terminated the process of generating the samples by pressing the <Esc> key, statistical information will be calculated using the generated samples. A sample mean, median, and standard deviation will be calculated for the entire family. Coefficient of skewness and kurtosis, and quantile values will be calculated for the family. This data will be saved in the data base for the current family.

Upon completion of these calculations, the following values will be displayed on the Uncertainty Results screen for viewing: the Family name, random seed used, the number of samples generated in the process, the total number of events and cut sets in the Family being processed, the point estimate, the mean, the median, the 5th and 95th percentile values, the minimum and maximum generated sample values, the standard deviation, the skewness and kurtosis, and the time involved to perform the analysis. Figure 99 illustrates the Family Uncertainty results screens for the Latin Hypercube sampling technique.

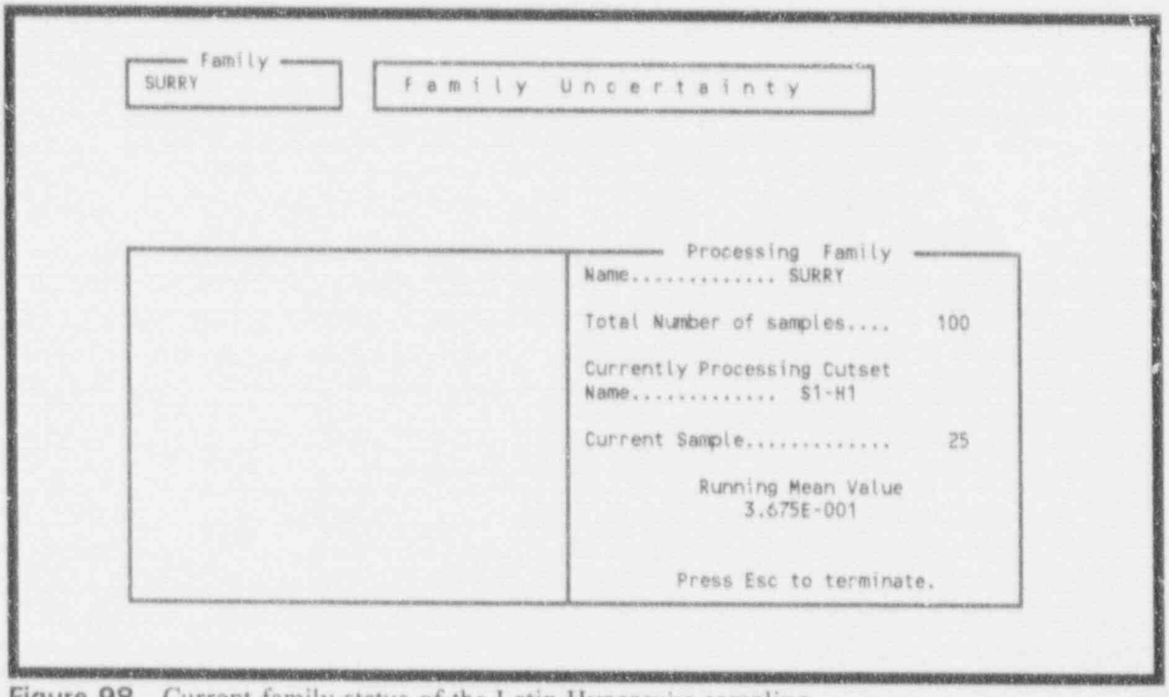


Figure 98. Current family status of the Latin Hypercube sampling.

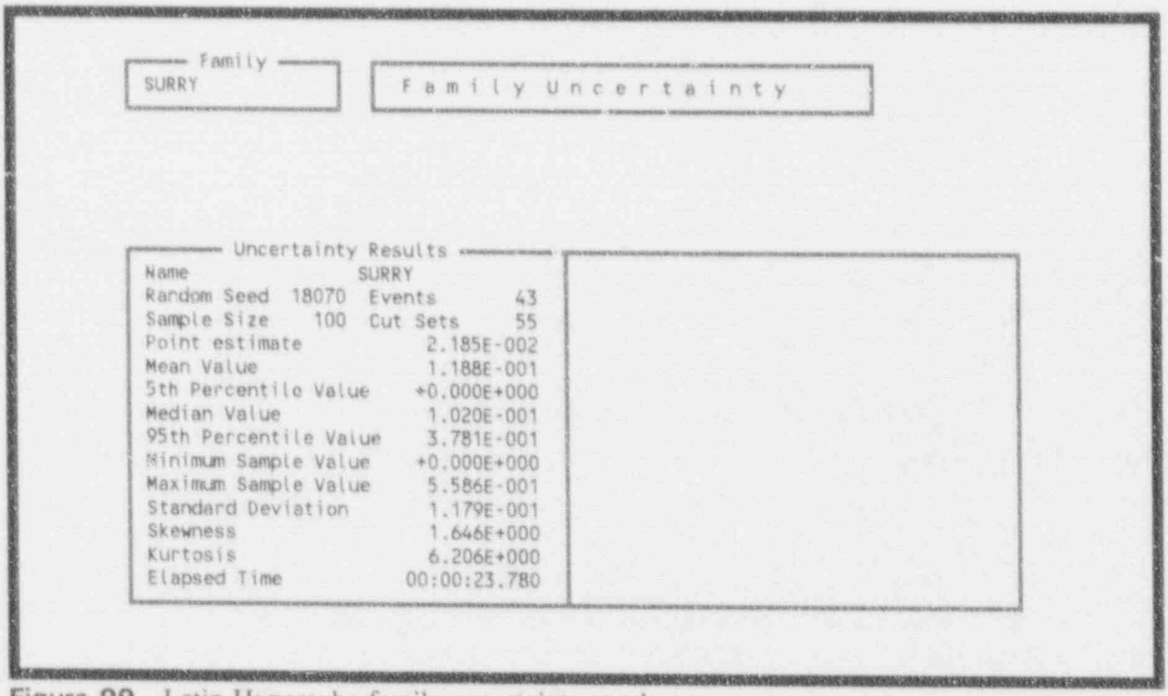


Figure 99. Latin Hypercube family uncertainty results.

4.4 Display Results

4.4.1 Display Event Tree Results

To display the results of your event tree analysis, highlight Display Results or type <D> on the Event Tree Analysis screen and press <Enter>. The Sequence Display screen will be displayed showing a list of the sequences contained in the current family (Figure 100). The following options are available: Exit, Report, Cutsets, Uncertainty, Importance, ENd state, and Sort.

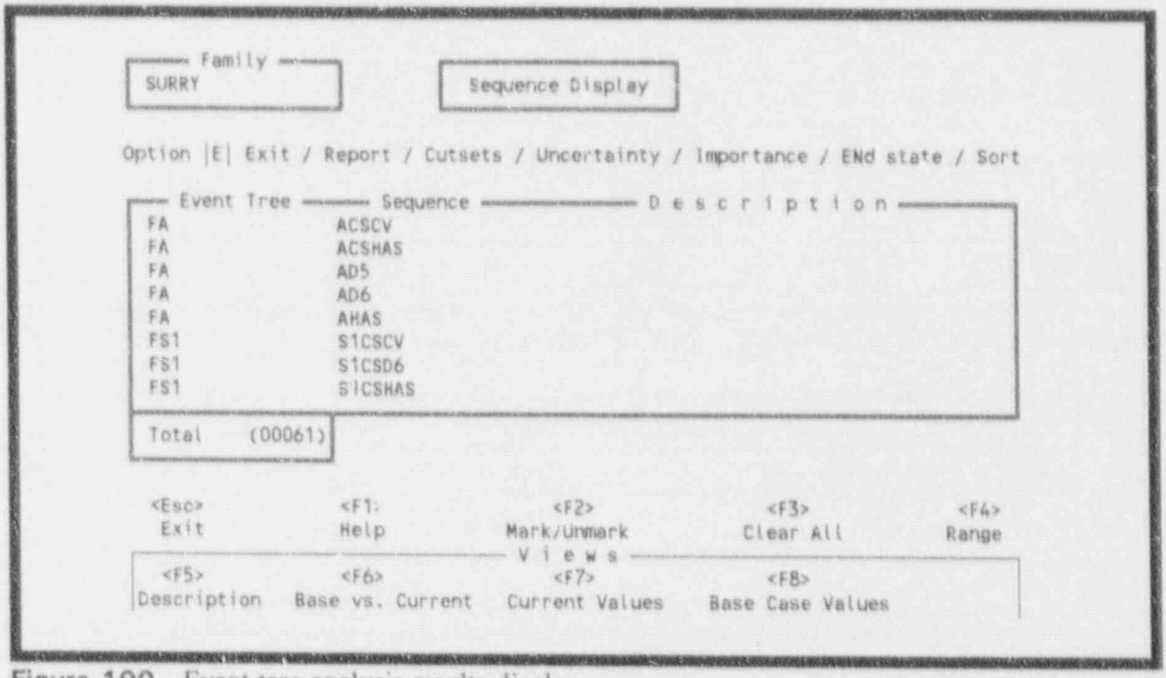


Figure 100. Event tree analysis results display.

Some additional functions appear at the bottom of the Sequence Display screen. These functions (the <Esc> and function keys) operate in the same manner whenever they appear at the bottom of a display.

<Esc>	Returns to the previous screen
<F1>	Displays a general help screen
<F2>	Marks or unmarks a single item in the display list
<F3>	Clears all marked items, or if none are marked then sets all items to marked
<F4>	Marks a range of items
<F5>	Displays a list showing sequence names, event trees, and descriptions.
<F6>	Displays a list showing sequence names, base case, and current frequency values
<F7>	Displays a list showing sequence names and current frequency values.
<F8>	Displays a list showing sequence names and base frequency values.

Selecting one of the view options, in this case <F6>, will change the display as shown in Figure 101.

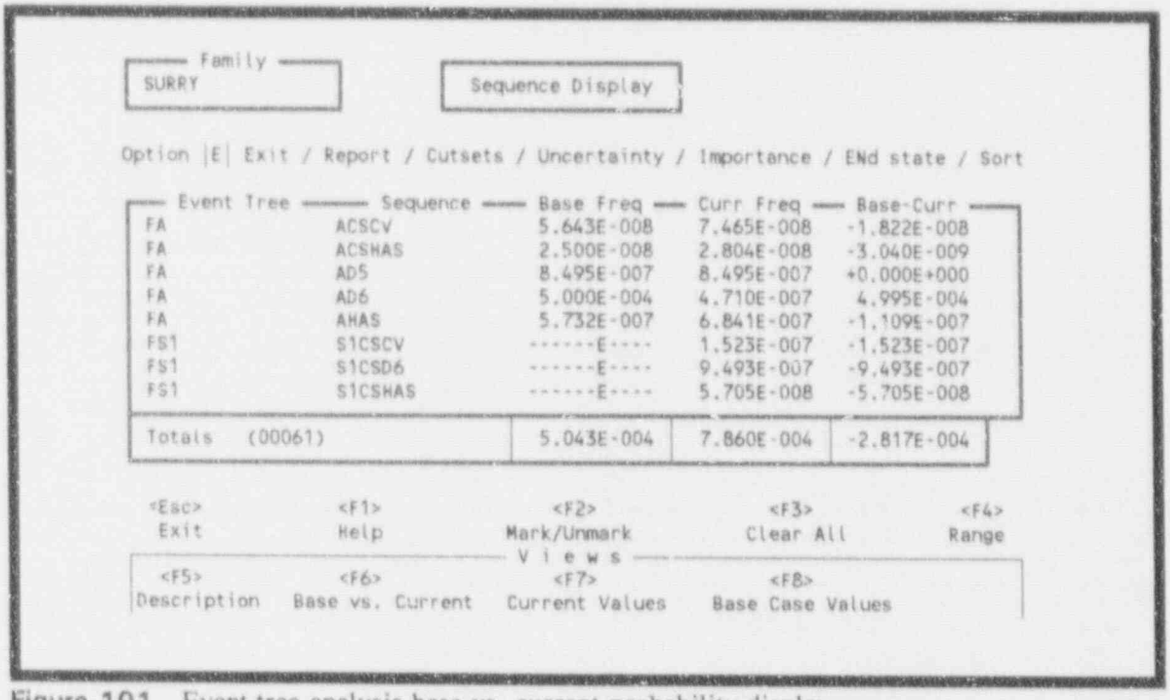


Figure 101. Event tree analysis base vs. current probability display.

4.4.1.1 Exit. This option terminates the process and returns you to the Event Tree Analysis screen. To invoke the option, type <E> in the option field and press <Enter>, or press the <Esc> key.

4.4.1.2 Report. The Report option allows you to generate a report of the data displayed on the screen. The report content is determined by the function key currently invoked (F5 through F8). For example, if you had invoked <F6>, then the "Sequence Base Case vs. Current Case Frequencies" report would be generated. This report shows the base frequency, current frequency, and the difference between the two for each sequence in the current family. The report may be displayed on the console, sent to an attached printer, or saved in a disk file for later processing.

To invoke this option, type <R> in the option field and press <Enter>. Upon pressing <Enter>, the "Report Options" screen is displayed (Figure 102). This screen shows a default report title and output file name; you may change these to match your needs.

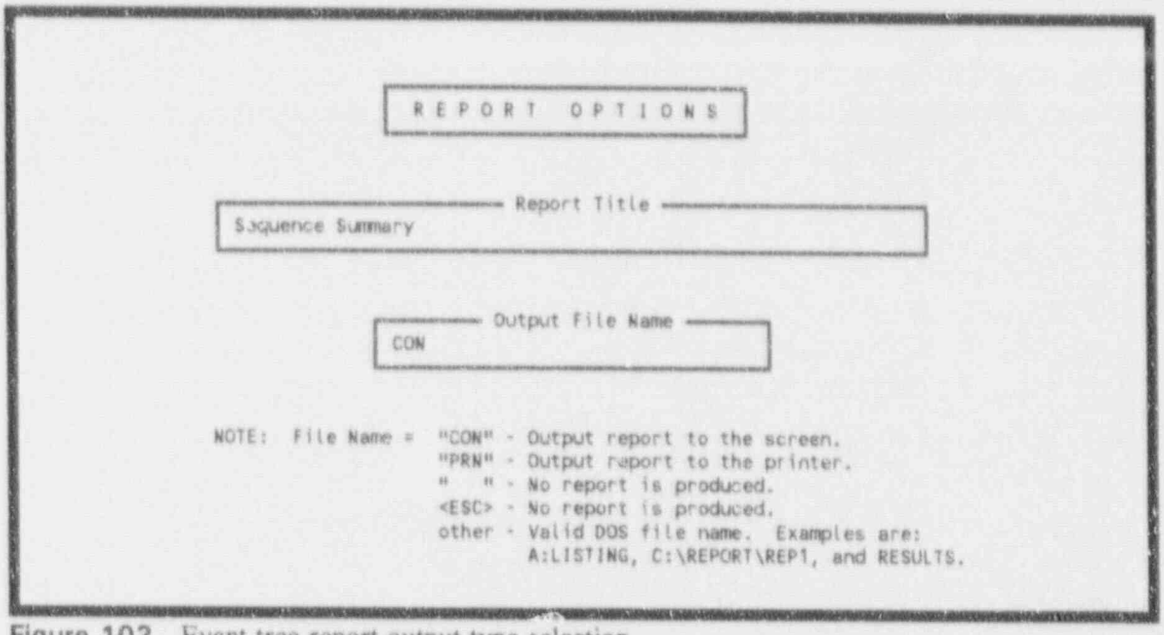


Figure 102. Event tree report output type selection.

4.4.1.3 Cutsets. This option displays the sequence cut sets for the selected sequence (see Figure 103), their percent of contribution to the sequence, frequency, and the event names that make up the cut sets. The sequence minimum upper bound, the number of cut sets that make up the sequence, the current partition upper bound, the percentage that the partition contributes to the sequence, and the number of cut sets in the partition are displayed at the bottom of the screen. To invoke this option, type <C>, highlight the desired sequence, and press <Enter>. From Figure 103, the following options are available: Exit, Partition, Report, Basic Events, and Complement.

4.4.1.3.1 Exit—This option terminates the process and returns you to the previous screen. To invoke this option, type <E> in the option field and press <Enter>, or press <Esc>.

4.4.1.3.2 Partition—The partition option allows you to redefine a sequence as a subset of the original cut sets. This is accomplished by defining a set of events to be used to determine whether a cut set belongs to a partition. The functions available to perform this task are: Exit, Include, EXclude, Complement, Reset, and View Events.

To invoke this option, type <P>, highlight a sequence, and press <Enter>. This will bring up the screen shown in Figure 104.

Exit: This option terminates the process and returns to the previous screen. To invoke this option, type <E> in the option field and press <Enter>, or press <Esc>.

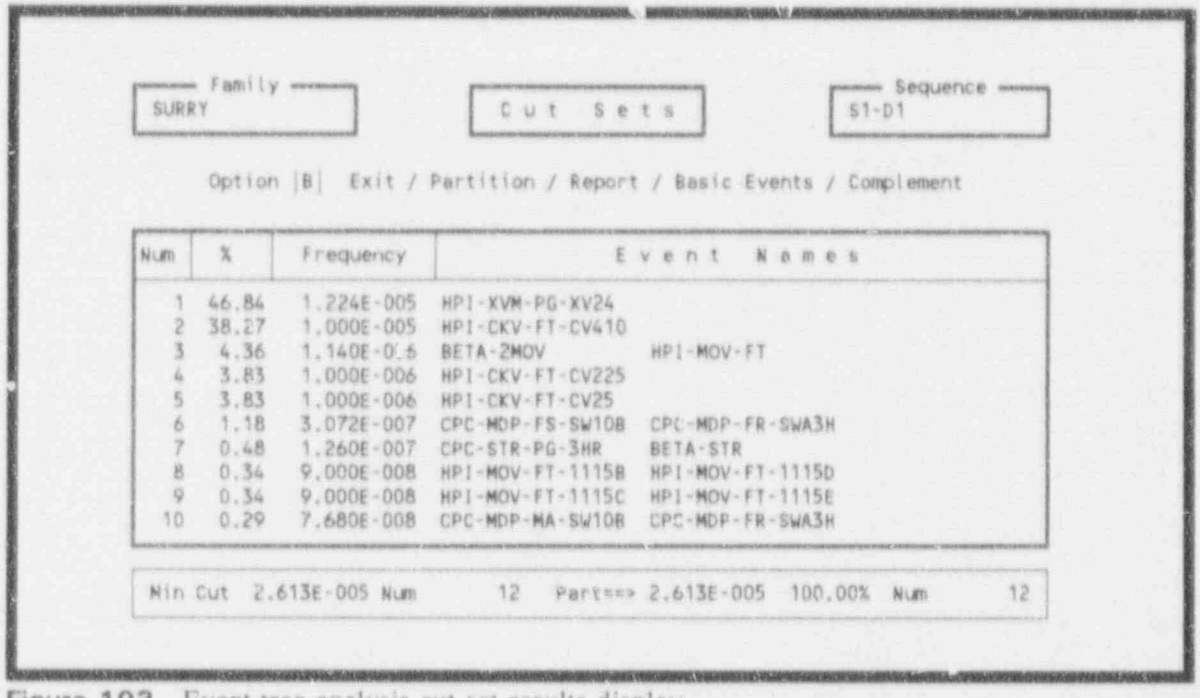


Figure 103. Event tree analysis cut set results display.

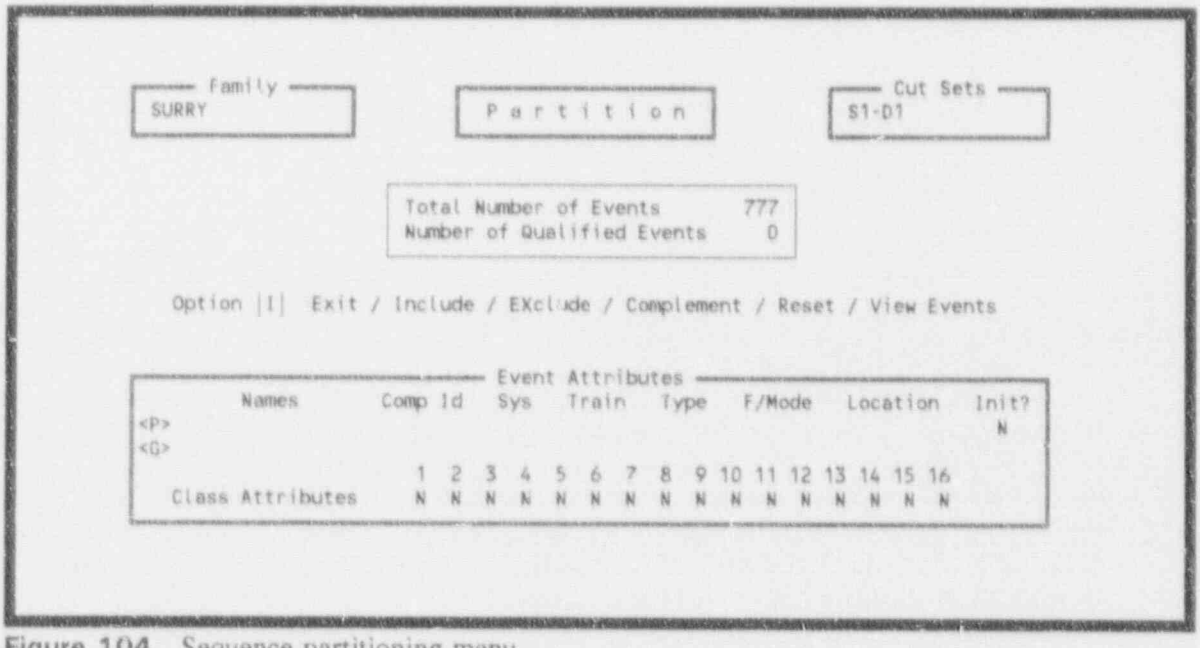


Figure 104. Sequence partitioning menu.

Include: To establish a partition via this option, type <I> in the option field, then fill in the entry fields on the screen that are to be used to qualify the events that may be used in the new partition and press <Enter>. The application proceeds to qualify the events and when complete will update the Number of Qualified Events field that appears at the top of the screen. In this case, qualified events are those events which contain the included attributes. Returning to the Cut Sets screen via the Exit option you will see that the sequence cut set list contains only those cut sets that are made up of qualified events. Figure 105 was the result of specifying the event name "HPI-MOV-FT-1115B" for the "Include" option. If the sequence cut sets do not contain any of the qualified events, then the message **No cutsets qualify** is displayed at the bottom of the screen.

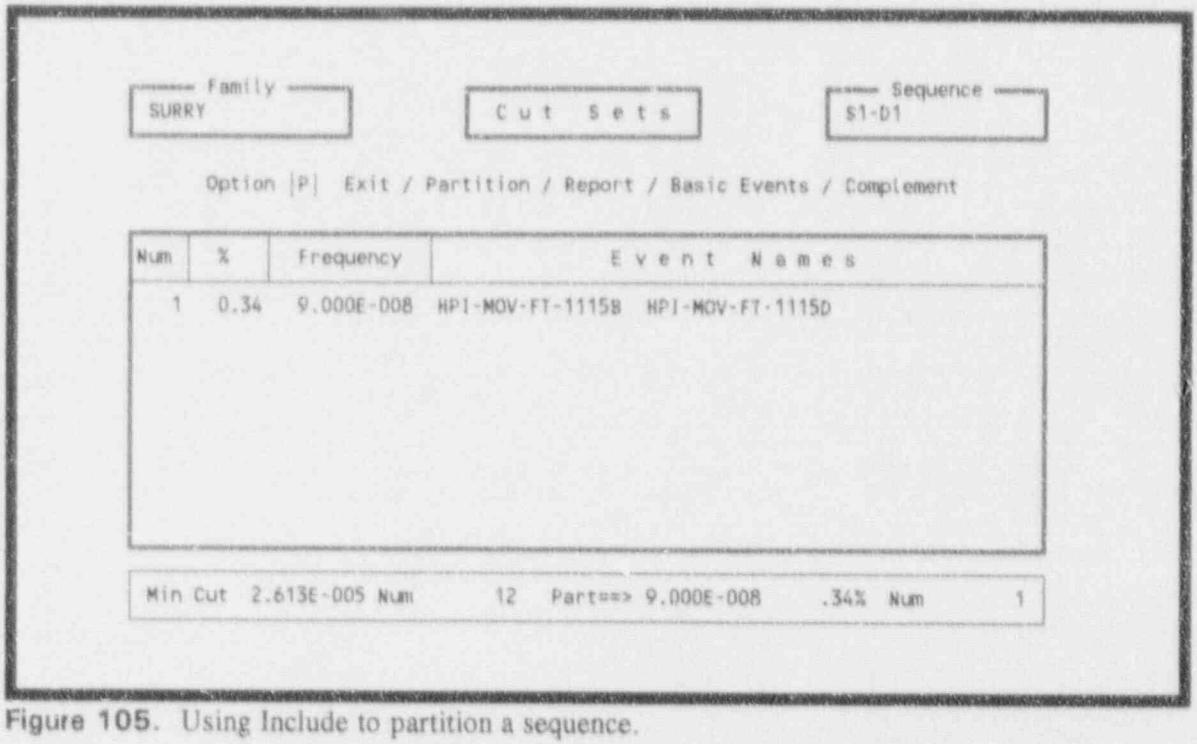


Figure 105. Using Include to partition a sequence.

EXclude: To establish a partition via this option, type <X> in the option field, then fill in the entry fields on the screen that are to be used to remove events from a list of qualified events. The application proceeds to remove the events. When complete, the Number of Qualified Events field that appears at the top of the screen will be updated accordingly. Returning to the Cut Sets screen via the Exit option you will see that the sequence cut set list contains only those cut sets that are made up of qualified events. Figure 106 was the result of specifying the event name "HPI-MOV-FT-1115B" for the "EXclude" option. If the sequence cut sets do not contain any of the qualified events, then the message **No cutsets qualify** is displayed at the bottom of the screen.

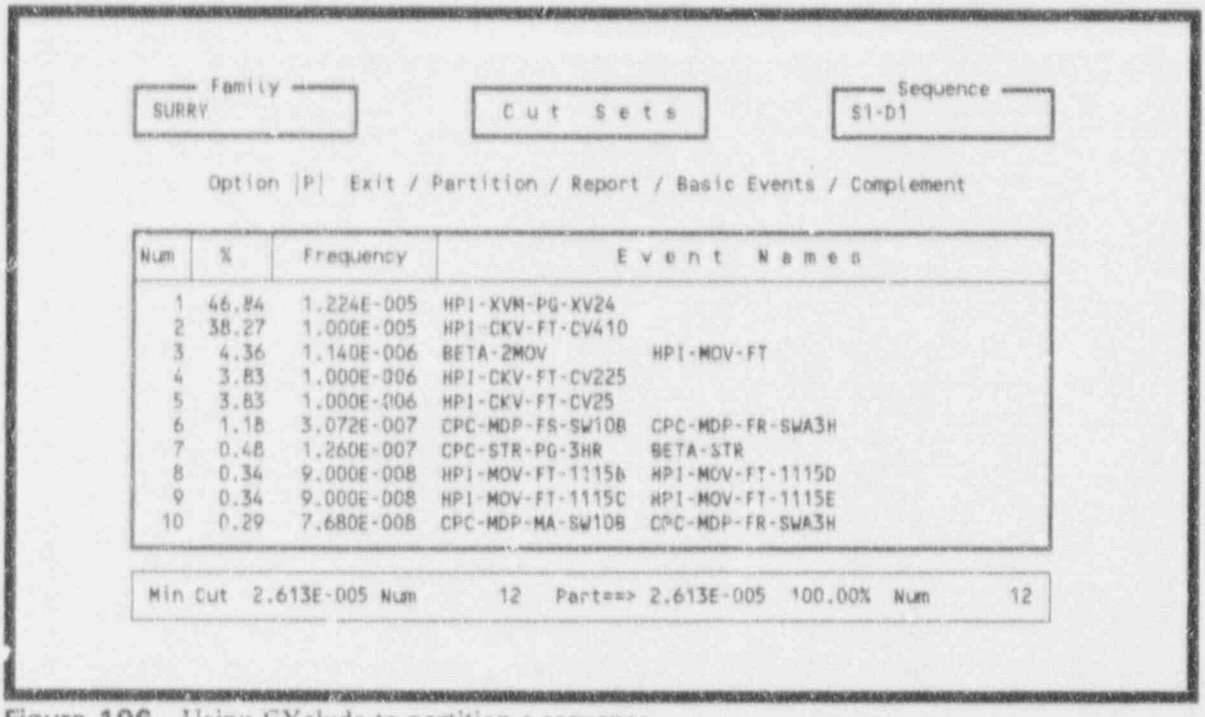


Figure 106. Using EXclude to partition a sequence.

Complement: To establish a partition via this option, type <C> in the option field, and press <Enter>. This causes all currently qualified events to be disqualified, and all unqualified events to become the set of qualified events. The Number of Qualified Events field at the top of the screen will change accordingly. Returning to the Cut Sets screen via the Exit option you will see that the sequence cut set list contains only those cut sets that are made up of qualified events. If the sequence cut sets do not contain any of the qualified events then the message **No cutsets qualify** is displayed at the bottom of the screen.

Reset: This option sets all family events to qualified. This, of course, removes all partitioning from the current sequence cut sets. To activate this option, type <R> in the option field and press <Enter>. (Assume the partition shown in Figure 105). Type <R> in the option field and press <Enter>. The original cut set list is the result, as shown in Figure 103.

View Events: This option displays the list of family events and allows you to mark those events that are to be considered qualified events (Figure 107). To activate this option, type <V> in the option field, and press <Enter>. Mark the events, using <F2>, <F3>, or <F4> keys, that are considered qualified and press <Enter>. If the sequence cut sets do not contain any of the qualified events, then the message **No cutsets qualify** is displayed at the bottom of the screen. You will be returned to the Partition screen.

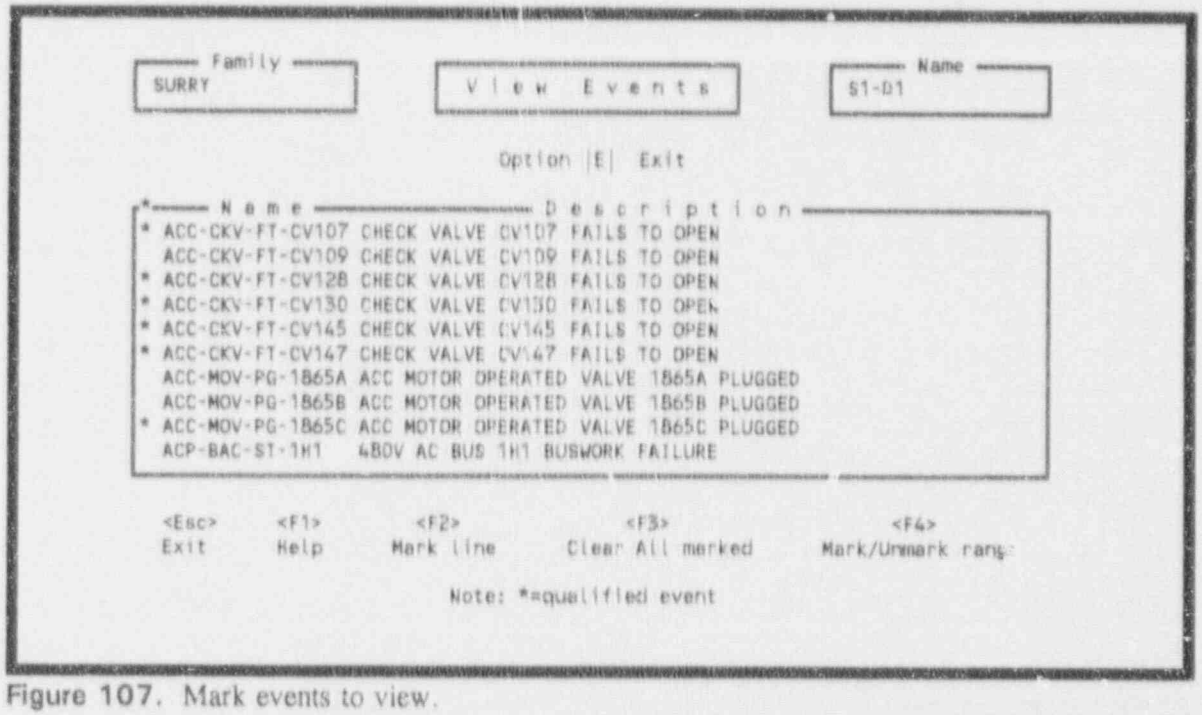


Figure 107. Mark events to view.

4.4.1.3.3 Report—The Report option allows you to generate a report of the data displayed on the screen. The report may be displayed on the console, sent to an attached printer, or saved in a disk file for later processing (Figure 108).

To invoke this option, type <R> in the option field, and press <Enter>. Upon pressing <Enter>, the Report Options screen is displayed (Figure 108). This screen shows a default report title and output file name. You may change these defaults to meet your needs.

4.4.1.3.4 Basic Events—The Basic Event option provides the following detailed information about the events that make up a cut set: name, description, probability, component ID, system, component type, failure mode, and location (Figure 109). To invoke this option, type <B> in the option field, highlight a cut set, and press <Enter>.

4.4.1.3.5 Complement—The Complement option operates on the current event tree partition. Its function is to set all currently qualified cut sets to unqualified. This allows you to split an event tree into two partitions and then switch between the two partitions to view the results. To invoke this option, type <C> in the option field, and press <Enter>. (Assume the partition shown in Figure 105). Type <C> and press <Enter>. The resulting display is shown in Figure 106).

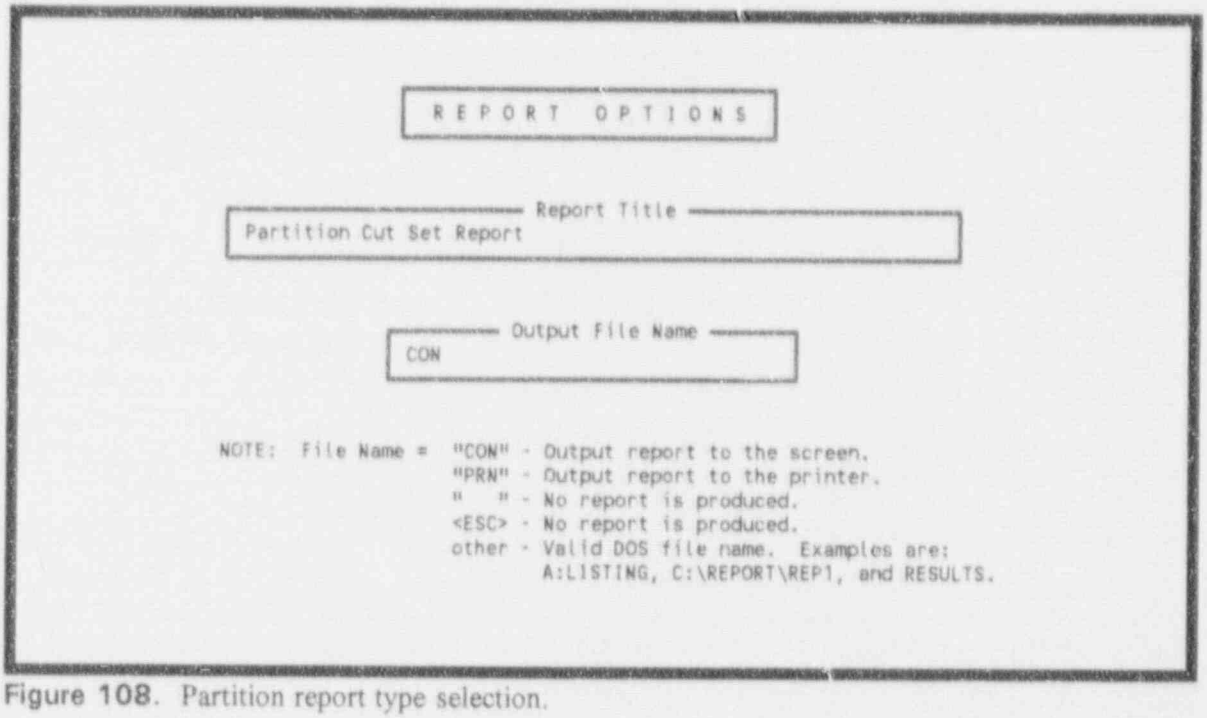


Figure 108. Partition report type selection.

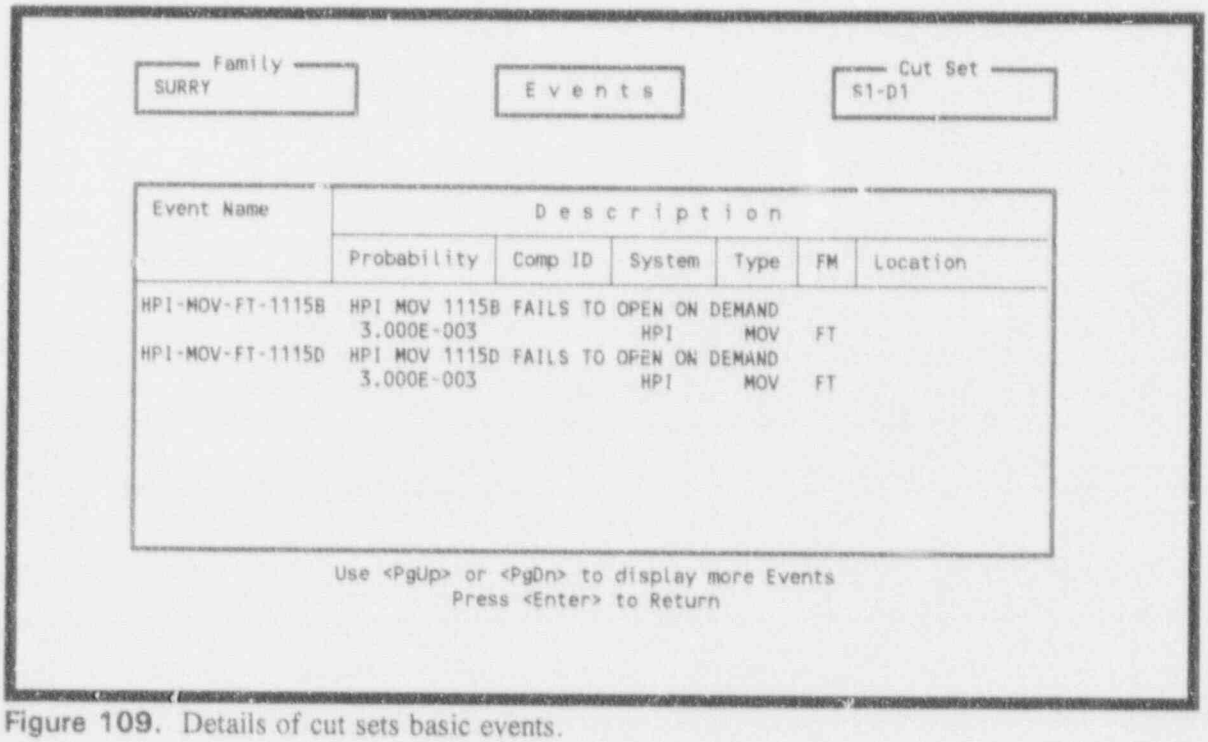


Figure 109. Details of cut sets basic events.

4.4.1.4 Uncertainty. The Uncertainty option displays the distribution and confidence limits of a system for both base and current data values. These values were calculated using either the Latin Hypercube simulation technique or the Monte Carlo simulation technique. To invoke this option, type <U> (Uncertainty) in the option field of the System Display screen, highlight the desired system (or don't highlight a system to display the uncertainty data for the entire family), and press <Enter>. Figure 110 shows the base and current case uncertainty data for the highlighted system.

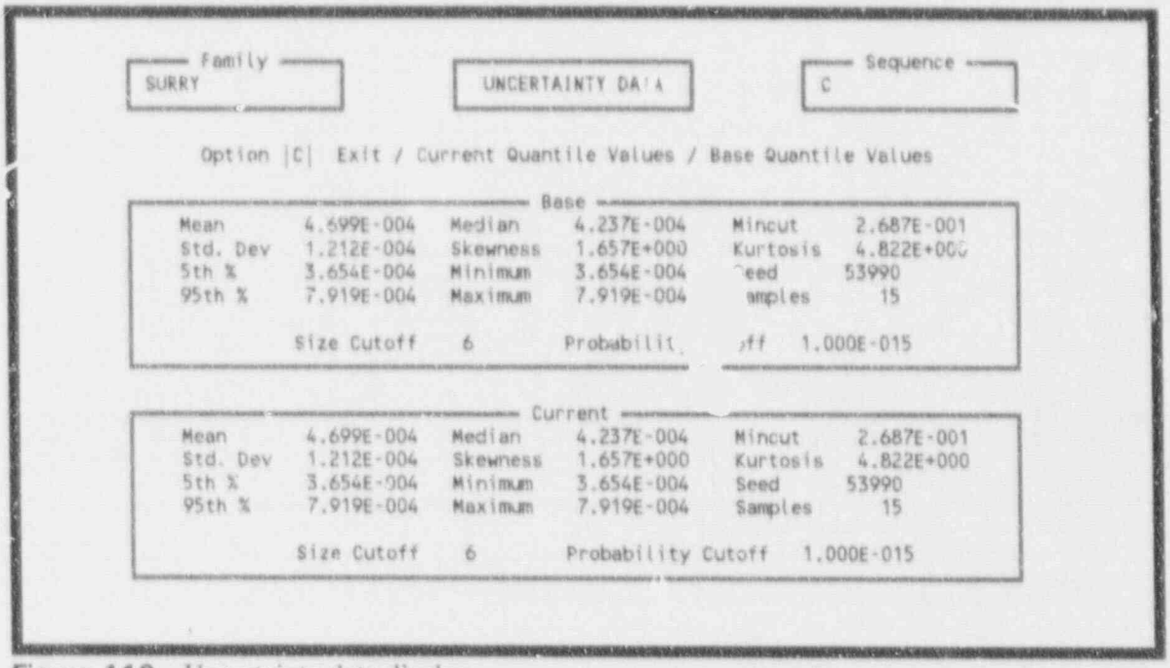


Figure 110. Uncertainty data display.

From this screen you may either return to the Sequence Display screen or view the quantile values associated with the current case data or the base case data. To return to the Sequence Display screen, type an <E> (Exit) in the option field and press <Enter>, or press the <Esc> key. To view the quantile values for the current case type a <C> in the option field and press <Enter>. A screen showing the quantile values will appear, (Figure 111). To return to the previous screen press <Enter>. If you wish to view base case quantile values, type a <B> in the option field and press <Enter>.

4.4.1.5 Importance. This option calculates and displays the following three important measures for each event in the sequence:

- Fussell-Vesely importance - an indication of the percentage of the minimal cut set upper bound contributed by the basic event.
- Risk Reduction Ratio - an indication of how much the minimal cut set upper bound would decrease if the basic event was made perfect (never fail).
- Risk Increase Ratio - an indication of how much the minimal cut set upper bound would increase if the basic event was always failed.

Distribution Quantile Level (in per cent)	95% Confidence Interval On Quantile Level in % (+/-)	Quantile Value	CURRENT CASE 95% Confidence Interval on Quantile Lower Bound	Upper Bound
0.5	6.7	3.6546E-004	3.6546E-004	3.6546E-004
1.0	8.4	3.6546E-004	3.6546E-004	3.6546E-004
2.5	11.2	3.6546E-004	3.6546E-004	3.7003E-004
5.0	14.4	3.6546E-004	3.6546E-004	3.7021E-004
10.0	18.5	3.7003E-004	3.6546E-004	3.9247E-004
20.0	23.6	3.9247E-004	3.6546E-004	4.2324E-004
25.0	25.2	3.9247E-004	3.6546E-004	4.2375E-004
30.0	26.5	3.9301E-004	3.7003E-004	4.2375E-004
40.0	28.1	4.2324E-004	3.7021E-004	4.6749E-004
50.0	28.6	4.2375E-004	3.9247E-004	4.9533E-004
60.0	28.1	4.6749E-004	4.0875E-004	4.9592E-004
70.0	26.5	4.9265E-004	4.2375E-004	6.9206E-004
75.0	25.2	4.9533E-004	4.2375E-004	7.9197E-004
80.0	23.6	4.9592E-004	4.6644E-004	7.9197E-004
90.0	18.5	6.9206E-004	4.9533E-004	7.9197E-004
95.0	14.4	7.9197E-004	4.9592E-004	7.9197E-004
97.5	11.2	7.9197E-004	6.9206E-004	7.9197E-004
99.0	8.4	7.9197E-004	7.9197E-004	7.9197E-004
99.5	6.9	7.9197E-004	7.9197E-004	7.9197E-004

Figure 111. Quantile values display.

If the Intervals flag is set in the Constants Menu, the Birnbaum measure (the partial derivative), the Risk Reduction Interval, and the Risk Increase Interval will be displayed.

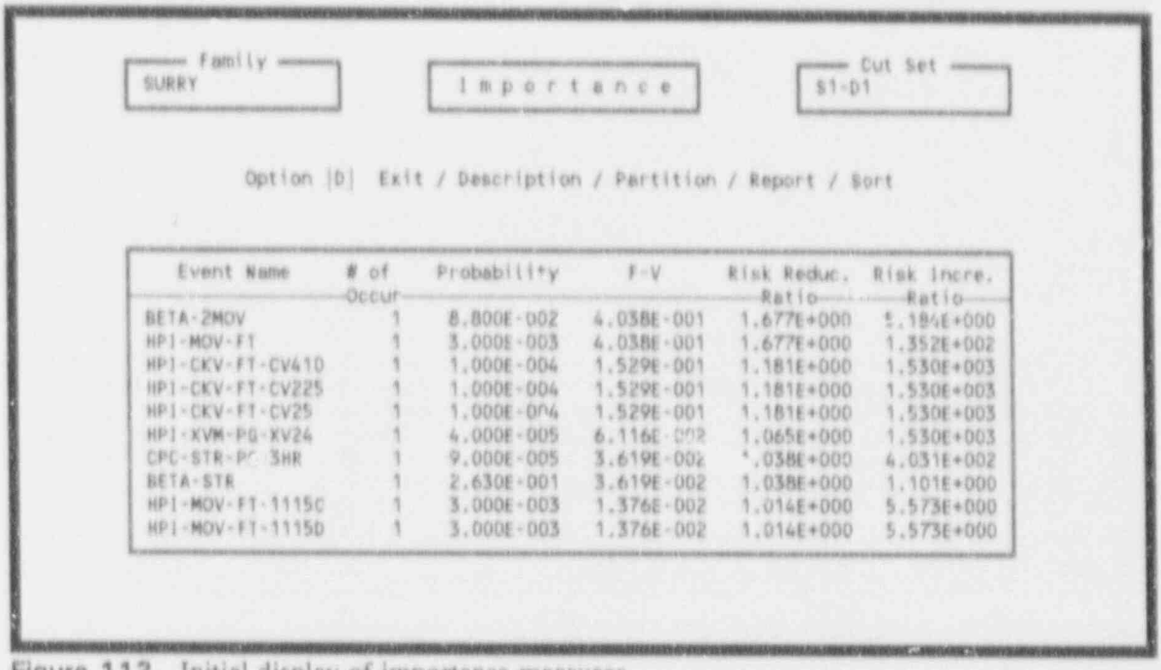
To invoke this option, type <I> in the option field, highlight a sequence (or show the importance to the family by not specifying a sequence) and press <Enter>. By default, when the importance data is first displayed it is sorted, high to low, on Fussell Vesely (Figure 112).

4.4.1.5.1 Exit—Returns to the Sequence Display screen.

4.4.1.5.2 Description—Displays the full description of the highlighted event on the bottom of the screen. To invoke this option, enter a <D>, highlight the desired event, and press <Enter>. If no event is highlighted, the message **An event must be selected first** will be displayed.

4.4.1.5.3 Selection—This option invokes the same process as described in Section 4.4.1.3.2, except the effect is to limit which events are displayed/reported.

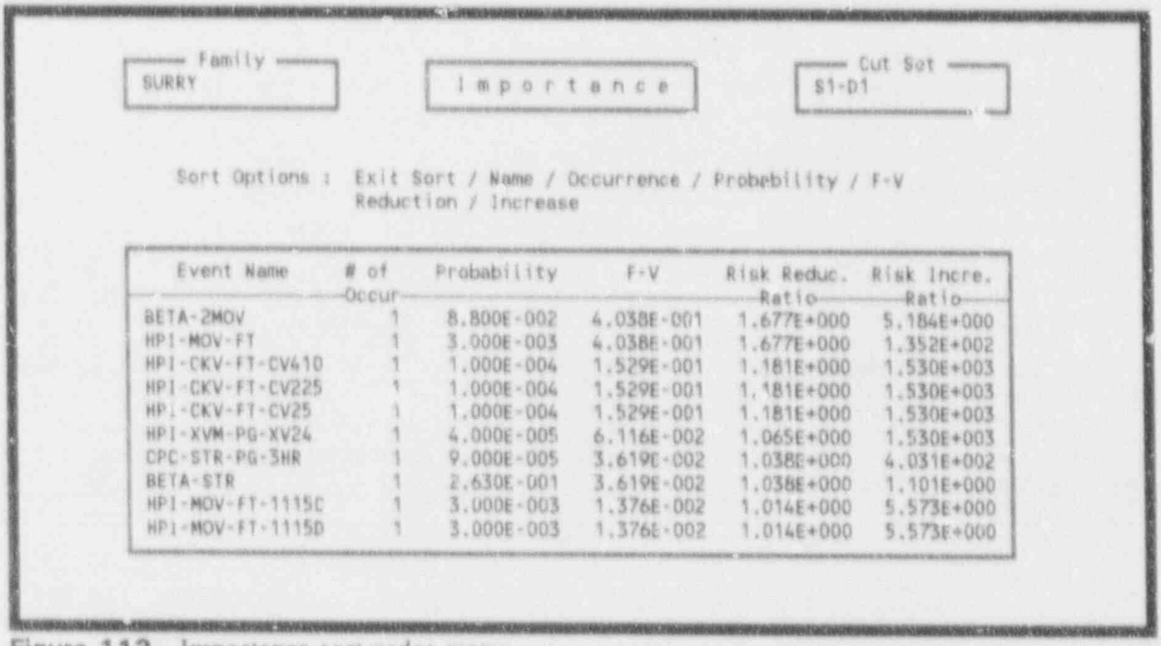
4.4.1.5.4 Report—This option invokes the same process as described in Section 4.4.1.3.3.



Event Name	# of Occur	Probability	F-V	Risk Reduc. Ratio	Risk Incre. Ratio
BETA-2MOV	1	8.800E-002	4.038E-001	1.677E+000	5.184E+000
HPI-MOV-FT	1	3.000E-003	4.038E-001	1.677E+000	1.352E+002
HPI-CKV-FT-CV410	1	1.000E-004	1.529E-001	1.181E+000	1.530E+003
HPI-CKV-FT-CV225	1	1.000E-004	1.529E-001	1.181E+000	1.530E+003
HPI-CKV-FT-CV25	1	1.000E-004	1.529E-001	1.181E+000	1.530E+003
HPI-XVM-PG-XV24	1	4.000E-005	6.116E-002	1.065E+000	1.530E+003
CPC-STR-PG-3HR	1	9.000E-005	3.619E-002	1.038E+000	4.031E+002
BETA-STR	1	2.630E-001	3.619E-002	1.038E+000	1.101E+000
HPI-MOV-FT-1115C	1	3.000E-003	1.376E-002	1.014E+000	5.573E+000
HPI-MOV-FT-1115D	1	3.000E-003	1.376E-002	1.014E+000	5.573E+000

Figure 112. Initial display of importance measures.

4.4.1.5.5 Sort—When you invoke this option, Figure 113 will be displayed. As shown, the data can be sorted by the following: Name, Occurrence, Probability, F-V, Reduction, and Increase.



Event Name	# of Occur	Probability	F-V	Risk Reduc. Ratio	Risk Incre. Ratio
BETA-2MOV	1	8.800E-002	4.038E-001	1.677E+000	5.184E+000
HPI-MOV-FT	1	3.000E-003	4.038E-001	1.677E+000	1.352E+002
HPI-CKV-FT-CV410	1	1.000E-004	1.529E-001	1.181E+000	1.530E+003
HPI-CKV-FT-CV225	1	1.000E-004	1.529E-001	1.181E+000	1.530E+003
HPI-CKV-FT-CV25	1	1.000E-004	1.529E-001	1.181E+000	1.530E+003
HPI-XVM-PG-XV24	1	4.000E-005	6.116E-002	1.065E+000	1.530E+003
CPC-STR-PG-3HR	1	9.000E-005	3.619E-002	1.038E+000	4.031E+002
BETA-STR	1	2.630E-001	3.619E-002	1.038E+000	1.101E+000
HPI-MOV-FT-1115C	1	3.000E-003	1.376E-002	1.014E+000	5.573E+000
HPI-MOV-FT-1115D	1	3.000E-003	1.376E-002	1.014E+000	5.573E+000

Figure 113. Importance sort order menu.

4.4.1.6 End State. This option allows you to display the end states assigned to the family (Figure 114). To invoke this option, type <N> in the option field and press <Enter>. Five options are available under this function: Exit, Sequences, Report, Importance, and Uncertainty.

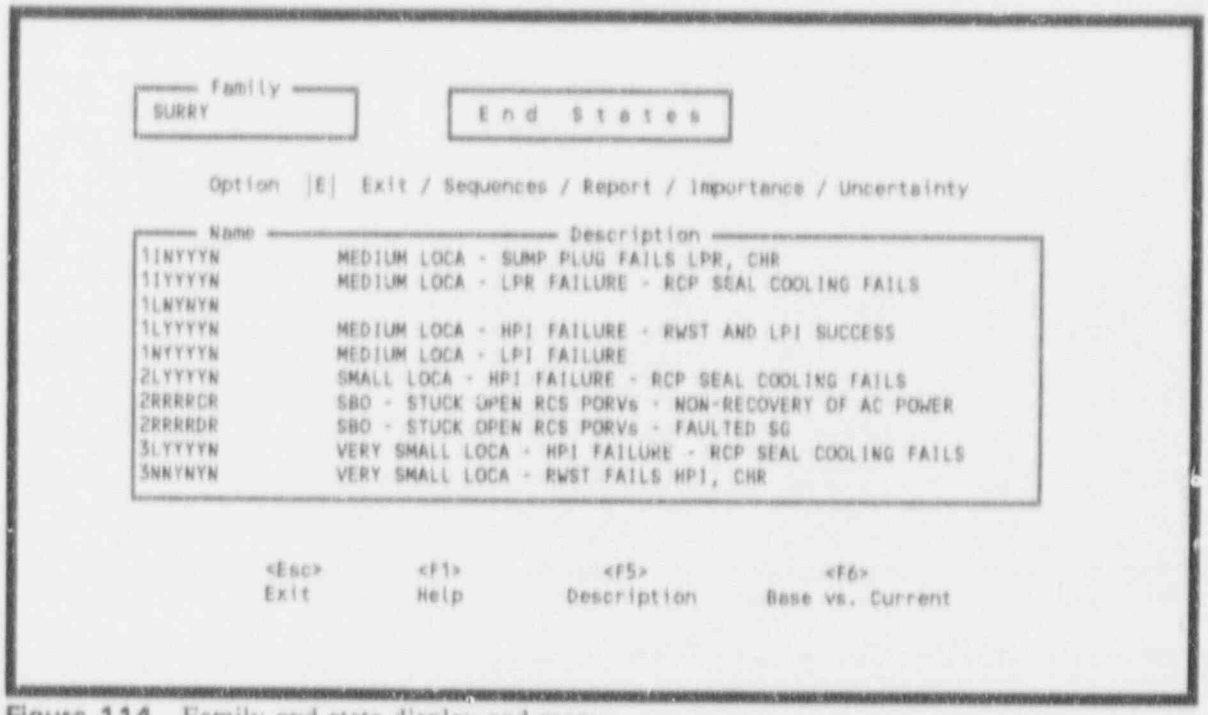


Figure 114. Family end state display and menu.

Exit: This option terminates the process and returns you to the previous screen. To invoke this option, type <E> in the option field and press <Enter>, or press <Esc>.

Sequences: This option allows you to display the sequences associated with a specific end state (Figure 115). To invoke this option, type <S> in the option field, highlight the desired end state, and press <Enter>.

Report: This option allows you to generate a report of the data displayed on the screen. The report may be displayed on the console, sent to an attached printer, or saved on a disk file for later processing (Figure 116). To invoke this option, type <R> and press <Enter>.

Importance: This option calculates and displays the following three important measures for each event in the sequence:

- Fussell-Vesely importance - an indication of the percentage of the minimal cut set upper bound contributed by the basic event.

