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**Systems Analysis
Programs for
Hands-on Integrated
Reliability Evaluations
(SAPHIRE) Vol. 3
Code Reference Manual – Part A**

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Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE) Vol. 3 Code Reference Manual – Part A

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ABSTRACT

The Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE) is a software application developed for performing a complete probabilistic risk assessment (PRA) using a personal computer. SAPHIRE is funded by the U.S. Nuclear Regulatory Commission (NRC) and developed by the Idaho National Laboratory (INL). The INL's primary role in this project is that of software developer. However, the INL also plays an important role in technology transfer by interfacing and supporting SAPHIRE users comprised of a wide range of PRA practitioners from the NRC, national laboratories, the private sector, and foreign countries.

SAPHIRE can be used to model a complex system's response to initiating events, quantify associated damage outcome frequencies, and identify important contributors to this damage (Level 1 PRA) and to analyze containment performance during a severe accident and quantify radioactive releases (Level 2 PRA). It can be used for a PRA evaluating a variety of operating conditions, for example, for a nuclear reactor at full power, low power, or at shutdown conditions. Furthermore, SAPHIRE can be used to analyze both internal and external initiating events and has special features for transforming models built for internal event analysis to models for external event analysis. It can also be used in a limited manner to quantify risk in terms of release consequences to both the public and the environment (Level 3 PRA).

SAPHIRE includes a separate module called the Graphical Evaluation Module (GEM). GEM provides a highly specialized user interface with SAPHIRE that automates SAPHIRE process steps for evaluating operational events at commercial nuclear power plants. Using GEM, an analyst can estimate the risk associated with operational events in a very efficient and expeditious manner.

This reference guide will introduce the SAPHIRE Version 7.0 software. A brief discussion of the purpose and history of the software is included along with general information such as installation instructions, starting and stopping the program, and some pointers on how to get around inside the program. Next, database concepts and structure are discussed. Following that discussion are nine sections, one for each of the menu options on the SAPHIRE main menu, wherein the purpose and general capabilities for each option are furnished. Next, the capabilities and limitations of the software are provided.

FOREWORD

The U.S. Nuclear Regulatory Commission has developed the Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE) software used to perform probabilistic risk assessments (PRAs) on a personal computer. SAPHIRE enables users to supply basic event data, create and solve fault and event trees, perform uncertainty analyses, and generate reports. In that way, analysts can perform PRAs for any complex system, facility, or process.

SAPHIRE can be used to model a plant's response to initiating events, quantify core damage frequencies, and identify important contributors to core damage (Level 1 PRA). The program can also be used to evaluate containment failure and release models for severe accident conditions, given that core damage has occurred (Level 2 PRA). In so doing, the analyst could build the PRA model assuming that the reactor is initially at full power, low power, or shutdown. In addition, SAPHIRE can be used to analyze both internal and external events, and it includes special features for transforming models built for internal event analysis to models for external event analysis. It can also be used in a limited manner to quantify the frequency of release consequences (Level 3 PRA). Because this software is a very detailed technical tool, users should be familiar with PRA concepts and methods used to perform such analyses.

SAPHIRE has evolved with advances in computer technology. The versions currently in use (6 and 7) run in the Microsoft Windows® environment. A user-friendly interface, Graphical Evaluation Module (GEM), streamlines and automates selected SAPHIRE inputs and processes for performing event assessments.

SAPHIRE has also evolved with users' needs, and Versions 6 and 7 include new features and capabilities for developing and using larger, more complex models. For example, Version 7 can solve up to 2 million sequences and includes enhancements for cut set slicing, event tree rule linkage, and reporting options.

This NUREG-series report comprises seven volumes, which address SAPHIRE/GEM Versions 6 and 7. Volume 1, "Overview/Summary," gives an overview of the functions available in SAPHIRE and presents general instructions for using the software. Volume 2, "Technical Reference," discusses the theoretical background behind the SAPHIRE functions. Volume 3, "SAPHIRE Users' Manual," provides installation instructions and a step-by-step approach to using the program's features. Volume 4, "SAPHIRE Tutorial Manual," provides an example of the overall process of constructing a PRA database. Volume 5, "GEM/GEMDATA Reference Manual," discusses the use of GEM. Volume 6, "SAPHIRE Quality Assurance (QA) Manual," discusses QA methods and tests. Lastly, Volume 7, "SAPHIRE Data Loading Manual," assists the user in entering PRA data into SAPHIRE using the built-in MAR-D ASCII-text file data transfer process.

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EXECUTIVE SUMMARY

The U.S. Nuclear Regulatory Commission (NRC) has developed a powerful personal computer (PC) software application for performing probabilistic risk assessments (PRAs), called Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE). SAPHIRE capabilities for performing a PRA are summarized in this volume, and a more detailed description can be found in the individual sections of the documentation.

With the release of SAPHIRE versions 5 and 6, INL included a separate module called the Graphical Evaluation Module (GEM). GEM provides a highly specialized user interface with SAPHIRE, automating SAPHIRE process steps for evaluating operational events at commercial nuclear power plants. In particular, GEM implements many of the accident sequence precursor (ASP) program analysis methods. Using GEM, an analyst can estimate the risk associated with operational events very efficiently and expeditiously.

This SAPHIRE manual is designed to be an on-line reference guide to the program. Divided into two parts (A and B), this manual is a step-by-step approach to using the features of SAPHIRE. Introductions and installation instructions for the SAPHIRE are first presented, along with some information about the basic features of SAPHIRE. The next sections contain information about SAPHIRE data base concepts so that you can begin learning how SAPHIRE works. The sections following present a step-by-step approach to using the features of SAPHIRE. Later sections provide information about the capabilities and limitations of SAPHIRE, including some of the advanced features of SAPHIRE.

For readers who are familiar with previous versions of SAPHIRE, following are a list of some of the features that have been enhanced or are new to SAPHIRE version 7.

- Improved Graphical Editing
- Improved Fault Tree Logic Editing
- Event Tree Linking Rules
- Sequence Recovery Rules
- Fault Tree Recovery Rules
- Partition Rules

SAPHIRE automatically detects when the database schema for a project is different from the current version of the code. When SAPHIRE attempts to open a project created with an older version of the database schema, the Version Conflict dialog will appear. Once the data has been converted to version 7, this data cannot be used with older versions of SAPHIRE (IRRAS, SARA, GEM, or FEP).

Users will find that SAPHIRE has evolved with advances in computers. Previously, it was run in the DOS operating system. It consisted of a suite of modules as described in the NUREG/CR-6116, "System Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE) Version 5.0," series of volumes 1 - 8. The current versions in use, 6 and 7, run under the Windows environment. Certain modules have been integrated in the SAPHIRE environment; however, the Graphical Evaluation Module (GEM) remains a separate interface with the SAPHIRE code. GEM is a user-friendly interface that streamlines and automates select SAPHIRE inputs and processes for performing events assessments.

SAPHIRE has also evolved with users' needs. New features and capabilities have been added in Versions 6 and 7 for developing and using larger, more complex models. For example, Version 7 can solve up to 2

million sequences. In addition, enhancements have also been made in Version 7 for cut set slicing, event tree rule linkage rules, and reporting options.

To help assure the quality of new releases, SAPHIRE Versions 6 and 7 were used extensively with models created in earlier versions of SAPHIRE. The models were loaded into the current version of the software and results of the analyses were compared against SAPHIRE Version 5.0. Any discrepancies found were corrected in subsequent minor versions of the code. SAPHIRE has been validated in several ways.

ACRONYMS

BPC	bound on the probability contribution
DOD	Department of Defense
DOE	Department of Energy
GEM	Graphical Evaluation Module
HEP	human error probability
HRA	human reliability analysis
INEEL	Idaho National Engineering and Environmental Laboratory
INL	Idaho National Laboratory
IRRAS	Integrated Reliability and Risk Analysis System
NRC	Nuclear Regulatory Commission
PC	personal computer
PRA	probabilistic risk analysis
PSF	performance shaping factor
RAW	risk achievement worth
SAPHIRE	Systems Analysis Programs for Hands-on Integrated Reliability Evaluations

Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE)

Vol. 3 Code Reference Manual – Part A

1. GETTING TO KNOW SAPHIRE

1.1 Background

The U.S. Nuclear Regulatory Commission (NRC) has developed a powerful personal computer (PC) software application for performing probabilistic risk assessments (PRAs), called Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE).

Using SAPHIRE on a PC, an analyst can perform a PRA for any complex system, facility, or process. Regarding nuclear power plants, SAPHIRE can be used to model a plant's response to initiating events, quantify associated core damage frequencies and identify important contributors to core damage (Level 1 PRA). It can also be used to evaluate containment failure and release models for severe accident conditions, given that core damage has occurred (Level 2 PRA). It can be used for a PRA assuming that the reactor is at full power, at low power, or at shutdown conditions. Furthermore, it can be used to analyze both internal and external initiating events, and it has special features for transforming models built for internal event analysis to models for external event analysis. It can also be used in a limited manner to quantify risk for release consequences to both the public and the environment (Level 3 PRA). For all of these models, SAPHIRE can evaluate the uncertainty inherent in the probabilistic models.

SAPHIRE development and maintenance has been undertaken by the Idaho National Laboratory (INL). The INL began development of a PRA software application on a PC in the mid 1980s when the enormous potential of PC applications started being recognized. The initial version, *Integrated Risk and Reliability Analysis System* (IRRAS), was released by the Idaho National Engineering Laboratory (now Idaho National Laboratory) in February 1987. IRRAS was an immediate success, because it clearly demonstrated the feasibility of performing reliability and risk assessments on a PC and because of its tremendous need (Russell 1987). Development of IRRAS continued over the following years. However, limitations to the state of the-art during those initial stages led to the development of several independent modules to complement IRRAS capabilities (Russell 1990; 1991; 1992; 1994). These modules were known as Models and Results Database (MAR-D), System Analysis and Risk Assessment (SARA), and Fault Tree, Event Tree, and Piping and Instrumentation Diagram (FEP).

IRRAS was developed primarily for performing a Level 1 PRA. It contained functions for creating event trees and fault trees, defining accident sequences and basic event failure data, solving system fault trees and accident sequence event trees, quantifying cut sets, performing sensitivity and uncertainty analyses, documenting the results, and generating reports.

MAR-D provided the means for loading and unloading PRA data from the IRRAS relational database. MAR-D used a simple ASCII data format. This format allowed interchange of data between PRAs performed with different types of software; data of PRAs performed by different codes could be converted into the data format appropriate for IRRAS, and vice-versa.

SARA provided the capability to access PRA data and results (descriptive facility information, failure data, event trees, fault trees, plant system model diagrams, and dominant accident sequences) stored in MAR-D. With SARA, a user could review and compare results of existing PRAs. It also provided the capability for performing limited sensitivity analyses. SARA was intended to provide easier access to PRA results to users that did not have the level of sophistication required to use IRRAS.

FEP provided common access to the suite of graphical editors. The fault tree and event tree editors were accessible through FEP as well as through IRRAS, whereas the piping and instrumentation diagram (P&ID) editor was only accessible through FEP. With these editors an analyst could construct from scratch as well as modify fault tree, event tree, and plant drawing graphical representations needed in a PRA.

Previous versions of SAPHIRE consisted of the suite of these modules. Taking advantage of the Windows 95 (or Windows NT) environment, all of these modules were integrated into SAPHIRE Version 6; more features were added; and the user interface was simplified.

With the release of SAPHIRE versions 5 and 6, INL included a separate module called the Graphical Evaluation Module (GEM). GEM provides a highly specialized user interface with SAPHIRE, automating SAPHIRE process steps for evaluating operational events at commercial nuclear power plants. In particular, GEM implements many of the accident sequence precursor (ASP) program analysis methods. Using GEM, an analyst can estimate the risk associated with operational events very efficiently and expeditiously.

1.2 Overall Capabilities

SAPHIRE capabilities for performing a PRA are summarized below. A more detailed description can be found in the individual sections of the documentation.

Graphical fault tree construction

Fault trees are constructed and modified with an interactive and flexible graphical editor; or with a fault tree logic editor similar to the hierarchical editor available in the Windows Explorer.

Graphical event tree construction

Event trees are constructed and modified with an interactive and extremely flexible graphical editor allowing the linkage of multiple event trees creating event trees of any size.

Rule-based fault tree linking

Accident sequences are generated using a linking module that uses a powerful set of user-defined rules to specify top event substitutions. These rules allow testing the current state of the solution process at each branch point.

Fast cut set generation

Extremely large fault trees and accident sequences are solved very quickly. SAPHIRE's solution engine is among the fastest in the industry.

Conditional truncation

Accident sequence cut sets can be generated using a "conditional truncation probability."

Fault tree flag sets

“Flag sets” are included for pruning parts of fault trees to adjust their logic to different conditions. This saves generating multiple copies of a fault tree that are slightly different from one another.

Failure data

Failure data are handled through a failure data module that includes a “template.” A template allows multiple basic events to refer back to a single “reference” basic event.

Uncertainty analysis

Both Monte Carlo and Latin Hypercube methods are available for performing uncertainty analysis. An event uncertainty “viewer” displays the cumulative distribution or probability density curve for individual basic events or groups of cut sets.

Importance measures

The traditional importance measures such as Fussell-Vesely, Risk Increase Ratio or Interval, Risk Reduction Ratio or Interval, and Birnbaum are available. However, because these measures are not suitable for all types of analyses, the NRC developed extended importance measures for passive components analysis which include cumulative Fussell-Vesely, Fussell-Vesely / Birnbaum, and group importance. These measures, including their uncertainty (via Monte Carlo methods) have been incorporated into SAPHIRE.

Cut set editor and recovery analysis tools

A rule-based editor is available for defining rules for modifying cut sets. These rules can be used to apply recovery on cut sets after an initial analysis has been performed. They can also be used to perform extensive changes to the cut set logic to incorporate new or different conditions.

Versatile cut set slice and display

A unique cut set “sort and slicer” is available to search and partition a large number of cut sets in fault trees, sequences, or end states.

Cut set path tracing

A “path tracer” is available to find the exact path through the logic that generated a particular cut set. As with other features contained within SAPHIRE, the speed of the “path tracer” is at the top of its class. This option will trace a cut set from an end state to its source in a fault tree.

Cut set comparison

A color-based cut set comparison utility is available for viewing changes between a “before and after” list of minimal cut sets.

Cut set end state partitioning

Cut sets can be partitioned into “end states” via a set of rules allowing each cut set to be assigned to a specific “end state.”

End state analysis

An “end state analysis module” provides the ability for gathering and analyzing accident sequence end states.

Fire/Flood/Seismic analysis

SAPHIRE provides a powerful set of tools for simplifying the process of performing external event analysis if an internal event PRA is available. Fault trees built for internal event analysis can be transformed into external event-specific fault trees automatically. Furthermore, locations can be clustered into zones, and location-specific event trees can be transformed into zone-specific fault trees.

User-defined analysis types

The user can define up to eight different analysis types for storing results. This is in addition to the eight fixed analysis types used by the software.

Plug-in architecture

A user-callable “plug-in” architecture allows interfacing to a customized library of probability calculation models. For example, included with SAPHIRE are plug-ins representing an alpha-factor common-cause, a multiple Greek letter common-cause, and a “supercomponent.” Also, advanced plug-in modules are available to determine corrosion rates from flow-accelerated corrosion and its corresponding impact on the pipe failure probability.

Report generation module

SAPHIRE provides a powerful report generation module. The user can create extensive reports containing any type of information he/she wishes to include. Output capability includes WordPerfect, Word, Excel, and text formats. Reports can be automatically generated to fit the NRC’s SPAR model report format.

Utility functions

SAPHIRE provides utility functions such as recovering a corrupted database, converting fault tree logic from alpha to graphics, and changing user defined constants.

Graphical export to Windows metafiles

With SAPHIRE a user can export the graphical fault trees and event trees to a Windows metafile. This allows importing the graphics into other Windows applications.

International language support

Enhancements to SAPHIRE allow for international text characters. For example, fault tree names can have a mixture of English and Russian. Consequently, logic gates or basic events with a name such as “Жзжібоњ TREE” are permissible.

Dual language support

SAPHIRE has the capability to store two names, descriptions, and text fields for each entity in a project. The user can switch the display between the primary and alternate information easily. This allows a project to contain English and another language for each entity.

On-line context sensitive help

SAPHIRE contains a help manual with over seven hundred pages of useful information.

NOTE: This document assumes the reader is familiar with PRA methods and terminology. This manual serves as an overview for the SAPHIRE software. An on-line reference manual is available with installation of the software. The on-line manual does not instruct the reader in PRA methodology, but merely serves as a reference guide for the SAPHIRE software.

Information on recent changes and enhancements may be found on the SAPHIRE web site at saphire.inl.gov.

1.3 New Features Found in Version 7

For readers who are familiar with previous versions of SAPHIRE, following are a list of some of the features that have been enhanced or are new to SAPHIRE version 7.

Improved Graphical Editing

- Zoom 100% - View and print fault trees at a uniform size.
- Undo - Roll back one or more changes to your fault tree or event tree diagram.
- Jump between event tree and fault tree diagrams - Now you can jump directly to the fault tree diagram that corresponds to a top in an event tree diagram.
- Fault tree graphics set up - Setting up a new fault tree diagram is now easier.
- Individual shape attributes - Now gates and events can be quickly be assigned unique color and font attributes, for easy visual differentiation.

Improved Fault Tree Logic Editing

- Edit and Add Fault trees, Gates, and Events - Add and edit items directly from the logic editor.

Easier project creation - Setting up a new project space is now simpler.

Dual Language Support

- Assign events, fault trees, and other objects primary and alternate names and descriptions. Then, toggle the user interface to display either the primary or the alternate names.

Event Table Viewer - Select only the event records and fields of interest, and view them at a glance, in the order of your choice.

Improved Reports

- The formatting of the reports has been updated. Output is now available in RTF, HTML, and ASCII. Additional reports are now available from the Reports menu, including change sets, flag sets, and various rule reports.

Improved Custom Reports - More complete information, including calculation summary results, is now available from this option.

Easier cross-reference reports - From the Modify option, see all references to an item in a single report.

- Fault Trees
- Basic Events
- End States

Slice Rules - Use a rule based approach to locating combinations of events in cut sets.

Advanced Rules - Continue to use SAPHIRE's original basic rules, or use a full scale programming language to develop linkage, recovery, and partition rules.

- Event Tree Linking Rules
- Sequence Recovery Rules
- Fault Tree Recovery Rules
- Partition Rules

Sensitivity Wizard - A convenient new interface for performing detailed sensitivity analysis.

Importance Measures Wizard - A convenient new interface for performing importance analysis, with added component grouping abilities.

Improved Load/Export capabilities - Load and/or extract groups of files at one time, to or from the folder of your choice.

- Extract All - Extract an entire project with one action.
- Load All - Load an entire project from any folder with one action.
- Extract All File Type - Extract a group of files that completely describe a particular type of object, with one action.

- Load All/Group - Load a group of files from any folder with one action.
- Fault Tree Logic & Related Information - Load the event and gate information directly referenced by a fault tree's logic. Maintain the paging information, too.
- Select a destination folder - Browse for file and/or folder names when you select an output destination.

Larger capacity - Now projects can contain up to 2,000,000 sequences.

Macro Script capabilities- Macro-scripts are written with keywords in a text editor and can be ran within SAPHIRE to automatically perform tedious and repetitious analysis options.

1.4 About This Manual

1.4.1 Document Organization

This manual is divided into two parts (A and B) and eight appendices. The first two sections provide an introduction to SAPHIRE, installation instructions and some information about the basic features of SAPHIRE. The third section contains information about SAPHIRE data base concepts so that you can begin learning how SAPHIRE works. The following sections present a step-by-step approach to using the features of SAPHIRE. Later sections provides information about the capabilities and limitations of SAPHIRE. The appendices cover some of the advanced features of SAPHIRE.

This manual is designed to be an on-line reference guide. Topics are generally limited to one full screen of information with links to related or more detailed information. At times, you may be able to click on a graphic figure for specific information about the area displayed. Unlike a traditional printed reference manual, you may "hop" about from link to link, therefore, there are no chapter or section numbers provided.

1.4.2 Documentation Conventions

Conventions used in this manual have been established to help you learn to use SAPHIRE quickly and easily.

- Dialog box names begin with uppercase letters and are italicized. For example, the *Fault Trees List* dialog box.
- Field names begin with uppercase letters and are italicized. For example, the *Fault Tree Mask* field.
- Key combinations joined with a plus sign indicate that you should press and hold the first key while you press the second key. Key combinations are printed in bold type. For example, **Ctrl+X**.
- Menu names, sub-menu options, and button names are printed in bold type. When discussing a particular sequence of menu options, the nomenclature:

Menu | Sub-menu Option | Button

will be used to indicate the SAPHIRE menu options and any successive sub-menu options and/or buttons. For example, **Modify | Project | Text** refers to selecting the **Modify** option from the menu and then the **Project** sub-menu option, followed by the **Text** button. The menu option may be followed by a menu option found in a pop-up menu, such as, **Fault Tree | View**. This indicates

that you should choose **Fault Tree** from the menu, select the desired fault tree(s), then right-click to invoke the pop-up menu and choose the **View** option.

- Topics will generally be arranged in the following format:

Topic Title
PURPOSE This section will contain one to two paragraphs describing the primary functions(s) of this option.
STEPS This section will list the actions needed to perform this function, often beginning with the menu bar selection. A graphic image of the dialog box or menu options may be included.  Occasionally, an instruction to "Click on the graphic above for specific information" will appear here.
Field Name – This will contain one or two sentences briefly describing the purpose of the field and/or data entry requirements. If more information is required, a <u>link</u> to another topic will be provided.
Button Name – This will contain one or two sentences briefly describing the action(s) performed as a result of choosing this button. If more information is required or another dialog box is launched, a <u>link</u> to another topic will be provided.
SEE ALSO <u>Other related topics</u> (This will provide a direct link to related topics or more detailed information.

Links in topic text and on graphic images (also known as hot-spots) are indicated when the cursor changes to . Additionally, hot-spot text is displayed in green.

- Mouse manipulation instructions are for a standard two-button mouse as follows:

Click -	The left mouse button is pressed and released.
Right-click -	The right mouse button is pressed and released.
Double-click -	The left mouse button is pressed and released two times in rapid succession.

Drag -

The left mouse button is depressed while moving the mouse to a different screen position, then the mouse button is released.

1.5 Installation

1.5.1 Software and Hardware Requirements

- Windows 98 or greater
- Pentium class IBM-PC compatible with 2-button mouse
- 50 MB free disk space (minimum for installation)

NOTE: The total disk space requirement is dependent on the number of projects you create and how large the projects are.

1.5.2 Installation Instructions

SAPHIRE can be installed from a variety of sources.

To install from SAPHIRE Web Site:

For SAPHIRE Users Group members, SAPHIRE can be installed from the Internet site, <http://saphire.inl.gov>. A password is required for access to this site.

1. Access the SAPHIRE web site at: <http://saphire.inl.gov>. Follow the instructions given on the web site to obtain the downloadable SAPHIRE program.
2. Once the executable is downloaded. Double click on the file or open the file from Windows Start Bar and click on **Run**.
3. The Setup program prompts you through the installation process. Follow the instructions on the screen.

To install from compact disk (CD):

1. Insert the CD in the disc drive.
2. From the Windows Start Bar, click Run.
3. Type d:\SETUP (replace d with the drive letter for your CD drive).
4. Choose OK.
5. The Setup program prompts you through the installation process. Follow the instructions on the screen.

1.6 Using SAPHIRE

1.6.1 Starting SAPHIRE

PURPOSE

Begin execution of the SAPHIRE code.

STEPS

1. From the Windows Start Bar, click **Programs**.
2. Select SAPHIRE for Windows.

OR

3. From the Windows NT 3.51. Program manager or Windows NT 4.0/Windows 95 desktop, double click the SAPHIRE program icon.
4. Proceed by selecting a project with which to work.

1.6.2 Exiting SAPHIRE

PURPOSE

End this session of the SAPHIRE program.

STEPS

1. Select File from the menu.
2. Select the **Exit** sub-menu option. The SAPHIRE database will be closed and the program will be terminated.

1.6.3 Using SAPHIRE for the First Time

PURPOSE

When SAPHIRE for Windows is launched for the first time after installation, the constants dialog will be displayed. This dialog allows you to provide default values desired for various functions within SAPHIRE. Most of the fields have default values provided for you. This dialog will not appear on subsequent entries into SAPHIRE.

STEPS

1. The first time you run SAPHIRE for Windows after installation, the Define Constants dialog will appear.
2. Fill in and change the information as appropriate.

Define Constants

General | Cut Set | Fault Tree | Event Tree

User Name:

Analysis type:

Display method

☐ Toolbar only
☐ Menu only
☒ Toolbar and Menu

Toolbar buttons

☐ Picture only
☐ String only
☒ Picture and String

Toolbar position

☒ Top ☐ Left
☐ Bottom ☐ Right
☐ Adjustable

☐ Use alternate names for display

Uncertainty values

Random number seed:
Sample size:

Uncertainty method

☐ Latin Hypercube
☒ Monte Carlo

Importance Measurement type

☒ Ratios ☐ Difference ☐ Uncertainty

3. When you have finished, choose the OK button.
4. The SAPHIRE window will appear and you are now ready to proceed.

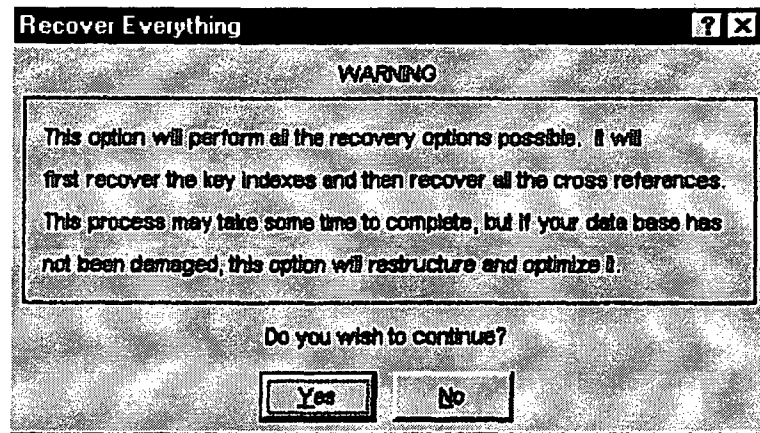
If you wish to change defaults, this dialog can be called up from the **Utility | Define Constants** option. To find out the definition for the various options and buttons, click on the question mark in the upper right corner of the dialog and then select the option in question.

1.6.4 Converting from Previous SAPHIRE (IRRAS) Versions

This section describes the procedure if you have been running a previous version of SAPHIRE (IRRAS, SARA, GEM, etc.).

SAPHIRE automatically detects when the database schema for a project is different from the current version of the code. When SAPHIRE attempts to open a project created with an older version of the database schema, the *Version Conflict* dialog will appear.

NOTE: Once the data has been converted to version 7, this data cannot be used with older versions of SAPHIRE (IRRAS, SARA, GEM, or FEP).



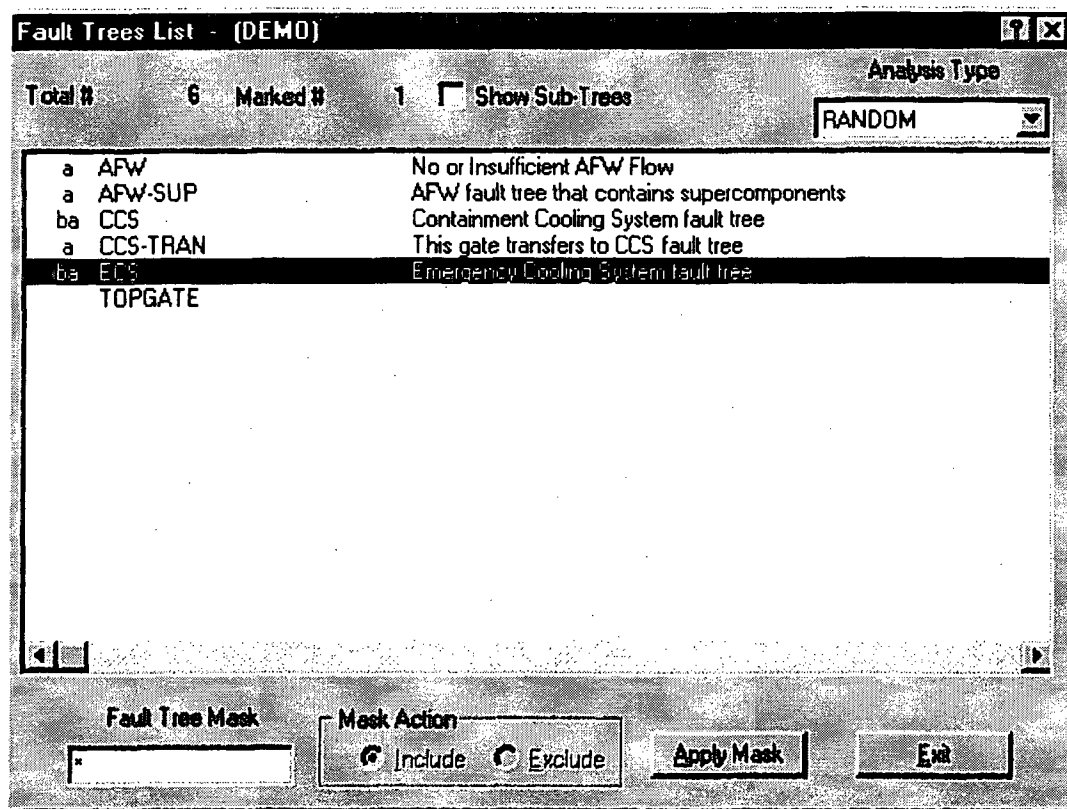
- Yes –** Convert the data for the current project to the current SAPHIRE version format. After conversion is complete, the SAPHIRE window will appear and you are now ready to proceed.
- No –** Do not convert the project data to the current SAPHIRE version format. The project will not be opened.

1.7 Getting Around Inside SAPHIRE

1.7.1 About List Boxes in SAPHIRE

Many dialogs in SAPHIRE contain list boxes. In some list boxes, multiple items can be selected for processing. The following discussion provides some hints on selecting list box items.

An item in a list box is "selected" if it is highlighted, that is, displayed in a color other than the other items in the list. The illustrations in this manual show selected list box items highlighted with a dark blue background and white foreground characters while the deselected items are displayed with a white background and black foreground characters. In the example here, the fault tree ECS is "selected."



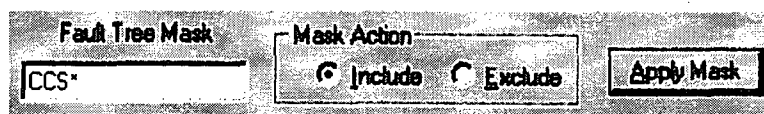
There are various ways to select items in a list:

- To select a single item, click on the desired item so that it is highlighted.
- To select multiple contiguous items, click on the first desired item in the list and drag up or down the list to the last desired item. Alternately, click the first desired item, then holding down the **Shift** key, click the last desired item.
- To select multiple non-contiguous items in the list, click several desired items while holding down the **Ctrl** (control) key.
- To select all items in the list, highlight the first item and press the **Shift** and **End** keys. Alternatively, pressing the **Ctrl** and **A** keys selects all items.

1.7.2 Selecting List Items Using the Mask Feature

PURPOSE

Some dialogs in SAPHIRE with list boxes provide a "Mask" capability which allows you to select items from the list based on matched criteria. The example here shows the *Fault Tree Mask* entry field with the *Include* radio button selected.



Generally, the mask is applied to the name of the item (e.g., Fault tree name or Event Tree name). The wildcard characters asterisk (*) and question mark (?) can be used in the mask. The asterisk represents one or more characters that a group has in common. The question mark represents a single character in that position of the string that a group has in common.

To use the mask capability, a dialog with a *mask entry field* must be active.

STEPS

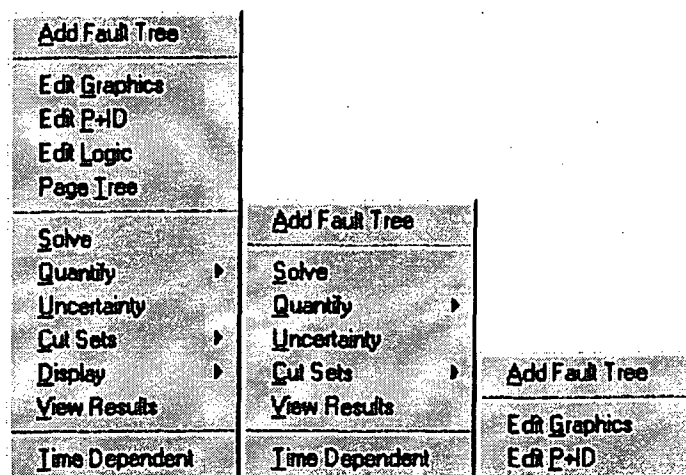
1. With an appropriate dialog active, in the mask entry field type the common characters of the names you wish to match including any wildcard characters, if desired.
2. In the Mask Action section, choose either the Include or Exclude radio button, depending on whether you want these items included in the selection or excluded from it.
3. Choose the **Apply Mask** button. All list items with names matching your mask will be selected or deselected.

You are now ready to perform any of the available functions on the active dialog.

1.7.3 Invoking Pop-up Menus

Many dialogs in SAPHIRE have pop-up menus available. Once the dialog has been called up, invoke the pop-up menu by right-clicking. While holding down the right-hand side mouse button, select the desired menu option by highlighting it and then releasing the mouse button. Pop-up menus from any one dialog may vary, especially if the dialog contains a multiple-select list box. The options in a pop-up menu may be dependent upon whether or not, or how many, items are selected.

The examples below show the *Fault Trees List* dialog pop-up menus with one list item selected, more than one list item selected, and no list items selected:

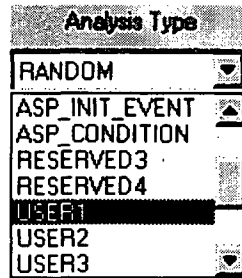


1.7.4 Selecting the Analysis Type

Many dialogs in SAPHIRE have an Analysis Type drop-down list. This drop-down list allows you to select from eight pre-defined and eight user-defined analysis types.

Select an analysis type by clicking on the down arrow on the right-hand side of the list and scrolling through the list until the desired analysis type is displayed. Then click on the desired analysis type. In the

example here, *Random* is the current analysis type. The list has been scrolled about halfway down and the *User1* analysis type is currently highlighted.



By selecting one of the analysis types from the drop-down list, you indicate the type of analysis to be performed on the selected fault tree(s), sequence(s) or end state(s). See the section, Analysis Types, for more information.

1.7.5 SAPHIRE Help

Included with the SAPHIRE installation is an on-line hypertext help system containing a complete reference to SAPHIRE. The help system can be accessed via the Help option from the menu or through context-sensitive help on each dialog.

Context-sensitive help provides information about the selected control on the active dialog box. It is accessed by choosing the **Help** button () located in the upper right-hand corner of the dialog.

In addition to the context-sensitive help, Tool Tips help is available on each dialog. To access Tool Tips, position the cursor over a control on the active dialog. A small box will appear containing a brief description about that control.

1.7.6 Toolbars

1.7.6.1 SAPHIRE Toolbars

The SAPHIRE toolbar provides single-click access to the common SAPHIRE functions.

Depending on what function is currently selected, the toolbar will change to reflect available options. When the current dialog contains a multiple-select list box, some of the toolbar options may be disabled, depending on the number of list items selected. During processing, such as cut set generation, only the **Help** button is available.

Main toolbar buttons

	Exit the SAPHIRE program.		Display the <i>Sequences</i> dialog . Recalculate sequence values after event failure data and/or cut sets have been modified.
	Create a new SAPHIRE project.		Display the <i>End State List</i> dialog . Recalculate end state values after events and/or cut sets have been modified.
	Open an existing SAPHIRE project.		Activate the <i>Modify Database</i> toolbar. Modify SAPHIRE database files (e.g., project, event tree, basic event, etc.)
	Generate change set data.		Display the <i>Reports Menu</i> dialog. Generate reports containing information about the current project.
	Display the <i>Fault Trees</i> dialog . Build, edit and analyze fault tree models		Activate the <i>Utilities</i> toolbar. Define constants, recover the database, and MAR D data exchange.
	Display the <i>Event Tree</i> dialog . Graphically build and edit event trees and edit sequence logic		Access the on-line hypertext help system.

The toolbar can be displayed or hidden by selecting the desired display method on the Define Constants dialog. Toolbar buttons can also be configured to display the bitmap (picture), text, or both.

1.7.6.2 Fault Tree Toolbar

The *Fault Tree* toolbar provides single-click access to the most common SAPHIRE fault tree options. This toolbar becomes active when the *Fault Trees List* dialog is displayed.

Depending the number of fault trees currently selected in the list, the toolbar will change to reflect available options. During processing, such as cut set generation, only the **Help** button is available.

Fault tree toolbar buttons

	Close the <i>Fault Trees List</i> dialog and return to the main toolbar.		Generate cut sets for a fault tree based on cut set generation cut off values.
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	Add a new fault tree record to the database.		Calculate a new minimum cut set upper bound for fault tree cut sets.
	Construct a new or modify the selected graphical fault tree.		Perform uncertainty analysis on a fault tree.
	Construct a new or modify a graphical P&ID (Piping and Instrumentation Diagram).		Activate the <i>Cut Set Options</i> toolbar. Perform various operations on cut sets: Update, Prune, Recover, Edit.
	Modify fault tree logic in an alphanumeric format.		Activate the <i>Display Options</i> toolbar. Display the results of fault tree analyses.
	Organize the fault tree logic into pages		View fault tree analysis information and compare base case and current case cut set results.
			Access the on-line hypertext help system.

The toolbar can be displayed or hidden by selecting the desired display method on the Define Constants dialog. Toolbar buttons can also be configured to display the bitmap (picture), text, or both.

1.7.6.3 Event Tree Toolbar

The *Event Tree* toolbar provides single-click access to the most common SAPHIRE event tree options. This toolbar becomes active when the *Event Tree List* dialog is displayed

Depending the number of event trees currently selected in the list, the toolbar will change to reflect available options. During processing, such as sequence logic generation, only the **Help** button is available.

Event tree toolbar buttons

	Close the <i>Event Tree List</i> dialog and return to the main toolbar.		Edit event tree partition rules.
	Add a new event tree record to the database.		Link event tree sequences (i.e., generate sequence logic).
	Construct a new or modify the selected graphical event tree.		Edit event tree end states.
	Edit event tree linkage rules.		Access the on-line hypertext help system.

The toolbar can be displayed or hidden by selecting the desired display method on the Define Constants dialog. Toolbar buttons can also be configured to display the bitmap (picture), text, or both.

1.7.6.4 Sequence Toolbar

The *Sequence* toolbar provides single-click access to the most common SAPHIRE sequence options. This toolbar becomes active when the *Sequences* dialog is displayed.

Depending on the number of sequences currently selected in the list, the toolbar will change to reflect available options. During processing, such as cut set generation, only the **Help** button is available.

Sequence toolbar buttons

	Close the <i>Sequences</i> dialog and return to the main toolbar.		Activate the <i>Cut Set Options</i> toolbar. Perform various operations on cut sets: Update, Prune, Recover, Edit.
	Generate cut sets for a sequence based on cut set generation cut off values.		Activate the <i>Display Options</i> toolbar. Display the results of sequence analyses.
	Calculate a new minimum cut set upper bound for sequence cut sets.		View sequence analysis information and compare base case and current case cut set results.
	Perform uncertainty analysis on selected the sequence(s).		Access the on-line hypertext help system.

The toolbar can be displayed or hidden by selecting the desired display method on the Define Constants dialog. Toolbar buttons can also be configured to display the bitmap (picture), text, or both.

1.7.6.5 End State Toolbar

The *End State* toolbar provides single-click access to the most common SAPHIRE end state options. This toolbar becomes active when the *End State List* dialog is displayed.

Depending on the number of end states currently selected in the list, the toolbar will change to reflect available options. During processing, such as cut set gathering, only the **Help** button is available.

End State toolbar buttons

	Close the <i>End State List</i> dialog and return to the main toolbar.		Edit the current case end state cut sets.
	Gather cut sets for an end state based on cut set generation cut off values.		Edit the base case end state cut sets.
	Calculate a new minimum cut set upper bound for end state cut sets.		Activate the <i>Display Options</i> toolbar. Display the results of end state analyses.
	Perform uncertainty analysis on selected the end state(s).		View end state analysis information and compare base case and current case cut set results.
	Update the current case cut sets for a selected fault tree.		Access the on-line hypertext help system.

The toolbar can be displayed or hidden by selecting the desired display method on the Define Constants dialog. Toolbar buttons can also be configured to display the bitmap (picture), text, or both.

1.7.6.6 Cut Set Toolbar

The *Cut Set* toolbar provides single-click access to the most common SAPHIRE Cut Set options. This toolbar becomes active when the either the *Fault Trees List* dialog or *Sequences* dialog is displayed and the *Cut Set* toolbar button is subsequently selected.

Fault tree cut set toolbar buttons

	Return to the <i>Fault Tree</i> toolbar.		Create and modify project recovery rules.
	Update the current case cut sets for a selected fault tree.		Edit the current case fault tree cut sets.
	Create and modify recovery rules for a selected fault tree.		Edit the base case fault tree cut sets.
	Apply all rules currently defined to the selected fault tree(s).		Access the on-line hypertext help system.

Sequence cut set toolbar buttons

	Return to the <i>Sequence</i> toolbar.		Define cut set partitioning rules for individual event trees.
	Update the current case cut sets for a selected sequence.		Apply the currently defined partition rules to the selected sequence(s) .
	Create and modify recovery rules for a selected sequence.		Clear the sequences created by the partitioning rule.
	Create and modify event tree recovery rules.		Edit the current case sequence cut sets.
	Apply all rules currently defined to the selected sequences.		Edit the base case sequence cut sets.
	Define cut set partitioning rules for individual sequences.		Access the on-line hypertext help system.

The toolbar can be displayed or hidden by selecting the desired display method on the Define Constants dialog. Toolbar buttons can also be configured to display the bitmap (picture), text, or both.

1.7.6.7 Display Options Toolbar

The *Display Options* toolbar provides single-click access to the most common SAPHIRE Display options. This toolbar becomes active when the either the *Fault Trees List*, or *Sequences* dialog is displayed and the *Display Options* toolbar button is subsequently selected.

Display options toolbar buttons

	Return to the previous toolbar.		Difference - Birnbaum importance, Risk Reduction Interval, and Risk Increase Interval will be calculated.
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	Display the cut sets, their percent of contribution, the frequency, and the event names that make up the cut sets.		Uncertainty Importance - Quantification of the contribution of each individual basic event's uncertainty to the total uncertainty.
	Display the base and current cut sets, their percent of contribution, the frequency, and the event names that make up the cut sets.		Display uncertainty analysis results.
	Ratio - Fussell-Vesely importance, Risk Reduction Ratio, and Risk Increase Ratio will be calculated.		Access the on-line hypertext help system.

The toolbar can be displayed or hidden by selecting the desired display method on the Define Constants dialog. Toolbar buttons can also be configured to display the picture, text, or both.

1.7.6.8 *Modify Database Toolbar*

The *Modify Database* toolbar provides access to the SAPHIRE modify database functions.

Modify Database toolbar buttons

	Return to the main toolbar.		Modify analysis type records.
	Modify the project record.		Modify gate records.
	Add, modify, copy, or delete event tree data records, or associated text.		Modify histogram records.
	Add, modify or delete fault tree data records, or associated text.		Modify Piping and Instrumentation Diagram (P&ID) records.
	Add, modify or delete the end state data records, or associated text.		Modify change set records.
	Add, modify or delete the basic event data records.		Modify flag set records.
	Activate the <i>Modify Attributes</i> toolbar. Edit records of the five attribute types in the current project: Systems, Locations, Failure Modes, Basic Event Types, and Trains.		Access the on-line hypertext help system.

Modify Attributes toolbar buttons

	Return to the main toolbar.		Modify basic event type attribute records.
	Modify system attribute type records.		Modify train attribute type records.
	Modify location attribute type records.		Access the on-line hypertext help system.

	Modify failure mode attribute type records.		
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The toolbar can be displayed or hidden by selecting the desired display method on the Define Constants dialog. Toolbar buttons can also be configured to display the picture, text, or both.

1.7.6.9 Utility Toolbar

The *Utilities* toolbar provides access to the most common SAPHIRE utility functions.

	Return to the main toolbar.		Extract fault trees from the database.
	Invoke the <i>Define Constants</i> dialog to specify general information, cut set option defaults, and default values for the graphical editors.		Load fault tree graphic files into the database.
	Load or extract data in the Models and Results Data Base (MAR D) or Set Equation Transformation System (SETS) formats.		Extract event trees from the database.
	Restructure the database and re index the data		Load event tree graphic files into the database.
	Convert fault tree or sub-tree alphanumeric logic to a graphical format.		Access the on-line hypertext help system.

The toolbar can be displayed or hidden by selecting the desired display method on the Define Constants dialog. Toolbar buttons can also be configured to display the picture), text, or both.

1.8 User Support

Training classes for NRC users, which provide instruction in the use of SAPHIRE, are supplied through the INEEL. Contact the NRC Program Manager for training information. Additional information about SAPHIRE training can be found on the SAPHIRE web site at: <http://saphire.inel.gov>. The SAPHIRE Users Group is designed to provide quality technical support for the SAPHIRE software along with regular updates and technical information.

1.9 SAPHIRE Quality Assurance

Software quality assurance comprises a variety of tasks. All of the methodologies applied to SAPHIRE to ensure software quality will not be covered in this document. This section will discuss the beta test activity performed prior to release of the current version of the software, the Validation and Verification (V&V) effort completed on SAPHIRE 5.0, and automated code testing techniques used to ensure quality software.

To help assure the quality of new releases, SAPHIRE Versions 6 and 7 were used extensively with models created in earlier versions of SAPHIRE. The models were loaded into the current version of the software and results of the analyses were compared against SAPHIRE Version 5.0. Any discrepancies

found were corrected in subsequent minor versions of the code. SAPHIRE has been validated in several ways. The following summarize these validation processes.

The Beta Version Process

Each new SAPHIRE version is beta tested before its release. The beta testers are analysts experienced with PRA methods and terminology, and typically are familiar with earlier versions of SAPHIRE and IRRAS. The primary objective of the beta testing is to verify that the results produced by the new version are correct. The secondary objective is to ensure that the software is user-friendly and functional. Based on feedback from beta testers, programmatic errors and discrepancies are corrected, the user interface is improved, and new features are recommended.

SAPHIRE V&V

A V&V of SAPHIRE 5.0 in the traditional sense was performed in 1995 and documented in NUREG/CR-6116, Volume 9, *Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE) Version 5.0, Verification and Validation (V&V) Manual*, 1995.

PRA Loading and Result Comparison

Because INEEL is continually loading new PRAs into SAPHIRE, new SAPHIRE releases are tested extensively by comparing with PRA models and results of earlier versions and especially with PRAs loaded in SAPHIRE Version 5.0. About thirty PRAs have been (completely or partially) loaded in SAPHIRE. The loading process requires a detailed comparison of the models and results with the models and results of the original PRAs. Identified discrepancies are resolved through the interaction with the analysts who performed the PRA.

Automated Code Testing

Because of advances in the state-of-the-art of computer science, an automated testing process has been established during 1998. This automated testing tool allows the test engineers to develop and maintain scripts for selected critical functions of the software. Prior to each release, these scripts are run against the SAPHIRE software on a number of machines with varying configurations. The test results are automatically compared and any discrepancies are resolved. The automated testing process has been used for the Windows Versions 6 and 7 of SAPHIRE.

2. DATABASE STRUCTURE AND CONCEPTS

2.1 Database Concepts

Before you can use SAPHIRE effectively, you need to have an understanding of the SAPHIRE 7.0 database structure and concepts. A relational database is used to manage inputs and outputs. SAPHIRE contains nine permanent relations, or tables, used to store and retrieve specific PRA information. For each relation, three files exist:

- *.DAT - This file contains the actual data and information about which data constitutes a “key.” The key is used for searching and locating information.
- *.IDX - This file contains indices into the data for keyed fields.
- *.BLK - This file contains variable length data (such as cut sets) that are accessible through pointers contained in the *.DAT file.

The SAPHIRE 7.0 database is divided into *projects*. Information for the project is divided into two separate parts, referred to as base case and current case. As delivered, SAPHIRE provides an initial project called DEMO. Access to any portion of the database is obtained through the appropriate project. Normally, a user will need to create a project for each PRA being performed. All the information in a project is stored together in a folder (or subdirectory).

NOTE: Only one project may be stored in an individual folder.

The following describes the steps a user would ordinarily take in order to perform a new PRA analysis using SAPHIRE. Certain information records are automatically added to the database depending on the functions performed by the user. Links are provided for detailed information about how the relations are used in each step:

1. Create a new project where the results of the PRA can be stored. Once the “Project” is created, the user is ready to add information to the database.
2. Adjust the program operating constants (via the **Utility | Define Constants** option).
3. Create the event trees for the Project.
4. Create the fault trees.
5. Enter the failure data for each basic event in the database.
6. Generate the sequence entries for each valid sequence in the event trees.
7. Perform analysis, varying failure data using change sets.

2.2 Database Structure

2.2.1 Project Relation

A *project* is any logical grouping of fault trees and sequences with their associated basic events, cut sets, reliability data, and descriptions. Each project is contained within a separate folder.

Information about the project is stored in the Project relation. The Project relation contains general information about the PRA. Along with the project name, description, plant design, etc., it also contains cross reference information for relationships between basic events, fault tree, sequence, event tree, end state, change sets, and gate in the project. The cross reference maps are updated automatically each time one of these pieces of data is modified. The Project relation also contains the project sequence partition, and project sequence, fault tree, and end state recovery information along with the macro text.

2.2.2 Fault Tree Relation

The Fault Tree editor is used to create fault trees for the project. SAPHIRE creates an entry in the Fault Tree relation for each fault tree created. SAPHIRE requires that certain conventions be used for naming fault trees. To use a fault tree as a top event in an event tree, or reference it in a sequence, the name of the fault tree must be specified in a special manner. The name of the fault tree and the name of the top gate in the fault tree must be the same. Also, the name of the top event in the event tree and the fault tree name must be the same.

SAPHIRE adds all the basic event references in the fault tree to the Event relation. If a description is provided for a basic event, then this description is also added to the database. All other information for the basic event is left unchanged or set to its default values.

SAPHIRE also creates an entry in the Gate relation for each gate defined in the fault tree. The name, type, and description of each gate contained in the fault tree is stored in the database. This information can be edited. However, the changes are only reflected in the graphical fault trees if the user performs an "alpha to graphics" conversion on the fault trees that use the gate.

Finally, SAPHIRE creates an entry in the Event relation for each transfer gate defined in the fault tree. This is done to allow the user to specify whether a transfer gate is to be expanded or whether the basic event representing the transfer gate is to be used.

This relation maintains data for the following fault tree attributes:

- Fault tree name and description,
- Fault tree logic,
- Graphic representation,
- Minimal cut sets,
- Top event probability,
- Default flag set,

- Default quantification method,
- Recovery rules,
- Importance measures, and
- Uncertainty analysis results.

2.2.3 Sequence Relation

The Sequence relation contains information about the sequences for an event tree. The user normally generates the sequence entries using the **Link Trees** option. When the user selects this option, SAPHIRE generates a sequence entry for each valid sequence in the event tree. Any sequences that may have been generated previously for this same event tree are automatically overwritten with the new valid sequence.

Each sequence contains an end state name that is created in the End State relation if it does not already exist. Changing the name of an end state in a sequence only changes the name for that specific sequence and does not change the information in the End State relation or the event tree for that sequence. When a sequence is solved, the cut sets generated are stored in the Sequence relation.

This relation maintains data for the following accident sequence attributes:

- Name and description,
- Logic (combination of successful and failed fault trees),
- Minimal cut sets,
- Sequence probability,
- Default flag set,
- Default quantification method,
- Sequence end state,
- Associated event tree,
- Partition and recovery rules,
- Importance measures, and
- Uncertainty analysis results.

2.2.4 Event Tree Relation

The Event Tree editor is used to generate the event trees for the project. When the user creates event trees using the Event Tree editor, SAPHIRE automatically adds certain information to the database.

When the event tree is saved, an entry is created in the Event Tree relation that contains the graphical information associated with the event tree. If the event tree contains an initiating event as the first top event in the tree, then entries are automatically created in the Event Tree relation. Entries include the name of the event tree, the initiating event for the event tree, and other descriptive data.

