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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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PREVIOUS REPORTS

Smith, C. L., et al., *Testing, Verifying, and Validating SAPHIRE Versions 6.0 and 7.0*, NUREG/CR-6688, October 2000.

K. D. Russell, et al. *Systems Analysis Programs for Hands-on Reliability Evaluations (SAPHIRE) Version 6.0 - System Overview Manual*, NUREG/CR-6532, May 1999.

K. D. Russell et al., *Integrated Reliability and Risk Analysis System (IRRAS) Version 5.0, Volume 2 - Reference Manual*, NUREG/CR-6116, EGG-2716, July 1994.

K. D. Russell et al., *Verification and Validation (V&V), Volume 9 – Reference Manual*, NUREG/CR-6116, EGG-2716, July 1994.

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

K. D. Russell et al., *Integrated Reliability and Risk Analysis System (IRRAS) Version 2.5 Reference Manual*, NUREG/CR-5300, EGG-2613, March 1991.

K. D. Russell, M. B. Sattison, D. M. Rasmuson, *Integrated Reliability and Risk Analysis System (IRRAS) - Version 2.0 User's Guide*, NUREG/CR-5111, EGG-2535, manuscript completed March 1989, published June 1990.

K. D. Russell, D. M. Snider, M. B. Sattison, H. D. Stewart, S.D. Matthews, K. L. Wagner, *Integrated Reliability and Risk Analysis System (IRRAS) User's Guide - Version 1.0 (DRAFT)*, NUREG/CR-4844, EGG-2495, June 1987.

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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CONTENTS

PREVIOUS REPORTS ii
ABSTRACT iii
FOREWORD v
CONTENTS vii
EXECUTIVE SUMMARY xix
ACRONYMS xxi
1. GETTING TO KNOW SAPHIRE 1
1.1 Background 1
1.2 Overall Capabilities 2
1.3 New Features Found in Version 7 5
1.4 About This Manual 7
1.4.1 Document Organization 7
1.4.2 Documentation Conventions 7
1.5 Installation 9
1.5.1 Software and Hardware Requirements 9
1.5.2 Installation Instructions 9
1.6 Using SAPHIRE 9
1.6.1 Starting SAPHIRE 9
1.6.2 Exiting SAPHIRE 10
1.6.3 Using SAPHIRE for the First Time 10
1.6.4 Converting from Previous SAPHIRE (IRRAS) Versions 11
1.7 Getting Around Inside SAPHIRE 12
1.7.1 About List Boxes in SAPHIRE 12
1.7.2 Selecting List Items Using the Mask Feature 13
1.7.3 Invoking Pop-up Menus 14
1.7.4 Selecting the Analysis Type 14
1.7.5 SAPHIRE Help 15
1.7.6 Toolbars 15
1.8 User Support 21
1.9 SAPHIRE Quality Assurance 21
2. DATABASE STRUCTURE AND CONCEPTS 23
2.1 Database Concepts 23
2.2 Database Structure 24
2.2.1 Project Relation 24
2.2.2 Fault Tree Relation 24

2.2.3 Sequence Relation 25
2.2.4 Event Tree Relation 25
2.2.5 Event Relation 26
2.2.6 Change Set Relation 27
2.2.7 UserInfo Relation 27

2.3 SAPHIRE Database Concepts 27
2.3.1 Unpredictable Results 27
2.3.2 Cross Reference Maps 27
2.3.3 Base Case Vs. Current Case Data 28
2.3.4 Change Sets Vs. Flag Sets 28

3. SELECTING A PROJECT 29

3.1 Managing Project Data 29

3.2 New Project 30

3.3 Select Directory 31

3.4 Open Project 32

3.5 Close Project 34

3.6 Unable to Select a Project 34

4. CHANGE SETS AND THE GENERATE OPTION 35

4.1 Change Sets and the Generate Options 35

4.2 Change Set (Definition) 37

4.3 Adding a Change Set 37

4.4 Modifying a Change Set 38

4.5 Copying a Change Set 39

4.6 Deleting a Change Set 40

4.7 Change Set - Marking and Processing Order 41

4.8 Reset Probability to Base 42

4.9 Generating Changes 43

4.10 Reporting Change Set Data 43

4.11 Class Changes 45

4.12 Single Event Probability Changes 46
4.12.1 Single Changes 46
4.12.2 Add an Event Change 47

4.12.3 Modify an Event Change 48
4.12.4 Event Probability Changes - Individual 49
4.12.5 Event Probability Changes - Group 50
4.12.6 Calculation Types 51
4.12.7 Calculation Type Equation Symbols 53
4.12.8 Distribution Types 53
4.12.9 Process Flag 53
4.12.10 Process Flag Dialog 54

5. FAULT TREE ANALYSIS 56

5.1 Fault Tree Analysis 56

5.2 Analysis Types 58

5.3 Fault Tree Graphics 58
5.3.1 Fault Tree Graphics 58
5.3.2 Fault Tree Graphics - Definitions 60
5.3.3 Fault Tree Graphics - Mouse Usage 60
5.3.4 Moving Objects 61
5.3.5 Selecting Objects 61
5.3.6 Selecting a Text Object 63
5.3.7 View Logic 63
5.3.8 Adding Objects 64
5.3.9 Modifying Objects 67
5.3.10 File Menu 69
5.3.11 Edit Menu 81
5.3.12 View Menu 97
5.3.13 Search Menu 104
5.3.14 Timed Backup 106

5.4 Piping and Instrumentation Diagram Editor 106
5.4.1 P&ID Graphics 106
5.4.2 P&ID Graphics - Definitions 108
5.4.3 P&ID Graphics - Mouse Usage 108
5.4.4 Selecting Objects (Regions) 108
5.4.5 P&ID Graphics - Standard Symbols 109
5.4.6 File Menu 110
5.4.7 Edit Menu 117
5.4.8 View Menu 125
5.4.9 Symbols Menu 129
5.4.10 Line Menu 131
5.4.11 Text Menu 134

5.5 Fault Tree Logic Editor 138
5.5.1 Interpreting Alphanumeric Fault Tree Logic 138
5.5.2 Fault Tree Logic Editor 139
5.5.3 Modify Gate Logic 141
5.5.4 Add Gate as Input 142
5.5.5 Gate Name 143
5.5.6 Add Event as Input 143
5.5.7 Delete 144

5.5.8 Find....145
5.5.9 Move....145
5.5.10 Follow Transfer....146
5.5.11 Rename Top....146
5.5.12 Save Logic....147
5.5.13 About Logic Dialogs....148
5.5.14 Tips on Using the Fault Tree Logic Editor....149

5.6 Page Fault Tree Logic....149
5.6.1 Page Tree....149
5.6.2 About Logic Dialogs....151
5.6.3 Page Tree - Multiple....151
5.6.4 Page Tree - Tops....153
5.6.5 Page Tree - Gate....154
5.6.6 Page Tree - Find....155
5.6.7 Page Tree - Merge....156
5.6.8 Page Tree - Auto Page....157
5.6.9 Page Tree - Exit....158

5.7 Solving Fault Trees....159
5.7.1 Solving Fault Trees....159
5.7.2 Cut Set Generation Dialog....162

5.8 Quantifying Fault Trees....163
5.8.1 Quantifying Fault Trees....163
5.8.2 Minimal Cut Set Upper Bound Approximation....164
5.8.3 Min Max Quantification....164
5.8.4 Rare Event Approximation....165

5.9 Uncertainty Analysis....165
5.9.1 Uncertainty Analysis....165
5.9.2 Intermediate Values....167
5.9.3 Monte Carlo Sampling (MCS)....168
5.9.4 Latin Hypercube Sampling (LHS)....168
5.9.5 The Uncertainty Analysis Process....169
5.9.6 Seismic Uncertainty....170
5.9.7 Uncertainty Distributions for Basic Events....171

5.10 Fault Tree Cut Set Analysis....172
5.10.1 Fault Tree Cut Set Analysis....172
5.10.2 Updating Cut Sets....173
5.10.3 Cut Set Generation Truncation....174
5.10.4 Recovering Fault Tree Cut Sets....175
5.10.5 Editing Fault Tree Cut Sets....183

5.11 Displaying Fault Tree Results....189
5.11.1 Displaying Fault Tree Results....189
5.11.2 Displaying Cut Sets....190
5.11.3 Comparing Cut Sets....212
5.11.4 Displaying Importance Results....216
5.11.5 Displaying Uncertainty....222

5.12 Viewing Fault Trees Results 226
5.12.1 Viewing Fault Tree Data 226
5.12.2 View Options 227

5.13 Time Dependent Analysis 228
5.13.1 Time Dependent Analysis 228

6. EVENT TREE ANALYSIS 230

6.1 Event Tree Analysis 230

6.2 Event Tree Graphics 231
6.2.1 Event Tree Graphics 231
6.2.2 Event Tree Graphics Definitions 233
6.2.3 Event Tree Graphics - Mouse Usage 233
6.2.4 Selecting Objects 233
6.2.5 Adding and Modifying Objects 235
6.2.6 Sequence Information Columns 240
6.2.7 File Menu 243
6.2.8 Edit Menu 252
6.2.9 View Menu 257
6.2.10 Timed Backup 266

6.3 Linkage Rule Editor (Event Tree) 267
6.3.1 Linkage Rules Editor Menu 267
6.3.2 Basic Linkage Rules Editor 267
6.3.3 Advanced Linkage Rules Editor 268
6.3.4 Linkage Rules Editor Functions 268
6.3.5 File Menu 269
6.3.6 Edit Menu 274
6.3.7 Search Menu 274
6.3.8 Window Menu 279
6.3.9 Lists Menu 280

6.4 Partition Rules Editor 285
6.4.1 Partition Rules Editor 285
6.4.2 File Menu 286
6.4.3 Edit Menu 290
6.4.4 Search Menu 291
6.4.5 Window Menu 296
6.4.6 Lists Menu 297