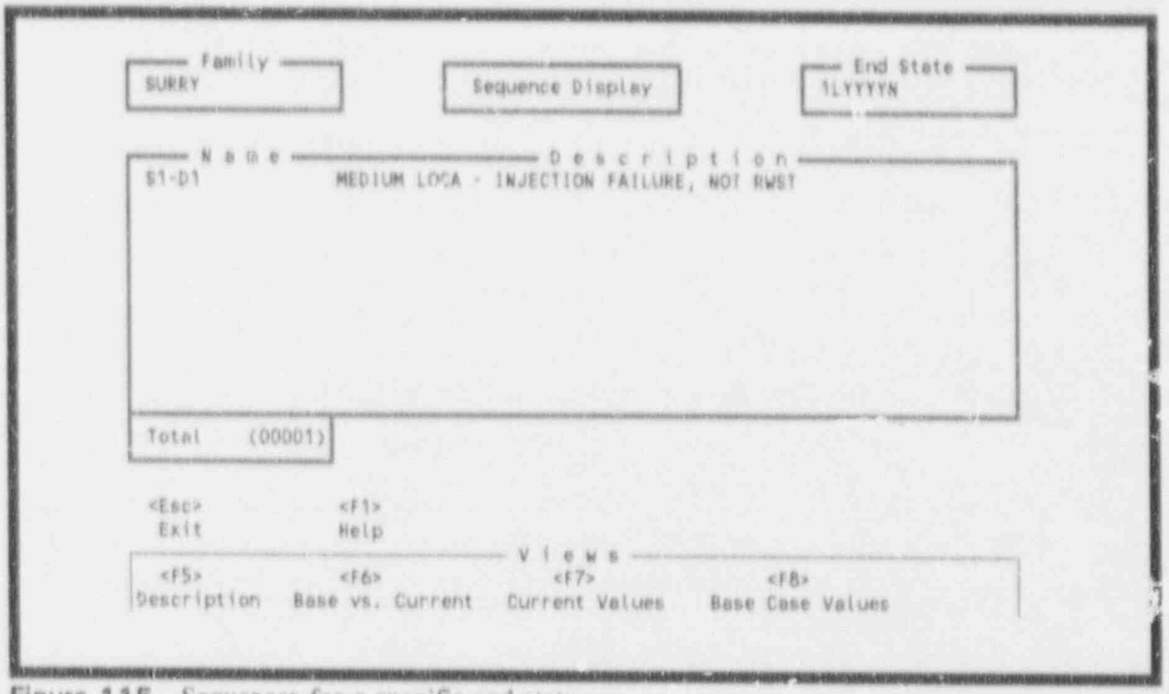


Figure 115. Sequences for a specific end state.

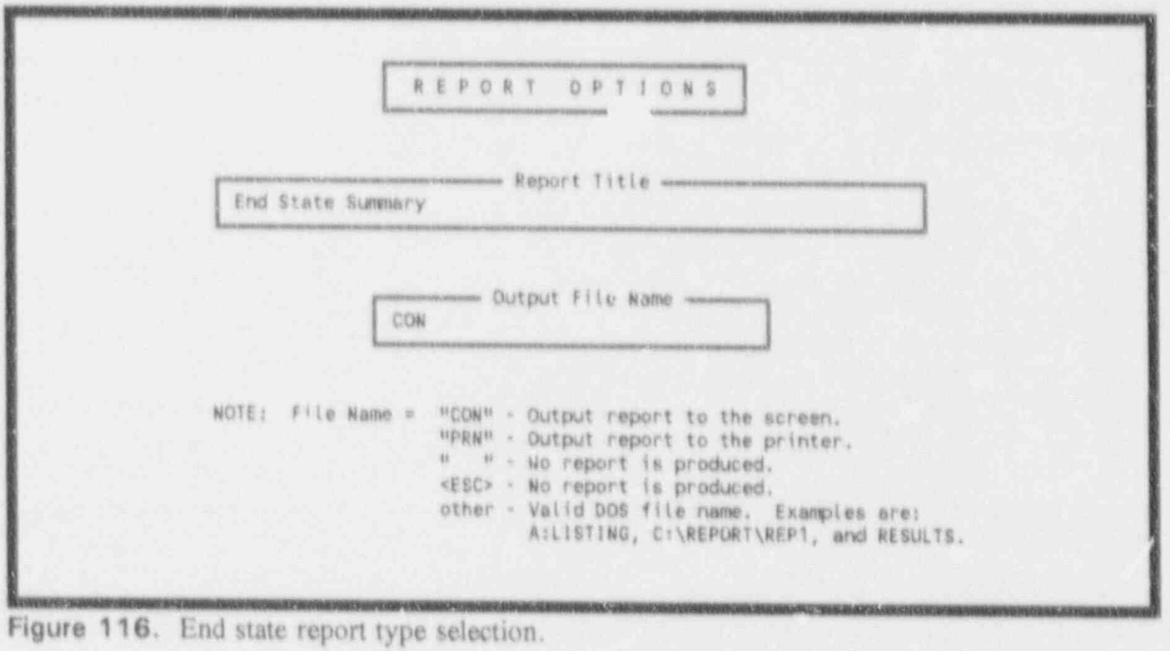
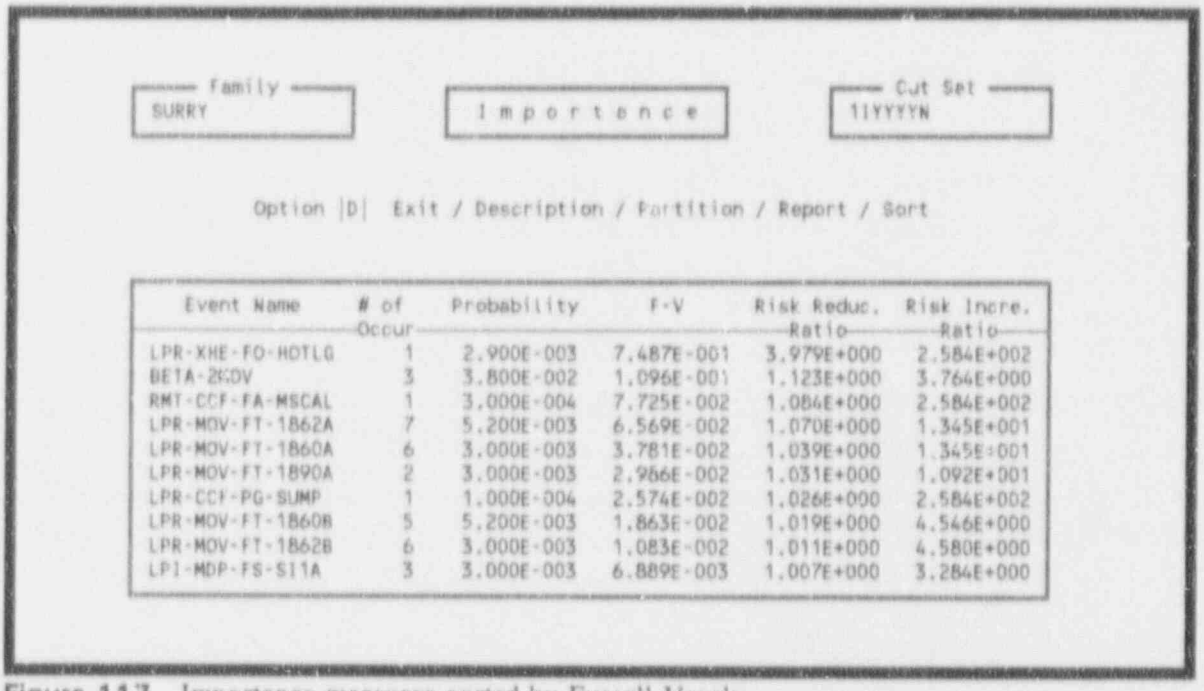


Figure 116. End state report type selection.

- Risk Reduction Ratio - an indication of how much the minimal cut set upper bound would decrease if the basic event was made perfect (never fail).

- Risk Increase Ratio - an indication of how much the minimal cut set upper bound would increase if the basic event was always failed.

To invoke this option, type <I> in the option field, highlight an end state and press <Enter>. By default, when the importance data is first displayed it is sorted, high to low, on Fussell-Vesely (Figure 117).



Event Name	# of Occur	Probability	F-V	Risk Reduc. Ratio	Risk Incre. Ratio
LPR-XHE-FO-HOTLG	1	2.900E-003	7.487E-001	3.979E+000	2.584E+002
BETA-2CDV	3	3.800E-002	1.096E-001	1.123E+000	3.764E+000
RMT-CCF-FA-MSCAL	1	3.000E-004	7.725E-002	1.084E+000	2.584E+002
LPR-MOV-FT-1862A	7	5.200E-003	6.569E-002	1.070E+000	1.345E+001
LPR-MOV-FT-1860A	6	3.000E-003	3.781E-002	1.039E+000	1.345E+001
LPR-MOV-FT-1890A	2	3.000E-003	2.966E-002	1.031E+000	1.092E+001
LPR-CCF-PG-SUMP	1	1.000E-004	2.574E-002	1.026E+000	2.584E+002
LPR-MOV-FT-1860B	5	5.200E-003	1.863E-002	1.019E+000	4.546E+000
LPR-MOV-FT-1862B	6	3.000E-003	1.083E-002	1.011E+000	4.580E+000
LPI-MDP-FS-S11A	3	3.000E-003	6.889E-003	1.007E+000	3.284E+000

Figure 117. Importance measures sorted by Fussell-Vesely.

From this screen, the following options are available:

Exit - Returns to the previous screen.

Description - Displays the full description of the highlighted event name on the bottom of the screen.

Partition - See Section 4.4.1.3.2.

Report - See Section 4.4.1.3.3.

Sort - See Section 4.4.1.5.5.

Uncertainty: The Uncertainty option displays the distribution and confidence limits for an end state for both base and current data values. These values were calculated using either the Latin Hypercube simulation technique or the Monte Carlo simulation technique. To invoke this option, type <U> in the option field of the End State display screen, highlight the desired sequences, and press <Enter>. Figure 118 shows the base and current case uncertainty data for the highlighted sequence.

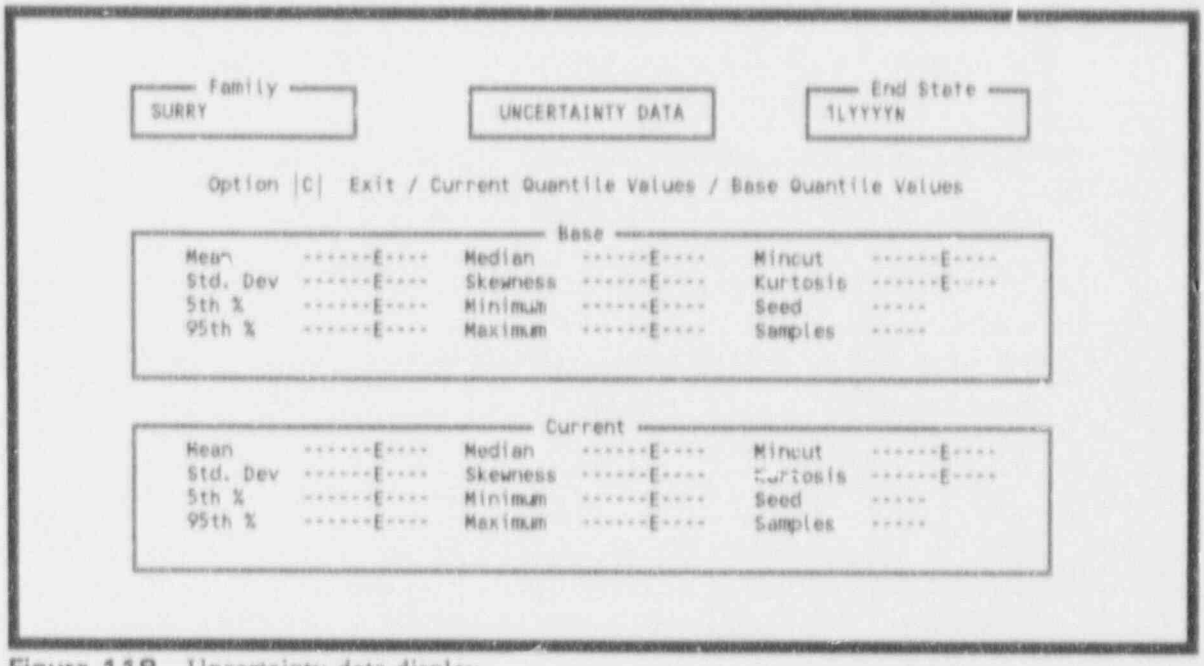


Figure 118. Uncertainty data display.

From this screen you may either return to the End State screen or view the quantile values associated with current case data or the base case data. To return to the End State Display screen, type an <E> in the option field and press <Enter>, or press the <Esc> key. To view the quantile values for the current case, type a <C> in the option field and press <Enter>. A screen showing the quantile values will appear. To return to the previous screen, press <Enter>. If you wish to view base case quantile values, type a <B> in the option field and press <Enter>.

4.4.1.7 Sort. This option allows you to sort the sequence display according to the following specifications:

1 - Name
2 - Base case minimum cut set frequency
3 - Current minimum cut set frequency
4 - Delta minimum cut set frequency (base case - current)
5 - Base case mean frequency
6 - Current mean frequency
7 - Delta mean frequency (base case - current)

To invoke this option, type <S> in the option field and press <Enter> (see Figure 119). To invoke one of the sort options, highlight the desired option and press <Enter>.

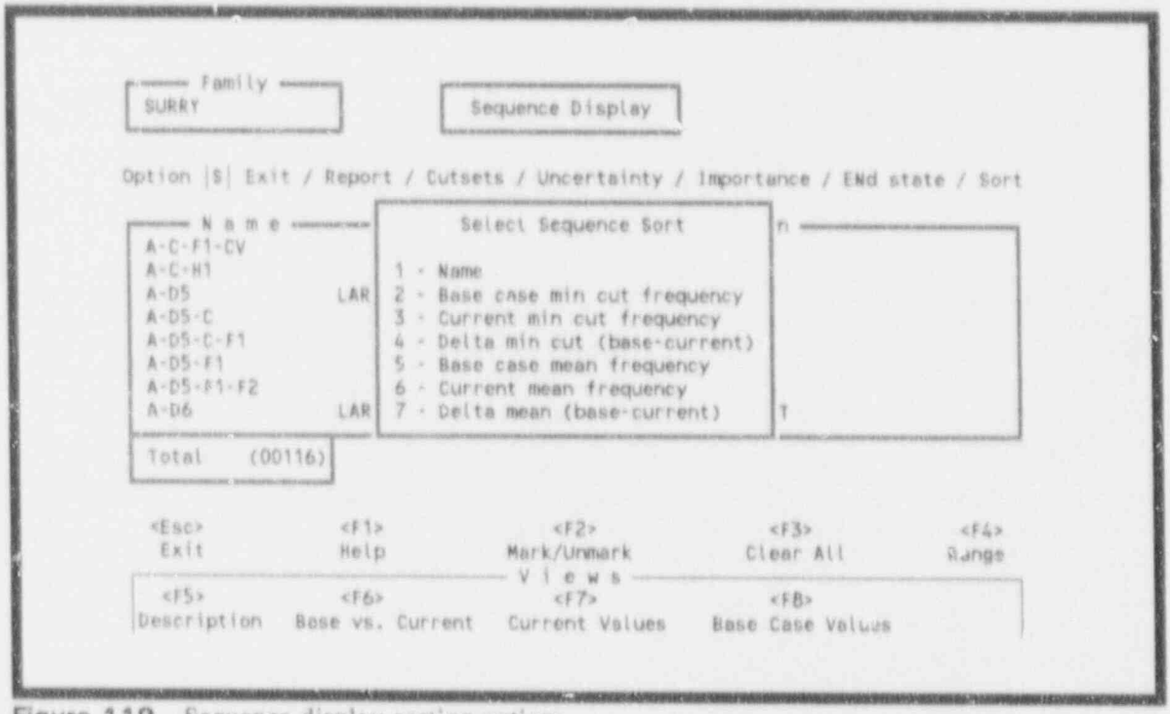


Figure 119. Sequence display sorting options.

4.5 Cut Set Editor

This option operates the same as described in Section 3.5. Refer to that section for a complete discussion of the Cut Set Editor.

5. GRAPHICS ANALYSIS

The graphics analysis module contains eight functions that fall into two operational groups: a graphics display only (piping and instrumentation diagrams (P&ID), fault trees and event trees), and line/bar plots of data base values (basic events, systems, sequences, end states, and families). The Graphics Analysis main menu is shown in Figure 120.

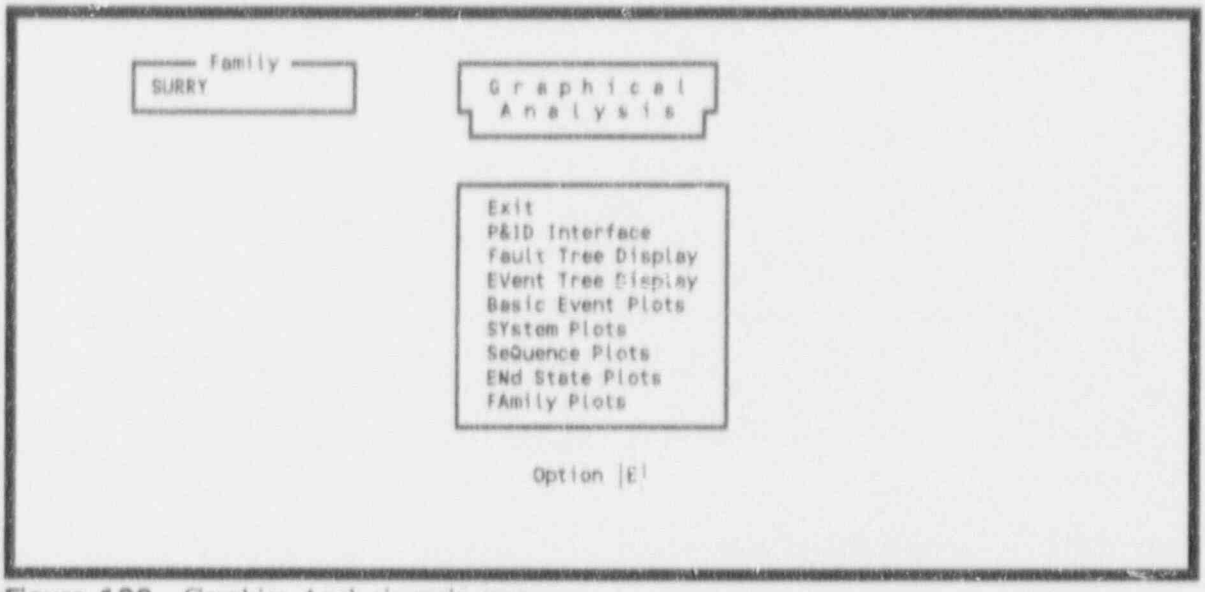


Figure 120. Graphics Analysis main menu.

If you have installed a mouse driver, the mouse may be used when accessing the P&ID, fault tree and event tree graphics screens. The keys <Enter> and <Ins> always correspond to the left (execute) button on a mouse; the keys <Del>, backspace, and <Esc>, corresponding to the right button on the mouse, cancel your previous selection. The mouse-driven cursor and key pad are synonymous. The key pad arrows move you around the screen in the following manner:

- up arrow: moves one row up
- down arrow: moves one row down
- left arrow: moves one column to the left
- right arrow: moves one column to the right
- PgUp: moves on a diagonal up and to the right
- PgDn: moves on a diagonal down and to the right
- Home: moves on a diagonal up and to the left
- End: moves on a diagonal down and to the left

On the graphics display screens, a pop-up menu (i.e., a list of submenus) is shown in the far left portion of the screen. The cursor position is displayed as an arrow and is located in the center of the screen. The submenus can be moved, or placed, anywhere on the screen. To move the submenu, position the cursor in the blank option box (normally under the EXIT box) of the submenu and press <Enter>. A white outline of the submenu appears. Move the cursor (outline) to the new location and press

<Enter>.

Pressing <Ctrl - Enter> at any point in a graphics display-only screen will return you to the graphics display main menu. To cancel a submenu, such as the view submenu, highlight the word view and press the cancel button on the mouse, or press <Esc>.

5.1 Exit

This option returns you to the SARA 4.0 main menu. To invoke this option, type Exit <E> in the field and press <Enter>.

5.2 P&ID Interface

This option allows you to display P&ID diagrams. A list of all P&ID diagrams belonging to the family will be displayed when this option is invoked (Figure 121). To invoke this option, type <P> in the option field (or highlight P&ID Display) and press <Enter>.

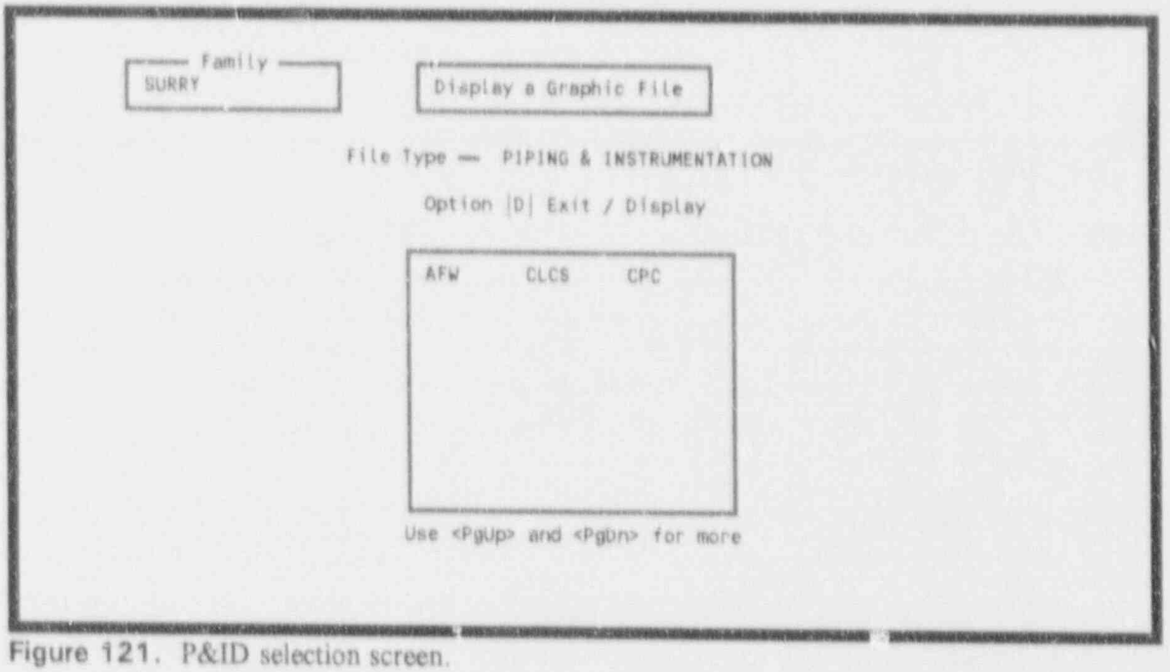


Figure 121. P&ID selection screen.

To display a P&ID diagram, highlight a diagram name in the list and press <Enter>. On the graphics display of the selected file, a pop-up menu is displayed in the far left portion of the screen. The remainder of the screen is the actual P&ID schematic. The pop-up menu contains the following options: EXIT, VIEW, PRNT, TRAN, and INFO. These options may be invoked by pressing <Enter> when the cursor is positioned in the desired option box. The cursor is in the box when the box border changes to a bright white.

5.2.1 EXIT

This option returns you to the previous menu. To invoke this option, position the cursor in the EXIT box and press <Enter>.

5.2.2 VIEW

The VIEW option allows you to change the position and size of the drawing on the screen. You may move to the next page of the drawing, the previous page of the drawing, move the drawing a page (screen) to the right or left, scroll to position the drawing on the screen, zoom in, zoom out or restore it to its original size and/or position. The VIEW submenu consists of the following options:

- Page ↑: Invoking this option allows you to shift the drawing up one page. In a multiple-page drawing, this function allows you to move quickly through the pages of the drawing. If the drawing is only one page (screen), when you invoke this option a blank screen will appear. Use the Page ↓ to return to the previous page.

- Page ↓: Invoking this option allows you to shift the drawing down one page. In a multiple-page drawing, this function allows you to move quickly through the pages of the drawing. If the drawing is only one page (screen), when you invoke this option a blank screen will appear. Use the Page ↑ to return to the previous page.

- Page →: Invoking this option allows you to shift the graphics display to the right one page. If the drawing is only one page (screen), when you invoke this option a blank screen will appear. Use the Page ← to return to the previous page.

- Page ←: Invoking this option allows you to shift the graphics display to the left one page. If the drawing is only one page (screen), when you invoke this option a blank screen will appear. Use the Page → to return to the previous page.

- Scroll: Invoking this option allows you to position the drawing anywhere on the screen. When you invoke this option, a white outline surrounds the drawing and a cross hair is placed in the center of the outline. Position the cursor at the desired location and press the left mouse button. The cross hair serves as a reference point for placing the drawing. The reference point (+) is used to give you some indication of the position of the object being moved relative to the screen. Move the mouse to position the outline and press the left mouse button. The drawing will be repositioned on the screen as it was on the outline.

- Zoom In (Zin): Invoking this option allows you to fill the screen with a small portion of the original display. To invoke this symbol, position the cursor in the zoom in box and press <Enter>. The message **Pick first corner** will be displayed. Move the cursor (now represented as a single point) to the position that will become one corner of the new display and press <Enter>. The message **Pick next corner** will be displayed. Move the cursor (an expanding outline of a box will be drug with the cursor) to the opposite corner of the new display and press <Enter>. The portion of the original display enclosed by the box will now fill the entire screen. To restore the display to its original

size, invoke the restore (Zres) option.

- Zoom Out (Zout): Invoking this option allows you to shrink the screen display by approximately 50%. To invoke the symbol, position the cursor in the zoom out box and press <Enter>. To restore the display to its original size, invoke the restore (ZRES) option.

- Zoom Restore (Zres): This symbol restores any display created by a "zoom" function to the original display size. To invoke the symbol, position the cursor in the Zres box and press <Enter>.

5.2.3 PRNT

The "PRNT" command displays a submenu giving you a choice of sending the drawing to an Epson compatible printer or in the case of the HP7475, to a file. If you choose the Epson, the screen clears, and the diagram is redrawn without the menus, then the printer starts.

When you choose the HP7475 the same procedure is followed except you are prompted to name a file, or accept the default file name. The default file name is the name of the P&ID you selected upon entering the P&ID option, with an extension of .HPP.

To invoke any of the print options, position the cursor in the appropriate box on the menu and press <Enter>.

5.2.4 TRAN

The "TRAN" command displays a menu that allows you to display additional diagrams that are represented as transfer points on the original or default diagram. There are two methods of viewing these additional diagrams:

- XFER→ : Invoking this symbol displays the message **Pick transfer symbol to transfer.** Move the cursor to the transfer symbol on the screen display and press <Enter>. The new diagram will be drawn on the screen.

- ←XFER: Invoking this symbol displays a list of files and the message **Pick a file to transfer to**. Selecting a file with the cursor and pressing <Enter> will display the new diagram. If there are no transfer files, the message **No transfer files** will be displayed.

5.2.5 INFO

The "INFO" command displays additional information about the drawing. When you invoke this option, the message **Pick a symbol** will be displayed. Position the cursor on the desired symbol and press the left mouse button. A screen similar to the one shown in Figure 122 will be displayed. This screen lists all the events associated with this symbol. From this screen, the following options are available:

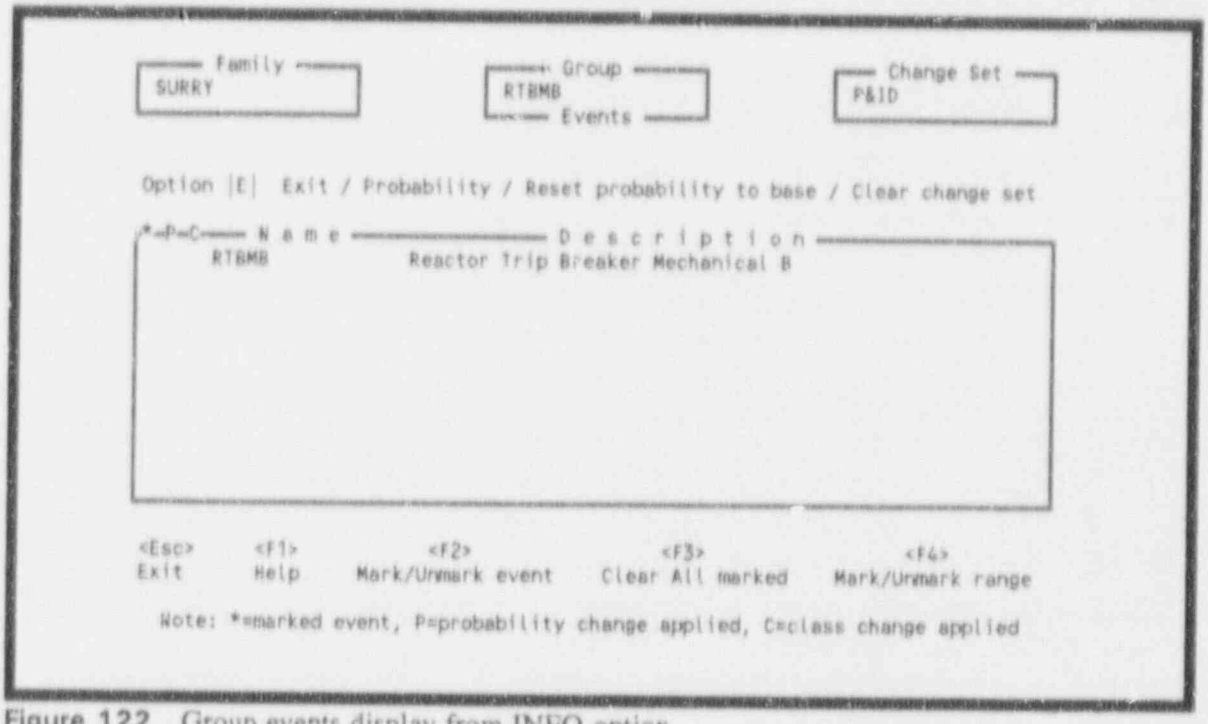


Figure 122. Group events display from INFO option.

Probability	This option allows you to modify uncertainty and failure data values for the current cut set. This option is the same as the Probability option discussed in Section 3.2.5.2. Refer to that section for details.
Reset probability to base	Refer to Section 3.2.5.3.
Clear change sets	This option clears all previously defined changes for the "P&ID" change set.

5.3 Fault Tree Display

This option allows you to display fault tree diagrams. When this option is invoked, a list of all fault tree diagrams defined for the family will be displayed (Figure 123). To invoke this option, type <F> in the option field (or highlight Fault Tree Display) and press <Enter>.

To display a fault tree diagram, highlight a diagram name in the list and press <Enter>. The corresponding diagram is displayed and a pop-up menu appears in the far left portion of the screen. The remainder of the screen is the actual fault tree schematic. The pop-up menu contains the following options: EXIT, VIEW, PRNT, and TRAN. These options may be invoked by pressing <Enter> when

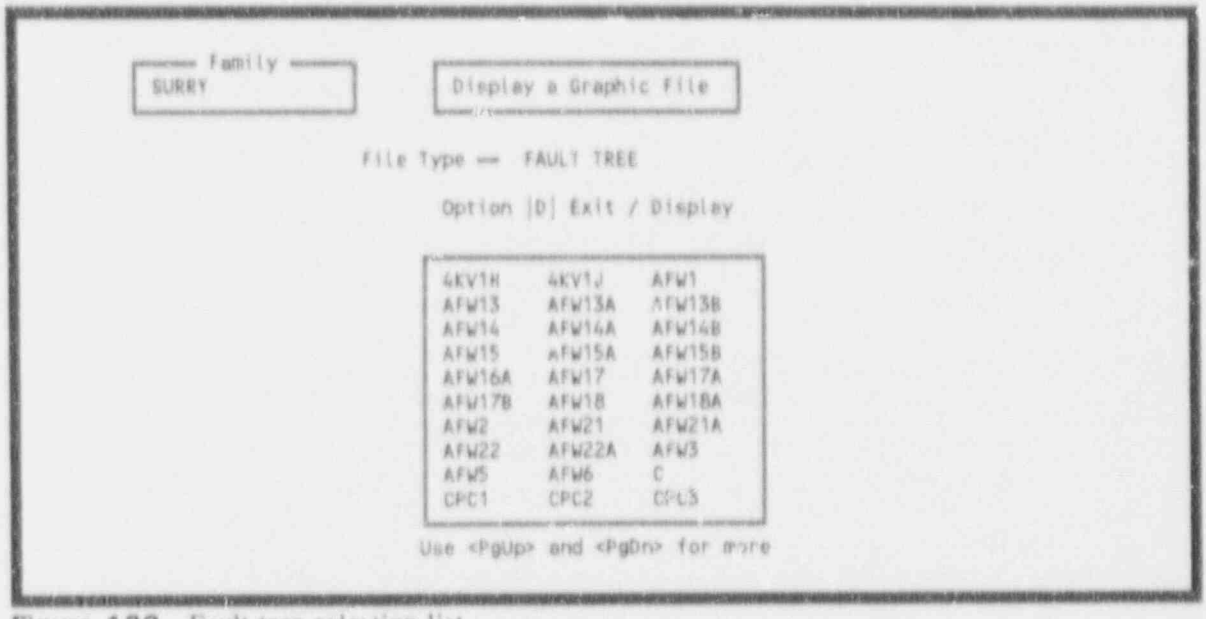


Figure 123. Fault tree selection list.

the cursor is positioned in the labeled box. The cursor is in the box when the box border changes to a bright white.

5.3.1 EXIT

This option returns you to the previous menu. To invoke this option, position the cursor in the EXIT box and press <Enter>.

5.3.2 VIEW

The VIEW option allows you to change the position and size of the drawing on the screen. You may move to the next page of the drawing, the previous page of the drawing, move the drawing a page (screen) to the right or left, scroll to position the drawing on the screen, zoom in, zoom out or restore it to its original size and/or position. This VIEW option operates the same as discussed in Section 5.2.2. Refer to that section for details.

5.3.3 PRNT

The "PRNT" command displays a submenu giving you a choice of sending the drawing to an Epson compatible printer or in the case of the HP7475, to a file. This option operates the same as described in Section 5.2.3.

5.3.4 TRAN

The "TRAN" command displays a menu that allows you to display additional diagrams that are represented as transfer points on the original or default diagram. This option operates the same as described in Section 5.2.4.

5.4 Event Tree Display

This option allows you to display event tree diagrams. When this option is invoked, a list of all event tree diagrams defined for the family will be displayed (Figure 124). To invoke this option, type <V> in the option field (or highlight Event Tree Display) and press <Enter>.

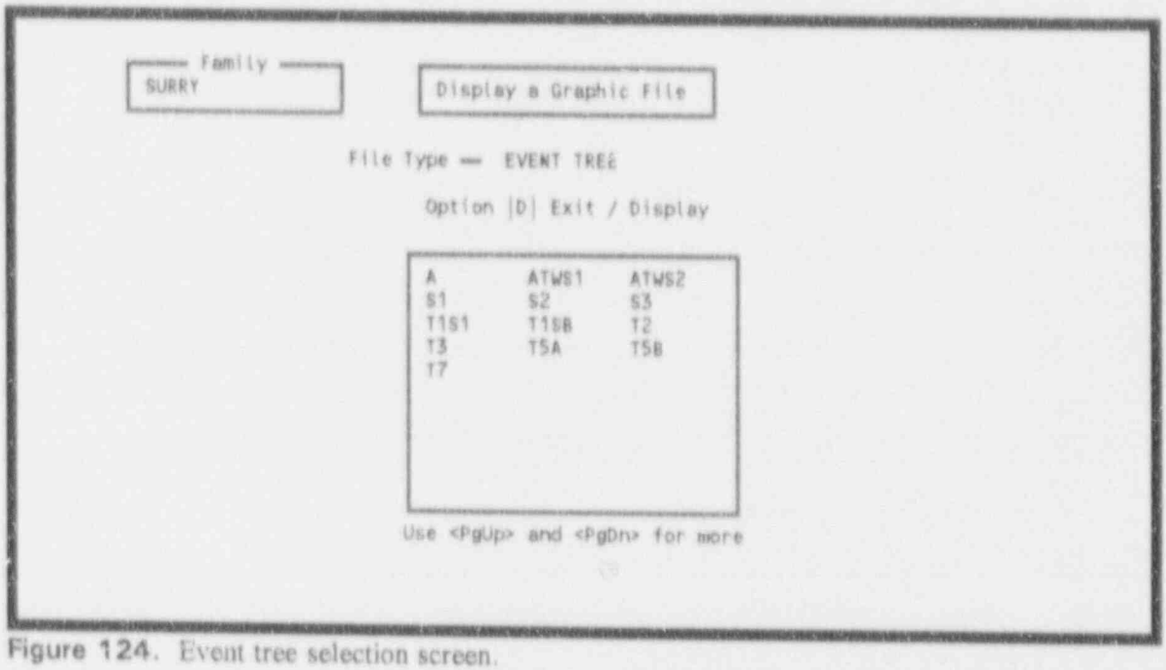


Figure 124. Event tree selection screen.

To display an event tree diagram, highlight a diagram name in the list and press <Enter>. On the graphics display of the selected file, a pop-up menu is displayed in the lower left corner. The remainder of the screen is the actual event tree schematic. The pop-up menu contains the following options: EXIT, VIEW, PRNT, and TRAN. These options may be invoked by pressing <Enter> when the cursor is positioned in the labeled box. The cursor is in the box when the box border changes to a bright white.

5.4.1 EXIT

This option returns you to the previous menu. To invoke this option, position the cursor in the EXIT box and press <Enter>.

5.4.2 VIEW

The VIEW option allows you to change the position and size of the drawing on the screen. You may move to the next page of the drawing, the previous page of the drawing, move the drawing a page (screen) to the right or left, scroll to position the drawing on the screen, zoom in, zoom out or restore

it to its original size and/or position. This VIEW option operates the same as discussed in Section 5.2.2. Refer to that section for details.

5.4.3 PRNT

The "PRNT" command displays a submenu giving you a choice of sending the drawing to an Epson compatible printer or in the case of the HP7475, to a file. This option operates the same as described in Section 5.2.3.

5.4.4 TRAN

The "TRAN" command displays a menu that allows you to display additional diagrams that are represented as transfer points on the original or default diagram. This option operates the same as described in Section 5.2.4.

5.5 Basic Event Plots

This option allows you to display the following types of basic event plots: probability density function and cumulative distribution function.

To invoke this option, type a <B> in the option field (or highlight Basic Event Plots) and press <Enter>. The resulting display (Figure 125) is a plot type selection menu. Highlight the desired selection and press <Enter> or enter the corresponding option number and press <Enter>.

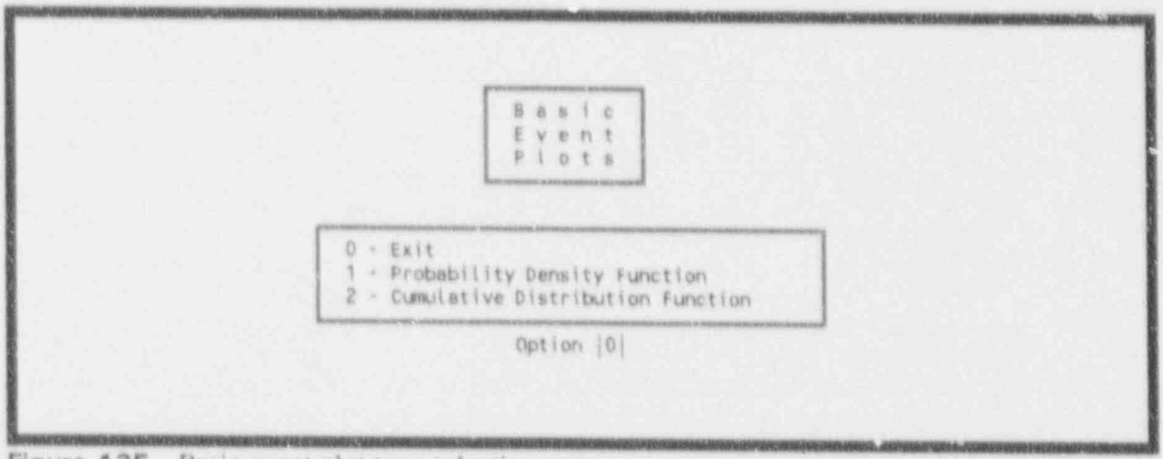


Figure 125. Basic event plot type selection menu.

5.5.1 Exit

Invoking this function returns you to the Graphical Analysis screen. To invoke this option, type a <0> (zero) in the option field and press <Enter>, or press the <Esc> key.

5.5.2 Probability Density Function

This option allows you to display a plot of the uncertainty distribution curve for a selected basic event. To invoke this option, enter a <1> (one) in the option field and press <Enter>. Figure 126 will be displayed. On this screen you select a basic event to plot. You may plot the curve using Latin Hypercube Sampling <L>, Monte Carlo Sampling <M>, or overlay the Latin Hypercube and Monte Carlo samplings <O>.

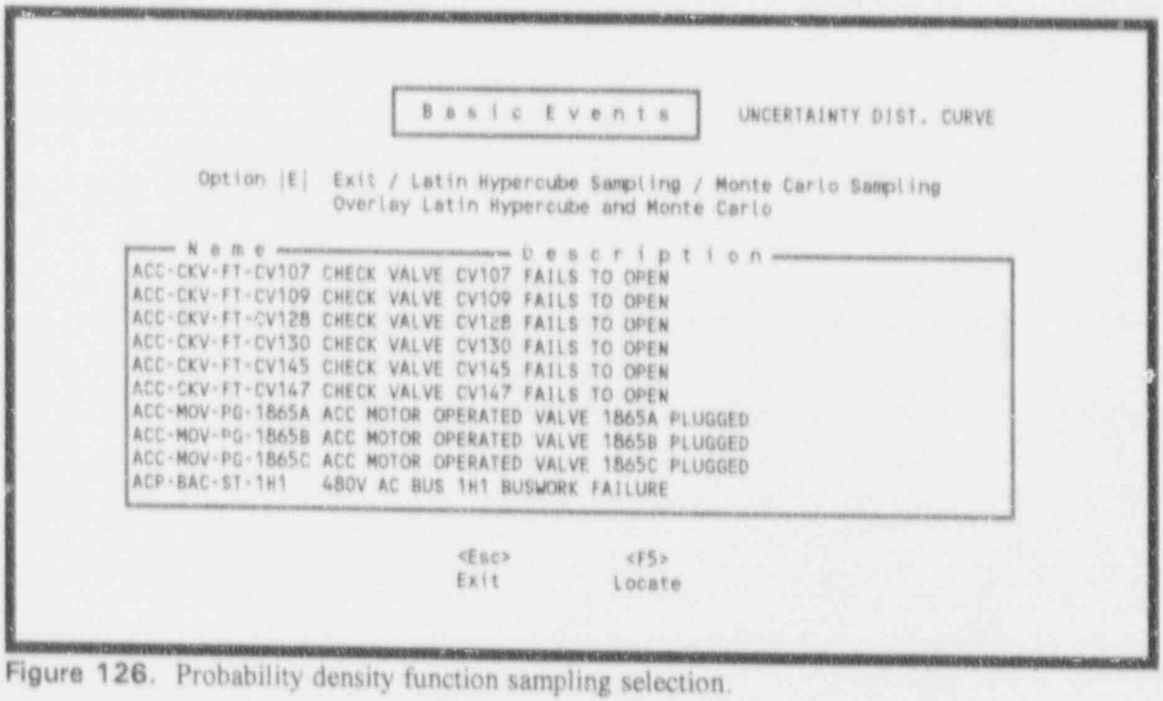


Figure 126. Probability density function sampling selection.

5.5.2.1 Latin Hypercube Sampling. This option plots an uncertainty distribution curve for a selected basic event using Latin Hypercube sampling. To invoke this option, type an <L> in the option field, highlight the basic event to plot and press <Enter>. Figure 127 will be displayed. This screen prompts you to enter the number of samples to be generated during simulation and the initial value of the seed for the random number generator. A default seed value for the random seed may be provided. You may use this value or enter a new value for the seed. To obtain a random seed from the system clock, enter a zero in this field. There will also be a default valu 'n the field for the number of samples. You may use this value or enter another value. When values have been entered, press <Enter>. The samples will be calculated and when complete, Figure 128 will be displayed. The screen shows the plot information that will be used to plot the uncertainty distribution curve. You can change any of the values

displayed. When complete, press <Enter>. The plot will be generated and displayed on the screen.

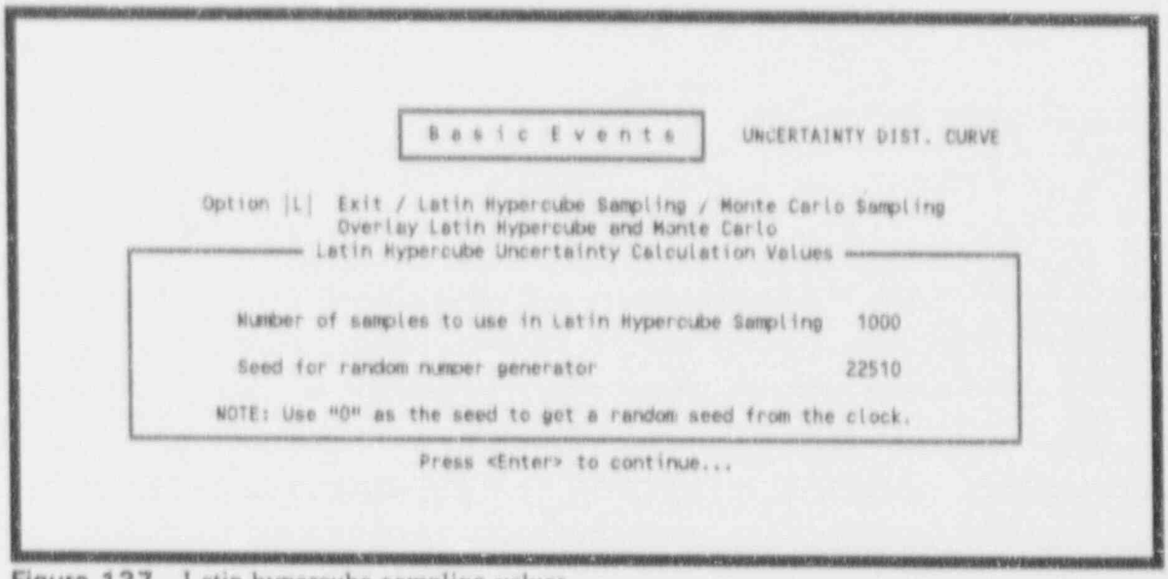


Figure 127. Latin hypercube sampling values.

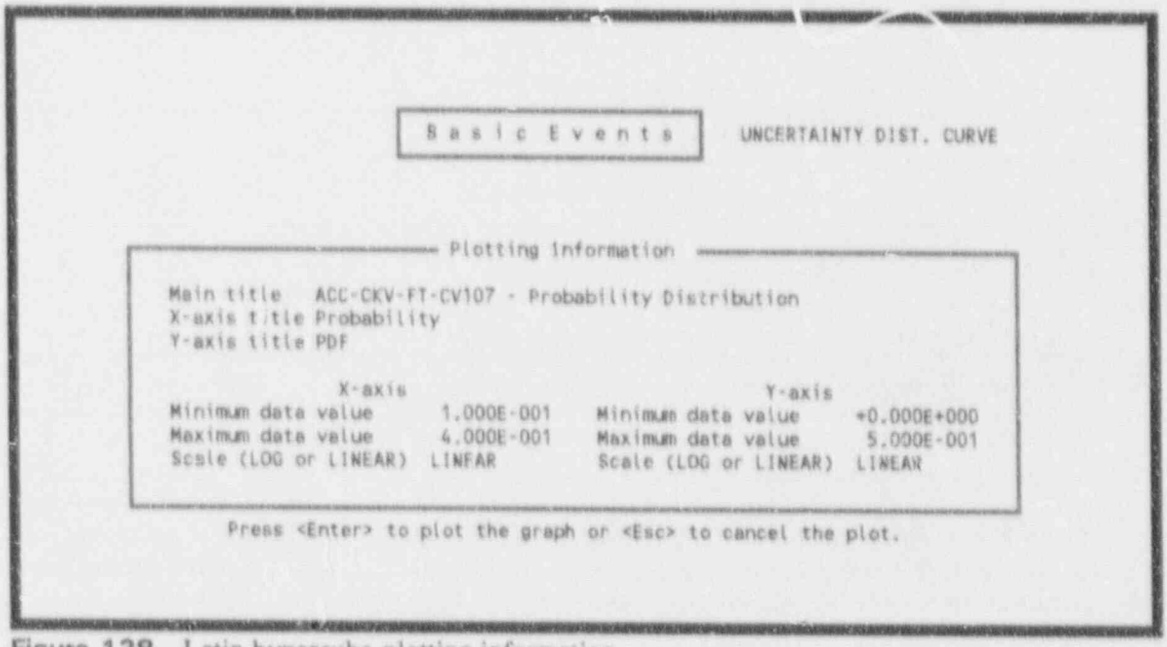


Figure 128. Latin hypercube plotting information.

After the plot has been drawn you may use Ctrl-P to send the drawing to your attached (Epson compatible) printer or HP LaserJet printer, or press <H> to create an .HPG file for the plotter.

5.5.2.2 Monte Carlo Sampling. This option plots an uncertainty distribution curve for a selected basic event using Monte Carlo sampling. To invoke this option, enter an <M> in the option field, highlight the desired event, and press <Enter>. Figure 129 will be displayed. This screen prompts you to enter the number of samples to be generated during simulation and the initial value of the seed for the random number generator. A default seed value for the random seed will be provided. You may use this value or enter a new value for the seed. To obtain a random seed from the system clock, enter a zero in this field. There will also be a default value in the field for the number of samples. You may use this value or enter another value. When values have been entered, press <Enter>. The samples will be calculated and when complete, Figure 130 will be displayed. The screen shows the plot information that will be used to plot the uncertainty distribution curve. You can change any of the values displayed. When complete, press <Enter>. The plot will be generated and displayed on the screen.

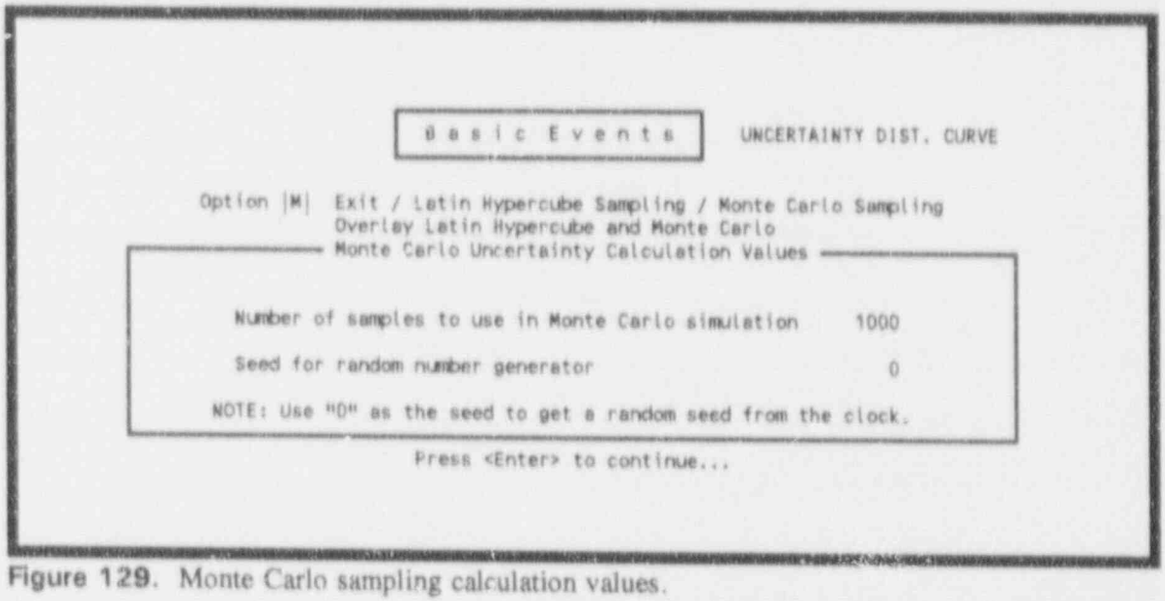


Figure 129. Monte Carlo sampling calculation values.

After the plot has been drawn you may use Ctrl-P to send the drawing to your attached (Epson compatible) printer or HP LaserJet printer, or press <H> to create an .HPG file for the plotter.

5.5.2.3 Overlay Latin Hypercube and Monte Carlo. This option plots an uncertainty distribution curve using both Latin Hypercube and Monte Carlo samplings. The curves will overlay one another on the plot. To invoke this option, enter an <O> in the option field, highlight the desired event, and press <Enter>. Figure 131 will be displayed. This screen prompts you to enter the number of samples to be generated during simulation and the initial value of the seed for the random number generator for both the Latin Hypercube and Monte Carlo simulations. A default seed value for the random seed will be provided. You may use this value or enter a new value for the seed. To obtain a random seed from the system clock, enter a zero in this field. There will also be a default value for the number of samples. You may use this value or enter another value. When values have been entered, press <Enter>. The samples will be calculated and when complete, Figure 132 will be displayed. The screen shows the plot information that will be used to plot the uncertainty distribution curves. You can change any of the values displayed. When complete, press <Enter>. The plot will be generated and displayed on the screen.

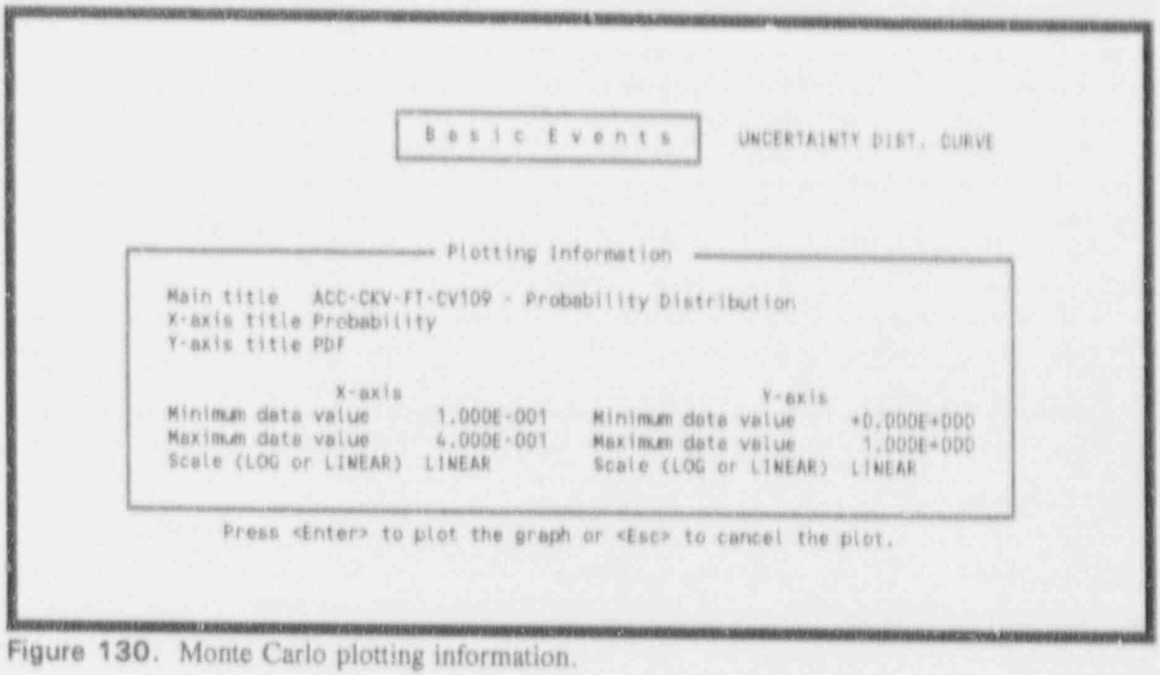


Figure 130. Monte Carlo plotting information.