Next, SAPHIRE creates an entry in the Fault Tree relation for each top event defined in the event tree. By default, SAPHIRE assumes that each top event is represented by a fault tree with the same name. At the time the fault tree entry is created, SAPHIRE also creates a basic event in the Event relation with the same name as the fault tree. This event is used when the fault tree logic is not expanded during fault tree analysis or when the logic has not yet been developed.

The Event Tree relation maintains data for the following event tree attributes:

- Event tree name and description,
- Event tree logic and graphic representation,
- Initiating event, and
- Event tree macro, recovery and partition rules

2.2.5 Event Relation

Once the fault trees are defined, the user will need to enter the failure data for each basic event in the database. This can be done with either the **Modify** option or with the **Generate** option and **Base Case Update** options.

If the **Modify** option is used to change the default failure data, then the user must be sure to use the **Generate** option to generate the current failure data to be used in the remainder of the analysis. Any time changes are made to the basic event failure data, the user **MUST** use the **Generate** option before the changes can be used. If it appears that changes made to basic event failure data are not being used properly by SAPHIRE, the user should check to ensure that the proper data were generated and saved.

The Event relation maintains data for the following basic event attributes:

- Basic event names and description,
- Event attributes,
- Transformation information,
- Uncertainty information,
- Failure data, and
- Process flag.

2.2.6 Change Set Relation

The Change Set relation stores the name, description and event changes for change sets and flag sets created for this project. This information can be edited from the **Modify** option, or for change sets, from the **Generate** option.

This relation is maintained to track event changes relating to event class and event probability.

2.2.7 UserInfo Relation

The User Information relation contains basic operating constants for SAPHIRE. The user may change these constants to reflect the desired defaults to be used. These data are unrelated to trees and/or projects. Information stored includes cut set generation cut off values, event tree and fault tree graphical editor preferences, and menu and toolbar defaults.

2.3 SAPHIRE Database Concepts

2.3.1 Unpredictable Results

The information stored in the SAPHIRE database is buffered in and out of memory during processing. When the information is modified, SAPHIRE may not write the information out to the hard disk immediately. If the user does not exit SAPHIRE normally by using the **File | Exit** option from the main menu, then the information that was changed may be lost. **The user should always exit SAPHIRE before turning off or rebooting the computer.**

If a power failure or abnormal program abort occurs, the user should enter SAPHIRE, select the **Utility** option, and from that select the **Recover Data Base** option. The user should then rebuild everything in the database before continuing to use the program on this data. Failure to do this may cause unpredictable results.

If a database is generating results that the user cannot explain, the database project in question should be rebuilt and the results checked again. If the results still cannot be explained, then a bug may be causing the error and should be reported immediately.

2.3.2 Cross Reference Maps

As the user adds information to the SAPHIRE database, a cross reference map is maintained for each basic event, change set, sequence, fault tree, and event tree in the database. This map is updated automatically each time one of the specified pieces of information is added or changed.

When the user decides to delete a piece of information from the database, SAPHIRE checks these cross reference maps to ensure the piece of information being deleted is not used anywhere in the database. If it is used, SAPHIRE will not allow the information to be deleted until those records referencing it are changed or deleted. For instance, if a basic event is to be deleted, the user must ensure that the event is not used by a fault tree logic, fault tree cut sets (base or current), event tree logic, sequence logic, or sequence cut sets (base or current). In the **Modify** option, SAPHIRE will display a "-" character in front of any event which it determines is not used by anything in the database.

2.3.3 Base Case Vs. Current Case Data

Base case and current case refer to two separate parts of a *project* data base. The base case data are stored in the data base files as a “permanent” record. The current case data, sometimes referred to as the alternate case, are used to perform an analysis (e.g., cut set generation and quantification).

All SAPHIRE calculations (e.g., cut set generation and sensitivity analysis) use the data stored in the current case. The current case is created by applying change sets to base case data (via the **Generate** option).

NOTE: The current case results are overwritten each time a specific analysis is performed. The base case results do not change each time an analysis is performed.

Current case data can equal the base case in order to reproduce the original study stored in the base case, however, only current case cut sets can be modified with the cut set editor. Changes made to cut sets with the cut set editor are implemented automatically. A cut set update is necessary if changes are made that create non-minimal cut sets.

Base case data and results are changed by updating the base case . Updating the base case transfers the current case data or results into the base case.

2.3.4 Change Sets Vs. Flag Sets

Change sets are a user-defined set of changes that will be applied to the base case data when event data is transferred to the current case. There is no limit to the number of change sets that can be added to the data base. A change set can contain one class change and unlimited individual probability changes, also referred to as “single” changes.

Class changes use a basic event attribute to search for a class of basic events to which the defined change applies:

- The search criteria are defined first
- The change to be applied is then defined

Probability, or single changes only modify a user-identified basic event

- The desired basic event is selected
- The changes to the basic event are then defined

Multiple change sets can be defined and applied singly or in combination to create different sensitivity studies. When multiple change sets are used in combination, the order of “marking” a change set is important. (Change sets are marked by double-clicking the line containing the change set.)

- The first selected change set will be the first one that is applied
- Later changes will overwrite earlier ones if there is any overlap
- Within a change set, individual probability changes will overwrite a class change

EXAMPLE: Two change sets are developed. The first is named "A" and sets all valves to failed. The second is named "B" and sets all pumps to failed. The possible scenarios are

Change set(s) that are marked	Sensitivity case
None	Original base case analysis
A	Valves failed
B	Pumps failed
A and B	Both valves and pumps failed

Flag sets are a special type of change set used to indicate modifications to particular events on a sequence-by-sequence basis. They are different from change sets in that they can only contain individually-specified types of changes. No "Class Changes" are allowed in a flag set.

Flag Sets can only contain either house flag changes to the calculation type or process type changes. You can not make changes to the probability of failure (e.g., change the probability from 2E-3 to 1E-1) for events in a Flag Set. Consequently, the allowable changes that can be made in a Flag Set are:

Type of change	Allowable values
Calculation type	T (TRUE) F (FALSE) I (IGNORE)
Process Flag	X Y W I

3. SELECTING A PROJECT

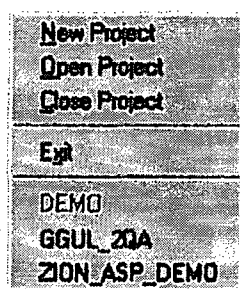
3.1 Managing Project Data

PURPOSE

A project is a group of models, such as those for a single plant, unit, or facility. When SAPHIRE is invoked, the most recent project used is automatically opened. From the **File** menu option, the ability to create a new project, open an existing project, or close the current project is available.

STEPS

1. From the SAPHIRE menu select **File**.
2. The drop-down menu with available items will be displayed.



A list of recently used projects is displayed on the **File** menu. By selecting one of the projects, the current project is automatically closed and the selected project will be opened.

- New Project** - Closes the current project and creates a new one.
- Open Project** - Closes the current project and opens an existing one.
- Close Project** - Closes the current project.
- Exit** - Closes the current project and terminates the SAPHIRE program.

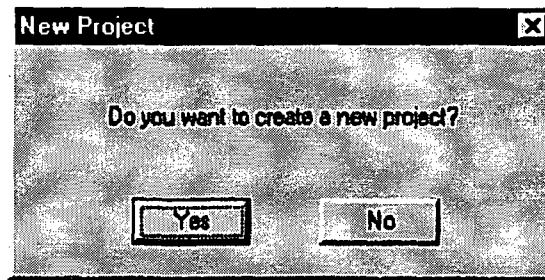
3.2 New Project

PURPOSE

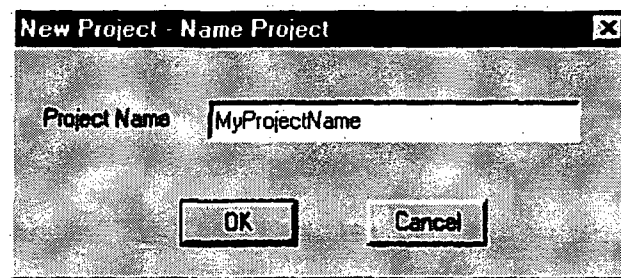
This option provides the means of creating a new project. The new project you are creating must reside in its own folder (i.e., a single folder cannot contain more than ".SRA" file).

STEPS

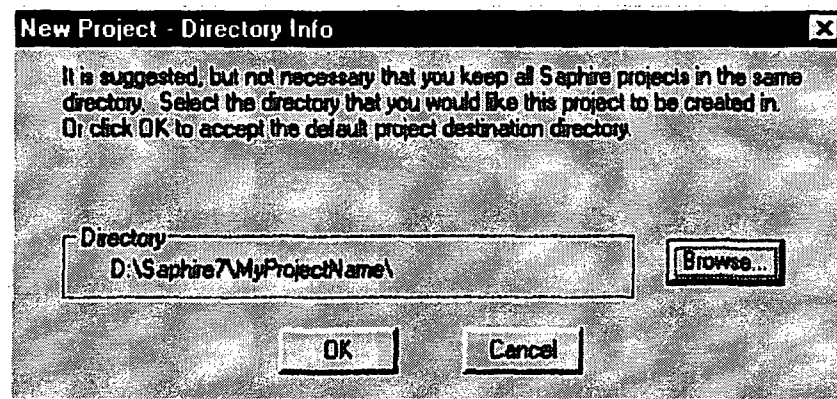
1. From the menu select **File**.
2. Choose the **New Project** submenu option. The *New Project* dialog will be displayed.



3. Choose the Yes button. The *New Project – Name Project* dialog will appear.



4. Enter the name of the project in the *Project name* field.
5. Choose the OK button. The *New Project – Directory Info* dialog will appear.



To accept the default directory, choose the OK button. You may select a different directory by choosing the browse button. When you choose OK, the directory will be created, and the new project will become SAPHIRE's current project.

Directory -	The currently selected directory in which to place the new project.
Browse -	Open the Select Directory dialog to choose a directory.
Open -	Create the project and close the <i>New Project</i> dialog.
Cancel -	Close the <i>New Project</i> dialog without creating a project.

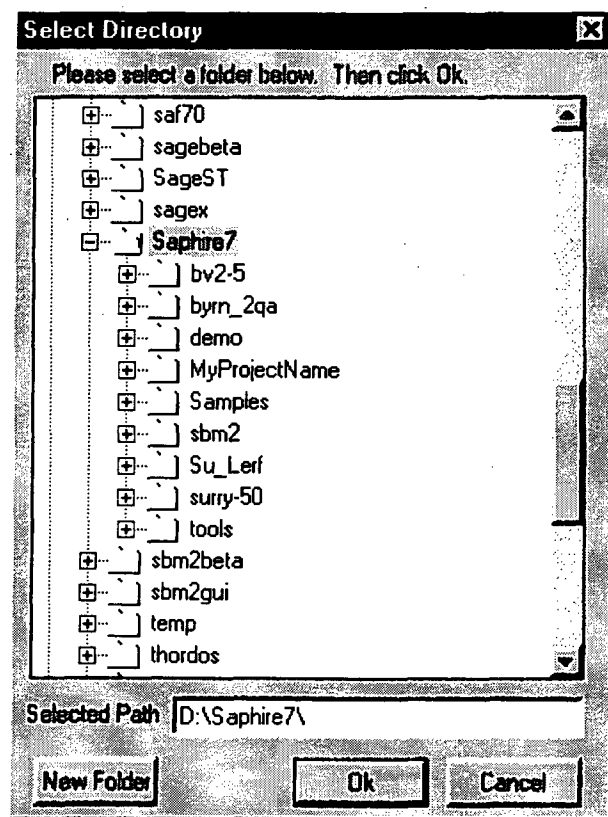
3.3 Select Directory

PURPOSE

This option allows you to select, and optionally create, a directory.

STEPS

1. From the menu select File.



Lists the available folders in a tree view, so you can see how the folders fit into your system hierarchy. Click  to expand a folder. Click  to collapse an expanded folder.

Selected Path - Contains the name of the currently selected directory, or, you may type in the name of an existing directory.

New Folder - Allows you to enter the name of a new directory. The new directory will be added beneath the currently selected folder in the tree view.

Ok - Select the currently highlighted directory.

Cancel - Close the *Select directory* dialog without selecting a directory.

3.4 Open Project

PURPOSE

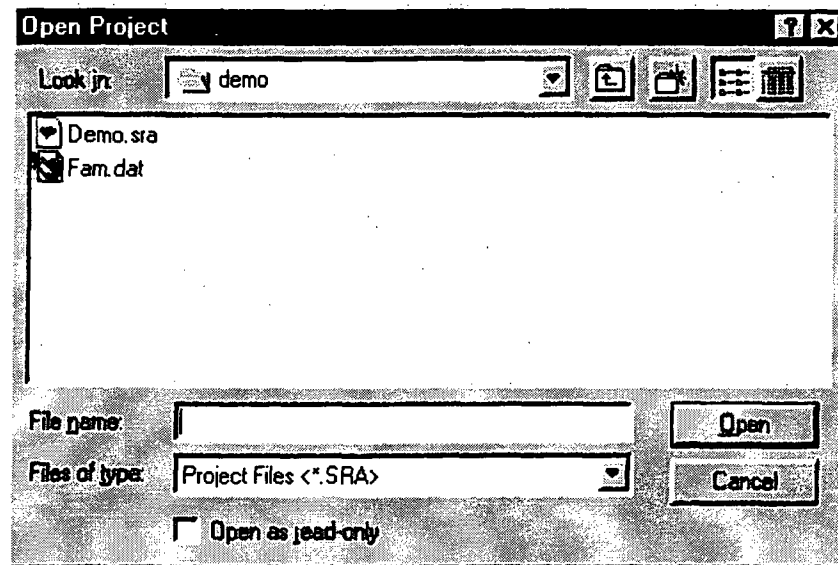
This option allows you to select (open) the project data set you wish to work with and provides the capability of copying raw (MAR-D) data files or SAPHIRE database files into a specific project. When the project is successfully selected, the name is shown on the title bar of the SAPHIRE window.

STEPS

1. From the menu select File.

2. Choose the Open Project sub-menu option. The Open Project dialog will be displayed.
3. Choose the folder that contains the desired project.
4. Double-click on the project ".SRA" file or "FAM.DAT" file.
OR
5. Highlight the desired project and choose the **Open** button.

The selected project will now be the current project and its name will appear in the title bar of the SAPHIRE window.



- | | |
|--|--|
| <p>Look in -</p> <div style="display: flex; align-items: center;">      </div> | <p>Lists the available folders and files. The box directly below it shows the contents of the current folder. The down-arrow to the right of this field shows how the folder fits into your system hierarchy.</p> <p>Moves up one level in the system hierarchy.</p> <p>Creates a new folder at the current level.</p> <p>Displays the icons and names of the contents of the current folder.</p> <p>Displays the icons, names, size, type, date and time modified, and archive flags of the contents of the current folder.</p> |
| <p>File Name -</p> | <p>Contains the name of the project.</p> |
| <p>Files of Type -</p> | <p>Lists the types of files to display. This is useful for narrowing the list of files displayed to only those you are interested in. In this case, only ".SRA" files are listed.</p> |
| <p>Open -</p> | <p>Open the highlighted project and close the <i>Open Project</i> dialog.</p> |
| <p>Cancel -</p> | <p>Close the <i>Open Project</i> dialog without opening a project.</p> |
| <p>Double-click -</p> | <p>Open the project and close the <i>Open Project</i> dialog.</p> |

The current directory is the current project unless you select another project. SAPHIRE retains the last project you selected when you exited the program so when you enter SAPHIRE again the last project selected is the current project.

If the selected project was created with an older version of SAPHIRE (IRRAS), the *Version Conflict* dialog will be displayed.

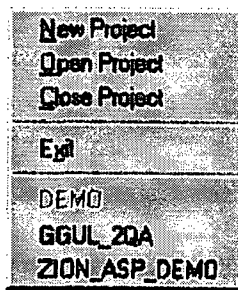
3.5 Close Project

PURPOSE

This option provides the means of closing the current project.

STEPS

1. From the menu select **File**.
2. Choose the **Close Project** submenu option.

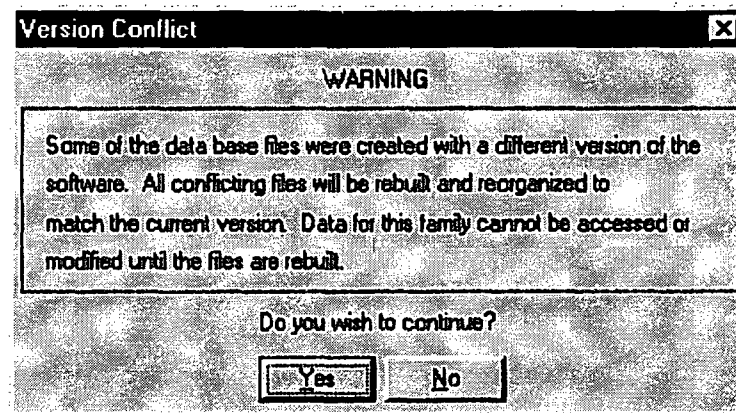


The current project database files will be closed. No project name will appear in the title bar of the SAPHIRE window. SAPHIRE menu options are no longer available, with the exception of **File** and **Help**, until a project is opened or created.

3.6 Unable to Select a Project

If for any reason the project cannot be selected, the message, "Unable to select desired project" appears, the previously selected project will be retained, and you will be given another chance to select a project.

If the highlighted project's data version does not match the current software version, the *Version Conflict* dialog appears, and you will be asked if you want to rebuild the data.



- Yes -** Rebuild the project data. This button must be chosen in order to selected the project. After the rebuild process is complete, the project is selected as the current project.
- No -** Do not rebuild the project's data. The project will not be selected, the former selected project will be retained, and the message, "Unable to select desired project" appears in the message bar.

4. CHANGE SETS AND THE GENERATE OPTION

4.1 Change Sets and the Generate Options

PURPOSE

The **Generate** option is used to create a working copy of user event data for use in a particular analysis. This data can then be modified using change sets or used to update the base case data. SAPHIRE always uses current case data for analysis.

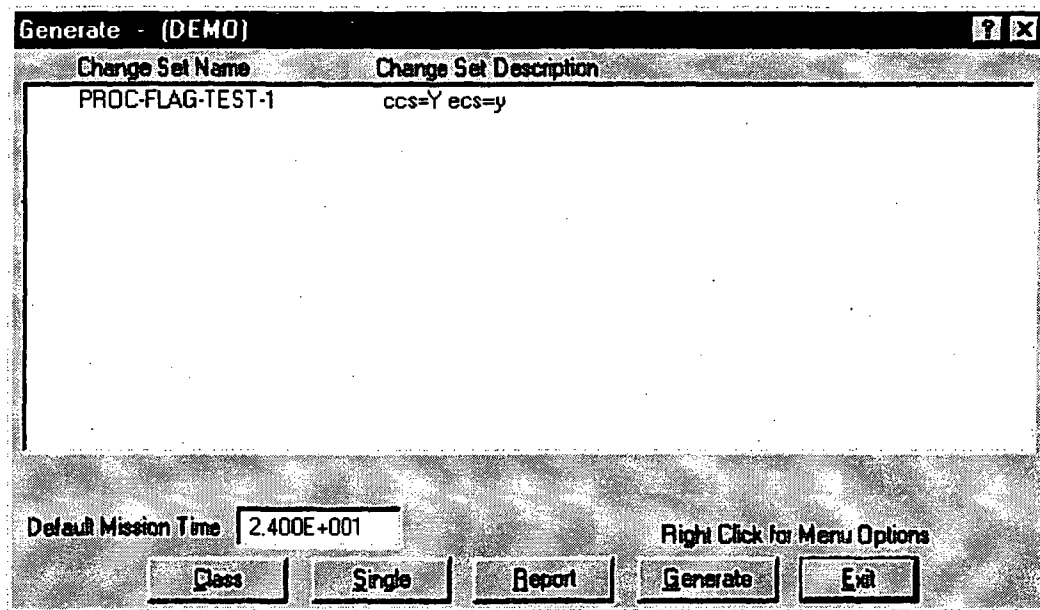
The event data can be manipulated, via change sets, to examine the changes in the probabilities of plant accidents and accident sequence failures based on basic events. A change set is a set of sensitivity analysis data modifications to be applied to basic events during fault tree or sequence analysis. 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.

Within a change set, the user can add events to the change set, modify selected event probabilities, or reset those event probabilities to the base case values. The probability of events occurring can be recalculated. The user can construct change sets to be applied to the basic events for later propagation through existing cut sets. In addition, the user can perform a "base case update" that takes all current basic event data and uses it to overwrite the base case data. Note that the original base case data are overwritten in the process.

If the base case data is changed and the Generate option is *not* performed, the data that is used for the analysis will not reflect the changes. But, if the user attempts to perform an analysis after making a data change, SAPHIRE will prompt the user to generate data changes.

STEPS

1. From the SAPHIRE menu select **Generate**.
2. The *Generate* dialog will be displayed.



Pop-up Menu Options - Perform operations on the change set relation.

- Add -** Add a new change set record to the current project database. When complete, the message, "Record added," is displayed in the message bar of the SAPHIRE window.
- Modify -** Edit the selected change set record. When complete, the message, "Record modified," is displayed in the message bar of the SAPHIRE window.
- Delete -** Delete the selected change set record(s).
- Copy -** Create a new change set record by copying an existing one.
- Text Edit -** View and edit the descriptive text associated with the selected change set.
- Mark/Unmark -** Set the order of change set processing. Change sets can also be marked by double-clicking on the desired change set in the list.

Button Options - Perform operations on the change set data.

- Class -** Add a class probability change to a group of events.
- Single -** Create and reset individual event probability changes.
- Report -** Create reports that reflect the event modifications that currently exist within the database.
- Generate -** Generate new current case event data using the temporary modifications made to the marked change sets.
- Exit -** Close the *Generate* dialog.

4.2 Change Set (Definition)

A change set is a set of sensitivity data modifications to be applied to basic events during fault tree or sequence analysis. 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.

Within a change set, you may add events to the change set, modify selected event probabilities, or reset those event probabilities to the base case values. In addition, you may perform a base case update that takes all current basic event data and makes it the new base case data. The original base case data are overwritten in this process.

4.3 Adding a Change Set

PURPOSE

This option allows you to create a new change set record. Enter the new change set's name, description and date.

STEPS

1. From the SAPHIRE menu select **Modify | Change Sets**. The *Change Sets* dialog is displayed.
OR
2. From the SAPHIRE menu select **Generate**. The *Generate* dialog is displayed.
3. Right-click to invoke the pop-up menu and choose **Add**. The *Add Change Set* dialog is displayed.

The screenshot shows a dialog box titled "Add Change Set - (DEMO)". It has a standard Windows-style title bar with a question mark icon and a close button (X). The dialog is divided into two main sections: "Primary" and "Alternate". Each section contains two text input fields: "Name" and "Description". Below these sections is a "Date" field with a calendar icon and the date "1999/09/16". At the bottom of the dialog are two buttons: "Ok" and "Cancel".

Ok - Save the new change set, and close the dialog. If the add operation is successful, the message, "Record added," is displayed in the message bar. If a change set record already exists with the same name, the message, "Duplicate record name - not added," is displayed in the message bar and the *Add Change Set* dialog remains open.

Cancel - Close the dialog without saving. A new change set record is not added to the database.

By default the set type is a *Change Set* and the *Read-only* attribute is not selected. These fields are not available on the *Add Change Set* dialog. If you wish to alter the set type or read-only attribute, you must **Modify** the change set.

4.4 Modifying a Change Set

PURPOSE

This option allows you to modify change set record data. In addition to editing the change set name, description, and date, you can also edit the set type and read-only attribute.

STEPS

1. From the SAPHIRE menu select **Modify | Change Sets**. The *Change Sets* dialog is displayed.
OR
2. From the SAPHIRE menu select **Generate**. The *Generate* dialog is displayed.
3. Highlight the change set you wish to edit.
4. Right-click to invoke the pop-up menu and choose **Modify**. The *Modify Change Set* dialog is displayed.

The screenshot shows a dialog box titled "Modify Change Set - (DEMO)". It contains two main sections: "Primary" and "Alternate". The "Primary" section has a "Name" field with the value "HRLY-BASIS-2" and a "Description" field with the value "Base case with hourly initiator frequencies". The "Alternate" section has a "Name" field with the value "РКДН-ИФЫШЫ-2" and a "Description" field with the value "Ифыу сфыу цшер рщккдн штшешфешк акуйгусшы". Below these sections are three fields: "Date" with the value "1999/09/16", "Set Type" with a dropdown menu showing "Change Set", and "Read-Only" with an unchecked checkbox. At the bottom of the dialog are two buttons: "Ok" and "Cancel".

Ok - Save the modified change set and close the dialog. If the modify operation is successful, the message, "Record modified," is displayed in the message bar. If a change set record already exists with the same name, the message, "Revised name is a duplicate - not modified," is displayed in the message bar and the *Modify Change Set* dialog remains open.

Cancel - Close the dialog without saving the modifications.

4.5 Copying a Change Set

PURPOSE

This option allows you to create a new change set record based on the highlighted one. The original change set name is displayed in the *Copy From:* field. You **MUST** enter a unique name for the new change set. Along with the source change set's name, description, and date, probability and class changes are also duplicated.

STEPS

1. From the SAPHIRE menu select **Modify | Change Sets**. The *Change Sets* dialog is displayed.
OR
2. From the SAPHIRE menu select **Generate**. The *Generate* dialog is displayed.
3. Highlight the change set you wish to copy.
4. Right-click to invoke the pop-up menu and choose **Copy**. The *Copy Change Set* dialog is displayed.

Copy Change Set - (DEMO)

Copy From: HRLY-BASIS-2

Copy To:

Primary

Name: HRLY-BASIS-X

Description: Base case with hourly initiator frequencies

Alternate

Name: РКДН-ИФЫШЫ-Ч

Description: Ифыу сфыу цшер рцккдн штешфешк акуйгусшл

Date: 1999/09/16

Copy Cancel

Copy - Save the newly created change set and close the dialog. If the copy operation is successful, the message, "Record added," is displayed in the message bar. If a change set record already exists with the same name, the message, "Duplicate record name - not added," is displayed in the message bar and the *Copy Change Set* dialog remains open.

Cancel - Close the dialog without saving the change set. A new change set record is not added to the database.

The set type and read-only flag of the source (original) change set will be duplicated in the destination (new) change set along with the basic event data changes. If you wish to alter the set type or read-only attribute, you must **Modify** the change set record. If you wish to alter the basic event data changes, you must choose the **Class** or **Single** buttons from the *Generate* dialog.

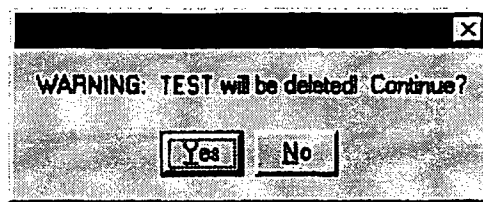
4.6 Deleting a Change Set

PURPOSE

This option allows you to remove the highlighted change set record from the database.

STEPS

1. From the SAPHIRE menu select **Modify | Change Sets**. The *Change Sets* dialog is displayed.
OR
2. From the SAPHIRE menu select **Generate**. The *Generate* dialog is displayed.
3. Highlight the change set you wish to delete.
4. Right-click to invoke the pop-up menu and choose **Delete**.
5. A message box will be displayed as shown below.



Yes - Perform the delete operation. The selected record will be removed from the database. The message, "Record deleted" is displayed in the message bar.

No - Cancel the delete operation. The selected record will NOT be removed from the database.

4.7 Change Set - Marking and Processing Order

PURPOSE

Change sets are "marked" to determine which change sets will be used to generate current case data. Order of marking determines which event changes take precedence. This option acts in the manner of a toggle.

Marking Change Sets:

STEPS

1. From the SAPHIRE menu select **Modify | Change Sets**. The *Change Sets* dialog is displayed.
OR
2. From the SAPHIRE menu select **Generate**. The *Generate* dialog is displayed.
3. Double-click on the desired change set to mark or unmark it.

If the selected change set was not previously marked, a numeric value (1 - 99) will appear to the left of the change set name, indicating the order of marking. The change sets in the list are rearranged by marked order, then alphabetically by type: first by condition assessment, then initiating event assessment type, finally by ordinary change set type.

If the change set was previously marked, it is unmarked (i.e., the numeric value is removed) and it is repositioned in the list.

If no change sets are marked when you select the **Generate** option, then the current case data will be initialized to the base case data.

Change Set Processing:

During change set processing (i.e., generating event data or updating base case values), three criteria are evaluated: probability changes, class changes, and the order of marked change sets.

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 over the class change if any discrepancies arise..

If more than one change set is marked, then the probability *and* class changes in the change sets marked with the highest number (2 is higher than 1, 3 is higher than 2) will take precedence over any changes from lower numbered change sets. For example, suppose that 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 overwrite the probability change from Change Set 1.

The following example illustrates the outcome of processing three marked change sets with four events:

- Event A has both a probability change and a class change associated with it in Change Set 2.
- Event B has a probability change in Change Set 1, and a class change in Change Set 3.
- Event C has only a class change in Change Set 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** operation on these three marked change sets would be as follows:

- The current case data for event A would be set to the values associated with the probability change in Change Set 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 values associated with the class change in Change Set 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 values associated with the class change in Change Set 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.)

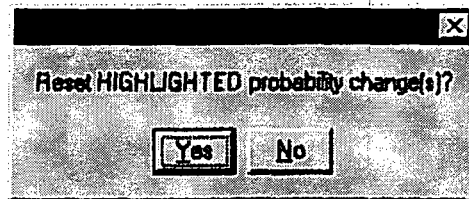
4.8 Reset Probability to Base

PURPOSE

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

STEPS

1. Choose Generate from the menu. The Generate dialog will be displayed.
2. Highlight the desired change set.
3. Choose the Single button. The Selected Events dialog will be displayed.
4. Highlight the basic events you wish to modify.
5. Right-click to invoke the pop-up menu and choose Reset.
6. A message box will be displayed as shown below.



Yes - Reset the probability back to the base case value.

No - Terminate the reset operation.

4.9 Generating Changes

PURPOSE

This option applies the event data modifications specified by the marked change sets to the current case basic event data. This option must be executed before any data analysis if you wish the change set modifications to be reflected in the analysis results. The **Generate** option creates new current event data, which is used when a user wishes to perform an analysis.

If an event in the change set has both a class change and a probability change associated with it, the probability change 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 that event.

STEPS

1. Choose Generate from the menu.
2. From the Generate dialog, mark the desired change set(s).
3. Change the Mission Time, if desired.
4. Choose the **Generate** button.

“New event data has been generated with changes” is displayed when the changes are successfully generated.

4.10 Reporting Change Set Data

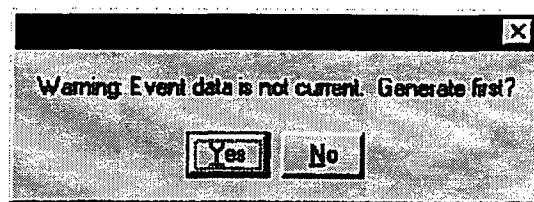
PURPOSE

Reports can be created that reflect the event modifications that currently exist within the basic event change data file. There are three report types: Unaffected Events, Affected Events, and All Events. 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 *Report Viewer*, a printer, or a disk file.

STEPS

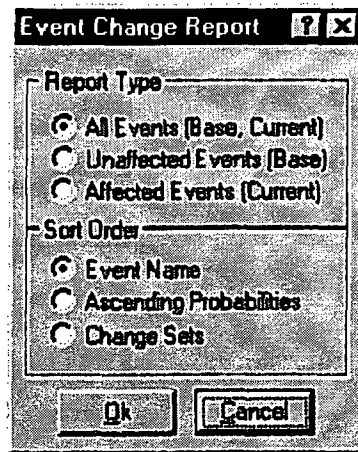
1. Choose Generate from the menu. The Generate dialog will be displayed.
2. Highlight the desired change set(s).
3. Choose the **Report** button.

If changes have been made to the selected change sets, but the **Generate** operation has not been performed, a warning dialog will be displayed. Otherwise, the *Event Change Report* dialog will be displayed.



Yes - Automatically perform the generate operation before displaying the *Event Change Report* dialog.

No - Display the *Event Change Report* dialog without first generating the changes. The report will present the basic event change data file as it currently exists. However, this file does not reflect the change set modifications made after the last generate operation.



Report Type options:

All Events (Base, Current) -

Generate a report which includes all basic events in the database.

Unaffected Events (Base) -

Generate a report with the events that are not included in any of the change sets for which current event data has been generated.

Affected Events (Current) -

Generate a report with the events whose current case value has been changed from the base case. These events are included in one or more change sets that have been marked and the basic event data generated.

Sort Order options:

Event Name -

Show the events included by the Report Type selection ordered by event name.

Ascending Probabilities -

Show the events included by the Report Type selection in ascending order by the current probability value.

Change Sets -

Show the events included by the Report Type selection by marked change set order.

The report generated by this option shows the basic event name, and current values for calculation type, lambda value, tau value, mission time, probability value, change set name, and type of change applied.

Ok - Generate the report based on the selected options. The Report Viewer will display the report.

Cancel - Close the *Event Change Report* dialog without creating a report.

4.11 Class Changes

PURPOSE

This option allows you to change event data parameters for a specified grouping of events in a change set.

STEPS

1. Choose **Generate** from the menu.

2. From the *Generate* dialog, highlight the desired change set and choose the **Class** button.
3. The *Edit Event Class* dialog will be displayed.

The event class is defined by entering some search criteria in the mask fields. The more of these fields that are filled in, the finer the class definition becomes.

- Ok** – Save the class mask and close the *Edit Event Class* dialog.
- Clear** – Clear the fields and close the *Edit Event Class* dialog.
- Cancel** – Close the *Edit Event Class* dialog without saving the mask.

It is important to remember that probability changes have a higher priority than class changes. When both are applied to an event, the probability change will be used during an analysis.

4.12 Single Event Probability Changes

4.12.1 Single Changes

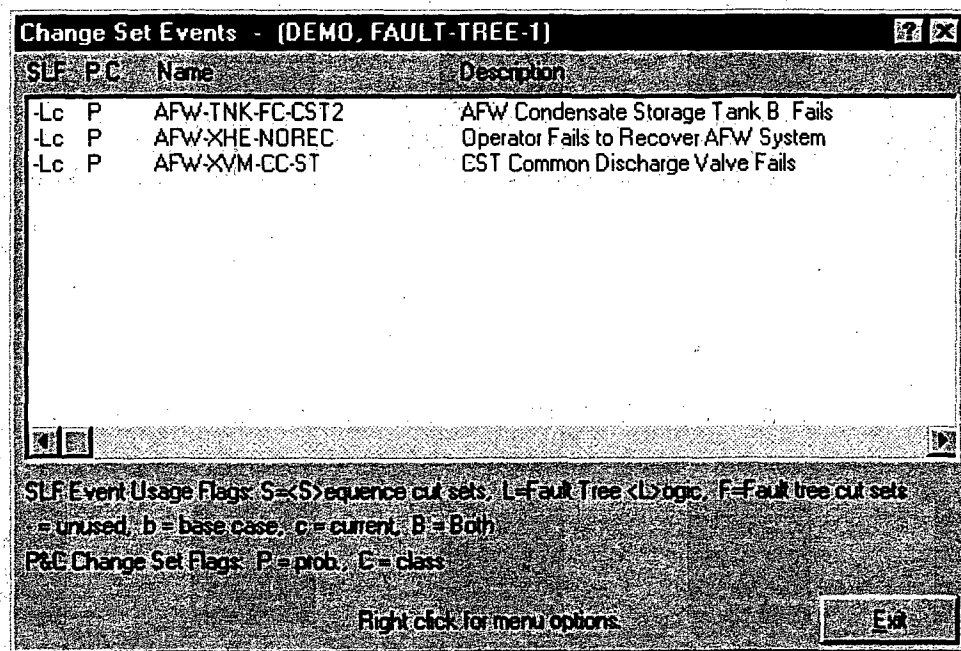
PURPOSE

This function allows the user the flexibility to experiment with setting individual basic event failure, uncertainty, and seismic fragility data. These data values may be set for a single event or for a selected group of events. This current data can then be applied to the specified event(s) for use during the analysis. The single change set type also provides a reset option to set data values back to the base case values.

STEPS

1. Choose Generate from the menu. The Generate dialog will be displayed.
2. Highlight the desired change set and choose the Single button.
3. The *Selected Events* dialog will be displayed.

This dialog lists the event name and description of each event included in the change set. In addition, the dialog shows the event usage and change set flags. The usage column (i.e., SLF) indicates whether the event has been marked or not used and whether the event is used in the base case, current, or both. The event usage flag is supplied for sequence cut sets ("S"), fault tree logic ("L"), or fault tree cut sets ("F"). The change set flag indicates if the event has been marked for a probability (single) change ("P"), a class change ("C") or both ("c"). The change set name is shown in the title bar of this dialog.



Add - Add basic event(s) to this change set and change their uncertainty, failure data, and/or seismic fragility values.

Modify - Modify uncertainty, failure data, and/or seismic fragility values of basic event(s) in this change set.

Reset - Reset changes for selected event(s) back to the base case values.

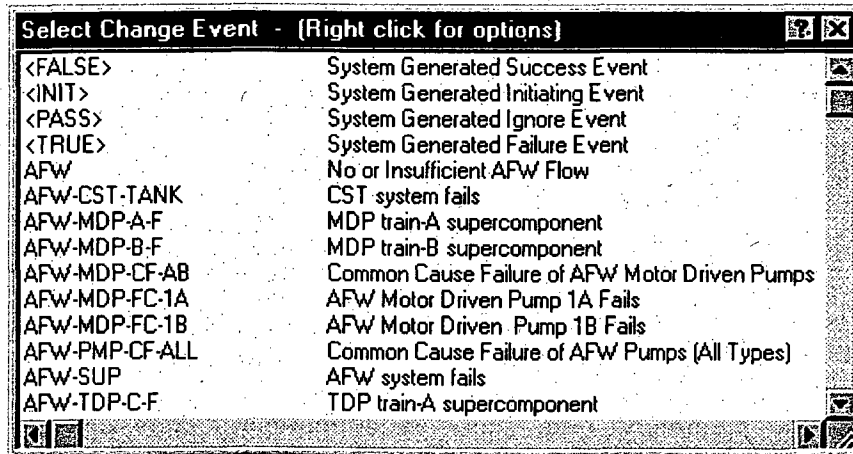
4.12.2 Add an Event Change

PURPOSE

This option allows you to add a basic event change to the currently selected change set.

STEPS

1. Choose **Generate** from the menu. The *Generate* dialog will be displayed.
2. Highlight the desired change set and choose the **Single** button. The *Selected Events* dialog will be displayed.
3. Right-click to invoke the pop-up menu and choose the **Add** option.
4. The *Select Event* dialog will be displayed.



5. Highlight the event(s) to be added to the change set.
6. Right-click to invoke the pop-up menu and choose the **Add** option.

If only a single event has been selected, then the *Event Probability Changes* dialog for single event changes will be displayed. If a group of events were selected, then the *Event Probability Changes* dialog for a group of events will be displayed.

The probability changes made are reflected on the *Selected Events* dialog by showing a "P" to the left of the event name. 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".

4.12.3 Modify an Event Change

PURPOSE

This option allows you to modify probability changes for the selected basic event(s) in the current change set.

STEPS

1. Choose **Generate** from the menu. The *Generate* dialog will be displayed.
2. Highlight the desired change set and choose the **Single** button.
3. The *Selected Events* dialog will be displayed.
4. Highlight the desired basic event(s).
5. Right-click to invoke the pop-up menu and choose **Modify**.

If only a single event has been selected, then the *Event Probability Changes* dialog for single event changes will be displayed. If a group of events were selected, then the *Event Probability Changes* dialog for a group of events will be displayed.

The probability changes made are reflected on the *Selected Events* dialog by showing a "P" to the left of the event name. 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".

4.12.4 Event Probability Changes - Individual

PURPOSE

This function allows you to temporarily change the current uncertainty, failure data, and seismic fragility values for the selected basic event. This current data can then be applied to the specified event for use during event tree analysis.

STEPS

1. Choose **Generate** from the menu. The *Generate* dialog will be displayed.
2. Highlight the desired change set.
3. Choose the **Single** button. The *Selected Events* dialog will be displayed.
4. Highlight the basic event you wish to modify.
5. Right-click to invoke the pop-up menu and choose **Add** or **Modify**.
6. The *Event Probability Changes* dialog for individual event changes will be displayed.

Event Probability Changes											
Names		Attributes		Susceptibilities							
	Comp Id	F/Mode	Location	1	2	3	4	5	6	7	8
<P>C-CVA											
<A>C-CVA	C-CVA	A1	FZ1	☒	☐	☐	☐	☐	☐	☐	☐
	Type	System	Train	9	10	11	12	13	14	15	16
<T>											
Category:	CV	CCS		☐	☐	☐	☐	☐	☐	☐	☐

Base		Random Failure Data		Current	
1		Calculation Type	- <BLANK> No Change		
1.000E-004		Mean Failure Probability	1.000E-003		
+0.000E+000		Lambda	-----E---		
+0.000E+000		Tau	-----E---		
+0.000E+000		Mission Time	-----E---		

Base		Uncertainty Data		Current	
L		Distribution Type	- <BLANK> No Change		
Log Normal		Name			
3.000E+000			-----E---		
-----E---			-----E---		
1		Correlation Class			

Process Flag	
	☐

Leave Current Values blank if no changes are desired.

OK Cancel

The dialog is divided into five data areas: Event Attributes, Random Failure Data, Uncertainty Data, Process Flag, and Seismic Fragility.

The Event Attributes data section is for information only; no changes may be made to the data fields in this area.

The Failure Data and Uncertainty Data areas display both the base case and current data values. You may change only the current data values.

- Ok** - Save the basic event probability changes and close the *Event Probability Changes* dialog.
- Cancel** - Close the *Event Probability Changes* dialog without saving the changes.

4.12.5 Event Probability Changes - Group

PURPOSE

This function allows you to temporarily change the current uncertainty, failure data, and seismic fragility for a group of selected basic events. This current data can then be applied to the specified events for use during event tree analysis.

STEPS

1. Choose **Generate** from the menu. The *Generate* dialog will be displayed.
2. Highlight the desired change set.
3. Choose the **Single** button. The *Selected Events* dialog will be displayed.
4. Highlight the basic events (two or more) you wish to modify.
5. Right-click to invoke the pop-up menu and choose **Add** or **Modify**.
6. The *Event Probability Changes* dialog for group event changes will be displayed.

Event Probability Changes

Failure/Seismic Data

Calculation Type: - <BLANK> No Change

Mean Failure Probability:

Lambda:

Tau:

Mission Time:

Uncertainty Data

Distribution Type: - <BLANK> No Change

Name:

Correlation Class:

Process Flag: ☐

Enter change values required. Note: All marked events' change probabilities will be affected.

This dialog is divided into three areas: Failure Data, Uncertainty Data, and Process Flag..

The changes entered on this dialog will be applied to all selected events.

- Ok** - Save the basic event probability changes and close the *Event Probability Changes* dialog.
- Cancel** - Close the *Event Probability Changes* dialog without saving the changes.

4.12.6 Calculation Types

In the Failure Data section the calculation type is a numerical reference to the calculation method to be used. Choose the desired calculation type from the drop-down list. An equation for each calculation type follows. See the symbol table for more details.

1 $P = p.$

The value specified in the probability field is directly used as the basic event failure probability or initiating event frequency

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

This calculation type is the full equation for the failure probability of an operating component without repair in a non-demand failure mode.

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

This calculation type is the full equation for the failure probability of an operating component with consideration given to the ability to repair the component.

7 $P = 1 + (\text{EXP}[L * T] - 1) / (L * T).$

This calculation type is the full equation for the failure probability of a standby component in a non-demand failure mode with consideration given to periodic testing.

8 $P = bp + p.$

This calculation type is available only in change sets. It indicates the value given in the change set probability field is to be added to the base case probability value.

9 $P = bp * p.$

This calculation type is available only in change sets. It indicates the value given in the change set probability field is to be multiplied with the base case probability value.

T $P = 1.0$ (House event - failed).

This calculation type indicates that the basic event is to be treated as a house event that is always failed. A house event never appears in the minimal cut sets. The model is modified to reflect the logic, given that the indicated basic event is always failed. To do this for an event that is guaranteed to occur (failure probability = 1.0), the event is removed from the logic where it appears as an input to an AND gate. If the basic event is input to an OR gate, the entire gate and its inputs are removed from the logic. The resulting minimal cut sets show the failure combinations that must occur for top event or sequence failure given that the indicated basic event is always failed.

F $P = 0.0$ (house event - successful).

This calculation type indicates that the basic event is to be treated as a house event that is never failed. A house event never appears in the minimal cut sets. The model is modified to reflect the logic given that the indicated basic event is never failed. To do this for an event that is guaranteed successful, the basic event is removed from the logic where it appears as an input to an OR gate. If the basic event is input to an AND gate, the entire gate and its inputs are removed from the logic. The resulting minimal cut sets show the failure combinations that must occur for top event or sequence failure given that the indicated basic event can never fail.

I $P = 0.0$ (ignore event).

This calculation type indicates that the basic event is to be treated as if it did not exist in the logic for the fault tree. Before the tree is solved, the logic is edited to remove all references to the specified event from the fault tree.

S $P = 0.0$ (find a fault tree with the same name and use its current mincut upper bound as the probability)

This calculation type indicates that the basic event is to replace its matching fault tree. If no matching fault tree exists, the probability will be set to 0.0.

E $P = 0.0$ (find an end state tree with the same name and use its current mincut upper bound as the probability)

This calculation type indicates that the basic event is to use its matching end state value. If no matching end state exists, the probability will be set to 0.0. This type is useful in level two analysis.

- G $P = \Pi[\ln(g/a)/Br]$.
This calculation type indicates that the basic event is to be treated as a seismic event. The probability value for screening will be calculated using the ground acceleration, failure acceleration, and Br entered by the user.
- H $P = \Pi[\ln(g/a)/Br]$.
This calculation type indicates that the basic event is to be treated as a seismic event. The probability for screening will be calculated from the failure acceleration, Br, and ground acceleration. The ground acceleration will be the highest g-level specified in the medium project hazard curve.
- V $P = N/A$ (not applicable)
The event is a "value" event and will not appear directly in fault tree or sequence logic. The value specified in the Value field is not necessarily a probability or frequency, but is rather an input value to a compound event.
- B $P = bp/$
This option is only available for use in a change set. It indicates that the base case value is to be used. This is useful when multiple change sets are marked and it is desired to override a previous change.
- C $P=F(x)$.
The event is a compound event whose probability/frequency value is defined as a function of other input values, formulas, and/or events (value events and regular basic events). This option is not currently available in change sets, since compound event data cannot be added via a change set (but it can be removed via a change set).
- X $P=F(x)$
This calculation type indicates that the event is a human action and will use built-in worksheets to calculate the human error probability (HEP). For each event, human performance shaping factors can be applied in the worksheet to adjust the HEP probability. Performance shaping factors include: stress/stressors, available time, complexity, experience/training, procedures, ergonomics, fitness for duty, and work processes.

4.12.7 Calculation Type Equation Symbols

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,
- T = average time to repair expressed in hours, input as tau,
- Π = standard normal cumulative distribution function,
- a = median killer acceleration (the approximate ground acceleration sufficient to cause the component to fail),
- Bu = confidence level that "a" is really the median killer acceleration,
- Br = the amount the killer acceleration "a" can vary
- ln = natural log
- g = ground acceleration for screening.

4.12.8 Distribution Types

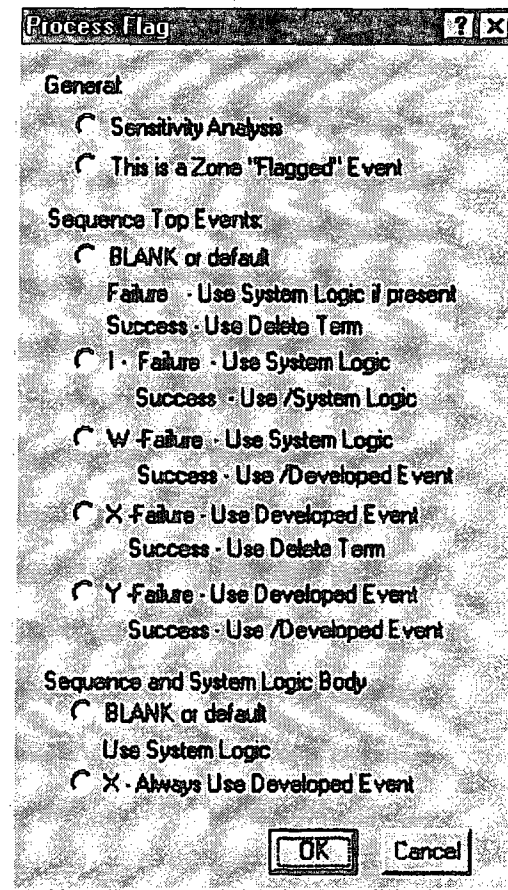
For the Uncertainty Data section, there are nine predefined distribution types available. The predefined distribution types are:

- normal
- lognormal
- beta
- dirichlet
- gamma
- chi-squared
- exponential
- uniform
- maximum entropy
- seismic lognormal
- constrained noninformative
- triangular

In addition to these predefined distribution types, user-defined histograms may be used. The default distribution type is no distribution. Choose the desired distribution type from the drop-down list.

4.12.9 Process Flag

The Process Flag is a one-character field that specifies if certain processes should take special note of the selected event. Select one of the following values:



4.12.10 Process Flag Dialog

4.12.10.1 Sensitivity Analysis

If an event is marked for sensitivity analysis, SAPHIRE will map a results frequency or probability plot. A sensitivity analysis allows you to see how sensitive the frequency or probability is in relation to an event.

4.12.10.2 Zoned Flagged Event

A zone flagged event is an event that has been marked as representing a zone (i.e., location or area). An example of a zone is a fire zone or a flood zone. When SAPHIRE encounters a zone flagged event, it performs a transformation. A transformation is an event or set of events that replace a zone flagged event.

4.12.10.3 Process Flag 'I'

Use fault tree logic (if top event fails), use the complement of the fault tree logic (if top event succeeds). That is, if the top event is a failure, SAPHIRE will expand the fault tree and solve; if the event succeeds, SAPHIRE will complement the fault tree logic and solve it. An "I" causes SAPHIRE 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.

4.12.10.4 Process Flag 'W'

Use fault tree logic (if top event fails), use complement of the developed event (if top event succeeds). That is, if the event fails SAPHIRE will expand the fault tree and solve; if the event succeeds, SAPHIRE will use the complement of the developed event for the fault tree.

4.12.10.5 Process Flag 'X'

Use developed event (if event fails), use cut set matching to eliminate cut sets (if event succeeds). That is, an "X" tells SAPHIRE that the top event is to be used for failure references, but success references are to be treated the same as if the flag was blank.

4.12.10.6 Process Flag 'Y'

Use developed event (if event fails), use complement of developed event (if event succeeds). That is, 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.

4.12.10.7 Process Flag 'X'

Always use developed event. That is, do not expand the fault tree or transfer. Instead, simply use the event probability.

4.12.10.8 Blank or Default

When the Process Flag field is blank, the transfer logic associated with this event is expanded for failure references. For success references, the transfer is also expanded; however, any "impossible" cut sets (i.e., those both failing and succeeding) are removed from the resulting failure cut sets using cut set matching (also known as the "delete term" process).

5. FAULT TREE ANALYSIS

5.1 Fault Tree Analysis

PURPOSE

A fault tree is a model of a system that is suitable for probabilistic analysis. The model is usually tailored for the study of the system's failure.

This option allows you to build, edit and analyze fault tree models. You are provided with the means to recalculate fault tree values after events and/or cut sets have been modified. The *Fault Trees List* shows the fault trees in the current project.