6.5 Link Trees 301
6.5.1 Linking Event Tree Sequences 301
6.5.2 The Sequence Generation Process 303
6.5.3 Generate Options Dialog 303

6.6 Edit End States (Sequence Logic) 304
6.6.1 Edit Event Tree End States 304
6.6.2 Exit Sequence Logic Editor 306
6.6.3 Line Edit 306
6.6.4 @Status 307

6.6.5 Frequency 307
6.6.6 Edit Header 308
6.6.7 Global Replace 309
6.6.8 Transfer 309
6.6.9 Change Transfer 310

7. SEQUENCE ANALYSIS 311

7.1 Sequence Analysis 311

7.2 Sequence Mask Feature 312

7.3 Sequence Mask Examples 314

7.4 Solving Sequences 317
7.4.1 Solving Sequences 317
7.4.2 Cut Set Generation Dialog 319

7.5 Quantifying Sequences 320
7.5.1 Quantifying Sequences 320
7.5.2 Minimal Cut Set Upper Bound Approximation 321
7.5.3 Rare Event Approximation 321
7.5.4 Min Max Quantification 321
7.5.5 Split Fraction 322

7.6 Uncertainty Analysis 323
7.6.1 Uncertainty Analysis 323
7.6.2 Uncertainty Analysis for Multiple Sequences 324
7.6.3 Intermediate Values 325
7.6.4 Monte Carlo Sampling (MCS) 326
7.6.5 Latin Hypercube Sampling (LHS) 326
7.6.6 The Uncertainty Analysis Process 327
7.6.7 Seismic Uncertainty 328
7.6.8 Uncertainty Distributions for Basic Events 329

7.7 Sequence Cut Set Analysis 330
7.7.1 Sequence Cut Set Analysis 330
7.7.2 Updating Cut Sets 330
7.7.3 Cut Set Generation Truncation 331
7.7.4 Recovering Sequence Cut Sets 332
7.7.5 Partitioning Sequence Cut Sets 336
7.7.6 Editing Sequence Cut Sets 357

7.8 Displaying Sequence Results 363
7.8.1 Displaying Sequence Results 363
7.8.2 Displaying Cut Sets 363
7.8.3 Comparing Cut Sets 383
7.8.4 Displaying Merged Cut Sets 387
7.8.5 Displaying Importance Results 390
7.8.6 Displaying Uncertainty 397

7.9 Viewing Sequences 400

7.9.1 Viewing Sequence Data 400
7.9.2 View Options....401

7.10 Time Dependent Analysis....402
7.10.1 Time Dependent Analysis 402

8. END STATE ANALYSIS 403

8.1 End State Analysis 403

8.2 Gathering End States 405
8.2.1 Gathering End States 405
8.2.2 Cut Set Probability Trunc....406
8.2.3 Cutoff by Event Probability 406
8.2.4 Cutoff by Size....406
8.2.5 Gather Cut Sets....406

8.3 Quantifying End States 407
8.3.1 Quantifying End States....407
8.3.2 Minimal Cut Set Upper Bound Approximation 407
8.3.3 Rare Event Approximation....408

8.4 Uncertainty Analysis....408
8.4.1 Uncertainty Analysis 408
8.4.2 Intermediate Values....410
8.4.3 Monte Carlo Sampling (MCS) 411
8.4.4 Latin Hypercube Sampling (LHS)....411
8.4.5 The Uncertainty Analysis Process....412
8.4.6 Seismic Uncertainty....413
8.4.7 Uncertainty Distributions for Basic Events 414

8.5 End State Cut Set Analysis 415
8.5.1 End State Cut Set Analysis....415
8.5.2 Updating Cut Sets....415
8.5.3 Cut Set Generation Truncation....416
8.5.4 Editing End State Cut Sets 417

8.6 Displaying End State Results....422
8.6.1 Displaying End State Results 422
8.6.2 Displaying Cut Sets 423
8.6.3 Comparing Cut Sets....444
8.6.4 Displaying Importance Results....447
8.6.5 Displaying Uncertainty....454

8.7 Viewing End States....458
8.7.1 Viewing End States 458
8.7.2 View Options....459

9. MODIFYING THE DATA BASE....460

9.1 Modifying the Data Base 460

9.2 Modifying Project Data 461

9.2.1 Project Data Entry Dialog 461
9.2.2 Name 462
9.2.3 Type....462
9.2.4 Location....462
9.2.5 Design....462
9.2.6 Model Type 462
9.2.7 Company 462
9.2.8 Vendor....462
9.2.9 LERF Enabled 462
9.2.10 Description 462
9.2.11 Default Locale 463
9.2.12 Site Hazard Curves....463
9.2.13 Operational Date....463
9.2.14 Qualification Date 463
9.2.15 Mission Time....463

9.3 Modifying Event Tree Data 463
9.3.1 Event Trees....463
9.3.2 Delete An Event Tree 464
9.3.3 Base Case Update....465
9.3.4 Clear Current Case 466
9.3.5 Database Text....467
9.3.6 Event Tree Data Entry Dialog 469
9.3.7 Event Tree Data Entry Dialog 470
9.3.8 Edit Sequences Dialog....470

9.4 Modifying Fault Tree Data 478
9.4.1 Fault Trees....478
9.4.2 Delete Fault Tree 479
9.4.3 Base Case Update....480
9.4.4 Clear Current Case 481
9.4.5 Top/Sub-tree Convert....482
9.4.6 Database Text....482
9.4.7 Fault Tree Cross-reference 484
9.4.8 Add Fault Tree Dialog....485
9.4.9 Modify Fault Tree Dialog....487

9.5 Modifying End State Data 489
9.5.1 End States....489
9.5.2 Delete Record....490
9.5.3 Base Case Update....491
9.5.4 Clear Current Case 492
9.5.5 Database Text....493
9.5.6 Cross Reference....495
9.5.7 Remove Unused End States....496
9.5.8 End State Data Entry Dialog 497

9.6 Modifying Basic Event Data....498
9.6.1 Basic Events 498
9.6.2 Delete Record....500
9.6.3 Basic Event Cross-reference....500

9.6.4 Remove Unused Event 501
9.6.5 Table View 502
9.6.6 Basic Event Property Sheet 506

9.7 Modifying Attribute Data 527
9.7.1 Attributes 527
9.7.2 Delete Record 529
9.7.3 Attribute Data Entry Dialog 529

9.8 Modifying Analysis Type Data 531
9.8.1 Analysis Types 531
9.8.2 Analysis Type Data Entry Dialog 531

9.9 Modifying Gate Data 533
9.9.1 Gates 533
9.9.2 Delete Record 534
9.9.3 Gate Data Entry Dialog 534

9.10 Modifying Histogram Data 536
9.10.1 Histograms 536
9.10.2 Delete Record 537
9.10.3 Add Histograms 537
9.10.4 Percentage Format Dialog 538
9.10.5 Range Format Dialog 540
9.10.6 Area Format Dialog 542
9.10.7 Fragility Format Dialog 544
9.10.8 Hazard Format Dialog 544

9.11 Modifying P&ID Data 546
9.11.1 P&IDs 546
9.11.2 Delete Record 547
9.11.3 P&ID Data Entry Dialog 548

9.12 Modifying Change Set Data 549
9.12.1 Change Sets 549
9.12.2 Delete Record 550
9.12.3 Database Text 550
9.12.4 Change Set - Marking and Processing Order 552
9.12.5 Add Change Set Dialog 553
9.12.6 Copy Change Set Dialog 555
9.12.7 Modify Change Set Dialog 556
9.12.8 Base Update Dialog 558

9.13 Modifying Flag Set Data 559
9.13.1 Flag Sets 559
9.13.2 Delete Record 560
9.13.3 Database Text 560
9.13.4 Add Flag Set Dialog 562
9.13.5 Copy Flag Set Dialog 563
9.13.6 Modify Flag Set Dialog 565
9.13.7 Flag Set Event Data 566

10. REPORTING ON THE DATABASE 572

10.1 Reporting on the Data Base 572

10.2 Process All Entries 573

10.3 Report Dialog 573
10.3.1 Report Output 573
10.3.2 Using the Report Viewer 575

10.4 Custom Reports Dialog 580
10.4.1 Custom Reports 580
10.4.2 Add Custom Report 581
10.4.3 Delete Custom Report 583
10.4.4 Rename Custom Report 583
10.4.5 Custom Report Field Selection Dialog 585

10.5 Project Reports Dialog 587
10.5.1 Project Reports 587

10.6 Attribute Reports 588
10.6.1 Attributes 588

10.7 Basic Event Reports 589
10.7.1 Basic Events 589
10.7.2 Basic Event Overview 590
10.7.3 Basic Event Probability Report 591
10.7.4 Basic Event Uncertainty Report 592
10.7.5 Transformations Report 593
10.7.6 Compound Event Report 594
10.7.7 Developed Event Report 595
10.7.8 Template Event Report 596
10.7.9 Basic Event Cross Reference Report 597
10.7.10 Seismic Events 598

10.8 Fault Tree Reports 600
10.8.1 Fault Tree 600
10.8.2 Fault Tree Summary Report 601
10.8.3 Fault Tree Logic Report 602
10.8.4 Fault Tree Graphics Report 604
10.8.5 Graphics Export 605
10.8.6 Cut Sets Report 606
10.8.7 Cut Set Report Options 607
10.8.8 Fault Tree Importance Report 608
10.8.9 Select Sort Criteria 610
10.8.10 X-Reference Fault Tree 611
10.8.11 X-Reference Sub-tree 612

10.9 Event Tree Reports 613
10.9.1 Event Tree 613
10.9.2 Event Tree Logic 615
10.9.3 Event Tree Graphics 616

10.9.4 Initiating Events Report....616
10.9.5 Cross Reference....617

10.10 End State Reports....618
10.10.1 End State....618
10.10.2 End State Summary Report....619
10.10.3 End State Cut Sets Report....621
10.10.4 Cut Set Report Options....622
10.10.5 End State Importance Reports....623
10.10.6 Select Sort Criteria....624
10.10.7 End State Cross Reference Report....625

10.11 Sequence Reports....627
10.11.1 Sequence....627
10.11.2 Sequence Summary Reports....628
10.11.3 Sequence Logic Report....629
10.11.4 Sequence Cut Sets Reports....630
10.11.5 Cut Set Report Options....632
10.11.6 Sequence Importance Reports....633
10.11.7 Select Sort Criteria....634

10.12 Change Set Reports....635
10.12.1 Change Sets....635
10.12.2 Change Set/Flag Set Summary Reports....636
10.12.3 Change Set Class Reports....637
10.12.4 Single Changes Report....638

10.13 Flag Set Reports....639
10.13.1 Flag Sets....639
10.13.2 Change Set/Flag Set Summary Reports....640
10.13.3 Single Changes Report....641
10.13.4 Flag Set Cross Reference Report....642

10.14 Gate Report....643
10.14.1 Gates....643

10.15 Histogram Reports....644
10.15.1 Histogram....644
10.15.2 Histogram Summary Report....645
10.15.3 Histogram Detail Report....645
10.15.4 Histogram Cross Reference Report....646

10.16 Slices Report....647
10.16.1 Slices....647

10.17 User Information Report....649
10.17.1 User Information....649

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.