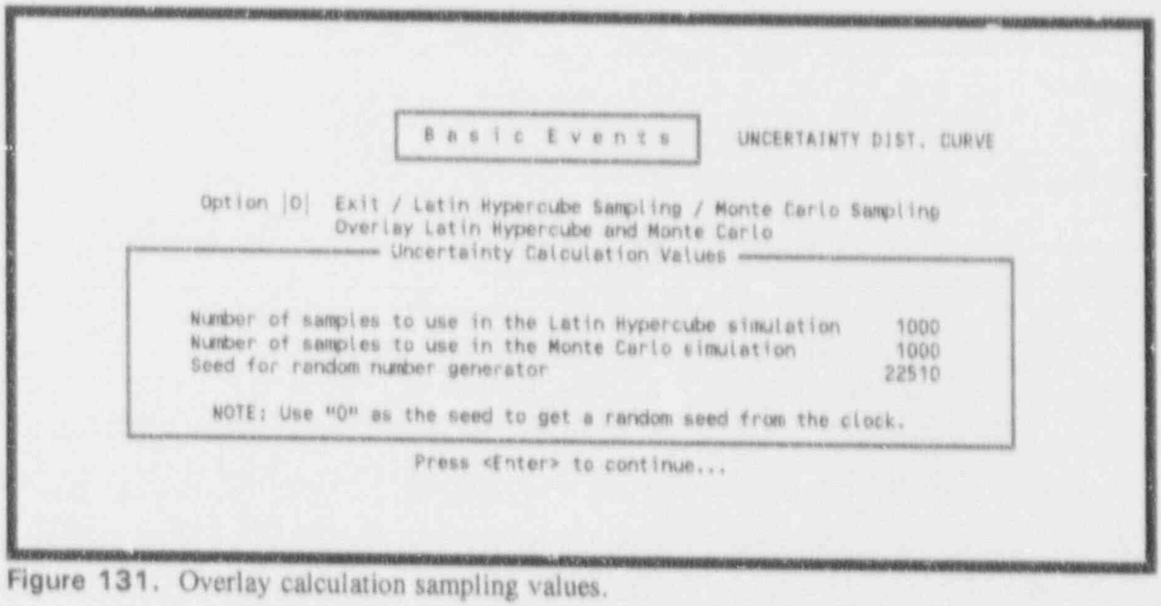


Figure 131. Overlay calculation sampling values.

After the plot has been drawn you may use Ctrl-P to send the drawing to your attached (Epson compatible) printer or HP LaserJet printer, or press <H> to create an .HPG file for the plotter.

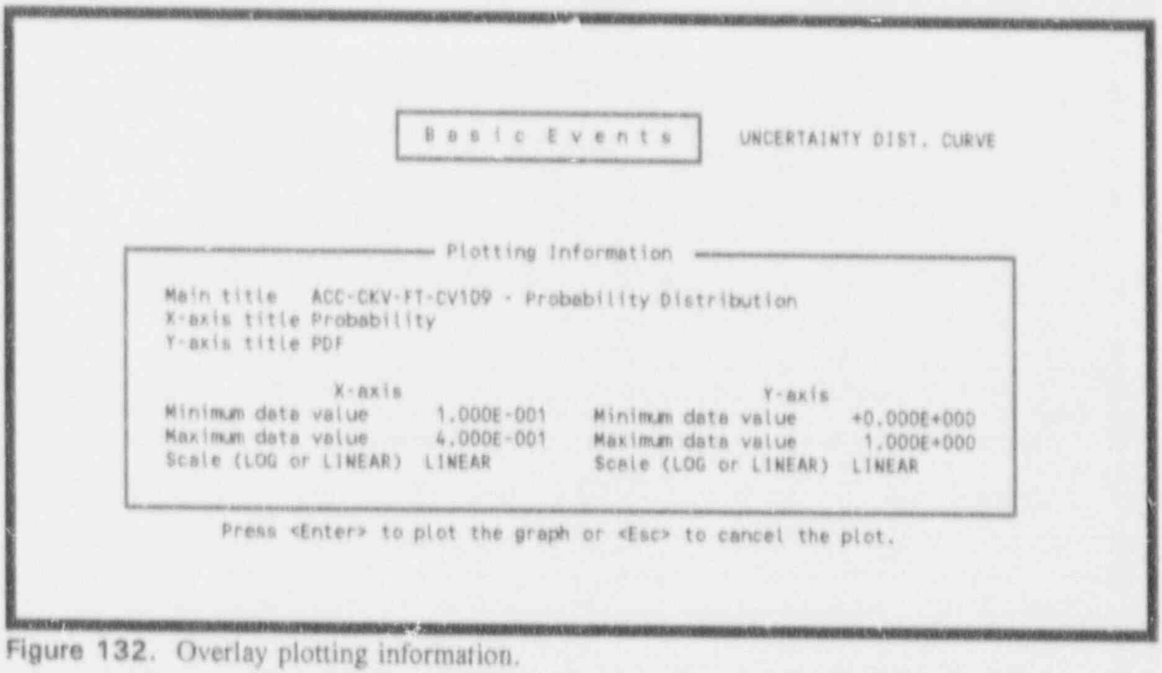


Figure 132. Overlay plotting information.

5.5.3 Cumulative Distribution Function

This option allows you to display a plot of the cumulative distribution curve for a selected basic event. To invoke this option, enter a <2> in the option field and press <Enter>. Figure 133 will be displayed. On this screen you select the basic event to plot. You may plot the curve using Latin Hypercube Sampling <L>, Monte Carlo Sampling <M>, or overlay the Latin Hypercube and Monte Carlo curves <O>. This option works in the same fashion as described in paragraphs 5.5.2.1 and 5.5.2.3, except this option produces a cumulative distribution curve.

5.6 Systems Plots

This option allows you to display system plots for the following data types: frequency point estimates, frequency mean values, probability density function, and cumulative distribution function. The distribution plots are line graphs, while the frequency plots are presented in bar graphs. The frequency plot values may be sorted according to several categories: name, base case value, current value, and difference (base - current).

To invoke this option, type <Y> in the option field (or highlight SYstem Plots) and press <Enter>. The resulting display (Figure 134) is a plot type selection menu. After a plot has been drawn you may use Ctrl-P to send the drawing to your attached (Epson compatible) printer or HP LaserJet printer, or press <H> to create an .HPG file for the plotter.

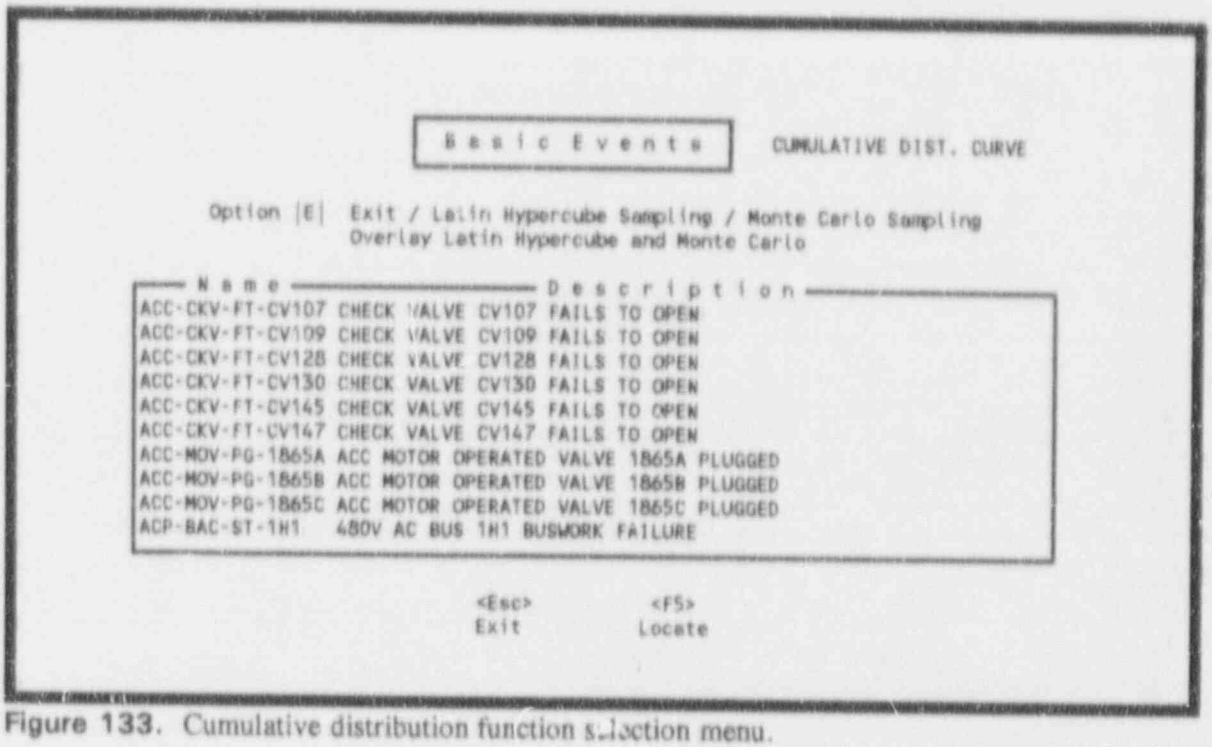


Figure 133. Cumulative distribution function selection menu.

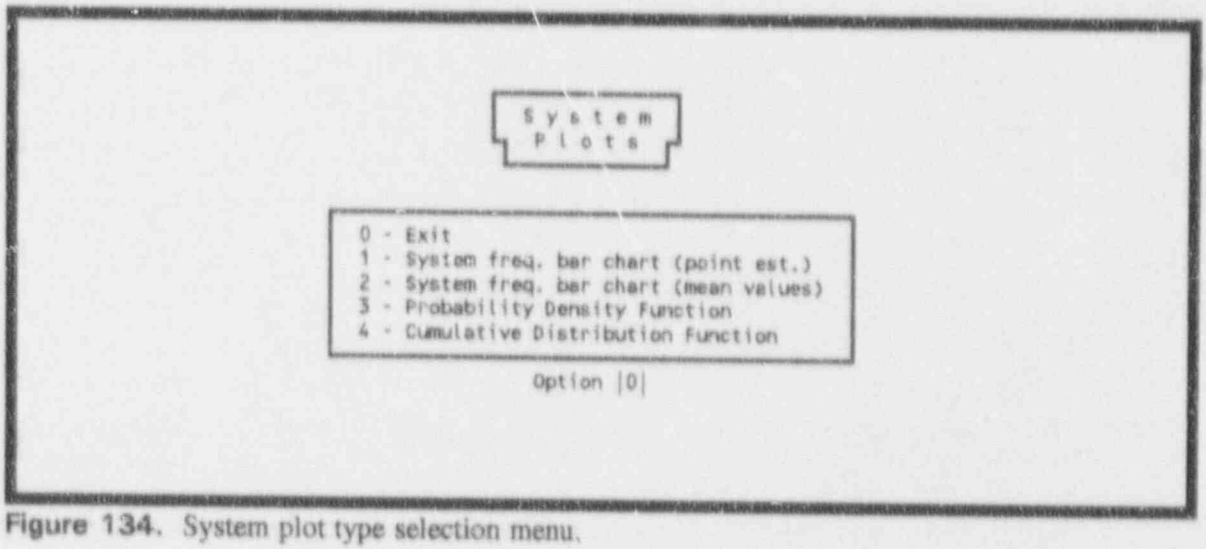


Figure 134. System plot type selection menu.

5.6.1 Exit

Invoking this option returns you to the Graphical Analysis screen. To invoke this option, type <E> in the option field and press <Enter>, or press <Esc>.

5.6.2 System Frequency Bar Chart (point estimate)

This option allows you to create a bar chart of the system frequency point estimates. To invoke the option, type a <1> in the option field or highlight System freq. bar chart (point est.) and press <Enter>. The resulting display (Figure 135) is a menu allowing you to specify the sort order of the data values to be plotted: name, base case value, current value, or difference (base- current).

After you have highlighted or selected one of the sort orders and pressed <Enter>, the bar chart is drawn displaying the first ten systems. The bar chart may be manipulated using the following key strokes:

- <Ctrl> <right arrow>: display the next ten systems
- <Ctrl> <left arrow>: display the previous ten systems
- <right arrow>: shift the display left by one system
- <left arrow>: shift the display right by one system

5.6.3 System Frequency Bar Chart (mean values)

This option allows you to create a bar chart of the system frequency mean values. To invoke this option, type a <2> in the option field or highlight System freq. bar chart (mean values) and press <Enter>. The resulting display (Figure 135) is a menu allowing you to specify the sort order of the data values to be plotted: name, base case value, current value, or difference (base-current).

Upon pressing <Enter>, after you have highlighted or selected one of the sort orders, the bar chart is drawn displaying the first ten systems. The bar chart may be manipulated using the following key strokes:

- <Ctrl> <right arrow>: display the next ten systems
- <Ctrl> <left arrow>: display the previous ten systems
- <right arrow>: shift the display left by one system
- <left arrow>: shift the display right by one system

5.6.4 Probability Density Function

This option allows you to create a line plot of a system's uncertainty distribution. To invoke this option, type a <3> in the option field or highlight Probability Density Function and press <Enter>. The resulting display (Figure 136) will present you with a list of the systems contained in the data base. Highlight the desired system and press <Enter>. Figure 137 will be displayed showing the plot information to be used in the plot. You may change any of the values on the screen. When complete, press <Enter> to display the line plot.

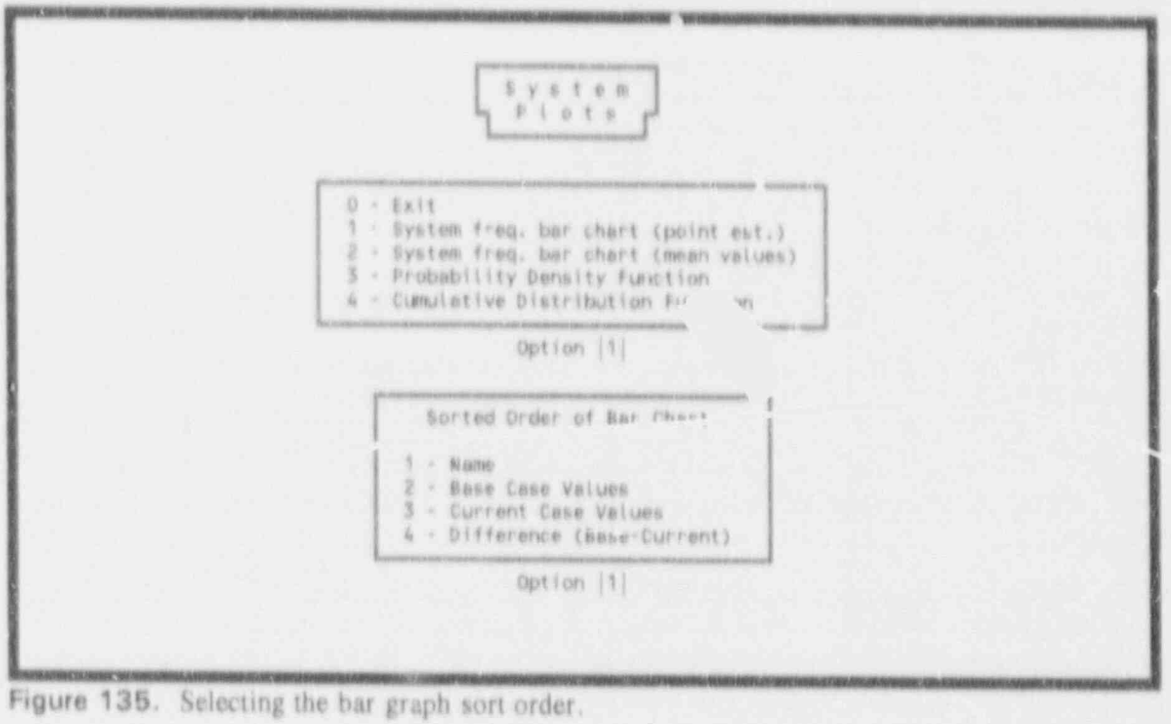


Figure 135. Selecting the bar graph sort order.

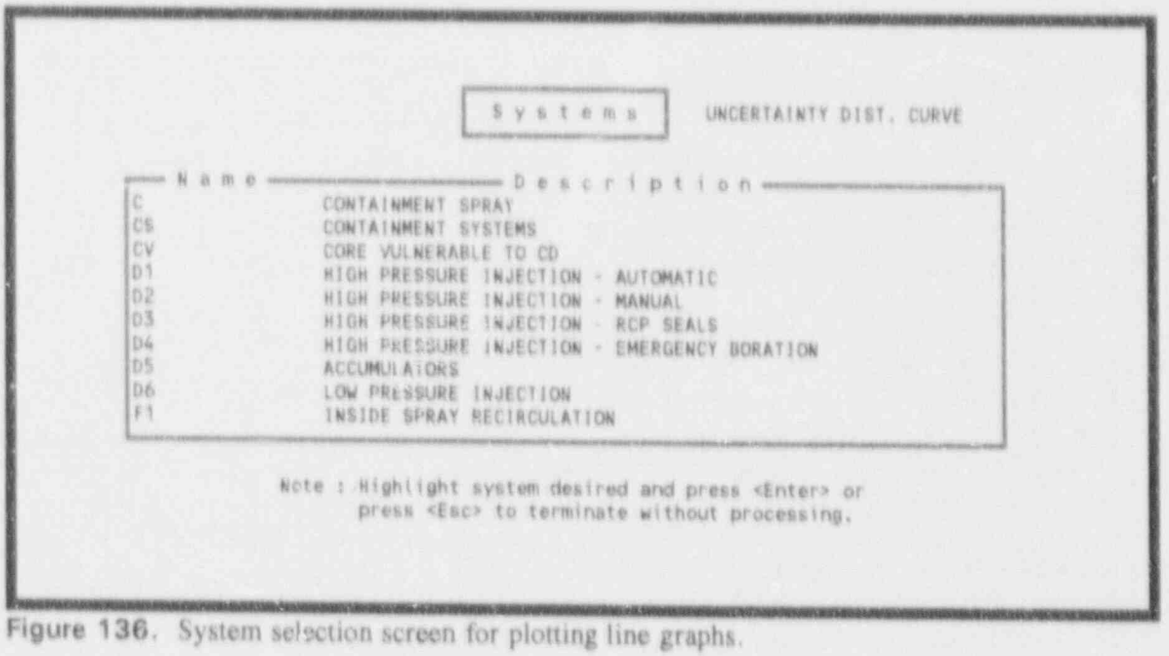


Figure 136. System selection screen for plotting line graphs.

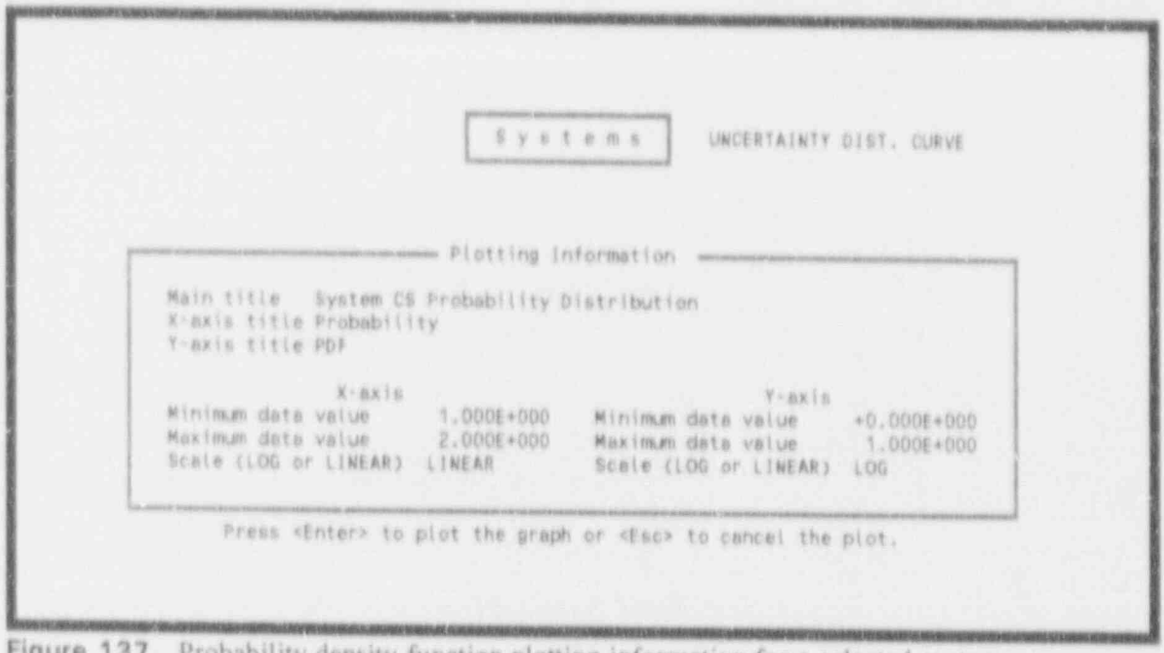


Figure 137. Probability density function plotting information for a selected system.

5.6.5 Cumulative Distribution Function

This option allows you to create a line plot of a system's cumulative distribution. To invoke this option, type a <4> in the option field or highlight Cumulative Distribution Function and press <Enter>. The resulting display (similar to Figure 136) will present you with a list of the systems contained in the data base. Highlight the desired system and press <Enter>. A screen similar to the one shown in Figure 137 will be displayed showing the plotting information to be used for the plot.

5.7 Sequence Plots

This option allows you to display sequence plots for the following data types: frequency point estimate, frequency mean, probability density function, and cumulative distribution function values. The distribution plots are line graphs, while the frequency plots are presented in bar graphs. The frequency plot values may be sorted according to several categories: name, base case value, current value, and difference (base-current).

To invoke this option, type <Q> in the option field (or highlight Sequence Plots and press <Enter>. The resulting display (Figure 138) is a plot type selection menu. After a plot has been drawn, you may use Ctrl-P to send the drawing to your attached (Epson compatible) printer or HP LaserJet printer or press <H> to create an .HPG file. As shown, four types of plots can be generated. These plots are generated in the same fashion as system plots discussed in Section 5.6. Refer to Section 5.6 for a detailed discussion.

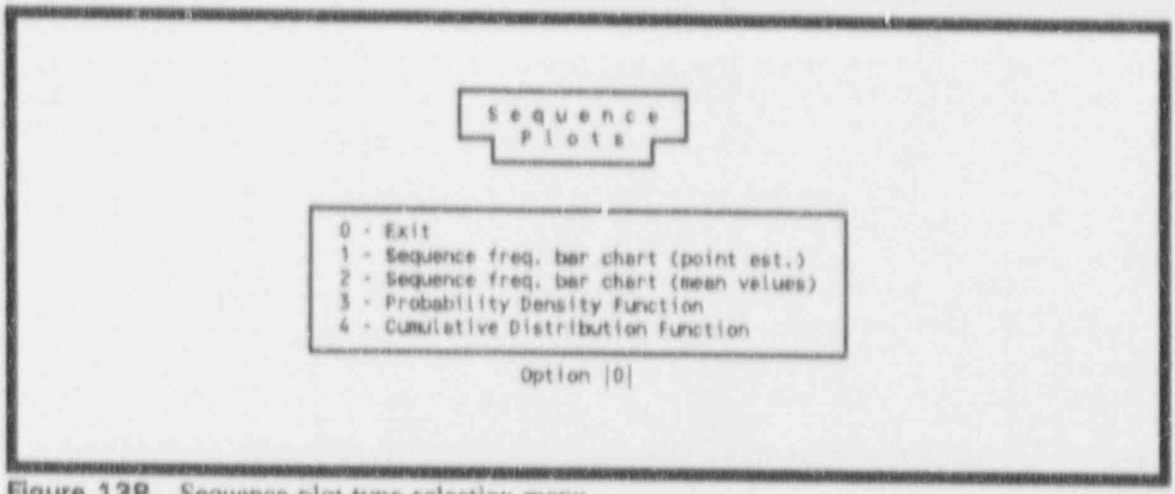


Figure 138. Sequence plot type selection menu.

5.8 End State Plots

End state plots present graphic displays of the base and current data values for the following data types: sequence sums point estimate, sequence sums mean values, probability density function, and cumulative distribution function. The plots of the sequence sums are presented in bar graphs. The values of the sequence sums may be sorted according to following categories: name, base case value, current case value, and difference (base - current).

To invoke this option, type <N> in the option field (or highlight End State Plots) and press <Enter>. The resulting display (Figure 139) is a plot type selection menu. After a plot has been drawn, you may use Ctrl-P to send the drawing to your attached (Epson compatible) printer or HP LaserJet printer or press <H> to create an .HPG file.

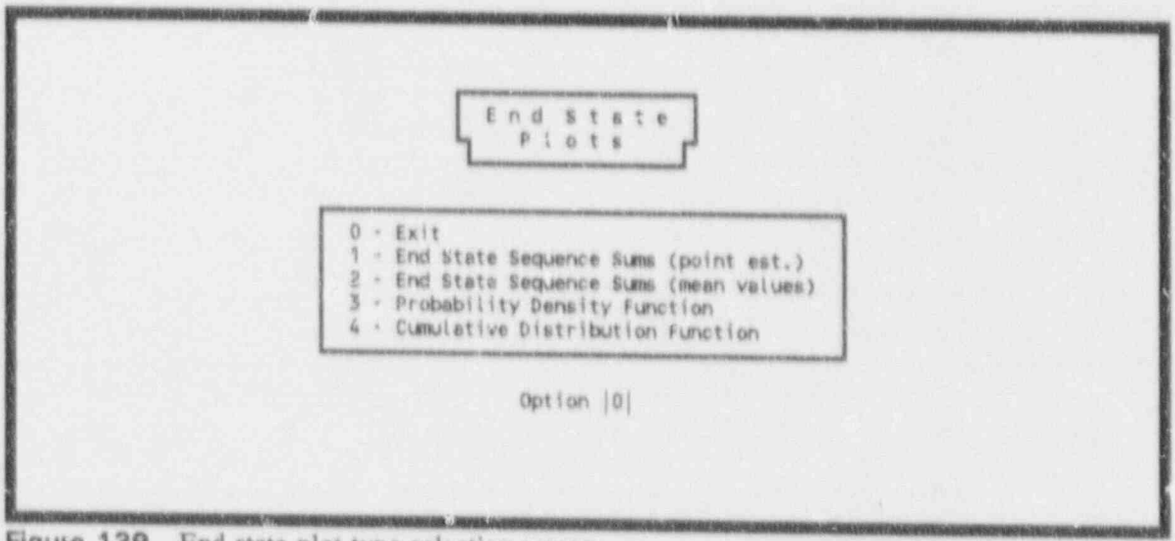


Figure 139. End state plot type selection screen.

5.8.1 Exit

Invoking this option returns you to the Graphic Analysis screen. To invoke the option, type <E> in the option field and press <Enter>, or press <Esc>.

5.8.2 End State Sequence Sums (point estimate)

This option allows you to create a bar chart of the end state sequence sums point estimates. To invoke the option, type a <1> in the option field or highlight End State Sequence Sums and press <Enter>. The resulting display (Figure 140) is a menu allowing you to specify the sort order of the data values to be plotted: name, base case value, current value, or difference (base-current).

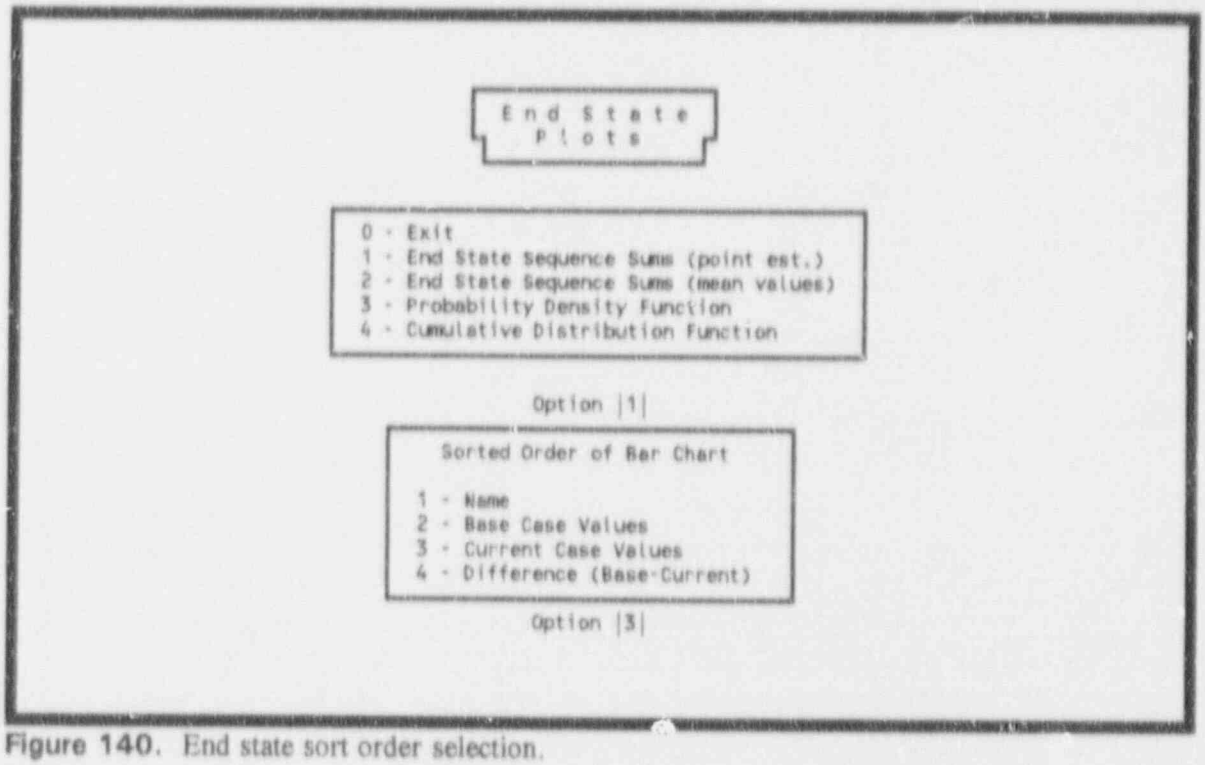


Figure 140. End state sort order selection.

Upon pressing <Enter>, after you have highlighted or selected one of the sort orders, the bar chart is drawn displaying the first ten end states. The bar chart may be manipulated using the following key strokes:

- <Ctrl> <right arrow>: display the next ten end states
- <Ctrl> <left arrow>: display the previous ten end states
- <right arrow>: shift the display left by one end state
- <left arrow>: shift the display right by one end state

5.8.3 End State Sequence Sums (mean values)

This option allows you to create a bar chart of the end state sequence sums mean values. To invoke the option, type a <2> in the option field or highlight End State Sequence Sums and press <Enter>. The resulting display (Figure 140) is a menu allowing you to specify the sort order of the data values to be plotted: name, base case value, current value, or difference (base-current).

After you have highlighted or selected one of the sort orders and pressed <Enter>, the bar chart is drawn displaying the first ten end states. The bar chart may be manipulated using the following key strokes:

- <Ctrl> <right arrow>: display the next ten end states
- <Ctrl> <left arrow>: display the previous ten end states
- <right arrow>: shift the display left by one end state
- <left arrow>: shift the display right by one end state

5.8.4 Probability Density Function

This option allows you to generate an uncertainty analysis curve for a selected end state. When you invoke this option, Figure 141 will be displayed. This screen displays all the end states in the system. Highlight the desired end state and press <Enter>. A screen will be displayed showing the plotting information that will be used for the plot. You can change any of the data displayed. When complete, press <Enter> to display the list plot.

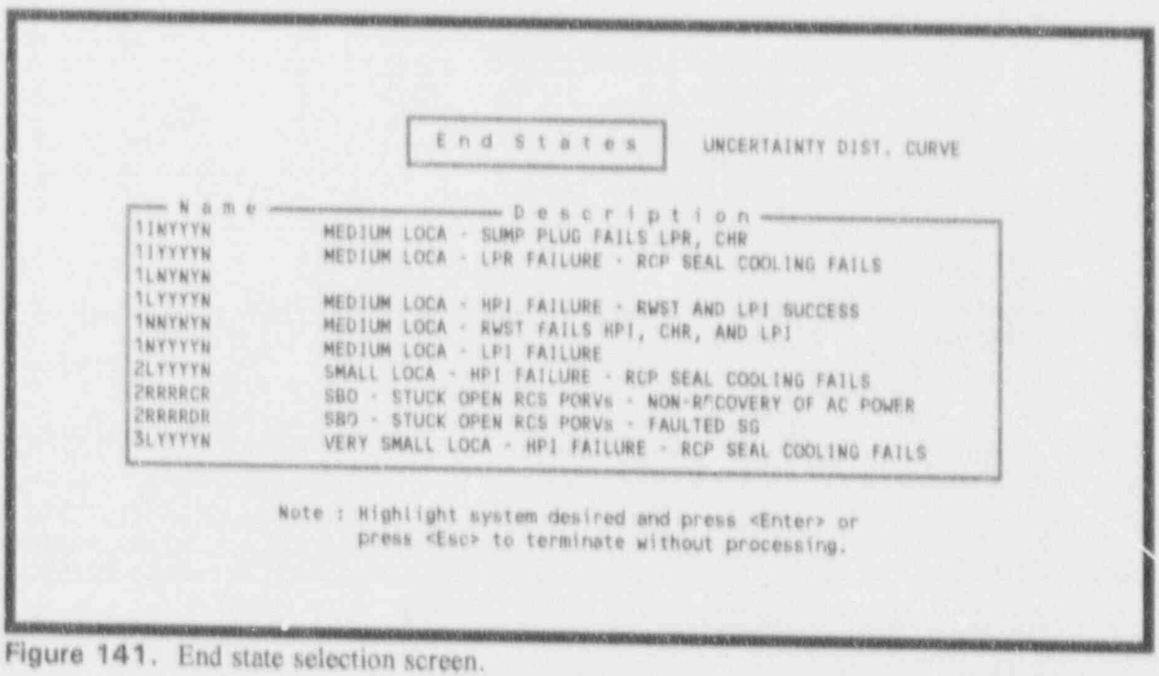


Figure 141. End state selection screen.

5.8.5 Cumulative Density Function

This option allows you to create a line plot based on an end state's cumulative distribution. To invoke this option, type a <4> in the option field or highlight Cumulative Distribution Function and press <Enter>. The resulting display (similar to Figure 141) will present you with a list of the end states contained in the data base. Highlight the desired end state and press <Enter>. A screen will be displayed showing the plotting information that will be used for the plot. You may change any of the data displayed. When complete, press <Enter> to display the line plot.

5.9 Family Plots

Family plots present graphic displays of the base and current data values for the following data types: probability density function and cumulative distribution function. To invoke this option, type <A> in the option field (or highlight Family Plot) and press <Enter>. The resulting display (see Figure 142) is a plot type selection menu. After a plot has been drawn, you may use Ctrl-P to send the drawing to your attached (Epson compatible) printer or HP LaserJet printer or press <H> to create an .HPG file.

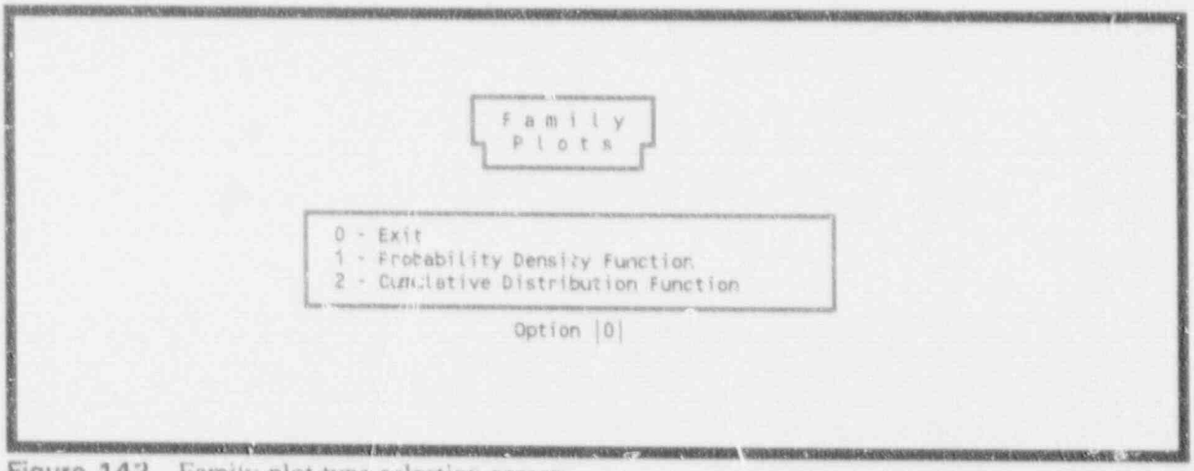


Figure 142. Family plot type selection screen.

5.9.1 Exit

Invoking this option returns you to the Graphics Analysis screen. To invoke this option, type <E> in the option field and press <Enter>, or press <Esc>.

5.9.2 Probability Density Function

This option allows you to generate an uncertainty analysis curve for a selected family. When you invoke this option, a screen will be displayed showing the plotting information that will be used for the plot. You can change any of the data displayed. When complete, press <Enter> to display the line

plot.

5.9.3 Cumulative Density Function

This option allows you to create a line plot based on a family's cumulative distribution. To invoke this option, type a <2> in the option field or highlight Cumulative Distribution Function and press <Enter>. A screen will be displayed showing the plotting information that will be used for the plot. You may change any of the data displayed. When complete, press <Enter> to display the line plot.

6. REPORTS

The reports option allows you to obtain information about the selected family. Reports are available for family, system, sequence, event tree, and basic event data. All reports can be either in summary or detailed form. Basic Event reports have added features such as cross reference and unused event reporting capabilities. The Reports main screen is shown in Figure 143.

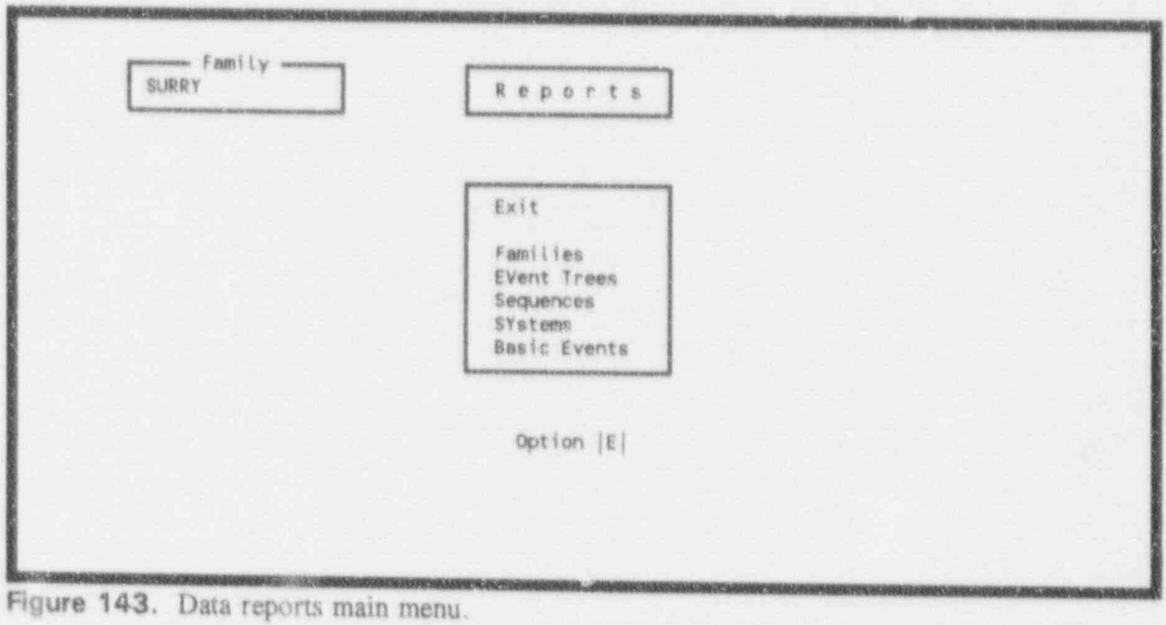


Figure 143. Data reports main menu.

In all of the reports, you mark the desired items for which you want a report. If no items are marked, you will be asked if you want a report on all the items. If you answer <N>, then you must highlight a single item or a group of items.

In each report option the following keys are activated:

<Esc> Exit to the previous function.
<F1> Help for a specific field or general help for an option.
<F2> Mark/Unmark an individual item.
<F3> Mark/Unmark all items.
<F4> Mark/Unmark a range of items.
<F5> Locate an item.

After selecting the type (summary or detail) of report for each category, you will be asked to specify the output file to which the report should be sent. Valid choices for output are "CON" for the screen (console), "PRN" for the printer, " " (blank) or <Esc> to terminate the report option, or any valid DOS filename. Figure 144 shows the report output device selection screen. After determining the output destination, the report will be generated.

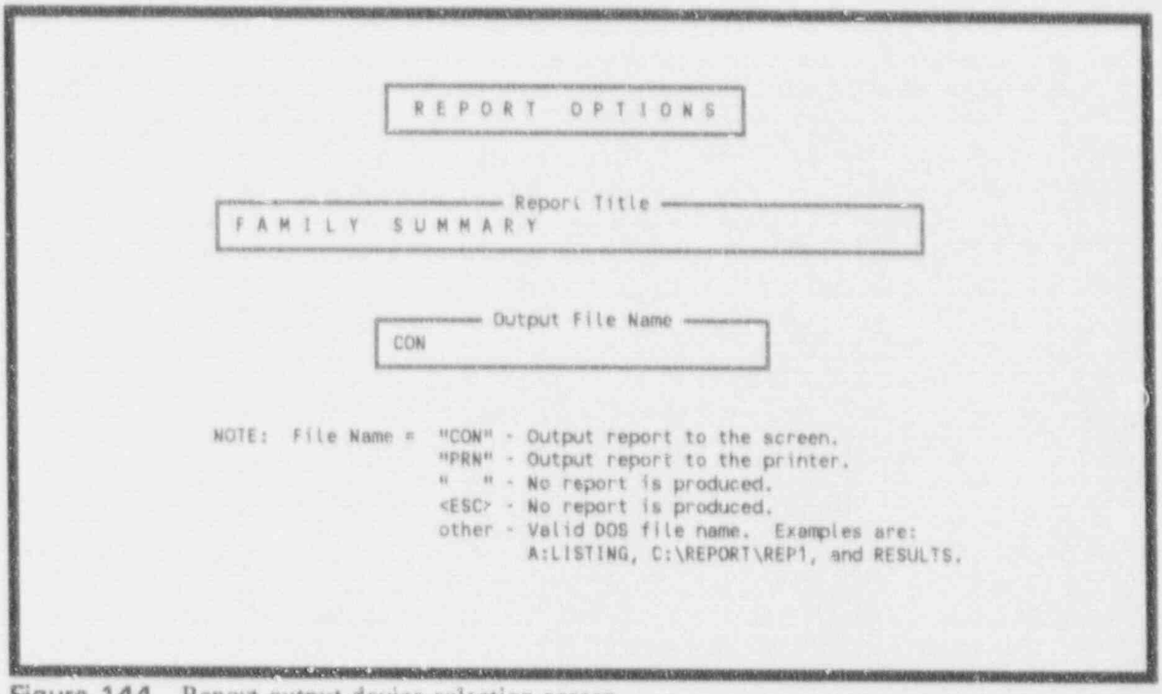


Figure 144. Report output device selection screen.

6.1 Exit

This option returns you to the SARA main menu. To invoke this option type <E> in the option field and press <Enter>.

6.2 Family Reports

The family report option allows you to generate either a summary or detailed report on the family information (Figure 145). You indicate which family to report by either marking (using the <F2> key) or highlighting the family. Otherwise, you may request a report on all listed families.

6.2.1 Family Summary Report

This option allows you to generate a family summary report. The summary includes the family name and related description. To invoke this option type <S> in the option field and do one of the following:

1) press <Enter> to report all families
2) highlight a family and press <Enter>
3) mark a group of families and press <Enter>

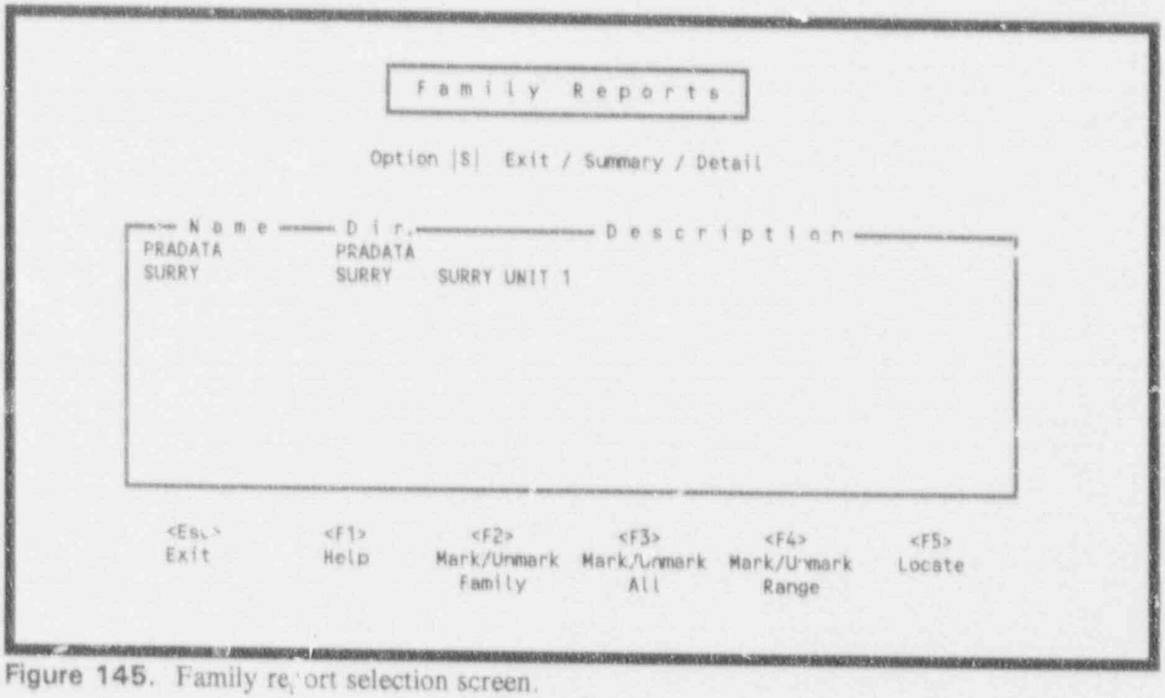


Figure 145. Family report selection screen.

NOTE: **The three steps listed above, used to select an item(s), are used throughout the Report option.**

6.2.2 Family Detail Report

This option <D> allows you to generate a family detailed report. The report includes family name, description, company, vendor, location, mission time, facility, operation date, qualification date, base sequence frequency sum, new sequence frequency sum, architectural engineer, numbers of basic events, fault trees and event trees, and any additional family information. To invoke this option type <D> in the option field and mark the family or families to include in the report.

6.3 Event Trees

The event trees report option lets you generate either a summary or detailed report on the event trees information. You indicate which event trees you want to generate a report for by either marking (using the <F2> key) or highlighting the event trees. Otherwise, you may request a report on a range (using the <F4> key) or all listed event trees (using the <F3> key). Figure 146 displays the event trees reports selection screen.

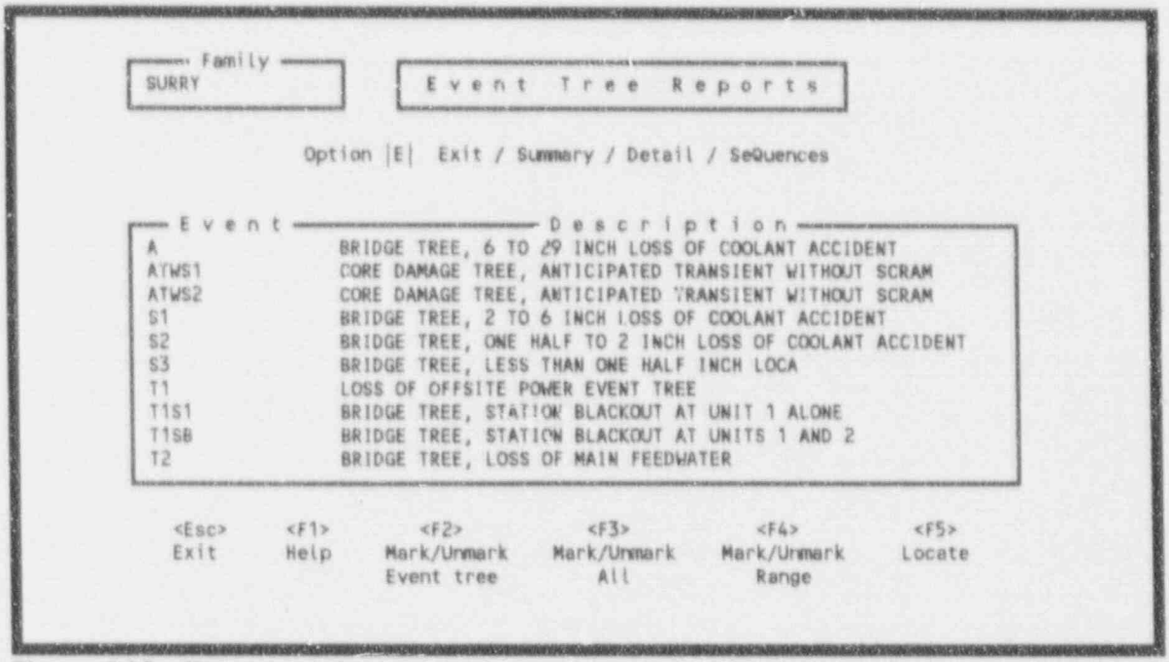


Figure 146. Event tree selection screen.

6.3.1 Event Tree Summary Report

This option allows you to generate an event tree summary report. The summary report shows the event tree name and related description. To invoke this option type <S> in the option field and mark the event tree(s) to include in the report.

6.3.2 Event Tree Detail Report

This option generates an event tree detail report. The report contains the event tree name, description, initiating event, and any additional event tree information. To invoke this option type <D> in the option field and mark the event tree(s) to include in the report.

6.3.3 Event Tree Sequences

This option allows you to generate a list of the sequences associated with an event tree. From this list of associated sequences you may mark desired sequences for summary or detailed reports. To invoke this option type <Q> in the option field and press <Enter>. Figure 147 will be displayed. Two options are available: Summary or Detail.

6.3.3.1 Sequence Summary Report. This option allows you to generate a sequence summary report. This summary provides the sequence name, related description, and sequence frequency. To invoke this option type <S> in the option field and mark the sequence(s) to include in the report.

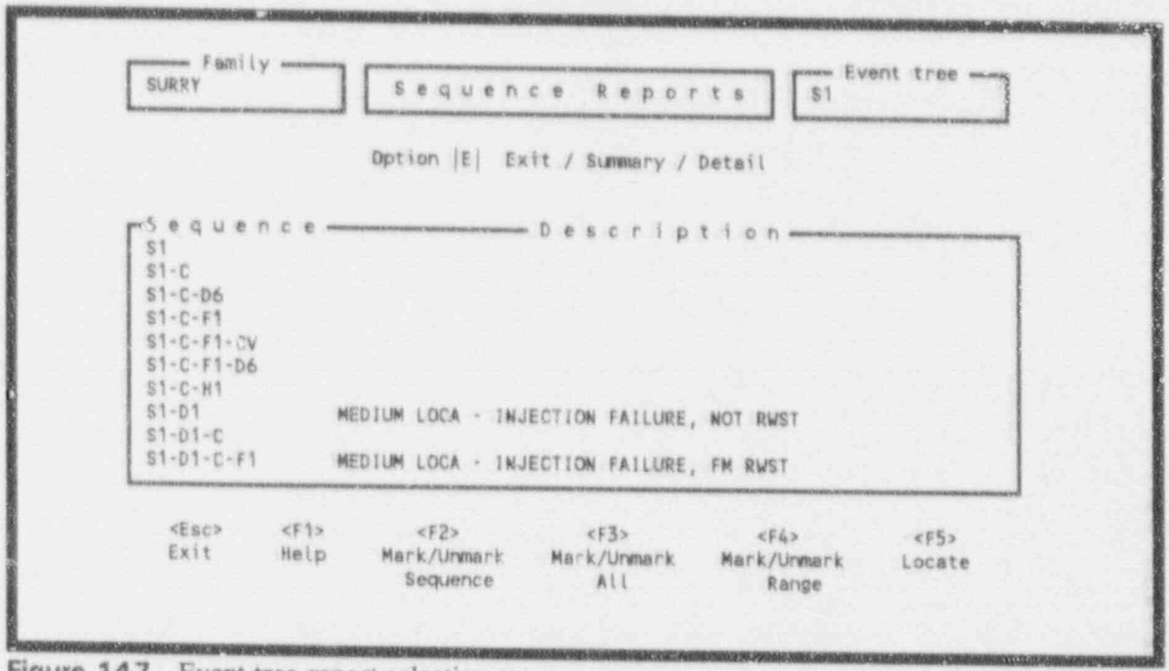


Figure 147. Event tree report selection screen.

6.3.3.2 Sequence Detail Report. This option allows you to generate a sequence detailed report. The detail report contains sequence name, associated event tree, description, base case minimum cut set upper bound, temporary minimum cut set upper bound, base probability cutoff, temporary probability cutoff, base uncertainty values, temporary uncertainty values, base number of cut sets, temporary number of cut sets, base number of events, temporary number of events, base number of samples, temporary number of samples, base random seed, temporary random seed, base size cutoff, and temporary size cutoff. The header titles are abbreviated with the first letter from each word of the description to restrict header size. To invoke this option type <D> in the option field and mark the event(s) to include in the report.

6.4 Sequence Reports

The sequence report option allows you to generate either a summary or detailed report on sequences. You indicate which sequence you want to generate a report for by either marking (using the <F2> key) or highlighting the sequence. Otherwise, you may request a report on a range (using the <F4> key), or all listed sequences (using the <F3> key). Figure 148 displays the sequence reports selection screen.

6.4.1 Sequence Summary Report

This option allows you to generate a sequence summary report. This summary provides the sequence name, related description, and sequence frequencies. To invoke this option type <S> in the option field and mark the sequence(s) to include in the report.

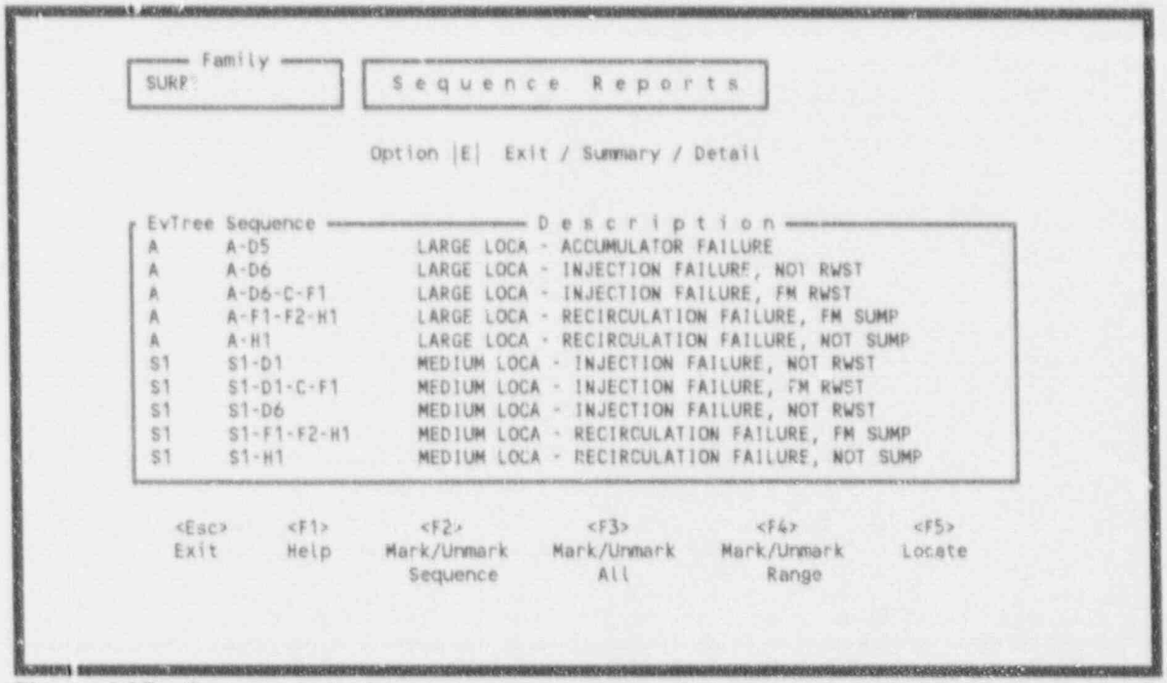


Figure 148. Sequence selection screen.