KEY TO FLAGS

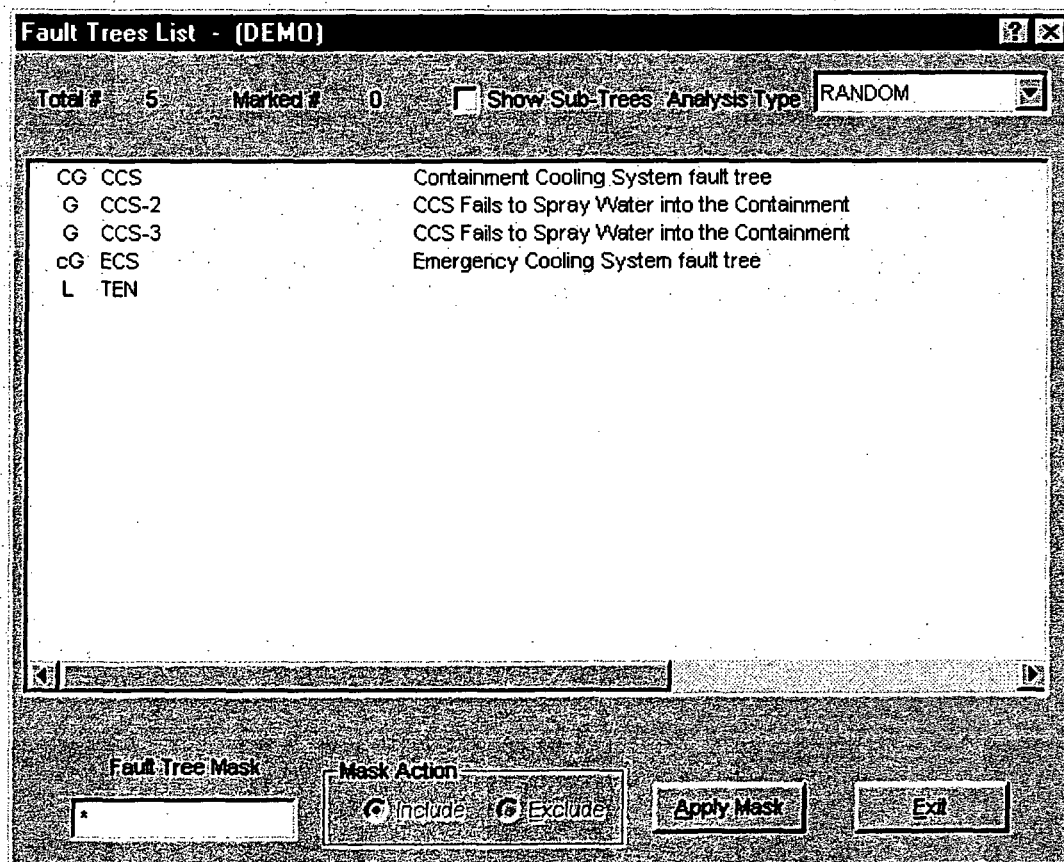
Located to the right of each fault tree is a set of flags that indicate the status of the fault tree:

- C** - both current and base case cut sets exist for the selected analysis type
 - only base case cut sets exist for the selected analysis type
- c** - only current case cut sets exist for the selected analysis type

- G** - both logic and graphics exist for the fault tree
- L** - only logic exists for the fault tree
- g** - only graphics exist for the fault tree

STEPS

1. From the SAPHIRE menu select **Fault Tree**.
2. The *Fault Trees List* dialog will be displayed.



From this dialog, you can select fault trees using the mouse or the Mask feature.

- | | |
|------------------------------|---|
| Analysis type - | Select the type of analysis from the drop-down list. |
| Show Sub-Trees - | When checked, include sub-trees in the list of fault trees. Only logical and graphical pop-up options are available when this option is selected |
| Pop-up Menu Options - | The following functions may be accessed from the pop-up menu, depending on whether or how many fault trees are highlighted. |
| Add Fault Tree - | Add a new fault tree record to the current project database. |
| Edit Graphics - | Construct and modify fault tree diagrams using the graphical <i>Fault Tree Editor</i> . |
| Edit P&ID - | Construct and modify piping and instrumentation diagrams using the <i>Piping & Instrumentation Diagram Editor</i> . |
| Edit Logic - | Modify the logic of a fault or sub-tree in an alphanumeric format. |
| Page Tree - | Organize the fault tree logic into pages. |
| Solve - | Generate cut sets for a fault tree based on cut set generation cut off values. |
| Quantify - | Calculate a new minimum cut set upper bound for fault tree cut sets using current data values (using event data changes and current case cut sets). |
| Uncertainty - | Perform uncertainty analysis on a fault tree using either the Monte Carlo or Latin Hypercube simulation technique. |

Cut Sets -	Perform various operations on cut sets: Update, Prune, Recover, Edit.
Display -	Display the results of fault tree analyses in various report forms.
View Results -	View fault tree analysis information and compare base case and current case minimal cut set upper bound results.
Time Dependent -	Perform time dependent fault tree analysis.

5.2 Analysis Types

SAPHIRE allows the user to store multiple analysis types in the same project. For instance, the user can perform a normal random analysis and then using the same database, perform a fire or flood analysis. Each analysis uses the same fault trees and failure data, but stores the results in a different location in the database. In SAPHIRE, there are eight reserved analysis types and eight user definable types.

The first six reserved types are “Random,” “Fire,” “Flood,” “Seismic,” “Event Assessment,” and “Condition Assessment.” The remaining two reserved types are undefined. When the user selects a different analysis type, the cut sets and other results generated for that analysis type are stored in a separate location. This ability allows the user to track all the results from a comprehensive analysis in the same database.

The default analysis type is “Random.” This default value can be changed in the **Utility | Define Constants | Analysis** option.

Associated with the analysis type is the ability to perform event transformations. This ability is useful in doing vital area or location analysis. With this ability, the user is able to define transformations for a basic event. When this event is used in a fault tree, the user can then choose to transform this event according to their definitions. The analysis type corresponds to the basic event susceptibility type. If an event is “susceptible” to “Fire,” then the user marks the event flag to indicate this. When a fault tree associated with this event is loaded, it will automatically be transformed if the current analysis type is one this event is “susceptible” to.

5.3 Fault Tree Graphics

5.3.1 Fault Tree Graphics

PURPOSE

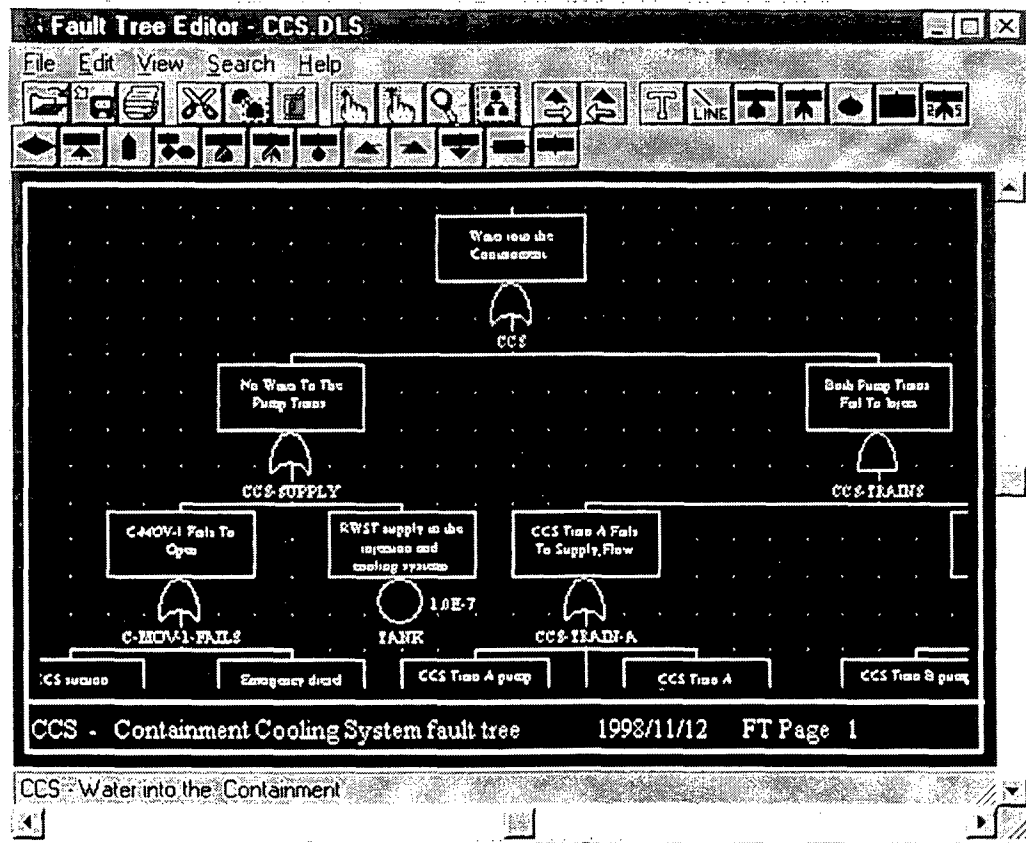
The *Fault Tree Editor* provides the means to construct a fault tree diagram. A fault tree diagram is a graphical representation or picture of the fault tree model built from fault tree objects.

A fault tree is a model of a system that is suitable for probabilistic analysis. The model is usually tailored for the study of the system’s failure. The fault tree logic structure can consist of any combination of the logic symbols that do not result in a logical loop. Fault tree logic can be thought of as a group or set of equations that describe the possible failure combinations of the system.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.

2. Highlight the desired fault tree. (Skip this step if creating a new fault tree.)
3. Right-click to invoke the pop-up menu and select the **Edit Graphics** option.
4. The *Fault Tree Editor* window will be displayed. The name of the current fault tree will be displayed in the title bar.



The *Fault Tree Editor* allows you to build the model using graphical symbols for gates, basic events, and connecting lines. These objects are tied to the SAPHIRE database. Various editing functions such as cut, paste, and copy are provided along with file functions such as save and print.

Options are available from the menu and/or the toolbar.

Menu Options

- File** - File manipulation functions such as open, save, print, etc.
- Edit** - Editing functions such as copy and paste along with attribute setting.
- View** - Control of visual display such as zoom, refresh, etc.
- Search** - Search and cursor positioning operations (e.g., *Find* and *Find and Replace*).
- Help** - SAPHIRE on-line help.

Toolbar Buttons



Open a fault tree graphics file from disk.



AND gate object

	Save the fault tree graphics file to disk.		OR gate object.
	Print the fault tree graphics file.		Basic event object.
	Cut an object from the diagram.		Basic event table object.
	Copy an object in the diagram.		N/M gate object.
	Paste an object into the diagram.		Undefined event object.
	Select the shape pick cursor.		Transfer gate object.
	Select the text pick cursor.		House event object.
	Zoom in/out.		Inhibit gate object.
	Fit to window		NAND gate object.
	Fit to standard size (100%).		NOR gate object.
	Forward transfer.		Boxed basic event object.
	Backward transfer.		Right transfer object.
	Text object.		Left transfer object.
	Line object.		Undefined transfer object.
			Horizontal box object.
			Vertical box object.

5.3.2 Fault Tree Graphics - Definitions

PURPOSE

The following definitions are used with reference to the SAPHIRE graphical Fault Tree Editor.

Objects -	The building blocks of a fault tree diagram. They include shapes, lines that connect shapes, and descriptive text. Each object has attributes that may include color, size, and name.
Pick Box -	An invisible rectangle which surrounds every object. It defines the area of the object where the mouse cursor must be positioned in order to select the object.
Rubber band rectangle -	A rectangle displayed on the screen showing the area currently selected during a <i>drag</i> function. This is used when selecting more than one object.

5.3.3 Fault Tree Graphics - Mouse Usage

All mouse actions defined in the SAPHIRE graphical *Fault Tree Editor* are for a standard right handed two-button mouse.

Click -	The left mouse button is pressed and released.
Right-click -	The right mouse button is pressed and released.

- Double-click -** The left mouse button is pressed and released two times in rapid succession.
Drag - The left mouse button is pressed and held down while moving the mouse.
End-drag - The left mouse button that was being held down during the *drag* is released.

5.3.4 Moving Objects

PURPOSE

Move selected object(s) to a different location in the diagram.

STEPS

1. Select the desired object.
2. Drag the mouse to the new position.
3. End-drag.

While dragging the mouse, the Move cursor  will be active.

5.3.5 Selecting Objects

PURPOSE

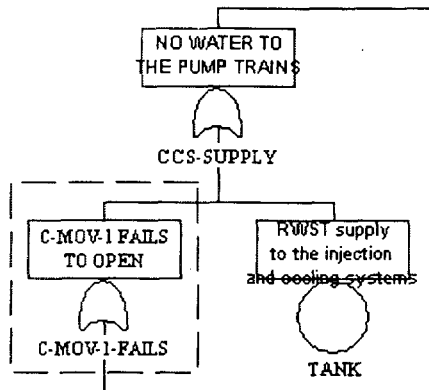
Prior to manipulating a shape object (e.g., moving, copying, etc.) in the fault tree diagram, it must be selected. This topic describes how to select object(s).

STEPS

To select a single object

1. Choose the Pick button  from the toolbar.
2. Move the cursor () on top of the object you wish to select.
3. Click the mouse.

If the mouse is clicked while inside an object's pick box, that object is selected. A dashed line will appear surrounding the selected object.



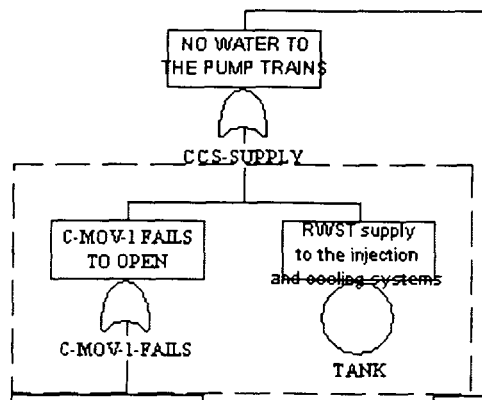
In the example here, the OR gate, C-MOV-1-FAILS, is selected.

STEPS

To select a group of objects

1. Choose the Pick button  from the toolbar.
2. Starting outside of any pick box, *drag* the mouse until the rubber band rectangle encloses all the objects you wish to manipulate.

If, when you begin *dragging* the mouse, an object's pick box appears, you were inside that object's pick box. Find an area without any visible objects to begin the mouse *drag* operation.



In the example here, the inputs to the CCS-SUPPLY gate, are selected.

NOTE: Because some object's pick boxes may overlap, there is an order of selection. Shapes get first priority, followed by lines, and then text. If objects of the same type overlap, then the object that was added first will be selected. Because text has the lowest priority when selecting, there is a special Text cursor that allows you to pick text that is superimposed on a shape or line. If desired text is not close to another object, you can select it by following the steps described above for a generic object. If the desired text is on top of or close to a shape or line, you should use the Text Pick cursor.

5.3.6 Selecting a Text Object

PURPOSE

Prior to manipulating a text object (e.g., moving, copying, etc.) in the fault tree diagram, it must be selected. This option describes how to select a text object.

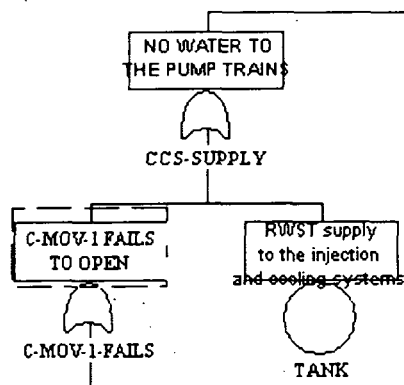
Because some object's pick boxes may overlap, there is an order of selection. Shapes get first priority, followed by lines, and then text. If objects of the same type overlap, then the object that was added first will be selected.

Because text has the lowest priority when selecting, there is a special text cursor that allows you to pick text that is superimposed on a shape or line. If desired text is not close to another object, you can select it by using the Pick cursor. If the desired text is on top of or close to a shape or line, you should follow the steps below.

STEPS

1. Choose the  button from the toolbar.
2. Move the cursor  on top of the text you wish to select.
3. Click the mouse.

If the mouse is clicked while inside a text object's pick box, that text object is selected.



In the example here, the text associated with the OR gate, C-MOV-1-FAILS, is selected.

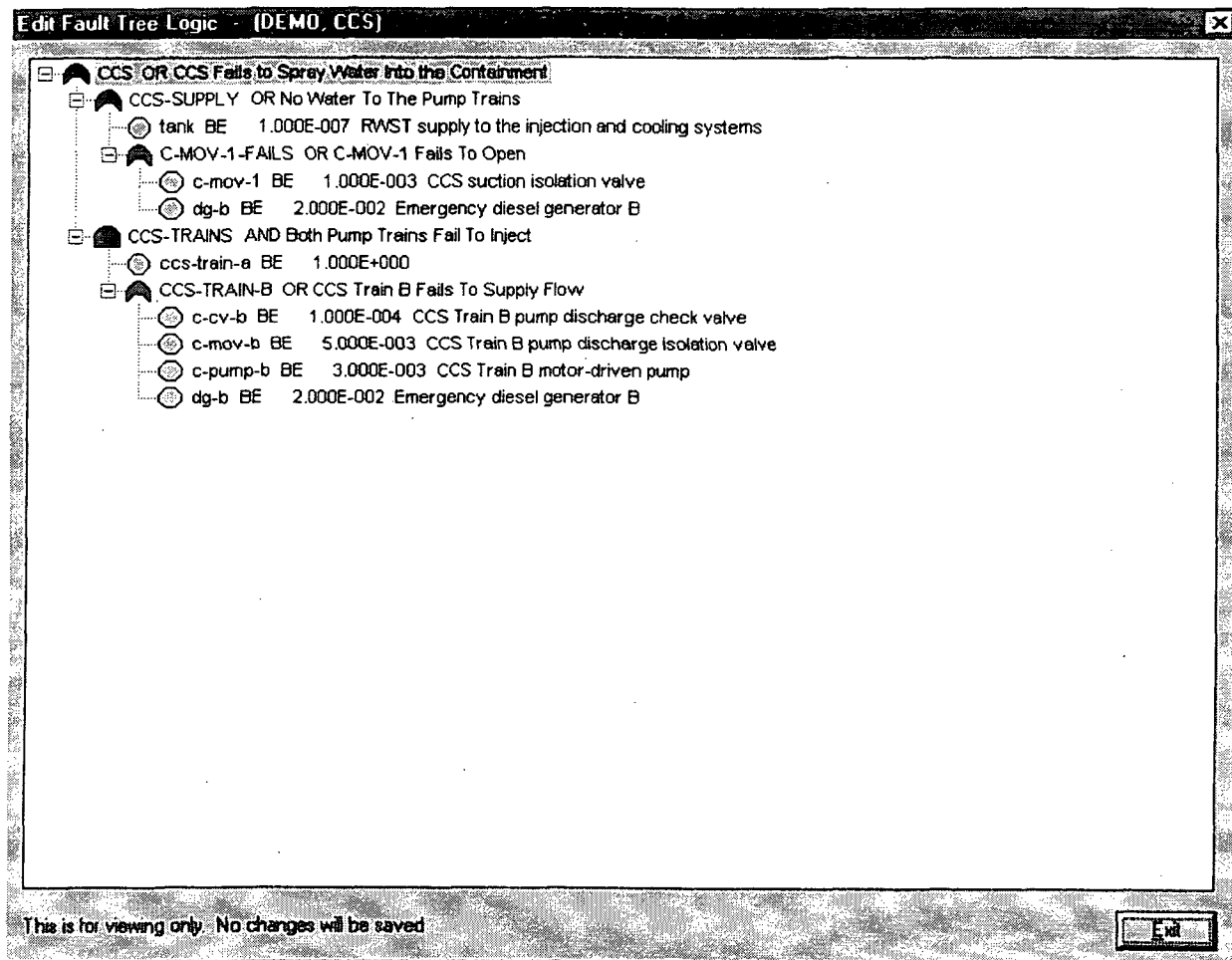
5.3.7 View Logic

PURPOSE

This option allows you to view the current diagram logic represented in the form of a hierarchical tree, where each gate can be expanded or condensed by clicking on the gate. The logic can only be viewed, not edited, from this dialog. See the topic, "About Logic Dialogs," for a description of the icons presented on this dialog.

STEPS

1. Right click anywhere in the Fault Tree Graphical Editor.
2. Select **View Logic** menu option.
3. The *Fault Tree Logic* dialog will be displayed



Exit - Close the *Fault Tree Logic* dialog.

5.3.8 Adding Objects

5.3.8.1 Adding An Object

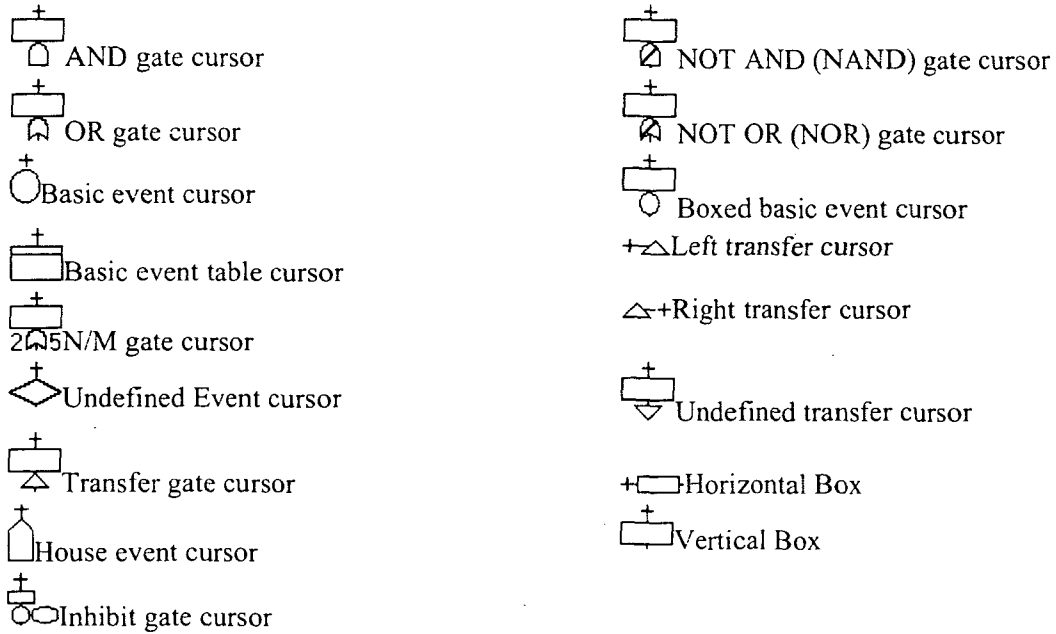
PURPOSE

Add a shape object (e.g., AND gate, basic event, etc.) to the diagram.

STEPS

1. Choose the desired object button (OR gate, AND gate, basic event, etc.) from the toolbar. The cursor will change to the associated object cursor.
2. Position the cursor at the desired location.
3. Click the mouse. The shape indicated by the cursor will be added.

Below is an example of each shape cursor available in the graphical *Fault Tree Editor*:



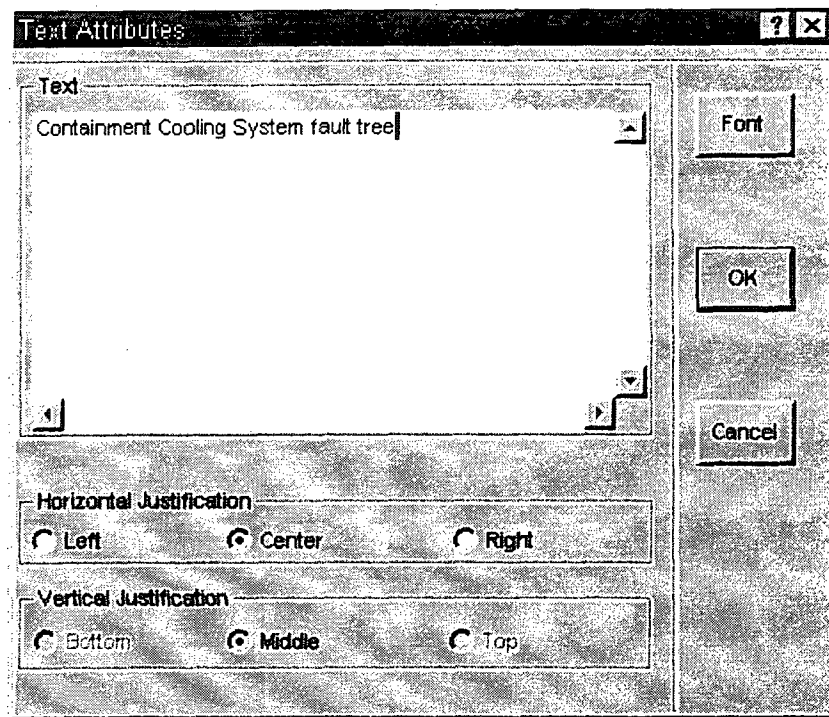
5.3.8.2 Adding Text

PURPOSE

Adds text to the diagram.

STEPS

1. Choose the Text object button  from the toolbar. The cursor will change to the Text cursor .
2. Position the Text cursor at the desired location.
3. Click the mouse. The *Text Attributes* dialog will be displayed.



Text - Descriptive text for a shape or explanatory text for the entire fault tree. Maximum of 600 alphanumeric upper- and lowercase characters.

Justification

Horizontal - The horizontal alignment of the text.

Vertical - The vertical alignment of the text.

Text Font - The font for the text.

OK - Close the *Text Attributes* dialog and add the input text to the diagram.

Cancel - Close the *Text Attributes* dialog without adding the text to the diagram.

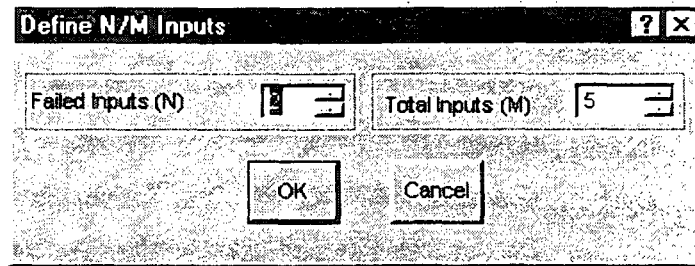
5.3.8.3 Adding An N/M Gate

PURPOSE

Adds an N/M gate to the diagram.

STEPS

1. Choose the N/M gate object button  from the toolbar. The cursor will change to the N/M gate cursor .
2. Position the N/M gate cursor at the desired location.
3. Click the mouse. The *Define N/M Inputs* dialog will be displayed.



- Failed Inputs (N) -** Must be less than the *Total Inputs*. Choose the value by using the buddy-control or enter the value.
- Total Inputs (M) -** Must be greater than 2 and less than 100. Choose the value by using the buddy-control or enter the value.
- OK -** Close the *Define N/M Inputs* dialog and add the N/M Gate to the diagram.
- Cancel -** Close the *Define N/M Inputs* dialog without adding the N/M Gate to diagram.

5.3.8.4 Adding Connecting Lines

PURPOSE

Adds connecting lines to the diagram. Connecting lines are used to logically link shape objects in the diagram.

STEPS

1. Choose the Line object button  from the toolbar. The cursor will change to the Line cursor .
2. Drag the mouse from one endpoint and to the other endpoint. (Hold the left mouse button down.)
3. Release the left mouse button (End drag) and the line will be drawn.

5.3.9 Modifying Objects

5.3.9.1 Modifying Objects

PURPOSE

This option allows you to modify the attributes of the selected shape object in the diagram.

STEPS

1. Select the object using the Pick cursor .

2. **Right-click** to invoke the pop-up menu and choose **Edit**.
OR
3. Choose **Edit | Attributes** from the menu.
4. The *Shape Definition* dialog will be displayed.

Name - The name of the selected shape. Enter up to 24 alphanumeric characters. (Embedded spaces are not allowed). The name entered here will be used in the Name field in the SAPHIRE database.

List - The available basic events and gates in the database.

Font - The font attributes (such as typeface, size, color, etc.) used to display the shape name.

Description - Brief description of the shape. Maximum length is 600 characters. The first 60 characters of the text entered here will be used in the Description field in the SAPHIRE database.

Auto Wrap -	Choose this button to fit the text inside the shape's text region.
Font -	The font attributes used to display the shape description.
Text Justification -	The horizontal and vertical alignment of the shape description.
Attributes	
Type -	Change the shape's type by selecting from the drop-down list.
Shape -	The fill color of the shape.
Line -	The outline color of the shape.
Cancel -	Close the <i>Shape Definition</i> dialog without applying the changes.
OK -	Close the <i>Shape Definition</i> dialog and apply any changes.

5.3.10 File Menu

5.3.10.1 File

These options provide file manipulation functions.

New -	Create a new file in the current window.
Open -	Open a file into the current window.
Save -	Save the file in the current window to disk.
Save As -	Save the file in the current window with a new file name.
Export As -	Convert the file to RTF, EMF, or WMF format.
Merge -	Graft another file into the current window.
Forward Transfer -	Follow a transfer gate.
Backward Transfer -	Display a previously viewed transfer.
Print -	Print the file in the current window.
Exit -	Terminate the <i>Fault Tree Editor</i> . If changes have been made you will be queried if you want to save the file.

5.3.10.2 New

PURPOSE

This option will allow you to clear the window and start a new diagram.

STEPS

1. From the Fault Tree Editor menu select File | New.
OR
2. Select and right click on a fault tree that does not yet contain graphics from the SAPHIRE Fault Tree List, and choose *Edit Graphics* from the pop-up menu.

3. If you have not saved the current diagram you will be prompted by a *Caution* dialog to do so.
4. The *Enter top gate information* dialog will appear, and you can begin building a new diagram.

Note: SAPHIRE requires the fault tree name and the top gate name to be the same. The *name* field and *list* button are disabled when the name of the fault tree is known. When a new diagram is started via the Fault Tree Editor File|New menu option, the name of the fault tree is not known. It is up to the user to save the diagram with the same name as the top gate.

Enter top gate information

Name:

Description: **Text Justification**

Horizontal: ☐ Left ☒ Center ☐ Right

Vertical: ☐ Top ☒ Middle ☐ Bottom

Attributes: Type: Shape: Line:

Preview: A fault tree diagram showing a top gate labeled 'NEWFT' with a single input line.

- Add** – Add the top gate to the information, and proceed to the Enter input to top gate dialog.
- Done** – Add the top gate to the diagram, close the *Enter Top Gate Information* dialog, and begin free form editing.

See *Modifying Objects* for more details on the rest of the information available from this dialog.

5.3.10.3 Enter input to top gate

PURPOSE

This option will add shapes as inputs to the top gate of the diagram. It initially appears after the **Add** button is selected from the Enter Top Gate Information dialog. It then appears repeatedly until the **Done** button is selected.

Enter input to top gate

Name:

Description:

Text Justification:

Horizontal	Vertical
☐ Left	☐ Top
☒ Center	☒ Middle
☐ Right	☐ Bottom

Attributes:

Type: Or

Shape: Blue

Line: White

Preview: A diagram showing a rectangular box labeled "GATE-3-0" with a smaller rectangular box attached to its top center.

Add – Attach the input to the top gate, and begin editing a new input to the top gate.

Done – Attach the input to the top gate, close the *Enter input to top gate* dialog, and begin free form editing.

See **Modifying Objects** for more details on the rest of the information available from this dialog.

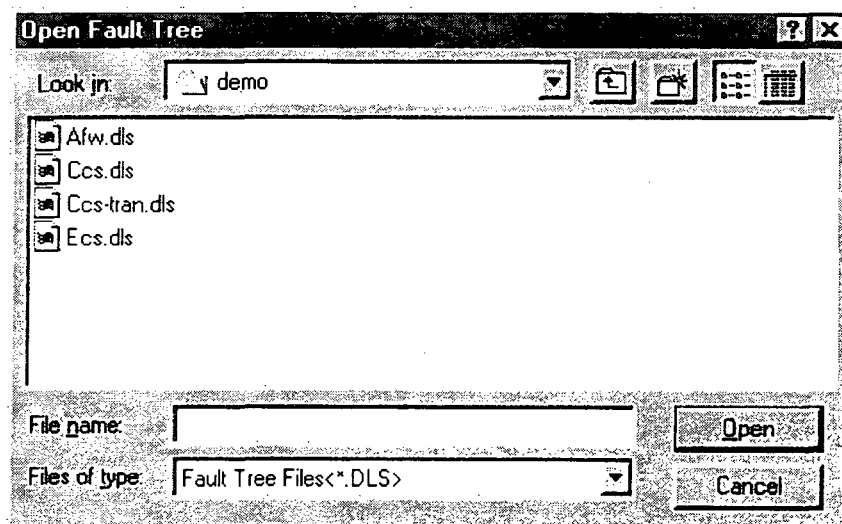
5.3.10.4 Open

PURPOSE

This option will allow you to select an existing diagram (i.e., fault tree graphics file) to view or edit.

STEPS

1. From the *Fault Tree Editor* menu select **File | Open**.
OR
2. Choose the **Open Diagram** button  on the toolbar.
3. The *Open Fault Tree* common dialog will be displayed listing all the fault tree diagrams (.DLS files) in the current project directory
4. Select the desired diagram and choose **Open**,
OR
5. **Double-click** on the diagram name.



- Look in -** Lists the available folders and files. The box directly below it shows the contents of the current folder. The down-arrow to the right of this field shows how the folder fits into your system hierarchy.
-  - Moves up one level in the system hierarchy.
-  - Creates a new folder at the current level.
-  - Displays the icons and names of the contents of the current folder.
-  - Displays the icons, names, size, type, date and time modified, and archive flags of the contents of the current folder.
- File Name -** Contains the name of the file in which the diagram will be saved.
- Files of Type -** Lists the types of files to display. This is useful for narrowing the list of files displayed to only those you are interested in. In this case, only “.DLS” files are listed.
- Open -** Open the highlighted diagram file and close the *Open Fault Tree* dialog.
- Cancel -** Close the *Open Fault Tree* dialog without selecting a different diagram.
- Double-click -** Open the diagram file and close the *Open Fault Tree* dialog.

If you have selected a diagram to open and you have not saved the current one you will be prompted by a *Caution* dialog to do so.

5.3.10.5 *Saving Changes*

PURPOSE

This option will save any changes made in the current fault tree diagram to the file presently open. If this is a new diagram, then you will be allowed to name the file. The logical representation of the diagram will also be saved in the SAPHIRE database.

STEPS

1. From the *Fault Tree Editor* menu select **File | Save**.
OR
2. Choose the **Save Diagram** button  on the toolbar.
3. If this is not a new diagram, the data is saved.
OR
4. If this is a new diagram, see Saving Changes to a Different File.

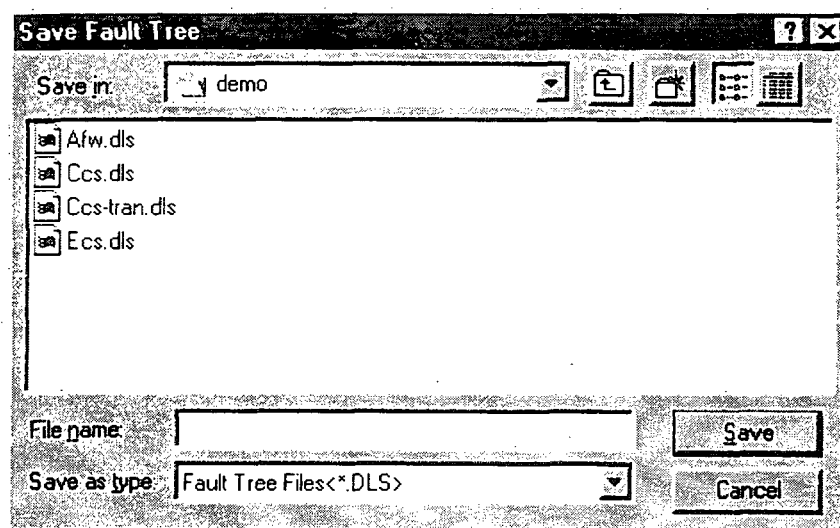
5.3.10.6 *Saving Changes to Different File*

PURPOSE

This option will save any changes made in the current fault tree diagram to a file you select. The logical representation of the diagram will also be saved in the SAPHIRE database.

STEPS

1. From the Fault Tree Editor menu select **File**.
2. Choose **Save as** from the menu
3. The *Save Fault Tree* common dialog will be displayed listing all the fault tree diagrams (.DLS files) in the current project directory.
4. Enter the name of the file in the *File Name* field,
OR
5. Select the desired diagram file and choose **Save**,
OR
6. **Double-click** on the diagram name.



Save in - Lists the available folders and files. The box directly below it shows the contents of the current folder. The down-arrow to the right of this field shows how the folder fits into your system hierarchy.



Moves up one level in the system hierarchy.

Creates a new folder at the current level.

Displays the icons and names of the contents of the current folder.

Displays the icons, names, size, type, date and time modified, and archive flags of the contents of the current folder.

File Name - Contains the name of the file in which the diagram will be saved.

Files of Type - Lists the types of files to display. This is useful for narrowing the list of files displayed to only those you are interested in. In this case, only .DLS files are listed.

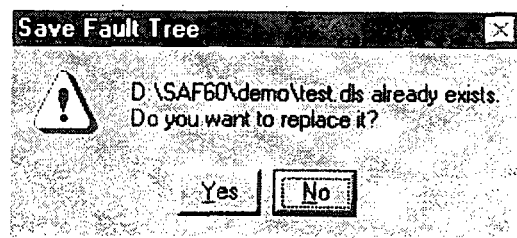
Save - Save the current diagram to the file in the *File name* field and close the *Save Fault Tree* dialog. If an existing file was selected, a warning dialog will be displayed.

Double-click - Save the current diagram to the file in the *File name* field and close the *Save Fault Tree* dialog.

Cancel - Close the *Save Fault Tree* dialog without saving the diagram.

5.3.10.7 Save Fault Tree Warning Dialog

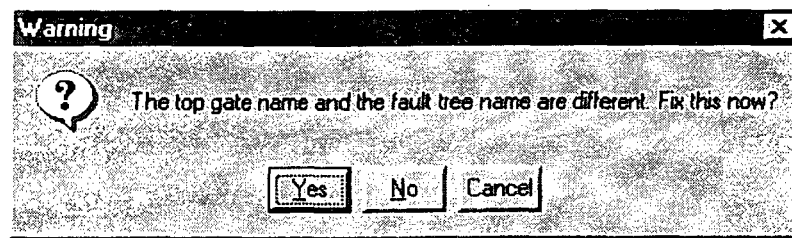
This dialog is displayed when you choose to save the current diagram to an already existing file.



- Yes -** Save the current diagram to the selected file. The diagram in the existing file will be overwritten.
- No -** Do not save the current diagram to the select file.

5.3.10.8 *Warning: File name and top gate name are different*

When saving a fault tree diagram, this dialog is displayed when name of the fault tree file and the name of the top gate do not match. To correctly interpret fault tree logic, SAPHIRE requires the two names to be the same.



- Yes –** Let SAPHIRE rename the top gate to match the file name.
- No –** Save the diagram anyway, but leave the file name and top gate names alone. SAPHIRE will not be able to use the logic from this diagram until the problem has been corrected.
- Cancel –** Cancel the save, and return to editing the diagram. Use this option if you prefer to fix the problem yourself.

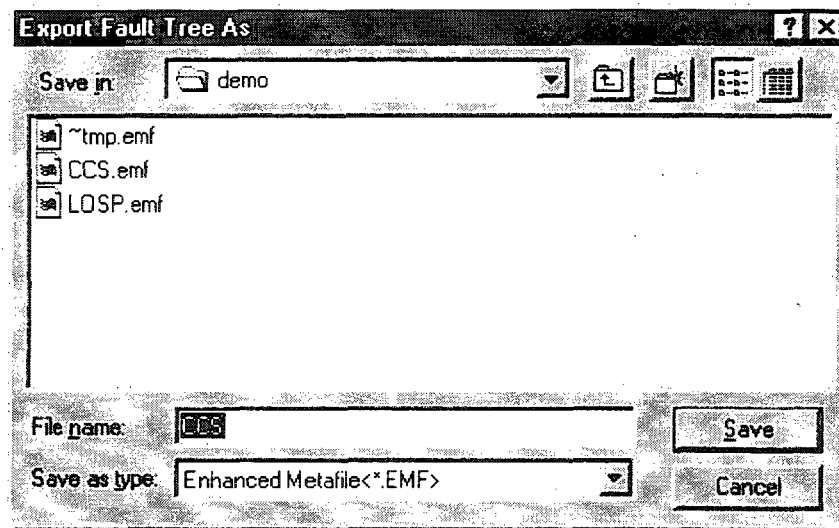
5.3.10.9 *Export As*

PURPOSE

This option will convert the diagram to a file in either Enhanced Metafile (EMF), Windows Metafile (WMF) format, or Rich Text Format (RTF). This option is available from the Fault Tree Graphic Editor and the Event Tree Graphic Editor.

STEPS

1. From the Fault Tree Editor menu select **File**.
2. Choose **Export as** from the menu
3. The *Export Fault Tree As* common dialog will be displayed listing all the EMF or WMF files in the current project directory.
4. Enter the name of the file in the *File Name* field,
OR
5. Select the desired file and choose **Save**,
OR
6. **Double-click** on the file name.



Save in - Lists the available folders and files. The box directly below it shows the contents of the current folder. The down-arrow to the right of this field shows how the folder fits into your system hierarchy.



Moves up one level in the system hierarchy.

Creates a new folder at the current level.

Displays the icons and names of the contents of the current folder.

Displays the icons, names, size, type, date and time modified, and archive flags of the contents of the current folder.

File name - Contains the name of the export file.

Save as type - Lists the types of files to display. This is useful for narrowing the list of files displayed to only those you are interested in. In this case, .RTF, .EMF or WMF files are listed.

Save - Save the current file in the *File name* field and close the *Export Fault Tree As* dialog. If an existing file was selected, a warning dialog will be displayed.

Double-click - Export the current diagram to the file in the *File name* field and close the *Export Fault Tree As* dialog.

Cancel - Close the *Export Fault Tree As* dialog without saving the diagram.

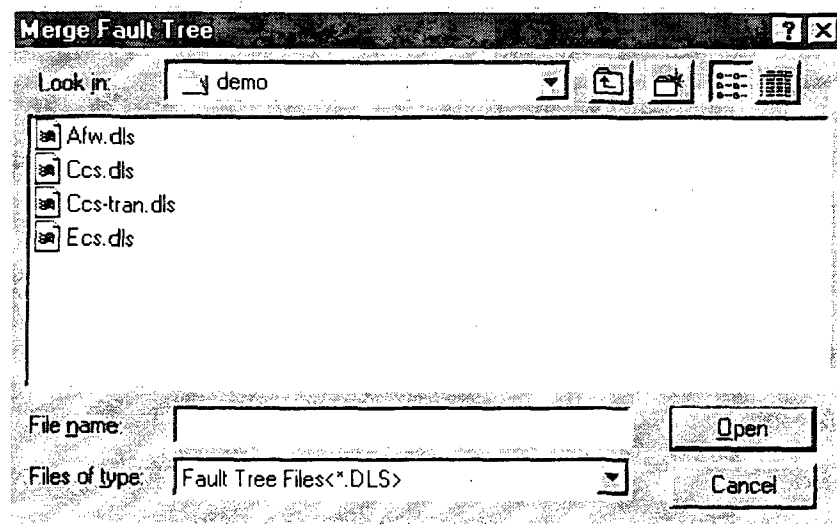
5.3.10.10 Merge Diagram

PURPOSE

This option will integrate an existing fault tree diagram into the current fault tree diagram.

STEPS

1. From the Fault Tree Editor menu select **File**.
2. Choose **Merge** from the menu.
3. The *Merge Fault Tree* dialog will be displayed listing all the fault tree diagrams (.DLS files) in the current project directory.
4. Select the desired diagram and choose **Open**,
OR
5. **Double-click** on the diagram name.



- Open -** Change the cursor to the Merge cursor and close the *Merge Fault Tree* dialog. Continue following the steps below.
- Double-click -** Change the cursor to the Merge cursor and close the *Merge Fault Tree* dialog. Continue following the steps below.
- Cancel -** Close the *Merge Fault Tree* dialog without merging in a diagram.

6. Position the Merge cursor  over the area where you want to graft in the diagram.
7. Click the mouse. The selected diagram will be grafted in.
OR
8. To cancel the merge operation, right-click the mouse and the cursor will change to the Pick cursor .

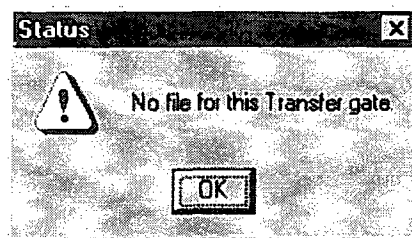
5.3.10.11 Forward Transfer

PURPOSE

This option will display the diagram corresponding to the selected transfer gate in the current fault tree diagram. Any changes made to the current fault tree diagram can be saved before viewing the transfer diagram.

STEPS

1. Select the transfer gate you wish to follow.
2. From the *Fault Tree Editor* menu select **File | Forward Transfer**.
OR
3. Choose the **Forward Transfer** button  on the toolbar.
4. If changes were made to the current diagram, the *Caution* dialog will be displayed.
5. If the diagram corresponding to the transfer gate exists, that will become the current diagram.
6. If no corresponding diagram exists, the *Status* dialog will be displayed.



OK : Close the *Status* dialog.

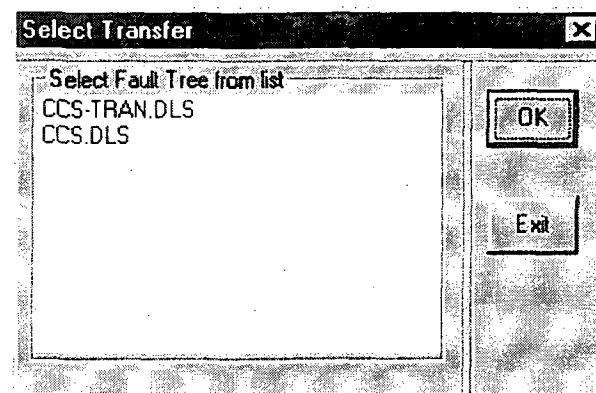
5.3.10.12 Backward Transfer

PURPOSE

This option will list all the diagrams previously viewed in the current chain of transfers, including the current diagram. Select the fault tree diagram you wish to edit. Any changes made to the current fault tree diagram can be saved before viewing the transfer diagram.

STEPS

1. From the *Fault Tree Editor* menu select **File | Backward Transfer**.
OR
2. Choose the **Backward Transfer** button  on the toolbar.
3. The *Select Transfer* dialog will be displayed.
4. Highlight a diagram in the list and choose **OK**.



- OK -** Close the *Select Transfer* dialog and load the selected fault tree diagram. If you have made any changes to the current diagram, the *Caution* dialog will appear.
- Exit -** Close the *Select Transfer* dialog without loading a new diagram.

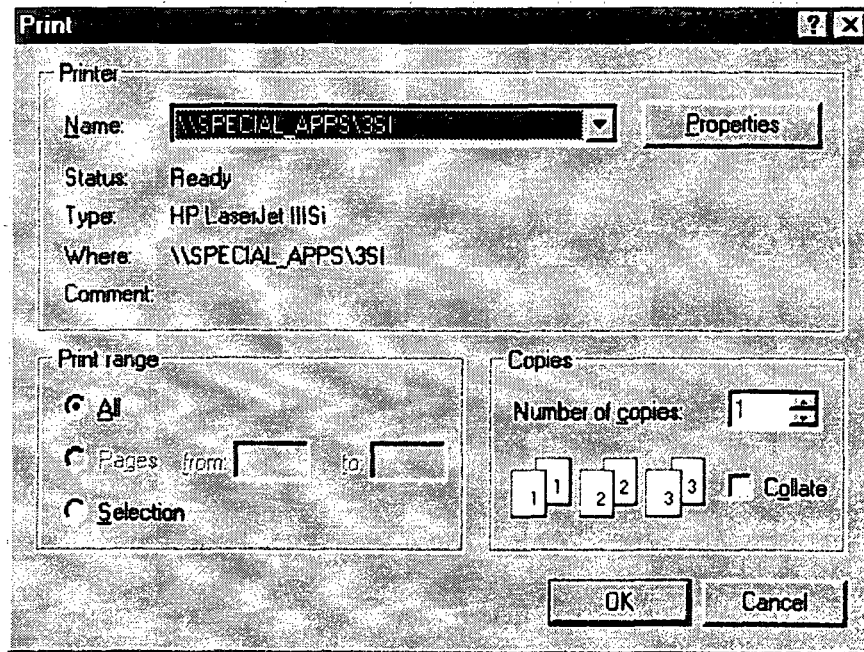
5.3.10.13 *Print*

PURPOSE

This option will print the current diagram to the selected printer. You are provided the opportunity to set additional options, such as page range, number of copies, etc., before printing the diagram.

STEPS

1. From the *Fault Tree Editor* or *Event Tree Editor* or *P&ID Editor* menu select **File | Print**.
OR
2. When in the *Fault Tree Editor*, choose the **Print** button  on the toolbar.
3. The *Print* common dialog will be displayed.

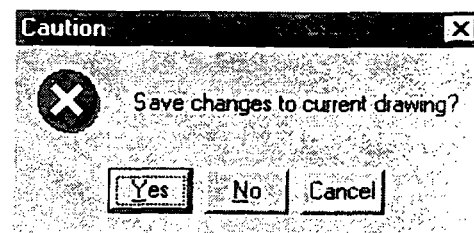


- Name -** List the printers that are set up for this computer.
- Properties -** Set-up options for the selected printer. Available options depend on the features of the printer.
- Status -** Condition of the selected printer.
- Type -** Kind of selected printer.
- Where -** Location of the selected printer.
- Comment -** Miscellaneous information about the selected printer.
- Print Range -** Print the entire document, specified range, or highlighted selection.
- Copies -** Enter the number of copies you wish to print.
- Collate -** For more than one copy, specify whether you want the copies collated.
- OK -** Close the *Print* Dialog and print the current diagram to the selected output device.
- Cancel -** Close the *Print* Dialog without printing the diagram.

5.3.10.14 *Caution: Save Changes To Current Drawing*

PURPOSE

This dialog will appear any time you are leaving the current diagram, which has not been saved. You leave the current diagram by exiting, following a transfer, opening another diagram, or creating a new diagram.



- | | |
|-----------------|--|
| Yes – | The current diagram will be saved to disk, and the next operation (Exit or change diagram) will be performed. |
| No - | The current diagram will not be saved to disk, and the next operation (Exit or change diagram) will be performed. |
| Cancel - | The current diagram will not be saved to disk and the next operation (Exit or change diagram) will not be performed. |

5.3.11 Edit Menu

5.3.11.1 Edit

These options provide editing and text formatting functions.

- | | |
|---------------------|---|
| Cut - | Remove the selected object(s) from the current window. |
| Copy - | Copy the selected object(s) from the current window. |
| Paste - | Copy the contents of the temporary file into the current window at the cursor position. |
| Delete - | Permanently remove the selected object(s) from the current window. |
| Attributes - | Set the attributes of the selected object(s) |

5.3.11.2 Undo

PURPOSE

This feature allows you to undo previous actions. SAPHIRE maintains a list of actions taken by the user in a diagram editing session. When the list contains items, *Undo* will roll back the most recently completed action. Successive undo commands will roll back the next most recent action.

Note: The rollback list is cleared whenever the diagram is saved. (This applies only to user performed saves, not to timed backups.)

STEPS

1. From the *Fault Tree Editor* menu or *Event Tree Editor* menu select **Edit | Undo**.
2. The most recent action will be undone.

5.3.11.3 Cutting Objects

PURPOSE

This option removes objects from the diagram and saves them in the clipboard.

STEPS

1. Select the object(s) you wish to cut.

2. Press the **Ctrl+X** key combination.
OR
3. Choose the **Cut** button  on the toolbar.
OR
4. From the *Fault Tree Editor* or *Event Tree Editor* menu select **Edit | Cut**.
OR
5. **Right-click** to invoke the pop-up menu and select **Cut**.

The selected object(s) will be removed from the diagram and placed in a temporary file as objects, as well as in the clipboard as a bitmap. This bitmap can be pasted (imported) into any document that can copy bitmaps from the clipboard.

5.3.11.4 Copying Objects

PURPOSE

This option copies selected objects from the diagram and places them in the clipboard.

STEPS

1. Select the object(s) you wish to copy.
2. Press the **Ctrl+C** key combination.
OR
3. Choose the **Copy** button  (FTE) or  (ETE) on the toolbar.
OR
4. From the *Fault Tree Editor* or *Event Tree Editor* menu select **Edit | Copy**.
OR
5. **Right-click** to invoke the pop-up menu and select **Copy**.

The selected object(s) will be copied from the diagram and placed in a temporary file as objects, as well as in the clipboard as a bitmap. This bitmap can be pasted (imported) into any document that can copy bitmaps from the clipboard.

5.3.11.5 Pasting Objects

PURPOSE

This option pastes (imports) objects into the current diagram.

STEPS

1. Press the **Ctrl+V** key combination.
OR
2. Choose the **Paste** button  on the toolbar.
OR
3. From the *Fault Tree Editor* or *Event Tree Editor* menu select **Edit | Paste**.
OR

4. **Right-click** to invoke the pop-up menu and select **Paste**.
5. The cursor is changed to the paste cursor .
6. Move the cursor to the location in the diagram where you wish to paste the object(s).
7. **Click** the mouse.