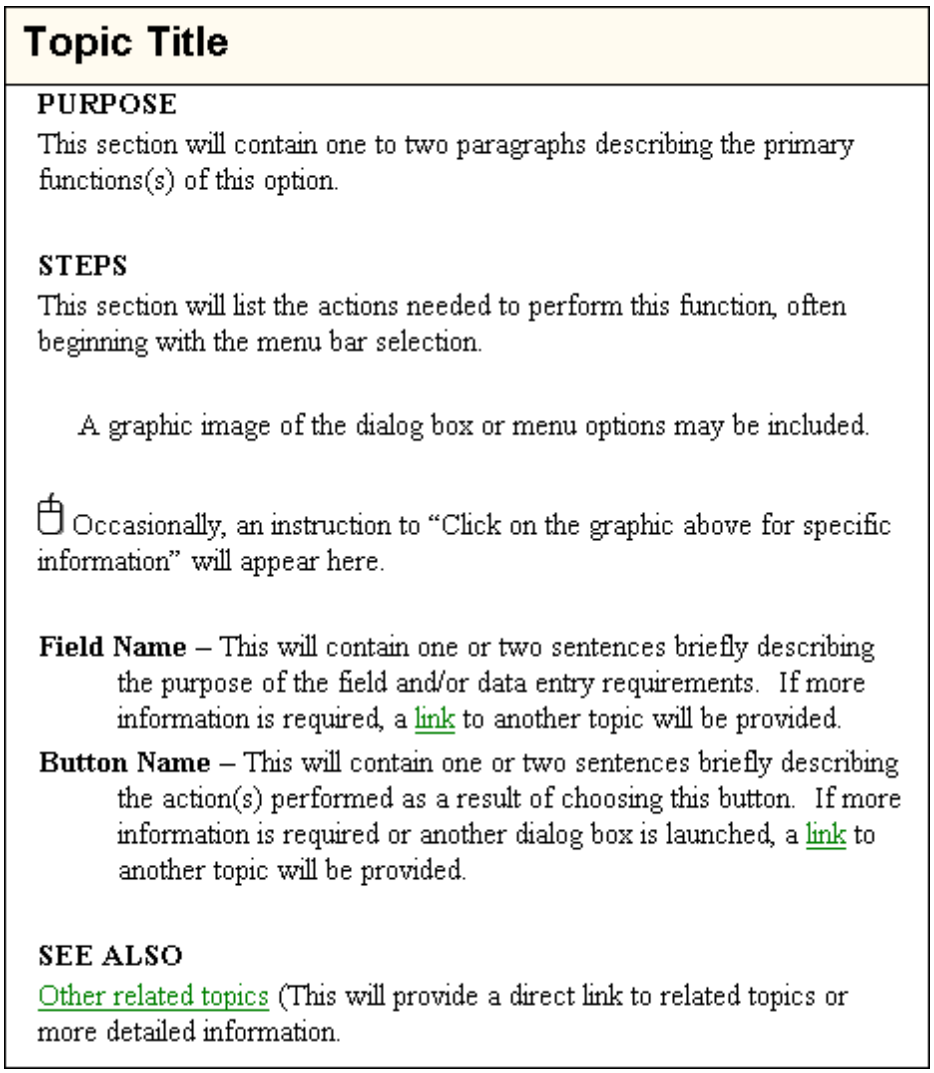
- Dialog box names begin with uppercase letters and are italicized. For example, the *Fault Trees List* dialog box.
- Field names begin with uppercase letters and are italicized. For example, the *Fault Tree Mask* field.
- Key combinations joined with a plus sign indicate that you should press and hold 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:



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.inel.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.

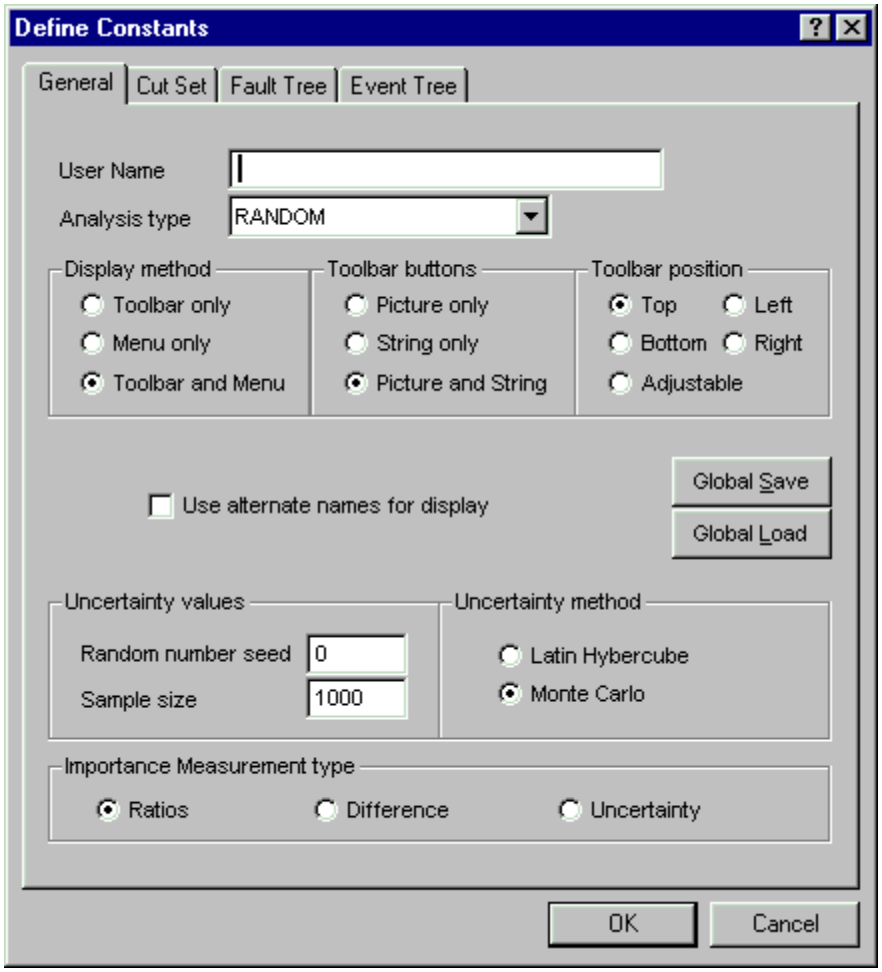
1.6.3 Using SAPHIRE for the First Time

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.



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

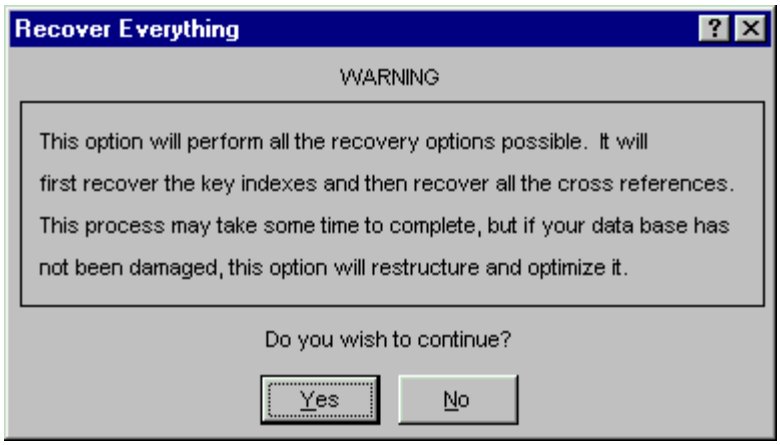
If you wish to change defaults, this dialog can be called up from the **Utility | Define Constants** option. To find out the definition for the various options and buttons, click on the question mark in the upper right corner of the dialog and then select the option in question.

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.