6.4.2 Sequence Detail Report

This option allows you to generate a detailed report of sequences. The detail report contains the sequence name, associated event tree, description, base case minimum cut set upper bound, temporary minimum cut set upper bound, base probability cutoff, temporary probability cutoff, base uncertainty values, temporary uncertainty values, base number of cut sets, temporary number of cut sets, base number of events, temporary number of events, base number of samples, temporary number of samples, base random seed, temporary random seed, base size cutoff, and temporary size cutoff. The header titles are abbreviated with the first letter from each word of the description to restrict header size. To invoke this option type <D> in the option field and mark the sequence(s) to include in the report.

6.5 System Reports

The system report option allows you to generate either a summary or detailed report on system information. You indicate which system you want to generate a report for by either marking (using the <F2> key) or highlighting the system. Otherwise, you may request a report on a range (using the <F4> key), or all listed systems (using the <F3> key). Figure 149 displays the system reports selection screen.

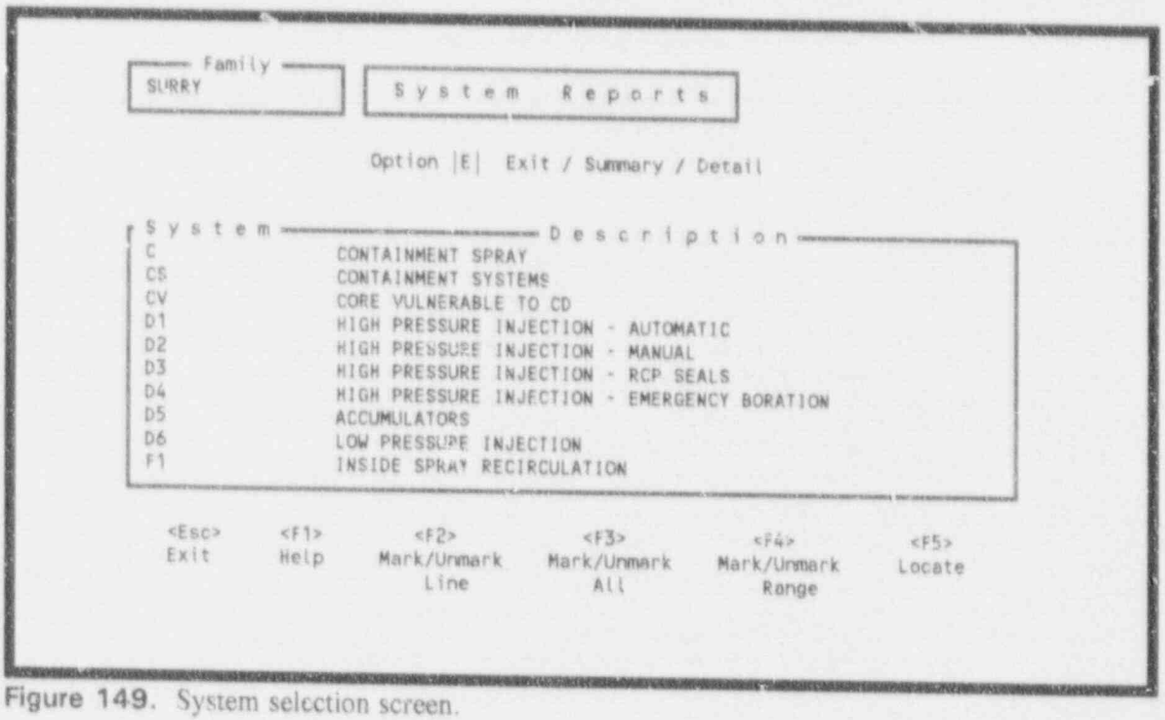


Figure 149. System selection screen.

6.5.1 System Summary Report

This option allows you to generate a system summary report. The summary includes the system name, related description, and minimum cut set. To invoke this option type <S> in the option field and mark the system(s) to include in the report.

6.5.2 System Detail Report

This option allows you to generate a detailed report on a system(s). The report provides system information such as name, description, system code, base probability cutoff, temporary probability cutoff, base minimum cut set upper bound, temporary minimum cut set upper bound, base mission time, temporary mission time, base size cutoff, temporary size cutoff, base no. of cut sets, temporary number of cut sets, base number of events, temporary number of events, fault tree level, system-related uncertainty data and any additional system descriptions. To invoke this option type <D> in the option field and mark the system(s) to include in the report.

6.6 Basic Event Reports

The basic event report option allows you to generate a summary or detailed report, or a report containing probabilities, uncertainty data, cross references, or unused event information (see Figure 150). On this screen, you indicate which basic event you want to generate a report for by either marking (using the <F2> key) or highlighting the basic event. Otherwise you may request a report on a range (using

the <F4> key), or all listed basic events (using the <F3> key)

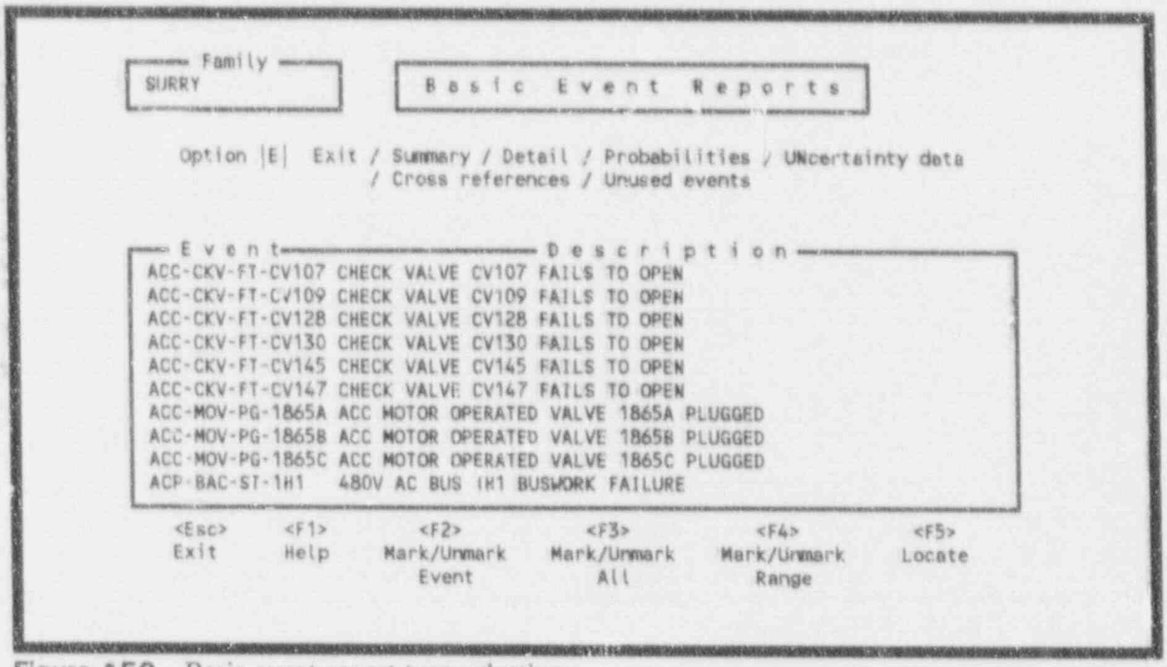


Figure 150. Basic event report type selection.

6.6.1 Basic Event Summary Report

This option allows you to generate a basic event summary report. The summary report includes the basic event name and related description. To invoke this option type <S> in the option field and mark the event(s) to include in the report.

6.6.2 Basic Event Detail Report

This option allows you to generate a basic event detail report. The report shows the basic event name, alternate name, group name, component identifier, event system, event train, event type, event failure mode, location, initiating event flag, uncertainty distribution type, correlation class and value, failure data calculation type, event failure probability, lambda, and tau values, event mission time, event class attributes, and additional event description information. To invoke this option type <D> in the option field and mark the event(s) to include in the report.

6.6.3 Basic Event Probabilities Report

This option allows you to generate a report containing the probabilities for the selected events. The probability report shows the event name, description, failure calculation type, event failure probability, event lambda and tau values, mission time, and the calculated event failure probability. To invoke this option type <P> in the option field and mark the basic events to include in the report.

6.6.4 Basic Event Uncertainty Report

This option allows you to generate a basic event uncertainty report. The report shows the event name, description, uncertainty distribution type, event failure probability, correlation class, and uncertainty distribution parameter value. To invoke this option type <N> in the option field and mark the event(s) to include in the report.

6.6.5 Basic Event Cross Reference Report

This option allows you to generate a report that cross references events with fault trees, event trees, systems, or sequences. Depending on the type of cross reference chosen, the report shows the system components with which each basic event is associated. After marking the desired basic events, the screen shown in Figure 151 appears to allow you to choose the type of cross reference report to generate.

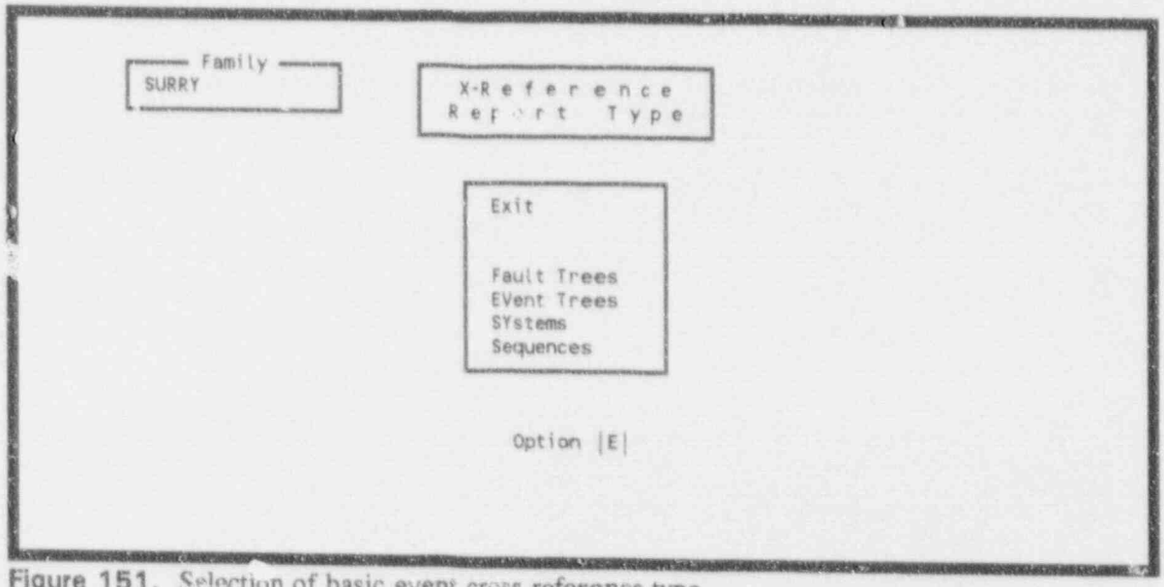


Figure 151. Selection of basic event cross reference type.

After selecting the type of cross reference report desired, the report is sent to the specified output device. The cross reference report form varies with the type of cross reference chosen but always presents the event name and the entities with which the event is associated.

6.6.6 Unused Basic Events Report

This option allows you to generate a report listing all of the unused basic events in a family, fault tree, system, or sequence. Figure 152 will be displayed showing the cross reference types available.

After choosing the type of unused basic event report desired, the report is sent to the selected output device. As with the cross reference reports, the report form varies depending upon the type of

report selected, but always shows the basic event names and descriptions that are unused in the type of report selected.

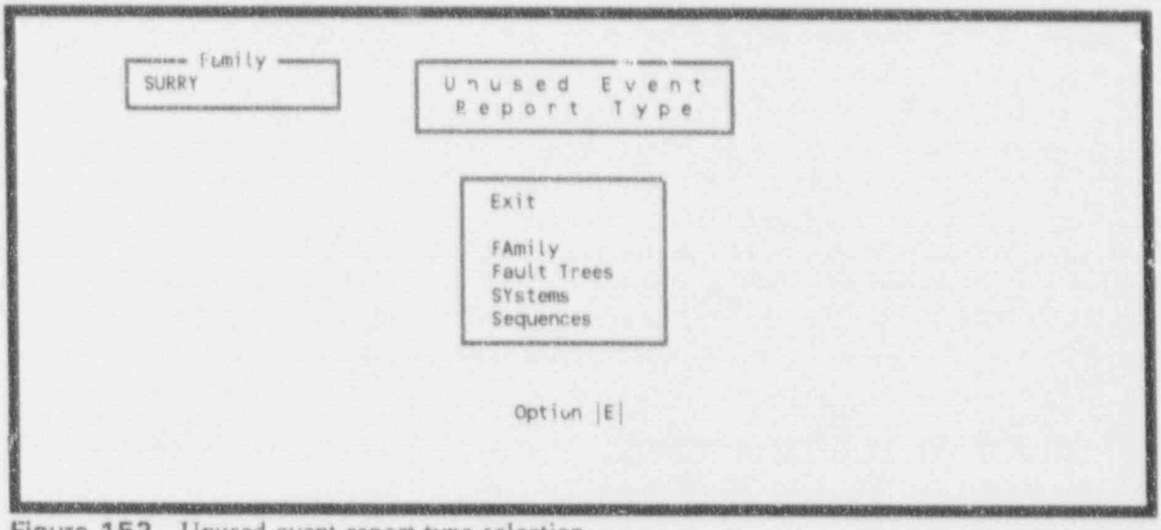


Figure 152. Unused event report type selection.

7. MODIFY DATABASE

This option allows you to modify the base or original family data files for a family, event trees, systems, end states, basic events, attributes, gates, graphics, and histograms. To invoke this option, type <M> in the option field or highlight Modify Database and press <Enter>. Figure 153 will be displayed.

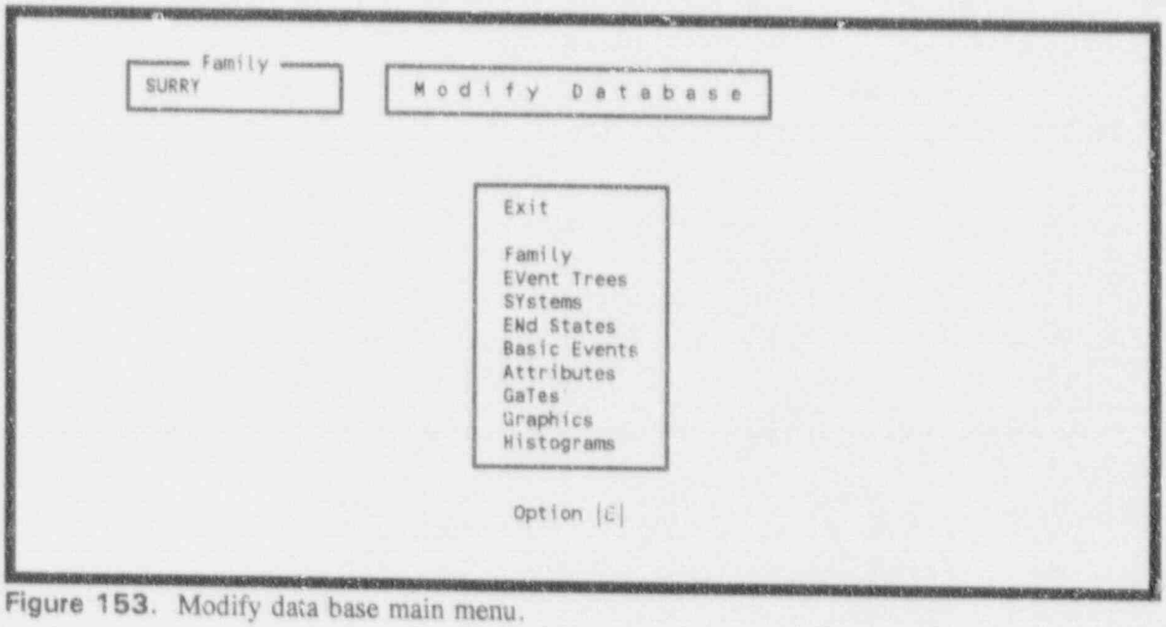


Figure 153. Modify data base main menu.

In general, each of the options shown in Figure 153 use the same modification functions: Exit, Add, Modify, Delete, and Locate. Some of the options have additional functions such as: Text and Sequences.

The following function keys are available throughout the Modify Database option:

<Esc>	Exits the current option and returns you to the Modify Database screen.
<F1>	Displays associated help messages.
<F2>	Mark/Clear tags items for use in the selected option.
<F3>	Clear All Marked events removes the marks (*) from the listed items. If no items are marked, this option will mark all of the items.
<F4>	Mark/Clear range of items quickly tags large numbers of items for processing.
<F5>	Locate an item. This option will display a blank field in the center of

the screen, and a message **Please enter name to locate** will appear. The user should enter the name to be located and then press <Enter>. This feature will place the highlight on the located name. If the required name is not found, then the next name in alphabetical order will be highlighted.

7.1 Exit

This option returns you to the SARA main menu. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.2 Family

This option allows you to add, modify, and delete a family or modify the associated text. To invoke this option, type <F> in the option field or highlight Family and press <Enter>. Figure 154 will be displayed.

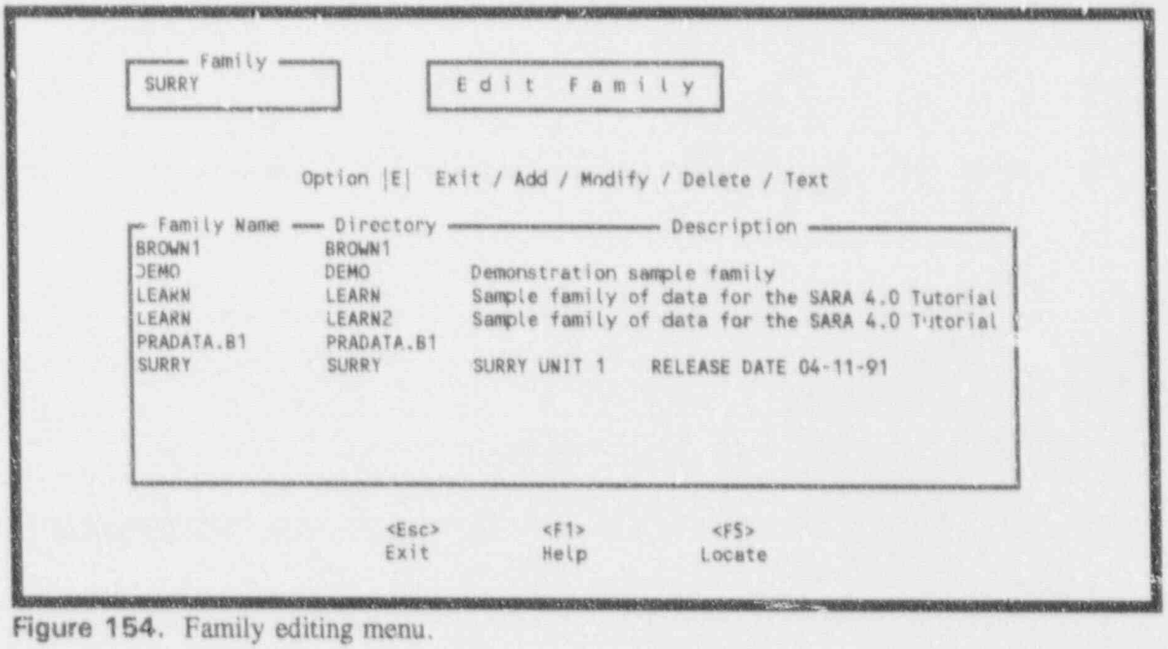


Figure 154. Family editing menu.

7.2.1 Exit

This option returns you to the Modify Database screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.2.2 Add

This option allows you to add a family to the data base. To invoke this option type <A> in the option field and press <Enter>. The Add Family screen (shown in Figure 155) will be displayed. The only required information to be entered on this screen is the family name. The options at this point are Exit, Add, and Passwords.

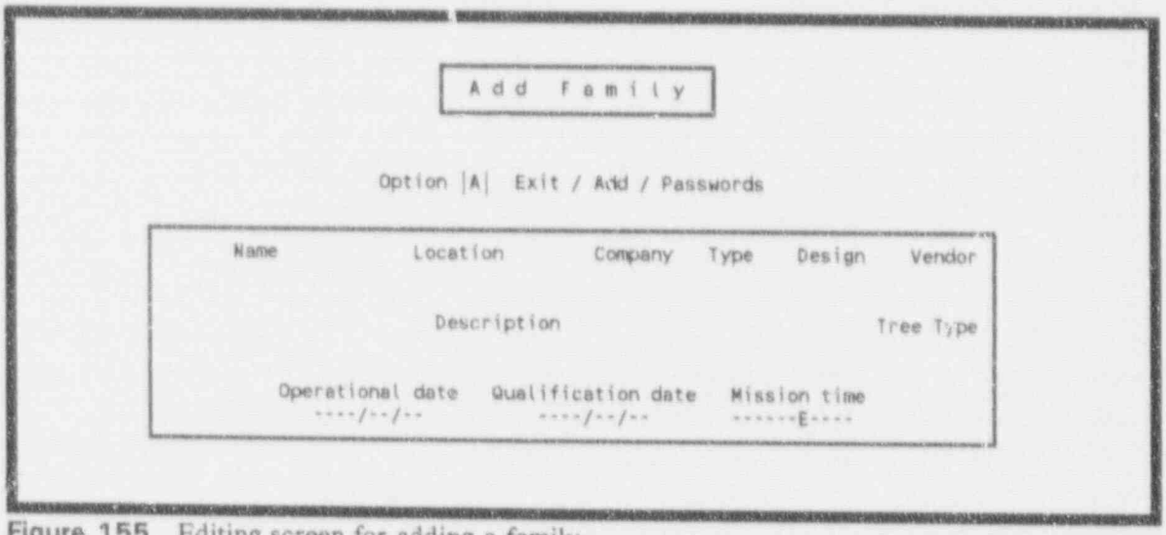


Figure 155. Editing screen for adding a family.

7.2.2.1 Exit. This option returns you to the Edit Family screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.2.2.2 Add. This option performs the actual addition of the family to the data base. To invoke this option, type <A> in the option field, enter a family name and any of the other information you wish, and press <Enter>. At completion of the Add you are returned to the Edit Family screen, where the addition of the new family will be reflected.

7.2.2.3 Passwords. This option not yet available.

7.2.3 Modify

This option allows you to modify the family data record. To invoke this option type <M> in the option field, highlight the family you wish to edit, and press <Enter>. The Modify Family screen is shown in Figure 156. The options at this point are Exit, Modify, and Passwords.

7.2.3.1 Exit. This option returns you to the Edit Family screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

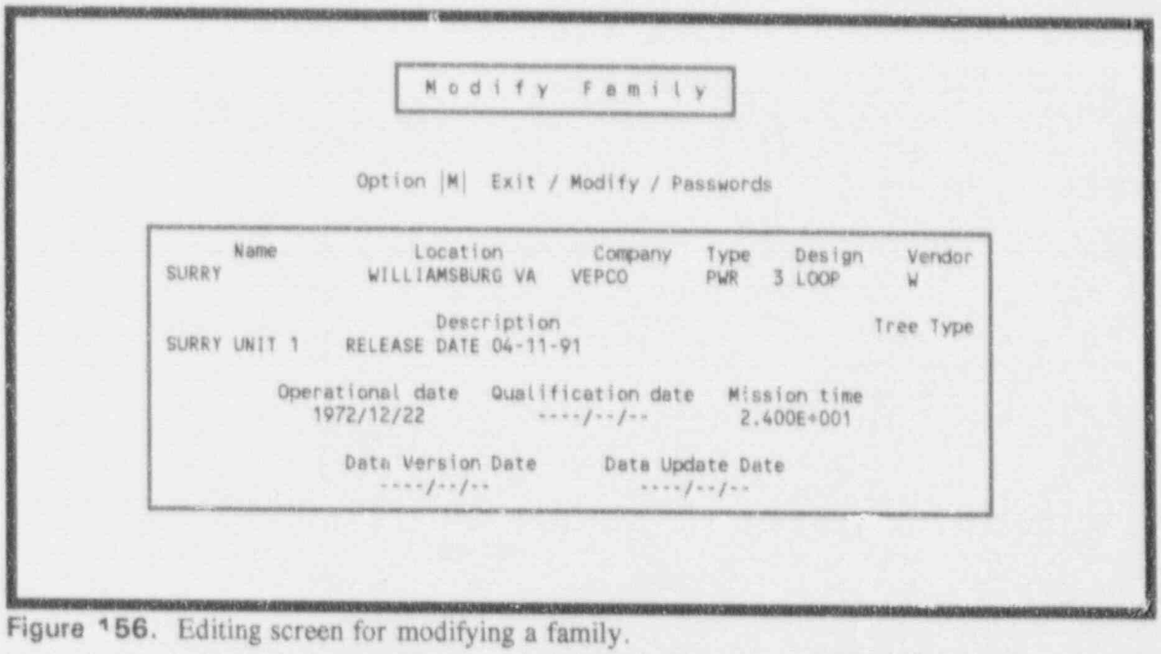


Figure 156. Editing screen for modifying a family.

7.2.3.2 Modify. This option applies the actual modification of the family data to the data base. To invoke this option, type <M> in the option field, modify any of the data fields on the screen and press <Enter>. On completion of the Modify you are returned to the Edit Family screen.

7.2.3.3 Passwords. This option not yet available.

7.2.4 Delete

NOTE: **A family that contains sub-families cannot be deleted. The deletion process must proceed up from the lowest to the highest sub-family.**

This option allows you to delete family data records from the data base. To invoke this option, type <D> in the option field and press <Enter>. The Delete Family screen is shown in Figure 157. The options at this point are Exit and Delete.

7.2.4.1 Exit. This option returns you to the Edit Family screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.2.4.2 Delete. This option verifies the delete family request. To invoke this option, type <D> in the option field and press <Enter>. A warning screen is superimposed over the Delete Family screen allowing you to cancel the deletion process (Figure 158). Enter a <Y> to delete the family or an <N> to terminate the deletion process. If you respond with a <Y>, the message **Deletion completed** will be displayed at the bottom of the screen.

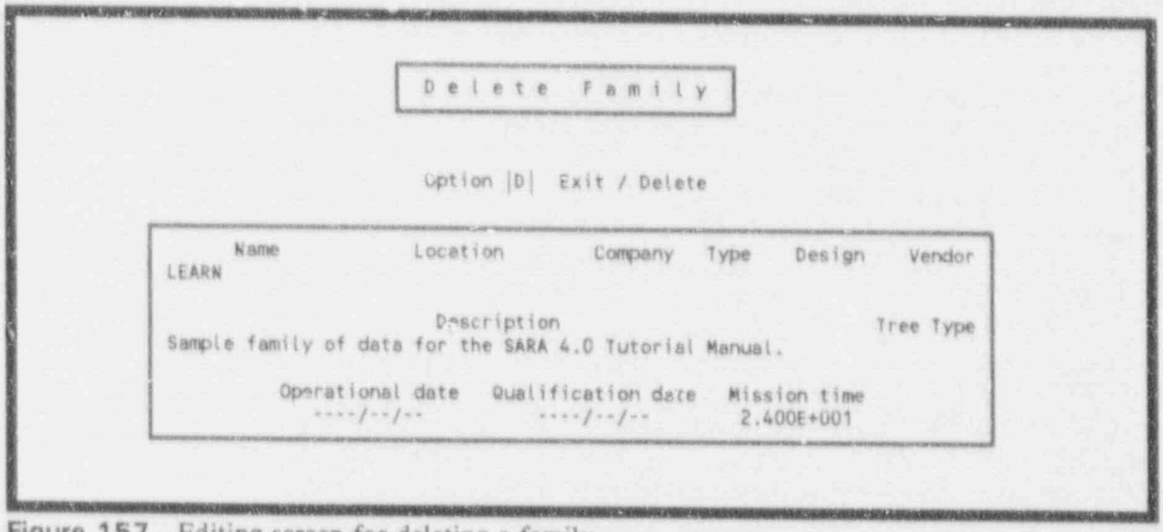


Figure 157. Editing screen for deleting a family.

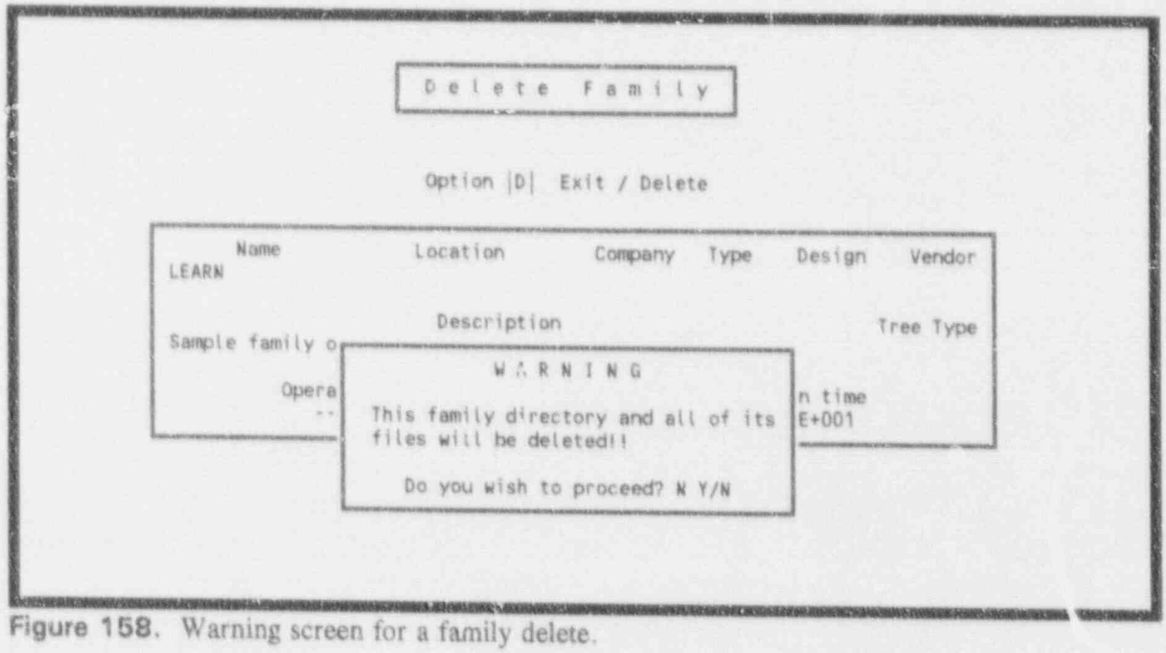


Figure 158. Warning screen for a family delete.

7.2.5 Text

This option allows you to view and edit any descriptive text associated with a specific family. To invoke this option, type <T> in the option field, highlight a family, and press <Enter>.

The initial display for this option displays the first 13 lines of the text block. The following keys allow you to display additional lines of text:

PgDn	-	Presents the next 13 lines of text.
PgUp	-	Presents the previous 13 lines of text.
Ctrl-PgDn	-	Presents the last 13 lines of text.
Ctrl-PgUp	-	Presents the first 13 lines of text.

The editing keys are

Ctrl-Z	-	Exits the text editing feature and saves the text information as it currently exists.
ESC	-	Exits without saving changes.
Alt-A	-	Adds a line after the line at the current cursor position.
Alt-B	-	Adds a line before the line at the current cursor position.
Alt-H	-	Displays editing keys help screen.
Alt-D	-	Deletes a line at the current cursor position.
Alt-R	-	Restores the previous deleted text.
Del	-	Deletes a character at current cursor position.
Ins	-	Inserts a character at current cursor position.
Ctrl-End	-	Deletes all characters from the current cursor position to the end of the cursor line.

The arrow keys are used to move the cursor within the block of text.

The editor does not line wrap, therefore, you must use <Alt-A> to establish each new line of text. If you wish to save your text changes, press <Ctrl-Z>. After you have pressed <Ctrl-Z> you are returned to the Edit Family screen with the message **Text record modified** displayed at the bottom of the screen. If you pressed <Esc>, you will be returned to the family selection screen with the message **Text record not modified** displayed at the bottom of the screen.

7.3 EVent Trees

This option allows you to modify event tree data records. To invoke this option, type <V> in the option field or highlight EVent Trees and press <Enter>. The Edit Event Trees screen listing all of the event trees belonging to the current family will be displayed (Figure 159). The modification options are: Exit, Add, Modify, Delete, Text, Sequences, Base Case Update, and Clear Alternate Case.

7.3.1 Exit

This option returns you to the Modify Database main menu. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

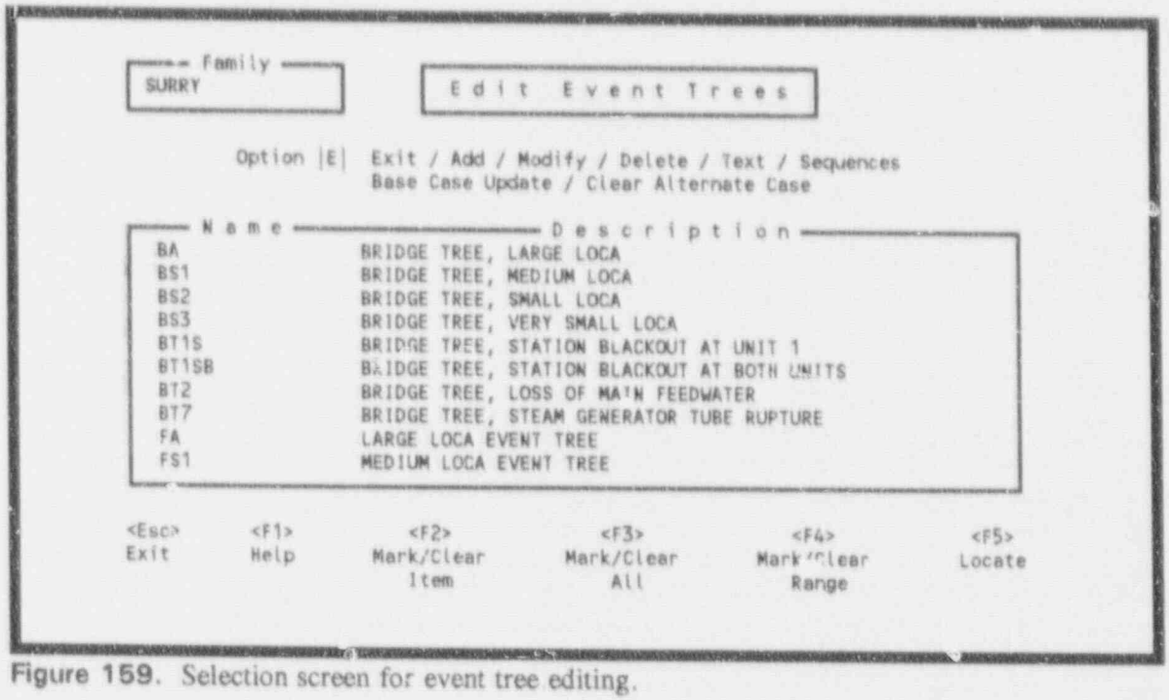


Figure 159. Selection screen for event tree editing.

7.3.2 Add

When the user creates event trees using the graphical event tree editor or loads a graphical event tree from another data base, an event tree record is automatically added to the data base. The user need only use this option if the graphical event tree format is not used. To invoke this option, type <A> in the option field and press <Enter>. The Add Event Tree screen will be displayed (Figure 160). The options at this point are Exit and Add.

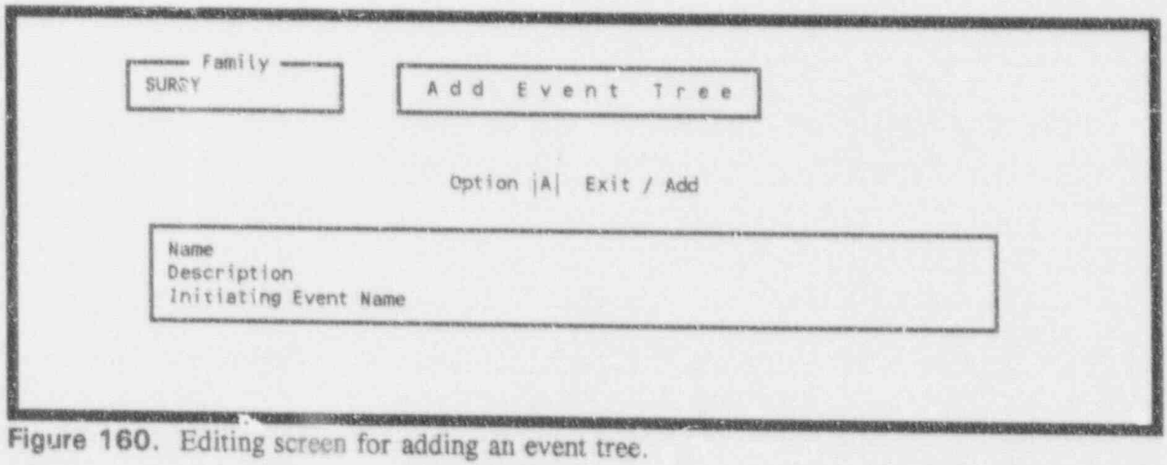


Figure 160. Editing screen for adding an event tree.

7.3.2.1 Exit. This option returns you to the Edit Event Trees screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.3.2.2 Add. This option performs the actual add of a new event tree record. To invoke this option, type <A> in the option field, fill in the requested data fields, and press <Enter>. The required information for an event tree add is the name and initiating event.

When you position the cursor in the Initiating Event Name field, a window will appear listing all initiating events for the current family. Press <F1> to position the cursor in the window. Use the arrow, tab, or space bar keys to scroll through the list of events. When the desired event is highlighted, press <Enter>. The selected event will be placed in the corresponding field. Upon pressing <Enter>, the message **Record added** will be displayed at the bottom of the screen.

7.3.3 Modify

This option allows you to modify an event tree record. To invoke this option, type <M> in the option field, highlight an event tree name, and press <Enter>. The Modify Event Tree screen is shown in Figure 161. The options at this point are Exit and Modify.

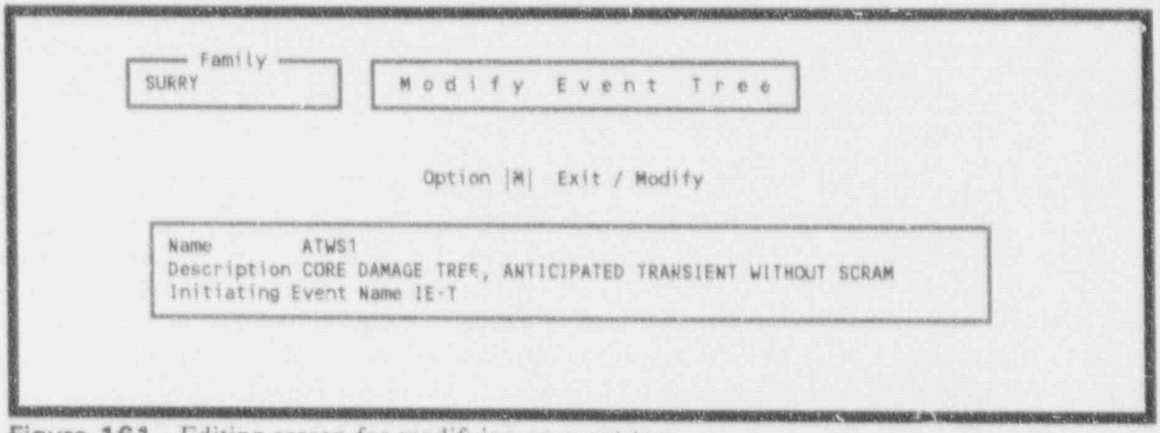


Figure 161. Editing screen for modifying an event tree.

7.3.3.1 Exit. This option returns you to the Edit Event Trees screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.3.3.2 Modify. This option performs the actual modification of the event tree record. To invoke this option, type <M> in the option field, modify any of the data fields on the Modify Event Trees screen, and press <Enter>.

To modify the initiating event field, position the cursor in the Initiating Event Name field to display a window listing all initiating events for the current family. Press <F1> to position the cursor in the window. Use the arrow, tab, or space bar keys to scroll through the list of events. When the desired event is highlighted, press <Enter>. The selected event will be placed in the corresponding field. Upon pressing <Enter>, the message **Record modified** will be displayed at the bottom of the screen.

7.3.4 Delete

This option allows you to delete an event tree record and associated sequence records from the data base. To invoke this option, type <D> in the option field, highlight an event tree, and press <Enter>. The delete event tree record is shown in Figure 162. The options at this point are Exit and Delete.

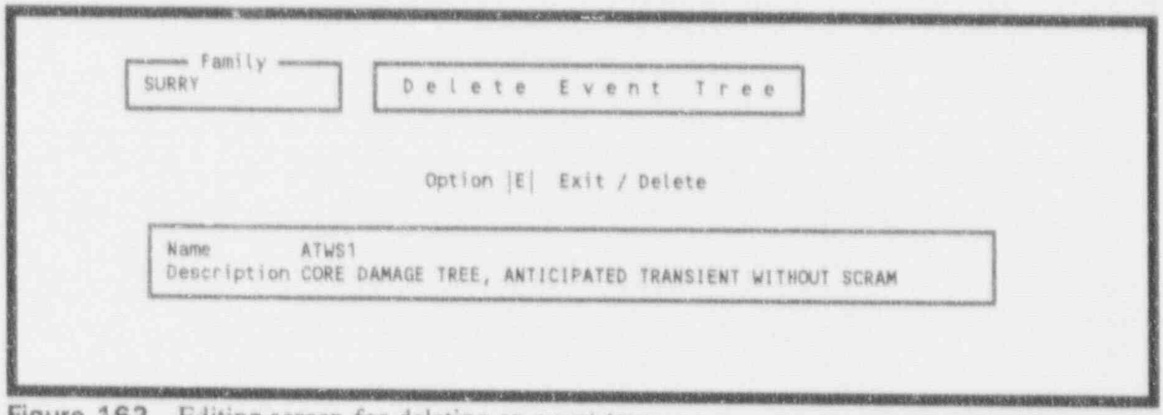


Figure 162. Editing screen for deleting an event tree.

7.3.4.1 Exit. This option returns you to the Edit Event Trees screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.3.4.2 Delete. This option performs the actual deletion of the event tree record. To invoke this option, type <D> in the option field and press <Enter>. A warning screen will appear, allowing you to cancel the deletion at this point (Figure 163). If you respond Y (yes), all sequence records associated with the event tree will be deleted from the data base. You will be returned to the Edit Event Trees screen with the message **Record deleted** displayed.

7.3.5 Text

This option allows you to view and edit any descriptive text associated with a specific event tree. This option operates the same as the Text option discussed in the Family section. Refer to Section 7.2.5.

7.3.6 Sequences

This option allows you to modify the sequences associated with an event tree. To invoke this option, type <S> in the option field, highlight an event tree name, and press <Enter>. If an event tree was not highlighted before pressing <Enter>, the message **An event tree must be highlighted first** will be displayed. After highlighting an event tree and pressing <Enter>, the Edit Sequences screen shown in Figure 164 will be displayed. The editing options for sequences are: Exit, Add, Modify, Delete, Text, Base Case Update, and Clear Alternate Case.

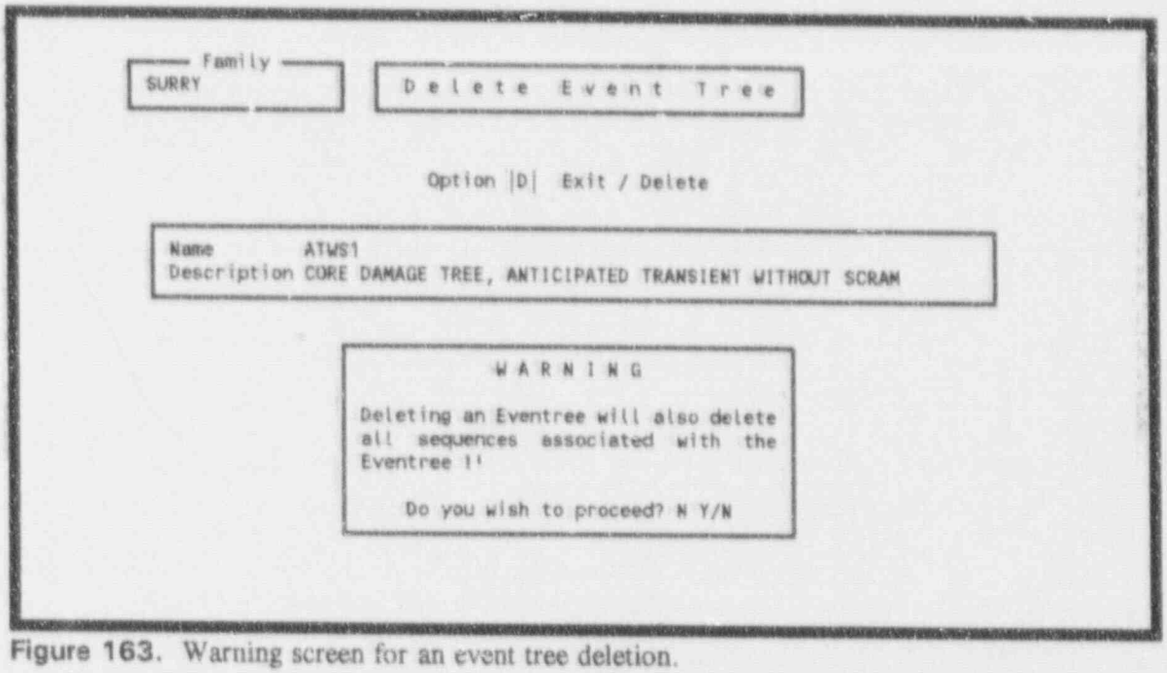


Figure 163. Warning screen for an event tree deletion.

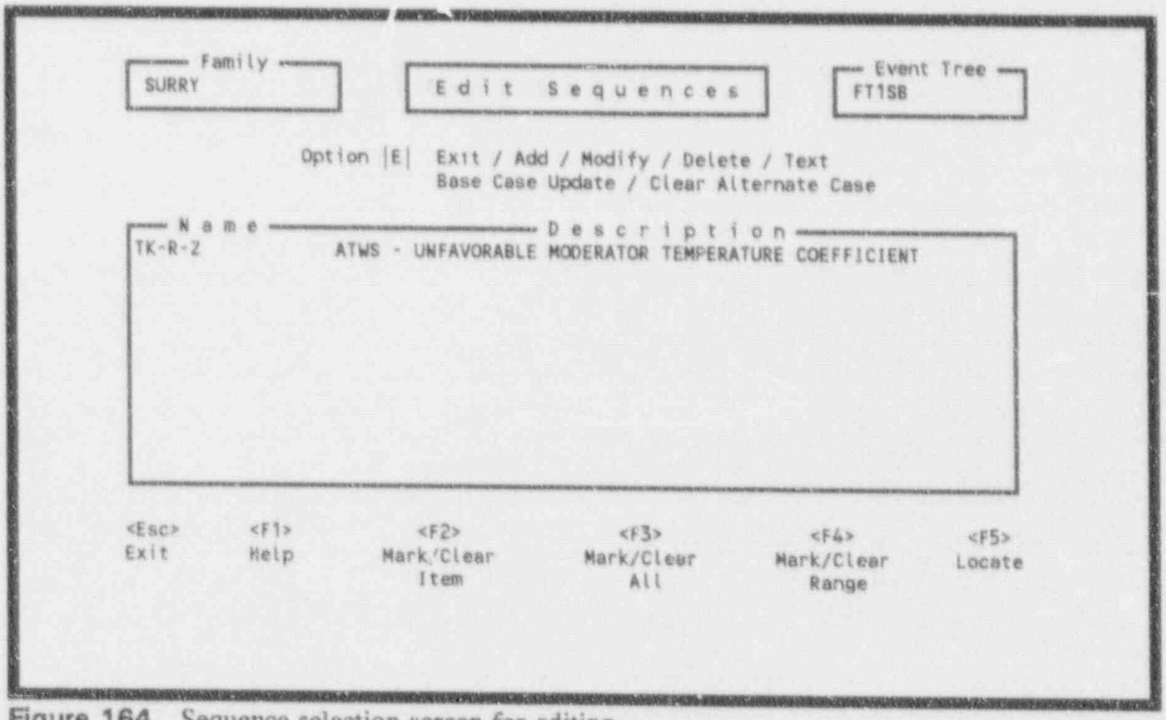


Figure 164. Sequence selection screen for editing.

7.3.6.1 Exit. This option returns you to the Edit Event Trees screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.3.6.2 Add. This option allows you to add a sequence record to the data base. To invoke this option, type <A> in the option field and press <Enter>. The Add Sequence screen is shown in Figure 165. The options at this point are Exit and Add.

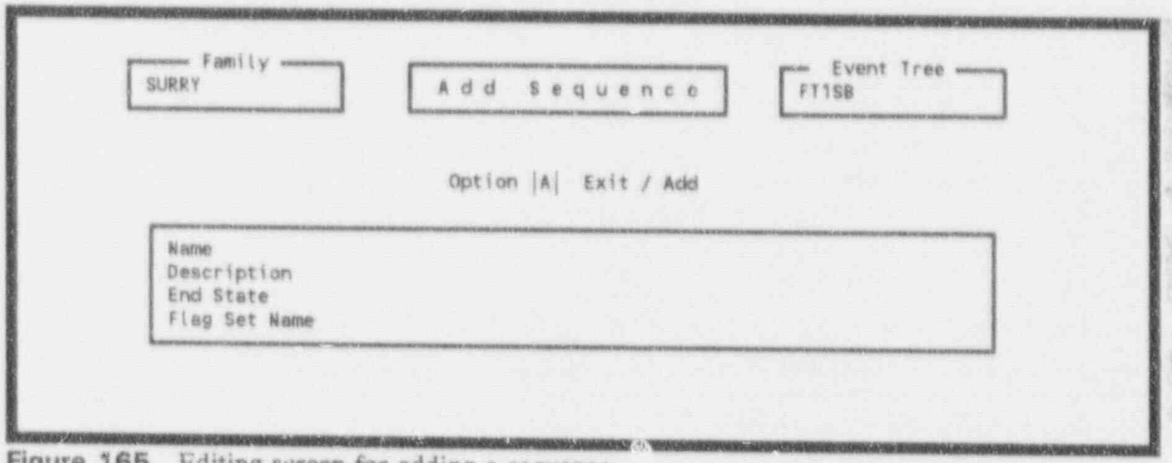


Figure 165. Editing screen for adding a sequence.

7.3.6.2.1 Exit—This option returns you to the Edit Sequences screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.3.6.2.2 Add—This option performs the actual add of a new sequence record. To invoke this option, type <A> in the option field, fill in the requested data fields, and press <Enter>. The only required information for a sequence add is the name.

When you position the cursor in the End State Field, a window will appear listing all end states for the current family. Press <F1> to position the cursor in the window. Use the arrow, tab, or space bar keys to scroll through the list of end states. When the desired end state is highlighted, press <Enter>. The selected end state will be placed in the corresponding field.

The Flag Set Name is the name of a change set containing flags to be used when generating cut sets for this sequence. SARA uses this default flag set name to modify or prune the fault tree logic for this sequence before it is solved (see Analyze Sequences). Enter a flag set name or leave blank and press <Enter>. Upon pressing <Enter>, the message **Record added** will be displayed at the bottom of the screen.

7.3.6.3 Modify. This option allows you to modify a sequence record. To invoke this option, type <M> in the option field, highlight a sequence name, and press <Enter>. The Modify Sequence screen is shown in Figure 166. The options at this point are Exit and Modify.

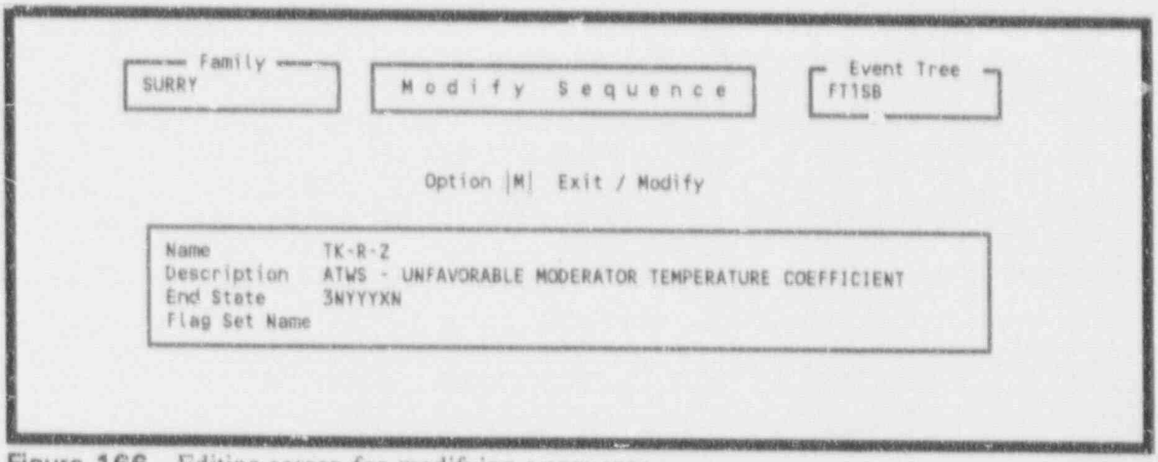


Figure 166. Editing screen for modifying a sequence.

7.3.6.3.1 Exit—This option returns you to the Edit Sequences screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.3.6.3.2 Modify—This option performs the actual modification of the sequence record. To invoke this option, type <M> in the option field, modify any of the data fields on the Modify Sequence screen, and press <Enter>. You will be returned to the Edit Sequences screen with the message **Record Modified** displayed at the bottom of the screen.

7.3.6.4 Delete. This option allows you to delete a sequence record. To invoke this option, type <D> in the option field, highlight a sequence name, and press <Enter>. The Delete Sequence screen is shown in Figure 167. Two options are available: Exit and Delete.

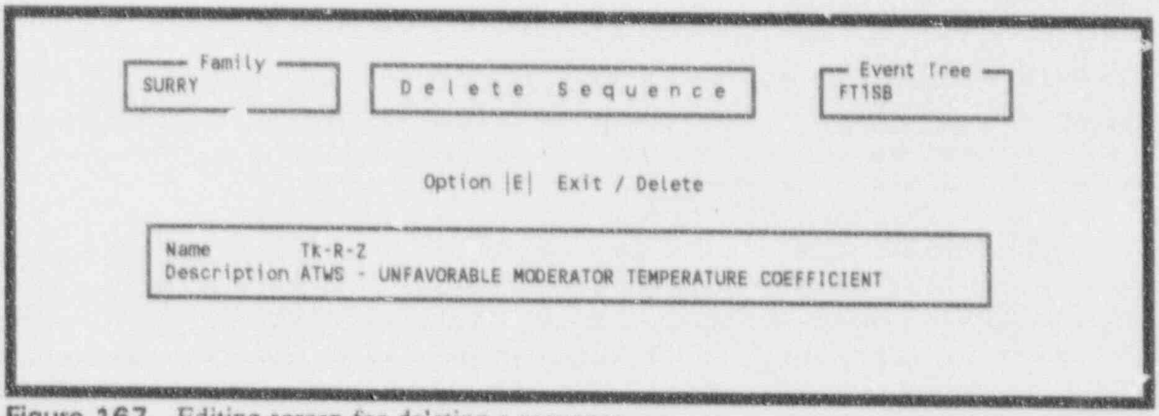


Figure 167. Editing screen for deleting a sequence.

7.3.6.4.1 Exit—This option returns you to the Edit Sequences screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.3.6.4.2 Delete—This option performs the actual deletion of the sequence record. To invoke this option, type <D> in the option field and press <Enter>. The message **Record deleted.** will be displayed at the bottom of the screen.

7.3.6.5 Text. This option allows you to view and edit any descriptive text associated with a specific sequence. This option operates the same as the Text option discussed in the Family section. Refer to Section 7.2.5.

7.3.6.6 Base Case Update. This option allows you to overwrite all base case (original) data with the current case data. The base case cut sets will be set to the alternate case cut sets; the base case uncertainty data will be set to the current case uncertainty data; and the base case quantile values will be set equal to the quantile values for the current case. The base case minimum cut set upper bound will be initialized to the current case minimum cut set upper bound. **WARNING: The original base case data will be lost if this option is executed!**

The base case update may be performed on a single sequence, a group of sequences, or on all of the sequences in the current family. To activate this option for a single sequence, type a <B> (Base Case Update) in the option field, highlight the desired sequence, and press <Enter>. To perform a base case update on a group of sequences, mark the desired sequences using the F2, F3, or F4 keys, type a <B> in the option field and press <Enter>. To perform this option on all sequences in the current family, type a <B> in the option field and press <Enter>. A message **Process all records? (Y/N)** will appear at the bottom of the screen. Type a <Y> to continue the base case update for all of the sequences, or type an <N> to discontinue the update for all sequences.