The selected object(s) will be copied the diagram centered, about the cursor.

5.3.11.6 *Deleting Objects*

PURPOSE

This option permanently removes the selected object(s) from the diagram. They are **NOT** put in the clipboard.

STEPS

1. Select the object(s) you wish to delete.
2. Press the **Delete** key.
- OR
3. From the *Fault Tree Editor* or *Event Tree Editor* menu select **Edit | Delete**.

The object(s) will be permanently deleted.

5.3.11.7 *Edit Database*

PURPOSE

This option allows you to modify the event record or gate record associated with the selected shape.

STEPS

1. Select the desired event or gate using the Pick cursor .
2. **Right-click** to invoke the pop-up menu.
3. Choose **Edit Database** from the pop-up menu.
4. The *Modify Event* or *Modify Gate* dialog will be displayed, depending on which shape type you selected.

5.3.11.8 *Temporary File*

DEFINITION

A holding place for objects that have been cut or copied . It is created when the graphical *Fault Tree Editor* is started and is available during the editing session. Objects in the holding file can be pasted into the current diagram. As long as the editing session is not ended and no new objects are cut or copied, the contents of the temporary file can be pasted.

5.3.11.9 *Modifying Attributes*

5.3.11.9.1 *Modifying Attributes*

The attributes of any of the objects in a fault tree diagram can be modified, individually or as a group. Depending on the type of object selected, different attributes can be changed.

STEPS

1. Select the object whose attributes you wish to modify.
2. Right-click to invoke the pop-up menu and choose **Edit**
OR
3. Select **Edit** from the *Fault Tree Editor* menu and choose **Attributes**.

See the following for specific details:

- Modifying Objects (Shapes)
- Modifying Inhibit Gates
- Modifying N/M Gates
- Modifying Lines
- Modifying Text
- Modifying Groups of Objects

5.3.11.9.2 *Modifying Objects*

PURPOSE

This option allows you to modify the attributes of the selected shape object in the diagram.

STEPS

1. Select the object using the Pick cursor .
2. **Right-click** to invoke the pop-up menu and choose **Edit**.
OR
3. Choose **Edit | Attributes** from the menu.
4. The *Shape Definition* dialog will be displayed.

Shape Definition

Name:

Description:

No Water To
The Pump Trains

Text Justification

Horizontal: ☐ Left ☒ Center ☐ Right

Vertical: ☐ Top ☒ Middle ☐ Bottom

Attributes

Type: Or

Shape:

Line:

OK Cancel

Preview: A rectangle containing the text "No Water To The Pump Trains" with a label "CCS-SUPPLY" below it.

- Name –** The name of the selected shape. Enter up to 24 alphanumeric characters. (Embedded spaces are not allowed). The name entered here will be used in the Name field in the SAPHIRE database.
- List –** The available basic events and gates in the database.
- Font -** The font attributes (such as typeface, size, color, etc.) used to display the shape name.
- Description -** Brief description of the shape. Maximum length is 600 characters. The first 60 characters of the text entered here will be used in the Description field in the SAPHIRE database.
- Auto Wrap -** Choose this button to fit the text inside the shape's text region.
- Font -** The font attributes used to display the shape description.
- Text Justification -** The horizontal and vertical alignment of the shape description.

Attributes

- Type -** Change the shape's type by selecting from the drop-down list.
- Shape -** The fill color of the shape.
- Line -** The outline color of the shape.

Cancel - Close the *Shape Definition* dialog without applying the changes.

OK - Close the *Shape Definition* dialog and apply any changes.

5.3.11.9.3 Listing Event/Gates

PURPOSE

This option allows you to select an event or gate name when modifying the attributes of the selected gate.

STEPS

1. Select the desired N/M gate using the Pick cursor .
2. **Right-click** to invoke the pop-up menu and choose **Edit**.
- OR
3. Choose **Edit | Attributes** from the menu.
4. The *Shape Definition* dialog will be displayed.
5. Choose the *List* button. The *Find Event/Gate* dialog will be displayed.

Find Event/Gate	
Name	Description
NAME	Description
C-MOV-1-FAILS	C-MOV-1 Fails To Open
CCS	CCS Fails To Spray Water Into The Containment
CCS-SUPPLY	No Water To The Pump Trains
CCS-TRAIN-A	CCS Train A Fails To Supply Flow
CCS-TRAIN-B	CCS Train B Fails To Supply Flow
CCS-TRAINS	Both Pump Trains Fail To Inject
E-MOV-1-FAILS	E-MOV-1 Fails To Open
ECS	ECS Fails To Inject Water Into The Reactor Vessel
ECS-SUPPLY	No Water To The Pump Trains
ECS-TRAIN-A	ECS Train A Fails To Inject
ECS-TRAIN-B	ECS Train B Fails To Inject
ECS-TRAINS	Both Pump Trains Fail To Inject
FRED	fred

Double-click – Selects the event or name in the list and closes the *Find Event/Gate* dialog.

5.3.11.9.4 Modifying Inhibit Gates

PURPOSE

This option allows you to modify the attributes of the selected inhibit gate.

STEPS

1. Select the desired inhibit gate using the Pick cursor .
2. **Right-click** to invoke up the pop-up menu and choose **Edit**.
OR
3. Choose **Edit | Attributes** form the menu.
4. The *Shape Definition* dialog will be displayed.

- Name -** The name of the gate. Enter up to 24 alphanumeric characters. (Embedded spaces are not allowed). The name entered here will be used in the Name field of the Gate relation in the SAPHIRE data base.
- List -** The available basic events and gates in the database.
- Font -** The font attributes (such as typeface, size, color, etc.) used to display the shape name.
- Event -** The name of the inhibiting basic event. Enter up to 24 alphanumeric characters. (Embedded spaces are not allowed). The name entered here will be used in the Name field of the Event relation in the SAPHIRE data base.
- Description -** Brief description of the gate. Maximum length is 600 characters. The first 60 characters of the text entered here will be used in the Description field of the Gate relation in the SAPHIRE data base.
- Auto Wrap -** Choose this button to fit the text inside the shape's text region.
- Font -** The font attributes used to display the shape description.
- Text Justification -** The horizontal and vertical alignment of the shape description.

Attributes

- | | |
|-----------------|--|
| Type - | Change the shape's type by selecting from the drop-down list. |
| Shape - | The fill color of the shape. |
| Line - | The outline color of the shape. |
|
 | |
| Cancel - | Close the <i>Shape Definition</i> dialog without applying the changes. |
| OK - | Close the <i>Shape Definition</i> dialog and apply any changes. |

5.3.11.9.5 Modifying N/M Gates

PURPOSE

This option allows you to modify the attributes of the selected N/M gate.

STEPS

1. Select the desired N/M gate using the Pick cursor .
2. **Right-click** to invoke the pop-up menu and choose **Edit**.
- OR*
3. Choose **Edit | Attributes** from the menu.
4. The *Shape Definition* dialog will be displayed.

Shape Definition

Name:

Failed Inputs (n): Total Inputs (m):

Description

Horizontal: ☐ Left ☒ Center ☐ Right

Vertical: ☐ Top ☒ Middle ☐ Bottom

Attributes

Type:

Shape:

Line:

Preview: A rectangle with inputs 2 and 5, and the name CCS-1-3 below it.

- Name -** The name of the gate. Enter up to 24 alphanumeric characters. (Embedded spaces are not allowed). The name entered here will be used in the Name field of the Gate relation in the SAPHIRE data base.
- List -** The available basic events and gates in the database.
- Font -** The font attributes (such as typeface, size, color, etc.) used to display the shape name.
- Failed Inputs (n) -** Must be less than the *Total Inputs*. Choose the value by using the buddy-control or enter the value.
- Total Inputs (m) -** Must be greater than 2 and less than 100. Choose the value by using the buddy-control or enter the value
- Description -** Brief description of the gate. Maximum length is 600 characters. The first 60 characters of the text entered here will be used in the Description field of the Gate relation in the SAPHIRE data base.
- Auto Wrap -** Choose this button to fit the text inside the shape's text region.
- Font -** The font attributes used to display the shape description.
- Text Justification -** The horizontal and vertical alignment of the shape description.
- Attributes**
- Type -** Change the shape's type by selecting from the drop-down list.

Shape – The fill color of the shape.
Line – The outline color of the shape.

Cancel - Close the *Shape Definition* dialog without applying the changes.
OK - Close the *Shape Definition* dialog and apply any changes.

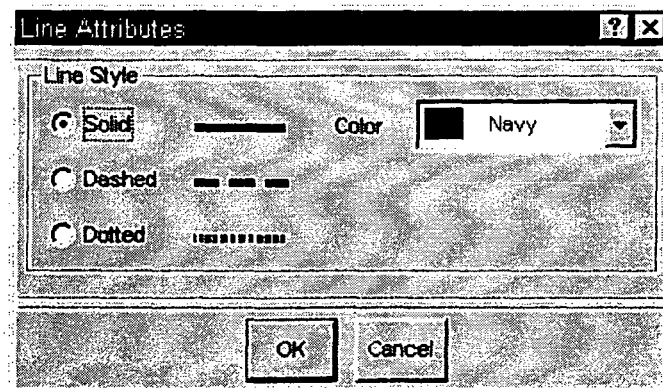
5.3.11.9.6 *Modifying Lines*

PURPOSE

This option allows you to modify the attributes of the selected line in the diagram.

STEPS

1. Select the desired line using the Pick cursor .
2. **Right-click** to invoke the pop-up menu and choose **Edit**.
OR
3. Choose **Edit | Attributes** from the menu.
4. The *Line Attributes* dialog will be displayed.



Line Style - Indicates the line's type (solid, dashed, or dotted). Choose the desired radio button
Color - Indicates the line's color. Select from the drop-down list.
Cancel - Close the *Line Attributes* dialog, without applying the changes.
OK - Close the *Line Attributes* dialog and apply any changes.

5.3.11.9.7 *Modifying Text*

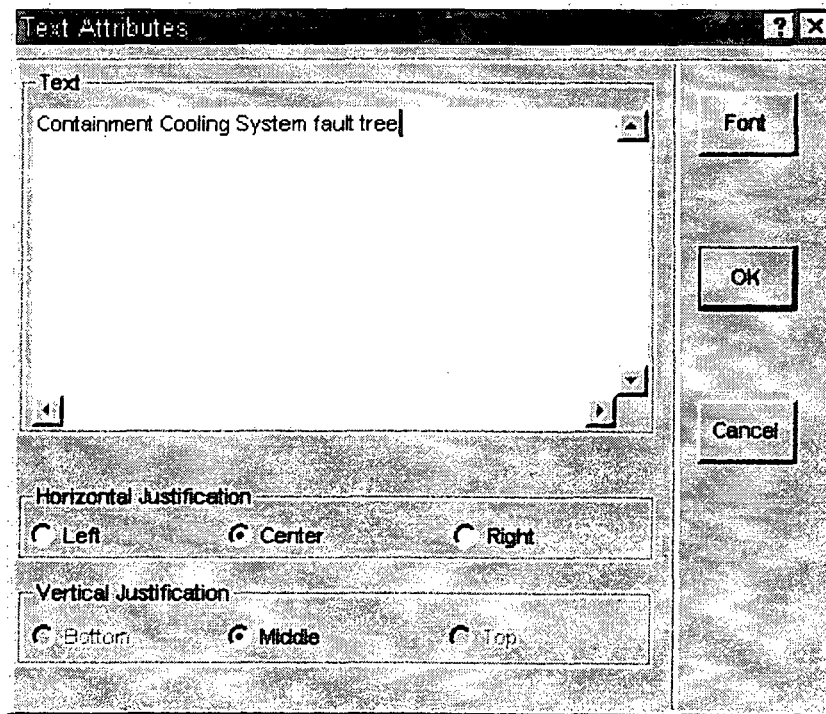
PURPOSE

This option allows you to modify the attributes of the selected text in the diagram.

STEPS

1. Select the desired text using the Text Pick cursor .

2. **Right-click** to invoke the pop-up menu and select **Edit**.
OR
3. Choose **Edit | Attributes** from the menu.
4. The *Text Attributes* dialog will be displayed.



Text -	Descriptive text for a shape or explanatory text for the entire fault tree. Maximum of 600 alphanumeric upper- and lowercase characters.
Horizontal Justification -	The horizontal alignment of the text.
Vertical Justification -	The vertical alignment of the text.
Font -	The font attributes for the text.
Cancel -	Close the <i>Text Attributes</i> dialog without applying the changes.
OK -	Close the <i>Text Attributes</i> dialog and apply any changes.

5.3.11.9.8 Modifying Groups Of Objects

PURPOSE

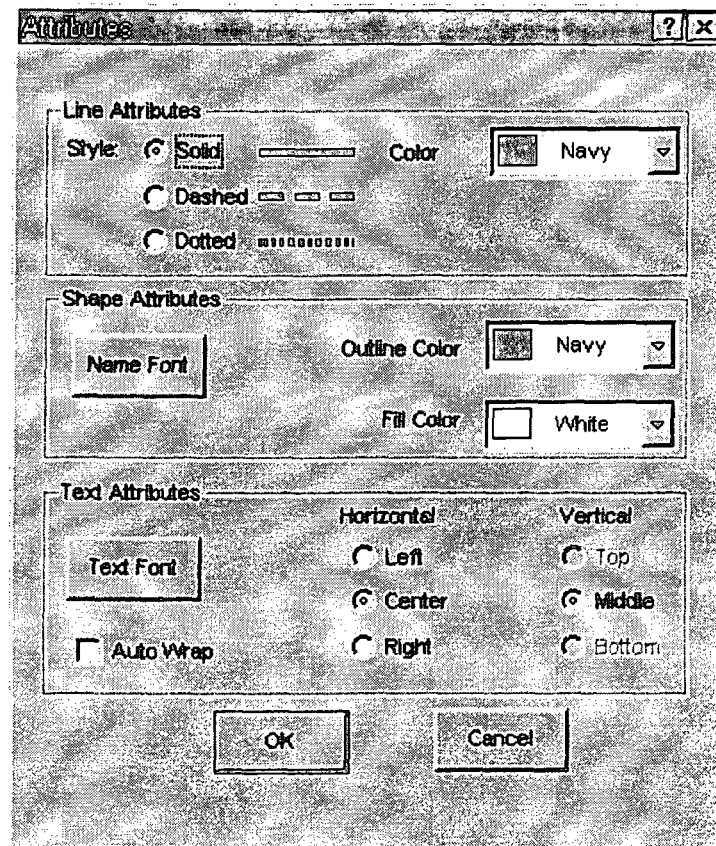
This option allows you to modify the attributes of any selected objects in the diagram. This dialog appears when multiple objects are selected simultaneously.

STEPS

1. Select the desired objects to be changed using the Pick cursor .
2. **Right-click** to invoke the pop-up menu and select **Edit**.

OR

3. Choose **Edit | Attributes** from the menu.
4. The *Attributes* dialog will be displayed.



Line Attributes

- Style -** The line style for all selected lines (solid, dashed, or dotted).
- Color -** The color for all selected connecting lines. Select from the drop-down list.

Shape Attributes

- Name Font -** The font attributes for all the selected shape names.
- Outline Color -** The exterior color for all selected shapes. Select from the drop-down list.
- Fill Color -** The interior color for all selected shapes. Select from the drop-down list.

Text Attributes

- Text Font -** The font attributes for all the selected text objects.
- Horizontal -** The horizontal alignment for all selected text.
- Vertical -** The vertical alignment for all selected text.

- OK-** Close the *Attributes* dialog and apply any changes.

Cancel - Close the *Attributes* dialog without applying the changes.

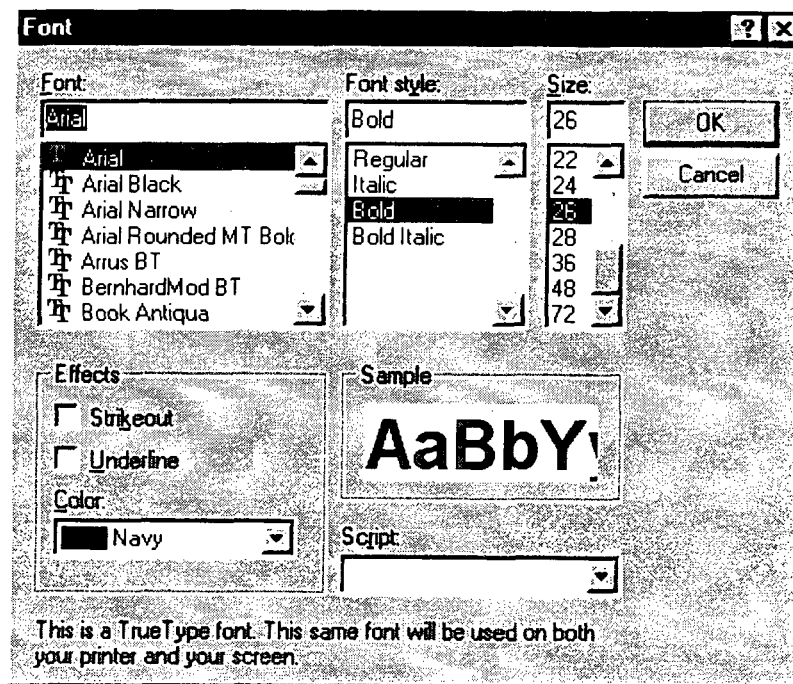
5.3.11.9.9 Font Selection

PURPOSE

This option allows you to change attributes for a text object font or shape name font. This option is accessible from either the *Preferences* dialog or any of the shape attributes dialogs in the *Fault Tree Editor* and from any of the “edit” dialogs in the *Event Tree Editor*.

STEPS

1. In the *Editor* window, select the desired object(s) whose font you want to change.
2. Choose **Edit | Attributes**.
OR
3. Choose **View | Preferences**. (Objects do not need to be selected before invoking this option)
4. On dialog, choose the **Font** button. The *Font* dialog will be displayed.
5. Select the desired font from the list and choose or change the style, size, color, etc.



- Font** - List of available typeface names.
- Font Style** - Bold, italic, bold italic, or regular styles.
- Size** - Point size of the selected typeface.
- Effects** - Underline, strikeout text color.
- Sample** - Example of the appearance of the highlighted font.
- Script** - Character set.

- OK -** Close the *Select Font* dialog and change the font. The font change will not be applied unless the **OK** button on the attributes or *Preferences* dialog is selected.
- Cancel -** Close the *Select Font* dialog without changing the font.

NOTE: The series of steps shown here, illustrate how to access the dialogs from the *Fault Tree Editor* menu. The dialogs can also be accessed via the pop-up menu.

5.3.11.9.10 *Line Style*

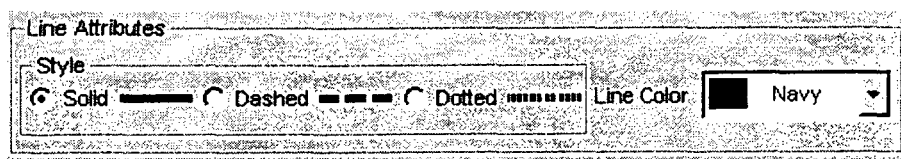
PURPOSE

This option allows you to change the type of line being drawn. This option is accessible from either the *Preferences* dialog or the *Line Attributes* dialog.

STEPS

1. In the *Fault Tree Editor* window, select the desired line(s) whose style you want to change.
2. Choose **Edit | Attributes**.
OR
3. Choose **View | Preferences**. (A line does not need to be selected before invoking this option.)

When the dialog is initially displayed, the style radio button and color are selected for the current default (*Preferences* dialog) or the currently selected line(s) (*Attributes* dialog).



Line Style

Choose the radio button to the left of the desired style. The possible line styles are solid, dashed, and dotted.

Line Color

Choose the line color from the drop-down list.

The line will be redrawn using the new style and color if the **Ok** button is chosen.

NOTE: The series of steps shown here illustrate how to access the dialogs from the *Fault Tree Editor* menu. The dialogs can also be accessed via the pop-up menu.

5.3.11.9.11 *Horizontal Justification*

PURPOSE

Allows you to change the horizontal justification of text. This option is accessible from the *Preferences* dialog, the *Text Attributes* dialog, or the *Attributes* dialog.

Each text object has a pick box that surrounds it called the text box. You can align text on the left or right sides of the text box or center text between the sides of the text box.

STEPS

In the *Fault Tree Editor* window, select the desired text object(s) whose justification you want to change.

1. Choose **Edit | Attributes**.
OR
2. Choose **View | Preferences**. (A text object does not need to be selected before invoking this option.)
3. In the *Horizontal Justification* section, choose the radio button to the left of the desired style.



Left - Align the text along the left side of the text box.

Center - Align the text so it is centered between the two sides of the text box.

Right - Align the text along the right side of the text box.

NOTE: The series of steps shown here illustrate how to access the dialogs from the *Fault Tree Editor* menu. The dialogs can also be accessed via the pop-up menu.

5.3.11.9.12 Vertical Justification

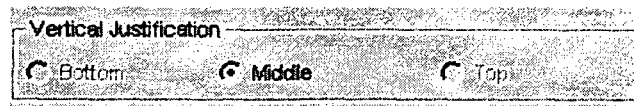
PURPOSE

Allows you to change the vertical justification of text. This option is accessible from the *Preferences* dialog, the *Text Attributes* dialog, or the *Attributes* dialog.

Each text object has a pick box that surrounds it, called the text box. You can align text along the top or bottom of the text box or slightly above the bottom (base) of the text box.

STEPS

1. In the *Fault Tree Editor* window, select the desired text object(s) whose justification you want to change.
2. Choose **Edit | Attributes**.
OR
3. Choose **View | Preferences**. (A text object does not need to be selected before invoking this option.)
4. In the *Vertical Justification* section, choose the radio button to the left of the desired style.



- Bottom -** Align the text at the bottom of the text box.
- Middle -** Align the text in the middle of the text box.
- Top -** Align the text at the top of the text box.

NOTE: The series of steps shown here, illustrate how to access the dialogs from the *Fault Tree Editor* menu. The dialogs can also be accessed via the pop-up menu.

5.3.12 View Menu

5.3.12.1 View

These menu options allow you to change the portion of the current diagram in the viewing window. For simple diagrams with a small number of gates, this is generally not necessary. For larger, more complex diagrams that do not fit on one screen, you may need to view different portions of the diagram. You can move the view window up, down, left, and right using the scroll bars or menu commands. You can change the size of the viewing window by zooming in or out, adjust the diagram to fit inside the viewing window, and restore the view window to its original size.

- Page Up -** Move the viewing window up about one-half page (i.e., screen) above the current location.
- Page Down -** Move the viewing window down about one-half page (i.e., screen) below the current location.
- Page Left -** Move the viewing window left about one-half page (i.e., screen) left of the current location.
- Page Right -** Move the viewing window right about one-half page (i.e., screen) right of the current location.
- Zoom -** Enlarge or shrink a portion of the diagram.
- Normal -** Restore the view window to its original size.
- Fit -** Adjust the diagram to fit inside the view window.
- Zoom Selected -** Enlarge the selected portion of the diagram.
- Preferences -** Change the fault tree graphical editor defaults.
- Refresh -** Redraw the viewing window.

5.3.12.2 Using Scroll Bars To Move The View Window

PURPOSE

This option allows you to change the portion of the diagram in the view window.

STEPS

To move the viewing window to the left slightly:

1. Click on the left arrow in the bottom scroll bar. 
2. The viewing window will move a little to the left.

To move the viewing window to the right slightly:

1. Click on the right arrow in the bottom scroll bar. 
2. The viewing window will move a little to the right.

To move the viewing window up slightly:

1. Click on the up arrow in the scroll bar on the right hand side. 
2. The viewing window will move up a little.

To move the viewing window down slightly:

1. Click on the down arrow in the scroll bar on the right hand side. 
2. The viewing window will move down a little.

To move the viewing window to the left about one-eighth page:

1. Click on bottom scroll bar between the left arrow and the thumb.  The area to click in is highlighted in green in this example.
2. The viewing window will move to the left.

To move the viewing window to the right about one-eighth page:

1. Click on bottom scroll bar between the right arrow and the thumb.  The area to click in is highlighted in green in this example.
2. The viewing window will move to the right.

To move the viewing window up about one-eighth page:



1. Click on bottom scroll bar between the top arrow and the thumb. The area to click in is highlighted in green in this example
2. The viewing window will move up.

To move the viewing window down about one-eighth page:



1. Click on right scroll bar between the bottom arrow and the thumb. The area to click in is highlighted in green in this example.
2. The viewing window will move down.

5.3.12.3 Zooming In/Out

PURPOSE

This option allows you to enlarge or shrink the diagram in the viewing window to change the portion of the diagram that can be seen. It has the effect of magnifying or reducing the diagram size.

STEPS

1. From the *Fault Tree Editor* or *Event Tree Editor* menu select **View | Zoom**.
OR

2. Select the **Zoom** button  (FTE) or  (ETE) from the toolbar.
OR

3. Press the **Ctrl+Z** key combination.

4. The cursor is changed to the Zoom cursor .
5. Move the cursor to the desired location.

To zoom in or magnify the diagram:

1. Click the mouse. The diagram will be magnified by 40%.

To zoom out or reduce the diagram:

1. **Right-click** the mouse. The diagram will be reduced by 40%.

5.3.12.4 *Restore the View Window*

PURPOSE

This option allows you to restore the diagram position in the viewing window to the same relative position as when the diagram file was initially opened. Changes to the objects (i.e., their position, attributes, etc.) are not restored.

STEPS

1. From the Fault Tree Editor or Event Tree Editor menu select **View | Normal**.
OR
2. Press the **Ctrl+N** key combination.
3. The initial position of the diagram is redisplayed.

5.3.12.5 *Fit the View Window*

PURPOSE

This option allows you to adjust the entire diagram to fit inside the viewing window. If the diagram is relatively large, the size of the shapes and text will be reduced so that the entire fault tree can be viewed without scrolling or paging the window. If the diagram is relatively small, the size of the shapes and text will be enlarged so that the diagram fills the window.

STEPS

1. From the *Fault Tree Editor* menu select **View | Fit** or from the *Event Tree Editor* menu select **View | Fit to Screen**.
OR
2. Select the **Fit to Window** button  (FTE) from the toolbar.
OR
3. Press the **Ctrl+F** key combination.
4. The diagram will be enlarged or reduced to fit inside the viewing window.

5.3.12.6 *Zoom 100%*

PURPOSE

This option allows you to resize the diagram to a standard size defined as 100%. The shapes included in all diagrams set to be viewed at 100% will be the same size. Likewise, all text (of matching point size) across diagrams will have the same magnification.

Use this option across diagrams to achieve a uniform magnification. To print a group of diagrams from the Reports menu at this size, diagrams must have been previously saved with this option set.

STEPS

1. From the *Fault Tree Editor* menu select **View | Zoom 100%**.

OR

2. Select the **Standard Size** button  from the toolbar.

OR

3. Press the **Ctrl+1** key combination.

The diagram will be magnified to the standard 100% size.

5.3.12.7 *Zoom Selected*

PURPOSE

This option allows you to enlarge the diagram in the viewing window to change the portion of the diagram that can be seen. It has the effect of magnifying the diagram size.

STEPS

1. Using the pick cursor, outline the area to be enlarged.
2. From the *Fault Tree Editor* menu select **View | Zoom Selected**.
3. The diagram will magnified to display the selected area.

5.3.12.8 *Modifying Preferences*

PURPOSE

This option allows you to modify the preferences for the graphical *Fault Tree Editor*. The changes made here will be reflected in the default values in the **Utility | Define Constants | Fault Tree** option.

STEPS

1. **Right-click** to invoke the pop-up menu.
- OR
2. Select **View** from the menu
 3. Select **Preferences** from the menu. The *Preferences* dialog will be displayed.

Shape Names -

All shapes created following these changes will use the prefixes entered here.

Primary

Gate Name -
Event Name -

Default prefix for the primary gate name.
Default prefix for the primary event name.

Alternate

Gate Name -
Event Name -

Default prefix for the alternate gate name.
Default prefix for the alternate event name.

Shape Attributes -

All shapes created following these changes will use the attributes selected here.

Name Font -
Fill Color -
Outline Color -

The shape name font attributes.
The interior color for shapes. Select from the drop-down list.
The exterior color for shapes. Select from the drop-down list.

Line Attributes -

Style -

Color -

Snap Line to Shape -

All lines created following these changes will use the attributes selected here.

The line style (solid, dashed, or dotted).

The color for connecting lines. Select from the drop-down list.

If checked, lines drawn from any part of one shape to any part of another will be adjusted to connect the two shapes. If not checked, lines will be placed exactly where dropped.

Text Attributes -

Text Font -

Horizontal -

Vertical -

All text objects created following these changes will use the attributes selected here.

The font attributes for text objects.

The horizontal alignment for text objects.

The vertical alignment for text objects.

Other

Show names -

Show Text -

Show Grid -

Show Probabilities -

Show Page Info -

Print Margins -

Background -

Primary Page Label -

Alternate Page Label -

If checked, the names for all shapes will be displayed.

If checked, all descriptive text will be displayed.

If checked, a background grid will be displayed to help align shapes and lines.

If checked, the probabilities of the basic events will be displayed.

If checked, turns on the display of page information at the bottom of the diagram.

Set the top, bottom, left, and right margins, in inches, for printing. Enter the values in real numbers.

Indicates the background color in the editor window. Select from the drop-down list.

The label entered is inserted in front of the page number. This label is used when primary names are displayed and printed.

The label entered is inserted in front of the page number. This label is used when alternate names are displayed and printed.

The alternate name display feature is set in the **Define Constants** option.

OK - Close the *Preferences* dialog and apply any changes.

Cancel - Close the *Preferences* dialog without applying the changes.

5.3.12.9 Default Shape Name

PURPOSE

Define the usage of the default gate and event names in the *Preferences* dialog.

When a new gate is added to the diagram, the entry in the *Gate* field is used as a prefix for every new gate's name. This default gate name prefix is combined with a counter number to form a gate name.

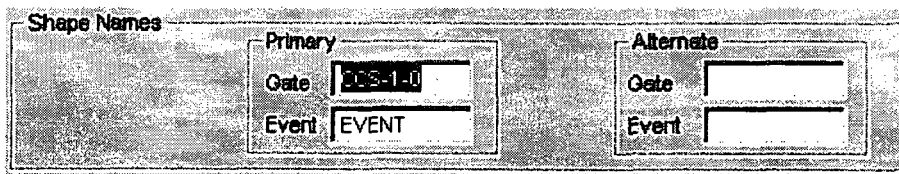
When a new event is added, the entry in the *Event* field is used as a prefix for every new event's name.

This default event name prefix is combined with a counter number to form an event name. The counter number will be incremented by one every time a gate or event is added. The counter number is initialized to 0 every time you start the graphical *Fault Tree Editor*.

For example, suppose that the default gate prefix is GATE and the default event prefix is EVENT. Also suppose that shapes for the fault tree are created in the following order: gate, gate, event, event, gate. The name of the first gate is, by default, GATE0. The name of the next gate is GATE1. The first event added is named EVENT2. The next event added is EVENT3. The last shape in this series is a gate. Its name is GATE4.

STEPS

1. In the *Fault Tree Editor* window, **right-click** to invoke the pop-up menu.
OR
2. Choose **View** from the menu.
3. Select **Preferences** from the menu. The *Preferences* dialog will be displayed.
4. In the *Shape Names* section, enter the desired prefix in the *Gate* or *Event* field.



5.3.13 Search Menu

5.3.13.1 Search

These options provide search and cursor positioning operations.

Find and Replace -	Find a word and replace it with another word.
Find Name -	Find a particular shape or verify that a certain shape exists in the diagram.

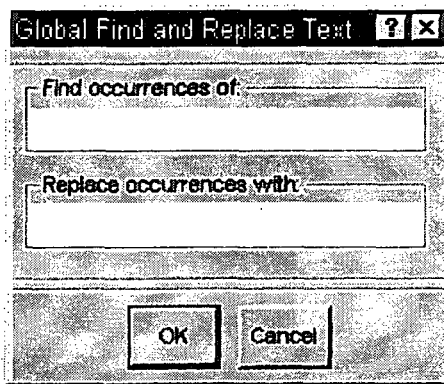
5.3.13.2 Global Find and Replace Text

PURPOSE

This option allows you to find a word (i.e., sequence of alphanumeric characters) and replace it with another word. All descriptive text and shape names will be searched and the replaced if found. The search operation is case-sensitive.

STEPS

1. From the *Fault Tree Editor* menu select **Search**.
2. Select **Find and Replace** from the menu.
3. The *Global Find and Replace Text* dialog will be displayed



Find occurrences of -
Replace occurrences with -
OK -

Enter the word or phrase you wish to replace
 Enter the replacement word or phrase.
 Search for the exact occurrence of the “find” word or phrase and substitute it with the exact replacement word or phrase. The *Global Find and Replace Text* dialog will be closed.
 Close the *Global Find and Replace Text* dialog without performing the search-and-replace operation.

Cancel -

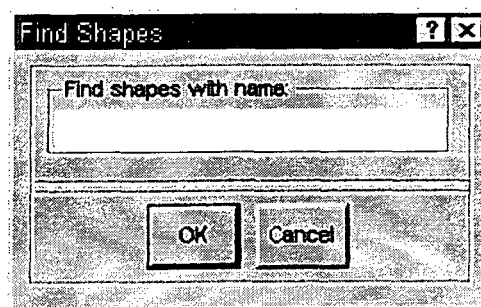
5.3.13.3 *Find Name*

PURPOSE

This option allows you to find a particular shape or verify that a certain shape exists in the diagram. The search operation is case-sensitive.

STEPS

1. From the *Fault Tree Editor* menu select **Search**.
2. Select **Find Name** from the menu.
3. The *Find Shapes* dialog will be displayed.



Find shapes with name -

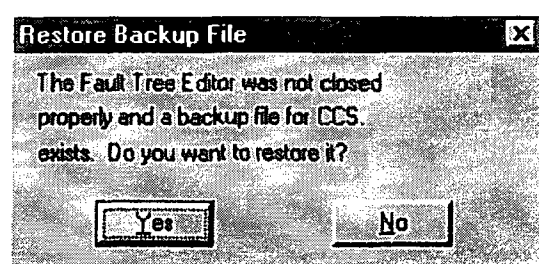
Enter the shape name search criteria (i.e., the name of the shape to perform the search on).

- OK -** Search for the shape whose name exactly matches the entered name and close the *Find Shapes* dialog. The shape matching the search criteria will be highlighted, if found.
- Cancel -** Close the *Find Shapes* dialog without performing the search operation.

5.3.14 Timed Backup

5.3.14.1 Restore Backup File

While editing a fault tree or event tree diagram, SAPHIRE will periodically make a backup of the file. If the editing session terminates abnormally, the next time the fault tree diagram is edited, the *Restore Backup File* dialog will be displayed.



- Yes -** Edit the backup version of the diagram. This option will restore most of the changes made from the aborted editing session.
- No -** Discard the backup version of the diagram. Edit the diagram as it existed prior to the aborted editing session.

5.4 Piping and Instrumentation Diagram Editor

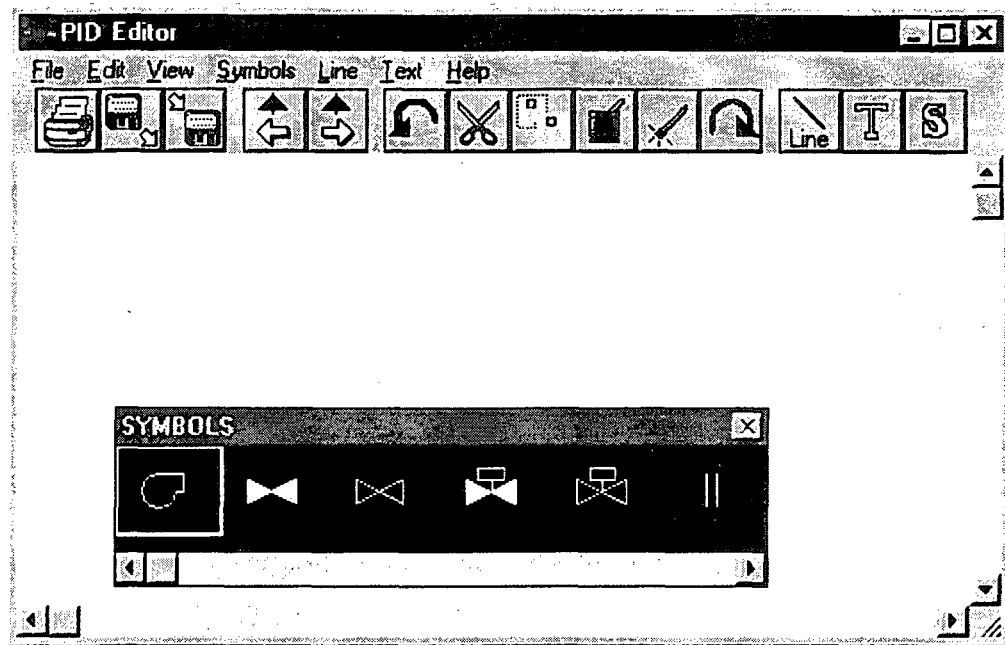
5.4.1 P&ID Graphics

PURPOSE

This graphical editor provides the ability to construct piping and instrumentation flow diagrams using the *Piping & Instrumentation Diagram Editor*. These diagrams are used only for graphical reference and are intended to represent the physical layout of a system.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree. (Skip this step if creating a new P&ID.)
3. Right-click to invoke the pop-up menu and select **Edit P+ID**.
4. The *PID Editor* window will be displayed.



Options are available from the menu and/or the too bar.

Menu Options

- File** - File manipulation functions such as open, save, print, etc.
- Edit** - Editing functions such as copy and paste along with attribute setting.
- View** - Control of visual display such as zoom, refresh, etc.
- Symbols** - Modify symbol attributes such as display of symbol table and color.
- Line** - Modify line attributes such as style and color.
- Text** - Modify text attributes such as color, size, alignment, etc.
- Help** - SAPHIRE on-line help.

Tool Bar Options



Print the current diagram



Open a diagram file from disk



Save a diagram file to disk



Display a previously viewed transfer



Follow a transfer to another diagram.



Not yet available.



Cut an object from the diagram



Copy an object in the diagram



Paste an object into the diagram



Delete an object from the diagram



Rotate an object



Line object



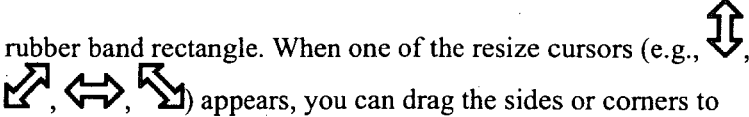
Text object



Symbol object

5.4.2 P&ID Graphics - Definitions

The following definitions are used with reference to the SAPHIRE graphical *P&ID Editor*.

Object -	The building blocks of a piping and instrumentation flow diagram. They include symbols, lines that connect symbols, and descriptive text. Each object has attributes which may include color, size, and name.
Pick Box -	An invisible rectangle which surrounds every object. It defines the area of the object where the mouse cursor must be positioned in order to select the object.
Rubber band rectangle -	A rectangle displayed on the screen showing the area currently selected during a <i>drag</i> function, sometimes referred to as a "region". This is used when selecting more than one object. The region enclosed by the rubber band rectangle can be redefined by positioning the mouse over one of the sides or corners of the rubber band rectangle. When one of the resize cursors (e.g., ) appears, you can drag the sides or corners to adjust the size of the rectangle.
Symbol -	A graphical representation of a component (e.g., pump, valve, etc.).
Line -	A special symbol used to link other symbols together, such as a pipe connecting two valves.

5.4.3 P&ID Graphics - Mouse Usage

All mouse actions defined in the SAPHIRE graphical *P&ID Editor* are for a standard two-button mouse.

Click -	The left mouse button is pressed and released.
Right-click -	The right mouse button is pressed and released.
Double-click -	The left mouse button is pressed and released two times in rapid succession.
Drag -	The left mouse button is pressed and held down while moving the mouse.

5.4.4 Selecting Objects (Regions)

PURPOSE

Prior to changing the attributes of objects (e.g., color, size, etc.) in the diagram, they must be selected. This option describes how to select objects.

STEPS

1. Position the standard cursor  over an area beside the desired object(s).
2. Drag the mouse to form a rubber band rectangle that completely surrounds the object(s).
3. Release the mouse button. The objects inside the rubber band rectangle are now the currently selected objects (i.e., are inside the selected region).
4. Editing functions can now be performed on these objects.

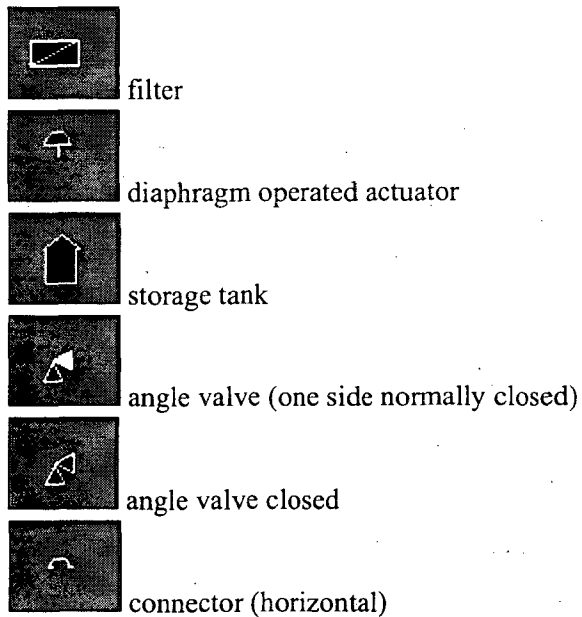
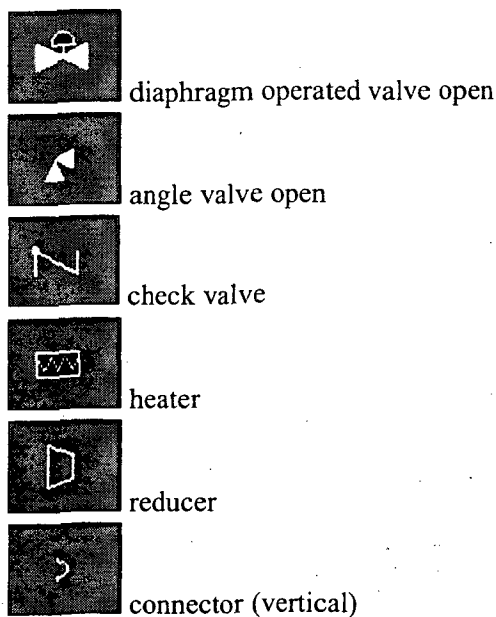
It is important to note that only those items that are completely within the boundaries of the rubber band rectangle will be "selected", except the lines. The rectangle only need to intersect with the lines in order for them to be "selected".

The rubber band rectangle can be redefined by repeating steps 2 and 3 or by using one of the resize cursors.

5.4.5 P&ID Graphics - Standard Symbols

The following are examples of the symbols in the standard P&ID Graphics standard Symbol Table.

	pump (centrifugal)		resistor
	gate valve open		orifice plate
	gate valve closed		solenoid operated
	solenoid operated valve open		vertical drum
	solenoid operated valve closed		And gate
	flange		Nand gate
	three-way valve		Or gate
	solenoid operated butterfly valve		Nor gate
	diaphragm operated butterfly valve		basic event
	diaphragm operated valve closed		house event



5.4.6 File Menu

5.4.6.1 File

These options provide file (diagram) manipulation functions in the *P&ID Editor*.

New -	Create a new file in the editing window.
Open -	Open a file in the editing window
Save -	Save changes in the diagram to disk
Save As -	Save the file in the editing window with a new file name.
Print -	Print the file in the editing window.
Transfer Out -	Display a previously viewed transfer.
Transfer In -	Follow a transfer to another diagram.
New Transfer -	Add a transfer symbol to the diagram.
Load New Symbol Table -	Use a different symbol table.
Defaults -	Change the P&ID graphical editor preferences.
Exit -	Terminate the <i>P&ID Editor</i> . If changes have been made you will be queried if you want to save the file.

5.4.6.2 New

PURPOSE

This option will allow you to clear the window and begin creating a new diagram.

STEPS

1. From the *P&ID Editor* menu select **File | New**.
2. The contents of the window will be cleared and you can begin building a new diagram.

If you have not saved the current diagram you will be prompted by a *Message* dialog to do so.

5.4.6.3 *Open*

PURPOSE

This option will allow you to select an existing diagram (i.e., P&ID graphics file) to view or edit.

STEPS

1. From the *P&ID Editor* menu select **File | Open**.
OR
2. Choose the **Open** button  on the toolbar.
3. The *Open* common dialog will be displayed listing all the P&ID diagrams (.PID files) in the current project directory.

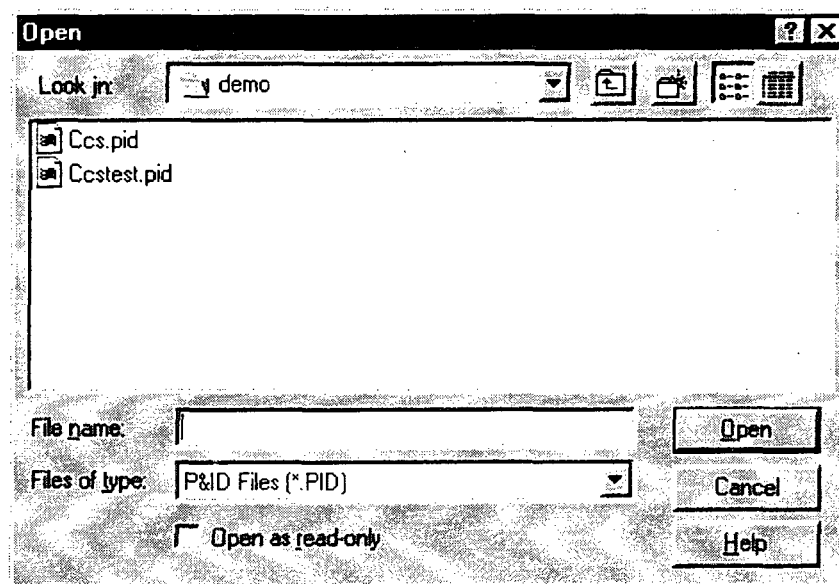
5.4.6.4 *Open Dialog*

PURPOSE

This dialog is displayed with opening an existing diagram or adding a transfer to an existing diagram.

STEPS

1. Select the desired diagram and choose **Open**,
OR
2. Double-click on the diagram name.



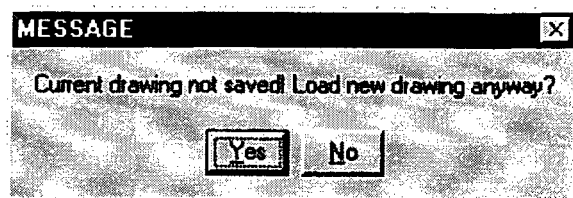
- Look in -** Lists the available folders and files. The box directly below it shows the contents of the current folder. The down-arrow to the right of this field shows how the folder fits into your system hierarchy.
-  Moves up one level in the system hierarchy.
-  Creates a new folder at the current level.
-  Displays the icons and names of the contents of the current folder.
-  Displays the icons, names, size, type, date and time modified, and archive flags of the contents of the current folder.
- File Name -** Contains the name of the file in which the diagram will be saved.
- Files of Type -** Lists the types of files to display. This is useful for narrowing the list of files displayed to only those you are interested in. In this case, only ".PID" files are listed.
- Open -** Open the highlighted diagram file and close the *Open* dialog.
- Cancel -** Close the *Open* dialog without selecting a diagram.
- Double-click -** Open the diagram file and close the *Open* dialog.

If you have selected a diagram to open and you have not saved the current one you will be prompted by a *Message* dialog to do so.

5.4.6.5 *Message : Current Drawing Not Saved*

PURPOSE

This dialog will appear any time you are leaving the current diagram which has not been saved. You leave the current diagram by exiting, following a transfer, opening another diagram, or creating a new diagram.



- Yes -** The current diagram will be saved to disk, and the next operation (Exit or change diagram) will be performed.
- No -** The current diagram will **not** be saved to disk and the next operation (Exit or change diagram) will **not** be performed.

5.4.6.6 *Save*

PURPOSE

This option will save any changes made in the current P&ID diagram to the file presently open. If this is a new diagram, then you will be allowed to name the file.

STEPS

1. From the *P&ID Editor* menu select **File | Save**.

OR

2. Choose the **Save** button  on the toolbar.
 3. If this is not a new diagram, the data is saved.
- OR
4. If this is a new diagram, see **Save As**.

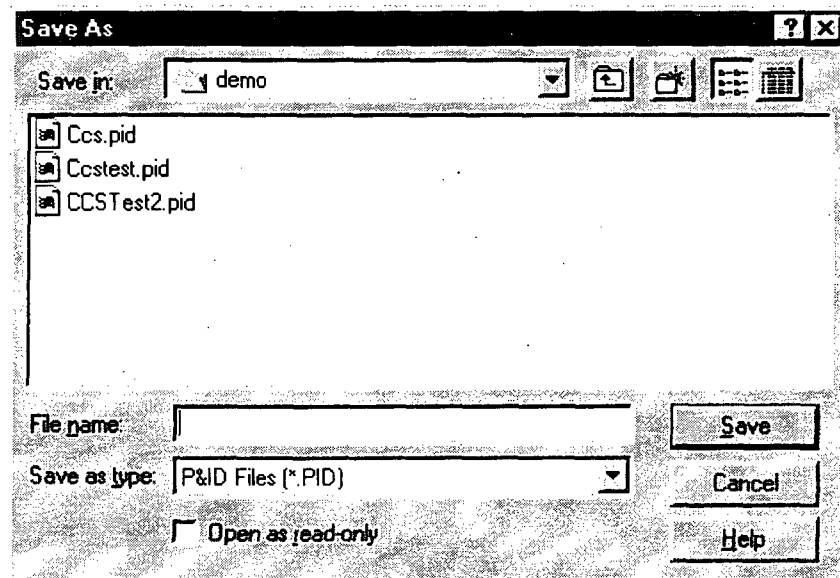
5.4.6.7 **Save As**

PURPOSE

This option will save any changes made in the current P&ID diagram to a file you select.

STEPS

1. From the *P&ID Editor* menu select **File**.
2. Choose **Save as** from the menu
3. The *Save* common dialog will be displayed listing all the P&ID diagrams (.PID files) in the current project directory.
4. Enter the name of the file in the *File Name* field,
OR
5. Select the desired diagram file and choose **Save**,
OR
6. **Double-click** on the diagram name.



Save in -

Lists the available folders and files. The box directly below it shows the contents of the current folder. The down-arrow to the right of this field shows how the folder fits into your system hierarchy.



Moves up one level in the system hierarchy.



Creates a new folder at the current level.

Displays the icons and names of the contents of the current folder.

Displays the icons, names, size, type, date and time modified, and archive flags of the contents of the current folder.

File Name - Contains the name of the file in which the diagram will be saved.

Files of Type - Lists the types of files to display. This is useful for narrowing the list of files displayed to only those you are interested in. In this case, only .PID files are listed.

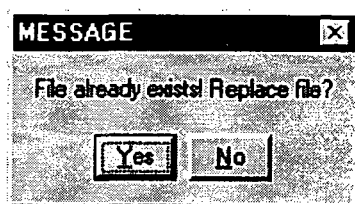
Save - Save the current diagram to the file in the *File name* field and close the *Save* dialog. If an existing file was selected, a warning dialog will be displayed.

Double-click - Save the current diagram to the file in the *File name* field and close the *Save* dialog.

Cancel - Close the *Save* dialog without saving the diagram.

5.4.6.8 Message : File Already Exists

This dialog is displayed when you choose to save the current diagram to an already existing file.



Yes - Save the current diagram to the selected file. The diagram in the existing file will be overwritten.

No - Do not save the current diagram to the select file.