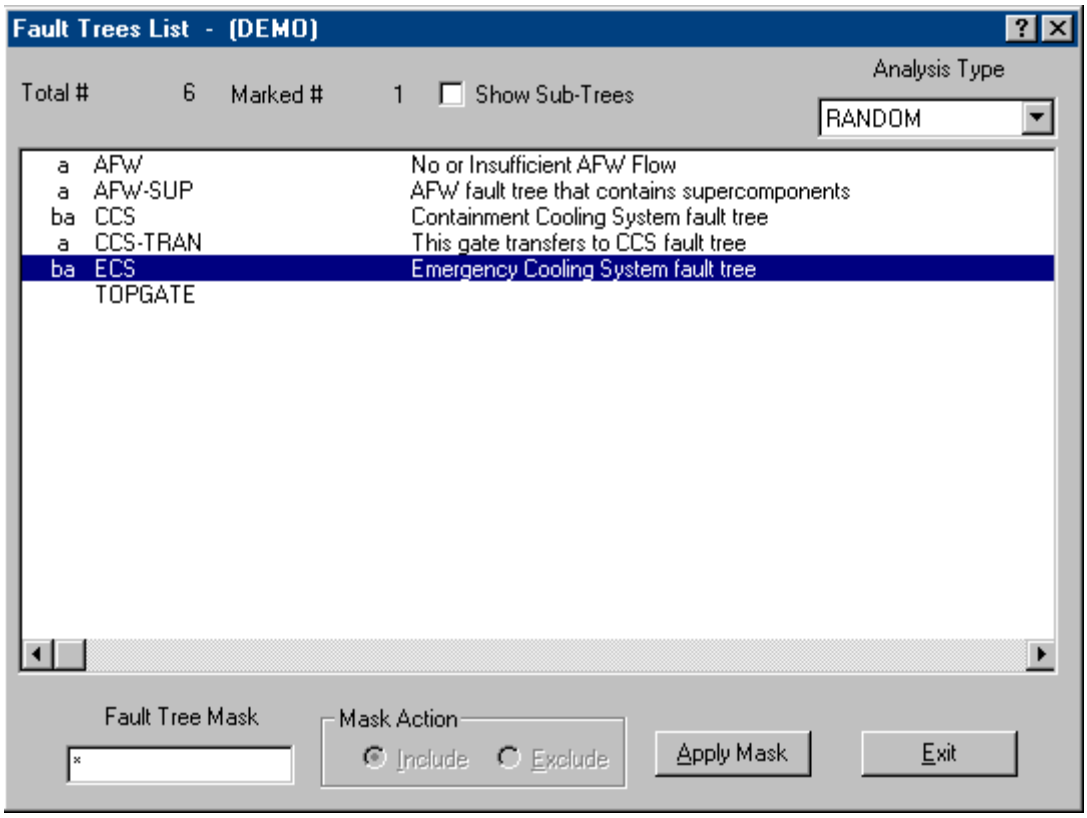
No – Do not convert the project data to the current SAPHIRE version format. The project will not be opened.

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."



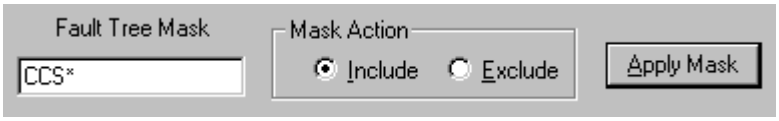
There are various ways to select items in a list:

- 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

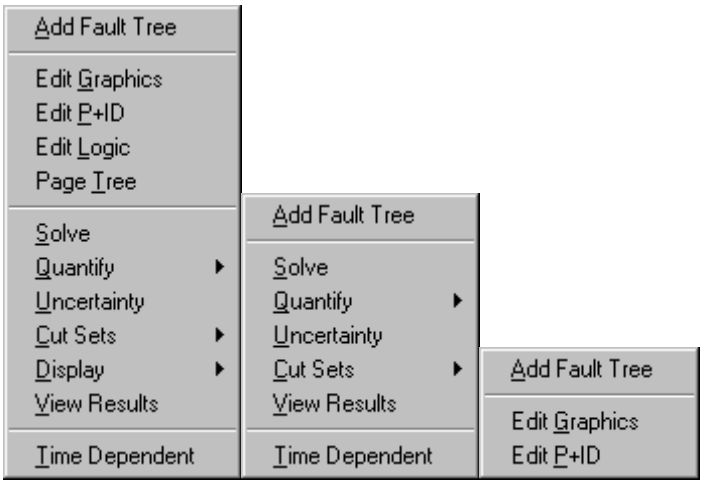
1. With an appropriate dialog active, in the mask entry field type the common characters of the names you wish to match including any wildcard characters, if desired.
2. In the Mask Action section, choose either the Include or Exclude radio button, depending on whether you want these items included in 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:

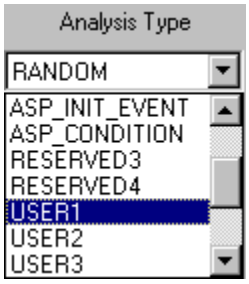


1.7.4 Selecting the Analysis Type

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 *Sequences* dialog . Recalculate sequence values after event failure data and/or cut sets have been modified.
	Create a new SAPHIRE project.		Display the *End State List* dialog . Recalculate end state values after events and/or cut sets have been modified.
	Open an existing SAPHIRE project.		Activate the *Modify Database* toolbar. Modify SAPHIRE database files (e.g., project, event tree, basic event, etc.)
	Generate change set data.		Display the *Reports Menu* dialog. Generate reports containing information about the current project.
	Display the *Fault Trees* dialog . Build, edit and analyze fault tree models		Activate the *Utilities* toolbar. Define constants, recover the database, and MAR D data exchange.
	Display the *Event Tree* 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 *Fault Trees List* dialog and return to the main toolbar.		Generate cut sets for a fault tree based on cut set generation cut off values.

	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 *Cut Set Options* toolbar. Perform various operations on cut sets: Update, Prune, Recover, Edit.
	Modify fault tree logic in an alphanumeric format.		Activate the *Display Options* 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 *Event Tree List* 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 *Sequences* dialog and return to the main toolbar.		Activate the *Cut Set Options* 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 *Display Options* 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 *End State List* 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 *Display Options* 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 *Fault Tree* 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 *Sequence* 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.

	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 *Modify Attributes* 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.		

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 *Define Constants* 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.

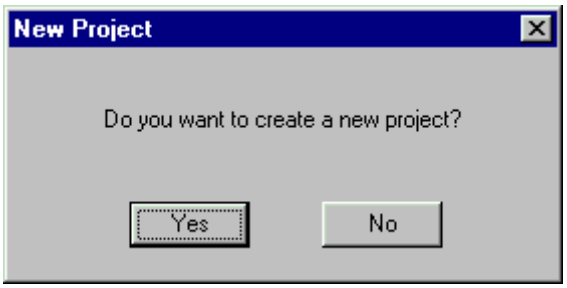
3.2 New Project

PURPOSE

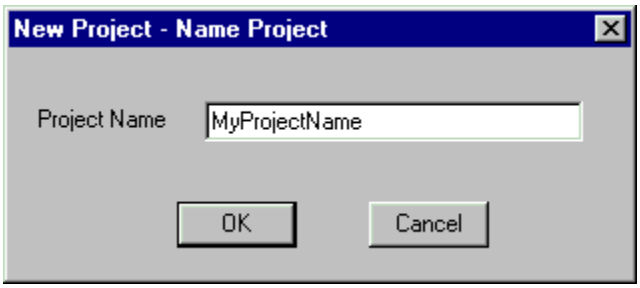
This option provides the means of creating a new project. The new project you are creating must reside in its own folder (i.e., a single folder cannot contain more than ".SRA" file).

STEPS

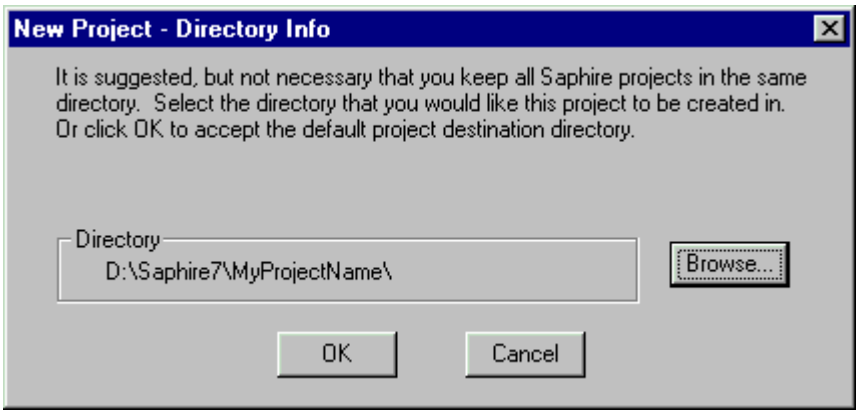
1. From the menu select **File**.
2. Choose the **New Project** submenu option. The *New Project* dialog will be displayed.



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 *New Project* dialog.
Cancel - Close the *New Project* dialog without creating a project.