A warning screen (Figure 168) will then be displayed asking for a (Y/N) confirmation prior to performing the update. To terminate the update, type an <N> in the option field or press the <Esc> key. To initiate the base case update, type a <Y> in the option field. This will cause the current case data to overwrite the base case data. Upon completion of this process, a message **Base case update complete** will be displayed at the bottom of the screen.

7.3.6.7 Clear Alternate Case. This option clears all alternate case information for the specified sequence(s). To invoke this option, type a <C> in the option field, highlight the desired sequence and press <Enter>. A warning will be displayed (see Figure 169). To continue enter a <Y> and press <Enter>; otherwise enter an <N> and press <Enter> to terminate the process.

7.3.7 Base Case Update

This option operates the same as described in Section 7.3.6.6, except all sequences for the specified event tree are updated.

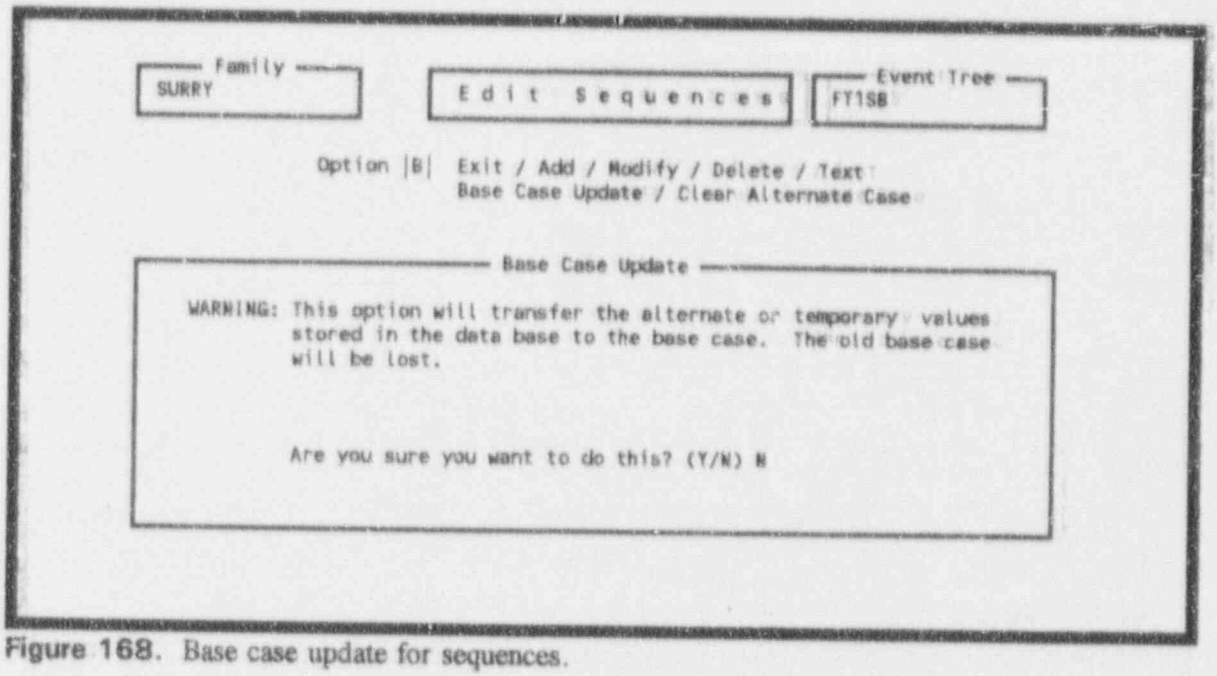


Figure 168. Base case update for sequences.

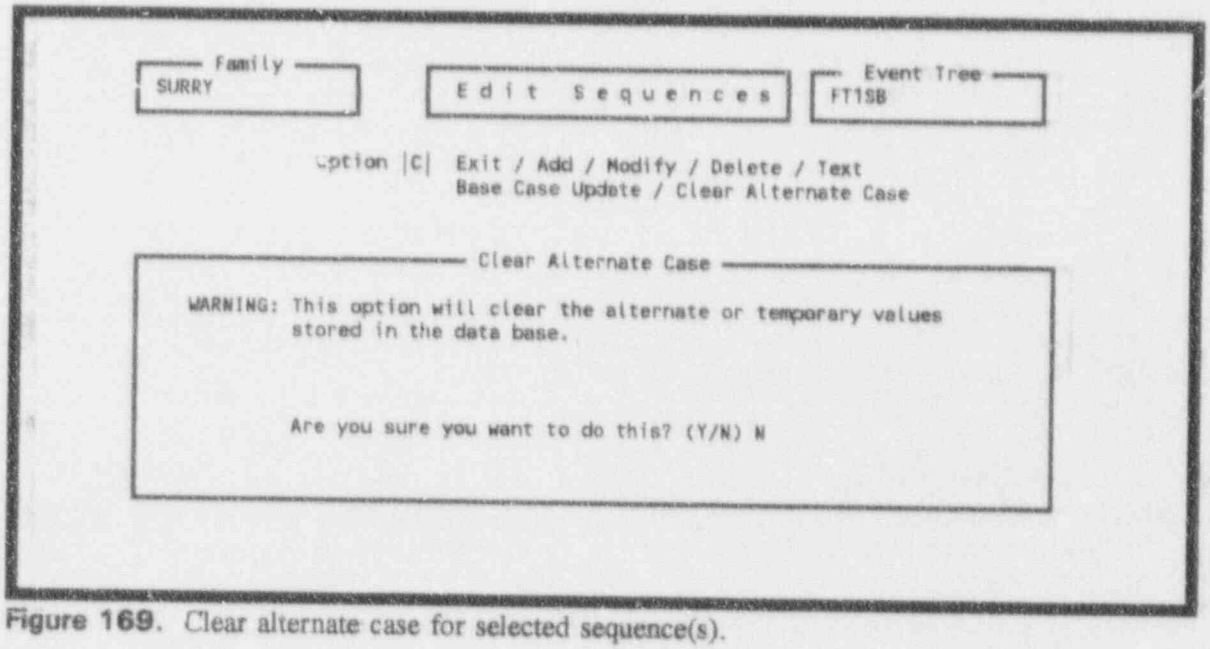


Figure 169. Clear alternate case for selected sequence(s).

7.3.8 Clear Alternate Case

This option operates the same as described in Section 7.3.6.7, except the alternate case information for all sequences for the specified event tree is cleared (see Figure 170).

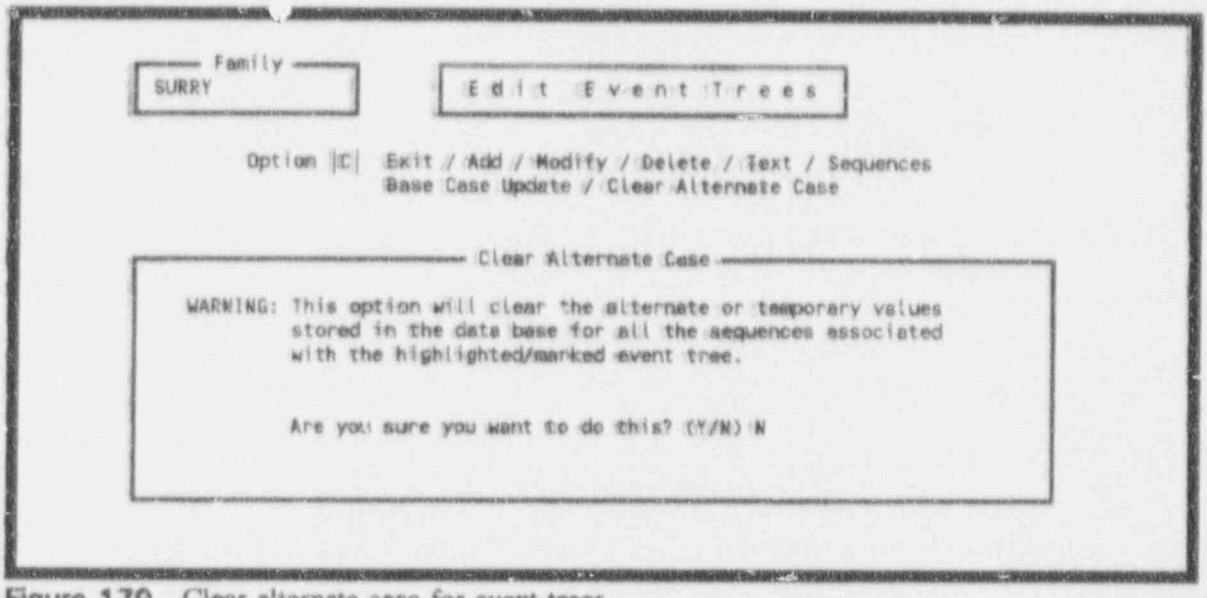


Figure 170. Clear alternate case for event trees.

7.4 SYstems

This option allows you to modify system data records. To invoke this option, type <Y> in the option field or highlight SYstems and press <Enter>. The Edit Systems screen lists all of the systems contained in the current family (Figure 171). The modification options are: Exit, Add, Modify, Delete, Text, Base Case Update, and Clear Alternate Case.

7.4.1 Exit

This option returns you to the Modify Database menu. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.4.2 Add

This option allows you to add a system record to the current family. To invoke this option, type <A> in the option field and press <Enter>. The Add System screen is shown in Figure 172. The options at this point are Exit and Add.

7.4.2.1 Exit. This option returns you to the Edit Systems screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.4.2.2 Add. This option performs the actual add of a new system record. To invoke this option, type <A> in the option field, fill in the requested data fields, and press <Enter>. The only required information for a system add is the name. When complete, you will be returned to the Edit Systems screen with the message **Record Added** displayed.

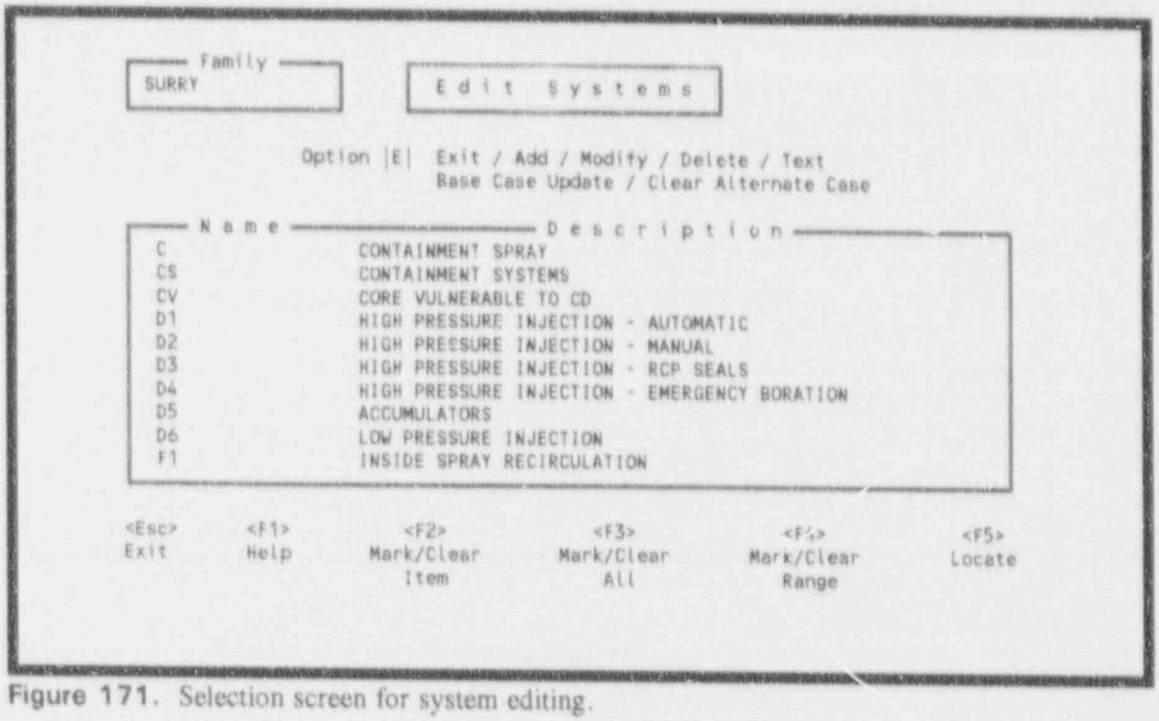


Figure 171. Selection screen for system editing.

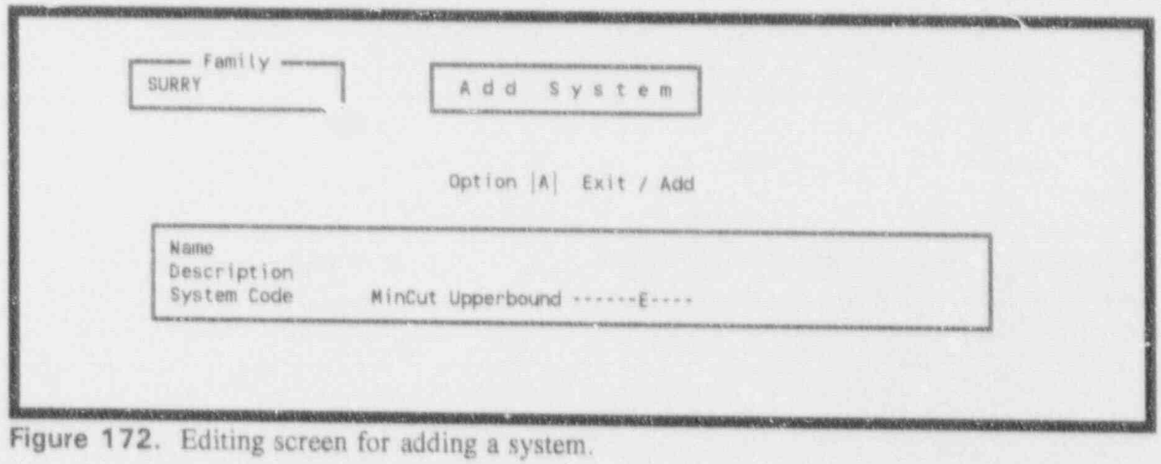


Figure 172. Editing screen for adding a system.

7.4.3 Modify

This option allows you to modify a system record. To invoke this option, type <M> in the option field, highlight a system name, and press <Enter>. The Modify System screen is shown in Figure 173. The options at this point are Exit and Modify.

7.4.3.1 Exit. This option returns you to the Edit Systems screen. To invoke this option, type <E> in the option field and press <Enter,> or press the <Esc> key.

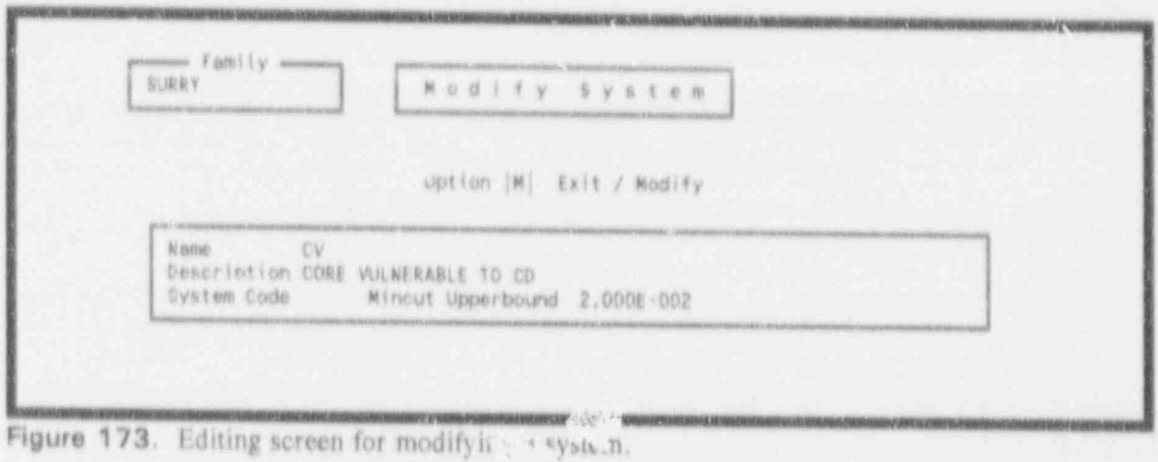


Figure 173. Editing screen for modifying a system.

7.4.3.2 Modify. This option performs the actual modification of the system record. To invoke this option, type <M> in the option field, modify any of the data fields on the Modify System screen, and press <Enter>. When completed, you will be returned to the Edit Systems screen with the message **Record modified** displayed.

7.4.4 Delete

This option allows you to delete a system record from the data base. To invoke this option, type <D> in the option field, highlight a system and press <Enter>. The Delete System screen is shown in Figure 174. The options at this point are Exit and Delete.

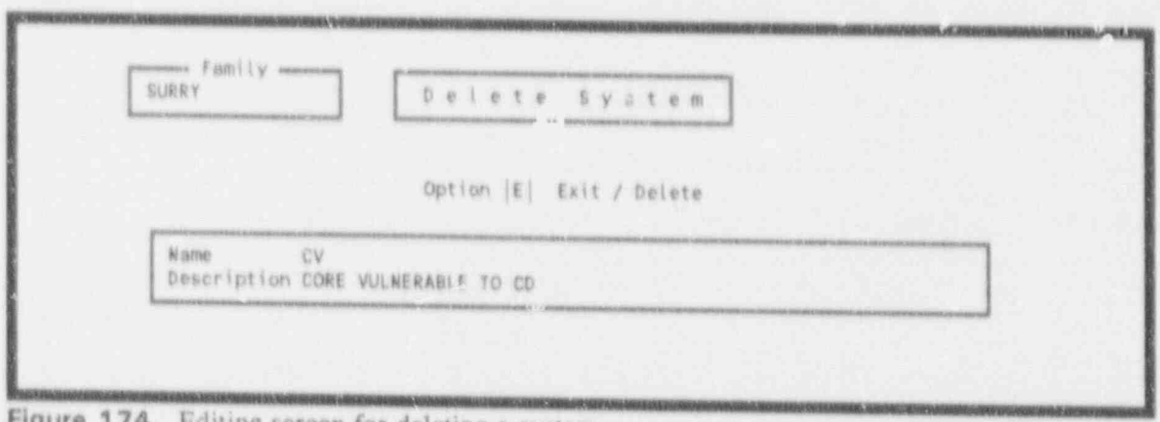


Figure 174. Editing screen for deleting a system.

7.4.4.1 Exit. This option returns you to the Edit Systems screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.4.4.2 Delete. This option performs the actual deletion of the system record. To invoke this option, type <D> in the option field and press <Enter>. When complete, you will be returned to the Edit Systems screen with the message **Record deleted** displayed.

7.4.5 Text

This option allows you to view and edit any descriptive text associated with a specific system. This option operates the same as the Text option discussed in the Family section. Refer to Section 7.2.5.

7.4.6 Base Case Update

This option operates the same as described for sequences in Section 7.3.6.6. Here, the update is performed on an entire system(s).

7.4.7 Clear Alternate Case

This option operates the same as described for sequences in Section 7.3.6.7. Here, the clearing is performed on an entire system(s).

7.5 ENd States

This option allows you to modify the end state data records. To invoke this option, type <N> in the option field or highlight ENd States and press <Enter>. The Edit End State screen, which lists all of the end states belonging to the current family, is shown in Figure 175. The modification options are: Exit, Add, Modify, Delete, and Text.

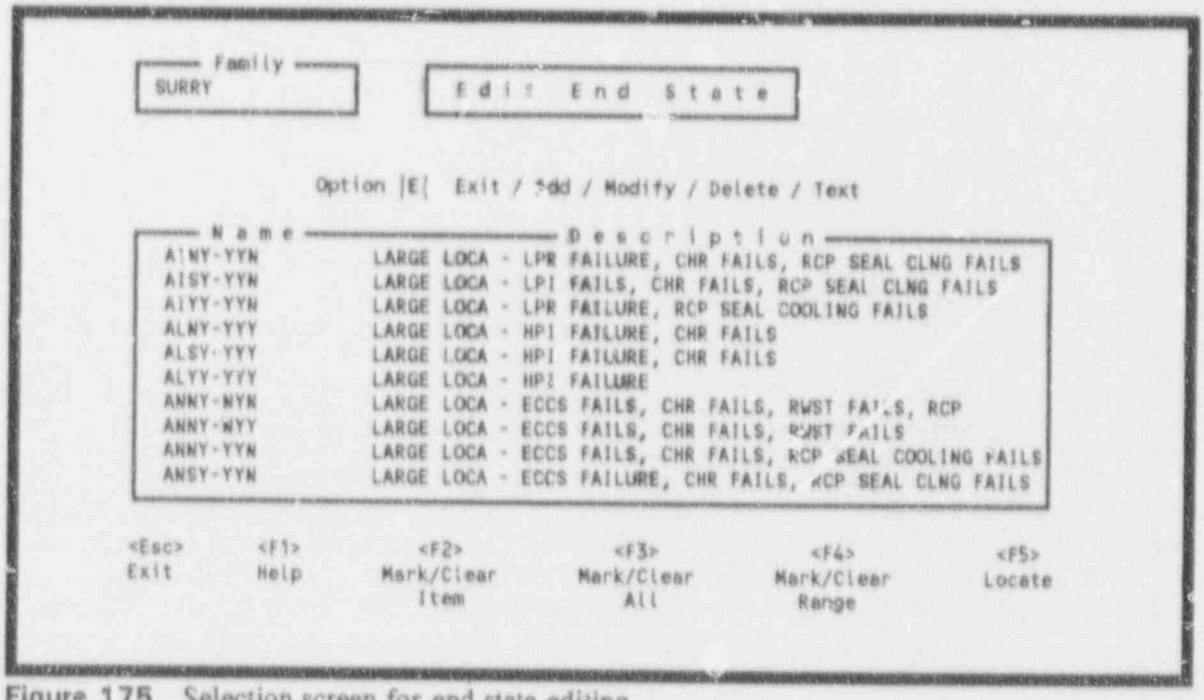


Figure 175. Selection screen for end state editing.

7.5.1 Exit

This option returns you to the Modify Database menu. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.5.2 Add

This option allows you to add an end state record to the current family. To invoke this option, type <A> in the option field and press <Enter>. The Add End State screen is shown in Figure 176. The options at this point are Exit and Add.

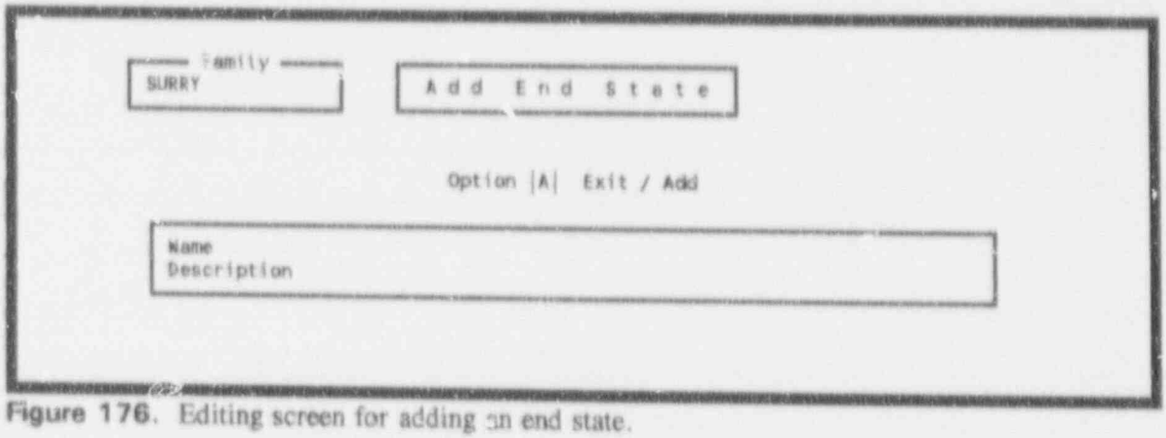


Figure 176. Editing screen for adding an end state.

7.5.2.1 Exit. This option returns you to the Edit End State screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.5.2.2 Add. This option performs the actual add of a new end state record. To invoke this option, type <A> in the option field, fill in the requested data fields, and press <Enter>. The only required information for an end state add is the name. When complete, you will be returned to the Edit End State screen with the message **Record added** displayed.

7.5.3 Modify

This option allows you to modify an end state record. To invoke this option, type <M> in the option field, highlight an end state name, and press <Enter>. The Modify End State screen is shown in Figure 177. The options at this point are Exit and Modify.

7.5.3.1 Exit. This option returns you to the Edit End State screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

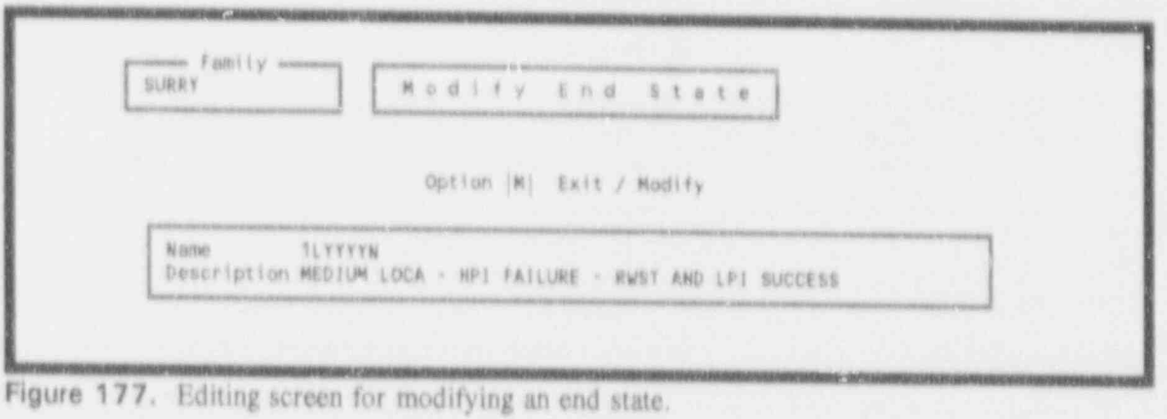


Figure 177. Editing screen for modifying an end state.

7.5.3.2 Modify. This option performs the actual modification of the end state record. To invoke this option, type <M> in the option field, modify any of the data fields on the Modify End State screen, and press <Enter>. When complete, you will be returned to the Edit End State screen with the message **Record modified** displayed at the bottom of the screen.

7.5.4 Delete

This option allows you to delete an end state record from the data base. To invoke this option, type <D> in the option field, highlight an end state and press <Enter>. The Delete End State screen is shown in Figure 178. The options at this point are Exit and Delete.

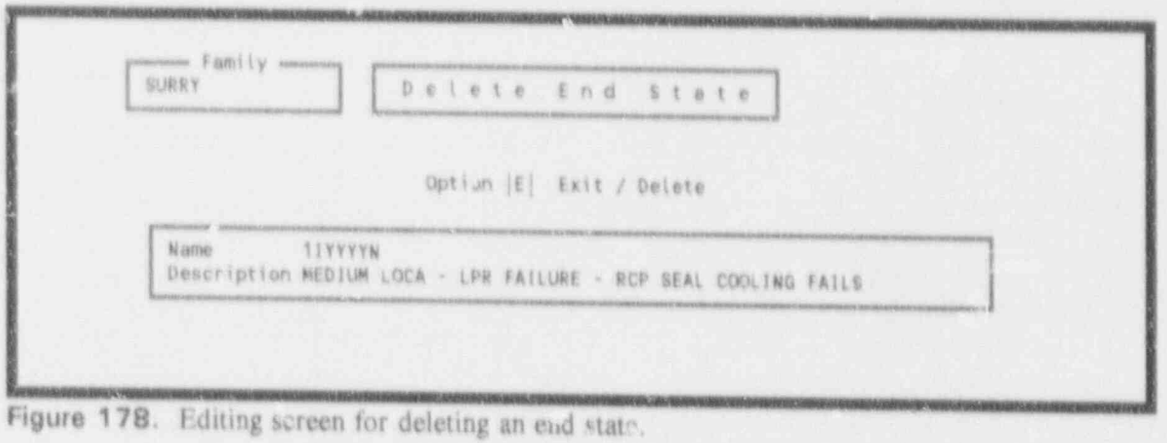


Figure 178. Editing screen for deleting an end state.

7.5.4.1 Exit. This option returns you to the Edit End State screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.5.4.2 Delete. This option performs the actual deletion of the end state record. To invoke this option, type <D> in the option field and press <Enter>. When complete, you will be returned to the Edit End State screen with the message **Record deleted** displayed at the bottom of the screen.

7.5.5 Text

This option allows you to view and edit any descriptive text associated with a specific end state. This option operates the same as the Text option discussed in the Family section. Refer to Section 7.2.5.

7.6 Basic Events

This option allows you to modify the basic event data records. To invoke this option, type <B> in the option field or highlight Basic Events and press <Enter>. The Edit Events screen, listing all of the basic events belonging to the current family, is displayed (Figure 179). The modification options are: Exit, Add, Modify, Delete, and Remove Unused Events.

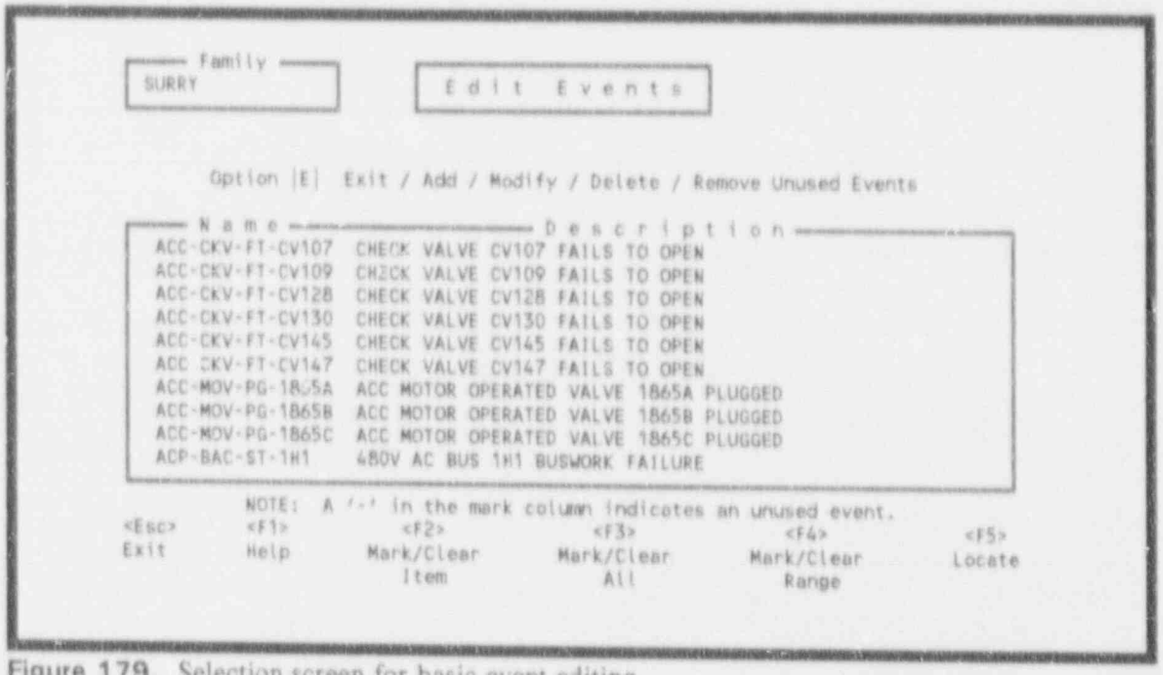


Figure 179. Selection screen for basic event editing.

7.6.1 Exit

This option returns you to the Modify Database menu. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.6.2 Add

This option allows you to add a basic event record to the current family. To invoke this option, type <A> in the option field and press <Enter>. The Add Event screen is shown in Figure 180. The options at this point are Exit and Add.

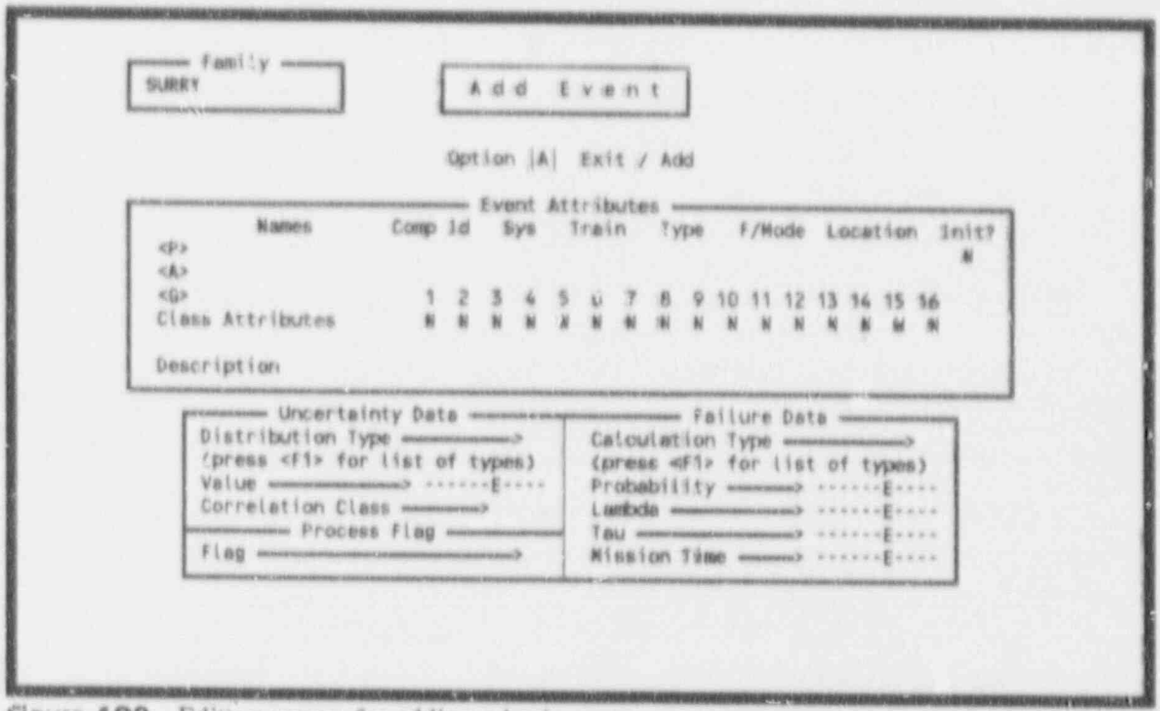


Figure 180. Editing screen for adding a basic event.

7.6.2.1 Exit. This option returns you to the Edit Events screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.6.2.2 Add. This option performs the actual add of a new basic event record. To invoke this option, type <A> in the option field, fill in the requested data fields, and press <Enter>. The only required information for a basic event add is the name. When complete, you will be returned to the Edit Event screen with the message **Record Added** displayed at the bottom of the screen.

7.6.3 Modify

This option allows you to modify a basic event record. To invoke this option, type <M> in the option field, highlight a basic event name, and press <Enter>. The Modify Basic Event screen is shown in Figure 181. The options at this point are Exit and Modify.

7.6.3.1 Exit. This option returns you to the Edit Events screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.6.3.2 Modify. This option performs the actual modification of the basic event record. To invoke this option, type <M> in the option field, modify any of the data fields on the Modify Event screen, and press <Enter>. When complete, you will be returned to the Edit Events screen with the

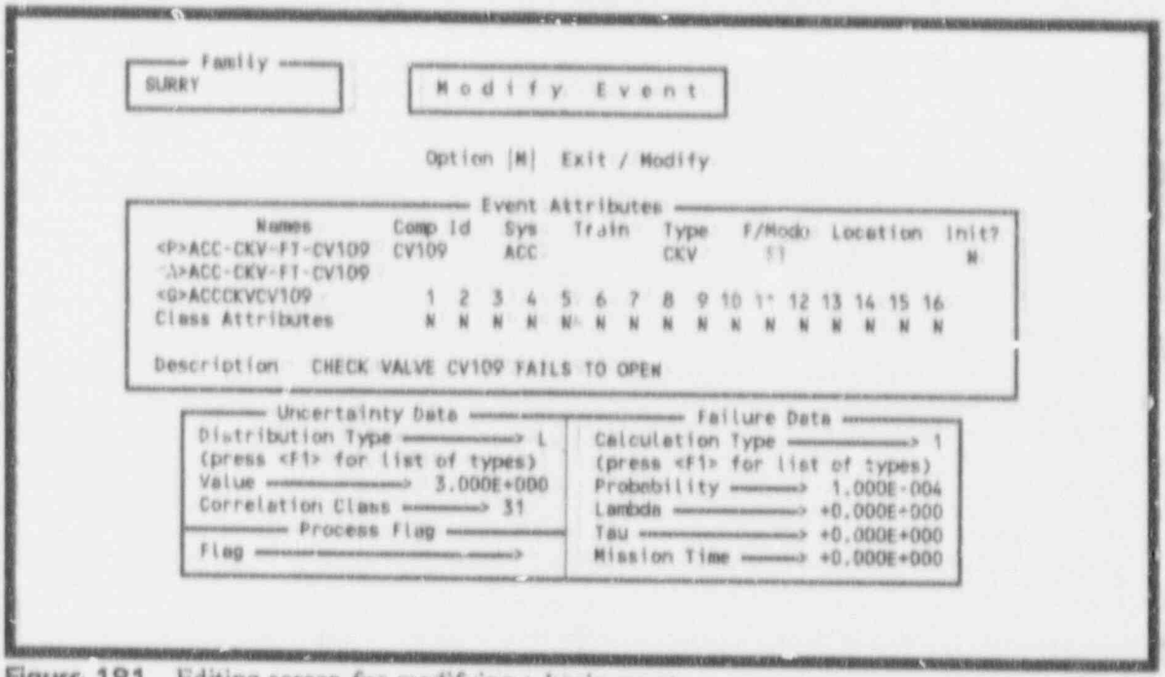


Figure 181. Editing screen for modifying a basic event.

message **Record Modified** displayed at the bottom of the screen.

7.6.4 Delete

This option allows you to delete a basic event record from the current family. To invoke this option, type <D> in the option field, highlight a basic event and press <Enter>. The Delete Event screen is shown in Figure 182. The options at this point are Exit and Delete.

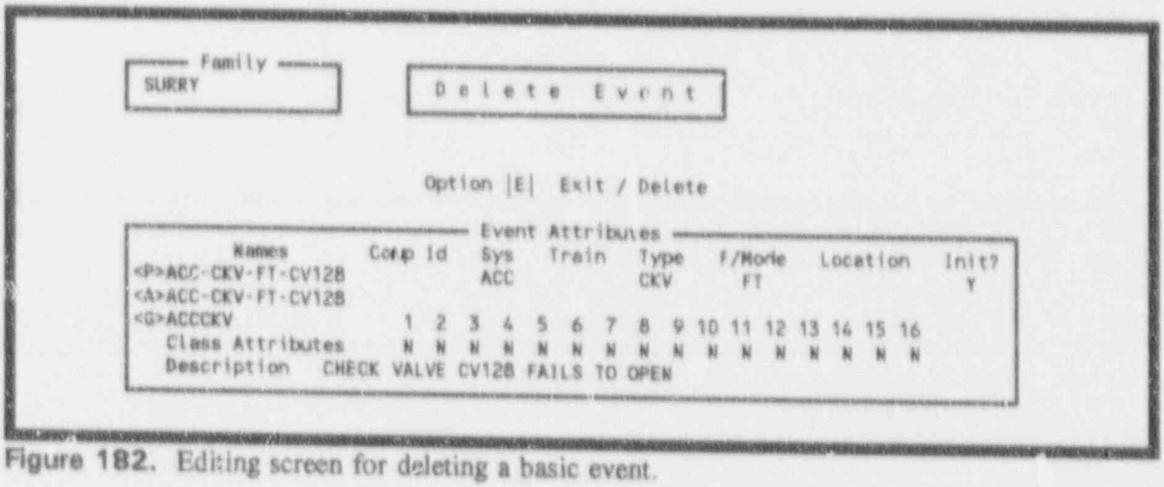


Figure 182. Editing screen for deleting a basic event.

7.6.4.1 Exit. This option returns you to the Edit Events screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.6.4.2 Delete. This option performs the actual deletion of the basic event record. To invoke this option, type <D> in the option field and press <Enter>. When complete, you will be returned to the Edit Events screen with the message **Record deleted** displayed at the bottom of the screen.

7.6.5 Remove Unused Event

This option looks at all references to an event in the current family and deletes any events that are not referenced by anything. When you invoke this option, a warning screen will be displayed telling you that all records that are marked as unused will be deleted. At this prompt, enter a <Y> to continue the deletion process, or enter an <N> to terminate without deleting the unused events (Figure 183).

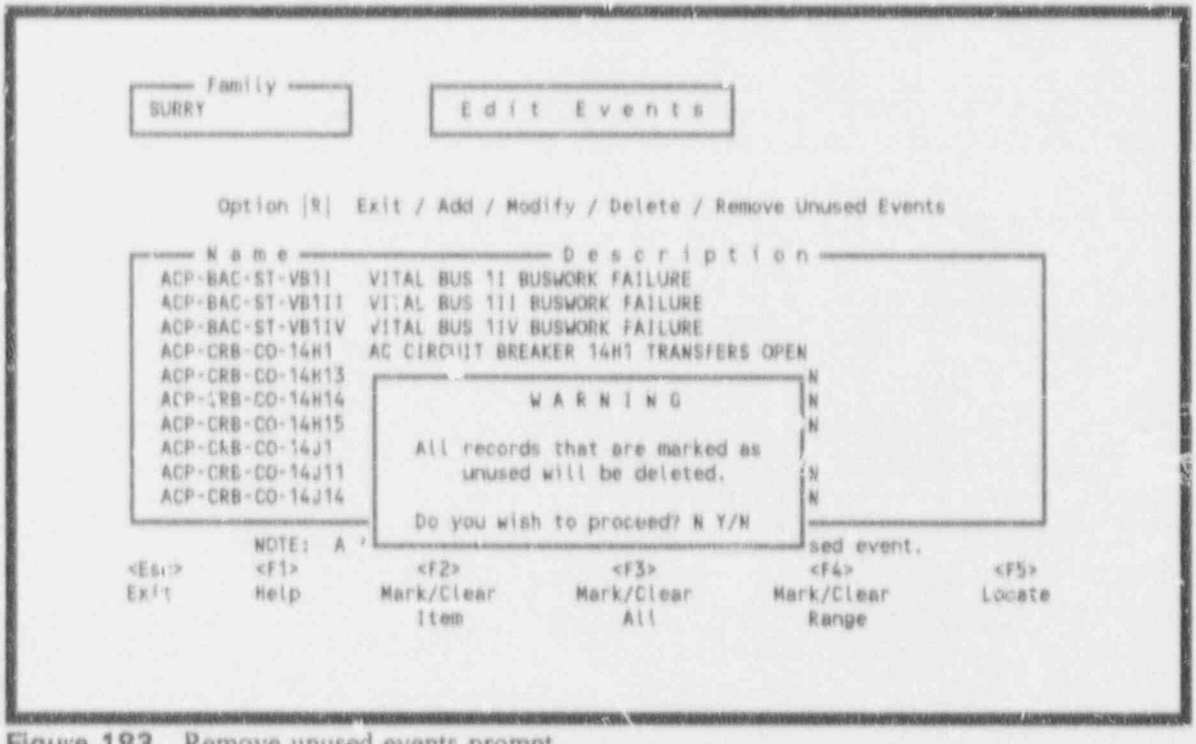


Figure 183. Remove unused events prompt.

7.7 Attributes

This option allows you to edit the six attributes in the current family (Figure 184): Systems, Locations, Failure Modes, Class Attributes, Basic Event Types, and Trains. The options available within each of these attributes are: Exit, Add, Modify, and Delete.

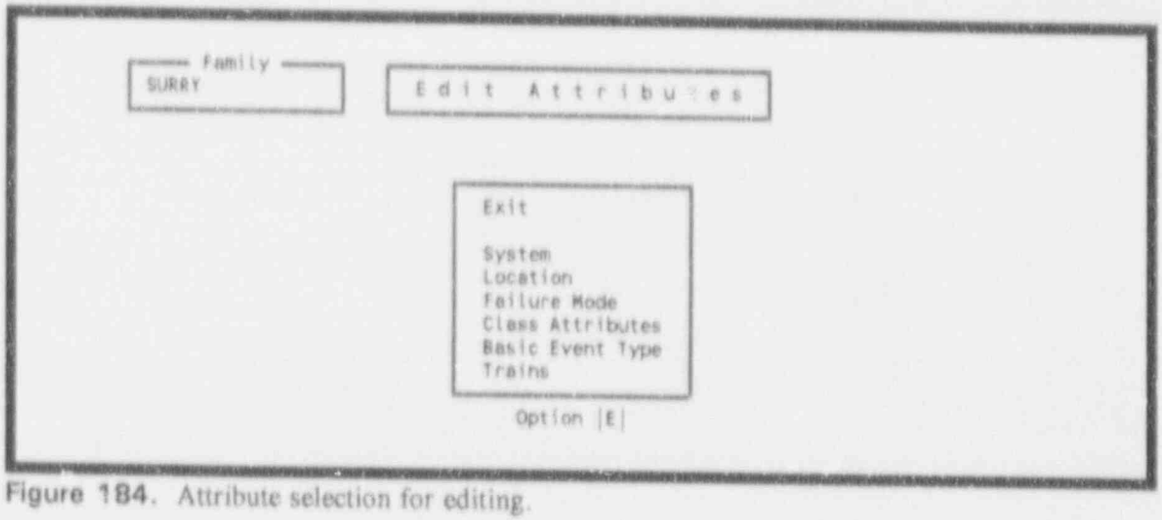


Figure 184. Attribute selection for editing.

The Edit Attributes screen shown in Figure 184 and succeeding screens (Figure 185 - Figure 188) are consistent throughout the attributes option for each of the six categories. Because this option operates the same for all six attribute categories, a generic write-up is presented.

To invoke this option, type <A> in the option field or highlight Attributes and press <Enter>. This will display a list of attribute categories (see Figure 184). Highlighting a category or typing a category's highlighted letter and pressing <Enter> displays the list of attributes available under the selected category. For each attribute category, the following options are available: Exit, Add, Modify, and Delete.

7.7.1 Exit

This option returns you to the Modify Database menu. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.7.2 Add

The add option allows you to add a new attribute record to the current family. To invoke this option, type <A> in the option field and press <Enter>. The Add Attribute screen is shown in Figure 186. The options at this point are Exit and Add.

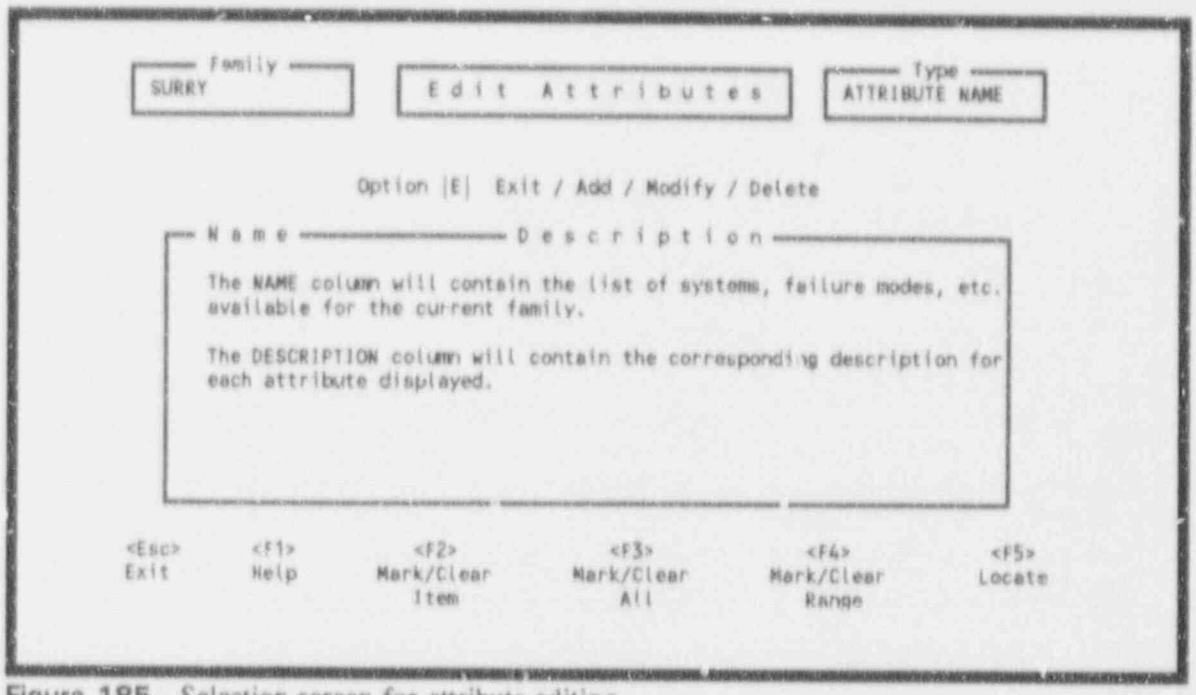


Figure 185. Selection screen for attribute editing.

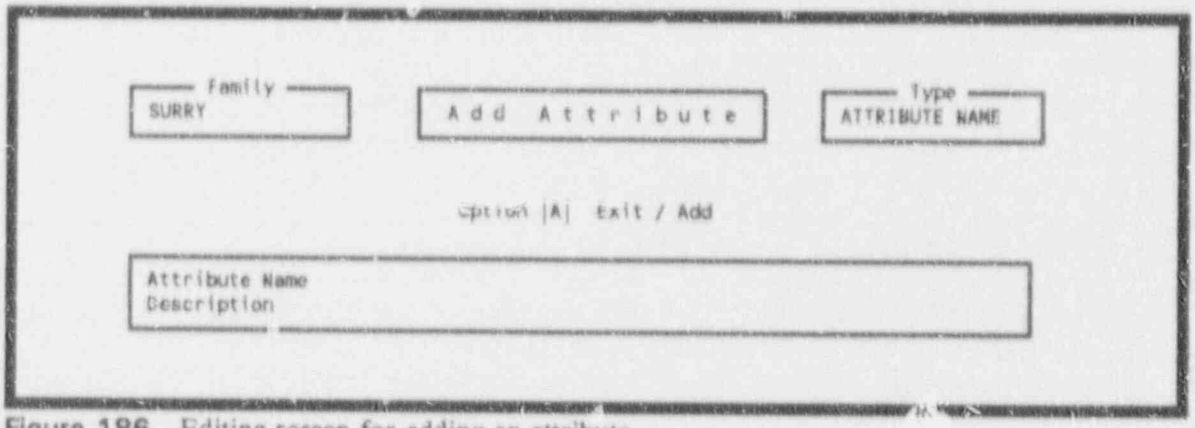


Figure 186. Editing screen for adding an attribute.

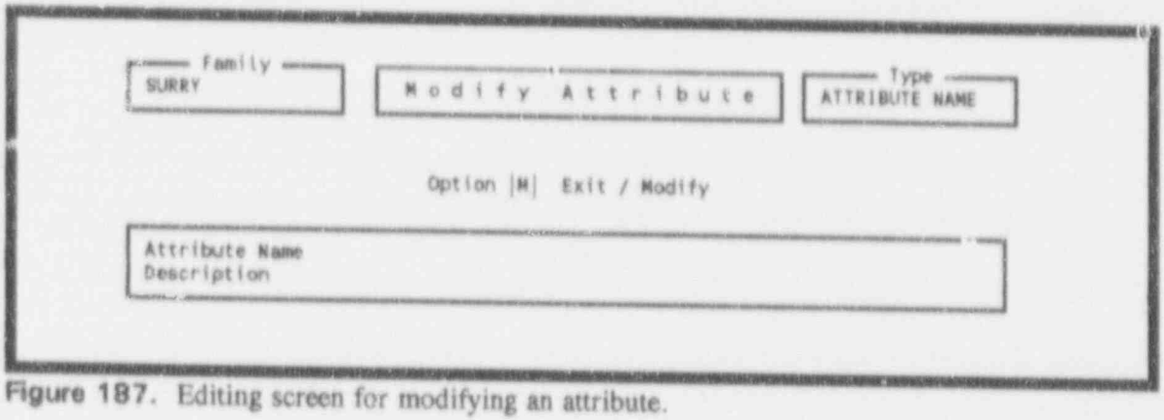


Figure 187. Editing screen for modifying an attribute.

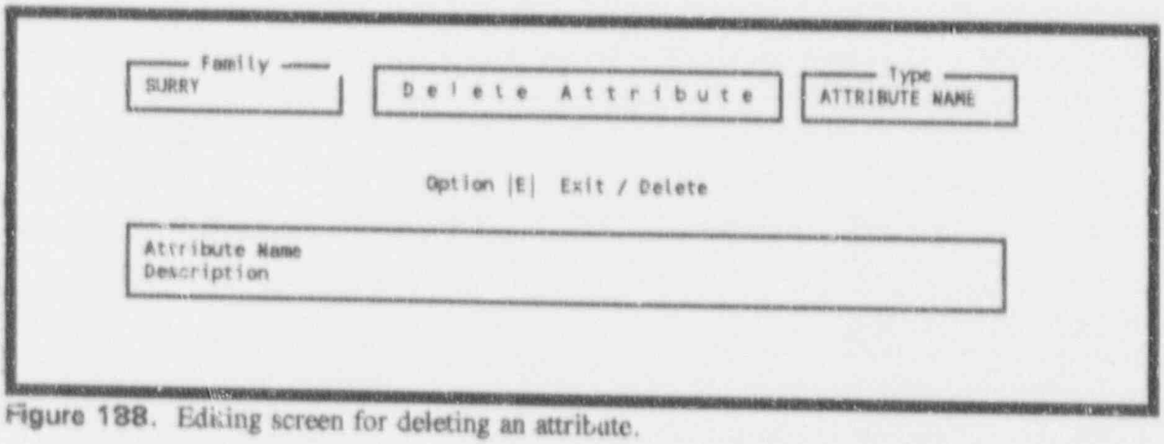


Figure 188. Editing screen for deleting an attribute.

7.7.2.1 Exit. This option returns you to the Edit Attributes screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.7.2.2 Add. This option performs the actual add of a new attribute record. To invoke this option, type <A> in the option field, fill in the requested data fields, and press <Enter>. The only required information for an attribute add is the name. When complete, you will be returned to the Edit Attributes screen with the message **Record added** displayed at the bottom of the screen.

7.7.3 Modify

This option allows you to modify an attribute record. To invoke this option, type <M> in the option field, highlight an attribute name, and press <Enter>. The Modify Attribute screen is shown in Figure 187. The options at this point are Exit and Modify.

7.7.3.1 Exit. This option returns you to the Edit Attributes screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.7.3.2 Modify. This option performs the actual modification of the attribute record. To invoke this option, type <M> in the option field, modify any of the data fields on the Modify Attribute screen, and press <Enter>. When complete, you will be returned to the Edit Attributes screen with the message **Record modified** displayed at the bottom of the screen.

7.7.4 Delete

This option allows you to delete an attribute record from the current family. To invoke this option, type <D> in the option field, highlight an attribute and press <Enter>. The Delete Attribute screen is shown in Figure 188. The options at this point are Exit and Delete.

7.7.4.1 Exit. This option returns you to the Edit Attributes screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.7.4.2 Delete. This option performs the actual deletion of the attribute record. To invoke this option, type <D> in the option field and press <Enter>. When complete, you will be returned to the Edit Attributes screen with the message **Record deleted** displayed at the bottom of the screen.

7.8 GaTes

This option allows you to modify gate records. To invoke this option, type <T> in the option field or highlight GaTes and press <Enter>. The Edit Gates screen, listing all of the gates belonging to the current family, is displayed (Figure 189). The modification options are: Exit, Add, Modify, and Delete.

7.8.1 Exit

This option returns you to the Modify Database menu. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.8.2 Add

This option allows you to add a gate record to the current family. To invoke this option, type <A> in the option field and press <Enter>. The Add Gate screen is shown in Figure 190. The options at this point are Exit and Add.