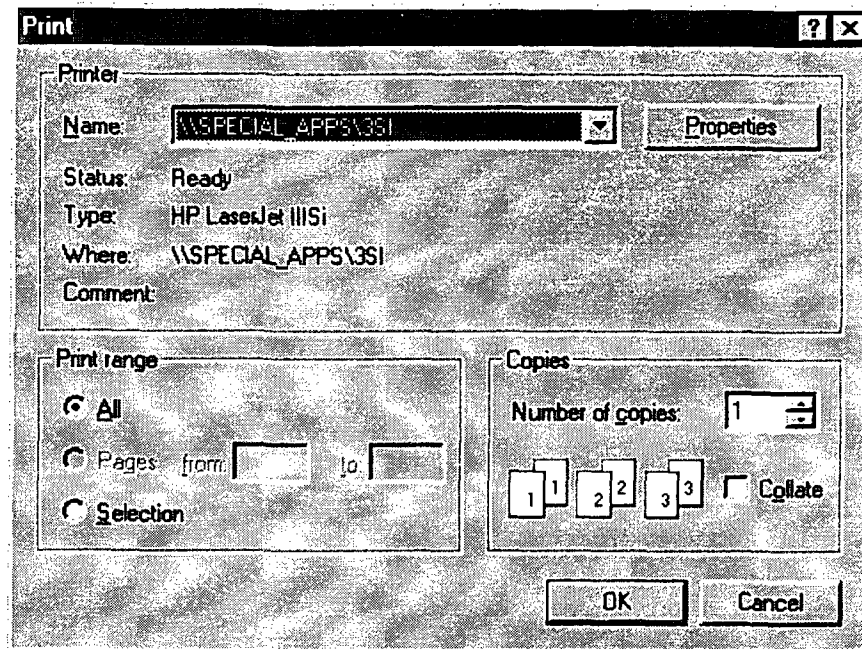
5.4.6.9 Print

PURPOSE

This option will print the current diagram to the selected printer. You are provided the opportunity to set additional options, such as page range, number of copies, etc., before printing the diagram.

STEPS

1. From the *Fault Tree Editor* or *Event Tree Editor* or *P&ID Editor* menu select **File | Print**.
OR
2. When in the *Fault Tree Editor*, choose the **Print** button  on the toolbar.
3. The *Print* common dialog will be displayed.



- Name -** List the printers that are set up for this computer.
- Properties -** Set-up options for the selected printer. Available options depend on the features of the printer.
- Status -** Condition of the selected printer.
- Type -** Kind of selected printer.
- Where -** Location of the selected printer.
- Comment -** Miscellaneous information about the selected printer.
- Print Range -** Print the entire document, specified range, or highlighted selection.
- Copies -** Enter the number of copies you wish to print.
- Collate -** For more than one copy, specify whether you want the copies collated.
- OK -** Close the *Print* Dialog and print the current diagram to the selected output device.
- Cancel -** Close the *Print* Dialog without printing the diagram.

5.4.6.10 Transfer Out

This option is not yet available.

PURPOSE

This option will list all the diagrams previously viewed in the current chain of transfers, including the current diagram. Select the diagram you wish to edit. Any changes made to the current diagram can be saved before viewing the transfer diagram.

STEPS

1. From the *P&ID Editor* menu select **File | Transfer Out**.
- OR

2. Choose the **Transfer Out** button  on the toolbar.

5.4.6.11 *Transfer In*

This option is not yet available.

PURPOSE

This option will display the diagram corresponding to the selected transfer in the current diagram. Any changes made to the current diagram can be saved before viewing the transfer diagram.

STEPS

1. From the *P&ID Editor* menu select **File | Transfer In**.
OR

2. Choose the **Transfer In** button  on the toolbar.

5.4.6.12 *New Transfer*

PURPOSE

This option allows you to add a transfer symbol to the current diagram. The transfer symbol is used to represent a corresponding P&ID file.

STEPS

1. From the *P&ID Editor* menu select **File**.
2. Choose **New Transfer** from the menu.
3. The cursor is changed to the Transfer cursor .
4. Position the cursor over the desired transfer location and click the mouse.
5. The *Open* common dialog will be displayed listing all the P&ID files (.PID files) in the current project directory.
6. Select the desired P&ID file and choose **OK**.
7. The transfer symbol  will be placed in the diagram. The symbol name will be the name of the corresponding file.

5.4.6.13 *Load New Symbol Table*

This option is not yet available.

PURPOSE

This option allows you to use a different symbol table with this diagram.

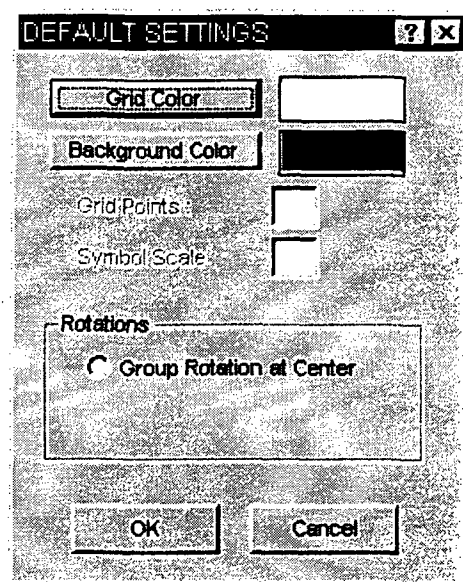
5.4.6.14 Defaults

PURPOSE

This option allows you to modify the preferred defaults for the graphical *P&ID Editor*.

STEPS

1. From the *P&ID Editor* menu select **File**.
2. Choose **Defaults** from the menu.
3. The *Default Settings* dialog will be displayed.



Grid Color -	The color of the grid.
Background Color -	The background color for the window.
Grid Points -	This option is not yet available.
Symbol Scale -	This option is not yet available.
Rotations -	This option is not yet available.
OK -	Apply the changes and close the <i>Default Settings</i> dialog.
Cancel -	Close the <i>Default Settings</i> dialog without applying the changes.

5.4.7 Edit Menu

5.4.7.1 Edit

These options provide editing and text formatting functions in the *P&ID Editor*.

Undo - Undo the previous editing operation.

Cut - Cut selected objects from the diagram.
Copy - Copy selected objects in the diagram.
Paste - Copy the clipboard object into the diagram at the cursor position.
Delete - Remove selected objects from the diagram.
Move - Move selected objects in the diagram.
Rotate - Turn selected objects in the diagram.
Scale - Change the size of selected objects in the diagram.
Flip - Invert selected objects in the diagram.
Symbol Fill Color - Change the symbol interior color.
Symbol Name - Change the name of selected symbols in the diagram.
Symbol Name Font - Change the font for symbol name display.
Line Color - Change the color of selected lines.
Text Attributes - Change the font, color, or alignment of the selected text objects.

5.4.7.2 *Undo*

This option is not yet available.

5.4.7.3 *Cut*

This option is not yet available.

5.4.7.4 *Copy*

PURPOSE

This option copies selected objects in the diagram and allows you to place the copies in another region of the diagram.

STEPS

1. Select the region in the diagram to be copied.
2. From the *P&ID Editor* menu select **Edit | Copy**.
OR
3. Choose the **Copy** button  on the toolbar.
4. Position the cursor in the area of the diagram where you want the copied symbols to be placed.

Click the mouse.

5.4.7.5 *Paste*

This option is not yet available.

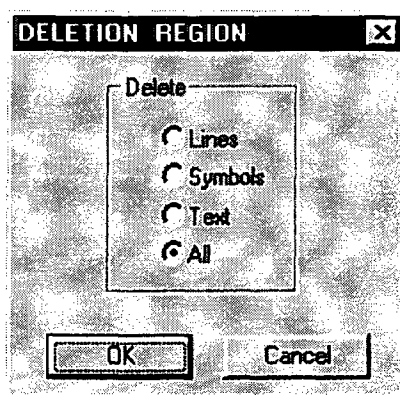
5.4.7.6 *Delete*

PURPOSE

This option deletes selected object(s) from the diagram.

STEPS

1. Select the object(s) in the diagram to be deleted. It is important to note that only those objects that are completely within the boundaries of the rubber band rectangle will be deleted, except for lines. To delete lines, the rectangle only needs to intersect with the lines.
2. From the *P&ID Editor* menu select **Edit | Delete**.
OR
3. Choose the **Delete** button  on the toolbar.
4. The *Delete Region* dialog will be displayed.



Delete

- Lines** - Delete all lines within the selected region.
- Symbols** - Delete all symbols within the selected region.
- Text** - Delete all text within the selected region.
- All** - Delete all objects within the selected region.

OK - Perform the delete operation based on the selected radio button and close the *Delete Region* dialog.

Cancel - Close the *Delete Region* dialog without deleting the selected objects.

5.4.7.7 Move

This option is not yet available.

PURPOSE

This option allows you to move the selected objects to a new location in the diagram.

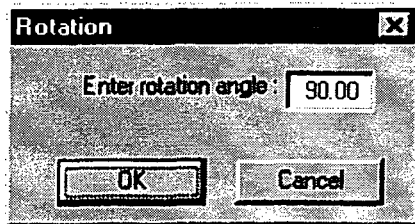
5.4.7.8 Rotate

PURPOSE

This option rotates or turns selected object(s) in the diagram.

STEPS

1. Select the object(s) in the diagram to be rotated.
2. From the *P&ID Editor* menu select **Edit | Rotate**.
OR
3. Choose the **Rotate** button  on the button bar.
4. The *Rotation* dialog will be displayed.



- Enter Rotation Angle** - The angle, in degrees (0 to 360), to turn the object(s).
OK - Rotate the selected object(s) the indicated number of degrees and close the *Rotation* dialog.
Cancel - Close the *Rotation* dialog without rotating the object(s).

5.4.7.9 Scale

This option is not yet available.

PURPOSE

This option allows you to change the size of objects in the diagram.

5.4.7.10 Flip

This option is not yet available.

PURPOSE

This option allows you to invert a symbol. For example, a given symbol may be defined in a particular drawing as having one input and one output. The input is on the left side of the symbol and the output on the right. This defines the flow or direction of the symbol as left to right. However, the logic or drawing may dictate that the flow is going in a right to left direction. Connecting the symbols inappropriately may yield incorrect logic in the diagram. Therefore, the symbol may be flipped to invert the direction of flow through the symbols.

5.4.7.11 Symbol Fill Color

This option is not yet available.

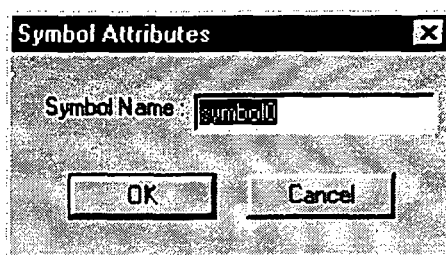
5.4.7.12 Symbol Name

PURPOSE

This option allows you to change the name of the selected symbol(s).

STEPS

1. Select the object(s) in the diagram to be renamed.
2. From the *P&ID Editor* menu select **Edit**.
3. Choose **Symbol Name** from the menu.
4. The *Symbol Attributes* dialog will be displayed.



- Symbol Name** - The current name of the symbol is displayed in this field. Enter the new name by typing over or inserting new text.
- OK** - Apply the change and close the *Symbol Attributes* dialog. If more than one object has been selected, the *Symbol Attributes* dialog will be displayed for each selected object.
- Cancel** - Close the *Symbol Attributes* dialog without changing the name.

5.4.7.13 *Symbol Name Font*

This option is not yet available.

5.4.7.14 *Modify Line Color*

PURPOSE

This option allows you to change the color of the selected line(s).

STEPS

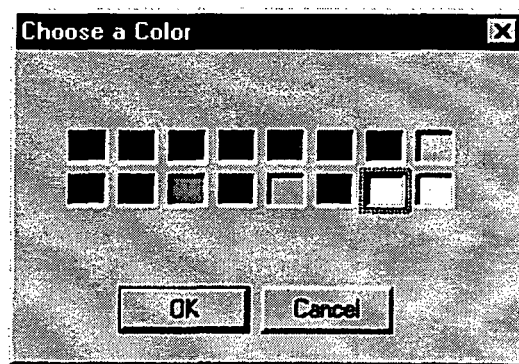
1. Select the desired line(s) in the diagram.
2. From the *P&ID Editor* menu select **Edit**.
3. Choose **Line Color** from the menu.
4. The *Choose a Color* dialog will be displayed.

5.4.7.15 *Choose a Color Dialog*

PURPOSE

This option allows you to change the color of selected objects and of objects created after this change.

Select the desired color by clicking on it.



In the example above the color, yellow, is currently selected.

OK - Change the color of the selected object(s) and close the *Choose a Color* dialog. Objects that are created after this change will be created with this color.

Cancel - Close the *Choose a Color* dialog without applying the color change.

5.4.7.16 *Text Attributes*

PURPOSE

This option allows you to change the font, color, or alignment of the selected text object(s).

STEPS

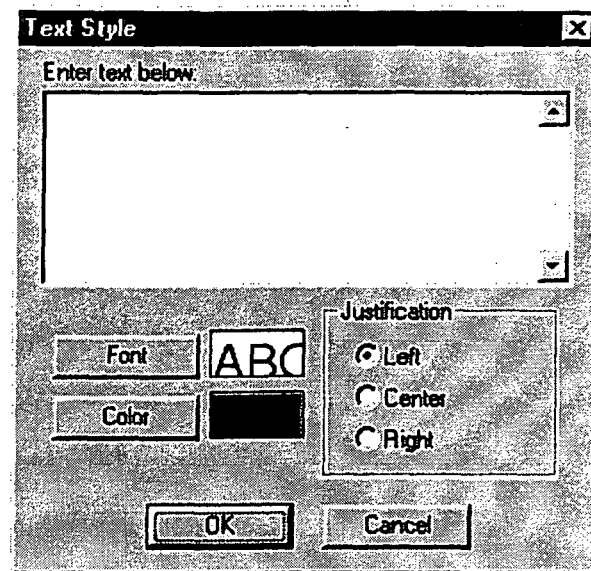
1. Select the desired line(s) in the diagram.
2. From the *P&ID Editor* menu select **Edit**.
3. Choose **Text Attributes** from the menu.
4. The *Text Style* dialog will be displayed.

If you choose the **OK** button on this dialog, the changes will be applied to the selected text. This change will apply to all new text objects.

5.4.7.17 *Text Style Dialog*

PURPOSE

This option allows you to change the font, color, or alignment of the text object(s).



Enter text below: - The alphanumeric characters that make up the text object.
Font - Change the font, font style, or size used to display the text.
Color - Change the color used to display the text.

Justification

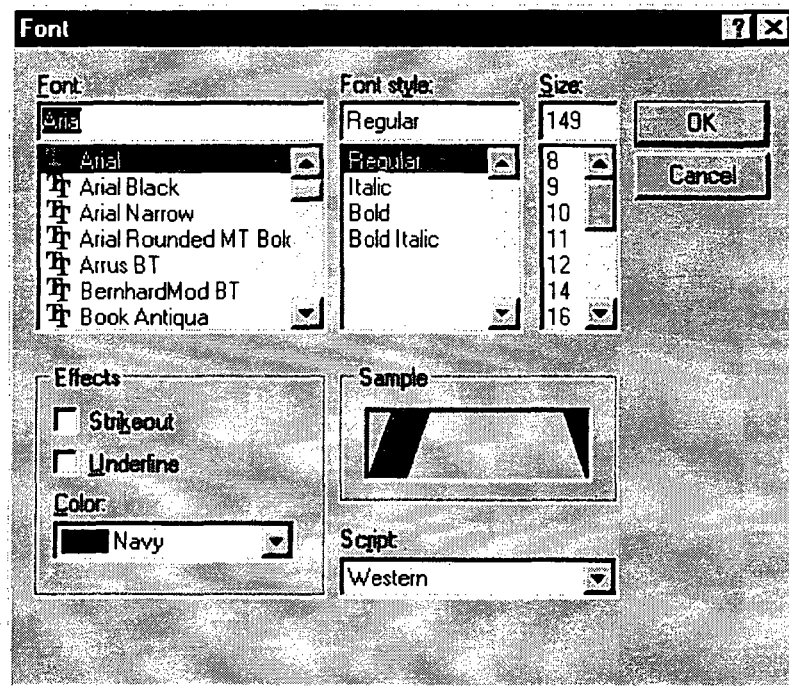
Left - Align the text to the left
Center - Align the text in the center
Right - Align the text to the right

OK - Save the changes and close the Text Style dialog.
Cancel - Close the Text Style dialog without saving the changes.

5.4.7.18 Font/Color Dialog

PURPOSE

This option allows you to change the font and color of the selected text object(s) and all text created after this change.



Font - The currently selected font and list of available fonts. Choose a new font from the drop-down list.

Font Style - The currently selected font style (e.g., bold, italic, etc.) and list of available styles. Choose a new style from the drop-down list.

Size - The currently selected size and list of available sizes. Choose from the drop-down list or enter any positive numeric value.

Effects

Strikeout - Display the text in strikeout mod. (Shown with a horizontal line through the characters.)

Underline - Display the text with an underline.

Color - The currently selected color. Choose a new color from the drop-down list.

Sample - Displays the current color of the text.

Script - Select the script from the drop-down list.

OK - Save the changes and close the *Font* dialog.

Cancel - Close the *Font* dialog without saving the changes.

5.4.8 View Menu

5.4.8.1 View

These menu options allow you to change the portion of the current diagram in the *P&ID Editor* viewing window. You can move the view window up, down, left, and right using the scroll bars or menu commands. You can change the size of the viewing window by zooming in or out, adjust the diagram to the previous zoom window, and restore the view window to its original size.

Zoom In -	“Enlarge” the objects in the viewing window.
Zoom Out -	“Shrink” the objects in the viewing window.
Zoom Restore -	Restore the viewing window to its original size
Zoom Previous -	Restore viewing window to the previous position.
Grid -	Display the background grid.
Snap -	Align objects to the grid.
Show Names -	Display the symbol names in the diagram.
Show Text -	Display text objects in the diagram.

5.4.8.2 Zoom In

PURPOSE

This option allows you to “enlarge” the objects in the viewing window. It has the effect of reducing the total amount of the diagram included in the viewing window.

STEPS

1. From the *P&ID Editor* menu select **View**.
2. Choose **Zoom In** from the menu.
3. The cursor will be changed to the Zoom cursor .
4. Outline the region of the diagram to be enlarged.

5.4.8.3 Zoom Out

PURPOSE

This option allows you to “shrink” the objects in the viewing window. It has the effect of increasing the total amount of the diagram included in the viewing window.

STEPS

1. From the *P&ID Editor* menu select **View**.
2. Choose **Zoom Out** from the menu.

5.4.8.4 Zoom Restore

PURPOSE

This option allows you to restore the diagram position in the viewing window to the same relative position as when the diagram file was initially opened. Changes to the objects (i.e., their position, attributes, etc.) are not restored.

STEPS

1. From the *P&ID Editor* menu select **View**.
2. Choose **Zoom Restore** from the menu.
3. The initial position of the diagram will be redisplayed.

5.4.8.5 *Zoom Previous*

PURPOSE

This option allows you to restore the diagram position in the viewing window to the position just prior to the most recent zoom action. Changes to the objects (i.e., their position, attributes, etc.) are not restored.

STEPS

1. From the *P&ID Editor* menu select **View**.
2. Choose **Zoom Previous** from the menu.
3. The previous position of the diagram will be redisplayed.

5.4.8.6 *Grid*

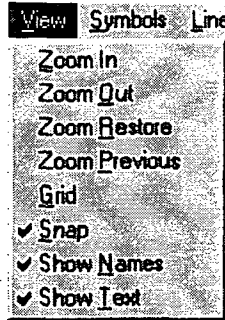
PURPOSE

This option displays a background grid to help align symbols, text, and lines. If selected, a check mark to the left of this menu item will be displayed and the grid will appear in the editing window. If deselected, there will not be a check mark next to the menu item and the background grid will not be displayed. This option acts as a toggle.

STEPS

1. From the *P&ID Editor* menu select **View**.
2. Choose **Grid** from the menu. The background grid will be displayed.

The next time the **View** menu is invoked, a check mark will appear to the left of this item.



In the example of the **View** menu shown here, the **Grid** option is not currently selected.

5.4.8.7 *Snap*

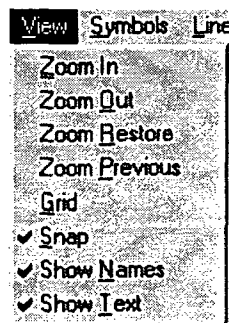
PURPOSE

This option aligns symbols, text, and lines to the grid as they are created. If selected, a check mark to the left of this menu item will be displayed and the snap option will be activated. If deselected, there will not be a check mark next to the menu item and snap option will be deactivated. This option acts as a toggle.

STEPS

1. From the *P&ID Editor* menu select **View**.
2. Choose **Snap** from the menu.

Until this option is deactivated, objects created or in the diagram will be aligned with the grid. The next time the **View** menu is invoked, a check mark will appear to the left of this item.



In the example of the **View** menu shown here, the **Snap** option is currently selected.

5.4.8.8 *Show Names*

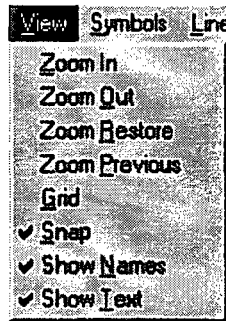
PURPOSE

This option allows you to display the symbol names. If selected, a check mark to the left of this menu item will be displayed and the symbol names will appear in the editing window. If deselected, there will not be a check mark next to the menu item and the symbol names will not be displayed. This option acts as a toggle.

STEPS

1. From the *P&ID Editor* menu select **View**.
2. Choose **Show Names** from the menu. The symbol names will be displayed.

The next time the **View** menu is invoked, a check mark will appear to the left of this item.



In the example of the **View** menu shown here, the **Show Names** option is currently selected.

5.4.8.9 Show Text

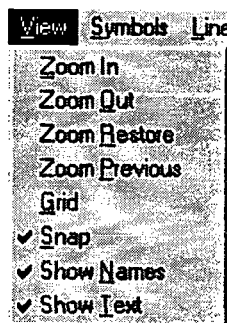
PURPOSE

This option allows you to display text objects in the diagram. If selected, a check mark to the left of this menu item will be displayed and the text objects will appear in the editing window. If deselected, there will not be a check mark next to the menu item and the text objects will not be displayed. This option acts as a toggle.

STEPS

1. From the *P&ID Editor* menu select **View**.
2. Choose **Show Text** from the menu. The text objects will be displayed.

The next time the **View** menu is invoked, a check mark will appear to the left of this item.



In the example of the **View** menu shown here, the **Text** option is currently selected.

5.4.9 Symbols Menu

5.4.9.1 Symbols

These menu options allow you to modify symbol attributes in the *P&ID Editor*.

- Symbol Table** - Display the Symbol Table.
- Color** - Set the default symbol fill color.
- Draw** - Add a symbol to the diagram.

5.4.9.2 Symbol Table

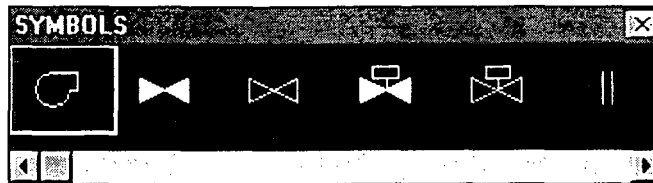
PURPOSE

This option allows you to display the symbol table. If selected, a check mark to the left of this menu item will be displayed and the symbol table will appear in the editing window. If deselected, there will not be a check mark next to the menu item and the symbol table will not be displayed. This option acts as a toggle.

The symbol table is used to select a symbol and place it in the diagram.

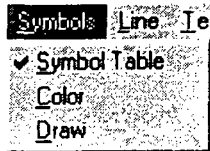
STEPS

1. From the *P&ID Editor* menu select **Symbols**.
2. Choose **Symbol Table** from the menu. The *Symbol Table* will be displayed.



As shown, this table contains a graphic representation of each symbol in the current symbol file. The symbol table is capable of displaying six symbols at one time. If there are more symbols contained within the current symbol-file, the horizontal scroll bar will be available.

The next time the Symbols menu is invoked, a check mark will appear to the left of this item.



In the example of the **Symbols** menu shown here, the **Symbol Table** option is currently selected.

5.4.9.3 Symbol Color

PURPOSE

This option allows you to set the fill (interior) color of the symbol(s) that will be created following this selection.

STEPS

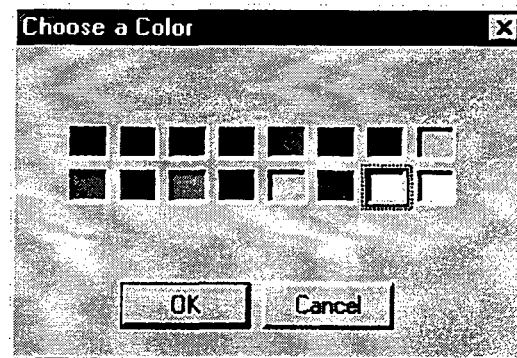
1. From the *P&ID Editor* menu select **Symbols**.
2. Choose **Color** from the menu. The *Choose a Color* dialog will be displayed.

5.4.9.4 *Choose a Color Dialog*

PURPOSE

This option allows you to change the color of selected objects and of objects created after this change.

Select the desired color by clicking on it.



In the example above the color, yellow, is currently selected.

OK - Change the color of the selected object(s) and close the *Choose a Color* dialog. Objects that are created after this change will be created with this color.

Cancel - Close the *Choose a Color* dialog without applying the color change.

5.4.9.5 *Draw Symbol*

PURPOSE

This option allows you to add a new symbol to the diagram.

STEPS

1. Select the desired symbol from the Symbol Table, if not currently selected.

2. From the *P&ID Editor* menu select **Symbols | Draw**.
OR
3. Choose the **Symbol** button  on the toolbar.
4. The cursor will change to the Symbol cursor .
5. Place the cursor over the desired position in the diagram.
6. **Click** the mouse. The symbol will be placed in the diagram.

The cursor will remain the Symbol cursor. Repeat steps 3 and 4 as many times as desired. Right-click to change the cursor to the standard cursor.

5.4.10 Line Menu

5.4.10.1 Line

These menu options allow you to modify line attributes in the *P&ID Editor*.

Style -	Set the default line style and color.
Orthogonal -	Set the default line style to orthogonal. (Draw lines at right angles.)
Color -	Set the default line color.
Draw -	Add a line to the diagram.

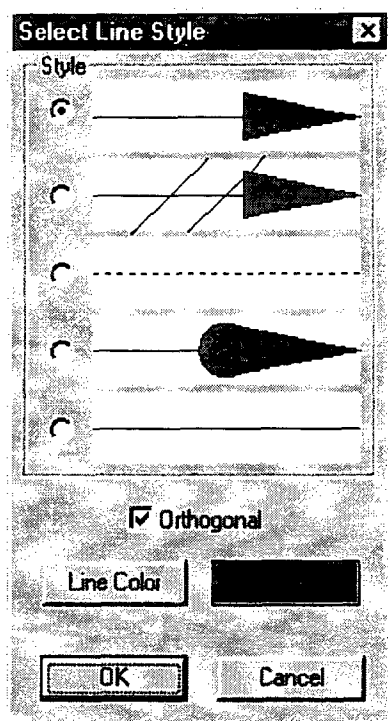
5.4.10.2 Line Style

PURPOSE

This option allows you to set the style of the line(s) that will be created following this selection.

STEPS

1. From the *P&ID Editor* menu select **Line**.
2. Choose **Style** from the menu.
3. The *Select Line Style* dialog will be displayed.



- Style -** Select one of the five desired line styles:
- Orthogonal -** Draw lines at right angles.
- Line Color -** Select the color of lines that will be drawn following this selection.
- OK -** Save the changes and close the *Select Line Style* dialog.
- Cancel -** Close the *Select Line Style* dialog without saving the changes.

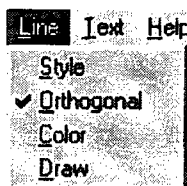
5.4.10.3 Orthogonal

PURPOSE

This option allows you to set the line style so that they will be drawn with right angles between connected symbols that are not directly horizontally or vertically aligned. If selected, a check mark to the left of this menu item will be displayed. If deselected, there will not be a check mark next to the menu item. This option acts as a toggle.

STEPS

1. From the *P&ID Editor* menu select **Line**.
2. Choose **Orthogonal** from the menu.



In the example of the **Line** menu shown here, the **Orthogonal** option is currently selected.

NOTE: This option can also be set on the *Select Line Style* dialog.

5.4.10.4 *Line Color*

PURPOSE

This option allows you to set the color of the line(s) and symbol outline(s) that will be created following this selection.

STEPS

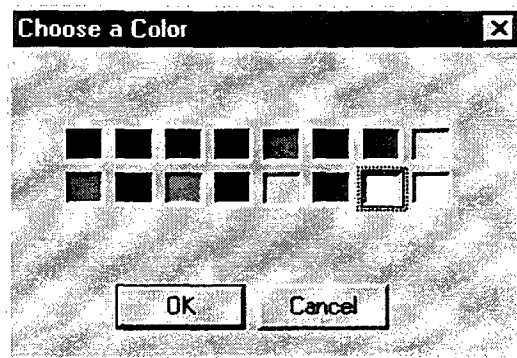
1. From the *P&ID Editor* menu select **Line**.
2. Choose **Color** from the menu.
3. The *Choose a Color* dialog will be displayed.

5.4.10.5 *Choose a Color Dialog*

PURPOSE

This option allows you to change the color of selected objects and of objects created after this change.

Select the desired color by clicking on it.



In the example above the color, yellow, is currently selected.

OK - Change the color of the selected object(s) and close the *Choose a Color* dialog. Objects that are created after this change will be created with this color.

Cancel - Close the *Choose a Color* dialog without applying the color change.

5.4.10.6 *Draw Line*

PURPOSE

This option allows you to add a new line to the diagram.

STEPS

1. From the *P&ID Editor* menu select **Line | Draw**.

OR

2. Choose the **Line**  button on the toolbar.
The cursor will change to the Line cursor .
3. Place the cursor over the desired position for an endpoint for the line in the diagram and click the mouse.
4. Move the cursor to the next endpoint position and click the mouse.

The cursor will remain the Line cursor. Repeat step 5 as many times as desired. Right-click to change the cursor to the standard cursor.

5.4.11 Text Menu

5.4.11.1 Text

These menu options allow you to modify text attributes in the *P&ID Editor*.

Font -	Set the text font.
Draw -	Add a text object to the diagram
Left Justify -	Set default text alignment to the left of the text box.
Center -	Set default text alignment to the center of the text box.
Right Justify -	Set default text alignment to the right of the text box.

5.4.11.2 Font

PURPOSE

This option allows you to set the font and color of the text object(s) and symbol name(s) that will be created following this selection.

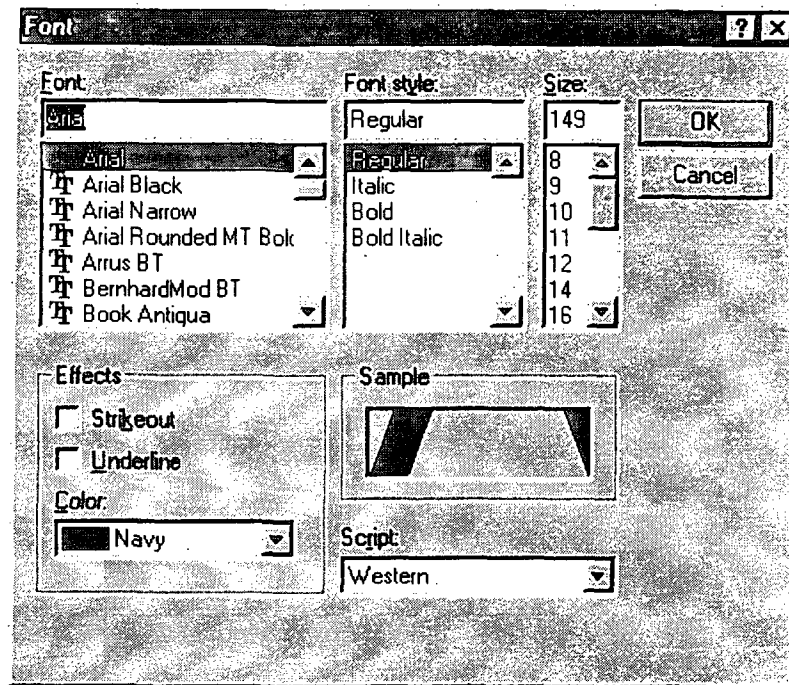
STEPS

1. From the *P&ID Editor* menu select **Text**.
2. Choose **Font** from the menu. The *Font* dialog will be displayed.

5.4.11.3 Font/Color Dialog

PURPOSE

This option allows you to change the font and color of the selected text object(s) and all text created after this change.



Font - The currently selected font and list of available fonts. Choose a new font from the drop-down list.

Font Style - The currently selected font style (e.g., bold, italic, etc.) and list of available styles. Choose a new style from the drop-down list.

Size - The currently selected size and list of available sizes. Choose from the drop-down list or enter any positive numeric value.

Effects

Strikeout - Display the text in strikeout mod. (Shown with a horizontal line through the characters.)

Underline - Display the text with an underline.

Color - The currently selected color. Choose a new color from the drop-down list.

Sample - Displays the current color of the text.

Script - Select the script from the drop-down list.

OK - Save the changes and close the *Font* dialog.

Cancel - Close the *Font* dialog without saving the changes.

5.4.11.4 Draw Text

PURPOSE

This option allows you to add a new text object to the diagram.

STEPS

1. From the *P&ID Editor* menu select **Text | Draw**.
OR
2. Choose the **Text** object button  on the toolbar.
3. The *Text Style* dialog will be displayed.
4. Enter the desired text and set the desired font and color. Choose **OK**.
5. The cursor will change to the Text cursor .
6. Place the cursor over the desired position in the diagram.
7. Click the mouse. The text object will be placed in the diagram.

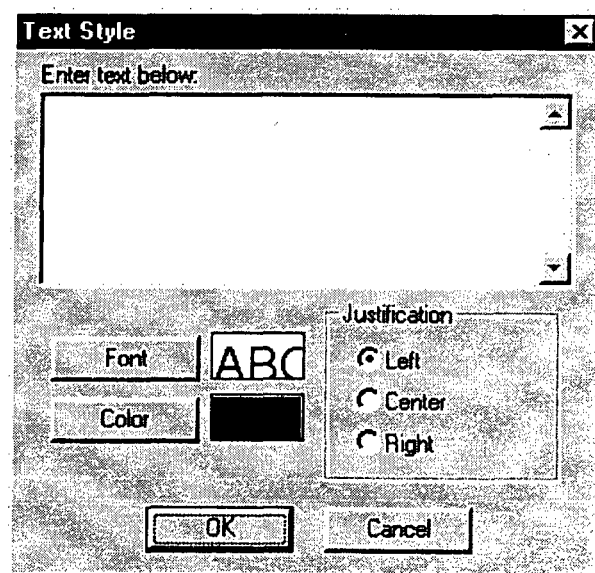
The cursor will change to the standard cursor when step 7 is complete.

To cancel the operation after step 6, right-click and the cursor will change to the standard cursor.

5.4.11.5 *Text Style Dialog*

PURPOSE

This option allows you to change the font, color, or alignment of the text object(s).



Enter text below: - The alphanumeric characters that make up the text object.

Font - Change the font, font style, or size used to display the text.

Color - Change the color used to display the text.

Justification

- Left -** Align the text to the left
- Center -** Align the text in the center
- Right -** Align the text to the right

OK - Save the changes and close the Text Style dialog.

Cancel - Close the Text Style dialog without saving the changes.

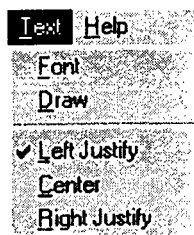
5.4.11.6 *Left Justify*

PURPOSE

This option allows you to set the text alignment so that text objects created after this change will be aligned along the left side of the text object box.

STEPS

1. From the *P&ID Editor* menu select **Text**.
2. Choose **Left Justify** from the menu. A check mark to the left of this menu item will be displayed the next time the Text menu is invoked. The prior text alignment option will be deselected.



In the example of the **Text** menu shown here, the **Left Justify** option is currently selected.

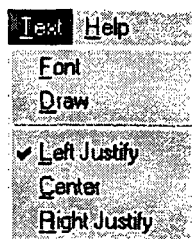
5.4.11.7 *Center*

PURPOSE

This option allows you to set the text alignment so that text objects created after this change will be centered inside the text object box.

STEPS

1. From the *P&ID Editor* menu select **Text**.
2. Choose **Center** from the menu. A check mark to the left of this menu item will be displayed the next time the Text menu is invoked. The prior text alignment option will be deselected.



In the example of the **Text** menu shown here, the **Center** option is NOT currently selected.

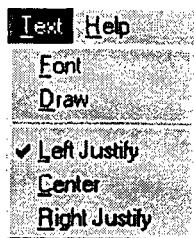
5.4.11.8 *Right Justify*

PURPOSE

This option allows you to set the text alignment so that text objects created after this change will be aligned along the right side of the text object box.

STEPS

1. From the *P&ID Editor* menu select **Text**.
2. Choose **Right Justify** from the menu. A check mark to the left of this menu item will be displayed the next time the Text menu is invoked. The prior text alignment option will be deselected.



In the example of the **Text** menu shown here, the **Right Justify** option is NOT currently selected.

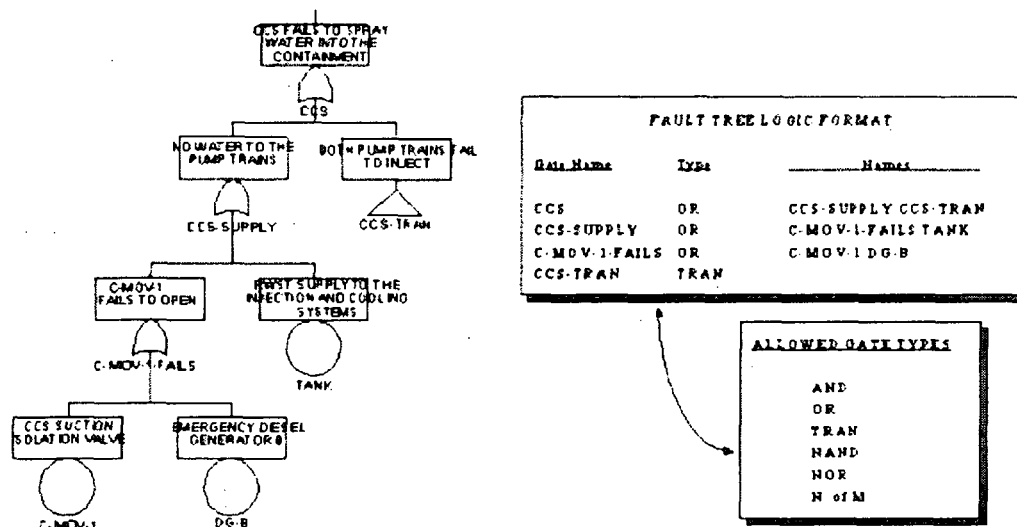
5.5 Fault Tree Logic Editor

5.5.1 Interpreting Alphanumeric Fault Tree Logic

PURPOSE

This example illustrates how the CCS graphical fault tree is presented in an alphanumeric format.

Containment Cooling Fault Tree



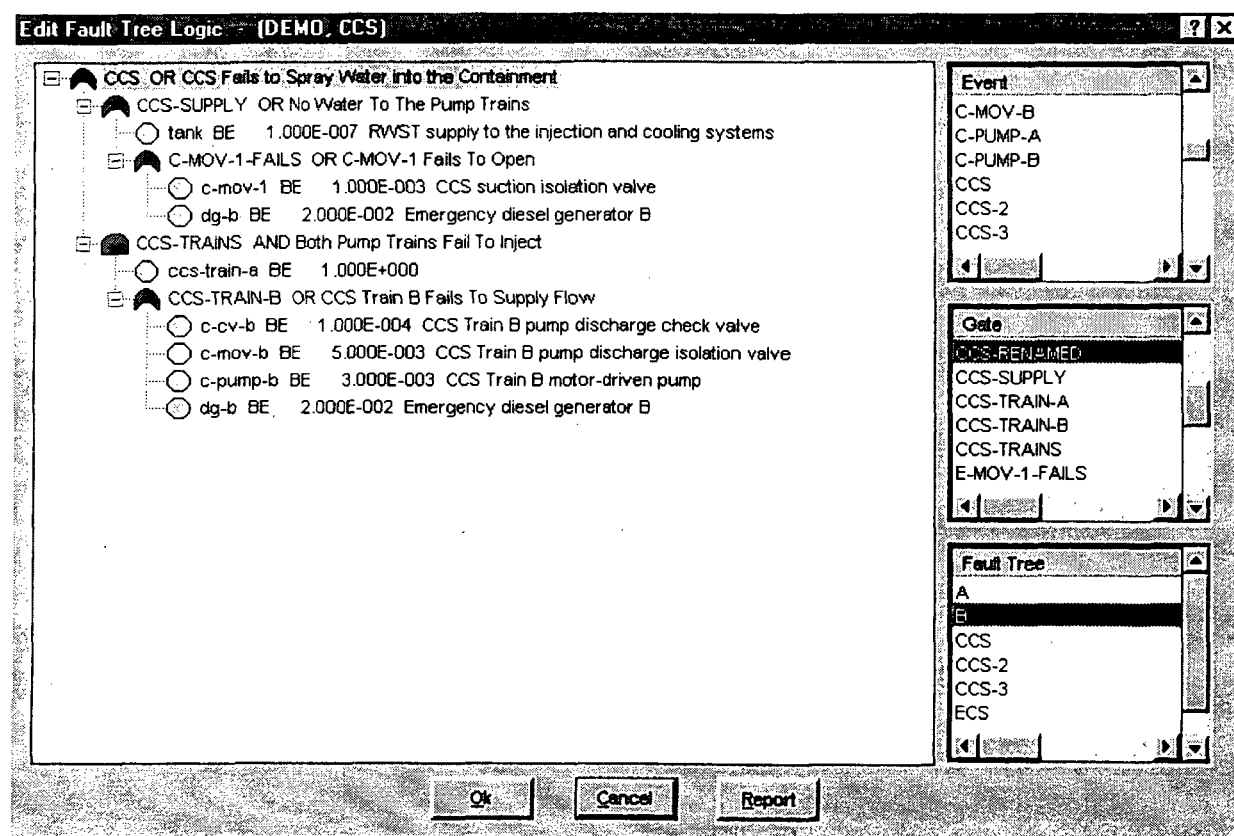
5.5.2 Fault Tree Logic Editor

PURPOSE

This option provides a means for editing the fault tree logic in an alphanumeric format. All gates, types, and inputs contained in the selected fault tree or sub-tree will be displayed. The fault tree logic editor is a convenient tool for quickly editing fault tree logic and entering gate and basic event data.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and select the **Edit Logic** option.
4. The *Edit Fault Tree Logic* dialog will be displayed.



As shown here, the logic is represented in the form of a hierarchical tree, where each gate can be expanded or condensed by clicking on the gate. See the topic, "About Logic Dialogs," for a description of the icons presented on this dialog.

Logic Tree View Pop-up Menu Options

Modify - Edit the selected basic event or gate logic .

Insert

Gate - Add a new gate to the database and insert it into the logic.

Event - Add a new basic event to the database and insert it into the logic.

Top Gate - Add a new or existing gate to the logic at the top level.

Delete - Remove the gate or basic event from the logic.

Find - Locate a specific basic event or gate in the logic.

Move - Move the selected gate or basic event to another location in the logic.

Follow Transfer - Follow the selected transfer. Available only when a transfer gate is selected.

Transfer Back - Follow the transfer back to the original tree. Available only after a transfer has been followed.

Rename Top - Change the name of the top gate. Available only when the top gate is selected.

Event Pop-up Menu Options

Add - Add a new event to the database.

Modify - Edit the selected basic event.

Select - Insert the selected basic event in the list to the selected point in the logic tree view.

Gate Pop-up Menu Options

Add - Add a new gate to the database.

Modify - Edit the selected gate.

Select - Insert the selected gate in the list to the selected point in the logic tree view.

Fault Tree Pop-up Menu Options

Add - Add a new fault tree to the database.

Modify - Edit the selected fault tree .

Select - Insert the selected fault tree as a transfer.

Edit - Load and edit the selected fault tree logic. If changes have been made to the current tree, you will be prompted to save those changes before switching to the selected fault tree.

Button Options

Report - Generate a report displaying the logic.

Ok - Save the changes made to the logic and close the *Edit Fault Tree Logic* dialog.

Cancel - Close the *Edit Fault Tree Logic* dialog without saving changes to the logic.

5.5.3 Modify Gate Logic

PURPOSE

This option allows you to edit the inputs to and/or the type of the selected gate.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and select the **Edit Logic** option.
4. From the *Edit Fault Tree Logic* dialog, select the gate in the tree to be modified.
5. Right-click to invoke the pop-up menu and select the **Modify** option.
6. The *Edit* dialog will be displayed showing the gate name, type and description along with its inputs.

Edit

Name: CCS-SUPPLY Type: Or

Description: No Water To The Pump Trains

Inputs

TANK	1.000E+000	RWST supply to the injection and cooling systems
C-MOV-1-FAILS	OR	C-MOV-1 Fails To Open

Buttons: Add Event, Edit, Complement, Add Gate, Delete, Toggle Type, Ok, Cancel

Gate Options

Change the gate type by choosing from the *Type* drop-down list.

Input Options

- Add Event -** Add a new event as an input to the current gate.
- Add Gate -** Add a new gate as an input to the current gate.
- Edit -** Modify the gate or event currently highlighted in the *Inputs* list.
- Delete -** Remove the highlighted event or gate from the *Inputs* list.
- Complement -** Change the highlighted event or gate to its complement.
- Toggle Type -** Change the highlighted gate to an event, or event to a gate.
- Ok -** Close the *Edit* dialog and save the changes.
- Cancel -** Close the *Edit* dialog without saving the changes.

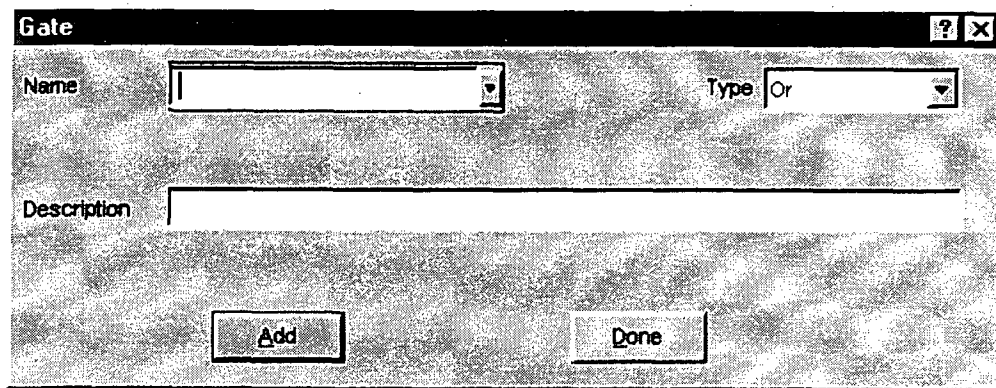
5.5.4 Add Gate as Input

PURPOSE

This option allows you to add a gate as an input to the currently selected gate. The new gate will be displayed in the *Inputs* list and the hierarchical tree.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and select the **Edit Logic** option. The *Edit Fault Tree Logic* dialog will be displayed.
4. Right-click to invoke the pop-up menu and select the **Insert Top** option.
OR
5. Highlight the gate to be modified.
6. Right-click to invoke the pop-up menu and select the **Modify** option.
7. The *Edit* dialog will be displayed showing the gate name, type and description along with its inputs.
8. Choose the **Add Gate** button.
9. The *Gate* dialog will be displayed.



Add - Add the gate as an input to the current gate. The dialog will remain open so you may continue to add gates.

Done - Close the *Gate* dialog without adding the gate as an input to the current gate.

5.5.5 Gate Name

This is a required field. Choose from the drop-down list or enter a new name. A maximum of 24 uppercase, alphanumeric characters may be entered. Embedded blanks are not allowed. The name should be descriptive so it can be readily identified.

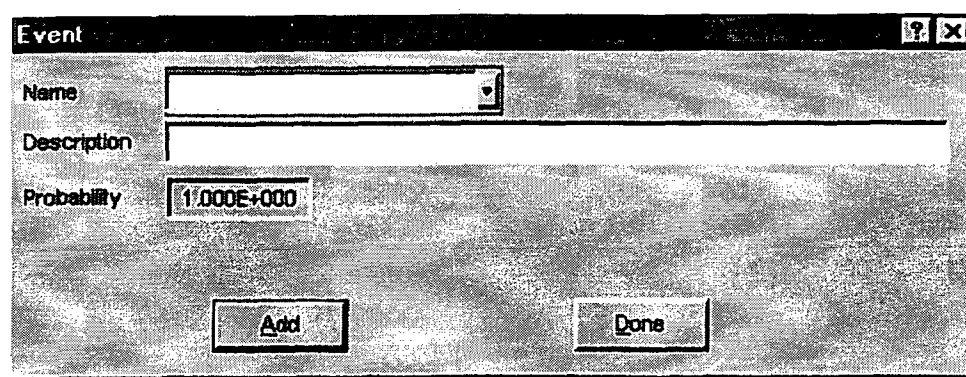
5.5.6 Add Event as Input

PURPOSE

This option allows you to add the basic events used as inputs to a gate.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and select the **Edit Logic** option.
4. From the *Edit Fault Tree Logic* dialog, select a gate.
5. Right-click to invoke the pop-up menu and select the **Modify** option. The Modify Gate Logic dialog will be displayed.
6. Select the **Add Event** button.



Select the desired event from the drop-down list. The associated description and probability will appear, but cannot be modified. Or, enter a new event name and description.

- Add** - Add the basic event as an input to the current gate. The dialog will remain open so you may continue to add events.
- Done** - Close the *Event* dialog.

5.5.7 Delete

PURPOSE

This option allows you to remove any gate or event from the current fault tree logic.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and select the **Edit Logic** option.
4. From the *Edit Fault Tree Logic* dialog, select the gate in the tree to be modified.
5. Right-click to invoke the pop-up menu and select the **Modify** option.
6. The *Edit* dialog will be displayed showing the gate name, type and description along with its inputs.
7. Select the desired event or gate in the Inputs list.
8. Choose the **Delete** button.

No confirmation of the delete operation is provided. The event or gate is removed immediately from the *Inputs* list. The event or gate will NOT be deleted from the database - only the logic.

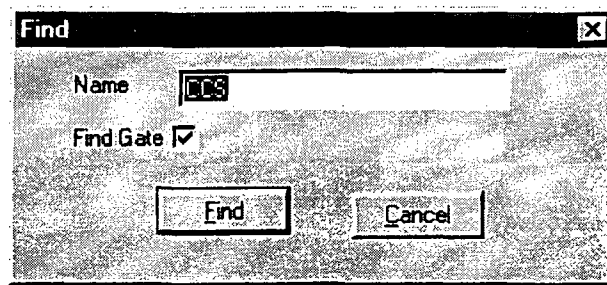
5.5.8 Find

PURPOSE

This option is used to locate a specific event or gate. If the located event or gate is an input to a condensed gate, that gate will be expanded.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and select the **Edit Logic** option. The *Edit Fault Tree Logic* dialog will be displayed.
4. Right-click to invoke the pop-up menu and select the **Find** option. The *Find* dialog will be displayed.



- | | |
|--------------------|---|
| Name - | Enter the name of the event or gate to be located. |
| Find Gate - | Select this check box if the search is for a gate. Deselect this check box if the search is for an event. |
| Find - | Execute the "find" operation based on the current criteria. |
| Cancel - | Close the <i>Find</i> dialog without executing the find operation. |

5.5.9 Move

PURPOSE

This option allows you to move a gate from one position in the fault tree logic to another.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and select the **Edit Logic** option. The *Edit Fault Tree Logic* dialog will be displayed.
4. Highlight the input (gate or event) to be moved.
5. Right-click to invoke the pop-up menu and select the **Move** option. The message, "Select gate to attach to" will be displayed in the message bar.
6. Select the gate as instructed. The input will be moved to the new location.

5.5.10 Follow Transfer

PURPOSE

This option can be used only on transfer gates. This option displays the logic of the fault tree specified by the transfer gate.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and select the **Edit Logic** option. The *Edit Fault Tree Logic* dialog will be displayed.
4. Selected the desired transfer gate.
5. Right-click to invoke the pop-up menu and select the **Follow Transfer** option.

The *Edit Fault Tree Logic* dialog will be displayed containing the logic of the specified fault tree. The name of the fault tree will be displayed in the title bar. The regular *Edit Fault Tree Logic* options are available. Notice that the **Transfer Back** pop-up menu option is now available. Selecting this option will return you to the previous logic display.