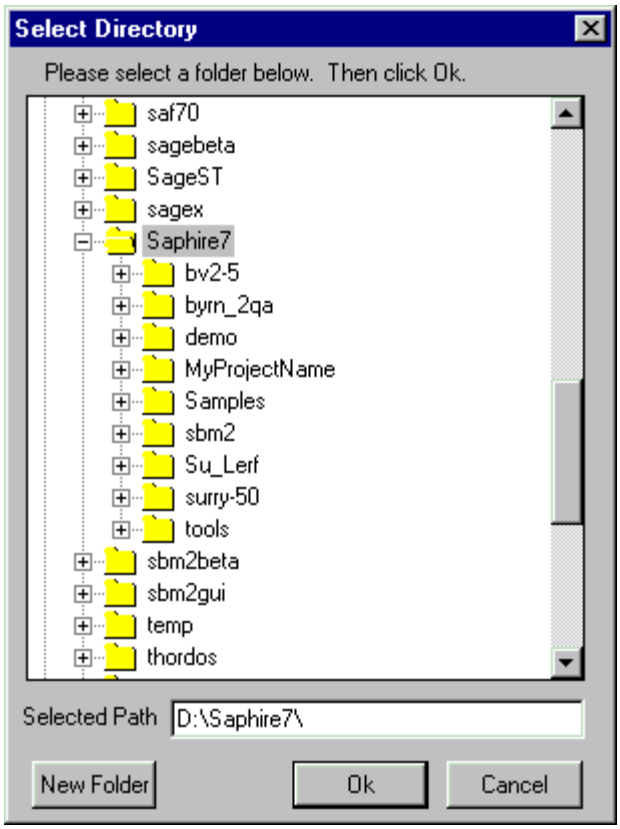
3.3 Select Directory

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

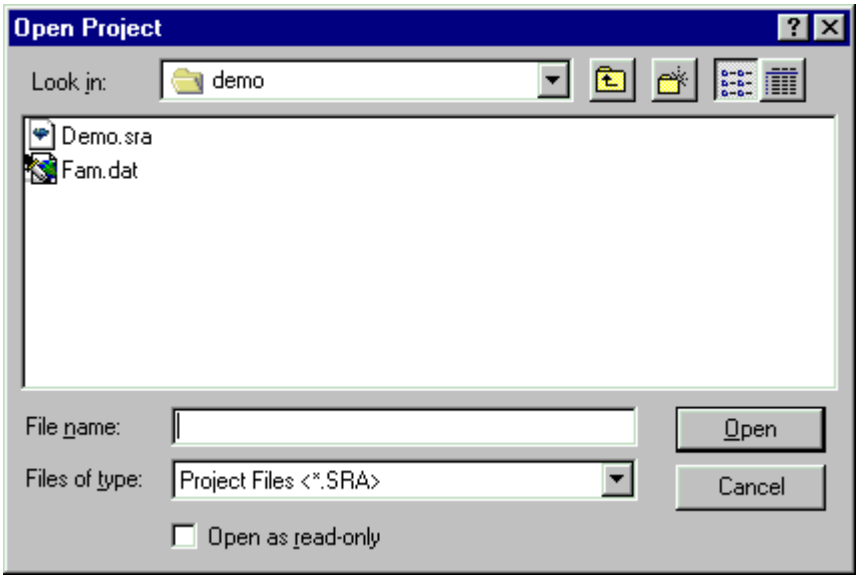
This option allows you to select (open) the project data set you wish to work with and provides the capability of copying raw (MAR-D) data files or SAPHIRE database files into a specific project. When the project is successfully selected, the name is shown on the title bar of the SAPHIRE window.

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.



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 project.

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 ".SRA" files are listed.

Open - Open the highlighted project and close the *Open Project* dialog.

Cancel - Close the *Open Project* dialog without opening a project.

Double-click - Open the project and close the *Open Project* dialog.

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

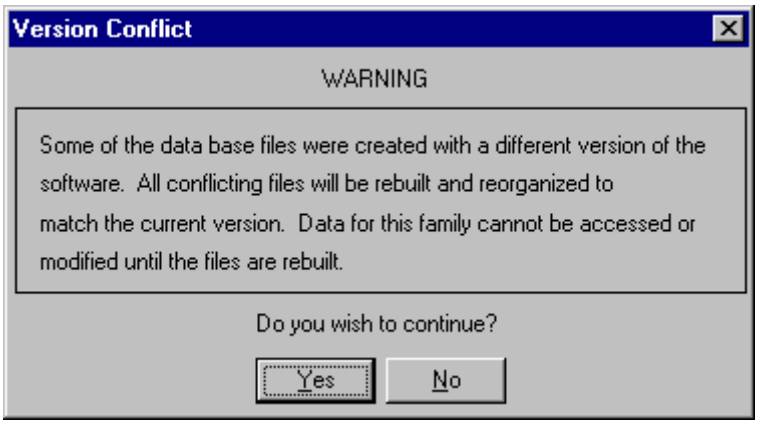
1. From the menu select **File**.
2. Choose the **Close Project** submenu option.

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

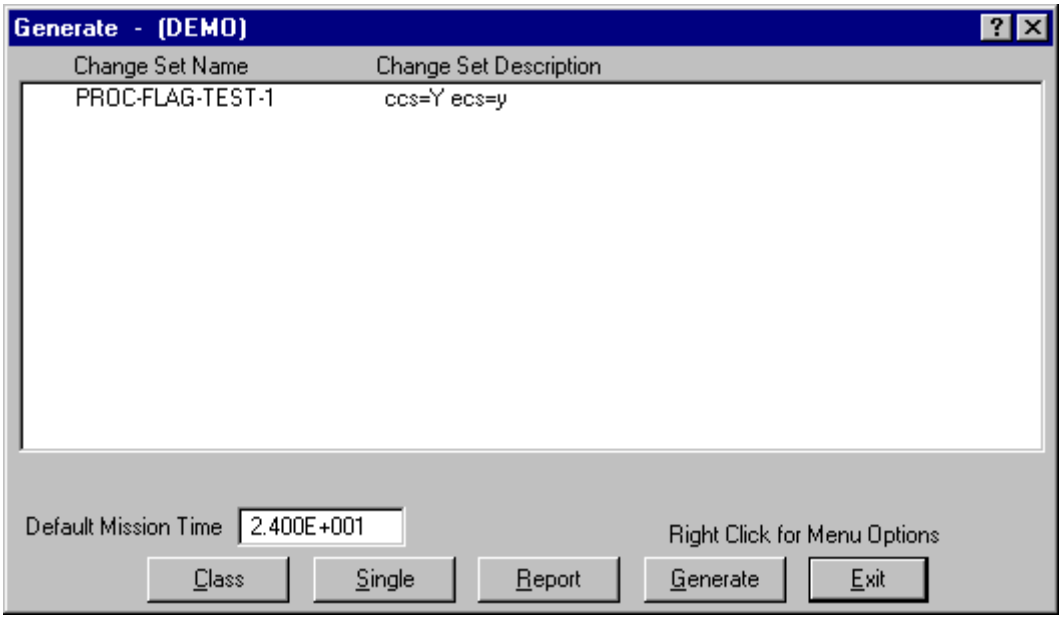
sets modify the current case basic event data. A change set consists of probability and/or class changes for a group of basic events.

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.

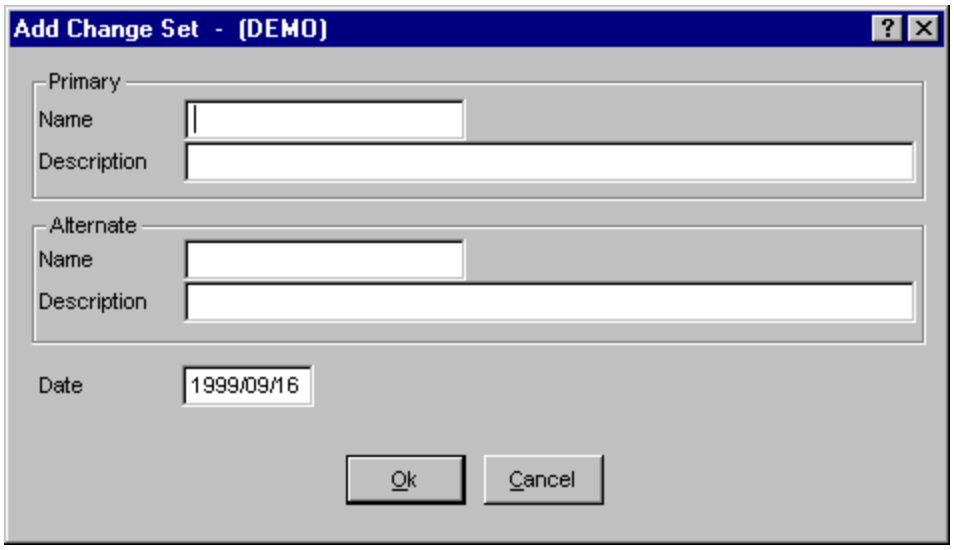
4.3 Adding a Change Set

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.



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

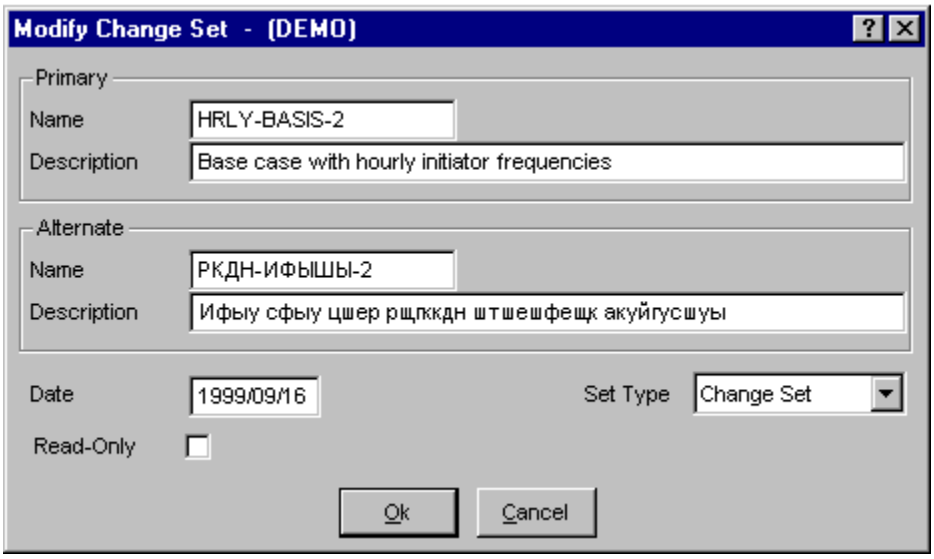
This option allows you to modify change set record data. In addition to editing the change set name, description, and date, you can also edit the set type and read-only attribute.

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.