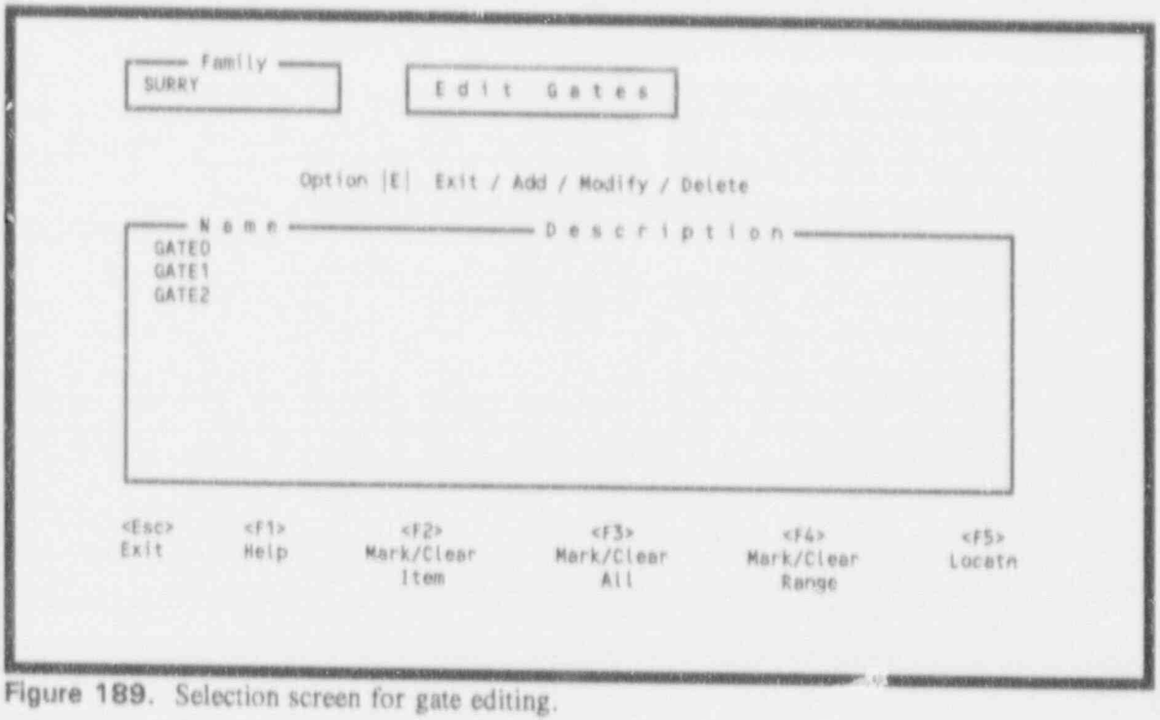


Figure 189. Selection screen for gate editing.

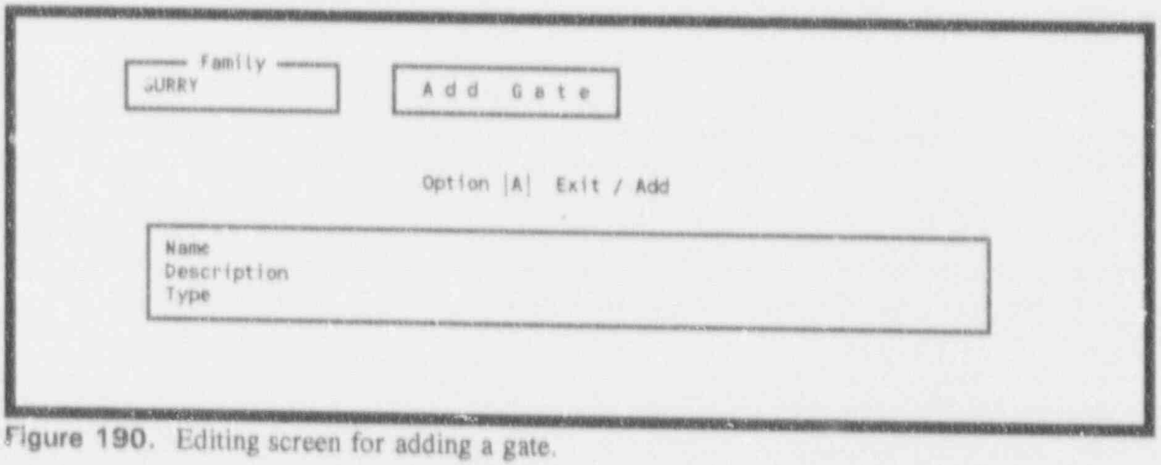


Figure 190. Editing screen for adding a gate.

7.8.2.1 Exit. This option returns you to the Edit Gates screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.8.2.2 Add. This option performs the actual add of a new gate record. To invoke this option, type <A> in the option field, fill in the requested data fields, and press <Enter>. The only required information for a gate add is the name and type fields. When complete, you will be returned to the Edit Gates screen with the message **Record Added** displayed at the bottom of the screen.

7.8.3 Modify

This option allows you to modify a gate record. To invoke this option, type <M> in the option field, highlight a gate name, and press <Enter>. The Modify Gate screen is shown in Figure 191. The options at this point are Exit and Modify.

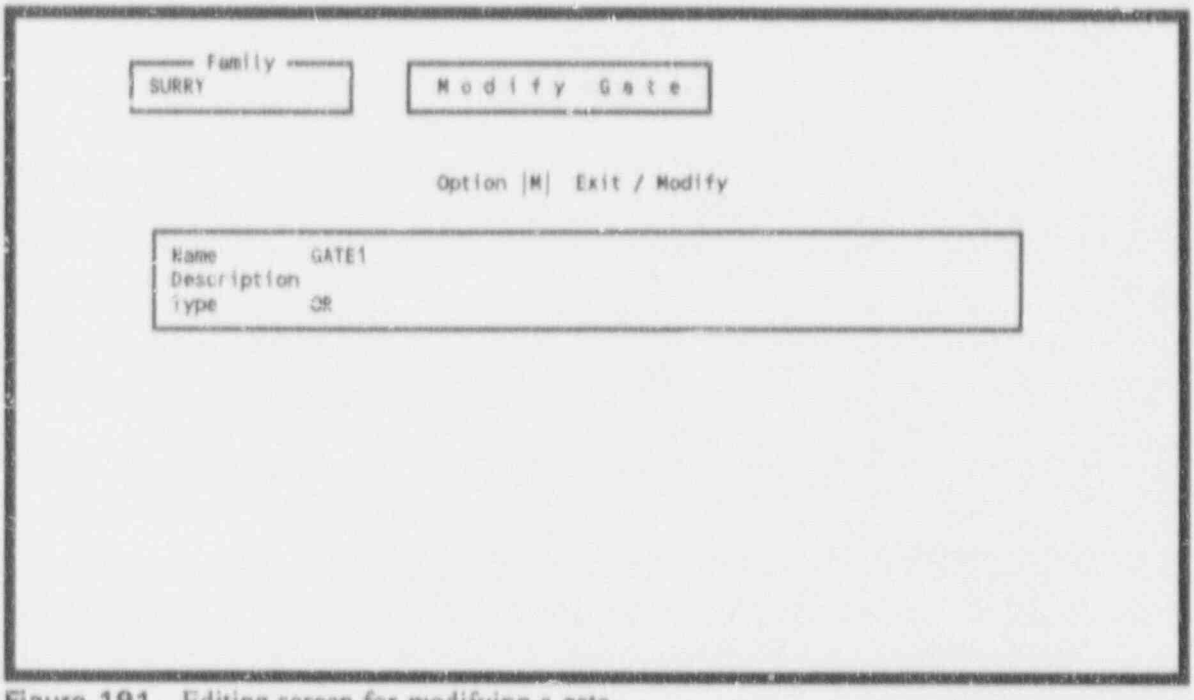


Figure 191. Editing screen for modifying a gate.

7.8.3.1 Exit. This option returns you to the Edit Gates screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.8.3.2 Modify. This option performs the actual modification of the gate record. To invoke this option, type <M> in the option field, modify any of the data fields on the Modify Gate screen, and press <Enter>. When complete, you will be returned to the Edit Gates screen with the message **Record Modified** displayed at the bottom of the screen.

7.8.4 Delete

This option allows you to delete a gate record from the current family. To invoke this option, type <D> in the option field, highlight the gate to be deleted, and press <Enter>. The Delete Gate screen is shown in Figure 192. The options at this point are Exit and Delete.

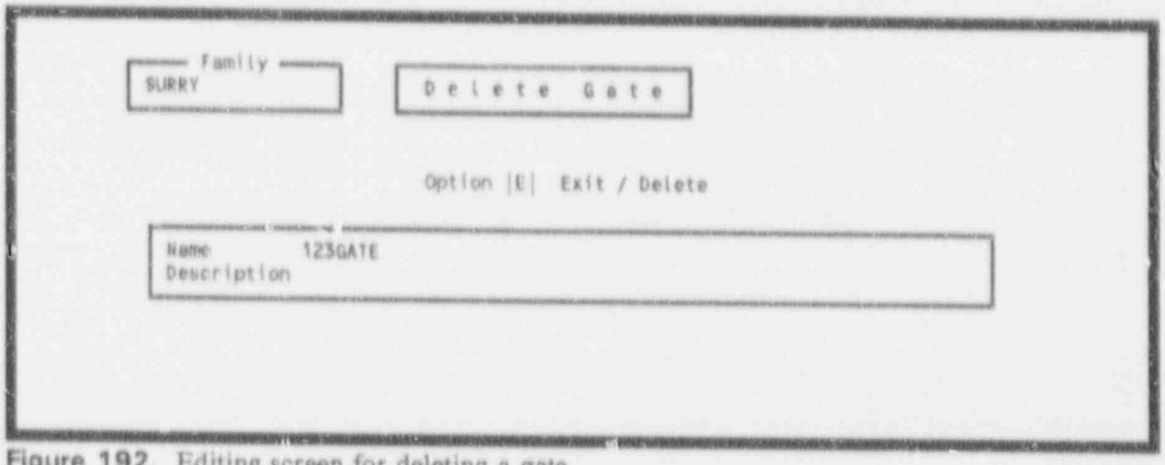


Figure 192. Editing screen for deleting a gate.

7.8.4.1 Exit. This option returns you to the Edit Gates screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.8.4.2 Delete. This option performs the actual deletion of the gate record. To invoke this option, type a <D> in the option field and press <Enter>. When complete, you will be returned to the Edit Gates screen with the message **Record deleted** displayed at the bottom of the screen.

7.9 Graphics

This option allows you to edit three categories of graphics data records (Figure 193). They are: Fault Tree Graphics, Event Tree Graphics, and P&ID Graphics. The options available within each of these categories are: Exit, Add, Modify, and Delete.

The Edit Graphics screen shown in Figure 194 and succeeding screens Figure 195 through Figure 197 are consistent throughout the graphics option for each of the three categories.

To invoke this option, type <G> in the option field or highlight Graphics and press <Enter>. This will display a list of graphics categories. Highlighting a category or typing a category's highlighted letter and pressing <Enter> displays the list of graphics records available under the selected category.

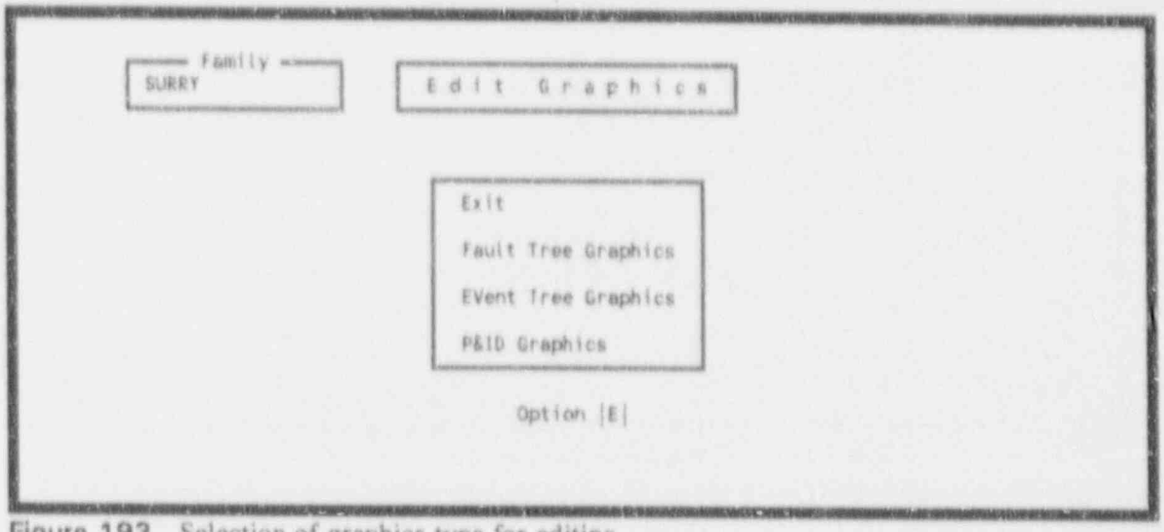


Figure 193. Selection of graphics type for editing.

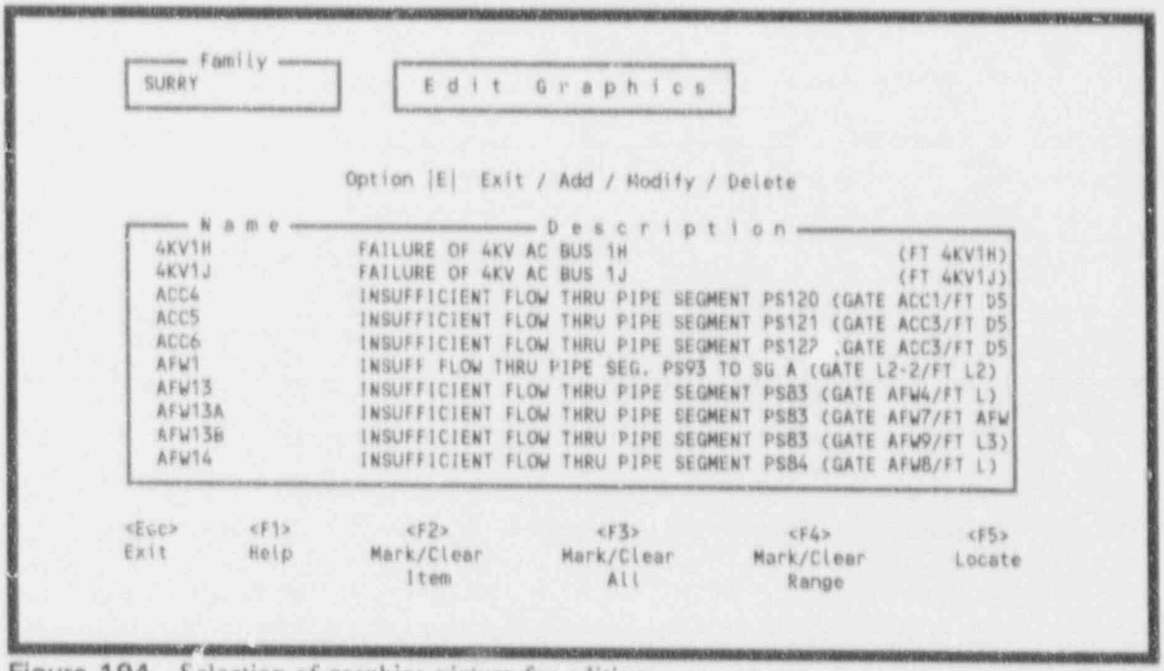


Figure 194. Selection of graphics picture for editing.

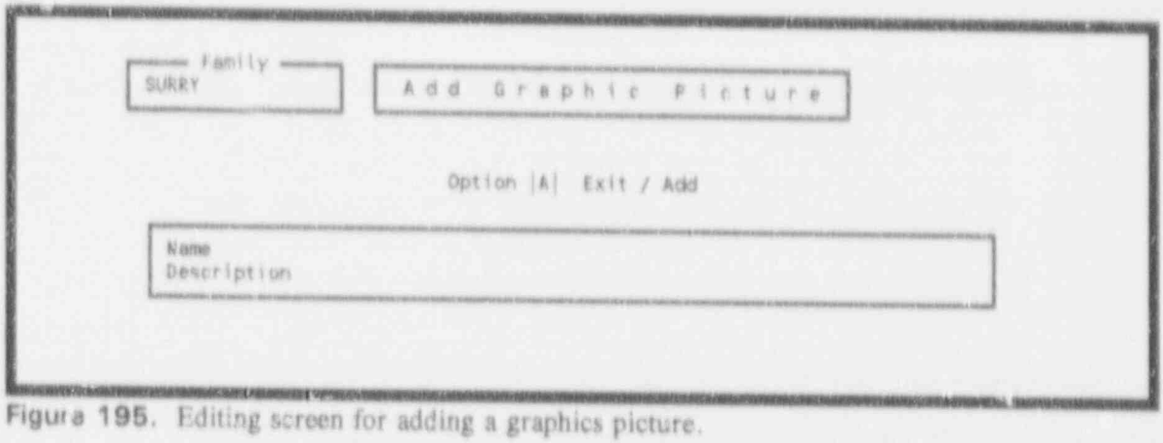


Figure 195. Editing screen for adding a graphics picture.

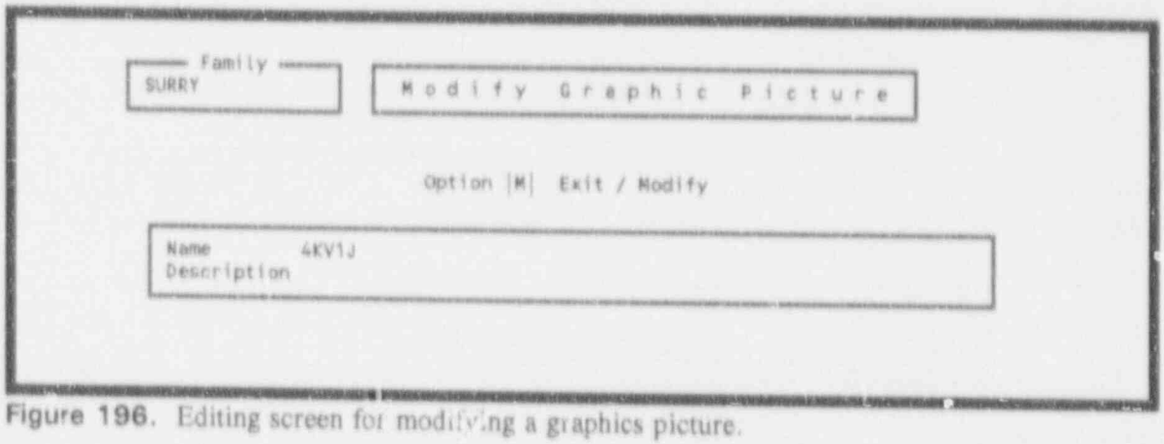


Figure 196. Editing screen for modifying a graphics picture.

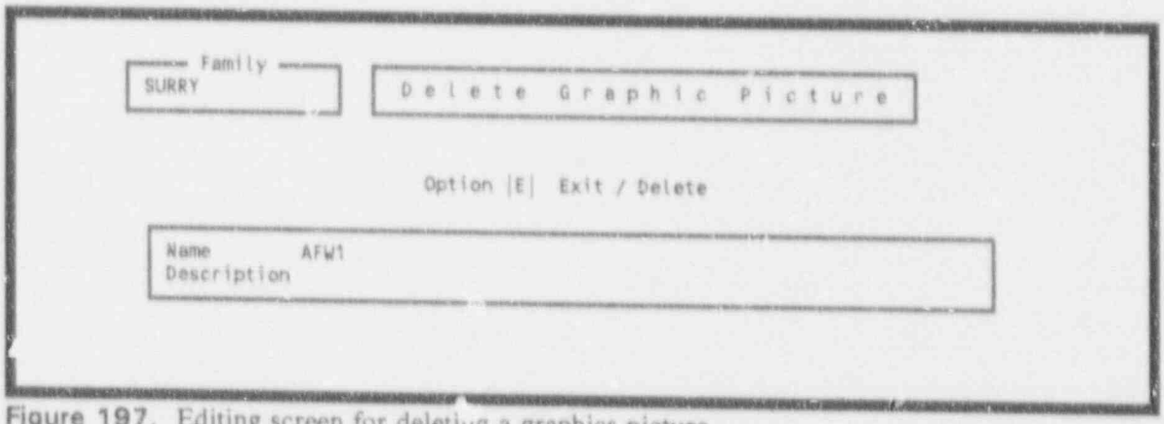


Figure 197. Editing screen for deleting a graphics picture.

7.9.1 Exit

This option returns you to the Edit Graphics main menu. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.9.2 Fault Tree Graphics

This option allows you to modify the Fault Tree Graphics records. To invoke this option, type <F> in the option field or highlight Fault Tree Graphics and press <Enter>. The screen shown in Figure 194, listing the fault tree graphics (pictures), will be displayed. The option available are Exit, Add, Modify, and Delete.

7.9.2.1 Exit. This option returns you to the Edit Graphics main menu. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.9.2.2 Add. This option allows you to add a graphics picture record to the data base. To invoke this option, type <A> in the option field and press <Enter>. The Add Graphics Picture screen is shown in Figure 195. The options at this point are Exit and Add.

7.9.2.2.1 Exit—This option returns you to the Edit Graphics screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.9.2.2.2 Add—This option performs the actual add of a new graphics picture record. To invoke this option, type <A> in the option field, fill in the requested data fields, and press <Enter>. The only required information for a graphics picture add is the name. When complete, you are returned to the Edit Graphics screen with the message **Record added** displayed at the bottom of the screen.

7.9.2.3 Modify. This option allows you to modify a graphics picture record. To invoke this option, type <M> in the option field, highlight a graphics picture name, and press <Enter>. The Modify Graphics Picture screen is shown in Figure 196. The options at this point are Exit and Modify.

7.9.2.3.1 Exit—This option returns you to the Edit Graphics screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.9.2.3.2 Modify—This option performs the actual modification of the graphics picture record. To invoke this option, type <M> in the option field, modify any of the data fields on the Modify Graphics Picture screen, and press <Enter>. When complete, you will be returned to the Edit Graphics screen with the message **Record modified** displayed at the bottom of the screen.

7.9.2.4 Delete. This option allows you to delete a graphics picture from the data base. To invoke this option, type <D> in the option field, highlight a graphics picture and press <Enter>. The Delete Graphics Picture screen is shown in Figure 197. The options at this point are Exit and Delete.

7.9.2.4.1 Exit—This option returns you to the Edit Graphics screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.9.2.4.2 Delete—This option performs the actual deletion of the graphics picture record. To invoke this option, type <D> in the option field and press <Enter>. When complete, you will be returned to the Edit graphics screen with the message **Record deleted** displayed at the bottom of the screen.

7.9.3 Event Tree Graphics

This option allows you to modify the Event Tree Graphics records. To invoke this option, type <V> in the option field or highlight Event Tree Graphics and press <Enter>. The screen shown in Figure 194, listing the event tree graphics pictures, will be displayed. The option available are Exit, Add, Modify, and Delete.

7.9.3.1 Exit. This option returns you to the Edit Graphics menu. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.9.3.2 Add. This option allows you to add a graphics picture record to the data base. To invoke this option, type <A> in the option field and press <Enter>. The Add Graphic Picture screen is shown in Figure 195. The options at this point are Exit and Add.

7.9.3.2.1 Exit—This option returns you to the Edit Graphics screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.9.3.2.2 Add—This option performs the actual add of a new graphics picture record. To invoke this option, type <A> in the option field, fill in the requested data fields, and press <Enter>. The only required information for a graphics add is the name. When complete, you will be returned to the Edit Graphics screen with the message **Record added** displayed at the bottom of the screen.

7.9.3.3 Modify. This option allows you to modify a graphics picture record. To invoke this option, type <M> in the option field, highlight a graphics picture name, and press <Enter>. The Modify Graphic Picture screen is shown in Figure 196. The options at this point are Exit and Modify.

7.9.3.3.1 Exit—This option returns you to the Edit Graphics screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.9.3.3.2 Modify—This option performs the actual modification of the graphics picture record. To invoke this option, type <M> in the option field, modify any of the data fields on the Modify Graphic Picture screen, and press <Enter>. When complete, you will be returned to the Edit Graphics screen with the message **Record modified** displayed at the bottom of the screen.

7.9.3.4 Delete. This option allows you to delete a graphics picture from the data base. To invoke this option, type <D> in the option field, highlight a graphics picture and press <Enter>. The Delete Graphic Picture screen is shown in Figure 197. The options at this point are Exit and Delete.

7.9.3.4.1 Exit—This option returns you to the Edit Graphics screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.9.3.4.2 Delete—This option performs the actual deletion of the graphics picture record. To invoke this option, type <D> in the option field and press <Enter>. When complete, you will be returned to the Edit Graphics screen with the message **Record deleted** displayed at the bottom of the screen.

7.9.4 P&ID Graphics

This option allows you to modify the P&ID Graphics records. To invoke this option, type <P> in the option field or highlight P&ID Graphics and press <Enter>. The screen shown in Figure 194, listing the P&ID graphics pictures, will be displayed. The option available are Exit, Add, Modify, and Delete.

7.9.4.1 Exit. This option returns you to the Edit Graphics main menu. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.9.4.2 Add. This option allows you to add a graphics picture record to the data base. To invoke this option, type <A> in the option field and press <Enter>. The Add Graphic Picture screen is shown in Figure 195. The options at this point are Exit and Add.

7.9.4.2.1 Exit—This option returns you to the Edit Graphics screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.9.4.2.2 Add—This option performs the actual add of a new graphics picture record. To invoke this option, type <A> in the option field, fill in the requested data fields, and press

<Enter>. The only required information for a graphic add is the name. When complete, you will be returned to the Edit Graphics screen with the message **Record added** displayed at the bottom of the screen.

7.9.4.3 Modify. This option allows you to modify a graphics picture record. To invoke this option, type <M> in the option field, highlight a graphics picture name, and press <Enter>. The Modify Graphic Picture screen is shown in Figure 196. The options at this point are Exit and Modify.

7.9.4.3.1 Exit—This option returns you to the Edit Graphics screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.9.4.3.2 Modify—This option performs the actual modification of the graphics picture record. To invoke this option, type <M> in the option field, modify any of the data fields on the Modify Graphic Picture screen, and press <Enter>. When complete, you will be returned to the Edit Graphics screen with the message **Record modified** displayed at the bottom of the screen.

7.9.4.4 Delete. This option allows you to delete a graphics picture from the data base. To invoke this option, type <D> in the option field, highlight a graphics picture and press <Enter>. The Delete Graphic Picture screen is shown in Figure 197. The options at this point are Exit and Delete.

7.9.4.4.1 Exit—This option returns you to the Edit Graphics screen. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

7.9.4.4.2 Delete—This option performs the actual deletion of the graphics picture record. To invoke this option, type <D> in the option field and press <Enter>. When complete, you will be returned to the Edit Graphics screen with the message **Record deleted** displayed at the bottom of the screen.

7.10 Histograms

This option allows you to create, modify, and delete user-defined histograms. This is a useful option for allowing you to input your own distribution for a variable that can not be expressed with one of the predefined distribution types. The Edit Histograms screen (Figure 198) displays the names of all the currently existing histograms with their associated format type. As shown, four options are available: Exit, Add, Modify, and Delete.

To activate this option type an <H> (Histograms) in the option field or highlight Histograms and press <Enter>. Figure 198 will be displayed.

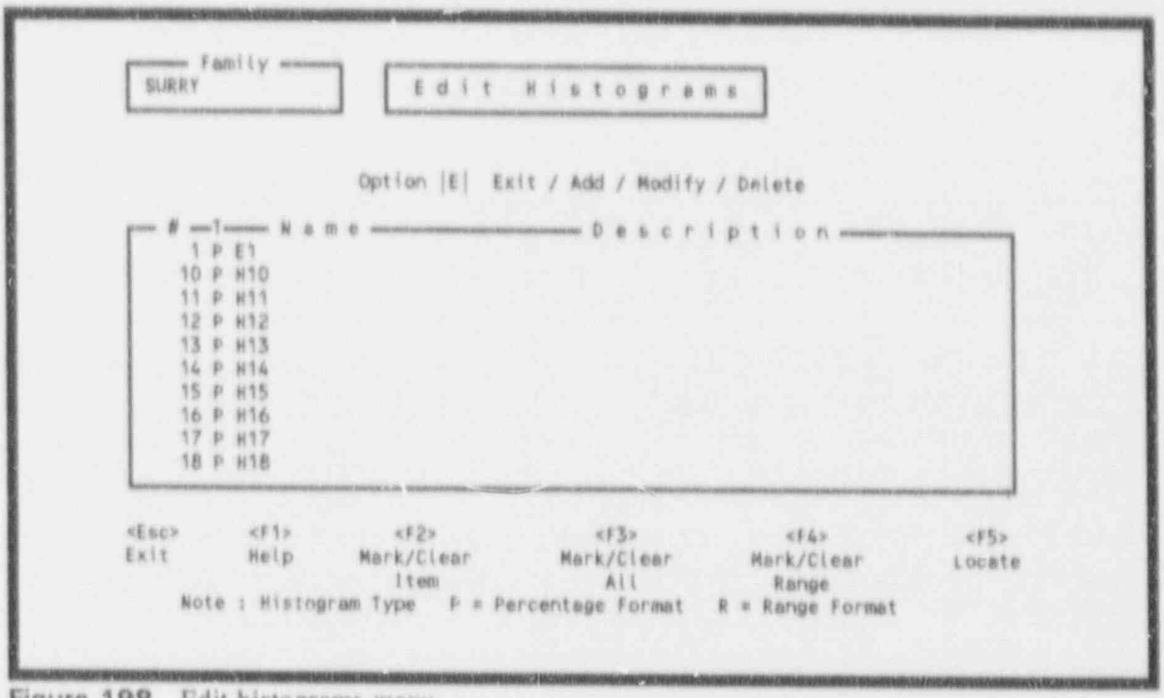


Figure 198. Edit histograms menu.

7.10.1 Exit

This option returns you to the Modify Database screen. To invoke this option, type an <E> (Exit) in the option field and press <Enter>, or press the <Esc> key.

7.10.2 Add Histograms

This option allows you to create a user-defined distribution type. To add a new histogram to the data base, type an <A> (Add) in the option field and press <Enter>. At this point, Figure 199 is displayed and you are given the choice of adding the histogram data in either a percentage format or range format.

If you wish to add a percentage histogram to the data base, enter a <P> (Percentage) in the option field. Entering a <P> in the option field will cause a Percentage Format Histogram screen to appear. From this screen you should type in a name and a description for the new histogram. Enter the percentages for the histogram along with the corresponding probabilities. Figure 200 demonstrates how to enter a percentage histogram, given that 15% of the data points have a probability of 0.04, 46% of the data points have a probability of 0.12, 36% of the data points have a probability of 0.02, and the remaining 3% of the data points have a probability of 0.8. The sum of the percentages entered must total 100%, in order for the histogram to be accepted as a valid percentage histogram (Figure 201). In the upper right-hand area of the screen is a box that shows the current sum of the percentages that have been input and the remaining percentage needed to reach the 100% total.

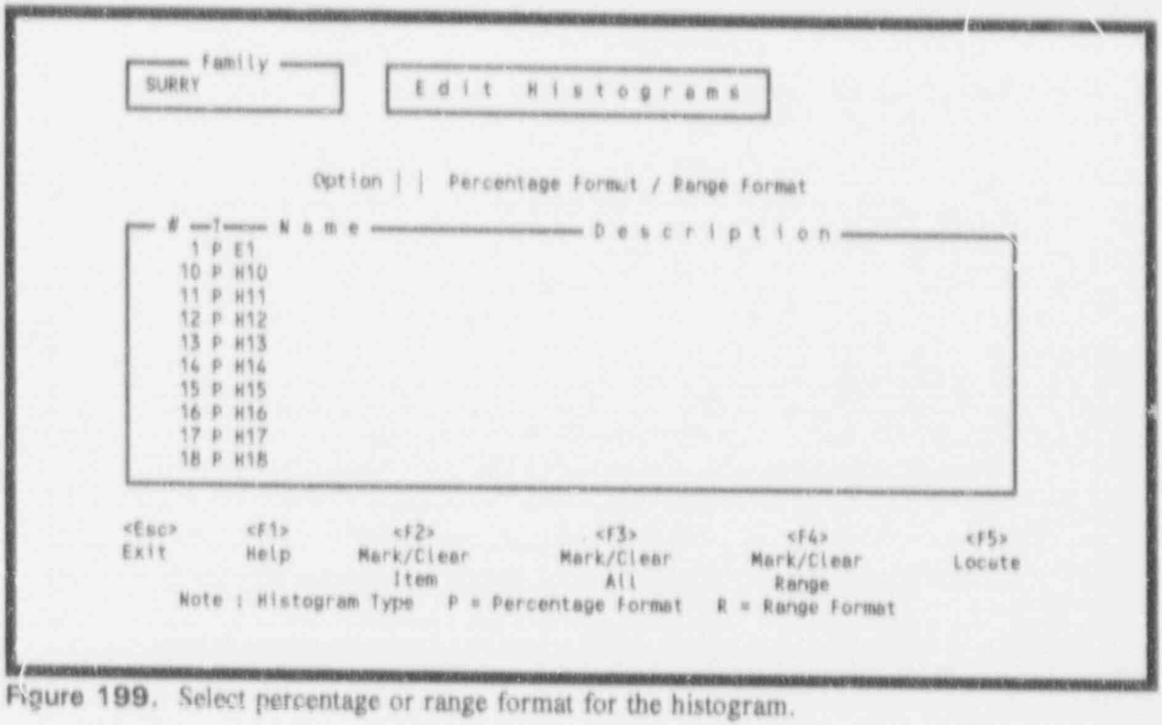


Figure 199. Select percentage or range format for the histogram.

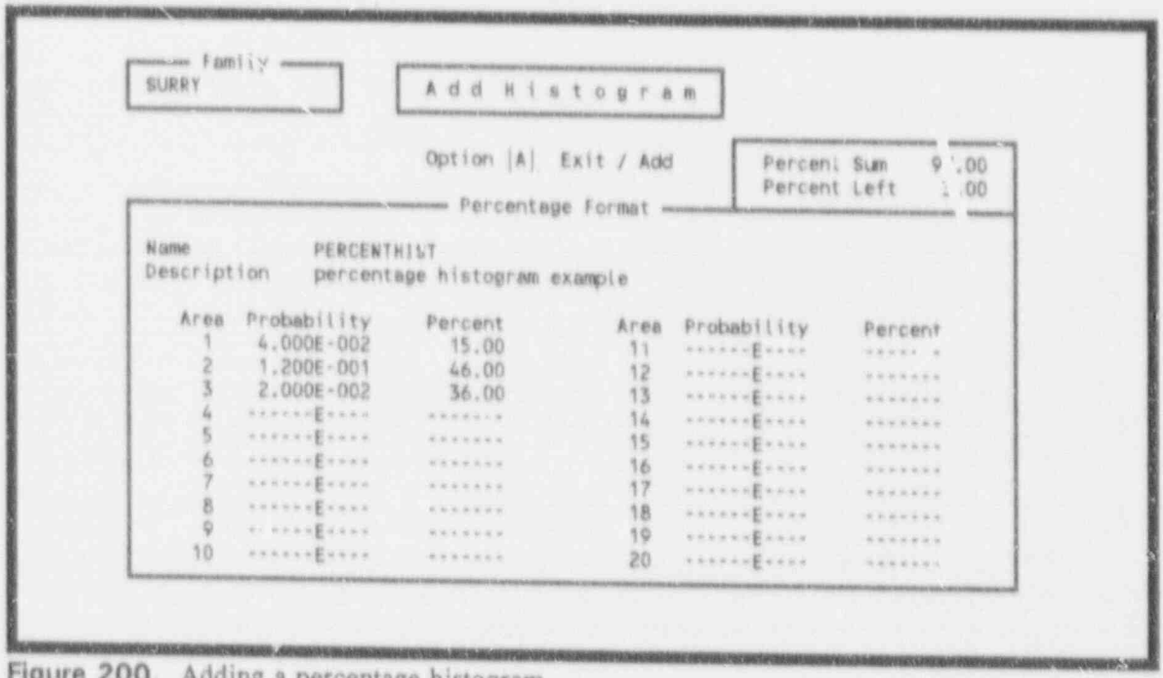


Figure 200. Adding a percentage histogram.

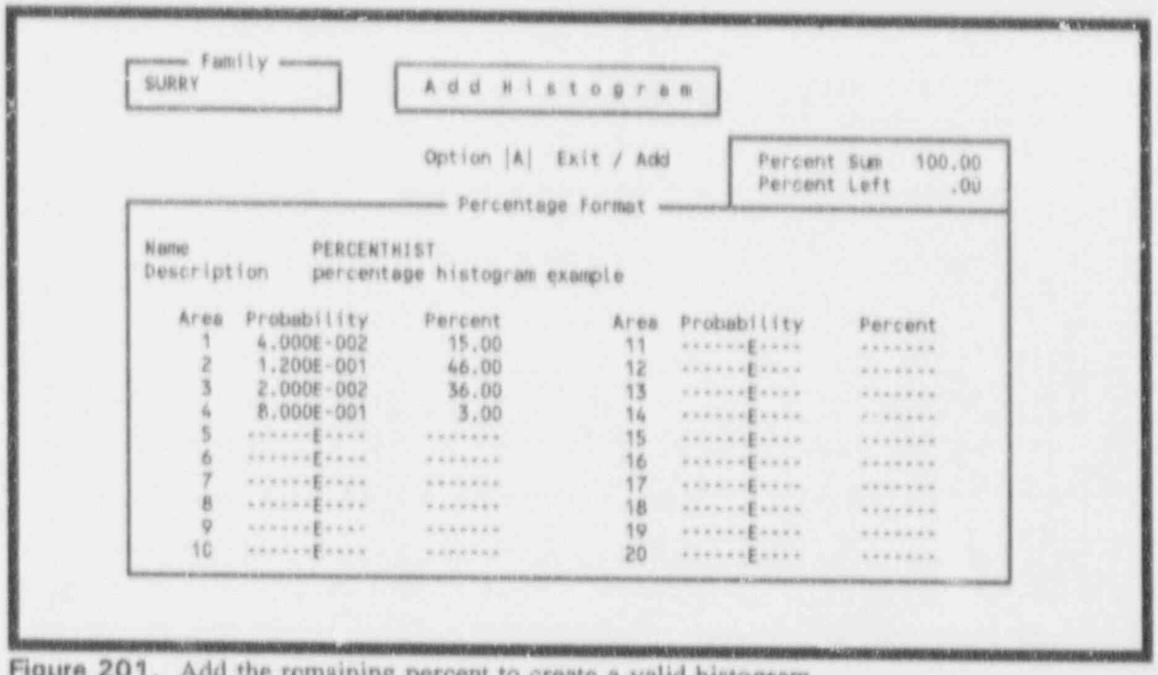


Figure 201. Add the remaining percent to create a valid histogram.

Another way to input a histogram is to use the range format. To add a range histogram to the data base, enter an <R> (Range> in the option field of the Add Histogram screen. This action will bring up a Range Format Histogram screen (Figure 202). On this screen, type in a name and description for the range histogram. Then, enter the starting probability point, the ending probability point, and the height associated with the first bin of the histogram. Next, for each successive bin of the histogram, an ending probability point and a height should be entered. There is a maximum of 20 bins allowed for each range histogram. Figure 202 is an example of inputting a range histogram whose data points lie on the closed interval of 0.0 and 1.0. The height associated with the data points on the sub-interval of 0.0 to 0.2 is 10.0 (Bin 1), the height for the sub-interval of 0.2 to 0.6 is 70.0 (Bin 2), the height for the sub-interval of 0.6 to 0.8 is 20.0 (Bin 3), and the height for the last sub-interval of 0.8 to 1.0 is 5.0 (Bin 4).

The code calculates the midpoint of each bin, finds the area of each bin, and normalizes each area so the sum of the areas equals 1.0. The midpoint is the probability for each bin and the normalized area corresponds to the percent in the Percent Histogram format. The basic event mean probability should correspond to the mean of the histogram.

Once you have typed in the histogram data, enter an <A> in the option field and press <Enter> to save the newly created histogram. When complete, you will be returned to the Edit Histograms screen with the message **Record Added** displayed at the bottom of the screen. However, if you wish to exit the Add process without saving the new histogram, enter an <E> in the option field or press the <Esc> key.

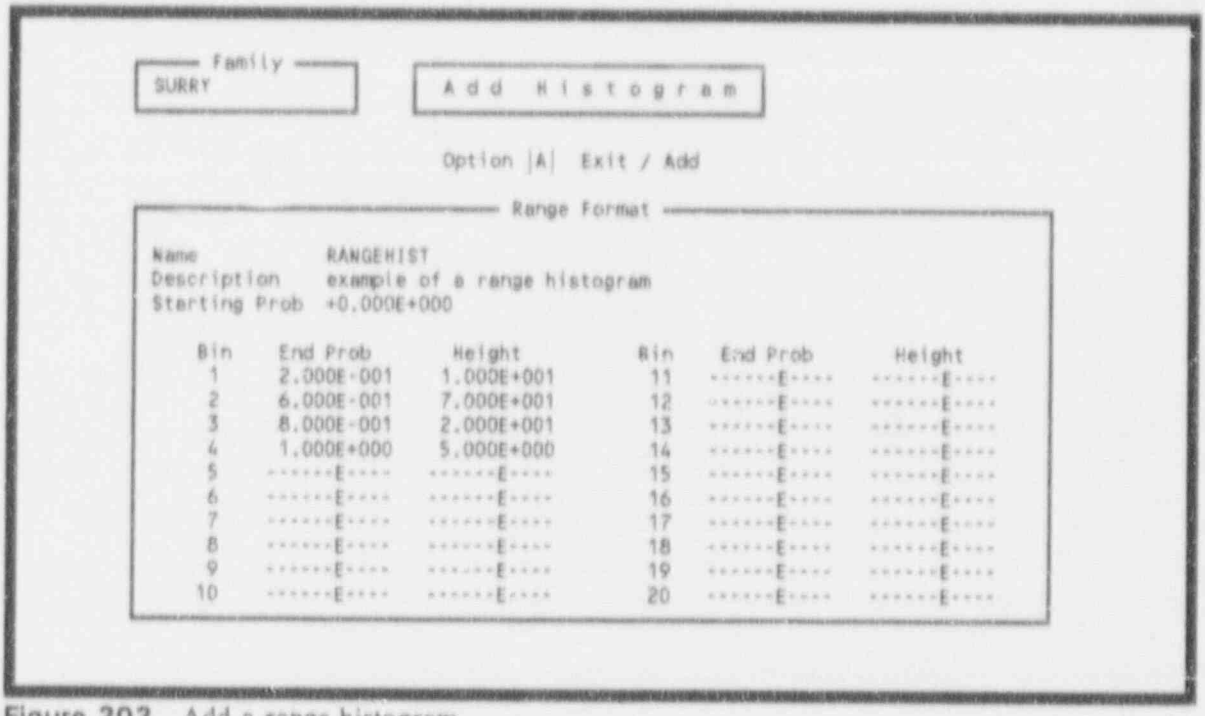


Figure 202. Add a range histogram.

7.10.3 Modify Histograms

To modify a currently existing histogram, type an <M> (Modify) in the option field of the Edit Histograms screen, highlight the desired histogram, and press <Enter>.

If you selected to modify a percentage histogram, then the histogram data will be displayed in percentage format. You may make modifications to the histogram's name, description, or any of the probabilities or percentages. The percentages must still total 100% before it will be accepted as a valid percentage histogram. Figure 203 demonstrates the screen for modifying histograms in percentage format.

If you selected to modify a range histogram, then the histogram data will be displayed in range format. You may change the histogram's name, description, and any of the bins' starting points, ending points or probabilities. Figure 204 demonstrates the screen for modifying histograms in range format.

If you wish to save the modifications made to the selected histogram, type an <M> (Modify) in the option field of the Modify Histograms screen and press <Enter>. When complete, you will be returned to the Edit Histograms screen with the message **Record modified** displayed at the bottom of the screen. If you wish to exit this screen without modifying the histogram, enter an <E> in the option field and press <Enter>, or press the <Esc> key.

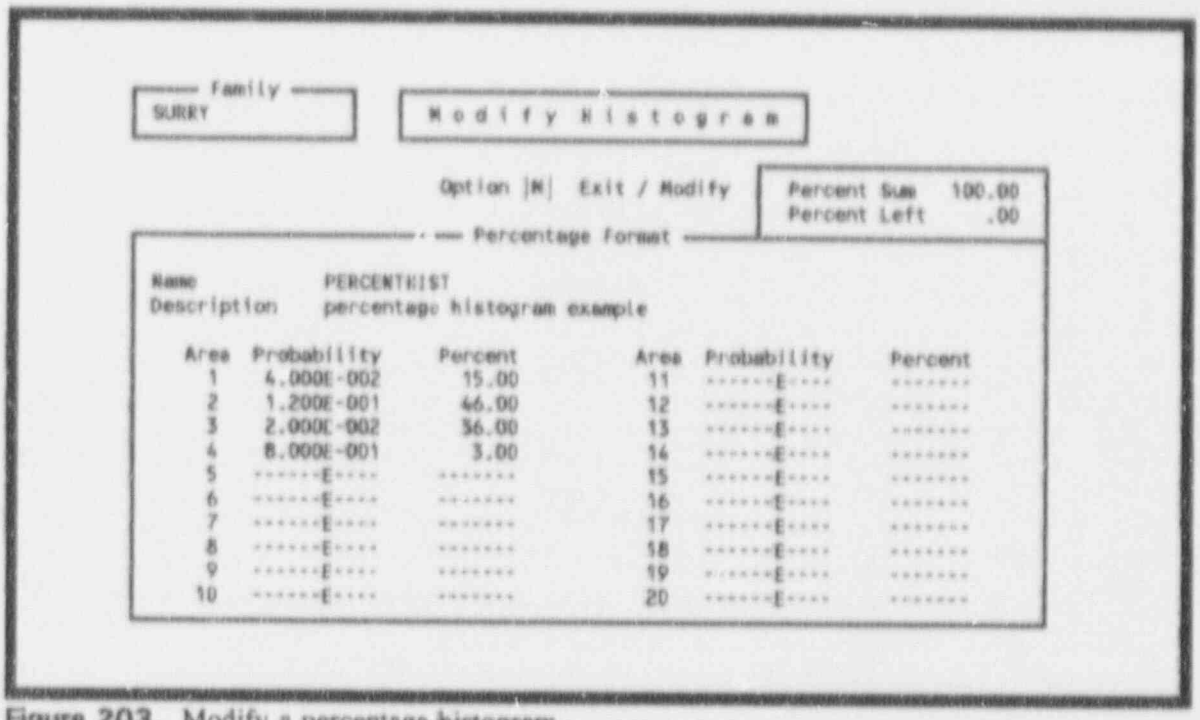


Figure 203. Modify a percentage histogram.

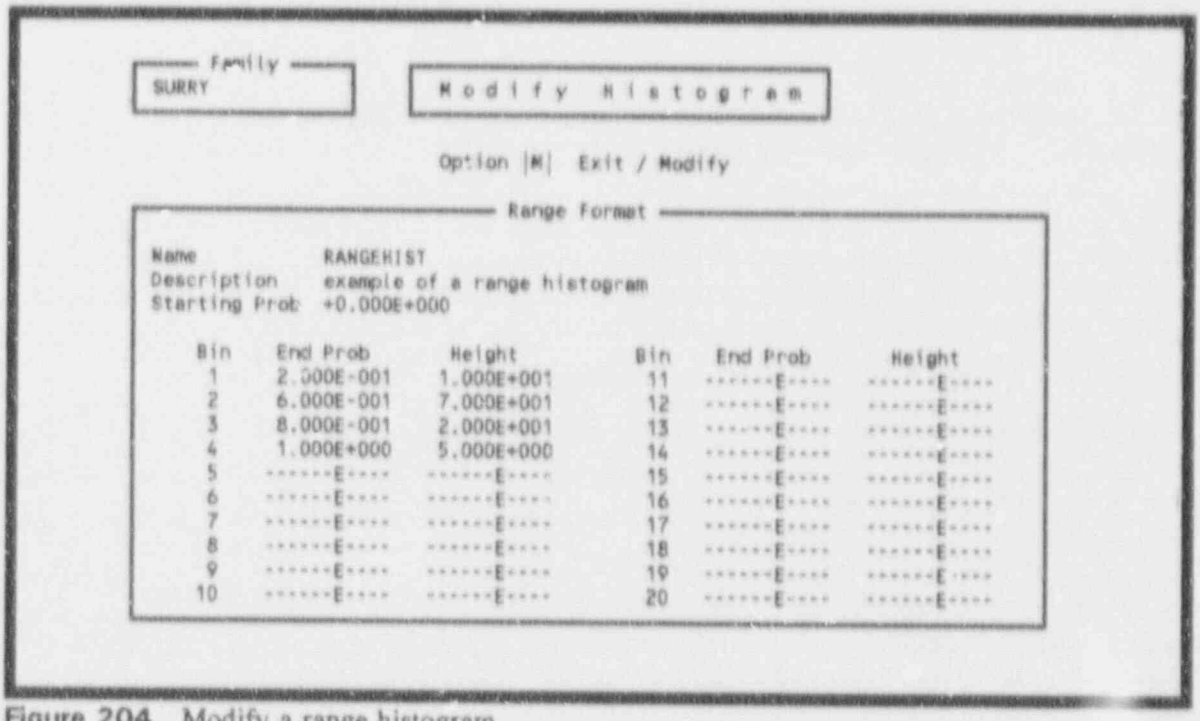


Figure 204. Modify a range histogram.

7.10.4 Delete Histograms

To delete an existing histogram from the data base, type a <D> (Delete) in the option field of the Edit Histograms screen, highlight the histogram to be deleted, and press <Enter>.

This action will result in displaying the selected histogram in the appropriate format on the Delete Histograms screen. To delete the histogram, type a <D> (Delete) in the option field and press <Enter>. When complete, you will be returned to the Edit Histograms screen with the message **Record Deleted** displayed at the bottom of the screen. To exit the Delete Histograms screen without deleting the histogram being displayed, press the <Esc> key or enter an <E> (Exit) in the option field and press <Enter>. Figure 205 and Figure 206 show examples of the Delete Histograms screen for percentage histograms and range histograms, respectively.

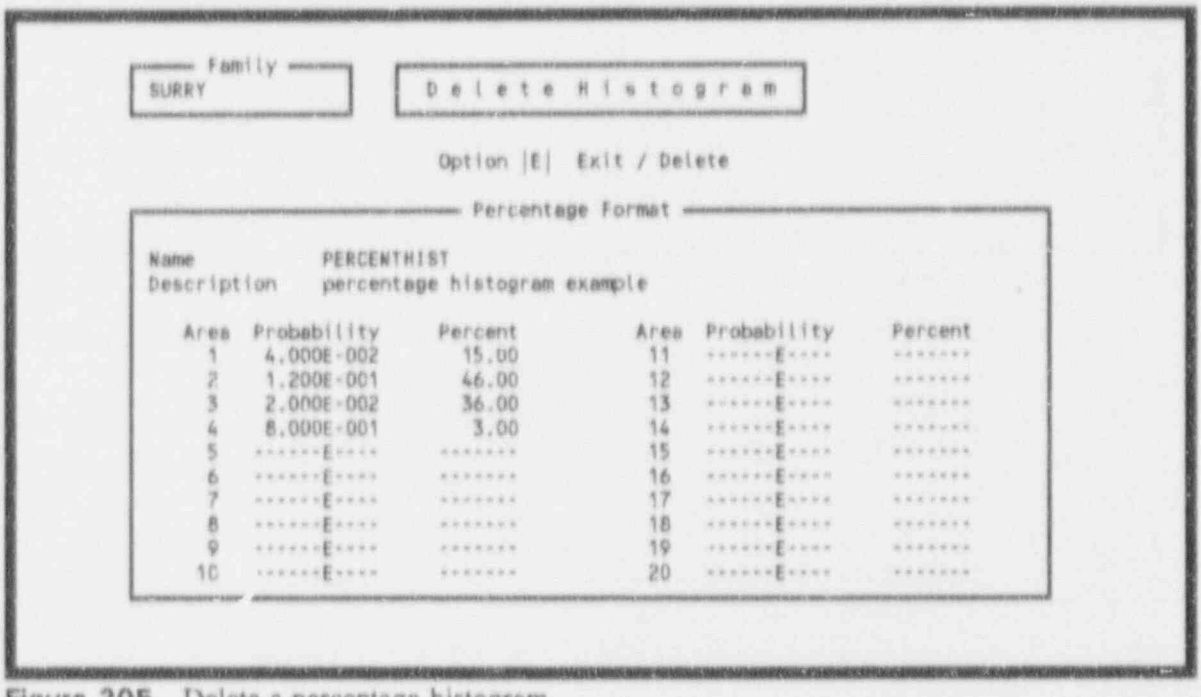


Figure 205. Delete a percentage histogram.

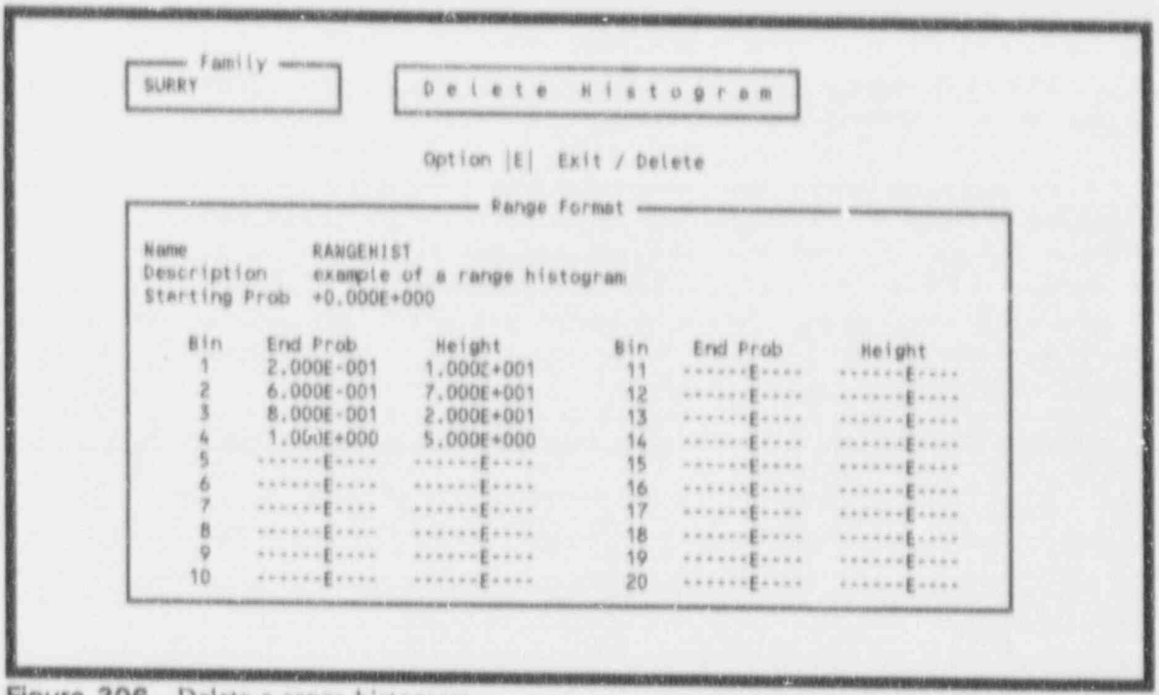


Figure 206. Delete a range histogram.

8. UTILITY OPTIONS

The SARA Utility options allow you to perform routine functions that are required by SARA such as defining constants, recovering the data base, and MAR-D data exchange. When you invoke this option <U>, Figure 207 will be displayed.

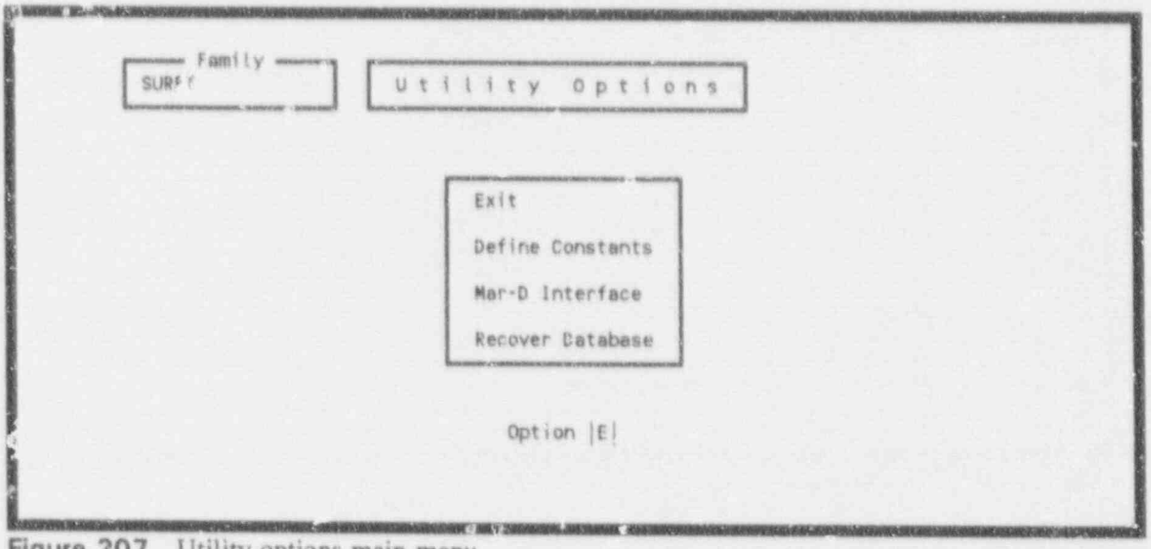


Figure 207. Utility options main menu.