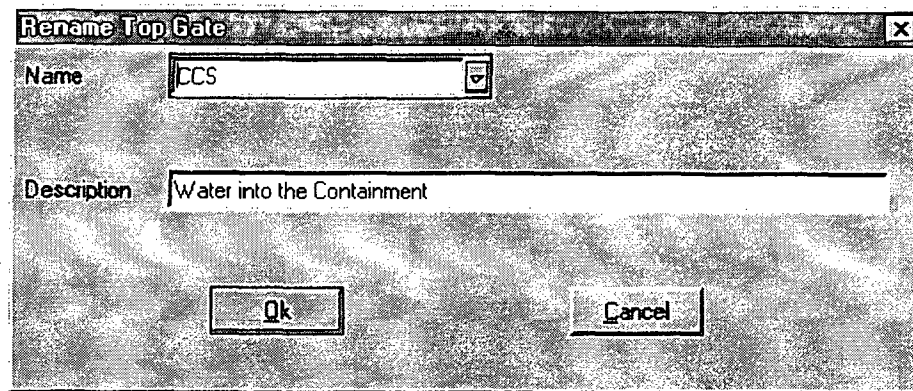
5.5.11 Rename Top

PURPOSE

This option allows you to move a gate from one position in the fault tree logic to another.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and select the **Edit Logic** option. The *Edit Fault Tree Logic* dialog will be displayed.
5. Highlight the top gate.
6. Right-click to invoke the pop-up menu and select the **Rename Top** option. The *Rename Top Gate* dialog will be displayed.



- Ok** - Change the name of the top gate and close the *Rename Top Gate* dialog.
- Cancel** - Close the *Rename Top Gate* dialog without changing the top gate name.

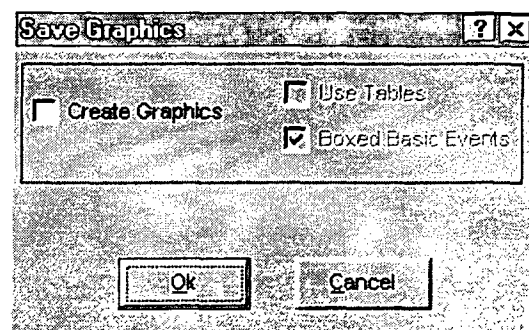
5.5.12 Save Logic

PURPOSE

This option allows you to save the logic, and optionally, create graphics to match the logic.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and select the **Edit Logic** option. The *Edit Fault Tree Logic* dialog will be displayed.
4. Make the desired changes.
5. Select **Ok**.
6. The *Save Graphics* dialog will be displayed.



Create Graphics -	Select this check box to automatically convert the alphanumeric logic changes to the graphical format. This will create corresponding .DLS for each new fault tree or sub-tree.
Use Tables -	For each logic gate with many basic events as inputs, create a table of basic events, using the Primary name field. SAPHIRE processes the table of basic events as if they were separate symbols. Enabled only when Create Graphics is checked.
Boxed Basic Events -	Create each basic event with a box for descriptive text. The text from the description field of the associated event will be placed in the box. This does not influence the logic of the fault tree, but adds clarity to the model for those using and reviewing it. Enabled only when Create Graphics is checked.
Ok -	Save the logic, create the graphics (if selected), and exit.
Cancel -	Close the <i>Save Graphics</i> dialog without saving the logic but do not close the <i>Edit Fault Tree Logic</i> dialog.

5.5.13 About Logic Dialogs

The gate names and gate types are displayed in uppercase characters. The event names are displayed in lowercase characters. The cut set events, indicated only in the **Path Search** option on the *Selected Cut Set Events* dialog, are enclosed in brackets (<>).

Presentation of the logic in dialogs and reports generated by SAPHIRE is limited to 255 characters in width. If the representation of the logic requires expansion past this limit, it will be truncated for display and reporting. The actual logic will remain in tact.

The following graphics are used for easy identification of gate types and their status:

-  An expanded gate. Click on the graphic to condense the gate.
-  A condensed gate. Click on the graphic to expand the gate.
-  The cut set events. Used on in the **Path Search** option.
-  Event tree top. Applicable only for sequence cut sets and used on in the **Path Search** option.
-  AND gate
-  OR gate
-  N/M gate
-  Transfer gate
-  NAND gate
-  NOR gate
-  Reference gate. This symbol indicates that the gate has been previously defined in the logic. Click on the gate next to this symbol. The gate where it is originally defined will be highlighted.

5.5.14 Tips on Using the Fault Tree Logic Editor

PURPOSE

Following are some hints on using the fault tree alphanumeric *Logic Editor*.

Tips on changing gate or event names:

When you change the name of a gate, the gate name will be changed **everywhere** it occurs.

When you change the name of a basic event as an input to a gate, it is changed everywhere in the current logic. If you highlight an event and choose the Modify option from the pop-up menu, it is changed at that location.

The fault tree *Logic Editor* does not allow the edited fault tree to be saved with a new fault tree name. The top gate in the fault tree must match the fault tree name.

After changes are made to the fault tree logic using the *Logic Editor*, select the Create Graphics check box to update the fault tree graphical file. It is not necessary to update the graphical file in order to perform analyses with the updated logic; however, to keep the fault tree logic and the fault tree graphic identical, you must perform this conversion.

5.6 Page Fault Tree Logic

5.6.1 Page Tree

PURPOSE

This option provides a variety of functions: (1) automatically divide a large fault tree logic file into a set of equivalent logic files with each file fitting more conveniently on a page (Auto Page); (2) break out a sub-tree at a user-specified gate (Gate); (3) output gates with multiple references into a separate sub-tree (Multiple); or (4) output multiple top gates into separate fault trees (Tops).

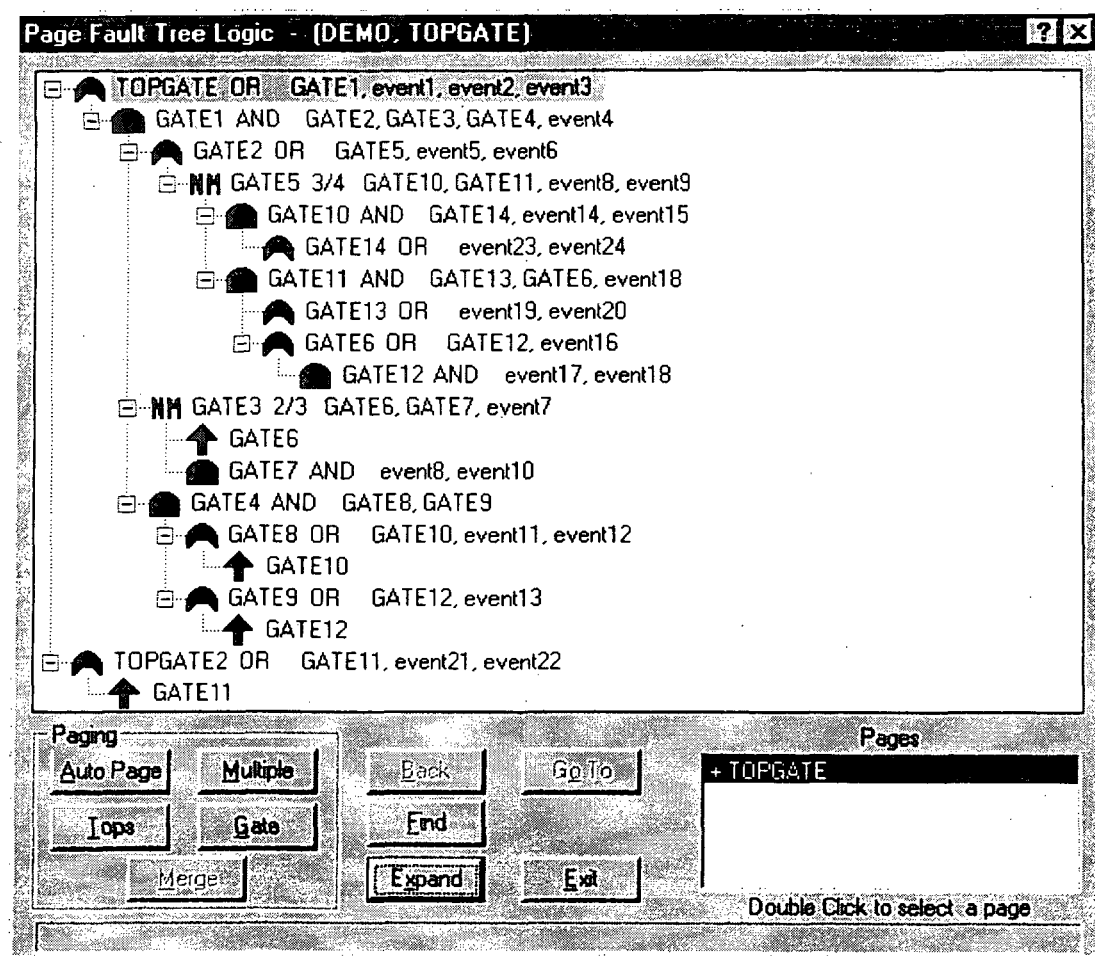
The fault tree shown below will be used to illustrate how the various Page Tree functions work. Examples described in the various Page Tree functions refer to this basic fault tree file, called TOPGATE.FTL.

Note that TOPGATE.FTL has a couple of interesting features that will be explored with the examples. First, this logic file has two top events, TOPGATE and TOPGATE2. Second, there are four gates that are referenced more than once: GATE6, GATE10, GATE11, and GATE12.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and choose **Page Tree**.
4. The *Page Fault Tree Logic* dialog will be displayed.

See the topic, "About Logic Dialogs," for a description of the icons presented on this dialog.



Paging Options

- Auto Page -** Automatically break the fault tree into easily viewable segments
- Multiple -** Break out gates with multiple references (i.e., gates that appear in more than one location within the fault tree) and output the logic into separate sub-trees. Enabled only when multiply-referenced gates are detected.
- Tops -** Automatically separate the logic file into different fault trees by the top events. Enabled only when multiple tops in the logic are detected.
- Gate -** Create a separate fault tree logic file with the specified gate as the top event.
- Merge -** Merge the logic represented by a transfer gate into the current fault tree file. This will occur only if the gate is not referenced more than once within the fault tree. Only transfer gates created during the current paging session can be merged. (Sub trees that existed prior to the current paging session cannot be merged from here. To merge a saved sub tree, see Fault Tree Logic Options .)

Back -	Reload the previous fault tree file. This option is enabled only after executing the Go To option.
Find -	Locate a specified gate.
Expand -	Expand all gates in the current fault tree file.
Go To -	Follow a transfer to another fault tree file.
Exit -	Close the <i>Page Fault Tree Logic</i> dialog. If changes were made to the fault tree logic, you will be prompted to save the changes before exiting.
Pages -	List of existing pages. Double-click on a page in the list to make it the current page.

5.6.2 About Logic Dialogs

The gate names and gate types are displayed in uppercase characters. The event names are displayed in lowercase characters. The cut set events, indicated only in the **Path Search** option on the *Selected Cut Set Events* dialog, are enclosed in brackets (<>).

Presentation of the logic in dialogs and reports generated by SAPHIRE is limited to 255 characters in width. If the representation of the logic requires expansion past this limit, it will be truncated for display and reporting. The actual logic will remain in tact.

The following graphics are used for easy identification of gate types and their status:

-  An expanded gate. Click on the graphic to condense the gate.
-  A condensed gate. Click on the graphic to expand the gate.
-  The cut set events. Used on in the **Path Search** option.
-  Event tree top. Applicable only for sequence cut sets and used on in the **Path Search** option.
-  AND gate
-  OR gate
-  N/M gate
-  Transfer gate
-  NAND gate
-  NOR gate
-  Reference gate. This symbol indicates that the gate has been previously defined in the logic. Click on the gate next to this symbol. The gate where it is originally defined will be highlighted.

5.6.3 Page Tree - Multiple

PURPOSE

This option breaks out gates with multiple references (i.e., gates that appear in more than one location within the fault tree) and outputs sub-tree logic files that meet the established screening criteria. This has the effect of breaking the fault tree logic file into smaller sections that will reduce the amount of repeated logic. When this process is executed, transfer gates are inserted as appropriate so that the final linked logic is equivalent to the original logic.

Screening criteria have been established to prevent the logic file from being broken into a large number of trivial fault trees. A gate will be broken out as a sub-tree only if:

It is referenced more than once in the logic file, and

It has in its input at least one logic gate that is referenced only once.

A gate with multiple references will not be broken out as a sub-tree if its inputs consist only of basic events, transfer gates, tables of events, other gates with multiple references, or any combination of these inputs.

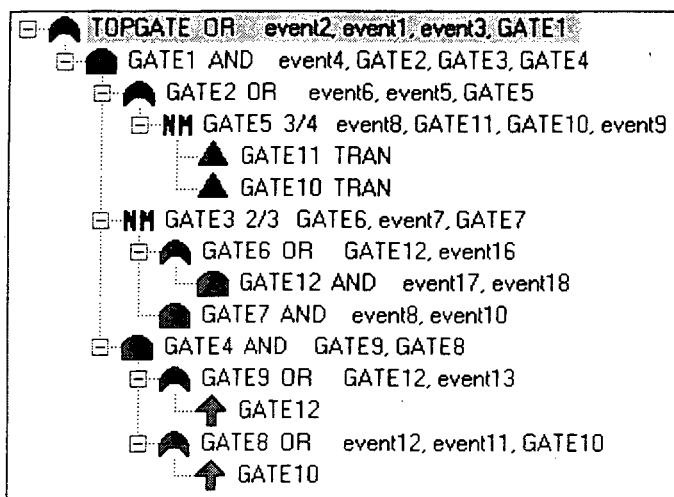
This option is enabled only when gates with multiple references are detected in the fault tree logic file.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and choose **Page Tree**.
4. The *Page Fault Tree Logic* dialog will be displayed.
5. Choose the **Multiple** button.

EXAMPLE

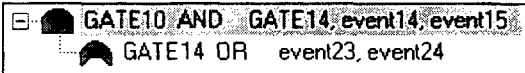
Using the example fault tree, the execution of the **Multiple** function results in four logic files: TOPGATE.FTL, TOPGATE2.FTL, GATE10.FTL and GATE11.FTL. Notice that the original fault tree logic file included two top events and four gates with multiple references. The two top event logic files have been split off because the Tops function is automatically executed during this process. Two other logic files were created because only GATE10 and GATE11 met the screening criteria. GATE6 does not meet the screening criteria because it has as one of its inputs a gate with multiple references (GATE12). GATE12 only has basic events as inputs and therefore, does not meet the screening criteria either.



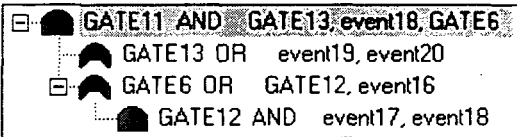
TOPGATE.FTL after the **Multiple** command.



TOPGATE2.FTL after the **Multiple** command.



GATE10.FTL after the **Multiple** command.



GATE11.FTL after the **Multiple** command.

5.6.4 Page Tree - Tops

PURPOSE

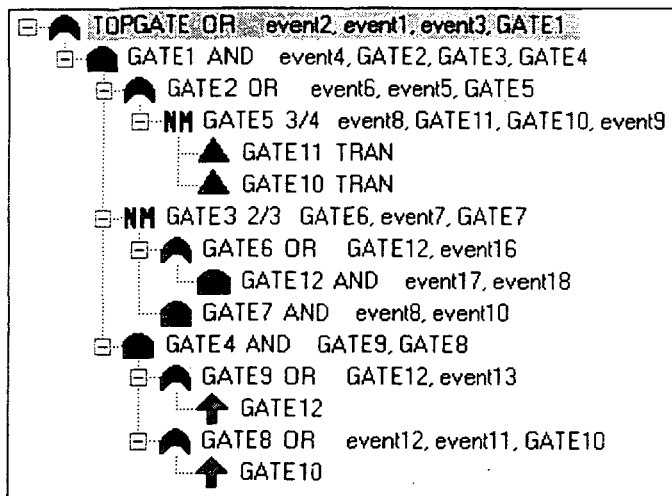
This option automatically separates the logic file into different fault trees by the top events. This option is enabled only when multiple tops in the logic are detected.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and choose **Page Tree**.
4. The *Page Fault Tree Logic* dialog will be displayed.
5. Choose the **Tops** button.

EXAMPLE

Notice that the example fault tree logic file included two top events. Execution of the **Tops** function results in four logic files: TOPGATE.FTL, TOPGATE2.FTL, GATE10.FTL and GATE11.FTL. The logic files GATE10.FTL and GATE11.FTL have been split off because the **Multiple** function is automatically executed during this process. The resulting top event logic files are each separate and complete. Further processing on these files can now be performed.



TOPGATE.FTL after the **Tops** command.



TOPGATE.FTL after the **Tops** command.

5.6.5 Page Tree - Gate

PURPOSE

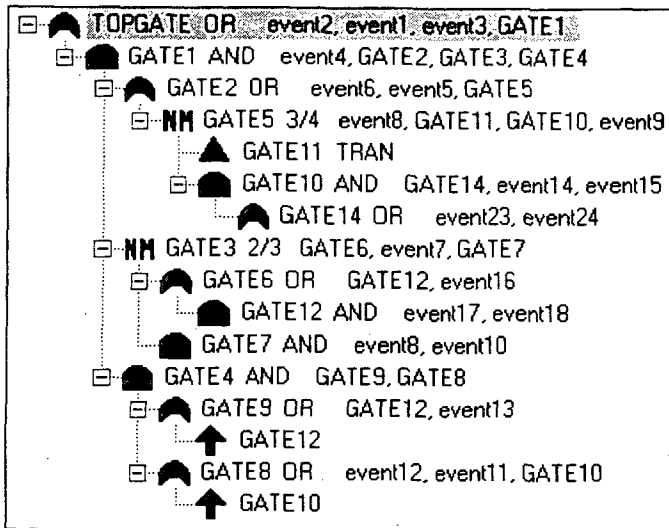
This option creates a separate fault tree logic file with the specified gate as the top event. Transfer gates will be inserted as appropriate so that the final linked logic is equivalent to the original logic.

STEPS

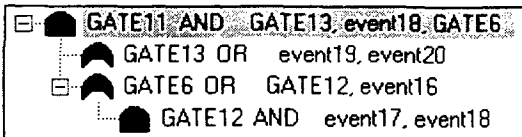
1. From the SAPHIRE menu select **Fault Tree**. The *Fault Tree List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and choose **Page Tree**. The *Page Fault Tree Logic* dialog will be displayed.
4. Highlight the desired gate.
5. Choose the **Gate** button.

EXAMPLE

Using the example fault tree, GATE11 was selected. A new fault tree logic file has been created with GATE11 as the top event. Notice the new TOPGATE.FTL file now contains a transfer to GATE11.



TOPGATE.FTL after the Gate command.



GATE11.FTL after the Gate command.

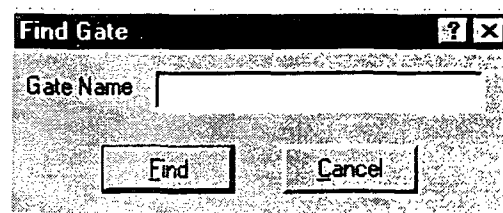
5.6.6 Page Tree - Find

PURPOSE

This option locates the specified gate.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and choose **Page Tree**.
4. The *Page Fault Tree Logic* dialog will be displayed.
5. Choose the **Find** button.
6. The *Find Gate* dialog will be displayed.



Gate Name - The name of the gate to be located.

- Find -** Perform the find operation and close the *Find Gate* dialog. If the operation is successful, the located gate will be highlighted.
- Cancel -** Close the *Find Gate* dialog without performing the find operation.

5.6.7 Page Tree - Merge

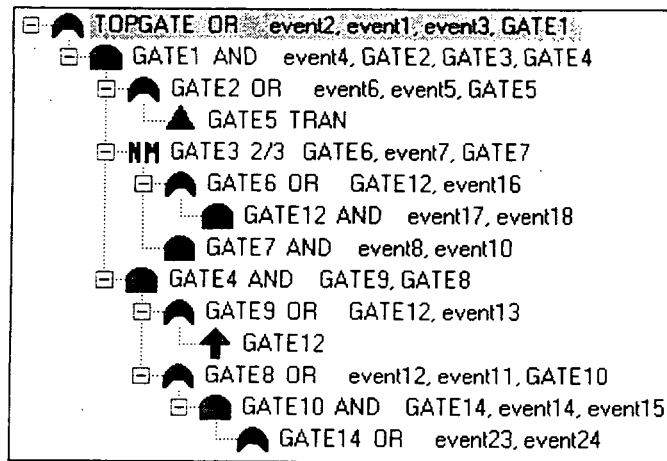
PURPOSE

This option incorporates the logic represented by a transfer gate into the current fault tree file. This process will occur only if the gate is not referenced more than once within the fault tree. If an attempt is made to merge a transfer gate that is referenced more than once, the message, "Transfer used in other places, cannot merge" will be displayed in the message bar of the *Page Fault Tree Logic* dialog.

This option is enabled only when transfer gates are detected in the fault tree logic file.

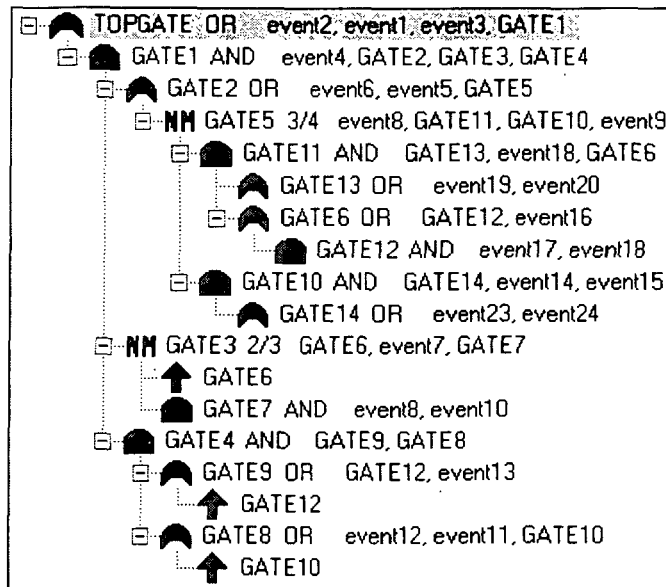
STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and choose **Page Tree**. The *Page Fault Tree Logic* dialog will be displayed.
4. Highlight the desired transfer gate.
5. Choose the **Merge** button.



EXAMPLE

Using the example TOPGATE.FTL file above (created by using the Gate option on GATE5 in the basic example), notice that GATE5 is a transfer gate. After performing the **Merge** function on transfer GATE5, the result is a single TOPGATE.FTL file.



TOPGATE.FTL after the **Merge** command.

5.6.8 Page Tree - Auto Page

PURPOSE

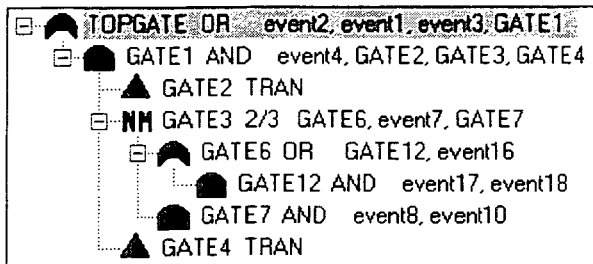
This option automatically breaks the fault tree into easily viewable segments. When this process is executed, the **Multiple** and **Tops** operations are performed automatically. Transfer gates will be inserted as appropriate so that the final linked logic is equivalent to the original logic. Generally, the process will result in pages containing trees no more than four levels deep and five inputs wide.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and choose **Page Tree**. The *Page Fault Tree Logic* dialog will be displayed.
4. Highlight the desired gate.
5. Choose the **Auto Page** button.

EXAMPLE

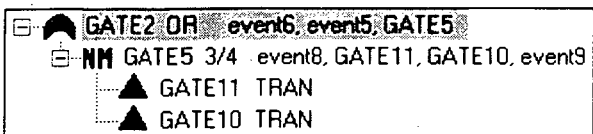
Using the example fault tree, the execution of the Auto Page function results in six logic files: TOPGATE.FTL, TOPGATE2.FTL, GATE2.FTL, GATE4.FTL, GATE10.FTL, and GATE11.FTL. Notice that the original fault tree logic file included two top events and four gates with multiple references. Remember that the **Auto Page** function automatically performs the **Multiple** and **Tops** functions. TOPGATE2 was recognized as a separate top event and was split off as a separate fault tree. Performing the Multiple function resulted in two more FTL files: GATE10 and GATE11 which met the screening criteria. Although GATE6 and GATE12 are also referenced more than once, GATE6 has as one of its inputs a gate with multiple references (GATE12) and GATE12 only has basic events as inputs and therefore, neither meet the screening criteria. GATE2 and GATE4 FTL files were split off for viewing convenience.



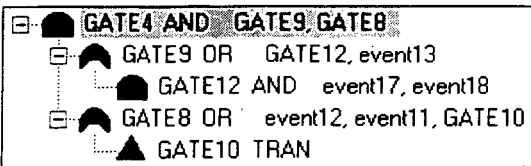
TOPGATE.FTL after the **Auto Page** command.



TOPGATE2.FTL after the **Auto Page** command.



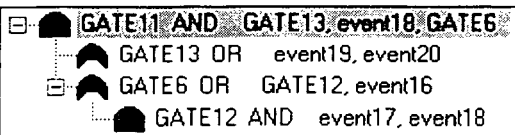
GATE2.FTL after the **Auto Page** command.



GATE4.FTL after the **Auto Page** command.



GATE10.FTL after the **Auto Page** command.

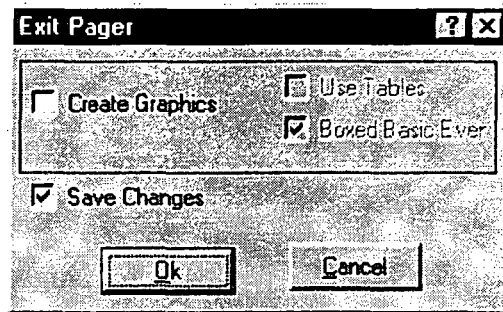


GATE11.FTL after the **Auto Page** command.

5.6.9 Page Tree - Exit

PURPOSE

This option closes the *Page Fault Tree Logic* dialog. If changes were made to the fault tree logic, you will be prompted to save the changes before exiting by the *Exit Pager* dialog.



- Create Graphics -** Select this check box to automatically convert the alphanumeric logic changes to the graphical format. This will create corresponding .DLS for each new fault tree or sub-tree.
- Use Tables -** For each logic gate with many basic events as inputs, create a table of basic events, using the Primary name field. SAPHIRE processes the table of basic events as if they were separate symbols.
- Boxed Basic Events -** Create each basic events with a box for descriptive text. The text from the description field of the associated event will be placed in the box. This does not influence the logic of the fault tree, but adds clarity to the model for those using and reviewing it.
- Save Changes -** Save the changes made to the fault tree logic file. If this check box is NOT selected, and the **Ok** button is chosen, the *Page Fault Tree Logic* dialog will be closed and the changes will not be saved.
- Ok -** Close the *Page Fault Tree Logic* dialog. Changes will be saved and graphic files created if the appropriate check boxes are selected.
- Cancel -** Close the *Exit Pager* dialog but do not close the *Page Fault Tree Logic* dialog.

5.7 Solving Fault Trees

5.7.1 Solving Fault Trees

PURPOSE

This option generates the cut sets for selected fault tree(s) based on cut set generation cutoff values. You are given the ability to generate cut sets for a selected fault tree, a group of fault trees, or all fault trees

within the current project. Various options are provided to allow cut sets to be generated in various ways. 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 fault tree(s).

STEPS

1. From the SAPHIRE menu select **Fault Tree**.
2. The *Fault Trees List* dialog will be displayed.
3. Highlight the desired fault tree(s).
4. Right-click to invoke the pop-up menu and choose **Solve**.

Whether you are generating cut sets for a single fault tree, a group of fault trees, or for all fault trees the *Cut Set Generation* dialog will be displayed.

The dialog below is displayed when the Analysis Type is "Random".

The screenshot shows the 'Cut Set Generation' dialog box. It has a title bar with a question mark and a close button. The dialog contains several options and input fields:

- Cutoff by Cut Set Probability**: ☒ (selected)
- Cutoff by Event Probability**: ☐ (unselected)
- Cutoff by**: ☐ Size, ☐ Zone, ☒ None
- Starting Gate Name**: [Empty text box]
- Flag Set Name**: [Empty dropdown menu]
- Auto Apply Recovery Rules**: ☒ (selected)
- Basic**: ☒ (selected), **Advanced**: ☐ (unselected)
- Global**: ☒ (selected), **Fault Tree**: ☐ (unselected)
- Global Cutoff Value**: [1.000E-008]
- Min < Cutoff Value**: [-----E-----]
- > Cutoff Value**: [6]
- NOTE**: To perform Event Probability truncation you must also specify OutSet Probability truncation and the associated cutoff value.
- Buttons**: OK, Cancel

The dialog below is displayed when any other Analysis Type is selected.

Cut Set Generation [?] [X]

Truncation

☒ Cutoff by Cut Set Probability
 ☐ Fault Tree
 ☒ Global
 < Global Cutoff Value

☐ Cutoff by Event Probability
 Min < Cutoff Value

☐ Cutoff by Size
☐ Zone
☒ None
 > Cutoff Value

☒ Auto Apply Recovery Rules
☒ Basic
☐ Advanced

Starting Gate Name
 Flag Set Name

NOTE: To perform Event Probability truncation you must also specify Cut Set Probability truncation and the associated cutoff value.

Transformation Data

Transformation Level
 Do Zones ☐
 Include Original Event ☐

You may change any of the data fields on this dialog. The default values that appear on this dialog may be reset to new values by selecting **Utility** from the SAPHIRE menu and then invoking the **Define Constants** option.

- Cutoff by Cut Set Probability** - Used for determining if the cut set should be retained or discarded based on the value in the < *Global Cutoff Value* field.
- Cutoff by Event Probability** - Used for determining if the cut set should be retained or discarded based on the value in the *Min < Cutoff Value* field.
- Cutoff by Size** - Used for determining if the cut set should be retained or discarded based on the value in the > *Cutoff Value* field or zoned flagged events.
- Starting Gate Name** - Used to specify the top gate of the tree.
- Flag Set Name** - Used to specify the flag set to be used during processing.
- Auto Apply Recovery Rules** - Used for automatically applying recovery rules while solving.
- Basic** - Apply rules created using the basic rule syntax
- Advanced** - Apply rules created using the advanced rule syntax.
- Transformation Level** - An integer 0 -255 which indicates the default level of substitution for the transformations to be performed.
- Do Zones** - If checked, perform zone transformation during cut set generation.
- Include Original Event** - Used for determining if the original event should be retained or discarded during processing.

During processing, the *Cut Set Generation Results* dialog is displayed and updated as the calculations proceed. Upon completion of the cut set generation, the summary results are displayed in this dialog. Note that the displayed results reflect the values prior to the application of recover rules, if that option was selected. Choose the **OK** button to close the dialog, or **View Results** button to review or print the results.

The only limit on the number of cut sets that can be stored for a given fault tree is the available hard drive space. When processing is complete, the *Fault Trees List* dialog is updated to show the letter "c" in front of the fault tree(s) with current case cut sets.

5.7.2 Cut Set Generation Dialog

Cutoff by Cut Set Probability

If you select this check box and choose the:

- Global* radio button - Only those cut sets whose product for all of its event probabilities is greater than or equal to the value in the *< Global Cutoff Value* field will be kept.
- Fault Tree* radio button - Only those cut sets whose product for all of its event probabilities is greater than or equal to the fault tree's cutoff value will be kept. This value is entered in the **Modify | Fault Trees** option.

All other cut sets will be removed.

If you uncheck this box, then the probability for the cut set will be irrelevant for determining if the cut set should be retained or discarded.

5.7.2.1 Cutoff by Event Probability

If you select this check box, then you must also choose the *Cutoff by Cut Set Probability* check box. This option will check all cut sets that are below the probability cutoff (*Min < Cutoff Value* field) and remove them only if they contain an event whose probability is below this value.

When you select this option, SAPHIRE will also perform the quantification.

5.7.2.2 Cutoff by Size

- Size** - If you choose this radio button, then only the cut sets whose number of events is less than or equal to the value specified in the *> Cutoff Value* field will be kept in the cut sets for that fault tree. All other cut sets will be removed.
- Zone** - If you choose this radio button, then only zone flagged events will be checked.
- None** - If you choose this radio button, then the number of events in a cut set will be irrelevant for determining if the cut set should be retained or discarded.

5.7.2.3 Starting Gate Name

If a gate is specified in this field, then this gate will be the gate assumed to be the top gate of the tree. If a name is not specified, the top gate will be determined by finding the gate that is not referenced by any other gate. This top gate should be named the same as the fault tree or sub-tree name.

5.7.2.4 Flag Set Name

Select the desired flag set, if any, from the drop-down list. If the field is left blank, the fault tree-specific flag set, if any, will be used. If a flag set is specified, that flag set will be used during processing. A pre-defined flag set option, NONE, is available. If you choose this option, no flag sets are used.

5.7.2.5 Include Original Event

If checked, the original event will be included in the logic along with the transformation event(s) during cut set generation. Otherwise, the original event will be replaced by the transformation event(s).

5.8 Quantifying Fault Trees

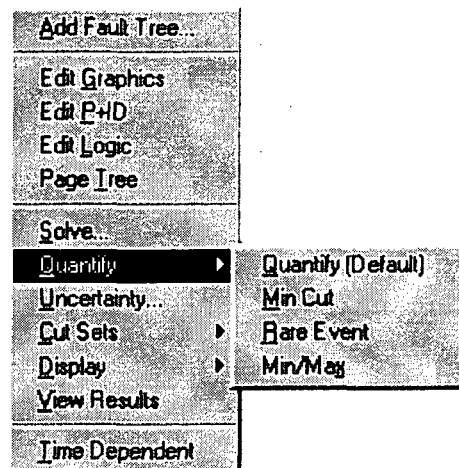
5.8.1 Quantifying Fault Trees

PURPOSE

The quantification process will re-quantify the cut sets using current data values (event change sets and current case cut sets). Quantification can be applied to a selected fault tree, for a group of fault trees, or for all of the fault trees within the current project. The new value is saved with the current case cut sets for the selected fault tree.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree(s) and right-click to invoke the pop-up menu.
3. Choose **Quantify**, then one of the submenu options.



Quantify (Default) –	Re-quantify using the quantification method for the specified fault tree. This is selected in the Modify Fault Trees option.
Min Cut –	Re-quantify using the Minimal Cut Set Upper Bound Approximation.
Rare Event –	Re-quantify by adding together the probabilities for the cut sets of a top event.
Min/Max –	Re-quantify using the “exact” calculation for the union of cut sets via the inclusion-exclusion rule.

If the selected quantification method differs from the default method of the fault tree, a warning box with the message, “The chosen quantification method was different from the Fault Tree default” is displayed. Choose the **Ok** button to continue processing.

During processing, the *Quantification Results* dialog is displayed. If an error occurs, the message, “Error quantifying cut sets” will be displayed in the message bar. If a single fault tree was selected, upon

completion of the quantification process, the results are displayed in the *Quantification Results* dialog. Choose **Ok** to close the dialog.

5.8.2 Minimal Cut Set Upper Bound Approximation

This calculation approximates the probability of the union of the minimal cut sets for the fault trees. The equation for the minimal cut set upper bound is

$$S = 1 - \prod_{i=1}^m (1 - C_i)$$

where

S = minimal cut set upper bound for the fault tree unavailability,
 C_i = probability of the i -th cut set, and
 m = the number of cut sets.

Example: If the cut sets for a fault tree are $X = A \cup B \cup C$ (i.e., the union of three events, A, B, and C); then the cut sets can be written as $X = A + B + C$ with the plus symbol indicating union. The fault tree unavailability computed from the minimal cut set upper bound approximation is then $X = 1 - (1 - A)(1 - B)(1 - C)$.

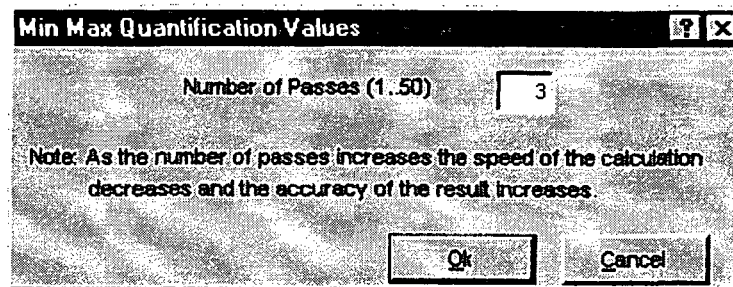
SEE TECHNICAL REFERENCE

Minimal Cut Set Upper Bound

5.8.3 Min Max Quantification

The Min-Max quantification option quantifies the current case cut sets using the “exact” probability quantification algorithm. This algorithm can be extremely time consuming if the number of cut sets is large. The user should be careful when selecting this option.

When you choose this option, the dialog shown below will be displayed. You are required to enter the number of passes. The number passes indicates the number of intermediate terms SAPHIRE will calculate when determining the minimum and maximum quantification values. Type a number from 1 to 10 to indicate the number of passes you want SAPHIRE to make. The higher the number, the more the calculation speed decreases and the accuracy increases. Choose the **Ok** button to proceed.



SAPHIRE will perform the specified number of intermediate terms and when complete will show the results on the *Quantification Results* dialog. The results of the Min/Max Quantification option are displayed only on this dialog.

How this option works:

To quantify the **union** of events, the first pass consists of adding the events, the second pass consists of subtracting pairs of events, the third pass consists of adding "triples", and so on.

For a simple example, assume that a fault tree has only three cut sets which are the union of A, B, and C which can be expressed as $A \cup B \cup C$. In this example, each cut set consists of only one term; however, the approach is not limited to one term per cut set. For 3 passes, the solution is shown below.

$$X = (A + B + C) - (A * B + A * C + B * C) + (A * B * C)$$

The Min/Max algorithm applies the Boolean idempotent law ($A * A = A$) to reduce identical terms during the multiplication of cut sets.

The table below shows the Min/Max equation and results, with $A = B = C = 0.8$. The minimal cut set upper bound approximation would be $1 - (1 - 0.8)^3 = 0.992$. (Note that the Min Max calculation will be the same as the minimal cut set upper bound when the cut sets do not contain common events.)

# Passes	Min/Max Equation	Min/Max Probability
1	$A + B + C$	2.4
2	$A+B+C - (A*B+A*C+B*C)$	$2.4 - 1.92 = 0.48$
3	$A+B+C - (A*B+A*C+B*C) + (A*B*C)$	$2.4 - 1.92 + 0.512 = 0.992$
4	$A+B+C - (A*B+A*C+B*C) + (A*B*C)$	$2.4 - 1.92 + 0.512 = 0.992$

5.8.4 Rare Event Approximation

The rare event approximation approach adds together the probabilities for the cut sets of a top event. This approximation is a good method when the cut set probabilities are small.

5.9 Uncertainty Analysis

5.9.1 Uncertainty Analysis

PURPOSE

This option can estimate the variability (due to the uncertainties in the basic event probabilities) of either a fault tree top event probability or an event tree sequence frequency. To do this, SAPHIRE provides two sampling techniques: Monte Carlo simulation and Latin Hypercube simulation. In addition, you may perform a seismic analysis to integrate the seismic fragility curve with the site hazard curve using the uncertainty analysis option.

In a traditional uncertainty analysis, SAPHIRE samples the user-specified distributions for each basic event in a group of cut sets, then quantifies these cut sets using the sample values. For a seismic uncertainty, however, SAPHIRE performs the analysis at each G-level in the site hazard curve for the current project. The seismic events are sampled at each new G-level and the quantification performed.

You are given the option of performing an uncertainty analysis on the current case cut sets for either a single, for a group, or for all of the fault trees (or sequences or end states) within the current project.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**.
2. The *Fault Trees List/Sequences/End State List* dialog will be displayed.
3. Highlight the desired fault tree(s)/sequence(s)/end state(s) and right-click to invoke the pop-up menu.
4. Choose **Uncertainty**.
5. The *Uncertainty Calculation Values* dialog will be displayed.

You may change any of the data fields on this dialog. The default values that appear on this dialog may be reset to new values by selecting the **Utility | Define Constants** option.

Number of samples (< 99999) -

A default value is provided for the number of samples to use in simulation. You may use this value or enter another value. The number must be less than 99,999.

Seed for random number generator -

A default seed is provided for the random seed. 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.

Uncertainty method -

Select the appropriate radio button for the desired uncertainty sampling technique.

Ground Acceleration Level -

If seismic uncertainty is selected, a ground level acceleration must be provided. This indicates the acceleration rate at which the component will always fail. The user can select to process all G-levels combined, all G-levels separately, or a specified G-level only.

Intermediate Values -

None -

Select this check box if you wish for the results and intermediate samples to be written to an ASCII file.

SAPHIRE format -

Select this check box if you wish for the results and intermediate samples to be written to an ASCII file, formatted in the traditional SAPHIRE format.

CSV format -

Select this check box if you wish for the results and intermediate samples to be written to an ASCII file, formatted as a comma delimited file, for easy import into a spreadsheet program.

File Name -

Specifies the name of the ASCII file where the intermediate values will be stored.

Browse -

Opens the *Choose File* dialog, to select a directory and file name to store the intermediate results.

5.9.2 Intermediate Values

PURPOSE

This option allows you to output the results and intermediate samples to the ASCII file specified in the **File Name** field.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequences/End State**. The *Fault Trees List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired fault tree(s)/sequence(s)/end state(s) and right-click to invoke the pop-up menu.
3. Choose **Uncertainty**. The *Uncertainty Calculation Values* dialog will be displayed.
4. Check the **Output Values** check box and enter a name in the **File Name** field.

The example below describes the layout of a SAPHIRE formatted ASCII file. The CSV (comma delimited file) layout is similar, but is comma delimited to be easily imported into a spreadsheet program.

Format for ASCII file containing intermediate samples:

```

$ Anything after a "$" is a comment.
$ MC File Format Version 1.00
$ Created by SAPHIRE 6.0 Program
$
$ In this description there are 2 variables and the MCS sample size is 500.
$
$ The first block contains point estimates for each variable. The point
$ estimate could be a mean, median, or other value.
$
$      DG                      1.000000E+000
$      DG                      1.000000E+000
$
@UNCERTAINTY
  @OBSERVATIONS  500
  @VARIABLES     2
    DG:
    DG:
$
$ Note a colon follows each variable name
$
$ This portion of the file contains the observation number(m) followed by
$ the number of variables (n), the value for the variable 1 for
$ observation m, the value for the variable n for observation m
$
@SAMPLEDATA
  1    2  1.000000E+000 1.000000E+000
  2    2  1.000000E+000 1.000000E+000
  3    2  1.000000E+000 1.000000E+000
      .
      .
      .
500    2  1.000000E+000 1.000000E+000

```

5.9.3 Monte Carlo Sampling (MCS)

Simple MCS is a fundamental uncertainty sampling approach. To perform the sampling, SAPHIRE makes repeated quantifications of the fault tree/sequence/end state cutsets using samples from the basic event uncertainty distributions. This type of sampling requires more samples than LHS for the same degree of accuracy.

When using this sampling technique, 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.

5.9.4 Latin Hypercube Sampling (LHS)

LHS is a stratified sampling technique where the random variable distributions are divided into equal probability intervals. A probability is randomly selected from within each interval for each basic event.

Generally, LHS will require fewer samples than simple MCS for similar accuracy. However, due to the stratification method, it may take longer to generate a value than for a MCS.

When using this technique, if the number of samples entered is less than twice the total number of unique events in the fault tree/sequence/end state, 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.

5.9.5 The Uncertainty Analysis Process

The following is a description of the uncertainty analysis process performed by SAPHIRE after values have been entered in the *Uncertainty Calculation Values* dialog.

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.

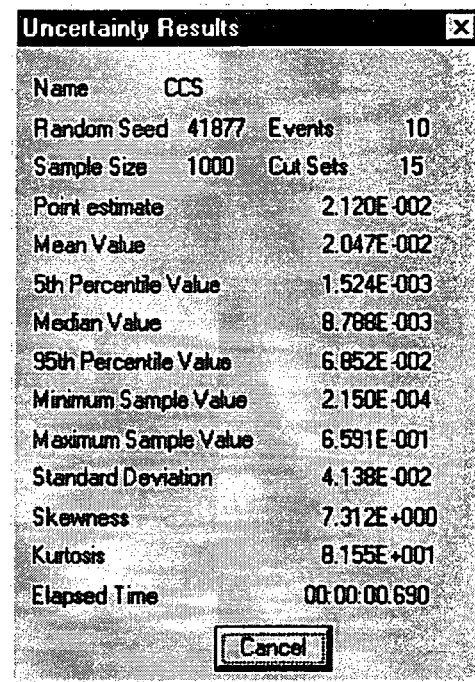
If an error occurs during the uncertainty analysis process, the process is terminated and a message box providing information about the specific error is displayed.

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.

After both of these checks have been passed, a point estimate will be calculated for the selected fault tree (or sequence or end state). At this point the samples for each event will be generated using the selected sampling technique, either the Monte Carlo Sampling technique or the Latin Hypercube Sampling technique. The uncertainty analysis function provides you with 11 different distribution types for both sampling techniques. The distribution types include normal, lognormal, beta, gamma, chi-squared, exponential, uniform, Dirichlet, constrained non-informative, maximum entropy, and the user-defined histograms.

During processing, the *Uncertainty Results* dialog will be displayed and updated as the samples are generated. When the requested number of samples have been generated, statistical information will be calculated using the generated samples. A sample mean, median, and standard deviation will be calculated for the selected fault tree (or sequence or end state). Coefficients of skewness and kurtosis, and quantile values will also be calculated. This data will be saved in the database for the selected fault tree (or sequence or end state).

Upon completion of these calculations, the following values will be displayed on the *Uncertainty Results* dialog for viewing: the name, random seed used, the number of samples generated in this process, the total number of events and cut sets 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.



If only one fault tree (or sequence or end state) was selected (highlighted) for the uncertainty analysis process, then you will need to close the *Uncertainty Results* dialog. However, if more than one is being processed, the *Uncertainty Results* dialog will be displayed for each, and when all of the selected fault trees (or sequences or end states) have been processed, the *Uncertainty Results* dialog will automatically be closed.

5.9.6 Seismic Uncertainty

PURPOSE

A seismic analysis integrates the seismic fragility curve with the site hazard curve using the uncertainty analysis option. If the user has chosen to perform a seismic analysis, then a G-level was also selected. This option allows the user to specify how SAPHIRE performs the analysis.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Trees List/Sequences/End State List* dialog will be displayed.
2. Select the "SEISMIC" value from the *Analysis Type* drop-down list.
3. Highlight the desired fault tree(s)/sequence(s)/end state(s) and right-click to invoke the pop-up menu.
4. Choose **Uncertainty**. The *Uncertainty Calculation Values* dialog will be displayed.
5. Provide appropriate values for the data entry fields on this dialog and choose one of the **Ground Acceleration Level** values.

The G-levels are described here:

- ALL COMBINED - SAPHIRE performs an uncertainty analysis on all G-levels defined in the site hazard curve for this project. The combined results are then stored in the database.
- ALL SEPARATE - SAPHIRE performs an uncertainty analysis on all G-levels, but does the analysis and stores the results separately for each G-level.
- Specific G-level - SAPHIRE only performs the analysis for that specified G-level.

5.9.7 Uncertainty Distributions for Basic Events

Within the SAPHIRE code, eleven types of uncertainty distributions are supported. The table below lists the different distributions, their identifier within SAPHIRE, and the uncertainty parameter that is needed by the code.

Along with the uncertainty parameter, most distributions require a second parameter. SAPHIRE requires that the *mean* value be specified for all distributions. The mean value is put in the database as a mean failure probability or a mean failure rate, depending on which calculation type is used.

To demonstrate how to specify an uncertainty distribution in SAPHIRE, assume that a basic event has a mean failure probability of 0.5 and the standard deviation is 0.2. The uncertainty distribution type is unknown. Assuming that the event is distributed with a uniform distribution, we can calculate the upper end point to be 0.846 from the equations (for a uniform distribution)

$$\begin{aligned}\text{Mean} &= (1/2) (b + a), \\ \text{Variance} &= (1/12) (b - a)^2,\end{aligned}$$

where *a* is the lower end point and *b* is the upper end point. Consequently, to enter this distribution in SAPHIRE, the mean value of 0.5 would be entered, a uniform distribution would be chosen (type U), and the upper end point of 0.846 would be specified.

Alternatively, if we assume that the event is lognormally distributed, we would need to calculate the error factor (EF). Knowing the mean ($\mu_{\ln}$) and standard deviation ($\sigma_{\ln}$), we can calculate the EF from the equation

$$EF = e^{1.645\sqrt{\ln(1+(\sigma_{\ln}/\mu_{\ln})^2)}}$$

From this equation, the EF is calculated to be 1.88. To enter this distribution in SAPHIRE, the mean value of 0.5 would be entered, a lognormal distribution would be chosen (type L), and the EF of 1.88 would be specified.

Basic event uncertainty distribution types supported by SAPHIRE.

Distribution	Identifier	Uncertainty Parameter
none	blank	none
lognormal	L	error factor
normal	N	standard deviation
beta	B	b in Beta(a,b)

gamma	G	r in $\Gamma(r)$
chi-squared	C	degrees of freedom
exponential	E	none
uniform	U	upper end point
histograms	H	histogram number (i.e., identifier)
maximum entropy	M	lower and upper end point
constrained noninformative	O	none
Seismic	S	Beta r , Beta u

If the event was assumed to be normally distributed, we would simply put the mean value in the probability data field and the standard deviation in the uncertainty parameter data field. To enter this distribution, the mean value of 0.5 would be entered, a normal distribution would be chosen (type N), and the standard deviation of 0.2 would be specified.

To review the process of specifying an uncertainty distribution in SAPHIRE, the required steps are to:

1. Enter the mean value for the basic event.
2. Choose the distribution type (from those shown in the "Identifier" column in the table above).
3. Specify the appropriate uncertainty distribution parameter (shown in the "Uncertainty Parameter" column in the table above).

Additional information on the uncertainty distributions and their parameters can be found in the SAPHIRE Technical Reference Manual.

5.10 Fault Tree Cut Set Analysis

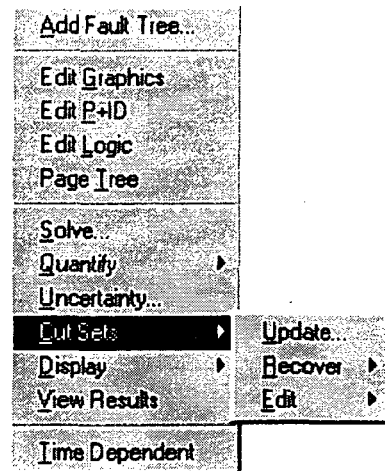
5.10.1 Fault Tree Cut Set Analysis

PURPOSE

This option provides the ability to perform a variety of analysis functions on the fault tree cut sets.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets**, then one of the sub-menu options.



- Update -** Update the current cut sets for a selected fault tree based on cut set generation cutoff values.
- Prune -** Eliminate cut sets from a selected fault tree that contains events that conflict in some way with one another.
- Recover -** Modify cut sets by adding recovery actions to them.
- Edit -** Modify the base case/current fault tree cut sets.

5.10.2 Updating Cut Sets

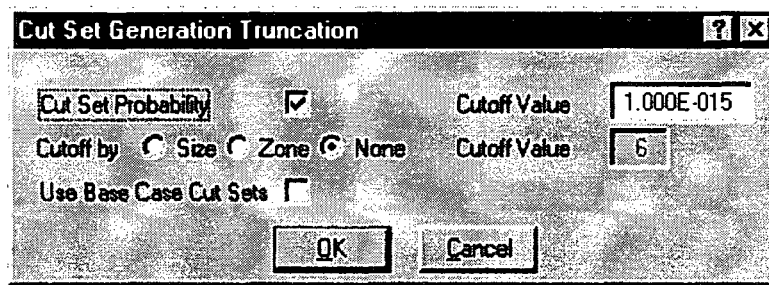
PURPOSE

This option will update the current case cut sets for a selected fault tree (or sequence or end state) 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. You are also given the choice of using either the base case cut sets or the current 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 current case cut sets.

Current case cut sets can be updated for a selected fault tree (or sequence or end state), a group of fault trees (or sequences or end states), or all of the fault trees (or sequences or end states) within the current project

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Trees List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired fault tree(s)/sequence(s)/end state(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets**, then the **Update** sub-menu option.
4. The *Cut Set Generation Truncation* dialog will be displayed.



You may change any of the data fields on this dialog. The default values that appear on this dialog may be reset to new values by selecting **Utility** on the SAPHIRE menu and then invoking the **Define Constants** option.

- Cut Set Probability** - Used for determining if the cut set should be retained or discarded based on the value in the *Cutoff Value* field.
- Cutoff by Size** - Used for determining if the cut set should be retained or discarded based on zoned flagged events or the value in the *Cutoff Value* field.
- Use Base Case Cut Sets** -Used to specify base case cut sets or current case cut sets.