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

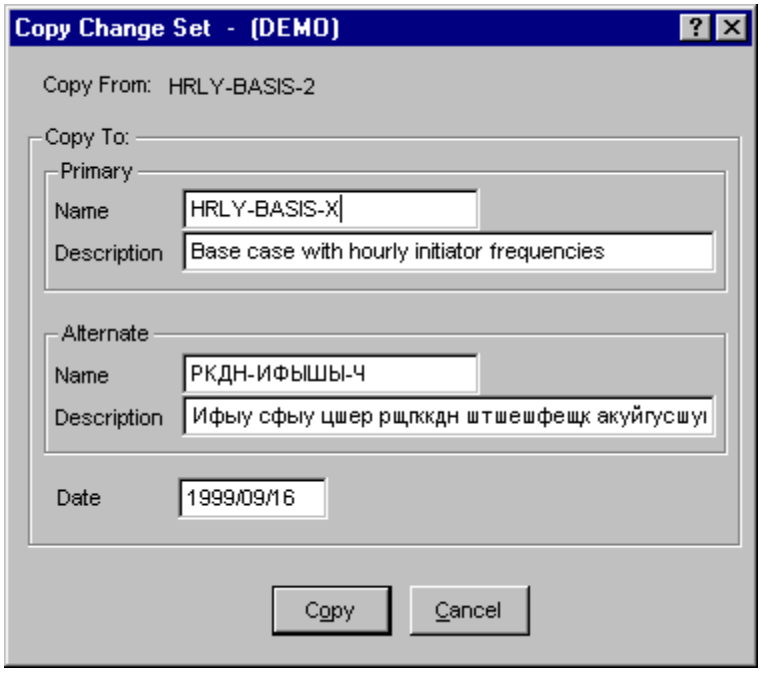
This option allows you to create a new change set record based on the highlighted one. The original change set name is displayed in the *Copy From:* field. You MUST enter a unique name for the new change set. Along with the source change set's name, description, and date, probability and class changes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

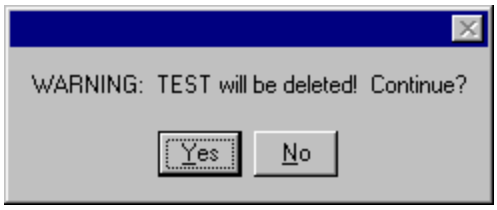
4.6 Deleting a Change Set

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.)

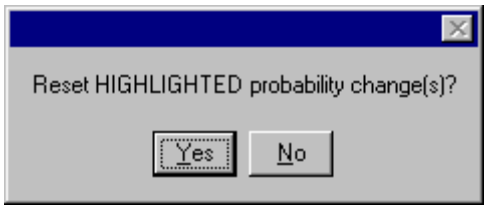
4.8 Reset Probability to Base

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.

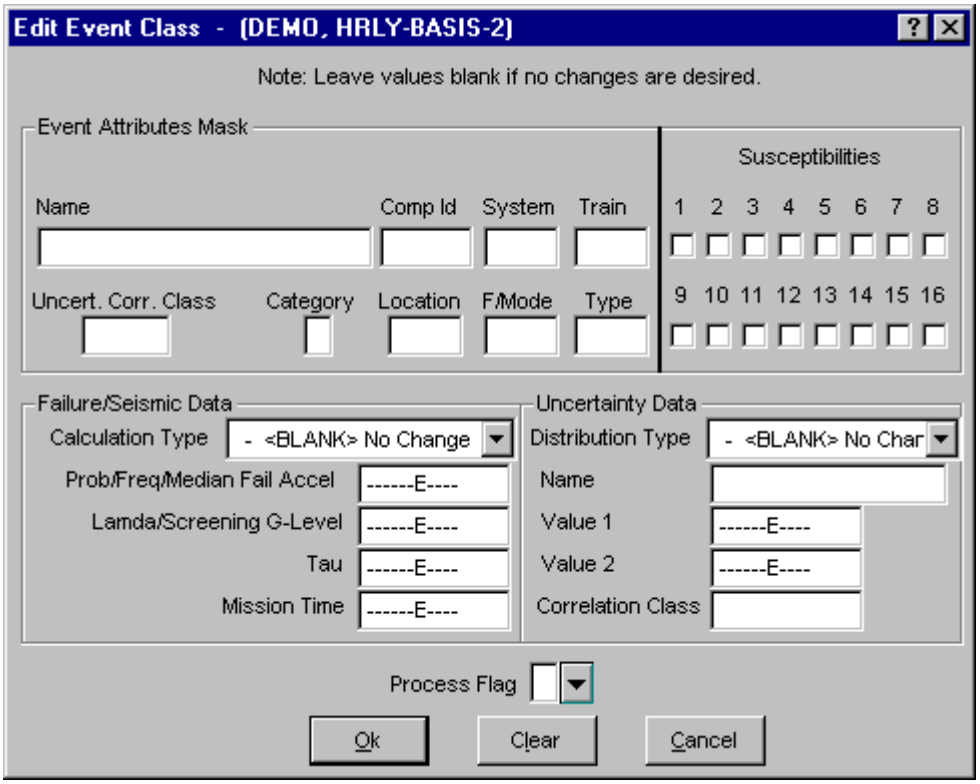
4.11 Class Changes

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

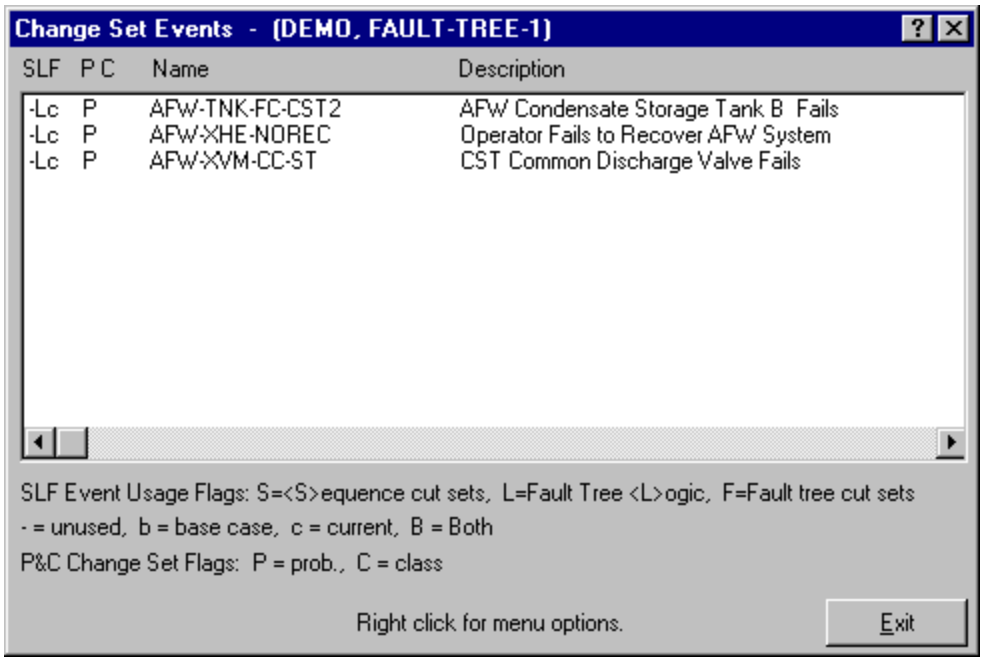
PURPOSE

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.

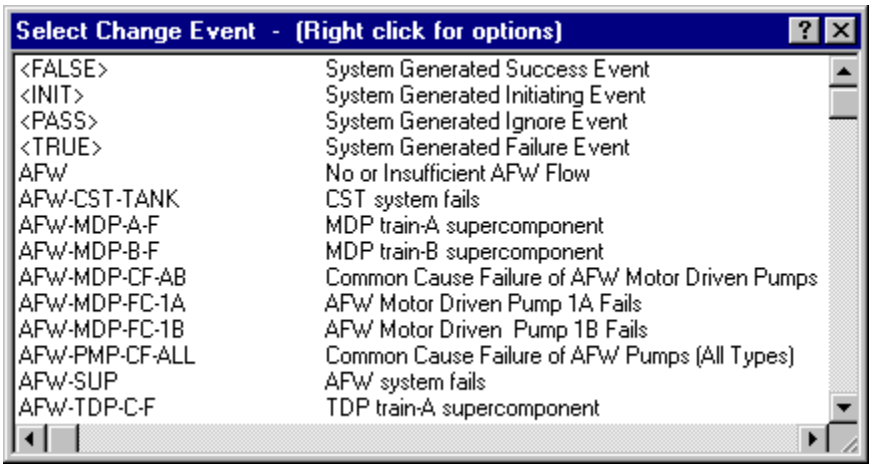
4.12.2 Add an Event Change

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".

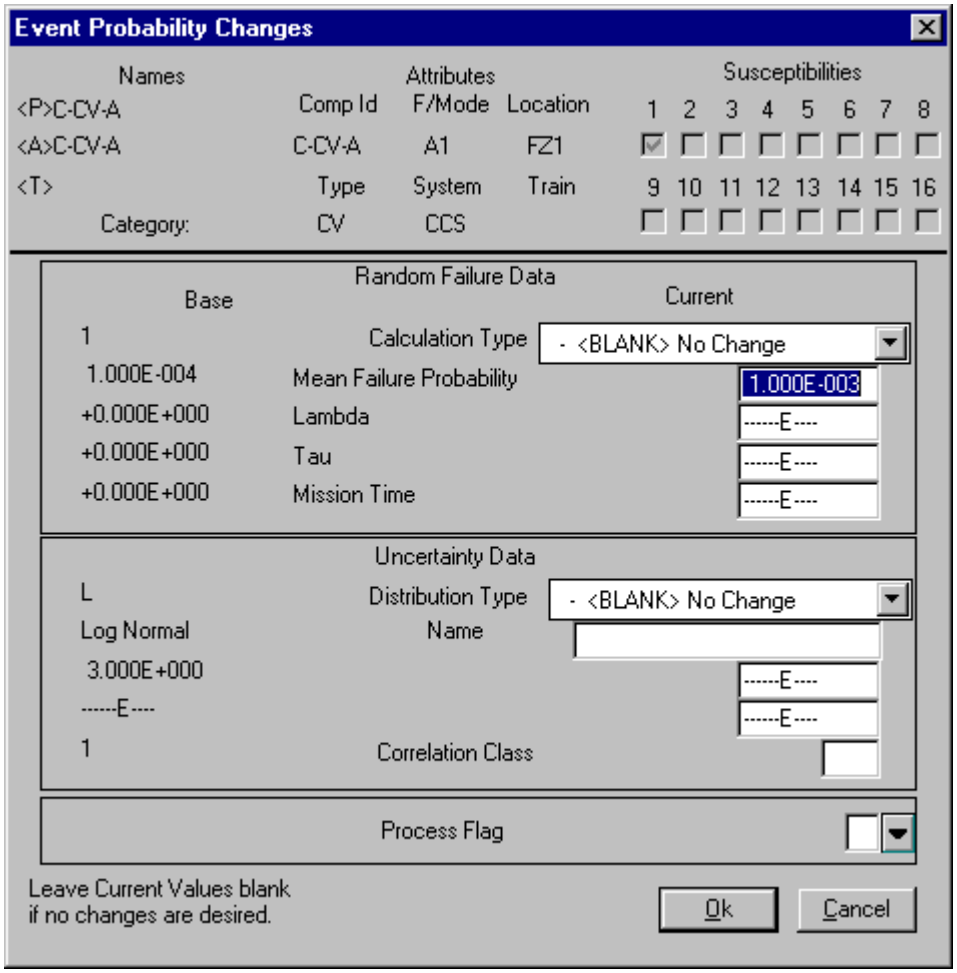
4.12.4 Event Probability Changes - Individual

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.