8.1 Exit

Type <E> in the command line, or highlight Exit, and press <Enter> or press the <Esc> key to return to the SARA main menu.

8.2 Define Constants

The Define Constants <D> option allows you to define what hardware the system uses as well as defining uncertainty settings, cut set constants, and default values for the graphics editor. After choosing this option, the User Information Constants screen shown in Figure 208 is displayed. Table 1 provides a brief description of each of the fields in Figure 208.

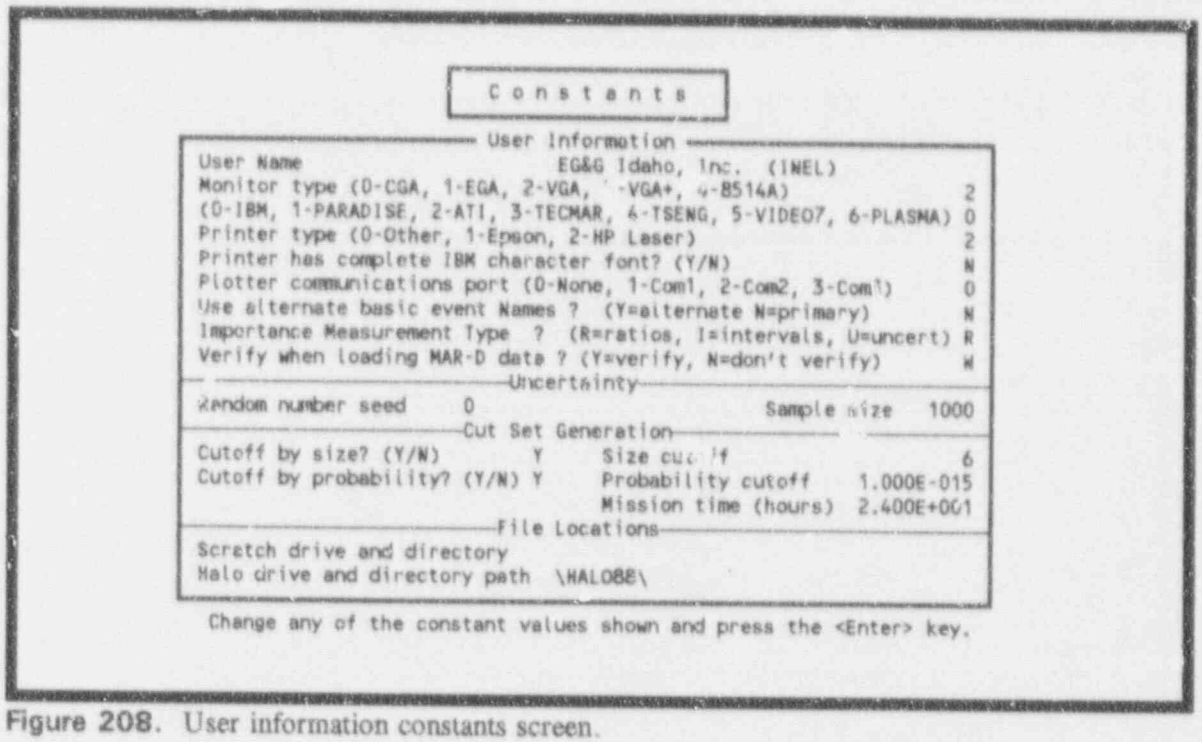


Figure 208. User information constants screen.

Table 1. User Information field descriptions for constants option

FIELD	DESCRIPTION
User Name	36 character user identification (optional) field
Monitor type	0 - Enhanced graphics monitor. 1 - DEFAULT - Standard color graphics monitor 2 - Video graphics monitor (2640 x 480) 3 - Video graphics monitor plus (800 x 600) 4 - 8514A
Card type	0 - IBM 1 - Paradise 2 - ATI 3 - TECMAR 4 - TSENG 5 - VIDEO-7 6 - PLASMA
Printer type	0 - Other 1 - Epson 2 - HP Laser (DEFAULT)
Printer has complete IBM character set?	Y - Yes. N - No (DEFAULT)
Plotter communications port	0 - No Plotter connected to port (DEFAULT). 1 - Plotter connected to Com1 port. 2 - Plotter connected to Com2 port. 3 - Plotter connected to Com3 port.
Use alternate basic event names?	Y - Alternate name will be used. N - Primary name will be used (DEFAULT).
Importance Measurement Type	R - Ratios (DEFAULT) I - Intervals U - Uncertainty
Verify when loading MAR-D data?	Y - File dependency will be checked. N - No file cross checking will done. (DEFAULT)
Random number seed for uncertainty calculations	5 digit numeric field indicating the first random number in the seed to be used in the Monte Carlo calculation. 0 (DEFAULT) indicates that the random number will be the current value of the real clock.
Sample size	6 digit numeric field indicating the default number of Monte Carlo samples to be run in the uncertainty analyses. Sample size may range from 1 to 999999 (DEFAULT = 1,000).

Table 1. (continued)

FIELD	DESCRIPTION
Cutoff by size?	Y - Do not generate fault tree or sequence cut sets containing more basic events than indicated in the Size cutoff field (DEFAULT). N - Generate all cut sets for the fault tree or sequence that meet the probability cutoff criteria (if in effect).
Size cutoff	The default maximum number of basic events allowed in cut set generation when size cutoff is in effect. DEFAULT = 6
Cutoff by probability?	Y - Do not generate fault tree or sequence cut sets that have a probability less than the cutoff indicated in the probability cutoff field (DEFAULT) N - Generate all cut sets that meet the size cutoff criteria (if in effect) regardless of the cut set probability.
Probability cutoff	The default minimum cut set probability allowed in cut set generation when probability cutoff is in effect. (DEFAULT = 000E-0.5)
Mission time (hours)	The default mission time to be used in the calculation of basic event probabilities (when appropriate). DEFAULT = 2.400E+001
Scratch drive and directory	36 character field indicating the drive and path to the scratch directory where files will be stored (DEFAULT set to blanks)
Halo drive and directory path	36 character field indicating the drive and path to the Halo graphics that SARA 4.0 should use (\HALO88\)

After setting the User Information constants, press <Enter>. The next screen displays the Fault Tree Graphics Constants (Figure 209). Table 2 provides a brief description of each of the fields in Figure 209.

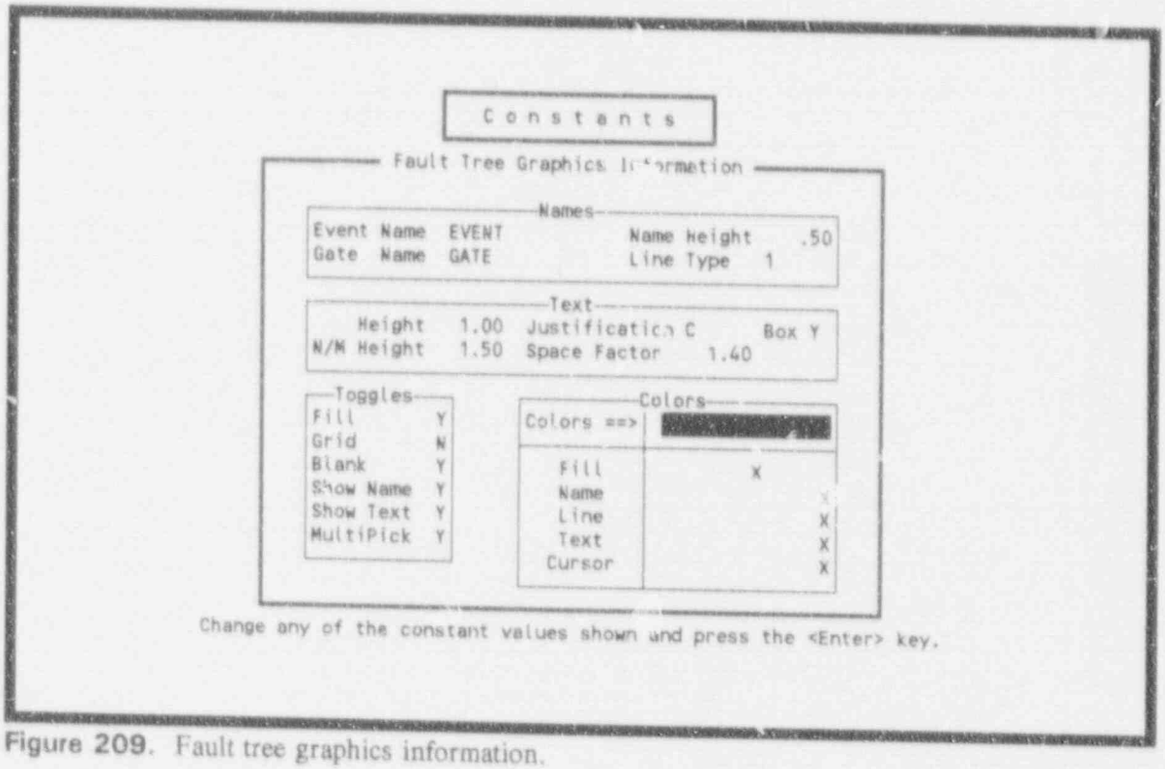


Figure 209. Fault tree graphics information.

Table 2. Fault tree graphics information field descriptions

FIELD	DESCRIPTION
Event Name	10-character field for the fault tree basic event default name. The default name is followed by a sequential number for each separate event, e.g., EVENT1, EVENT2, etc. (DEFAULT = EVENT)
Gate Name	10-character field for the fault tree gate default name. The default name is followed by a sequential number for each separate event, e.g., GATE1, GATE2, etc. (DEFAULT = GATE)
Name Height	The height of the event and gate names. This is a number between 0.01 and 66.00, where 66.00 represents the full 66 lines from the top of the screen to the bottom. (DEFAULT = 0.50)
Line Type	1 - Solid line (DEFAULT) 2 - Dashed line. 3 - Dotted line.
Text Height	The height of the text to be written. This is a number between 0.01 and 66.00 (see Name Height). DEFAULT = .50
N/M Height	The height of the numbers on an N/M OR gate showing the N and M values. This is a number between 0.01 and 66.00. (DEFAULT = 1.50)
Justification	Text justification. L - Left justified. C - Centered (DEFAULT). R - Right justified.
Space Factor	The spacing between lines of text written consecutively. This is a number between 1.00 and 10.00. A value of 1.00 will cause the top of the following line of text to touch the bottom of the preceding line. (DEFAULT = 1.40)

Table 2. (continued)

FIELD	DESCRIPTION
Fill	Yes/No toggle turning the fill on/off for plotting. DEFAULT = No
Grid	Yes/No toggle turning a reference grid on/off. DEFAULT = No
Blank	Y - The immediate area surrounding a gate or event name will be blanked out. (DEFAULT) N - The gate and event names will be written over any lines drawn in the areas for the names.
Show Name	Yes/No toggle turning on/off the display of event and gate names when the SHOW command is used. DEFAULT = Yes
Show Text	Yes/No toggle turning on/off the display of descriptive text when the SHOW command is used. DEFAULT = Yes.
MultiPick	When building trees, multipick will generate multiple gates for each pick of a gate type. DEFAULT = Yes.
Fill Color	An X under the desired color selects the default color for filling in shapes. DEFAULT color = blue.
Name Color	An X under the desired color selects the default color for displaying names. DEFAULT color = white.
Line Color	An X under the desired color selects the default color for drawing lines. DEFAULT color = white.
Text Color	An X under the desired color selects the default color for writing text. DEFAULT color = white.
Cursor Color	An X under the desired color selects the default color for the cursor. DEFAULT color = white.

After setting the Fault Tree graphics information constants press <Enter>. The next screen displays Event Tree graphics information (Figure 210). Make any changes needed and press <Enter>. Table 3 provides a brief description of each of the fields in Figure 210.

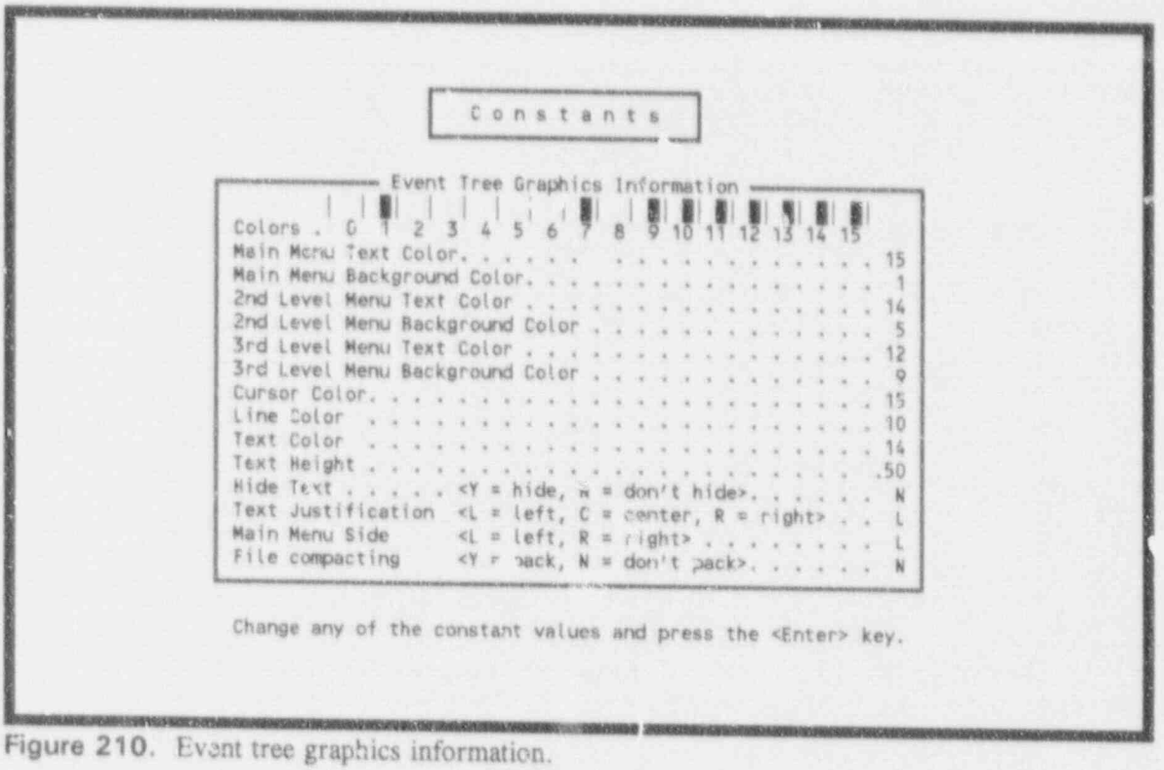


Figure 210. Event tree graphics information.

Table 3. Event tree graphics information field descriptions

FIELD	DESCRIPTION
Colors	Colors that can be used in event tree graphics and their associated reference numbers.
Main Menu Text Color	Color of main menu's text. DEFAULT = 15 (white).
Main Menu Background Color	Background color upon which text is written. DEFAULT = 1 (blue).
2nd Level Menu Text Color	Color of text in second level menus. DEFAULT = 14 (yellow).
2nd Level Menu Background Color	Background color of second level menus upon which text is written. DEFAULT = 5 (purple).
3rd Level Menu Text Color	Color of text in third level menus. (DEFAULT = 12 (cyan).
3rd Level Menu Background Color	Background color of third level menus upon which text is written. DEFAULT = 9 (light blue).
Cursor Color	Default color of cursor. DEFAULT = 15 (white).
Line Color	Default color of lines. DEFAULT = 15 (white).
Text Color	Default color of text. DEFAULT = 14 (yellow).
Text Height	Default text height. DEFAULT = 1.00.
Hide Text	Y/N Hide text when displaying tree. DEFAULT = N.
Text Justification	L = Left (DEFAULT) C = Center R = Right.
Main Menu Side	L/R - Side of screen to place main menu. (DEFAULT = left).
File Compacting	Y/N - Compact file when leaving editor. DEFAULT = No.

8.3 MAR-D Interface

The MAR-D Interface <M> option facilitates loading and unloading of Probabilistic Risk Assessment (PRA) data from the Models and Results Data Base (MAR-D). The process converts information from the generic format found in the MAR-D data base to the SARA data base format. It also makes a conversion from SARA format to the MAR-D data base format. When you select this option, Figure 211 will be displayed.

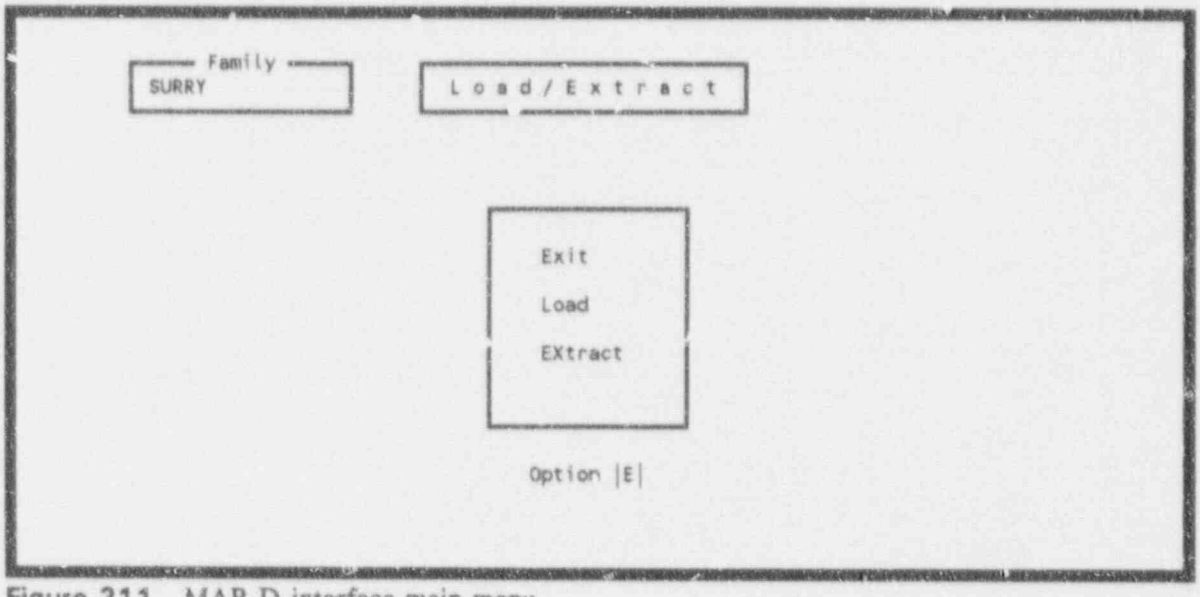


Figure 211. MAR-D interface main menu.

8.3.1 LOAD

Before loading any data, a family must be created through the MODIFY Database Family option. Copy the files you wish to load into that family's directory (use the DOS copy command or the File Copy option under Select Family). Select that family and verify that the family name displayed in the top left corner of each menu is where the data should be loaded. If it is not correct, use the SELECT Family option again to choose the desired family.

Upon entering the LOAD module, Figure 212 will be displayed. As you cursor down through the data tools, autohelp menus will appear to the right, listing the types of data that can be loaded (Figure 213). The right arrow or <Enter> will take you to this second menu (Figure 214). Again, as you cursor down through the data types, menus will appear listing the specifics of what types of data can be loaded (Figure 215). After choosing the data to load (Figure 216), the form in Figure 217 will appear listing the files which contain that data and have the proper extension.

Each of the subsections below contains additional information on loading various types of data. In general, new data loaded into the data base overwrites old data of the same name. After loading data, you may generate either a Summary Report or a Detailed Data Report to verify the data.

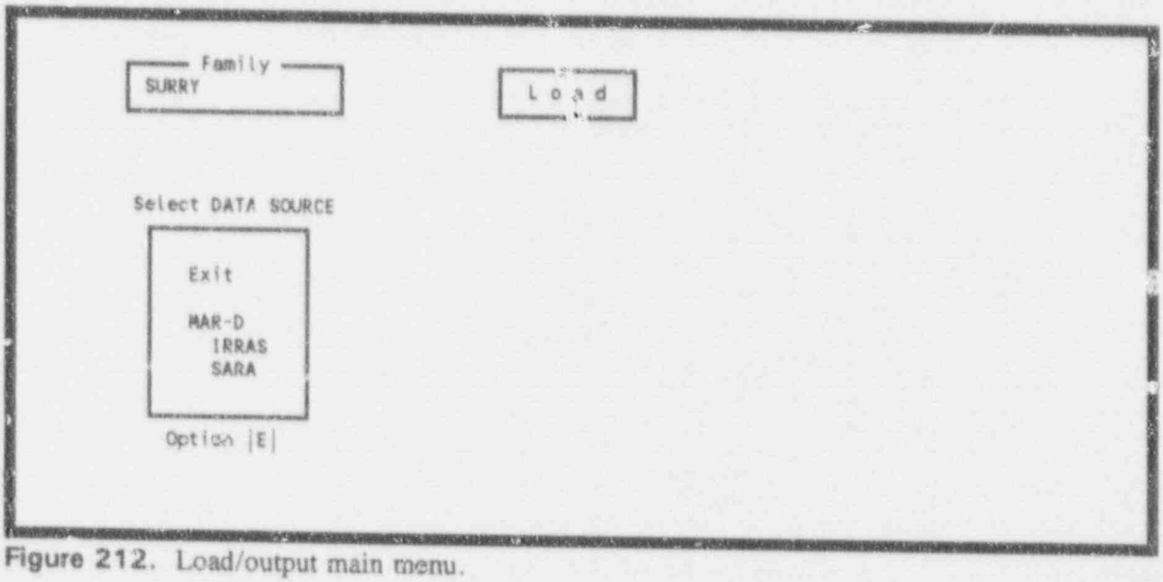


Figure 212. Load/output main menu.

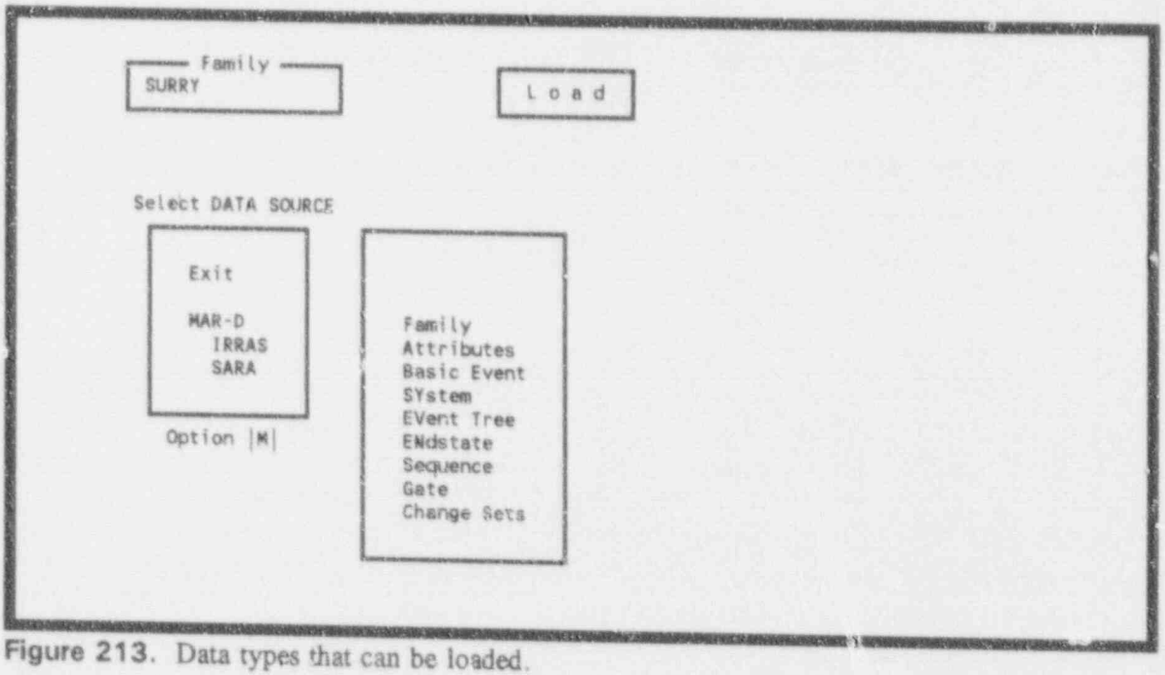


Figure 213. Data types that can be loaded.

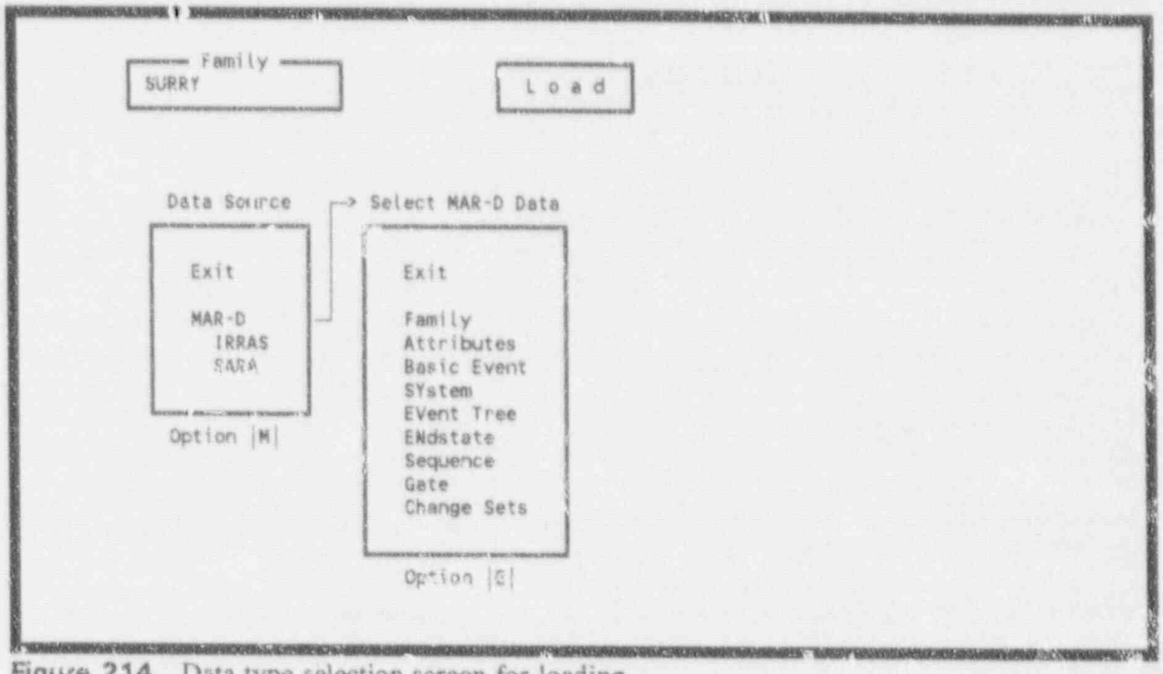


Figure 214. Data type selection screen for loading.

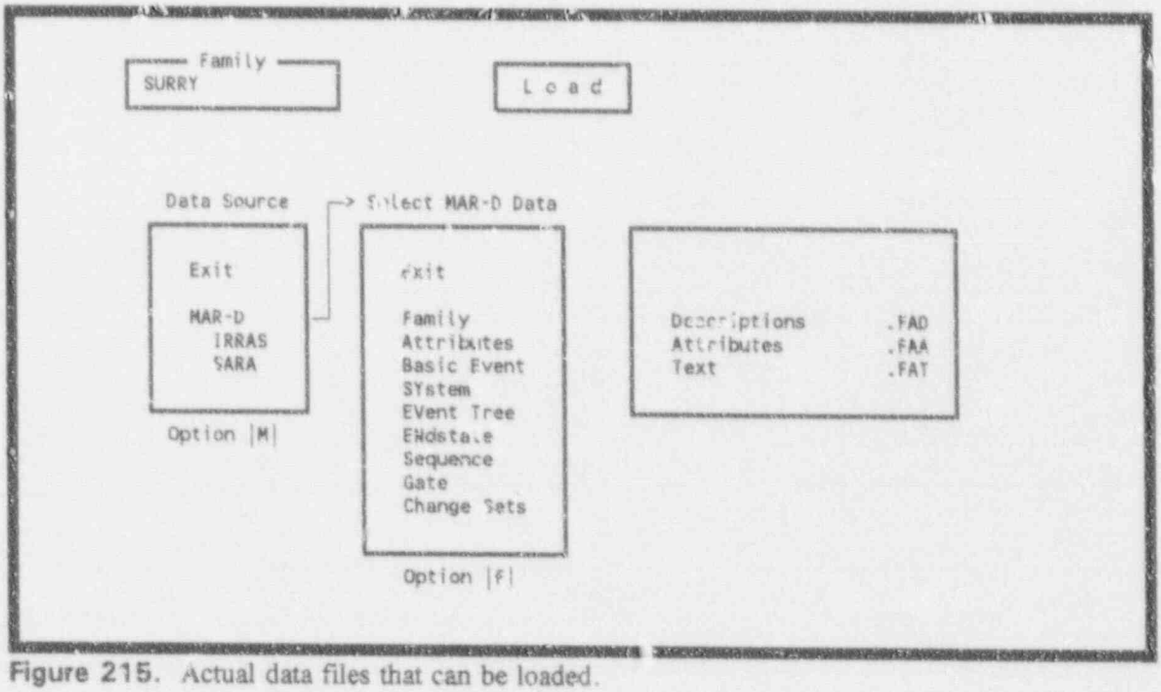


Figure 215. Actual data files that can be loaded.

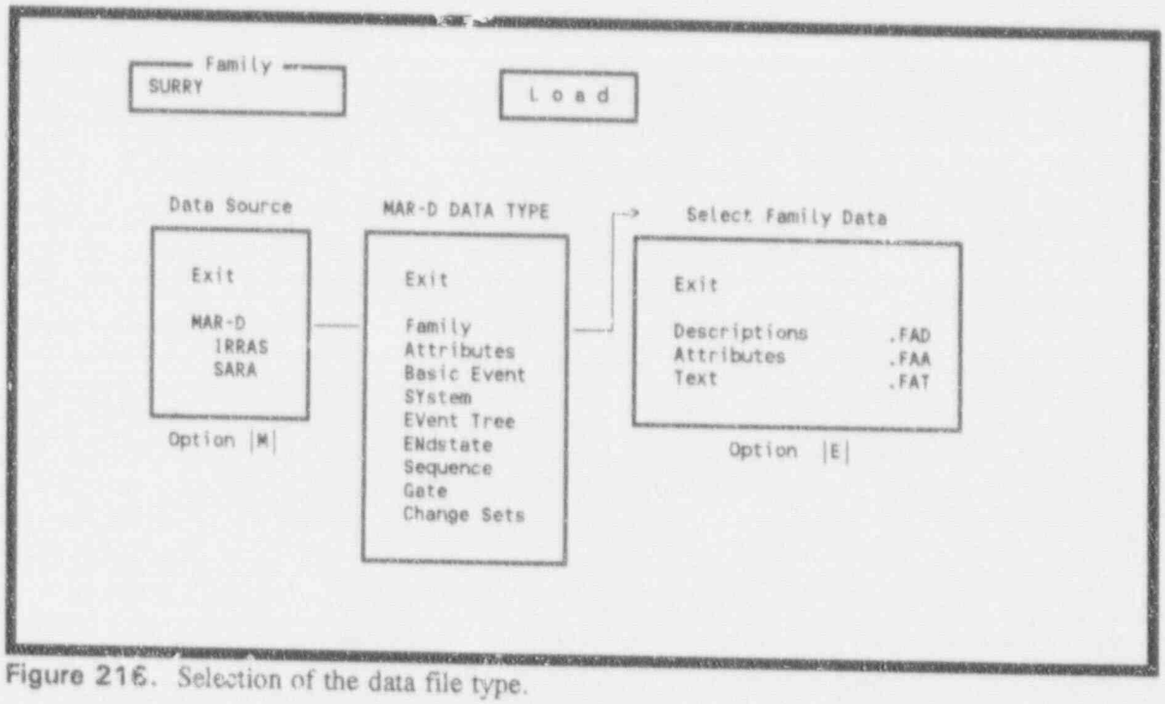


Figure 216. Selection of the data file type.

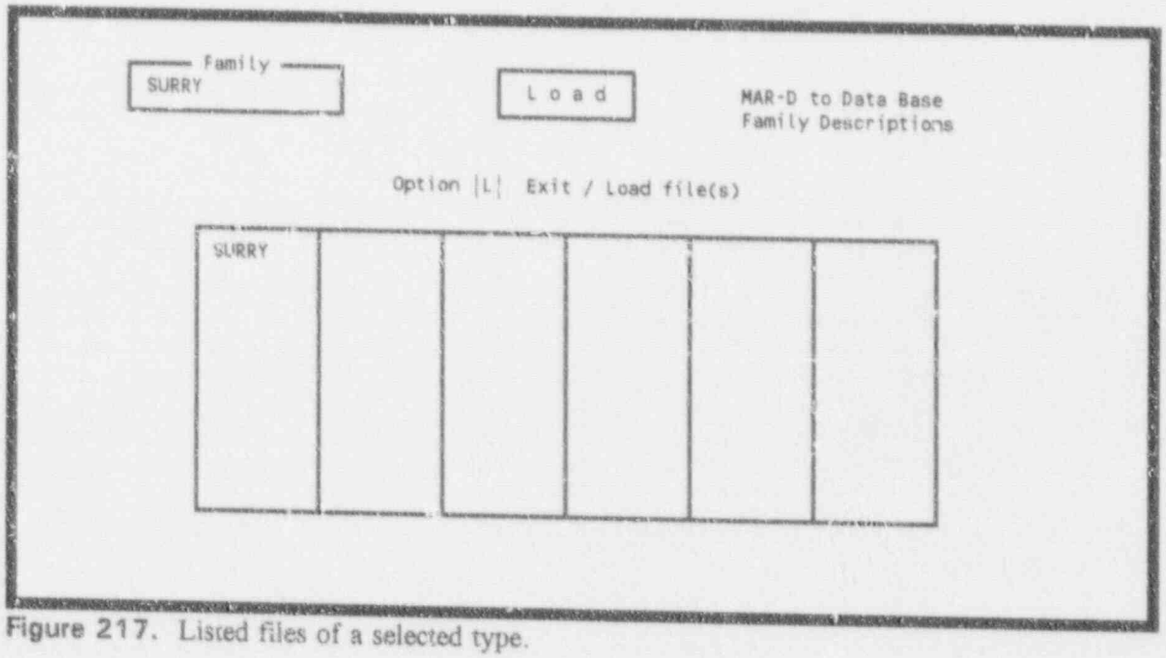


Figure 217. Listed files of a selected type.

8.3.1.1 Load Verification. Consistency checking for names contained in multiple files can be done by setting "Verify when loading MAR-D data?" to "Y" using the Define Constants option (see Section 8.2). Data files that have no prerequisite loaded files (*.CTD, *.FTD, *.BED, etc.) are assumed to be correct and are loaded directly into the data base without any field checking taking place. Data files having prerequisite loaded files contain dependent fields referenced in those data files (e.g., the *.BEI file contains event names also contained in the *.BED file). See Table 4 for a listing of files and their prerequisite files and dependent fields.

Table 4. MAR-D files load order dependencies

Group	File	Prereq. files	Dependent fields
Family:	.FAD	----	----
	.FAT	----	----
	.FTT	----	----
NOTE: consistency checking for family names is active for all files.			
Attributes:	.CAD	----	----
	.CTD	----	----
	.FMD	----	----
	.LCD	----	----
	.STD	----	----
BasicEvents:	.BED	----	----
	.BEI	.BED	Event Name
	.BEA	.BED	Event Name
		.CAD	Class Attr
		.CTD	Comp Type
		.FMD	Fail Mode
		.LCD	Location
		.STD	System Type
Systems:	.FTD	----	----
	.DLS	----	----
	.FTL	.BED	Event Name
	.FTC	.FTD	System Name
		.BED	Event Name
	.FTA	.FTD	System Name
	.FTT	.FTD	System Name
NOTE: .DLS and .FTL files are put into graphic relation instead of system relation. No cross relational cross checking available for graphics name.			
EventTrees:	.ETD	----	----
	.ETA	.ETD	Event Tree Name
		.BEI	Init Event
	.ETG	.ETD	Event Tree Name
	.ETL	.ETD	Event Tree Name
		.BEI	Init Event: unless Top
		.FTD	System Name for TOPS
	.ETT	.ETD	Event Tree Name
NOTE: .ETG is currently loaded as text. .ETL should look exactly like .ETG file.			
EndStates:	.ESD	----	----
	.ESI	????	????
	.EST	.ESD	End State Name
Sequences:	.SQD	.ETD	Event Tree Name
	.SQC	.ETD	Event Tree Name
		.SQD	Sequence Name
		.BED	Event Name
	.SQA	.ETD	Event Tree Name
		.SQD	Sequence Name
		.ESD	End State Name

.SQT	.ETD	Event Tree Name
	.SQD	Sequence Name

If a dependent field does not exist in the database at load time, that field will be displayed in a confirmation/add menu. Thus, if an event name contained in a *.BEI file does not match any event name previously loaded by the *.BED file, the new name will be displayed with the option to add the event name or simply abort the load process. Note that the dependent field name cannot be edited at this point. If the name is not correct then exit, fix the mistake, and reload.

However, if you suspect your data files have multiple cross-reference errors, load the files and allow the load procedure to find the errors for you. As an error is displayed to the screen, write down the line number and file name and continue with the load. When the load is finished, make the necessary corrections to the data files, delete the database files for that family (i.e., the *.DAT, *.IDX, and *.BLK files), and restart the load procedure.

8.3.1.2 Family. Family descriptions, attributes, and text can be loaded into the database. This information is currently stored in only the MAR-D format (see Appendix B). Note that each file contains data for only one family, and that a change in the data file family name will not change the database family name.

8.3.1.3 Event Attributes. Basic event attributes descriptions (locations, failure modes, class attributes, system types and component types) can be loaded using the MAR-D attributes option. The file format is described in Appendix B.

8.3.2.4 Basic Events. Event descriptions, failure rates, and attributes can be loaded into the database. The alternate name of the event defaults to the value of the primary name if an alternate name is not specified. The file formats are described Appendix B.

8.3.1.5 Systems. System descriptions, graphics, logic, cut sets, attributes, text and piping and instrumentation diagrams (P&IDs) can be loaded into the database. System cut sets and attributes data can be loaded into either the base case (permanent) or alternate (temporary) field areas. MAR-D database applications will normally use the base case load option because only permanent data should be loaded into the database. Analysis software such as IRRAS or SARA will use alternate fields for comparisons of changed value results. The file formats are described in Appendix B.

Any basic event found within the system logic or cut sets will be added to the Event relation.

8.3.1.6 Event Trees. Event tree descriptions, graphics, logic, attributes, rules, and text can be loaded into the database. The file format is described in Appendix B.

8.3.1.7 End States. End state names, descriptions, and text can be loaded into the database. The file format is described in Appendix B. Formats for end state information have not yet been determined.

8.3.1.8 Sequences. Sequence cut sets for MAR-D (IRRAS, SARA) file formats can be loaded. In the MAR-D format, sequence descriptions, attributes, text, and logic can be loaded as well. With cut sets and attributes, data can be loaded into either the base case or alternate field areas. The file formats are described in Appendix B.

The event tree initiating event must have been entered into the database prior to loading sequence cut sets and, therefore, does not need to be included; any found will be removed from the cut set data. The event tree initiating event will be included in each cut set term for SETS *.DNF format output.

8.3.1.9 Gates. Gate names and descriptions and types can be loaded into database for use in graphics conversion. The file format is described in Appendix B.

8.3.1.10 Change Sets. All change set information used in the GENERATE change set option can be loaded via this file.

8.3.2 Extract

Data can be output in MAR-D (IRRAS, SARA) format using the EXTRACT option. The extract file is created in the current family subdirectory. The default output file name for description, information, and attribute data is the first eight characters of the family name plus the appropriate extension. For MAR-D cut set, logic, graphic, and textual information, if all files are selected for extraction, the file name will be the family name with the extension. Otherwise, the file name will be the first six characters of the name plus a 2-character ID number.

NOTE: If a file with this name already exists it will be overwritten.

The EXTRACT menus are identical with the LOAD menus (see Figure 218 through Figure 222). A data tool type is selected, then a data type, and finally the specific data to be output. In outputting some data, a fourth menu appears. Read the note at the bottom of the screen as well as the appropriate section on extracting that data type.

8.3.2.1 Family. Family descriptions, attributes, and text can be output from the database. Note that each file will contain information for the selected family.

8.3.2.2 Event Attributes. Event attributes (locations, failure modes, class attributes, system types, and component types) can be output from the data base. Event attributes will be output for the entire family.

8.3.2.3 Events. Event descriptions, failure rates, and attributes can be output for all the events in a family. If alternate basic event names are used, the constant is set to "Y", and the alternate name will be used instead of the primary name for descriptions and failure rates. Primary names will be output.

8.3.2.4 Systems. Descriptions and attributes can be output for all the systems in a family. System logic, graphics, and cut sets are selected from an output menu. If all logic or graphics is selected, a single file will be created for each of the names; for all cut sets and text, the family name will be used, with systems separated by ^EOS.

8.3.2.5 Event Trees. Descriptions and attributes can be output for all the event trees in a family. Event tree logic, graphics, rules, attributes, and text are selected from an output menu.

8.3.2.6 End States. End state descriptions can be output for the whole family. Text is selected from an output menu.

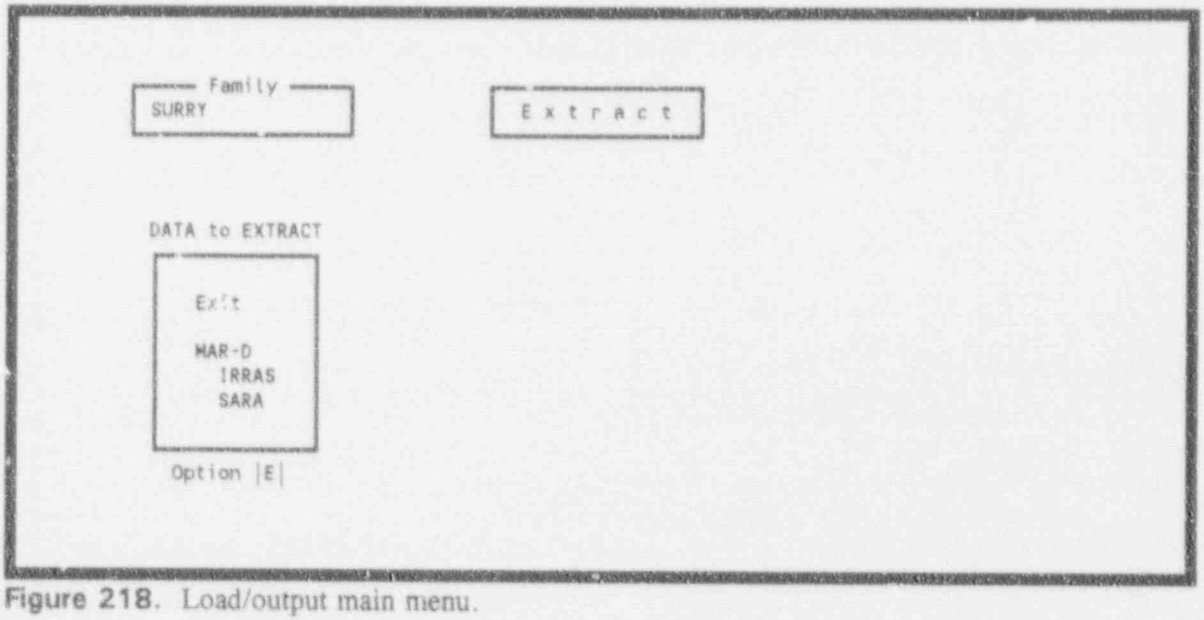


Figure 218. Load/output main menu.

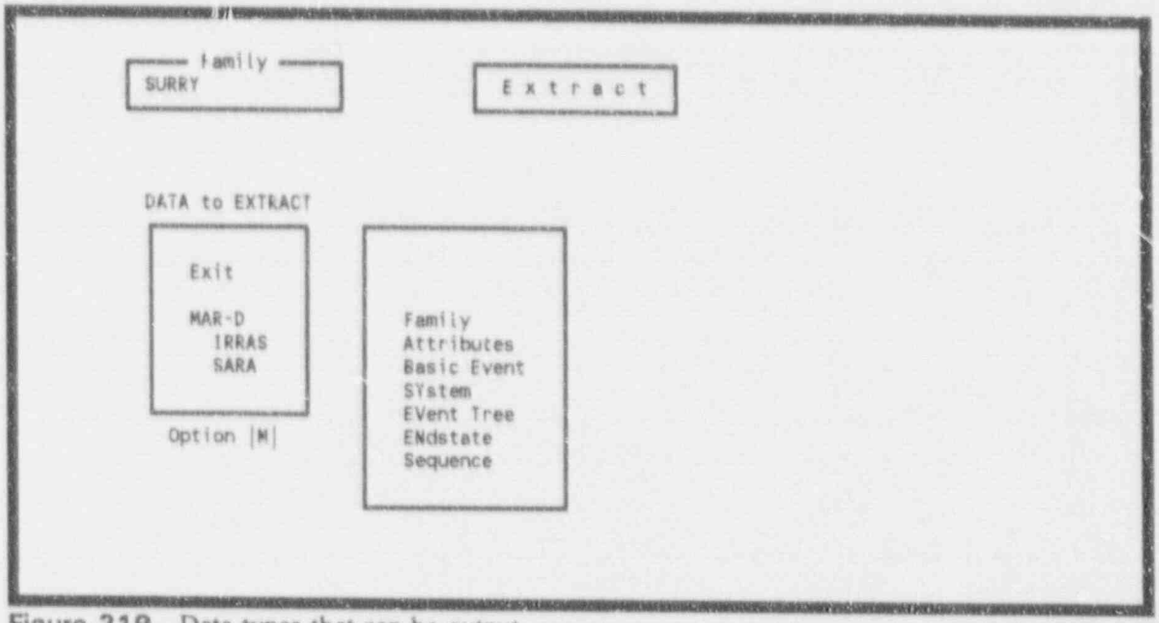


Figure 219. Data types that can be output.

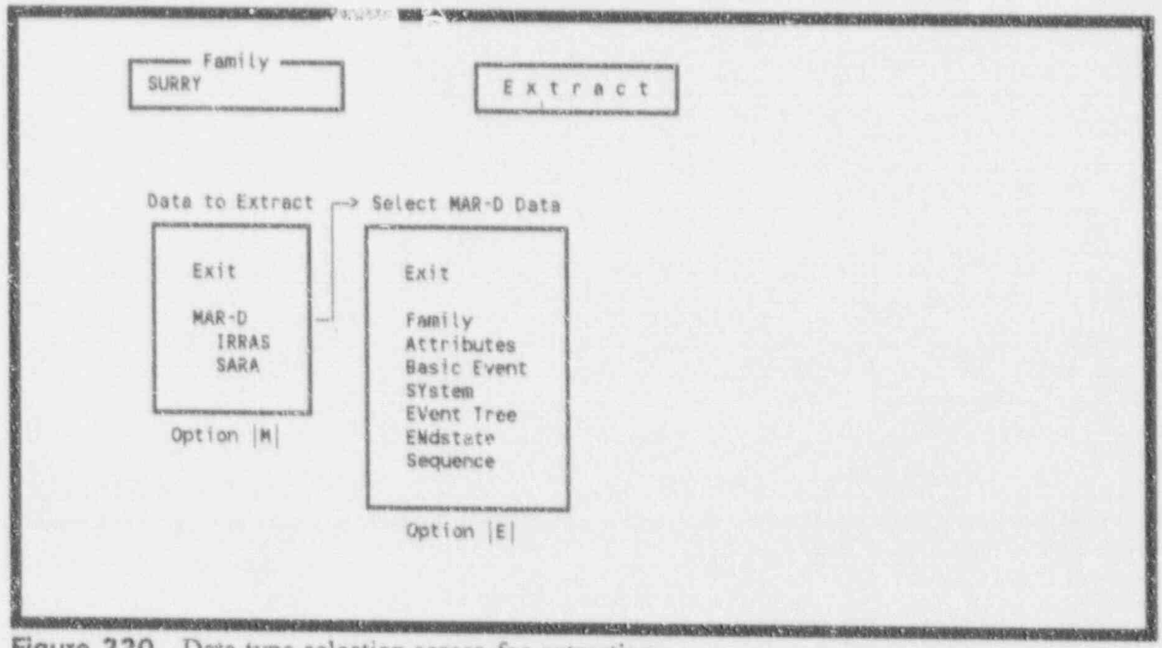


Figure 220. Data type selection screen for extracting.

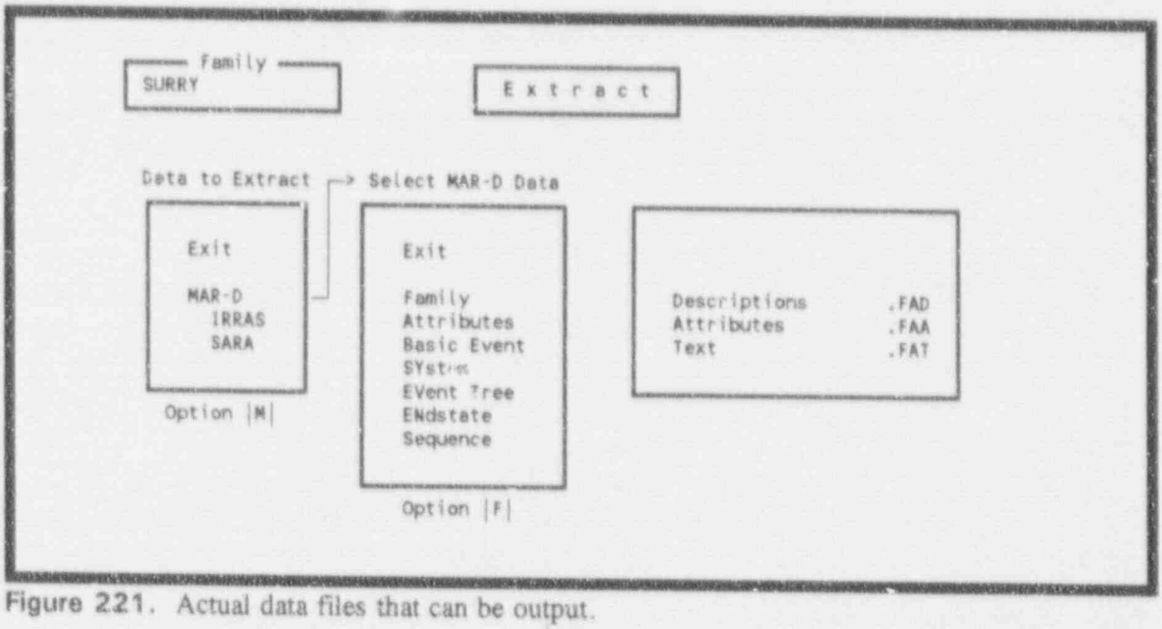


Figure 221. Actual data files that can be output.

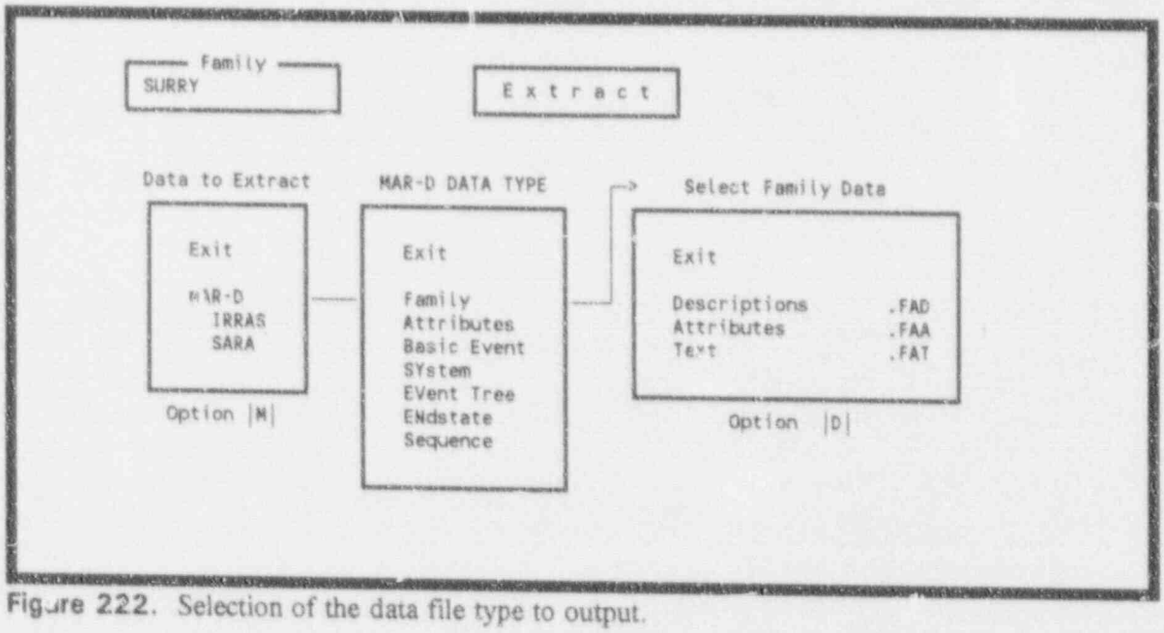


Figure 222. Selection of the data file type to output.

8.3.2.7 Sequences. Sequence descriptions and attributes can be output for an entire family. Sequence cut sets, logic, and text must first have an event tree selected, then that event tree's sequences are displayed and can be output. If all event trees are selected, the sequences for each event tree will be output to a file with that event tree's name. If a single event tree is selected, the output sequence menu containing all of the sequences associated with that event tree will be displayed. If all of the sequences are selected, those sequences will be output to a single file with the event tree's name. If a single sequence is selected, it is output to a file with that sequence's name.

8.3.2.8 Gate. Gate names and descriptions and types can be output for an entire family.

8.3.2.9 Change Sets. All change set information used in the GENERATE option can be output for an entire family.

For further details see *Models and Results Data Base User's Guide Ver. 2.0,* October 1989, EGG-CATT-8249.

8.4 Recover Database

NOTE: **Before recovering the data base, it is suggested that you backup the *.DFL files and corresponding data files (*.IDX , *.DAT, and *.BLK) in the directory of the family to be rebuilt.**

The Recover Database <R> option allows you to restructure the data base and re-index the data. Some indications that a data base rebuild is necessary include:

1. Data elements such as events/systems have been deleted and seem to reappear
2. During cut set generation or update, the mi cut upper bound seems surprisingly high
3. Cross Reference reports show/don't show events being used properly
4. Events/systems that don't appear to be referenced cannot be deleted, and
5. After a software version update.

You may rebuild the data base anytime because the rebuild process compacts the data and generally helps the software run faster. The screen shown in Figure 223 appears when this option is selected. As shown, several different recovery methods are available. Each method is discussed in the following paragraphs.

8.4.1 Recover Everything

This option performs all the recovery methods shown on the screen. This option will recover all key indexes and then recover the cross references. This option will take several minutes to complete. If your data base has not been damaged, this option will restructure and optimize your data base.

To invoke this option, highlight Recover Everything or enter an <R> in the option field and press <Enter>. When you invoke this option, a warning screen will be displayed (see Figure 224). At the prompt, enter a <Y> and press <Enter> to continue with the recovery, or enter an <N> and press <Enter> to terminate the process.