During processing, the *Cut Set Generation Results* dialog is displayed and updated as the calculations proceed. If a single fault tree (or sequence or end state) was selected, upon completion of the cut set generation, the results are displayed in this dialog. Choose the **Ok** button to close the dialog.

Once the cut sets are updated, they are automatically quantified.

5.10.3 Cut Set Generation Truncation

5.10.3.1 Cut Set Probability

If you select this check box, 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 current case cut sets for that fault tree.

If you uncheck this box, then the probability for the cut set will not be relevant for determining if the cut set should be retained or discarded.

5.10.3.2 Cutoff by Size

- Size** - If you choose this radio button, then only the cut sets whose number of events is less than or equal to the value specified in the *> Cutoff Value* field will be kept in the cut sets for that fault tree. All other cut sets will be removed.

- Zone** - If you choose this radio button, then only zone flagged events will be checked.
- None** - If you choose this radio button, then the number of events in a cut set will be irrelevant for determining if the cut set should be retained or discarded.

5.10.3.3 Use Base Case Cut Sets

If you select this check box, then base case cut sets will be used as the cut sets to be updated and then stored in the current case cut sets. However, if unchecked, the current cut sets will be used as the cut sets to be updated and then resaved in the current case cut sets.

5.10.4 Recovering Fault Tree Cut Sets

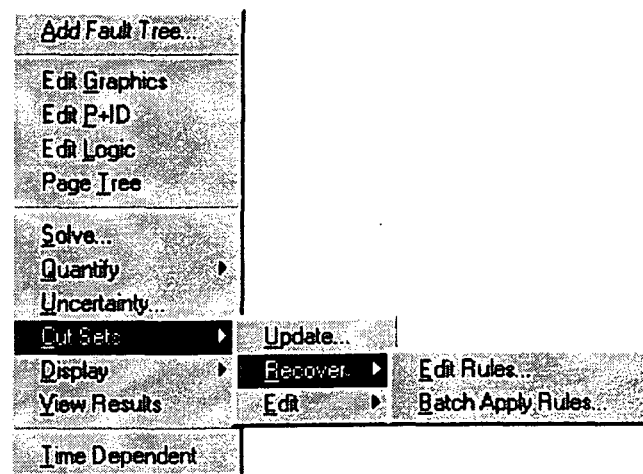
5.10.4.1 Recovering Fault Tree Cut Sets

PURPOSE

The “recovery” option allows the user to post-process cut sets by modifying them according to a pre-defined set of rules. The user constructs recovery rules to be applied to each cut set which then define the action to be taken. The rules are constructed using the same editor that is used for event tree rules definition. This editor is a macro-based editor, which means that the user can define macros (or variables) that can be used as the search criteria tests.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets | Recover**.
4. Select one of the sub-menu options



- Edit Rules** - Create and modify recovery rules for a highlighted fault tree.
- Batch Apply** - Apply all rules currently defined to the highlighted fault trees.

5.10.4.2 Batch Apply

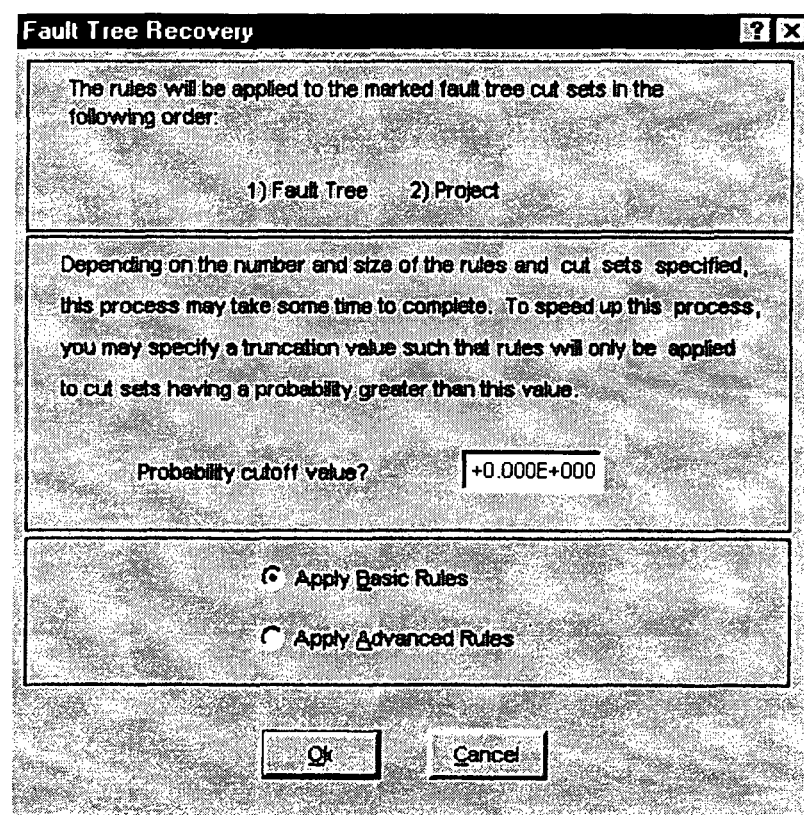
PURPOSE

This option allows you to apply all rules currently defined to the highlighted or marked fault trees.

The application of recovery rules can potentially require numerous comparisons of rules to cut sets, resulting in a long analysis time. Consequently, when the rules are applied in SAPHIRE for the entire project, the analyst is presented with the option to apply rules to cut sets down to a specified truncation level. By setting a truncation value in the *Probability cutoff value* field, only those cut sets with a “high” probability will have rules applied.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets | Recover**.
4. Select the **Batch Apply** submenu option.
5. The *Fault Tree Recovery* dialog will be displayed.



Apply Basic Rules -

Recover the selected fault trees using rules created using Basic Rules .

Apply Advanced Rules -

Recover the selected fault trees using rules created using Advanced Rules .

Probability cutoff value -

The rules are applied only to those cut sets having a probability greater than this value. A value of zero will force the rules to be applied to all cut sets.

Ok -

Apply the selected rules using the specified cutoff value.

Cancel -

Close the *Fault Tree Recovery* dialog without applying rules.

5.10.4.3 Fault Tree Recovery Rule Options

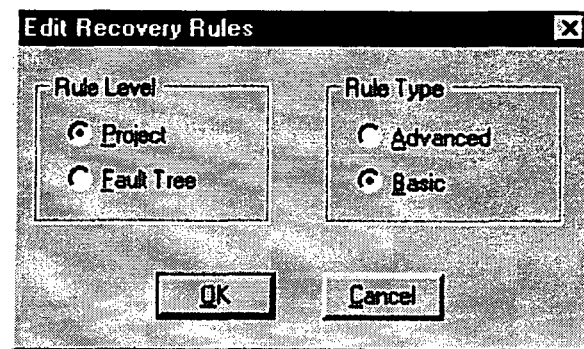
PURPOSE

The “recover” option allows the user to post-process cut sets by modifying them according to a pre-defined set of rules. The user constructs recovery rules to be applied to each cut set which then define the action to be taken. The rules are constructed using the same editor that is used for event tree rules definition. This editor is a macro-based editor, which means that the user can define macros (or variables) that can be used as the search criteria tests.

The rules may be developed for a particular fault tree or all fault trees, depending on the *Rule Level* selected.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets | Recover | Edit Rules**.
4. The *Edit Recovery Rules* dialog will be displayed.



Rule Level

- Project -** Edit rules whose scope you wish to apply to all or multiple fault trees across the project.
- Fault Tree -** Edit rules whose scope you wish to apply only to the highlighted fault tree.

Rule Type

- Advanced -** Edit rules using the advanced recovery rules language.
- Basic -** Edit rules using the basic recovery rules language.

- OK -** Create and modify fault tree recovery rules.
- Cancel -** Close the *Edit Recovery Rules* dialog without editing any rules.

5.10.4.4 *Basic Recovery Rules Editor*

PURPOSE

This is a free format line editor that provides you with an if-then-else logic structure. There is no limit to the number of rules the user may input to the editor. Each rule is processed in sequential order.

Basic rules can have different logic than the Advanced Rules and are saved separately.

SEE

Recovery Rules Editor Functions

5.10.4.5 *Advanced Recovery Rules Editor*

PURPOSE

This editor functions much the same as the Basic Rules Editor. However, the Modula-2 programming language is used to allow more robust programming capabilities. Using the Advanced Editor, users can define variables that can be assigned values based on specified criteria during run-time. Procedures can also be implemented which allows use of modular programming techniques.

When the advanced rules are compiled, a special dynamic link library (DLL) is created and saved in a special folder.

When this option is invoked the first time (before any advanced rules for the selected project/ fault tree exist), you will be given the option to convert a copy of the basic rules, if any, into advanced rule format. At that time, applying the basic or advanced rules should produce identical results. However, advanced rules are saved separately, and can be modified to have different logic than the Basic Rules.

SEE

Recovery Rules Editor Functions

Applying Recovery Rules

5.10.4.6 *Edit Rules*

5.10.4.6.1 *Recovery Rules Editor*

PURPOSE

This option allows you to create or modify rules that affect existing cut sets in a “post-processing” fashion. The rule-based editor is available for both fault tree and sequence cut sets. The Recovery Rules editor provides a means to develop logic rules that allow for probabilistic risk assessment techniques such as automated inclusion of recovery events, inclusion of common-cause failure cut sets, or elimination of mutually-exclusive events (e.g., restricted or impossible combinations of events).

The rules are entered in a free-form text editor within SAPHIRE. The same editor is used to create both basic and advanced recovery rules. The following discussions use the basic rule syntax, except where

noted. Although the syntax/keywords differ between basic and advanced rules, the objectives and application of either kind of rule are the same.

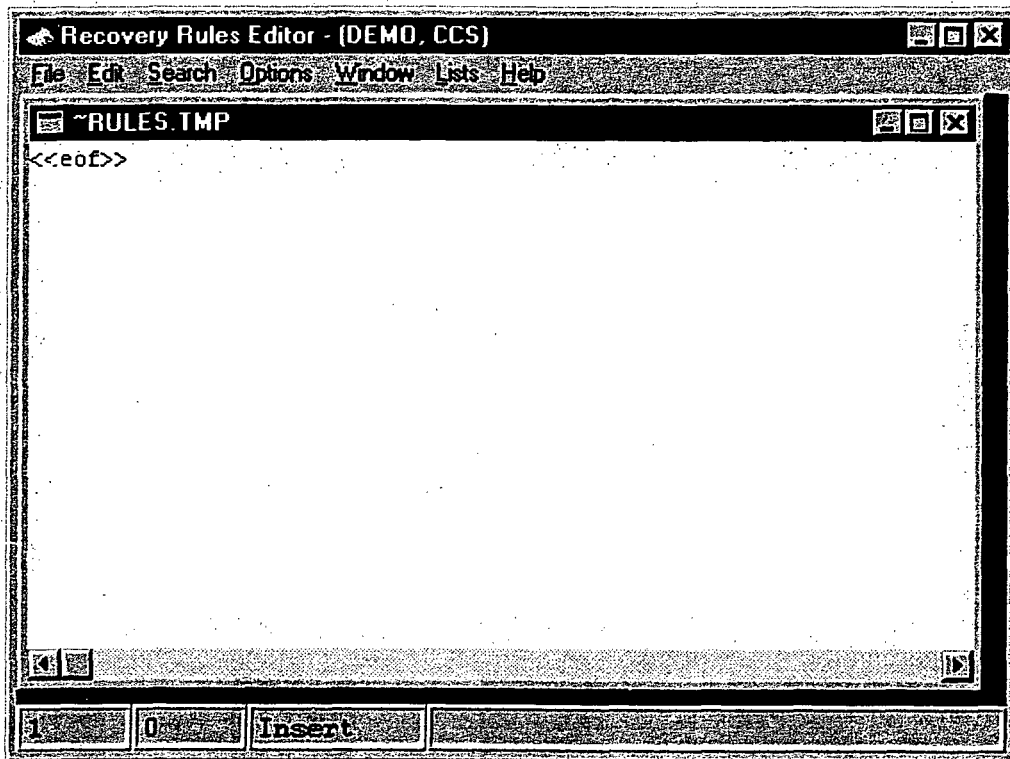
Recovery rules follow a format similar to the structure that is found in traditional programming languages (e.g., BASIC or PASCAL). As such, the ability exists to define "macros" and "if...then" type of structures. After creating or editing rules, SAPHIRE compiles the rules to check their validity. Alternatively, rules can be exported from SAPHIRE or entered in any word processor or text editor (that can output ASCII files) and then loaded directly into the SAPHIRE database.

The recovery rules can be applied to cut sets for a particular sequence, a single event tree, or all sequences in the project. The rules can also be applied to cut sets for a particular fault tree or all fault trees in the project.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence**. The *Fault Trees List/Sequences* dialog will be displayed.
2. Highlight the desired fault tree(s)/sequence(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets | Recover | Edit Rules**. The Edit Recovery Rules dialog will appear.
4. Select the desired *Rule Level* and *Rule Type*, and press **OK**.

If rules have been previously defined they will be displayed in the edit window.



Type the rules in the editor. Note that rules are not case sensitive.

File - File functions such as open, save, print, preferences, etc.

Edit -	Editing functions such as copy and paste along with text format operations.
Search -	Search and cursor positioning operations such as find, replace, goto, etc.
Window -	Window management functions such as cascade, tile horizontally, etc.
Lists -	Display lists of initiators, fault trees, etc. for inserting into the rules.

5.10.4.6.2 Editor File Functions

These options provide file management functions.

Open -	Open a file into a new window. This feature is not usually used while editing SAPHIRE rules.
New -	Create a new file in a new window. This feature is not usually used while editing SAPHIRE rules.
Close -	Close the edit current window. If changes have been made you will be prompted to save the file.
Quit -	Close the current edit window without saving.
Save -	Save the file in the current window to disk.
Save As -	Save the file in the current window with a new file name.
Save All -	Save all the files in all edit windows currently open.
Save Block -	Save the currently highlighted text into a new file. The Save As dialog will be invoked.
Import File -	Insert the contents of a file into the current edit window at the current cursor position. The Edit external file dialog will be invoked.
Print -	Print the file in the current edit window.
Page setup -	Set printer page layout options, such as pages per sheet and line numbers.
Preferences -	Select editing options such as tab width, undo levels, etc.
Exit -	Terminate the <i>Editor</i> session.

5.10.4.6.3 Editor Edit Functions

These options provide editing and text formatting functions.

Undo -	Undo the previous editing operation.
Cut -	Remove the highlighted text from the current window and place it in the clipboard.
Copy -	Copy the highlighted text from the current window and place it in the clipboard.
Paste -	Copy the clipboard text into the current window at the cursor position.
Delete -	Remove the highlighted text from the current window without placing it in the clipboard.
Shift left indent -	Shift the text to the left by the Shift Size specified under Options.
Shift right indent -	Shift the text to the right by the Shift Size specified under Options.
Shift left space -	Shift the text to the left by a single space.
Shift right space -	Shift the text to the right by a single space.
Delete to end of line -	Delete to the end of the current line beginning after the current cursor position.
Delete line -	Delete the line on which the cursor is currently positioned.
Capitalize word -	Convert the entire word under the current cursor position to upper case.
Downcase word -	Convert the entire word under the current cursor position to lower case.

5.10.4.6.4 Editor Search Functions

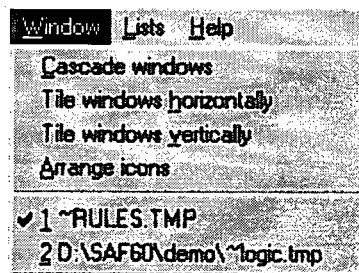
These options provide search and cursor positioning operations.

Find -	Search the text in the current window for the specified string.
Replace -	Search the text in the current window for a string and replace it with another string.
Find Procedure -	Search the text in the current window for the specified procedure.
Find/Replace again -	Repeat the previous search operation.
Find Altered lines -	Find the lines of text that have changed since the last save operation.
Find line number -	Go to the specified text line number in the current window.
Match symbol -	Find the matching symbol pair for the character under the cursor "(), {}, [], (**)"
Goto next error -	Position the cursor at the next compilation error.
Goto previous error -	Position the cursor at the previous compilation error.
Goto Marker -	Position the cursor at the previously saved file position. Up to four marker positions can be retrieved.
Set Marker -	Save the current file position for later retrieval.

5.10.4.6.5 Editor Window Functions

These options are used for managing the open edit windows within the application window, such as the *Linkage Rules Editor* or the *Event Tree Logic Editor* window. Along with the options listed below and segregated by a separation bar, the names of each open file is listed in the menu.

Cascade windows -	Resize and reposition the non-minimized windows in an overlapping fashion so that the title of each window is displayed in a cascade arrangement. The current edit window will be on top.
Tile windows horizontally -	Resize and reposition the non-minimized windows in a horizontally tiled arrangement.
Tile windows vertically -	Resize and reposition the non-minimized windows in a vertically tiled arrangement.
Arrange Icons -	Arrange the minimized window icons at the bottom of the application window.



In the example above, the files “~RULES.TMP” and “~LOGIC.TMP” are open. ~RULES.TMP is the active window, as indicated by the check mark on the menu.

5.10.4.6.6 Recovery Rules Lists

Selecting from the lists allows you to insert or replace items in the editor.

Macros -	Allows you to insert a macro into the editor.
Events -	Select basic events used to replace others instead of typing in the basic event names.
Initiators -	Select initiators used to replace others instead of typing in the initiator names.
Recovery Events -	Select recovery events used to replace others instead of typing in the event names.

5.10.4.6.7 *MACRO*

(Basic Rule syntax)

A macro is a user-definable keyword that specifies a search criteria. The macro name must be all uppercase, must be 24 characters or less, and must not include any of the restricted characters (e.g., a space, *, ?, \, /). The macro line can wrap around to more than one line, but must end with a semicolon.

MACRO-NAME = SEARCH-CRITERIA;

if **MACRO-NAME** "and optional other search criteria" then

perform some action on each cut set...;

endif

| Macros are only applicable in the particular rule they are entered into.

5.10.5 **Editing Fault Tree Cut Sets**

5.10.5.1 *Editing Cut Sets*

PURPOSE

The *Cut Set Editor* provides you with the means to edit the fault tree (or sequence or end state) cut sets. SAPHIRE provides space for two sets of cut sets in the database: base case and current case. Whenever SAPHIRE generates 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 current cut sets; however, **the results of the editing are always stored in the current case location.**

Using the cut set editor, you can insert new cut sets, delete cut sets, or add or modify basic events in the cut sets. 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 one minus the failure probability.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Trees List/Sequences/End State List* dialog will be displayed.

2. Highlight the desired record(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets**, then the **Edit** sub-menu option.
4. Choose either **Current** or **Base** from the sub-menu.
5. The *Cut Set Editor* dialog will be displayed.

Cut Set No	Events	CURRENT CASE
1	C-CV-A C-CV-B	
2	C-CV-A C-MOV-B	
3	C-CV-A C-PUMP-B	
4	C-CV-B C-MOV-A	
5	C-MOV-A C-MOV-B	
6	C-MOV-A C-PUMP-B	
7	C-CV-B C-PUMP-A	
8	C-MOV-B C-PUMP-A	
9	C-PUMP-A C-PUMP-B	
10	C-CV-B DG-A	

Buttons: Find, Previous, Next, Insert, Delete, Event List, Exit

- Find -** Locate the cut set(s) containing the marked basic event(s).
- Previous -** Locate the previous cut set containing the event(s) matching the criteria of most recent "Find" operation.
- Next -** Locate the next cut set containing the event(s) matching the criteria of most recent "Find" operation.
- Insert -** Add a new cut set or basic event.
- Delete -** Delete an existing cut set or basic event.
- Event List -** List the basic events in the data base.
- Exit -** Close the *Cut Set Editor* dialog. The *Cut Set Editor* message box is displayed with three options:
- Yes -** Close the dialog and save changes to the cut sets.
 - No -** Close the dialog without saving changes to the cut sets.
 - Cancel -** Do not close the dialog. Changes are not saved.

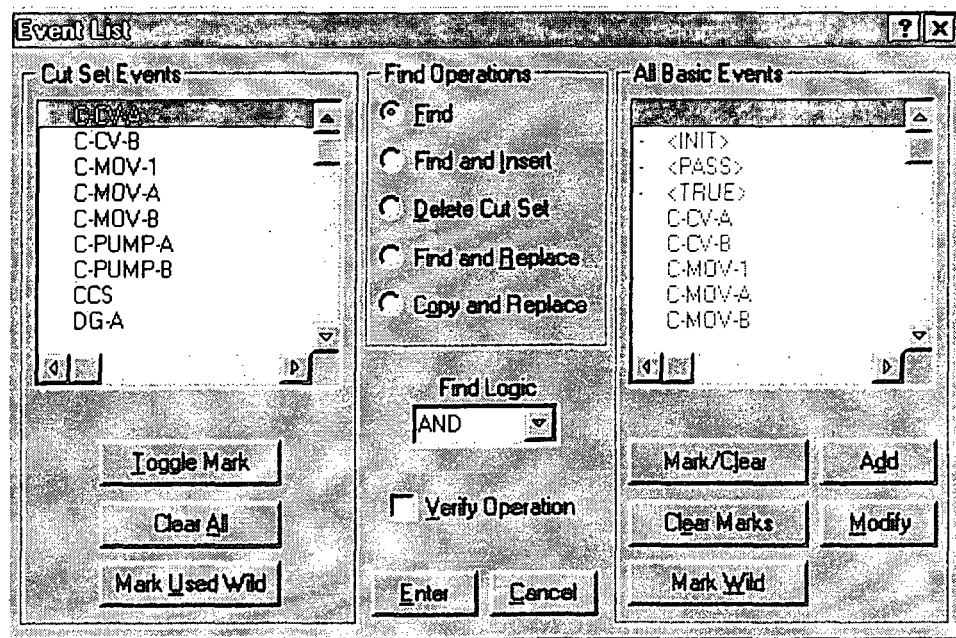
5.10.5.2 Find

PURPOSE

This option locates the cut set(s) containing the selected criteria.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Trees List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired record(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets**, then the **Edit** sub-menu option.
4. Choose either **Current** or **Base** from the sub-menu.
5. The *Cut Set Editor* dialog will be displayed.
6. Choose the **Find** button.
7. The *Event List* dialog will be displayed.



The *Event List* dialog consists of four sections. The functions that apply to each section are discussed briefly:

Cut Set Events

Basic Event List -

Contains all basic events used in the cut sets being edited.

Toggle Mark -

Marks or unmarks selected events in the *Cut Set Events* list. An asterisk (*) next to the event name indicates that it is currently marked. A slash (/) indicates that the event is marked as a complimented event.

- Clear All -** Removes all marks from the events in the *Cut Set Events* list.
- Mark Used Wild -** Marks events in the *Cut Set Events* list based on matching criteria. The *Event Class Mask* dialog is displayed.
- Find Operations**
- Find -** Locate the cut set(s) containing the marked event(s) in the *Cut Set Events* list using the selected *Find Logic*.
- Find and Insert -** Locate the cut sets(s) containing the marked event(s) in the *Cut Set Events* list using the selected *Find Logic* and insert the marked event(s) from the *All Basic Events* list. The new events are inserted into the cut set after the “find” event(s).
- Delete Cut Set -** Remove the cut set(s) containing the marked event(s) in the *Cut Set Events* list using the selected *Find Logic*.
- Find and Replace -** Locate the cut sets(s) containing the marked event(s) in the *Cut Set Events* list using the selected *Find Logic* and replace them with the marked event(s) from the *All Basic Events* list.
- Copy and Replace -** Copy the cut sets(s) containing the marked event(s) in the *Cut Set Events* list using the selected *Find Logic* and replace the event(s) with the marked event(s) from the *All Basic Events* list. This creates a new cut set for each cut sets matching the “find” criteria.
- All Basic Events - This section is enabled for use with the Find and Insert, Find and Replace, and Copy and Replace functions:**
- Basic Event List -** Contains all basic events in the database.
- Mark/Clear -** Marks or unmarks selected events in the *All Basic Events* list.
- Clear Marks -** Remove all marks from the events in the *All Basic Events* list.
- Mark Wild -** Marks events in the *All Basic Events* list based on matching criteria. The *Event Class Mask* dialog is displayed.
- Add -** Add a new basic event to the database. This new event will appear in the *All Basic Events* list.
- Modify -** Modify the selected event in the *All Basic Events* list.

Other options

- Find Logic drop-down list -** Allows selection between the logical AND and OR operations. The selected logical operation is applied to the events in the *Cut Set Events*.

Verify Option -	If this check box is selected, you are prompted to confirm the operation for each successful find. If this check box is deselected, the operation will be performed immediately.
Enter -	Perform the “find” operation using the currently selected criteria.
Cancel -	Do not perform the “find” operation and close the <i>Event List</i> dialog.

5.10.5.3 *Insert*

PURPOSE

This option allows you to insert a new cut set or basic event. If the I-bar is in a *Cut Set No* cell (i.e., the first column of cells on the *Cut Set Editor* dialog), then a row for a cut set will be added at the end of the cut set list. If the I-bar is in one of the *Events* cells, and the last event row for the current cut set (i.e., all three cells in the current cut set row) is filled, then a row for the current cut set will be added.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Trees List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired record(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets**, then the **Edit** sub-menu option.
4. Choose either **Current** or **Base** from the sub-menu.
5. The *Cut Set Editor* dialog will be displayed.
6. Place the cursor in the desired cell and choose the **Insert** button.

5.10.5.4 *Delete*

PURPOSE

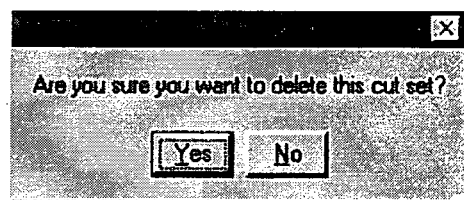
This option allows you to delete an existing cut set or basic event. If the I-bar is in a *Cut Set No* cell (i.e., the first column of cells on the *Cut Set Editor* dialog), then the entire cut set will be deleted. If the I-bar is in one of the *Events* cells, then the event in that cell will be removed from the cut set.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Trees List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired record(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets**, then the **Edit** sub-menu option.
4. Choose either **Current** or **Base** from the sub-menu.
5. The *Cut Set Editor* dialog will be displayed.

6. Place the cursor in the desired cell and choose the **Delete** button.

If you are deleting a cut set, you will be prompted:



Yes - Continue the delete operation.

No - Cancel the delete operation.

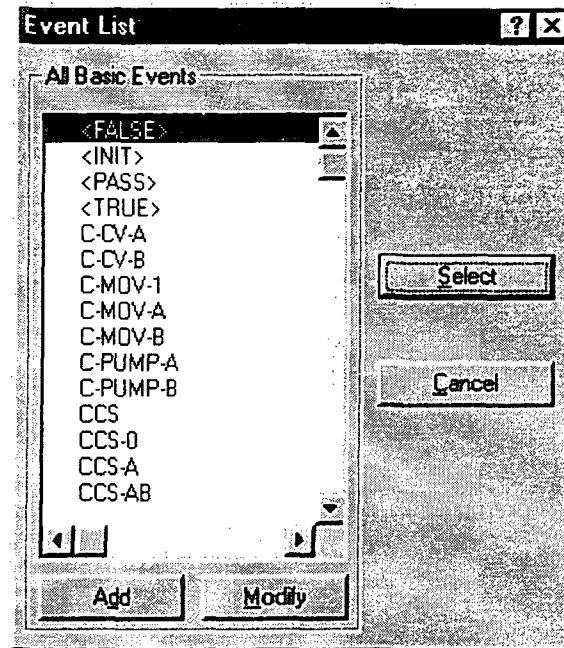
5.10.5.5 *Event List*

PURPOSE

This option lists all the basic events in the database. From this dialog you can add a new event to the database, modify an existing event's data, or select the event to be included in the current cut set. The cursor must be positioned in one of the *Events* cells in order to activate this option. The selected event will replace an existing event in the current cell.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Trees List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired record(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets**, then the **Edit** sub-menu option.
4. Choose either **Current** or **Base** from the sub-menu.
5. The *Cut Set Editor* dialog will be displayed.
6. Place the cursor in the desired *Event* cell.
7. Choose the **Event List** button. The *Event List* dialog will be displayed.



- Add** - Add basic event to the data base. The *Basic Event* data entry dialog will be displayed.
- Modify** - Modify the data of the highlighted basic event. The *Basic Event* data entry dialog will be displayed.
- Select** - Include the highlighted basic event in the cut set. The selected event will be placed in the cell currently occupied by the cursor.
- Cancel** - Close the *Event List* dialog and do not change the current cell.

5.11 Displaying Fault Tree Results

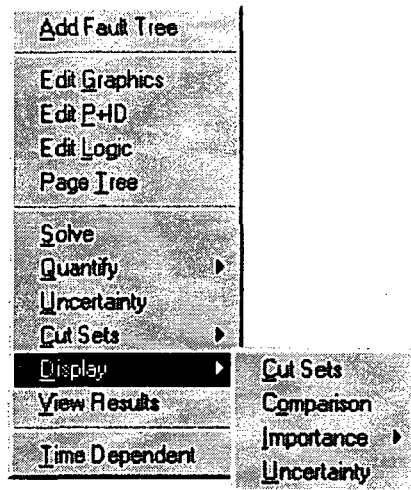
5.11.1 Displaying Fault Tree Results

PURPOSE

This option displays the results of fault tree analysis functions. You can display the case cut sets and uncertainty analysis results, and perform importance measure analyses.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree and right-click to invoke the pop-up menu.
3. Choose **Display**, then the desired sub-menu option.



- Cut Sets -** Display the fault tree's cut sets, their percent of contribution to the fault tree, the frequency, and the event names that make up the cut sets.
- Comparison -** Display the fault tree's base and current cut sets, their percent of contribution to the fault tree, the frequency, and the event names that make up the cut sets.
- Importance -** Perform and display "reliability-worth" information about the basic events in the cut sets.
- Uncertainty -** Display uncertainty analysis results.

5.11.2 Displaying Cut Sets

5.11.2.1 Displaying Cut Sets

PURPOSE

This option displays the current case cut sets. Three tabbed pages provide different views of the cut sets. The first tab, labeled *Full List*, contains the complete list of cut sets for the selected fault tree (or sequences or end states). This page always contains the complete set of cut sets found for the selected fault tree/sequences/end state.

When the dialog is invoked, the fault tree (or sequence or end state) cut sets are shown. Displayed with each cut set is its associated percent of contribution to the minimal cut set upper bound, its probability (or, perhaps, frequency), and the event names that make up the cut sets. Also displayed are the minimal cut set upper bound for the total, the number of cut sets that make up the total, the current slice minimal cut set upper bound, the percentage that the slice contributes to the total, and the number of cut sets in the slice.

The *Included In List* and *Excluded From List* tabs will not contain data until a slice has been defined, via one of the *Slice By* options.

The second tab, labeled *Included In Slice*, contains those cut sets specified (qualified) by the user via either the **Remove** and/or **Slice By** options. The third tab, labeled *Excluded From Slice*, contains the inverse of the second tab; it contains those cut sets not included in the qualified cut set list. The summary information at the top of each page shows the summary information for just the cut sets shown on the current page, and also in relation to the full list of cut sets.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Trees List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item(s) and right-click to invoke the pop-up menu.
3. Choose **Display**, then the **Cut Sets** sub-menu option.
4. The *Selected Cut Sets* dialog will be displayed.

Selected Cut Sets

Full List | Included In Slice | Excluded From Slice

Min Cut: 1.760E-003 Num: 19 100.00 %

Cut Set No.	Frequency	% Total	Events
1	9.200E-004	52.29	DG-A, DG-B
2	2.300E-004	13.07	DG-B, E-MOV-A
3	2.300E-004	13.07	C-MOV-B, DG-A
4	1.380E-004	7.84	C-PUMP-B, DG-A
5	1.380E-004	7.84	DG-B, E-PUMP-A
6	4.600E-005	2.61	DG-B, E-MOV-1
7	4.600E-005	2.61	C-MOV-1, DG-A
8	4.600E-006	0.26	C-CV-B, DG-A
9	4.600E-006	0.26	DG-B, E-CV-A
10	2.300E-006	0.13	C-MOV-1, E-MOV-1
11	2.300E-007	0.01	TANK

Slice By:

Tabbed pages

- Full List** - Display the complete (unsliced) list of cut sets.
- Included in Slice** - Display all currently qualified cut sets.
- Excluded From Slice** - Display all currently unqualified cut sets.

Pop-up menu (only) functions

- Path** - Display the logic that generated the highlighted cut set.
- Remove** - Remove the highlighted cut set(s) from the current list, and place them into the *Excluded From Slice* list.
- Reset Explicit** - Restore the cut set(s) that were deleted, via the **Remove** option, to the current list.

Slice By	
Event -	Define the event criteria upon which cut sets will be qualified.
Cutoff -	Define the cut off criteria upon which cut sets will be qualified.
Rule -	Define the rule-based criteria upon which cut sets will be qualified.
View -	Display information about the selected cut set including basic event data.
Report -	Generate a report of the cut sets that are displayed in the currently selected tab.
Save -	Copy the cut sets from the currently selected tab to an end state.
Close -	Close the <i>Selected Cut Sets</i> dialog.

5.11.2.2 Path Search

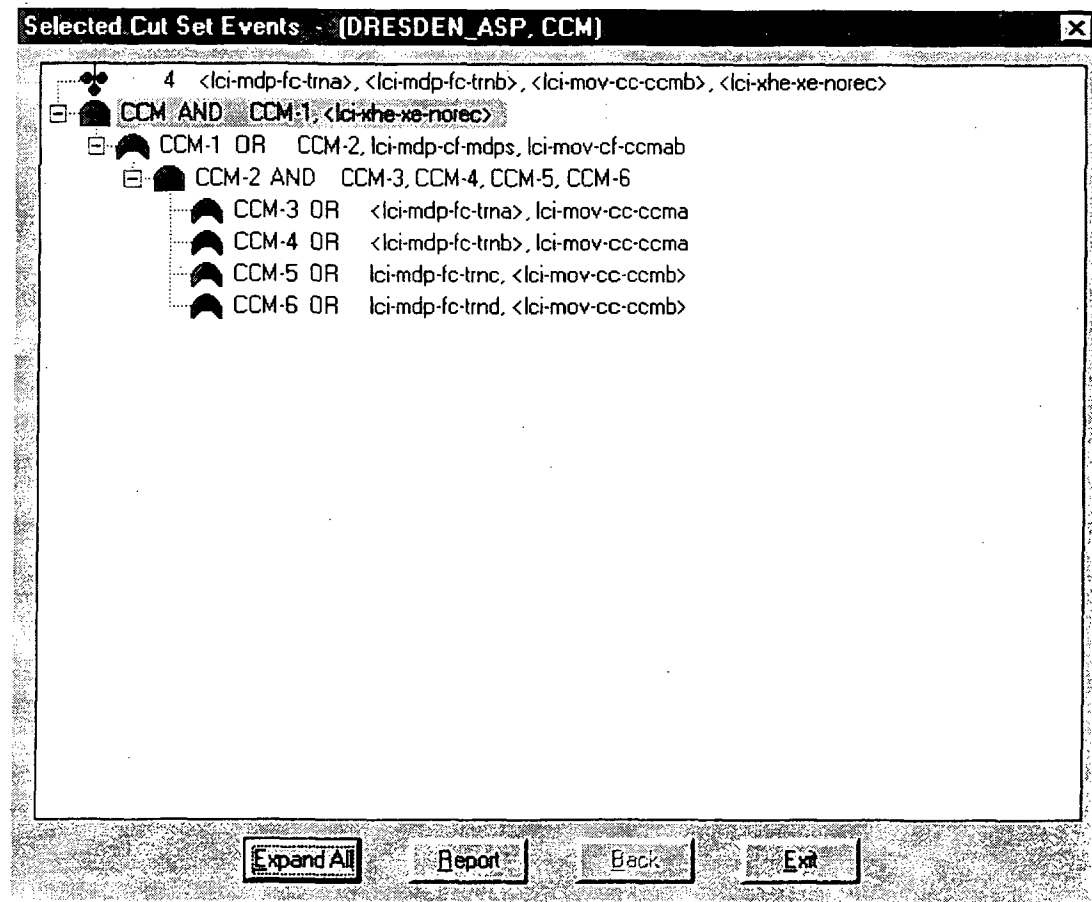
PURPOSE

This option displays the representation of the logic that generated the selected cut set. The representation is in the form of a hierarchical tree, where each gate can be expanded or condensed by clicking on the gate. Only the failure path is traced here.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
4. Highlight the desired cut set and right-click to invoke the pop-up menu.
5. Choose the **Path** option.
6. The *Selected Cut Set Events* dialog will be displayed.

See the topic, "About Logic Dialogs ," for a description of the icons presented on this dialog.



Expand All - Expand all gates.

Report - Generate a report representing the expanded hierarchical tree. The output destination for the report must be specified.

Back - Return to the referenced gate. Active only after a referenced gate has been traced to the location where it was originally defined (i.e., the reference gate icon has been clicked).

Exit - Close the *Selected Cut Set Events* dialog.

5.11.2.3 About Logic Dialogs

The gate names and gate types are displayed in uppercase characters. The event names are displayed in lowercase characters. The cut set events, indicated only in the **Path Search** option on the *Selected Cut Set Events* dialog, are enclosed in brackets (<>).

Presentation of the logic in dialogs and reports generated by SAPHIRE is limited to 255 characters in width. If the representation of the logic requires expansion past this limit, it will be truncated for display and reporting. The actual logic will remain in tact.

The following graphics are used for easy identification of gate types and their status:

- ☐- An expanded gate. Click on the graphic to condense the gate.

-  A condensed gate. Click on the graphic to expand the gate.
-  The cut set events. Used on in the **Path Search** option.
-  Event tree top. Applicable only for sequence cut sets and used on in the **Path Search** option.
-  AND gate
-  OR gate
-  N/M gate
-  Transfer gate
-  NAND gate
-  NOR gate
-  Reference gate. This symbol indicates that the gate has been previously defined in the logic. Click on the gate next to this symbol. The gate where it is originally defined will be highlighted.

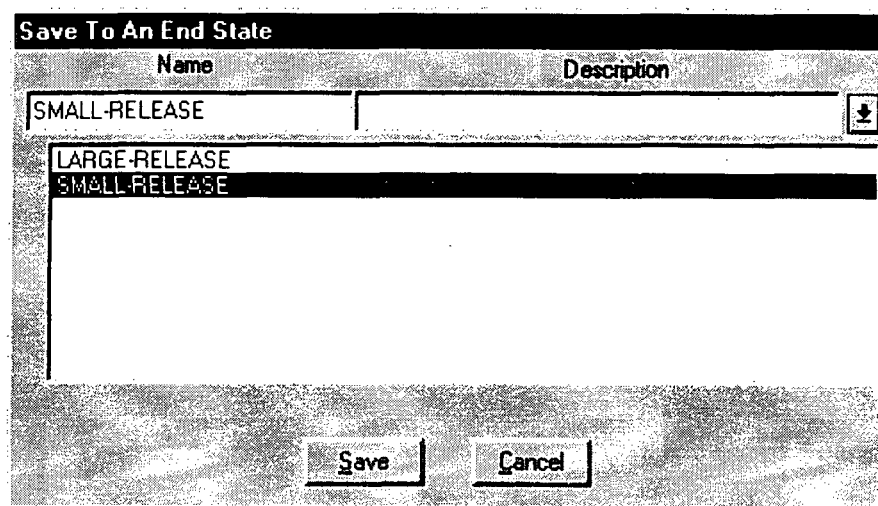
5.11.2.4 Save

PURPOSE

Save the results of the existing cut set slice (currently displayed on the *Selected Cut Sets* dialog) to an end state.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
4. Slice, or qualify, the cut sets as desired. Select the tab containing the cut set list you want to save.
5. Choose the **Save** button. The *Save To An End State* dialog will be displayed.



In the example here, the down arrow to the right of the *Description* field was selected to display the list of existing end states.

- Name -** Enter the name of the new end state. Up to 24 uppercase, alphanumeric characters are allowed.
- Description -** Enter the description of the new end state. Up to 60 upper- and lowercase, alphanumeric characters area allowed
- Save -** Perform the save operation. A new end state record will be saved in the SAPHIRE data base with the name and description as entered here, and current slice for its cut sets. Selecting an existing end state will cause the existing cut sets for that end state to be overwritten.
- Cancel -** Close the *Save To An End State* dialog without saving the cut sets or creating a new end state record.

5.11.2.5 *Slice Options*

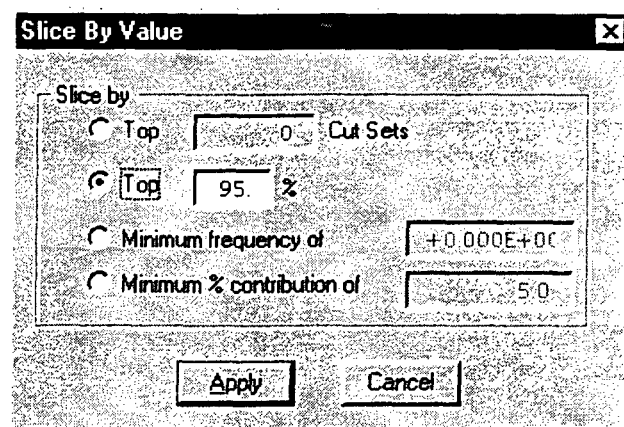
5.11.2.5.1 *Slice By Cutoff*

PURPOSE

This option provides the ability to divide the original cut set list into two subsets (slices) – qualified and unqualified cut sets. This is accomplished by defining a cut off value to determine whether or not a cut set is qualified. This qualification criteria can be used to help the analyst determine the affect of specified cut sets on the minimal cut set upper bound.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
4. Choose the *Slice By Cutoff* button.
5. The *Slice By Value* dialog will be displayed.



Select one of four types of cutoff value expressions:

- Top X Cut Sets –** Display only the top X cut sets in the qualified list.

- Top X% -** Display only the cut sets which contribute to the top X% of the min cut upper bound.
- Minimum frequency of X –** Display only the cut sets which contribute at least a value of X to the min cut upper bound.
- Minimum % contribution of X –** Display only the cut sets which contribute at least a X% to the min cut upper bound.
- Apply -** Cut sets in the current slice will be evaluated. Those cut sets meeting the qualification criteria will be retained in the current slice of qualified cut sets. Other cut sets not meeting the qualification criteria will be placed in the unqualified list.
- Cancel -** Close the *Slice By Value* dialog without applying the qualification criteria.

5.11.2.5.2 *Slice By Event*

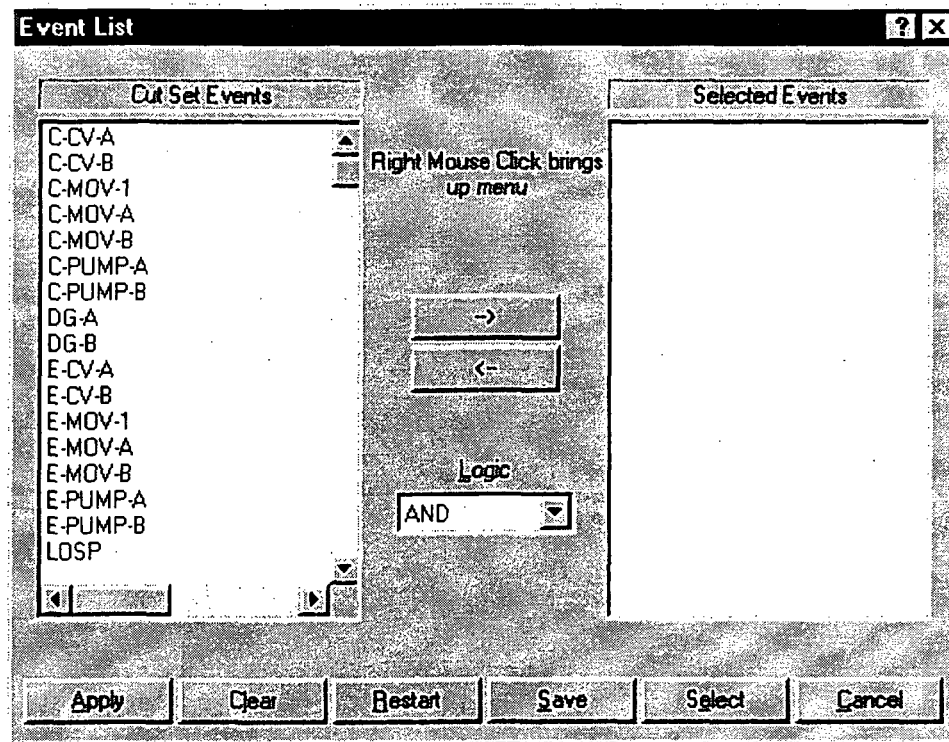
5.11.2.5.2.1 *Slice By Event*

PURPOSE

This option provides the ability to divide the original cut set list into two subsets (slices) – qualified and unqualified cut sets. This is accomplished by defining a set of events used to evaluate whether or not a cut set is qualified. This qualification criteria can be used to help the analyst determine the affect of specified events on the minimal cut set upper bound.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
4. Choose the *Slice By Event* button.
5. The *Event List* dialog will be displayed.



The Event List dialog is divided into three sections:

- Cut Set Events* list - Contains all the basic events included in the cut set(s) for the currently selected fault tree, sequence(s) or end state(s).
- Selected Events* list - Contains all basic events that define the qualification criteria. This list is initially empty.
- Logic* drop-down list - Allows selection between the logical “AND” and “OR” operations. The selected logical operation is applied to the events in the *Selected Events* list to determine which cut sets are qualified.

The various functions available from this dialog are accessed three different ways. When an event in the Cut Set Events list is highlighted, the following options are available from the pop-up menu. The highlighted event(s) will be added to the Selected Events list.

- Wild Card Mark -** Use the event class mask to highlight events in the *Cut Set Events* list.
- Add Event -** Cut sets containing this event, in any state (either failed or success), will be qualified.
- Add Failure Event -** Cut sets containing the failure (+) of this event will be qualified.
- Add Success Event -** Cut sets containing the success (/) of this event will be qualified.
- Add NOT Event In -** Cut sets that do not contain (~) this event, in any state (either failed or success), will be qualified.
- Apply Selected -** Evaluate the qualification criteria. This is the same process as if the **Apply** button was chosen.

When an event in the **Selected Events** list is highlighted, the following options are available from the pop-up menu. The qualification criteria state will be changed for the highlighted event(s):

Remove Event -	Delete this event from the <i>Selected Events</i> list. This event will no longer be used in the qualification criteria.
Event (either / or +) -	The state of the highlighted event, whether successful or failed, is irrelevant.
Failed Event -	Change the state of the highlighted event to failed (+).
Success Event -	Change the state of the highlighted event to successful (/).
Event NOT In -	The highlighted event are is not contained (~) in qualified cut sets.
Apply Selected -	Evaluate the qualification criteria. This is the same process as if the Apply button was chosen.

The following functions are performed by choosing the appropriate button:

Apply -	Cut sets in the current slice will be evaluated. Those cut sets meeting the qualification criteria will be retained in the current slice of qualified cut sets. Other cut sets not meeting the qualification criteria will be placed in the unqualified list.
Clear -	Remove all events from the <i>Selected Events</i> list (i.e., clear the qualification criteria).
Restart -	Restore the original cut sets and clear the qualification criteria. The <i>Event List</i> dialog will be closed and the <i>Included In List</i> and <i>Excluded From List</i> pages will be cleared.
Save -	Save the selected events in a stored slice record.
Select -	Choose a saved slice record and place the events in the <i>Selected Events</i> list.
Cancel -	Close the <i>Event List</i> dialog without applying the qualification criteria.

5.11.2.5.2.2 Wild Card Mark

PURPOSE

This option uses the event class mask to highlight events in the *Cut Set Events* list. This selection is used with either the *Cut Set Editor* or the **Cut Set | Slice** option.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.

To access from the **Slice#1**

1. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
2. Choose the **Slice** button. The *Event List* dialog will be displayed.
3. Right-click to invoke the pop-up menu and choose the **Wild Card Mark** option.

To access from the *Cut Set Editor#1*

1. Choose **Cut Sets | Edit | Current or Base**. The *Cut Set Editor* dialog will be displayed.
2. Choose the **Find** button. The *Event List* dialog will be displayed.
3. Choose the **Mark Used Wild** button. The *Event Class Mask* dialog will be displayed.

Event Attributes Mask									Susceptibilities							
Primary	Id	System	Train	Uncert. Corr. Class	Category	Type	F/Mode	Loc	1	2	3	4	5	6	7	8
									☐	☐	☐	☐	☐	☐	☐	☐
									9	10	11	12	13	14	15	16
									☐	☐	☐	☐	☐	☐	☐	☐

Ok Cancel

- Primary -** Select all basic events with matching primary names (maximum 24 characters). Wildcard characters may be used.
- Id -** Select all basic events with matching component identifiers.
- System -** Select all basic event with matching systems.
- Train -** Select all basic event with matching trains
- Uncert. Corr. Class -** Select all basic event with matching uncertainty correlation classes.
- Category -** Select all basic event with matching categories.
- Type -** Select all basic event with matching types.
- F/Mode -** Select all basic event with matching failure modes.
- Location -** Select all basic event with matching locations.
- Susceptibilities -** Select all basic event with matching susceptibility attributes set.

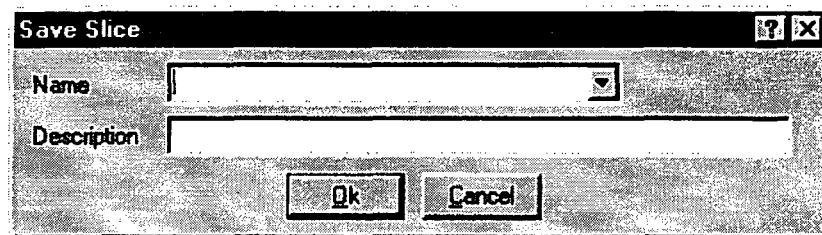
5.11.2.5.2.3 Save Slice

PURPOSE

This option allows you to save the basic events currently displayed in the *Selected Events* list in a stored slice record or a set.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
4. Choose the **Slice** button. The *Event List* dialog will be displayed.
5. Select the desired events to be saved in the slice.
6. Choose the **Save** button. The *Save Slice* dialog will be displayed.



Ok - Save the new slice record and close the dialog.

Cancel - Close the dialog without saving.

5.11.2.5.2.4 Slice Name

This is a required field. A maximum of 24 uppercase, alphanumeric characters may be entered, or an existing slice may be overwritten by selecting it from the drop-down list. When entering a new name, embedded blanks are not allowed. The name should be descriptive so the slice can be readily identified.

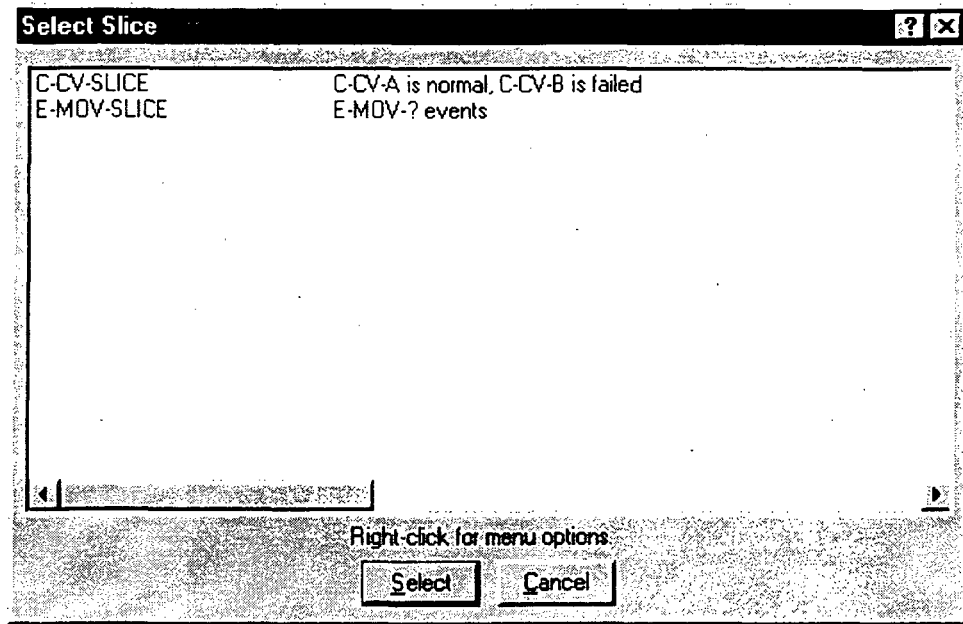
5.11.2.5.2.5 Select Slice

PURPOSE

Choose a saved slice record and place the events in the *Selected Events* list. When a slice record is loaded, the basic events saved in the slice replace all basic events currently displayed in the *Selected Events* list. If a basic event that was saved in a slice does not appear in the *Cut Set Events* list, it will not be displayed in the *Selected Events* list, although it will remain in the slice record.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
4. Choose the **Slice** button. The *Event List* dialog will be displayed.
5. Choose the **Select** button. The *Select Slice* dialog will be displayed.