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.

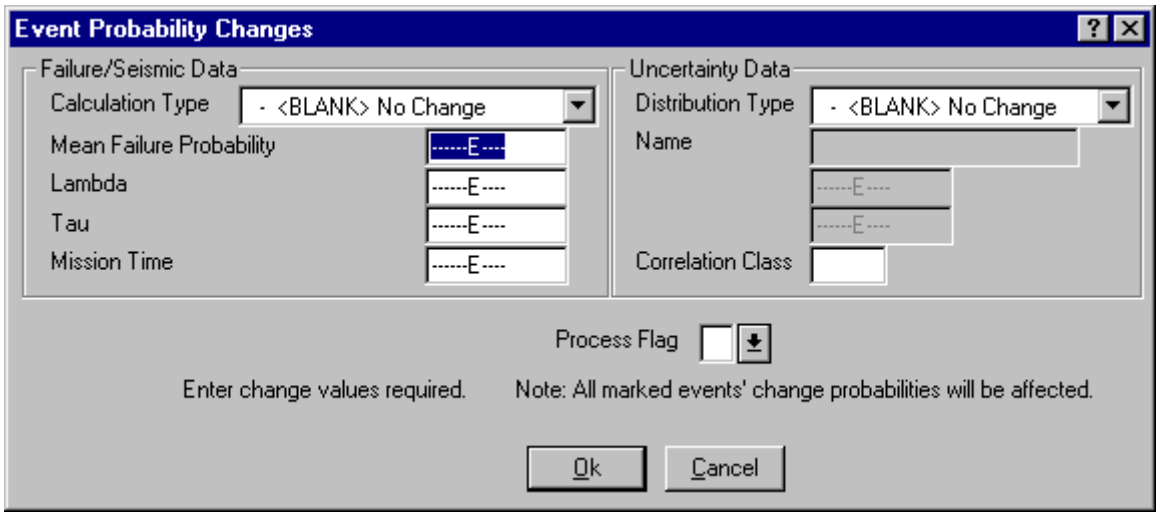
4.12.5 Event Probability Changes - Group

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.



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 = II[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 = II[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,
∏ = 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

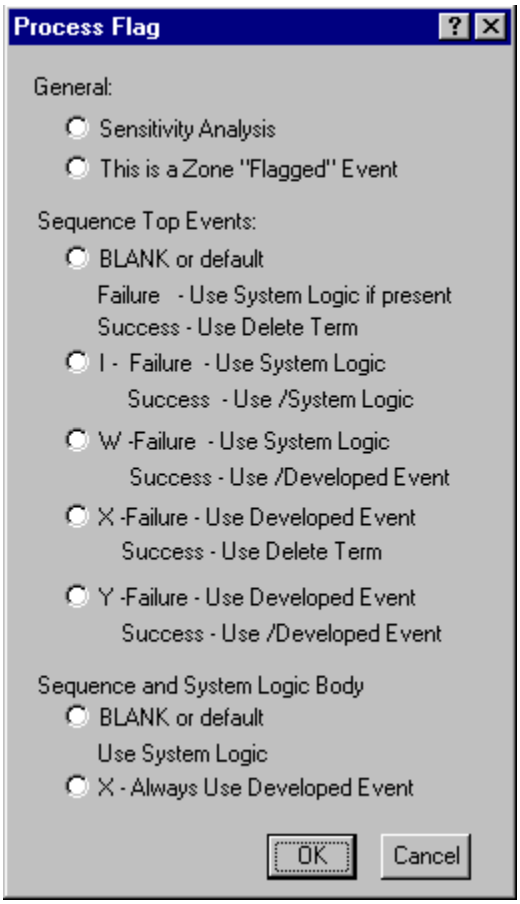
For the Uncertainty Data section, there are nine predefined distribution types available. The predefined distribution types are:

- 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

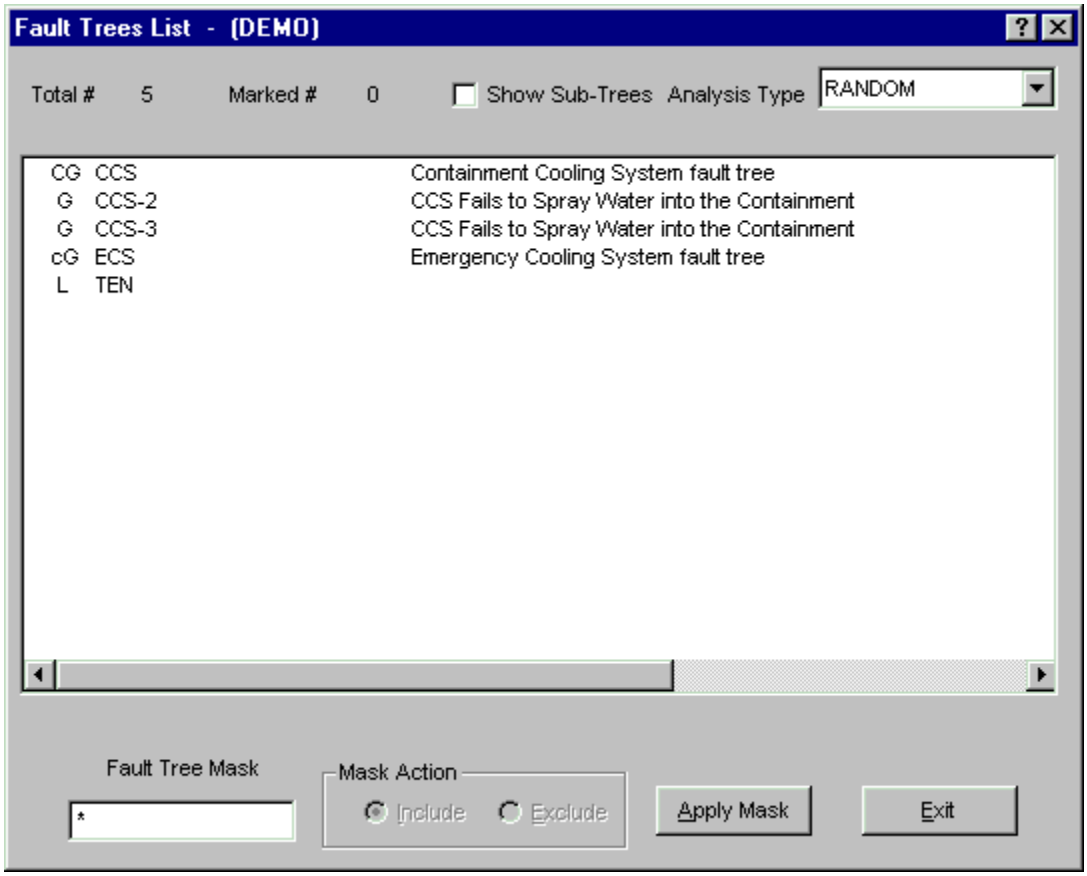
G - both logic and graphics exist for the fault tree

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 *Fault Tree Editor*.

Edit P&ID - Construct and modify piping and instrumentation diagrams using the *Piping & Instrumentation Diagram Editor*.

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

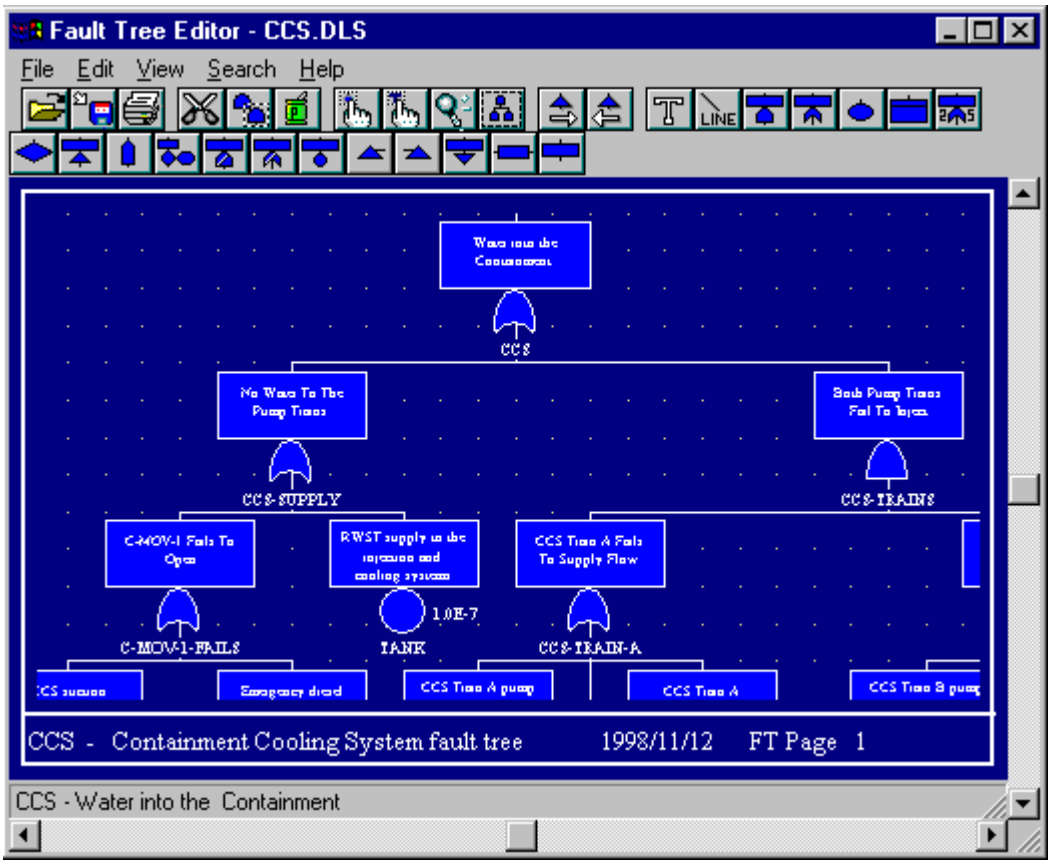
The *Fault Tree Editor* provides the means to construct a fault tree diagram. A fault tree diagram is a graphical representation or picture of the fault tree model built from fault tree objects.