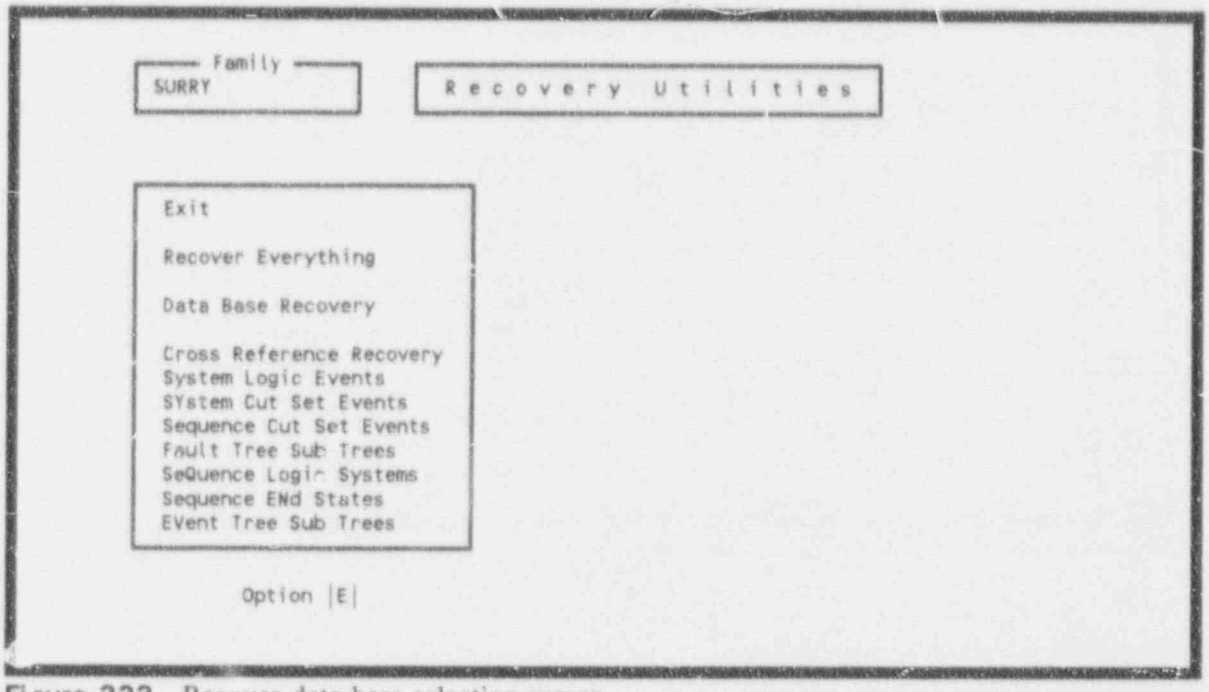


Figure 223. Recover data base selection screen

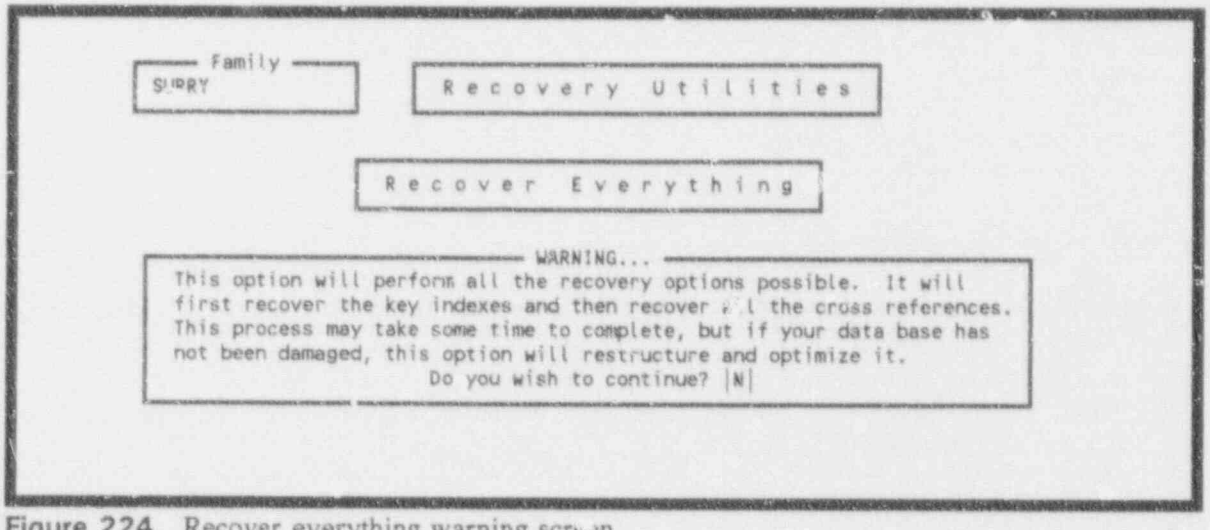


Figure 224. Recover everything warning screen.

8.4.2 Data Base Recovery

This option rebuilds all the files contained in your data base. If you think your data base has been damaged, use this option to recover all data files. If your data base has not been damaged, this option will restructure and optimize your data base.

To invoke this option, enter a <D> in the option field or highlight Data Base Recovery and press <Enter>. When you invoke this option, a warning screen will be displayed (see Figure 225). At the prompt, enter a <Y> and press <Enter> to continue with the recovery, or enter an <N> and press <Enter> to terminate the process.

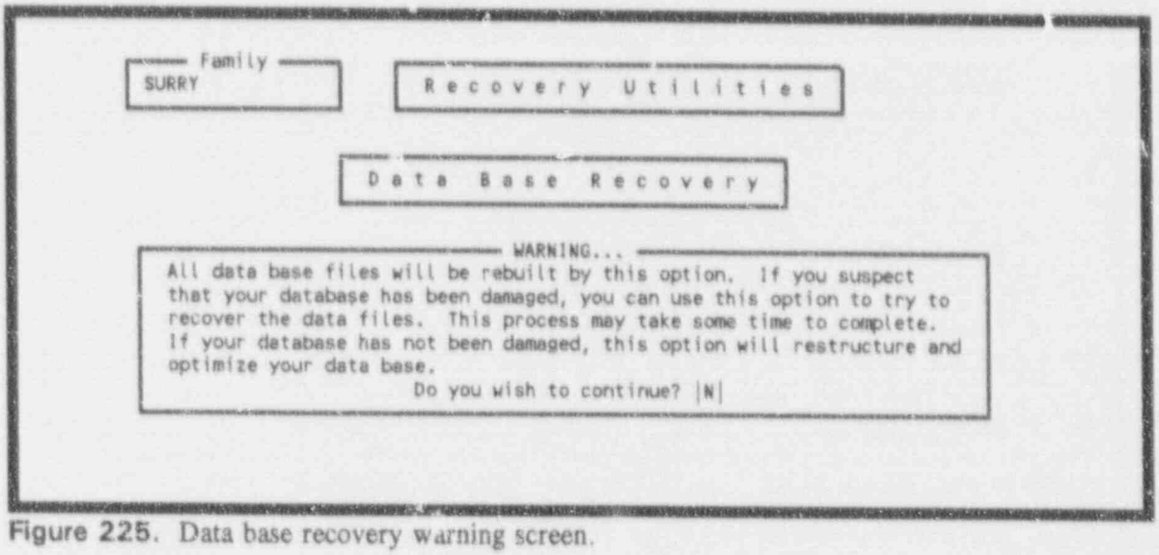


Figure 225. Data base recovery warning screen.

8.4.3 System Logic Events

This option rebuilds the system logic events cross reference list. Each system's logic record is read and each event used is tracked. If no logic exists for a system, the list is cleared, and a message will be displayed on the screen, and the recovery process will continue. If an event is referenced, but not used, it will be added.

To invoke this option, enter an <L> in the option field or highlight System Logic Events and press <Enter>. When you invoke this option, a warning screen will be displayed (see Figure 226). At the prompt, enter a <Y> and press <Enter> to continue with the recovery, or enter an <N> and press <Enter> to terminate the process.

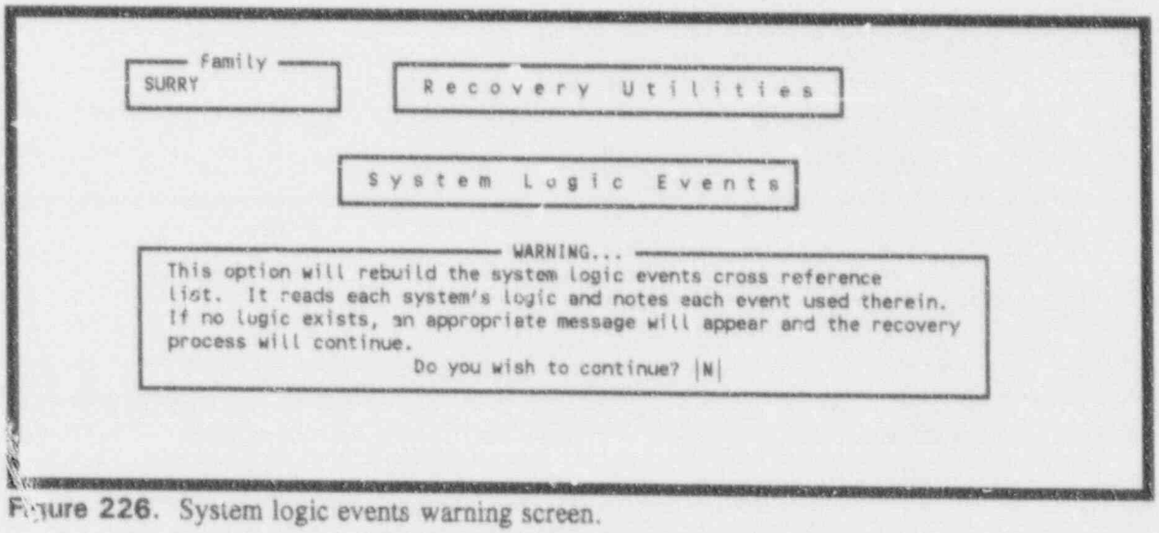


Figure 226. System logic events warning screen.

8.4.4 SYstem Cut Set Events

This option rebuilds the system cut set events cross reference list. Each system's base and current cut sets are read. The program tracks each event used. If no cut sets exist for a system, a message will be displayed on the screen and the recovery process will continue. If an event is referenced but not used, it will be added.

To invoke this option, enter a <Y> in the option field or highlight SYstem Cut Sets Events and press <Enter>. When you invoke this option, a warning screen will be displayed (see Figure 227). At the prompt, enter a <Y> and press <Enter> to continue with the recovery, or enter an <N> and press <Enter> to terminate the process.

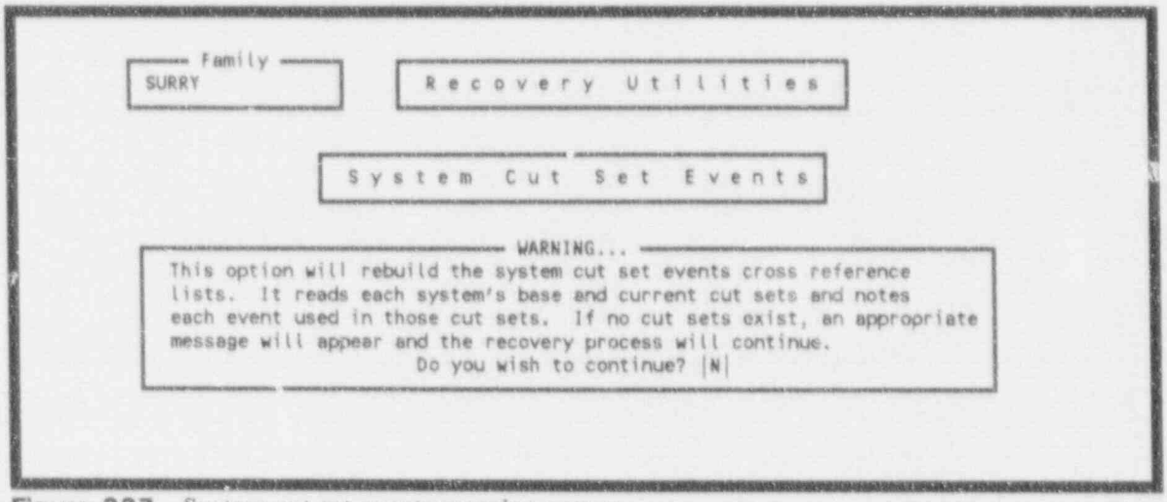


Figure 227. System cut set events warning screen.

8.4.5 Sequence Cut Set Events

This option rebuilds the sequence cut set events cross reference list. Each sequence's base and current cut sets are read. The program tracks each event used. If no cut sets exist for a sequence, a message will be displayed on the screen and the recovery process will continue. If an event is referenced but not used, it will be added.

To invoke this option, enter an <S> in the option field or highlight Sequence Cut Sets Events and press <Enter>. When you invoke this option, a warning screen will be displayed (see Figure 228). At the prompt, enter a <Y> and press <Enter> to continue with the recovery, or enter an <N> and press <Enter> to terminate the process.

8.4.6 Fault Tree Sub Trees

This option rebuilds the fault tree subtree cross reference list. Each fault tree graphic relation's logic is read. The program notes any transfer in that logic. If a subtree is referenced, but does not exist in the data base, that subtree will be added to the data base.

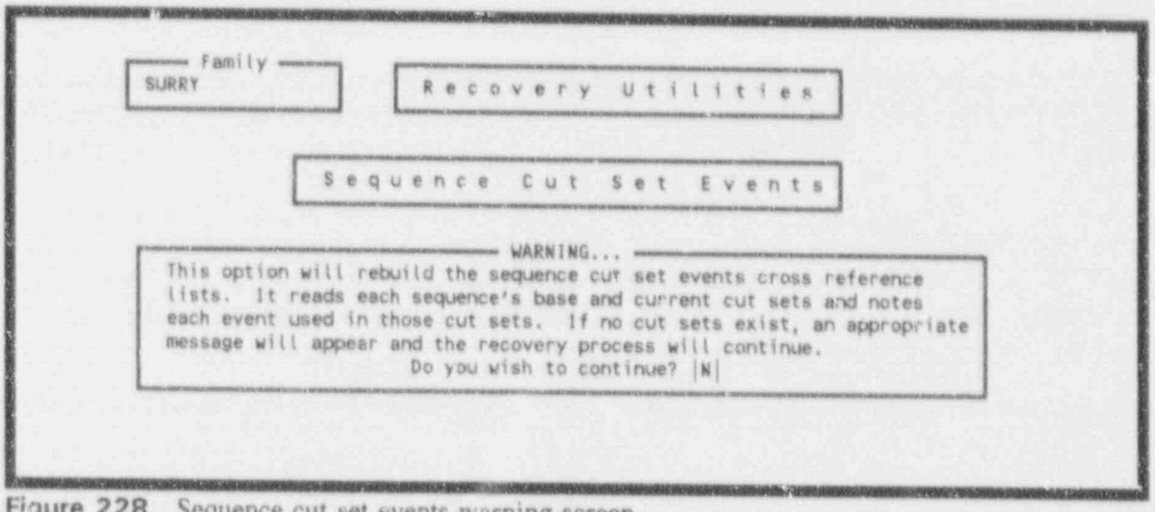


Figure 228. Sequence cut set events warning screen.

To invoke this option, enter an <F> in the option field or highlight Fault Tree Sub Trees and press <Enter>. When you invoke this option, a warning screen will be displayed (see Figure 229). At the prompt, enter a <Y> and press <Enter> to continue with the recovery, or enter an <N> and press <Enter> to terminate the process.

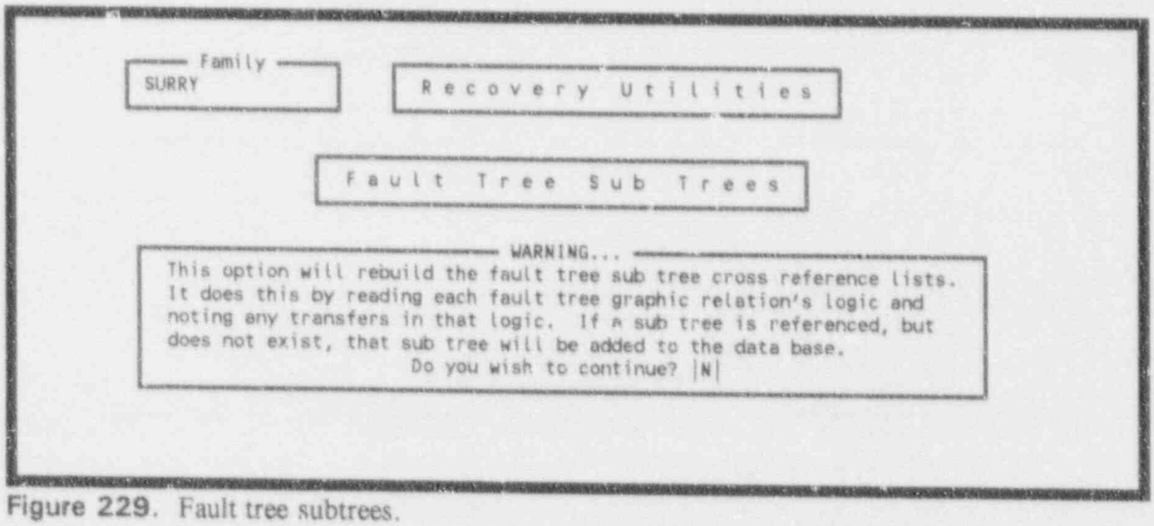


Figure 229. Fault tree subtrees.

8.4.7 SeQuence Logic Systems

This option rebuilds the sequence logic systems cross reference list. Each sequence's logic is read and each system used is noted. If no logic exists a message will be displayed and the recovery process will continue.

To invoke this option, enter a <Q> in the option field or highlight SeQuence Logic Systems and press <Enter>. When you invoke this option, a warning screen will be displayed (see Figure 230).

At the prompt, enter a <Y> and press <Enter> to continue with the recovery, or enter an <N> and press <Enter> to terminate the process.

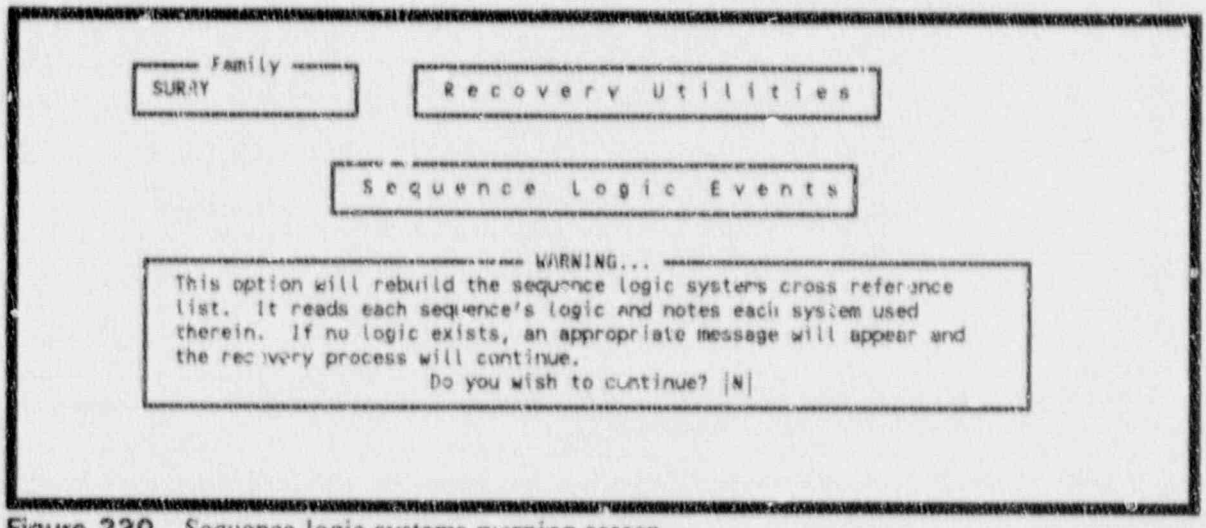


Figure 230. Sequence logic systems warning screen.

8.4.8 Sequence ENd States

This option actually checks that the end states for each sequence are contained in the end state relation. Each sequence is read and each end state is noted. If a referenced end state does not exists, it will be added to the end state relation and the recovery process will continue.

To invoke this option, enter a <Q> in the option field or highlight Sequence ENd States and press <Enter>. When you invoke this option, a warning screen will be displayed (see Figure 231). At the prompt, enter a <Y> and press <Enter> to continue with the recovery, or enter an <N> and press <Enter> to terminate the process.

8.4.9 EVent Tree Sub Trees

This option rebuilds the event tree subtree cross reference list. Each event tree graphic relation's logic is read. The program notes any transfer in that logic. If a subtree is referenced, but does not exists in the data base, that subtree will be added to the data base.

To invoke this option, enter a <V> in ,the option field or highlight EVent Tree Sub Trees and press <Enter>. When you invoke this option, a warning screen will be displayed (see Figure 232). At the prompt, enter a <Y> and press <Enter> to continue with the recovery, or enter an <N> and press <Enter> to terminate the process.

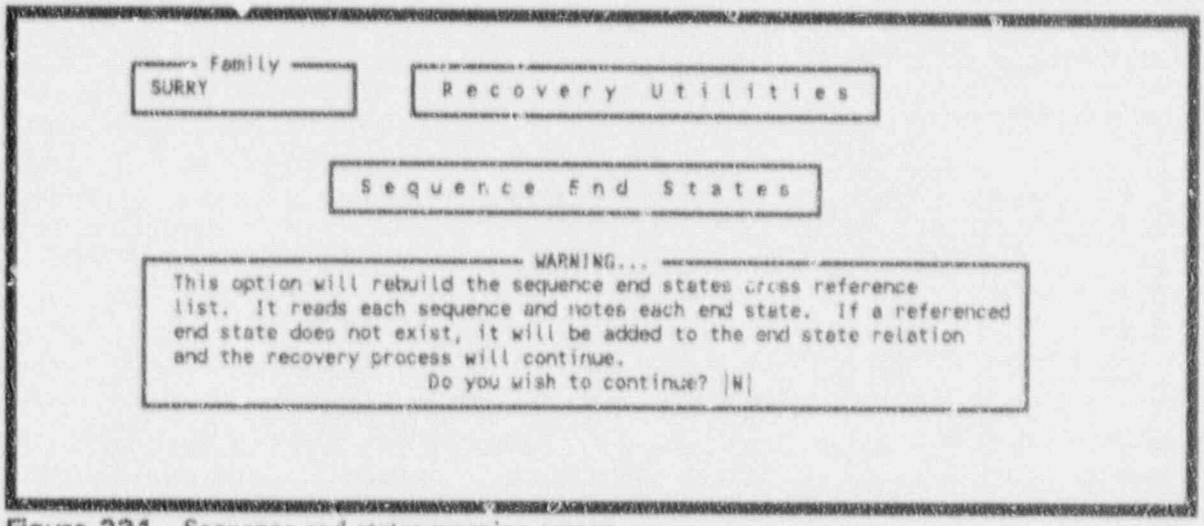


Figure 231. Sequence end states warning screen.

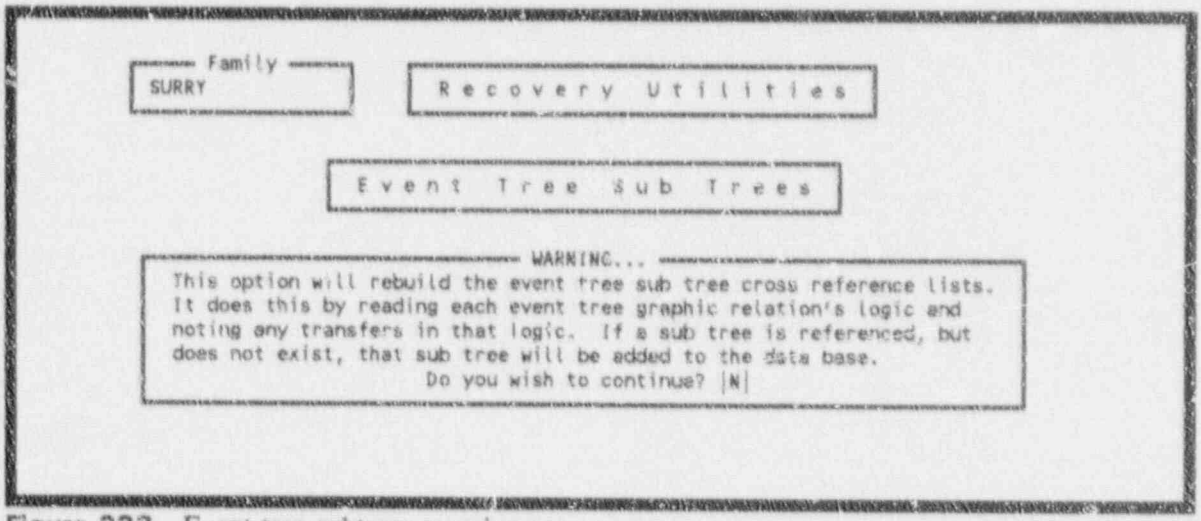


Figure 232. Event tree subtrees warning screen.

9. BIBLIOGRAPHY

1. M. F. Bohn et al., *Approach to Uncertainty Analysis in Probabilistic Risk Assessment*, NUREG/CR-4836, Sandia National Laboratory, January 1988.

2. G. C. Corynen, *A Fast Bottom up Algorithm for Computing the Cutsets of Non-Coherent Fault Trees*, NUREG/CR-5242, October 1988.

3. J. B. Fussell, "How to Hand Calculate System Reliability and Safety Characteristics," *IEEE Transactions on Reliability*, August 1975, R-24.

4. E. J. McGrath and D. C. Irving, "Variance Reduction," *Techniques for Efficient Monte Carlo Simulation, III*, ORNL/RSIC-38, April 1975.

5. K. D. Russell, *Integrated Reliability and Risk Analysis System (IRRAS) Version 4.0, Volume 1 - Reference Manual*, NUREG/CR-5813, EGG-2664, January 1992.

6. D. W. Stack, *A SETS User's Manual for the Fault Tree Analyst*, NUREG/CR-0465, SAND77-2051, November 1978.

7. W. E. Vesely et al, *Fault Tree Handbook*, NUREG-0492, January 1981.

APPENDIX A

HARDWARE REQUIREMENTS AND INSTALLATION PROCEDURE

APPENDIX A

HARDWARE REQUIREMENTS AND INSTALLATION PROCEDURE

The SARA 4.0 system requires the following hardware configurations:

IBM-PC/XT/AT PS2 or 100% compatible 640K main memory
DOS 3.3 or later
20M hard disk (minimum)
Math co-processor (optional)
16 color enhanced monitor (EGA or better)
graphics input devices - keyboard or mouse.

If an enhanced graphics adapter is used, it must have the memory expansion option to extend the standard 4 colors to 16. This option is an upgrade to the IBM EGA board, but is usually standard on boards manufactured by other vendors. SARA 4.0 does not support the 4-color mode on the EGA adapter.

The recommended configuration contains a VGA color monitor and adapter, a mouse as the graphics input device, and a math co-processor. The keyboard can serve as the graphics input device but is not nearly as user-friendly as the mouse. SARA will not run as fast if a math co-processor is not present.

NOTE: The SARA 4.0 system requires the above specified amount of random access memory (RAM). This memory must be available for the program and not used by memory resident programs, such as "Side-Kick". Also certain memory resident programs may interfere with the execution of SARA 4.0. These should be unloaded before using SARA 4.0. The MS/DOS command "CHKDSK" can be used to display the amount of memory available on your machine.

To install the system on your hard drive C, put the #1 diskette in drive A and type A:INSTALL C: <Enter>. For PS/2 users with an external 5 1/4" drive, use the MS/DOS Command ASSIGN to assign your external drive as the A drive. You will be prompted when you should insert the remaining disks. Be certain to insert the disks in the order specified in the installation procedure. The directories \PRADATA.B1\DEMO, and \HALO88 will be created and loaded with the appropriate software.

NOTE: You must have at least 3.0 megabytes of disk storage on your destination disk before installing SARA.

After the installation is completed, you need to locate and modify your CONFIG.SYS file. This

file is in the root directory. If you do not have a file by this name, you must create one. In either case, the following parameters must be included in the file, if not already present.

```
FILES = 30
BUFFERS = 15
DEVICE = ANSI.SYS
```

The device driver ANSI.SYS must also be copied from the DOS directory to the root directory if it is not already there.

The installation procedure will create a batch procedure, SARA.BAT, for executing SARA 4.0 in the \PRADATA.B1 directory. This procedure may be used directly or adapted to meet your specific needs. If you choose not to modify the procedure, the following format is used to execute SARA 4.0. Type:

```
CD\PRADATA.B1
SARA
```

This completes the installation of the SARA 4.0 software. The user must now insure that the proper graphics input device is hooked up and ready for use. When this is done, the SARA 4.0 system is ready for use. Refer to Section 8.2 for a discussion on defining constants for your configuration.

APPENDIX B

DATA INTERCHANGE FORMATS

B.1 MAR-D (IRRAS, SARA)

B.1.1 General Format Rules

1. All name references (family names, event names, etc.) must be upper case alphanumeric. All lower case characters will be converted to upper case. Any alpha fields that are longer than the format specified will be truncated. No spaces are allowed in the middle of names.

2. Descriptions can have both upper-case and lower-case characters. No character checking will be done. No commas are allowed in the description.

3. Commas are used as field delimiters in most formats, and can be used as placeholders for unknown fields. Any number of leading and trailing field spaces can be inserted. Exceptions to this format are detailed as needed.

4. Text rules:
    1. File is standard ASCII text, single spaced, upper and lower case.
    2. First line of paragraph is indented 5 spaces, with a blank line between paragraphs.
    3. ^EOS signals the End of Section so that multiple names in the same family can be collected in one file.

These rules apply to all files unless specifically stated otherwise.

B.1.2 Family (Plant) Information

B.1.2.1 Family Names and Descriptions.

File Name:

xxxxxx.FAD

File Format:

name,description

where

name	- 16 character	Family name (first 8 characters must be unique).
description	- 60 character	Family description

B.1.2.2 Family Attribute File.

File Name:

xxxxxx.FAA

File Format:

name,mission,newSum,co,loc,type,design,vendor,AE,OpDate,QualDate

where

name	- 16 character	Family name
mission	- Floating point	Default mission time in hours
newSum	- Floating point	New sequence frequency sum
co	- 10 character	Company name
loc	- 16 character	Location name
type	- 3 character	Facility type
design	- 10 character	Facility design
vendor	- 5 character	Vendor name
AE	- 10 character	Architectural Engineer
OpDate	- (yyyy/mm/dd)	Operational date
QualDate	- (yyyy/mm/dd)	Qualification date

B.1.2.3 Family Textual Information.

File Name:

xxxxxx.FAT

File Format:

family =

-- text --

where

family	- 16 character	Family name

B.1.3 Basic Event Information

B.1.3.1 Basic Event Names and Descriptions.

File Name:

xxxxxx.BED

File Format:

family =
name,description
. . . , . . .

where

family	- 16 character	Family name
name	- 16 character	Event name
description	- 60 character	Alphanumeric description

B.1.3.2 Basic Event Rate Information.

The basic event failure rates are stored in the Event relation. This information can also be entered through the modify option.

File Name:

xxxxxx.BEI

File Format:

family =
name, calc, udC, udT, udV, prob, lambda, tau, mission, init
. . . , . . . , ... , . . . , . . . , . . . , . . . , . . . , . . . , . . . , . . .

where

family	- 16 character	Family name
name	- 16 character	Basic event name
calc	- 1 character	Calculation type

1 - Probability
2 - Lambda * Mission Time
3 - 1 - Exp(-Lambda * Mission Time)
4 - Lambda * Min(Mission Time, Tau)
5 - Operating component with full repair
6 - Lambda * Tau / 2.0
7 - 1+(EXP(-Lambda*Tau)-1.0)/(Lambda*Tau)
8 - Base Probability * Probability
9 - Base Probability * Probability
T - Set to House Event (Failed, Prob=1.0)
F - Set to House Event (Successful,Prob=0.0)

udC - 4 characters Uncertainty correlation class
Events in same class are 100% correlated.

udT - 1 character		Uncertainty distribution type
	L	- Log normal, error factor
	N	- Normal, standard deviation
	B	- Beta, b of Beta(a,b)
	G	- Gamma, a Gamma(a)
	E	- Exponential, none
	U	- Uniform, Upper end pt.

udV	-	Floating point Uncertainty distribution value
prob	-	Floating point Probability value
lambda	-	Floating point Basic event failure rate per hr
tau	-	Floating point Time to repair in hours
mission	-	Floating point Mission time
init	-	Boolean Initiating event flag (Y/N)

General Rules:

1. The name field is mandatory.

B.1.3.3 Basic Event Attribute Codes.

Basic event attributes are entered through MODIFY--Basic Event and stored in Event.

File Name:

xxxxxx.BEA

File Format:

family =
name,Aname,type,sys,fail,loc,compID,Gname,train,att1,..,att16
. . . , . . . , . . . , . . . , . . . , . . . , . . . , . . . , . . . , . . .

where

family	- 16 character	Family name
name	- 16 character	Event name
Aname	- 16 character	Alternate event name
type	- 3 character	Event component type
sys	- 3 character	Event component system
fail	- 2 character	Failure mode
loc	- 3 character	Component location
compID	- 7 character	Component ID
Gname	- 16 character	Event group identifier
train	- 1 character	Train identifier
att1..att16	- Class attribute flags--16 values of Y or N (yes or no) indicate whether the attribute described in the class attribute file is applicable.	

General Rules:

1. The name field is mandatory.

B.1.4 Event Attribute Descriptions

B.1.4.1 Failure Mode Descriptions.

File Name:

xxxxxx.FMD

File Format:

family =
fail,description
. . . , . . .

where

family	- 16 character	Family name
fail	- 2 character	Failure mode identifier
description	- 60 character	Failure mode description

B.1.4.2 Component Type Descriptions.

File Name:

xxxxxx.CTD

File Format:

family =
comp, description
. . . , . . .

where

family	- 16 character	Family name
comp	- 3 character	Component type identifier
description	- 60 character	Component type description

B.1.4.3 System Type Descriptions.

File Name:

xxxxxx.STD

File Format:

family =
sys,description
. . . , . . .

where

family	- 16 character	Family name
sys	- 3 character	Component system identifier
description	- 60 character	System description

B.1.4.4 Location Descriptions.

File Name:

xxxxxx.LCD

File Format:

family =
loc,description
. . . , . . .

where

family	- 16 character	Family name
loc	- 3 character	Component location identifier
description	- 60 character	Component location description

B.1.4.5 Class Attribute Descriptions.

File Name:

xxxxxx.CAD

File Format:

family =
Attr#,description
. . . , . . .

where

family	- 16 character	Family name
Attr#	- Integer 1..16	Attribute number
description	- 60 character	Attribute description

B.1.5 Fault Tree Information

B.1.5.1 Fault Tree Names and Descriptions.

File Name:

xxxxxx.FTD

File Format:

family =
name,description[,s]
. . . , . . .

where

family	- 16 character	Family name
name	- 16 character	Fault tree name
description	- 60 character	Fault tree description
s	- 1 character	If included indicates fault tree is a subsystem

B.1.5.2 Fault Tree Graphics.

Fault tree graphics are stored in the block data file of the Graphics relation. The MAR-D file (.DLS) is a display list sequence for the graphics in a binary format. It is loaded and output as-is with no conversion performed.

File Name:

xxxxxx.DLS

File Format:

IRRAS 2.5/4.0 Fault Tree Graphics file (DLS format)

B.1.5.3 Fault Tree Logic.

Fault tree logic is stored in the block data file of the Graphics relation.

File Name:

xxxxxx.FTL

File Format:

family, fault tree =
* gatename1,description
gatename1 gatetype input1 input2 . . . inputn
. . . .
* gatenamen,description
gatenamen gatetype input1 input2 . . inputn
. .

where

family	- 16 character	Family name
fault tree	- 16 character	Fault tree name

gatename	- 16 character	Gate name
gatetype	- 4 character	Gate type
AND	= logical AND	
OR	= logical OR	
TBL	= table of events	
TRAN	= transfer followed by a 16-character fault tree name	
NAND	= logical NOT AND	
NOR	= logic NOT OR	
N/M	= N out of M logic gate	
CONT	= continuation of inputs to the previous gate	
input	- 16 character	inputs to the gate (event or gate names)
description	- 60 character	gate name descriptions included as comment

General Rules:

1. A gate definition cannot exceed 255 characters.
2. A line beginning with an asterisk ("*") is a comment.
3. For each gate name a comment should be included giving the gate description.

B.1.5.4 Fault Tree Cut Sets.

The fault tree cut sets are stored in the System relation in the block data file.

File Name:

xxxxx FTC

File Format:

```
family, fault tree =
eventname * eventname +
eventname * eventname * eventname *
eventname +
eventname * eventname.
^EOS
family, fault tree2 =
```

where

family	- 16 character	Family name
fault tree	- 16 character	Fault tree name
eventname	- 16 character	Event names in the cut set

General Rules:

1. An asterisk ("*") separates cut set events. Spaces are ignored.
2. A plus sign ("+") separates cut sets.
3. A period (".") denotes the end of a sequence.
4. A slash ("/") precedes complemented events.
5. Event names are a maximum of 16 characters including the "/".
6. A line beginning with an asterisk ("*") is a comment.

B.1.5.5 Fault Tree Attributes.

File Name:

xxxxx.FTA

File Format:

family =
name,level,mission,mincut,probCut,sample,seed,sizCut,sys,cuts,
events,value1,..,value9
. . . , . . . , . . . , . . . , . . . , . . . , . . . , . . . , . . . , . . . ,

where

family	- 16 character	Family name
name	- 16 character	Fault tree name
level	- Integer 2	0 = top level tree
mission	- Floating point	Mission time
mincut	- Floating point	Mincut upper bound
probCut	- Floating point	Probability cut off value
sample	- Integer 4	Sample size
seed	- Integer 8	Random number seed
sizecut	- Integer 2	Size cut off value
sys	- 3 character	System identifier
cuts	- Integer 5	Base number of cut sets
events	- Integer 5	Base number of events
value	- Floating point	Base uncertainty values

B.1.5.6 Fault Tree Textual Information.

File Name:

xxxxxx.FTT

File Format:

family, fault tree =
-- text --
^EOS
family, fault tree2 =
. . .

where

family	- 16 character	Family name
fault tree	- 16 character	Fault tree name

B.1.6 Event Tree Information

B.1.6.1 Event Tree Names and Descriptions.

File Name:

xxxxxx.ETD

File Format.

family =
name,description[,s]
. . . , . . .

where

family	- 16 character	Family name
name	- 16 character	Event tree name
description	- 60 character	Event tree description
s	- 1 character	If included indicates fault tree is a system

B.1.6.2 Event Tree Attributes.

File Name:

xxxxxx.ETA

File Format:

family =
name,init
. . . , . . .

where

family	- 16 character	Family name
name	- 16 character	Event tree name
init	- 16 character	Initiating event name

B.1.6.3 Event Tree Graphics.

The IRRAS Event Tree Graphics file (*.ETG) is a display list sequence for the graphics. Its format and contents are the same as the Event Tree Logic File.

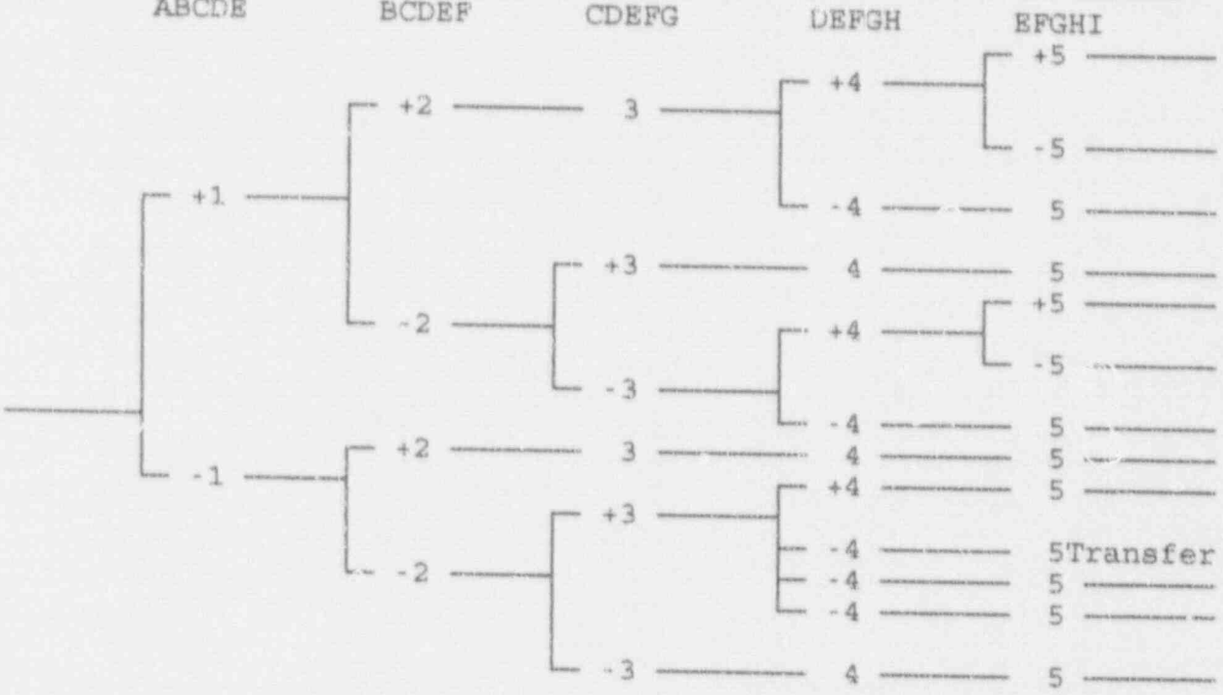
File Name:

xxxxxx.ETG

File Format:

See file format for the Event Tree Logic

SAMPLE GRAPHICAL EVENT TREE



B.1.6.4 Event Tree Logic.

File Name:

xxxxxx.ETL

File Format:

family, event tree, init event [,T] =
^TOPS
* 1 | 2 | 3 | 4 | 5 | this is a comment
ABCDE BCDEF CDEFG DEFGH EFGHI
^LOGIC

+1	+2	3	+4	+5
				-5
			-4	5
	-2	+3	4	5
		-3	+4	+5
				-5
			-4	5
-1	+2	3	4	5
	-2	+3	+4	5
			-4	5
			-4	5
			-4	5

-3 4 5

^SEQUENCES

Y/N, header#1,	Y/N, header#2,	Y/N, header#3,	Y/N,header#4
Y/N, sequence#1,	Y/N, end state#1,	Y/N, xdata1#1,	Y/N,xdata2#1
Y/N, sequence#2,	Y/N, end state#2,	Y/N, xdata1#2,	Y/N,xdata2#2
Y/N, sequence#3,	Y/N, end state#3,	Y/N, xdata1#3,	Y/N,xdata2#3
Y/N, sequence#4,	Y/N, end state#4,	Y/N, xdata1#4,	Y/N,xdata2#4
Y/N, sequence#5,	Y/N, end state#5,	Y/N, xdata1#5,	Y/N,xdata2#5
Y/N, sequence#6,	Y/N, end state#6,	Y/N, xdata1#6,	Y/N,xdata2#6
Y/N, sequence#7,	Y/N, end state#7,	Y/N, xdata1#7,	Y/N,xdata2#7
Y/N, sequence#8,	Y/N, end state#8,	Y/N, xdata1#8,	Y/N,xdata2#8
Y/N, sequence#9,	Y/N, tran file#9,	Y/N, xdata1#9,	Y/N,xdata2#9, T
Y/N, sequence#10,	Y/N, end state#10,	Y/N, xdata1#10,	Y/N,xdata2#10
Y/N, sequence#11,	Y/N, end state#11,	Y/N, xdata1#11,	Y/N,xdata2#11
Y/N, sequence#12,	Y/N, end state#12,	Y/N, xdata1#12,	Y/N,xdata2#12
Y/N, sequence#13,	Y/N, end state#13,	Y/N, xdata1#13,	Y/N,xdata2#13

^TEXT
SIZE s
JUST j
COLOR j
XY xvalue,yvalue
"60 character line of text"
XY xvalue, yvalue
"60 character line of text"
"60 character line of text"

^PARMS
START yvalue
WINDOW x1,y1,x2,y2
HEADER x1,x2,x3,x4
^EOS
family, event tree2 ==
(additional event trees)

where

family	- 16 character	Family name
event tree	- 16 character	Event tree name
init event	- 16 character	Initiating Event
[,T]	- 1 character	Optional flag indicating init event name is a Top event system
TOPS	- 16 character	Top event/system names
Y/N	- Boolean	End state text displayed?
header	- 16 character	Sequence header
sequence	- 16 character	Sequence name
endstate	- 16 character	End state name
tran file	- 16 character	Name of transfer file

xdata1	- 16 character	Information (optional)
xdata2	- 16 character	Information (optional)

General Rules:

1. A line beginning with an asterisk ("*") is a comment.
2. Literal "^TOPS", "^LOGIC", "^SEQUENCES" labels must be present.
3. Logic is built according to the position of the top event in the definition.
   Plus sign ("+")---the specified top event succeeded.
   Minus sign ("-")---the specified top event failed.
   Blank (" ")---the response of the indicated top event did not matter.
4. Header, Sequence name, End State name, Xdata1, Xdata fields associated with each sequence. "Y/N" indicates whether the specified field is visible. A "T" at the end indicates the sequence transfers to another tree.
5. User text is input following the ^TEXT command. Parameters include the size, justification, color, and location of the text block.
6. The ^PARMS command allows input of program control parameters.

B.1.6.5 Event Tree Rules.

File Name:

xxxxxxxx.ETR

File Format:

```
family, event tree =
IF  top1 top2 top3
THEN top4 = sys1,
     top5 = sys2.
IF top3 top4 top5 THEN top3 = sys4.
     . . .
^EOS
family, event tree2
```

where:

family	- 16 character	Family name
event tree	- 16 character	Event tree name
tops	- 16 character	Top event/system names

B.1.6.6 Event Tree Textual Information.

File Name:

xxxxxx.ETT

File Format:

```
family, event tree =
        -- text --
^EOS
family, event tree2 =
        -- text --
```

where

family	- 16 character	Family name
event tree	- 16 character	Event tree name

B.1.7 End State Information

Each sequence can be tied to a single plant damage state. The end state probabilities are currently entered by the user. The name and description data are loaded with the SARA *.PDS file.

B.1.7.1 End State Names and Descriptions.

File Name:

xxxxxx.ESD

File Format:

family =
name,description
. . . , . . .

where

family	- 16 character	Family name
name	- 16 character	End state name
description	- 60 character	End state description

B.1.7.2 End State Information.

File Name:

xxxxxx.ESI

File Format:

family =

********** will be defined later **********

B.1.7.3 End State Textual Information.

File Name:

xxxxxx.EST

File Format:

family, end state =
-- text --
^EOS
family, end state2 =

where

family	- 16 character	Family name
end state	- 16 character	End State name

B.1.8 Sequence Information

B.1.8.1 Sequence Names and Descriptions.

File Name:

xxxxxx.SQD

File Format:

family,eventree =
name,description
. . . , . . .
^EOS

where

family	- 16 character	Family name
eventree	- 16 character	Event tree name
name	- 16 character	Sequence name
description	- 60 character	Sequence description

B.1.8.2 Sequence Cut Sets.

The sequence cut sets are the minimal cut sets for sequence logic as derived from the fault tree logic. The cut sets are stored in the block data file of the Sequence relation.

The MAR-D sequence cut sets (.SQC) are in a format similar to that of the fault tree cut sets described in Section 5.1.5.

File Name:

xxxxxx.SQC

File Format:

family, event tree, sequence =
eventname * eventname +
eventname * eventname * eventname *
eventname +
eventname * eventname.
^EOS
family, event tree2, sequence2 =

where

family	- 16 character	Family name
event tree	- 16 character	Event tree name
sequence	- 16 character	Sequence name
eventname	- 16 character	Event names in the cut set

General Rules:

1. An asterisk ("*") separates events in a cut set. Spaces are ignored.
2. A plus sign ("+") separates cut sets.
3. A period (".") denotes the end of the sequence.
4. A slash ("/") precedes complemented events.
5. Event names have a maximum of 16 characters including the "/" character for complemented events.
6. A line beginning with an asterisk ("*") is a comment.

B.1.8.3 Sequence Attributes.

File Name:

xxxxxx.SQA

File Format:

family, event tree =
name,endstate,mincut,mission,procut,sample,seed,size,cuts,
events,value1, . . . ,value9,default flags, used flags
. . . , . . . , . . . , . . . , . . . , . . . , . . . , . . . , . . .
^EOS
family, event tree2 =

where

family	- 16 character	Family name
event tree	- 16 character	Event tree name
name	- 16 character	Sequence name
endstate	- 16 character	End State name
mincut	- Floating point	Mincut upper bound
mission	- Floating point	Mission time in hours
procut	- Floating point	Probability cut off value
sample	- Integer 4	Sample size
seed	- Integer 8	Random number seed
size	- Integer 2	Size cut off value
cuts	- Integer 5	Base number of cut sets
events	- Integer 5	Base number of events
value	- Floating point	Base uncertainty values
value1	- 5th percentile	
value2	- Median	
value3	- Mean	
value4	- 95th percentile	
value5	- Minimum sample	
value6	- Maximum sample	
value7	- Standard deviation	
value8	- Skewness	
value9	- Kurtosis	
Default flags	- Default flag set for this sequence	
Used flags	- Flag set used to generate these cut sets	

B.1.8.4 Sequence Logic.

File Name:

xxxxxxxx.SQL

File Format:

family, event tree, sequence=
sys1 sys2 /sys3 sys4

. . .

^EOS
family, event tree2, sequence2=

where

family	- 16 character	Family name
event tree	- 16 character	Event tree name
sequence	- 16 character	Sequence name
sys	- 16 character	System name

General Rules:

1. Complemented systems are prefixed with "/".

B.1.8.5 Sequence Textual Information.

File Name:

xxxxxx.SQT

File Format:

family, event tree, sequence=
--- text ---
^EOS
family, event tree2, sequence2=
--- text ---

where

family	- 16 character	Family name
sequence	- 16 character	Sequence name
event tree	- 16 character	Event tree name

B.1.9 Piping and Instrumentation Diagrams

B.1.9.1 P&ID.

The piping and instrumentation diagrams is a graphics file in binary format. It will be loaded and output as-is: no conversion will be performed.

File Name:

xxxxxx.PID

File Format:

(P&ID Editor format)

B.1.10 Gate

B.1.10.1 Gate Description.

File Name:

xxxxxx.GTD

File Format:

family=
name,description

where

family	- 16 character	Family name
name	- 16 character	Gate name
description	- 60 character	Gate description

B.1.10.2 Gate Attributes.

File Name:

xxxxxx.GTA

File Format

family=
name,attribute

where

family	- 16 character	Family name
name	- 16 character	Gate name
attribute	- 4 characters	Gate type

B.1.11 Change Sets

B.1.11.1 Change Set Description.

File Name:

xxxxxx.CSD

File Format:

family=
name,description
...,...

where

family	- 16 character	Family name
name	- 16 character	Change set name
description	- 60 character	Change set description

B.1.11.2 Change Set Information.

File Name:

xxxxxx.CSI

File Format:

family,change=
^PROBABILITY
eventname,calc,udT,prob,lambda,tau,udV,udC,mission,init
^CLASS
eventname,group,compType,compId,system,location,failMode,train,init,att1,..att16
calcType,udT,prob,lambda,tau,udV,udC,mission,init
^EOS
family,change2=

where

change	- 16 character	change set name
eventname	- 16 characters	name mask
group	- 16 characters	event group mask
compType	- 7 characters	component type mask
compId	- 3 characters	component ID mask
system	- 3 characters	system mask
location	- 3 characters	location mask
failMode	- 2 characters	failure mode mask
train	- 2 characters	train mask
init	- 1 character	initiating event (Y/N)
att1..att16	- Class attribute flats--16 values of Y or N (yes or no) indicate whether the attribute described in the class attribute file is applicable.	

calc - 1 character Calculation type

1 - Probability
2 - Lambda * Mission Time
3 - 1 - Exp(-Lambda * Mission Time)
4 - Lambda * Min(Mission Time, Tau)
5 - Operating component with full repair
6 - Lambda * Tau / 2.0
7 - 1+(EXP(-Lambda*Tau)-1.0)/(Lambda*Tau)
8 - Base Probability * Probability
9 - Base Probability ^ Probability
T - Set to House Event (Failed, Prob=1.0)
F - Set to House Event (Successful,Prob=0.0)

udT	-	1 character	Uncertainty distribution type
		L -	Log normal, error factor
		N -	Normal, standard deviation
		B -	Beta, b of Beta(a,b)
		G -	Gamma, a Gamma(a)
		E -	Exponential, none
		U -	Uniform, Upper end pt.
prob	-	Floating point Probability value	
lambda	-	Floating point Basic event failure rate per hr.	
tau	-	Floating point Time to repair in hours	
udV	-	Floating point Uncertainty distribution value	
udC	-	4 characters	Uncertainty correlation class
			Events in same class are 100% correlated.
mission	-	Floating point Mission time	
init	-	Boolean (T/F) Initiating event	

B.2 SETS

B.2.1 Sequences

B.2.1.1 Sequence Cut Sets.

File Name:

xxxxxx.DNF.

The format of the SETS output cut sets file (.DNF) is dependent upon the command issued within SETS. The factored form is

$$A * (B + C)$$

The disjunctive normal form is

$$A * B + A * C.$$

ONLY the disjunctive normal form is accepted by the MAR-D at this time.

File Format:

sequence-name =
eventName * eventName +
eventName * eventName.

where

. . . . .

General Rules:

1. An asterisk ("*") separates event names. Spaces are ignored.
2. A plus sign ("+") separates cut sets.
3. A period (".") denotes the end of a sequence.
4. An asterisk ("*") in the first column denotes a comment.

B.2.2 Fault Trees

B.2.2.1 Fault Tree Logic.

File Name:

xxxxxx.SET.

File Format:

FAULT TREE$ fault-tree-name.
COMMENT$ descriptive material $
gate-type $ gate-name. IN$ input-1, input-2, . . . , input-n.
OUT$ output-1, output-2, . . . , output-n.
event-type $event-name. OUT$ output-1, . . . , output-n.

where

fault-tree-name	- The name of the fault tree.
gate-type	- The type of gate being defined. AG = AND gate OG = OR gate EOR = Exclusive OR gate (converted to SG) EAG = Exclusive AND gate (converted to SG) SG = Special Gate
gate-name	- The name of the gate being defined (16 characters) input-n - The names of the gates or primary events that are the immediate inputs to the gate being defined (16 characters)
output-n	- The names of the gates that are the immediate outputs of the gate or primary event being defined (16 characters).
event-type	- The type of primary event being defined. BE = Basic Event CE = Conditional Event UE = Undeveloped Event DE = Developed Event EE = External Event
COMMENT$	- Defines a comment. Must follow a "," delimiter.

B.2.2.2 Fault Tree Cut Sets.

The fault tree cut sets are stored in the System relation in the block data file. The format of the cut set file (.DNF) is given above.

B.2.3 Basic Events

B.2.3.1 Basic Event Failure Rates.

File Name:

xxxxxxx.VBK.

File Format:

VALUE BLOCK$ value-block-name
prob $ name-list$
prob $ name-list$

where

prob	- point value probability estimate
name-list	- list of event names separated by commas

B.2.4 Output Reports

Output reports can be converted to other formats or loaded by the user. They are not stored intact in the database. The cut sets are stripped from the listing file (.LIS) and stored in the Sequence relation. A variable occurrence table is written to file "sequence-name.VOT" in the family directory.

File Name:

xxxxxx.LIS.

File Format:

. . . Header information
EXECUTE
LDBLK (sequence name, sequence name, . . .)
. . .
COMTRMVAL (sequence name)
-- blank line --
/OMEGA means empty cut set
-- 12 blank lines --
Variable Occurrence Table--Output as is
-- 5 lines to cut set table --
41 character leader + 1 space + basic event name

THE MAXIMUM TERM--ends the cut sets
. . .

General Rules:

1. A plus sign ("+") followed by a blank line separates cut sets.
2. Cut set terms can be continued on separate lines.
3. An asterisk ("*"), plus sign ("+"), or blank (" ") separates basic event names.
4. A period (".") denotes the last cut set.

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This NUREG is the reference manual for the System Analysis and Risk Assessment (SARA) System Version 4.0, a microcomputer-based system used to analyze the safety issues of a family [i.e., a power plant, a manufacturing facility, any facility on which a probabilistic risk assessment (PRA) might be performed].

The SARA data base contains PRA data for the dominant accident sequences of a family and descriptive information about the family including event trees, fault trees, and system model diagrams. The number of facility data bases that can be accessed is limited only by the amount of disk storage available. To simulate changes to family systems, SARA users change the failure rates of initiating and basic events and/or modify the structure of the cut sets that make up the event trees, fault trees, and systems. The user then evaluates the effects of these changes through the recalculation of the resultant accident sequence probabilities and importance measures. The results are displayed in tables and graphs.

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