Pop-up Menu Options

- Modify** - Change the slice record name and/or description. See Save Slice .
- Delete** - Delete the slice record from the database.
- Exit** - Close the *Select Slice* dialog.

Button Options

- Select** - Choose the highlighted slice record and load the saved events.
- Cancel** - Close the *Select Slice* dialog.

5.11.2.5.3 *Slice By Rule*

5.11.2.5.3.1 *Slice By Rule*

PURPOSE

This option provides the ability to divide the original cut set list into two subsets (slices) – qualified and unqualified cut sets. This is accomplished by defining one or more rules to evaluate whether or not a cut set is qualified. The rules provide the ability to qualify cut sets using logical expressions, including mixed logic (combining "ands" and "ors") if desired. The rules are saved in the project for repeated use.

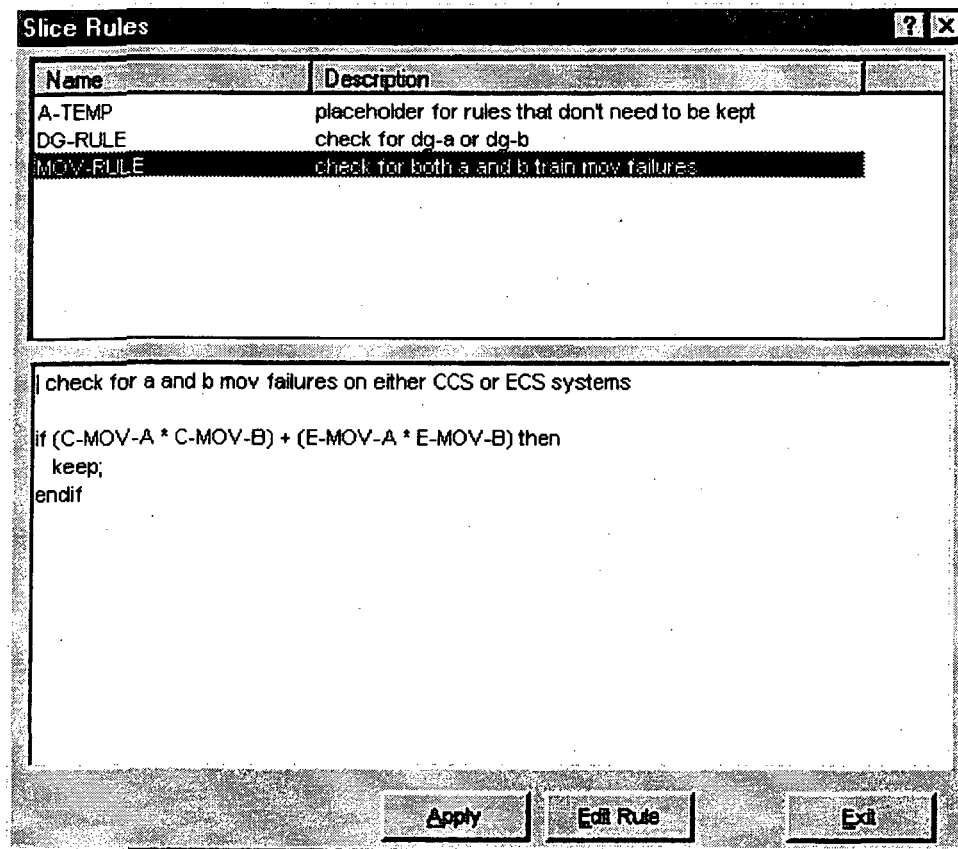
When the dialog is invoked, a list of slice rules is displayed. The highlighted rule is previewed in the bottom text area. To add/modify/delete a slice rule name and description, right click and select the appropriate menu option. To edit a rule, choose the **Edit Rule** button. To apply a rule to the current cut sets, choose the **Apply** button.

To clear the qualified and unqualified lists, choose the **Reset** option from the *Slice By Event* option, or, apply a different slice option to override the current slice.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.

2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
4. Choose the *Slice By Rule* button. The *Slice Rules* dialog will be displayed.



Pop-up Menu Options

- Add** - Create a new, empty rule.
- Copy** - Make a copy of an existing rule. You must supply a unique name before saving the rule.
- Modify** - Modify the name and/or description of the selected rule.
- Delete** - Remove the rule from the project.
- Apply** - The full list of current cut sets will be evaluated. Those cut sets meeting the qualification criteria will be retained in the current slice of qualified cut sets. Other cut sets not meeting the qualification criteria will be placed in the unqualified list.
- Edit Rules**-Edit the selected rule logic.
- Exit** - Close the *Slice Rules* dialog without applying a rule.

5.11.2.5.3.2 *Slice Rules Editor*

PURPOSE

This option allows you to create or modify rules that divide cut sets into two subsets - qualified and unqualified. The Slice Rules editor provides a means to develop logic rules that locate and separate cut sets containing desired event combinations.

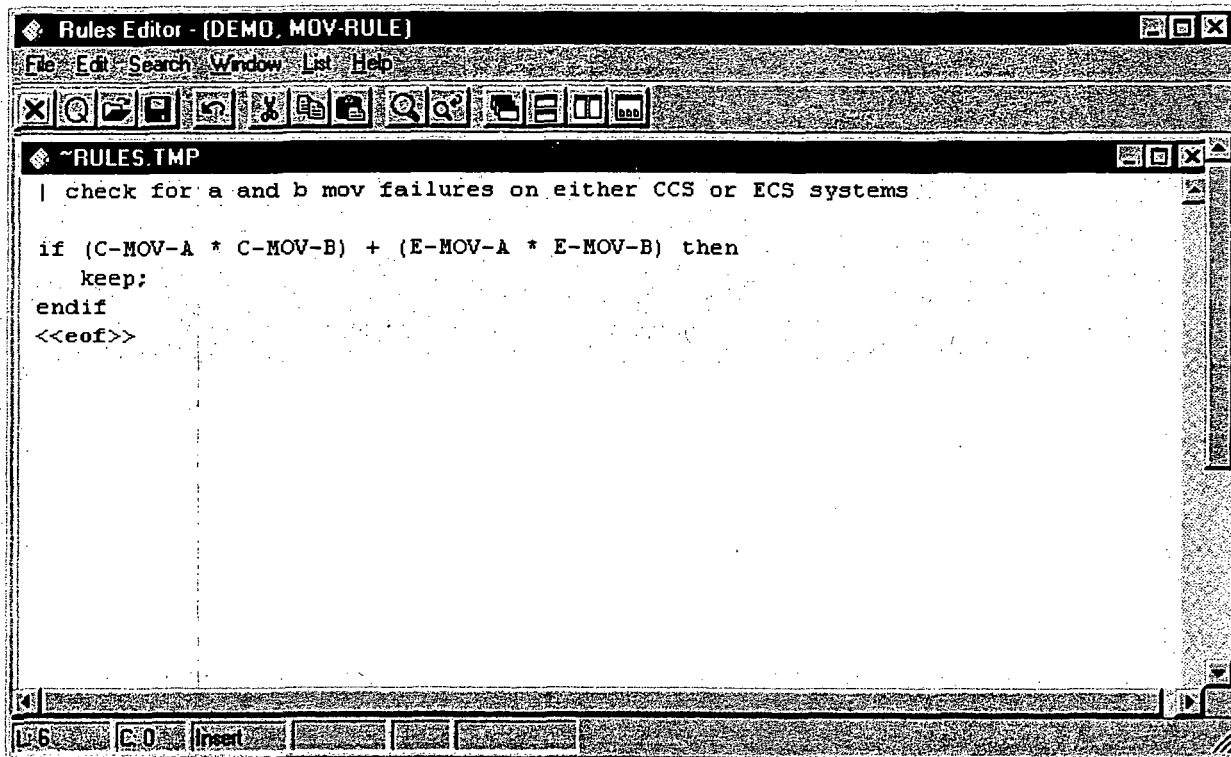
The slice rules are entered in a free-form text editor within SAPHIRE. The editor options and rule syntax are similar to that of SAPHIRE's recovery rules. However, unlike to recovery rules, slice rules are not tied to the fault tree, sequence(s) or end state(s) whose cut sets are currently displayed. (A slice rule is available to be applied to any type of displayed cut sets.)

Slice rules follow a format similar to the structure that is found in traditional programming languages (e.g., BASIC or PASCAL). As such, the ability exists to define "macros" and "if...then" type of structures. After creating or editing rules, SAPHIRE compiles the rules to check their validity.

Note: An alternative method of entering rules into the project is to export them from SAPHIRE and create or edit them in any word processor or text editor (that can output ASCII files) and then loaded directly into the SAPHIRE database.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Trees List/Sequences/End States* dialog will be displayed.
2. Highlight the desired fault tree(s)/sequence(s)/end state(s) and right-click to invoke the pop-up menu.
3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will appear.
4. Choose the *Slice By Rule* button. The *Slice Rules* dialog will appear.
5. If necessary, add a new rule by right clicking and choosing the **Add** menu option.
6. Highlight the desired slice rule and choose **Edit Rules**. If rules have been previously defined they will be displayed in the edit window.



Type the rules in the editor. Note that the rules are not case sensitive.

File -	File functions such as open, save, print, preferences, etc.
Edit -	Editing functions such as copy and paste along with text format operations.
Search -	Search and cursor positioning operations such as find, replace, goto, etc.
Window	Window management functions such as cascade, tile horizontally, etc.
Lists -	Display lists of macros and events for inserting into the rules. Three different event lists are available: initiators, a complete list of events, and only those events available in the currently displayed cut sets.

5.11.2.5.3.3 Editor File Functions

These options provide file management functions.

Open -	Open a file into a new window. This feature is not usually used while editing SAPHIRE rules.
New -	Create a new file in a new window. This feature is not usually used while editing SAPHIRE rules.
Close -	Close the edit current window. If changes have been made you will be prompted to save the file.
Quit -	Close the current edit window without saving.
Save -	Save the file in the current window to disk.
Save As -	Save the file in the current window with a new file name.

Save All -	Save all the files in all edit windows currently open.
Save Block -	Save the currently highlighted text into a new file. The Save As dialog will be invoked.
Import File -	Insert the contents of a file into the current edit window at the current cursor position. The Edit external file dialog will be invoked.
Print -	Print the file in the current edit window.
Page setup -	Set printer page layout options, such as pages per sheet and line numbers.
Preferences -	Select editing options such as tab width, undo levels, etc.
Exit -	Terminate the <i>Editor</i> session.

5.11.2.5.3.4 *Editor Edit Functions*

These options provide editing and text formatting functions.

Undo -	Undo the previous editing operation.
Cut -	Remove the highlighted text from the current window and place it in the clipboard.
Copy -	Copy the highlighted text from the current window and place it in the clipboard.
Paste -	Copy the clipboard text into the current window at the cursor position.
Delete -	Remove the highlighted text from the current window without placing it in the clipboard.
Shift left indent -	Shift the text to the left by the Shift Size specified under Options.
Shift right indent -	Shift the text to the right by the Shift Size specified under Options.
Shift left space -	Shift the text to the left by a single space.
Shift right space -	Shift the text to the right by a single space.
Delete to end of line -	Delete to the end of the current line beginning after the current cursor position.
Delete line -	Delete the line on which the cursor is currently positioned.
Capitalize word -	Convert the entire word under the current cursor position to upper case.
Downcase word -	Convert the entire word under the current cursor position to lower case.

5.11.2.5.3.5 *Editor Search Functions*

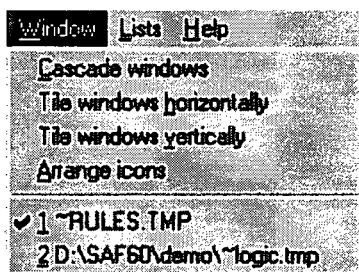
These options provide search and cursor positioning operations.

Find -	Search the text in the current window for the specified string.
Replace -	Search the text in the current window for a string and replace it with another string.
Find Procedure -	Search the text in the current window for the specified procedure.
Find/Replace again -	Repeat the previous search operation.
Find Altered lines -	Find the lines of text that have changed since the last save operation.
Find line number -	Go to the specified text line number in the current window.
Match symbol -	Find the matching symbol pair for the character under the cursor "(), {}, [], (**)"
Goto next error -	Position the cursor at the next compilation error.
Goto previous error -	Position the cursor at the previous compilation error.
Goto Marker -	Position the cursor at the previously saved file position. Up to four marker positions can be retrieved.
Set Marker -	Save the current file position for later retrieval.

5.11.2.5.3.6 *Editor Window Functions*

These options are used for managing the open edit windows within the application window, such as the *Linkage Rules Editor* or the *Event Tree Logic Editor* window. Along with the options listed below and segregated by a separation bar, the names of each open file is listed in the menu.

- | | |
|------------------------------------|---|
| Cascade windows - | Resize and reposition the non-minimized windows in an overlapping fashion so that the title of each window is displayed in a cascade arrangement. The current edit window will be on top. |
| Tile windows horizontally - | Resize and reposition the non-minimized windows in a horizontally tiled arrangement. |
| Tile windows vertically - | Resize and reposition the non-minimized windows in a vertically tiled arrangement. |
| Arrange Icons - | Arrange the minimized window icons at the bottom of the application window. |



In the example above, the files “~RULES.TMP” and “~LOGIC.TMP” are open. ~RULES.TMP is the active window, as indicated by the check mark on the menu.

5.11.2.5.3.7 *Slice Rules Lists*

Selecting from the lists allows you to insert or replace items in the editor.

- | | |
|-------------------------|---|
| Macros - | Allows you to insert a macro into the editor. |
| Events - | Select any basic event instead of typing in the basic event name. |
| Cut Set Events - | Select from a list of only those events found in the currently displayed cut sets, instead of typing in the event name. |
| Initiators - | Select an initiating event instead of typing in the initiator name. |

5.11.2.5.3.8 *MACRO*

(Basic Rule syntax)

A macro is a user-definable keyword that specifies a search criteria. The macro name must be all uppercase, must be 24 characters or less, and must not include any of the restricted characters (e.g., a space, *, ?, \, /). The macro line can wrap around to more than one line, but must end with a semicolon.

MACRO-NAME = SEARCH-CRITERIA;

if **MACRO-NAME** “and optional other search criteria” then

perform some action on each cut set...;

endif

| Macros are only applicable in the particular rule they are entered into.

5.11.2.6 Importance

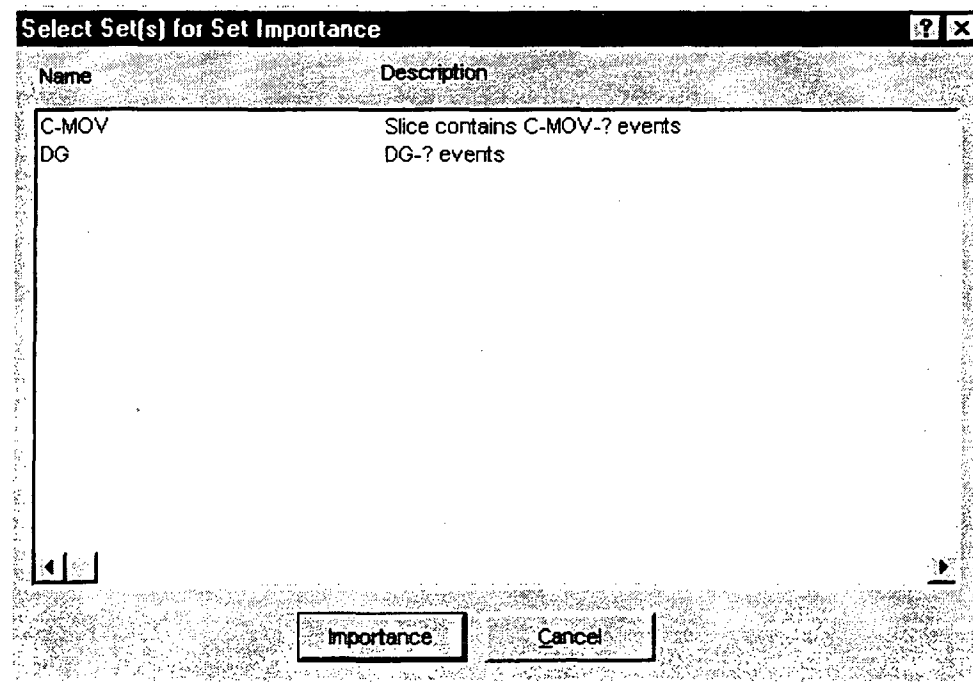
5.11.2.6.1 Sets Importance

PURPOSE

This option displays the Fussell-Vesely importance of the selected set(s) of cut sets including interactions among the events. The selected sets are previously saved slices.

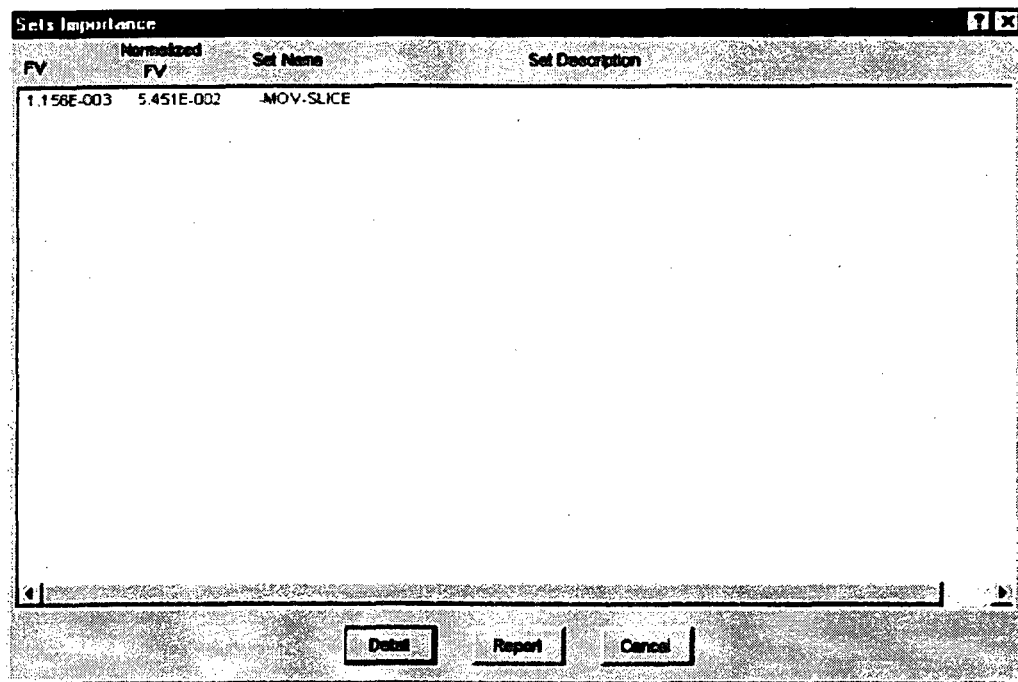
STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
4. Choose the **Sets** button. The *Select Set(s) for Set Importance* dialog will be displayed.



Select the desired set(s) and choose the **Importance** button.

The *Sets Importance* dialog will be displayed containing the Fussell-Vesely importance, normalized Fussell-Vesely, name of the set, and its description, for each selected set.



Detail - Displays the *Cut Set Importance* dialog after selecting one of the sets. Choose the **Top** or **Bottom** buttons for Sets importance details .

Report - Generates a report containing the Fussell-Vesely importance, normalized Fussell-Vesely, set name, and description of the selected set.

Cancel - Closes the *Sets Importance* dialog.

5.11.2.7 View Option

5.11.2.7.1 View Cut Set

PURPOSE

This option displays the basic events of the selected cut set with their failure probabilities and descriptions. At the bottom of the *Selected Cut Set Events* dialog, information about this cut set is displayed: percent of contribution to the total, the cut set frequency, and the number of events that make up this cut set.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.

3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
OR
4. Choose **Display | Comparison**. The *Base & Current Case Cut Sets* dialog will be displayed.
5. Highlight the desired cut set.
6. Choose the **View** button. The *Selected Cut Set Events* dialog will be displayed.

Event Name	Value	Description
I LOSP	2.300E+000	Loss of Offsite Power Initiating Event
C-PUMP-B	3.000E-003	CCS Train B motor-driven pump
DG-A	2.000E-002	Emergency diesel generator A
E Undefined EndState		

Frequency 1.380E-004 7.84 % Number of Events 3

View Event **Exit**

When viewing fault tree cut sets, the end state, if any, is designated with the letter “E” to the left of the *Event Name* column. It will be the last item listed.

When viewing sequence cut sets, the initiating event is designated with the letter “I” to the left of the *Event Name* column. It will be the first item listed. The end state will be designated with the letter “E” to the left of the *Event Name* column and will be the last item listed.

When viewing end state cut sets, the initiating event is designated with the letter “I” to the left of the *Event Name* column. It will be the first item listed. The originating sequence is designated by the letter “S” to the left of the *Event Name* column and will be the last item listed.

View Event - Display individual basic event information.

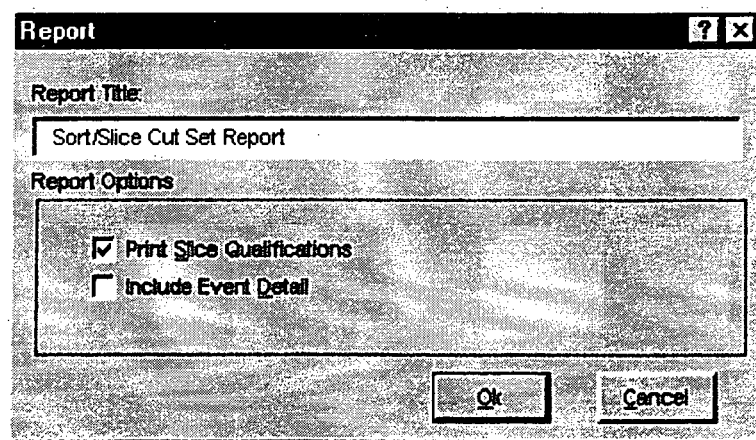
5.11.2.7.2 View Event

PURPOSE

This option provides the following detailed information about the basic events that make up a cut set: event names and description, event attributes, random failure data, uncertainty data, susceptibility flags, and transformation data.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
OR
4. Choose **Display | Comparison**. The *Base & Current Case Cut Sets* dialog will be displayed.
5. Highlight the desired cut set.
6. Choose the **View Cut Set** button. The *Selected Cut Set Events* dialog will be displayed.
7. Highlight the desired basic event.
8. Choose the **View Event** button. The *View Event* dialog will be displayed.



- | | |
|-------------------------------------|--|
| Report Title - | A default report title is provided. Edit this value to customize the title. |
| Print Slice Qualifications - | When checked, the criteria used to qualify the cut sets is included in the report. |
| Include Event Detail - | When checked, the report will report one event per line, and including event probability and description information. When this option is not checked, the events will appear as a comma delimited list, with no supplementary event information included. |

5.11.3 Comparing Cut Sets

5.11.3.1 Cut Set Comparison

PURPOSE

This option displays both the base case and current case cut sets for the selected fault tree (or sequences or end states). The source (either base or current) of the cut sets is indicated both by color and a symbol. The color red and the “-” symbol in the first column indicate a base case cut set. The color black and a blank (“ ”) in the first column indicate that the cut set is both a current case and base case cut set. The color green and the “+” symbol in the first column indicate a current case cut set.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Trees List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item(s) and right-click to invoke the pop-up menu.
3. Choose **Display**, then the **Comparison** sub-menu option. The *Base & Current Case Cut Sets* dialog will be displayed.

Base & Current Case Cut Sets - (DEMO, LOSEP, 3)

Sort by: ☒ Probability ☐ Source

Cut Set No.	Frequency	% Total	Events
+ 1	4.600E-002	93.68	CCS-TRAIN-B, DG-A
2	9.200E-004	1.87	DG-A, DG-B
- 3	2.300E-004	0.47	C-MOV-B, DG-A
4	2.300E-004	0.47	DG-B, E-MOV-A
- 5	1.380E-004	0.28	C-PUMP-B, DG-A
6	1.380E-004	0.28	DG-B, E-PUMP-A
7	4.600E-005	0.09	C-MOV-1, DG-A
8	4.600E-005	0.09	DG-B, E-MOV-1
+ 9	1.150E-005	0.02	C-MOV-A, CCS-TRAIN-B, E-MOV-1
+ 10	6.900E-006	0.01	C-PUMP-A, CCS-TRAIN-B, E-MOV-1
- 11	4.600E-006	0.01	C-CV-B, DG-A
12	4.600E-006	0.01	DG-B, E-CV-A
13	2.300E-006	0.00	C-MOV-1, E-MOV-1
+ 14	2.875E-007	0.00	C-MOV-A, CCS-TRAIN-B, E-MOV-A, E-MOV-B
15	2.300E-007	0.00	TANK
+ 16	2.300E-007	0.00	C-CV-A, CCS-TRAIN-B, E-MOV-1
+ 17	1.725E-007	0.00	C-MOV-A, CCS-TRAIN-B, E-MOV-A, E-PUMP-B

Source:
 - Old (base case)
 Blank - Both
 + New (current case)

Total Value: 4.774E-002 Total Number: 140

Sort by

Probability -

List the cut sets by frequency in descending order.

Source -

List the cut sets by source, listing first base case cut sets, then cut sets existing in both, followed by current case cut sets.

View -

Display information about the selected cut set including basic event data.

Report -

Generate a report of the data that is displayed on the dialog.

Exit -

Close the *Base & Current Case Cut Sets* dialog.

5.11.3.2 View Cut Set

PURPOSE

This option displays the basic events of the selected cut set with their failure probabilities and descriptions. At the bottom of the *Selected Cut Set Events* dialog, information about this cut set is displayed: percent of contribution to the total, the cut set frequency, and the number of events that make up this cut set.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
OR
4. Choose **Display | Comparison**. The *Base & Current Case Cut Sets* dialog will be displayed.
5. Highlight the desired cut set.
6. Choose the **View** button. The *Selected Cut Set Events* dialog will be displayed.

Event Name	Value	Description
I LOSP	2.300E+000	Loss of Offsite Power Initiating Event
C-PUMP-B	3.000E-003	CCS Train B motor-driven pump
DG-A	2.000E-002	Emergency diesel generator A
E Undefined EndState		

Frequency: 1.360E-004 7.84 % Number of Events: 3

When viewing fault tree cut sets, the end state, if any, is designated with the letter “E” to the left of the *Event Name* column. It will be the last item listed.

When viewing sequence cut sets, the initiating event is designated with the letter “I” to the left of the *Event Name* column. It will be the first item listed. The end state will be designated with the letter “E” to the left of the *Event Name* column and will be the last item listed.

When viewing end state cut sets, the initiating event is designated with the letter “I” to the left of the *Event Name* column. It will be the first item listed. The originating sequence is designated by the letter “S” to the left of the *Event Name* column and will be the last item listed.

View Event - Display individual basic event information.

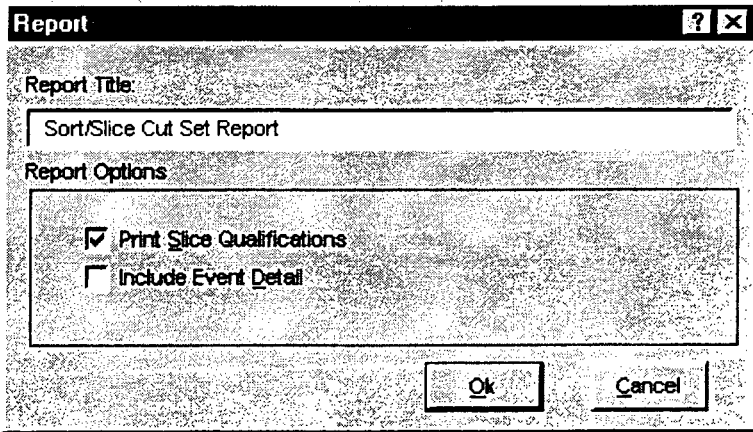
5.11.3.3 Cut Set Report

PURPOSE

This option allows you to generate a report of the data that is currently displayed on the dialog. The report may be displayed in the *Report Viewer*, sent to a printer, or saved to a file for later processing.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
4. Choose the **Report** button. The *Report* dialog will be displayed.
5. Select the desired report options and choose **OK**. The Report Viewer will display the report.



Report Title -

A default report title is provided. Edit this value to customize the title.

Print Slice Qualifications -

When checked, the criteria used to qualify the cut sets is included in the report.

Include Event Detail -

When checked, the report will report one event per line, and including event probability and description information. When this option is not checked, the events will appear as a comma delimited list, with no supplementary event information included.

5.11.4 Displaying Importance Results

5.11.4.1 Importance Measures

PURPOSE

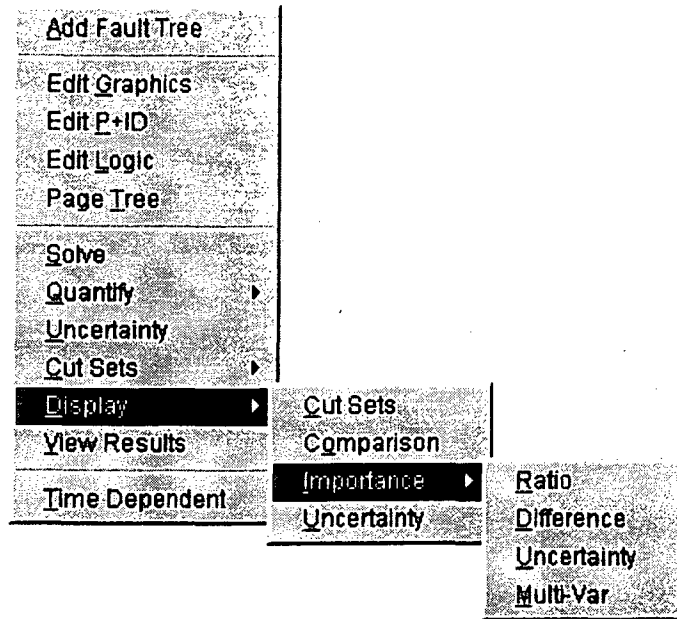
Importance measures provide “reliability-worth” information about basic events appearing in the cut sets for a fault tree or accident sequence. The “importance” for a basic event is essentially the event’s contribution to the overall top event probability (for fault trees) or sequence frequency (for event trees). The measure of contribution can take on many forms depending on what concern the analyst has for a particular basic event. Consequently, SAPHIRE calculates seven different basic event importance measures. These are the Fussell-Vesely importance, risk reduction ratio, risk increase ratio, Birnbaum (or first derivative) importance, risk reduction difference, risk increase difference, and the uncertainty importance.

The ratio importance measures are dimensionless and consider only relative changes. The difference definitions account for the actual risk levels that exist and are more appropriate when actual risk levels are of concern, such as comparisons or prioritizations across different plants. For purely relative evaluations, such as prioritizations within a plant, the ratios sometimes give more graphic results.

These importance measures are calculated for each basic event for the respective fault tree or accident sequence. Once the results have been calculated, they can be displayed and then partitioned as a subset of the original cut sets.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display**, then the **Importance** sub-menu option.
4. Choose from one of the following sub-menu options:



- Ratio -** Fussell-Vesely importance, Risk Reduction Ratio, and Risk Increase Ratio will be calculated and displayed.
- Difference -** Birnbaum importance, Risk Reduction Interval, and Risk Increase Interval will be calculated and displayed.
- Uncertainty -** Quantification of the contribution of each individual basic event's uncertainty to the total output uncertainty.
- Multi-Var -** Importance for a group of events will be calculated and displayed.

5.11.4.2 Fussell-Vesely Importance (FV)

The FV measure is an indication of the percentage of the minimal cut set upper bound contributed by the cut sets containing the basic event. The equation for FV importance is

$$FV = F(i)/F(x)$$

where

- F(i) is the minimal cut set upper bound for the group of cut sets containing the event
- F(x) is the original minimal cut set upper bound

Prior to SAPHIRE version 7.27, the FV equation used and approximate expression

$$FV = 1 - F(0)/F(x)$$

where

- F(0) is the minimal cut set upper bound with the event probability set equal to 0.0.
- F(x) is the original minimal cut set upper bound.

5.11.4.3 Birnbaum Importance (B)

This indicates the sensitivity of the minimal cut set upper bound with respect to a change in the basic event probability.

$$B = F(1) - F(0)$$

where

$F(1)$ is the minimal cut set upper bound with the event probability set equal to 1.0.

$F(0)$ is the minimal cut set upper bound with the event probability set equal to 0.0.

5.11.4.4 Risk Reduction Ratio (RRR) or Risk Reduction Interval (RRI)

These are an indication of how much the minimal cut set upper bound would decrease if the basic event was reduced to a probability of 0.0 (typically if the corresponding component never failed).

$$RRR = F(x)/F(0)$$

$$RRI = F(x) - F(0)$$

Note the similarity between RRI and FV; the relative importance ranking of basic events will be the same for the two importance measures.

5.11.4.5 Risk Increase Ratio (RIR) or Risk Increase Interval (RII)

These are an indication of how much the minimal cut set upper bound would increase if the basic event was increased to 1.0 (typically if the corresponding component always failed). Note: If the event probability is close to 1.0, this importance measure may yield a small RIR or RII.

$$RIR = F(1)/F(x)$$

$$RII = F(1) - F(x)$$

where

$F(x)$ is the original minimal cut set upper bound

$F(1)$ is the minimal cut set upper bound with the event probability set equal to 1.0.

5.11.4.6 Uncertainty Importance

The uncertainty in each input parameter, as expressed through its probability distribution, contributes to the uncertainty in the output parameter of interest (e.g., core damage frequency). The uncertainty importance measure in SAPHIRE attempts to quantify the contribution of each individual basic event's uncertainty to this total output uncertainty. The measure used in SAPHIRE is based on a Taylor series expansion of the variance of the output of interest. The equation used by SAPHIRE is

$$Var(R) \approx \sum_{i=1}^n \left(\frac{\partial R}{\partial p_i} \right)^2 \sigma_i^2$$

where R is the output of interest, p_i is the probability of the i th basic event, and σ_i^2 is the variance of the uncertainty distribution for the i th event. This approximation, which hinges upon the basic events being mutually statistically independent, says that the variance of the output is approximately the sum of n separate contributions, one from each basic event. The magnitude of each contribution (each contribution is positive) measures how much of the output variance is contributed by each basic event. Because it is

more convenient, SAPHIRE uses the square root of each individual contribution as the uncertainty importance:

$$I_{unc} = \frac{\partial R}{\partial p_i} \sigma_i$$

where σ_i is the standard deviation of the uncertainty distribution of the i th basic event. Note that the partial derivative in the above equation for the uncertainty importance is, by definition, the Birnbaum importance of that event. Therefore, no new calculations are needed; the uncertainty importance is the Birnbaum importance multiplied by the standard deviation of the input probability distribution.

5.11.4.7 *Multi-Var Importance*

This option allows the user to calculate an importance for a group of events.

For instance, the user can select all motor operated valves in a set of cut sets and get a combined importance measure for these valves together. All of the valves are treated as a single event in the importance calculations and the result is displayed with the name "Multi-variable."

5.11.4.8 *Importance Measures Dialog*

5.11.4.8.1 *Importance Measures Results*

PURPOSE

This option displays the results of the importance measure analysis.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display**, then the **Importance** submenu option.
4. Choose from one of the submenu options: **Ratio**, **Difference**, **Uncertainty**, **Multi-Var**. The *Importance Measures* dialog will be displayed.

The results shown here are Fussell-Vesely importance measures. If the analysis type is seismic, the program will prompt you to select a ground acceleration level defined in the project hazard curve.

Importance Measures - (DEMO, CCS)					
Sort					
F-V					
Event Name	# of Occur	Probability	F-V	Risk Reduc. Ratio	Risk Incre. Ratio
DG-B	1	2.000E-002	9.418E-001	1.718E+001	4.715E+001
C-MOV-1	1	1.000E-003	4.619E-002	1.048E+000	4.715E+001
DG-A	3	2.000E-002	7.477E-003	1.008E+000	1.366E+000
C-MOV-B	4	5.000E-003	6.692E-003	1.007E+000	2.322E+000
C-PUMP-B	4	3.000E-003	4.015E-003	1.004E+000	2.325E+000
C-MOV-A	3	5.000E-003	1.869E-003	1.002E+000	1.371E+000
C-PUMP-A	3	3.000E-003	1.121E-003	1.001E+000	1.372E+000
C-CV-A	3	1.000E-003	3.738E-004	1.000E+000	1.373E+000
C-CV-B	4	1.000E-004	1.338E-004	1.000E+000	2.329E+000

- Sort -** Select from the drop-down list to sort results by Occurrence, Probability, F-V / Birnbaum / Uncertainty, Reduction, or Increase. By default, when the importance data are first displayed it is sorted, high to low, by F-V / Birnbaum / Uncertainty importance value.
- Description -** Display the full description for the highlighted event in the message bar of the SAPHIRE main window.
- Partition -** Limit which events are displayed/reported.
- Report -** Generate a report of the data that is displayed on the dialog.
- Exit -** Close the *Importance Measures* dialog.

5.11.4.8.2 Importance Results Partition

PURPOSE

This option allows you to redefine a fault tree 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.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display | Importance**.
4. Choose from one of the submenu options: **Ratio, Difference, Uncertainty, Mult-Var**. The *Importance Measures* dialog will be displayed.
5. Choose the **Partition** button. The *Partition* dialog will be displayed.

Partition - (DEMO, CCS) [?] [X]

Total Number of Events: 26 Number of Qualified Events: 0

Event Attributes

Names	Comp Id	Sys	Train	Type	FMode	Location	Category
<P> []	[]	[]	[]	[]	[]	[]	[]

Susceptibilities

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]

- Include -** Fill in the entry fields that are to be used to qualify the events that may be used in the new partition. Choose the **Include** button. The events in the cut set are qualified and when complete, will update the **Number of Qualified Events** field that appears in the upper right of the *Partition* dialog.
- Exclude -** Fill in the entry fields that are to be used to remove events from the list of qualified events. Choose the **Exclude** button. The events in the cut set are qualified and when complete, will update the **Number of Qualified Events** field that appears in the upper right of the *Partition* dialog.
- Compliment -** Cause all currently qualified events to be disqualified, and all unqualified events to become the set of qualified events.
- Reset -** Set all events in the database to be qualified. This removes all partitioning from the current cut sets.
- View Events -** Display the list of all events in the project. Mark those events that are to be considered qualified.
- Exit -** Close the *Partition* dialog. Only those cut sets that are made up of qualified events are displayed on the *Importance Measures* dialog.

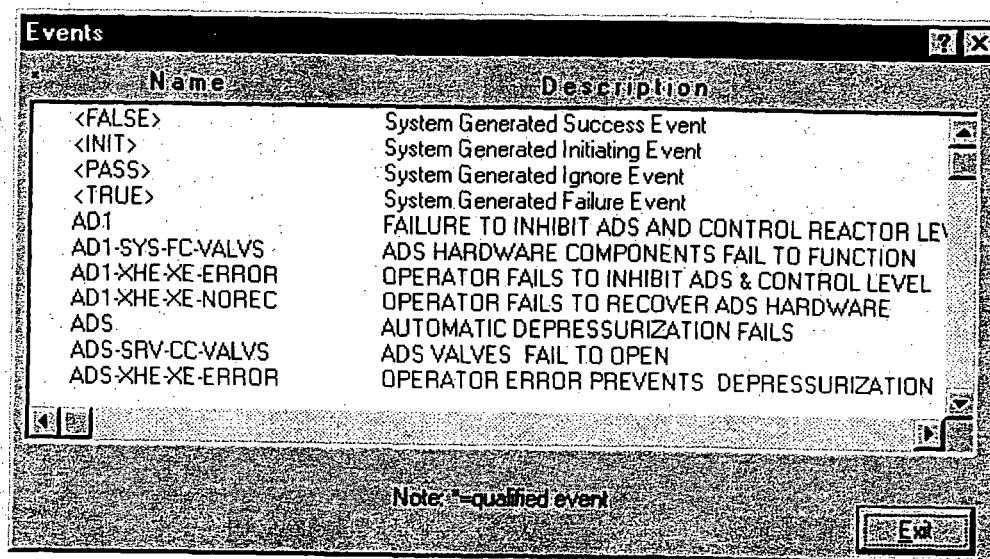
5.11.4.8.3 View Events

PURPOSE

This option allows you to display the list of all events in the project and mark those events that are to be used to determine whether a cut set belongs to a partition.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display | Importance**.
4. Choose from one of the sub-menu options: **Ratio, Difference, Uncertainty, Mult-Var**.
5. The *Importance Measures* dialog will be displayed.
6. Choose the **Partition** button. The *Partition* dialog will be displayed.
7. Choose the **View Events** button. The *Events* dialog will be displayed.



- Double-click -** Mark the selected event. An asterisk (*) will appear to the left of the event name.
- Exit -** Close the *Events* dialog. Choose the **Include** or **Exclude** button from the *Partition* dialog..

5.11.5 Displaying Uncertainty

5.11.5.1 Displaying Uncertainty Results

PURPOSE

This option displays the results of the uncertainty analysis previously performed. The results displayed are the distribution and probability bounds for both base and current results. These values were calculated using either the Latin Hypercube or the Monte Carlo simulation technique.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.
3. Choose **Display**, then the **Uncertainty** sub-menu option. The *Fault Tree/Sequence/End State Uncertainty* dialog will be displayed.

If the analysis type is seismic, you will be prompted to select a ground acceleration level defined in the project hazard curve.

Base					
Mean	2.111E-002	Median	8.797E-003	Mincut	2.120E-002
Std. Dev	4.420E-002	Skewness	8.129E+000	Kurtosis	+0.000E+000
5th %	1.452E-003	Minimum	3.483E-004	Seec	7550
95th %	7.723E-002	Maximum	7.526E-001	Samples	1000
Size Cutoff	--	Probability Cutoff	1.000E-015		

Current					
Mean	2.270E-002	Median	8.720E-003	Mincut	2.120E-002
Std. Dev	5.037E-002	Skewness	8.004E+000	Kurtosis	9.916E+001
5th %	1.564E-003	Minimum	1.320E-004	Seec	57877
95th %	7.759E-002	Maximum	8.639E-001	Samples	1000
Size Cutoff	--	Probability Cutoff	1.000E-006		

Current Quantile Values -

View the quantile values associated with the current case data.

Base Quantile Values-

View the quantile values associated with the base case data.

Exit -

Close the *Fault Tree/Sequence/End State Uncertainty*

dialog.

5.11.5.2 Uncertainty Quantile Values

PURPOSE

Display the uncertainty quantile (or probability) values associated with either the current or base case data. These quantile values can be used to construct a cumulative distribution plot of the analysis uncertainty results.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired fault tree and right-click to invoke the pop-up menu.
3. Choose **Display**, then the **Uncertainty** sub-menu option. The *Fault Tree/Sequence/End State Uncertainty* dialog will be displayed.
4. Choose the **Current Quantile Values** or **Base Quantile Values** button.

Distribution Quantile Level (in per cent)	95% Confidence Interval On Quantile Level in % (+/-)	Quantile Value	95% Confidence Interval on Quantile Lower Bound	Upper Bound
0.5	0.5	6.2185E-004	3.6160E-004	8.1985E-004
1.0	0.7	8.1985E-004	5.3501E-004	1.0688E-003
2.5	1.0	1.1657E-003	1.0634E-003	1.3215E-003
5.0	1.4	1.6235E-003	1.3281E-003	1.7995E-003
10.0	1.9	2.2045E-003	2.0049E-003	2.4574E-003
20.0	2.5	3.3830E-003	3.0875E-003	3.6982E-003
25.0	2.7	4.0422E-003	3.6952E-003	4.3167E-003
30.0	2.9	4.5621E-003	4.2275E-003	5.0094E-003
40.0	3.1	6.2820E-003	5.6327E-003	6.8446E-003
50.0	3.1	8.8435E-003	7.9240E-003	9.5918E-003
60.0	3.1	1.1394E-002	1.0605E-002	1.2502E-002
70.0	2.9	1.6375E-002	1.4758E-002	1.8275E-002

Buttons: Plot, Report, Exit

Distribution Quantile Level (in percent) - The probability level, which ranges from 0.5% to 99.5%.

95% Confidence Interval On Quantile Level in % (+/-) - The 95% confidence level on the quantile level (e.g., 5%, 50%, 90%) expressed in terms of the percent of the quantile level. Note that this is the confidence on the quantile level, not the quantile value.

Quantile Value - The value obtained from the uncertainty analysis at the *i*'th % quantile (or probability) level. The units on the value varies depending on the type of analysis (e.g., failure probability, core damage frequency, etc.).

95% Lower Bound Confidence Level On Quantile Value - The lower bound confidence level on the quantile value.

95% Upper Bound Confidence Level On Quantile Value - The upper bound confidence level on the quantile value.

Plot - Show a graphical representation of the uncertainty distribution defined by the uncertainty quantile values.

Report - Generate a report containing the quantile values as displayed here.

Exit - Close the *Uncertainty Quantile Values* dialog.

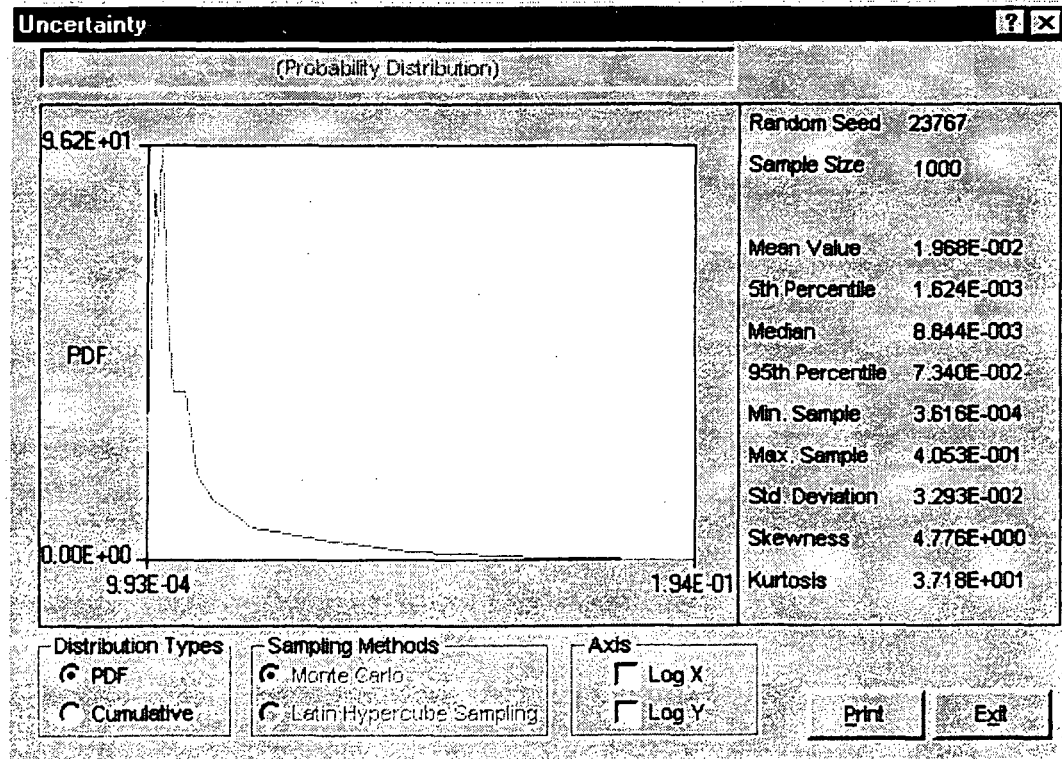
5.11.5.3 Plot Uncertainty Quantile Values

PURPOSE

Show a graphical representation of the distribution defined by the uncertainty quantile (or probability) values associated with either the current or base case data.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired fault tree and right-click to invoke the pop-up menu.
3. Choose **Display**, then the **Uncertainty** sub-menu option. The *Fault Tree/Sequence/End State Uncertainty* dialog will be displayed.
4. Choose the **Current Quantile Values** or **Base Quantile Values** button.
5. Choose the **Plot** button. The *Uncertainty* plot dialog will be displayed.



Print – Print the plot as displayed. The *Print* common dialog will be launched where you can select the desired printer.

Exit – Close the *Uncertainty* plot dialog.

5.11.5.4 Distribution Types

Select the type of graph to be displayed:

- PDF -** Default) - Displays a graph showing the Probability Density Function.
Cumulative - Displays a graph showing the Cumulative Density Function.

5.11.5.5 *Sampling Methods*

The selected radio button indicates the sampling method used for the uncertainty calculation. Note the sampling method used cannot be changed here. In order to view results using a different sampling method, the uncertainty analysis must be re-run using the desired sampling method.

- Monte Carlo -** Displays a graph that is based on Monte Carlo Sampling of the defined uncertainty distribution.
Latin Hypercube Sampling - Displays a graph that is based on Latin Hypercube Sampling of the defined uncertainty distribution.

5.11.5.6 *Axis*

- Log X -** Produces a graph where the Log base 10 of the X-Values are used instead of just the X-Values.
Log Y - Produces a graph where the Log base 10 of the Y-Values are used instead of just the Y-Values.

5.12 Viewing Fault Trees Results

5.12.1 Viewing Fault Tree Data

PURPOSE

The data displayed from this option originates from the fault tree analyses previously performed. One or more fault trees can be viewed using this option.

STEPS

1. From the SAPHIRE menu select **Fault Tree**. The *Fault Tree List* dialog will be displayed.
2. Highlight the desired fault tree(s) and right-click to invoke the pop-up menu.
3. Choose **View Results** from the menu. The *Fault Tree Review* dialog will be displayed.

Current Case -	Includes current case values for cut set probability, mean, 5 th percentile, median, 95 th percentile, probability truncation, and size truncation used when solving.
Base Case Uncertainty -	Includes base case values for cut set probability, mean, 5 th percentile, median, 95 th percentile, minimum, maximum, standard deviation, skewness, kurtosis, sample size, and random number seed.
Current Case Uncertainty -	Includes current case values for cut set probability, mean, 5 th percentile, median, 95 th percentile, minimum, maximum, standard deviation, skewness, kurtosis, sample size, and random number seed.

5.13 Time Dependent Analysis

5.13.1 Time Dependent Analysis

PURPOSE

The time dependent analysis function allows the user to calculate a time profile of the selected fault tree or sequence cut sets. The user defines a start and stop "mission" time and a delta time or number of samples. From this data, SAPHIRE calculates a probability for each event in the cut sets using the start mission time. The cut sets are quantified and a min cut upper bound is determined. The mission time is then incremented by a delta and new event probabilities and a new min cut upper bound are calculated. Events that do not have mission time as part of their calculation type are not changed. This process continues until the mission time equals the stop time, at which point the results of the distribution are displayed. This allows the user to calculate a distribution of results for events that are dependent on time.

STEPS

1. From the SAPHIRE menu select **Fault Tree/Sequence**. The *Fault Tree List/Sequences* dialog will be displayed.
2. Highlight the desired list item(s) and right-click to invoke the pop-up menu.
3. Choose **Time Dependent** from the menu. The *Time Dependent Calculation Values* dialog will be displayed.

Time Dependent Calculation Values

Start Time: [] E

Stop Time: [] E

Simulation Values

☒ Delta Time delta to use: [] E

☐ Samples Number of samples to use: 1000

Ok Cancel

Start Time - The time, in hours, to begin the analysis.

Stop Time - The time, in hours, to end the analysis.

Simulation Values

Delta - If this radio button is selected, use the delta indicated in the *Time delta to use* field to determine the number of samples used in the analysis. The smaller the delta, the greater the number of samples.

Time delta to use - The incremental change, in hours, for which the analysis will be performed beginning at the **Start Time** and terminating at the **Stop Time**.

Sample - If this radio button is selected, use the *Number of samples to use* field to determine the time delta used in the analysis. The greater the number of samples, the smaller the delta.

Number of samples to use - The total number of samples used for this analysis. The number of samples will determine the time delta to be used.

Ok - Begin the time analysis.

Cancel - Close the *Time Dependent Calculation Values* dialog without calculating the time profile.