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 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.

Print the fault tree graphics file.

Cut an object from the diagram.

Copy an object in the diagram.

Paste an object into the diagram.

Select the shape pick cursor.

Select the text pick cursor.

Zoom in/out.

Fit to window

Fit to standard size (100%).

Forward transfer.

Backward transfer.

Text object.

Line object.

OR gate object.

Basic event object.

Basic event table object.

N/M gate object.

Undefined event object.

Transfer gate object.

House event object.

Inhibit gate object.

NAND gate object.

NOR gate object.

Boxed basic event object.

Right transfer object.

Left transfer 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 *drag* 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

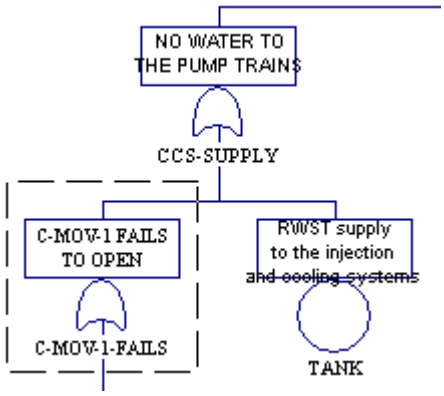
Prior to manipulating a shape object (e.g., moving, copying, etc.) in the fault tree diagram, it must be selected. This topic describes how to select object(s).

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.



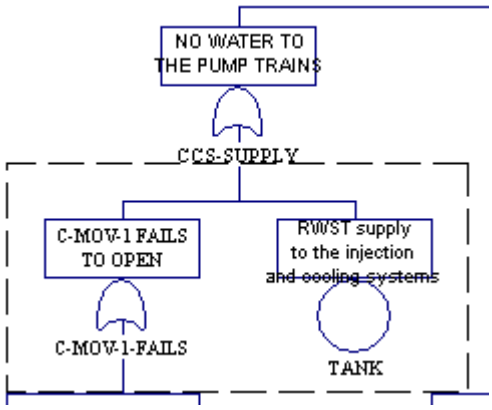
In the example here, the OR gate, C-MOV-1-FAILS, is selected.

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.

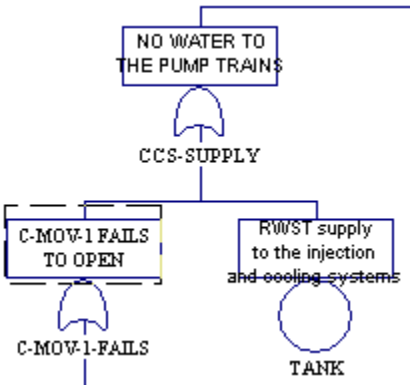
Because some object's pick boxes may overlap, there is an order of selection. Shapes get first priority, followed by lines, and then text. If objects of the same type overlap, then the object that was added first will be selected.

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.

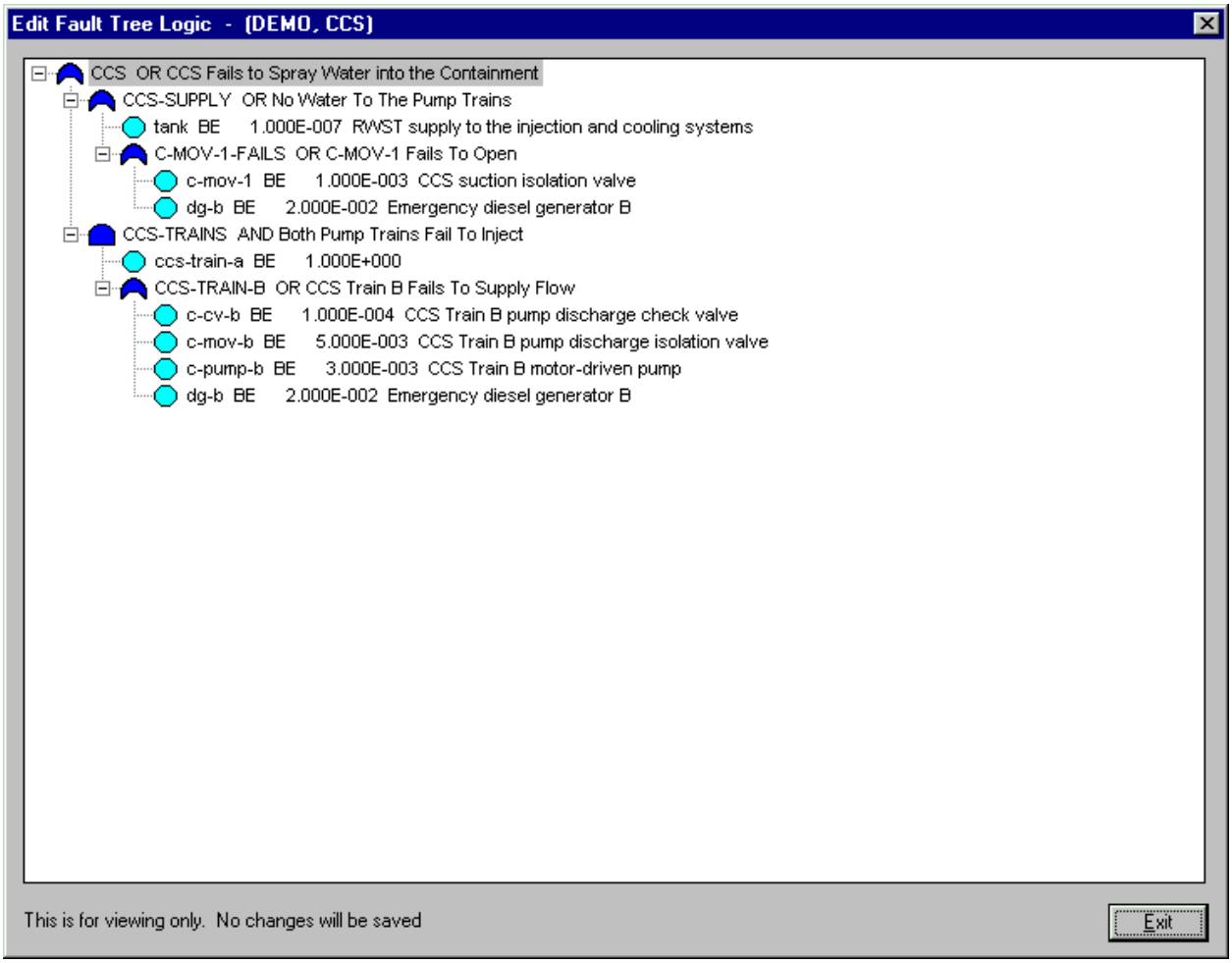
5.3.7 View Logic

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

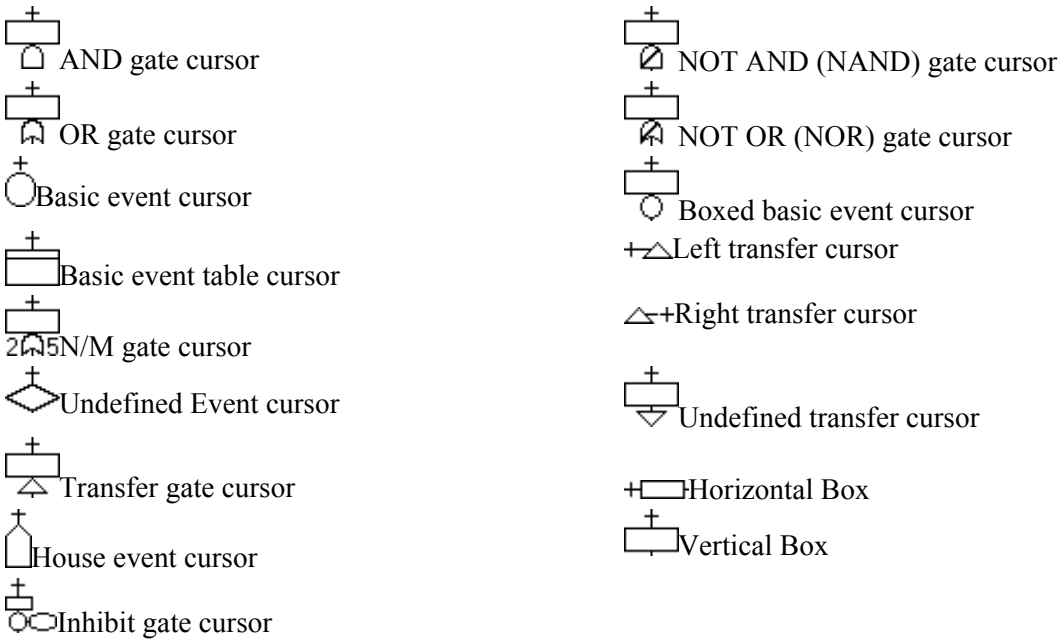
PURPOSE

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*:



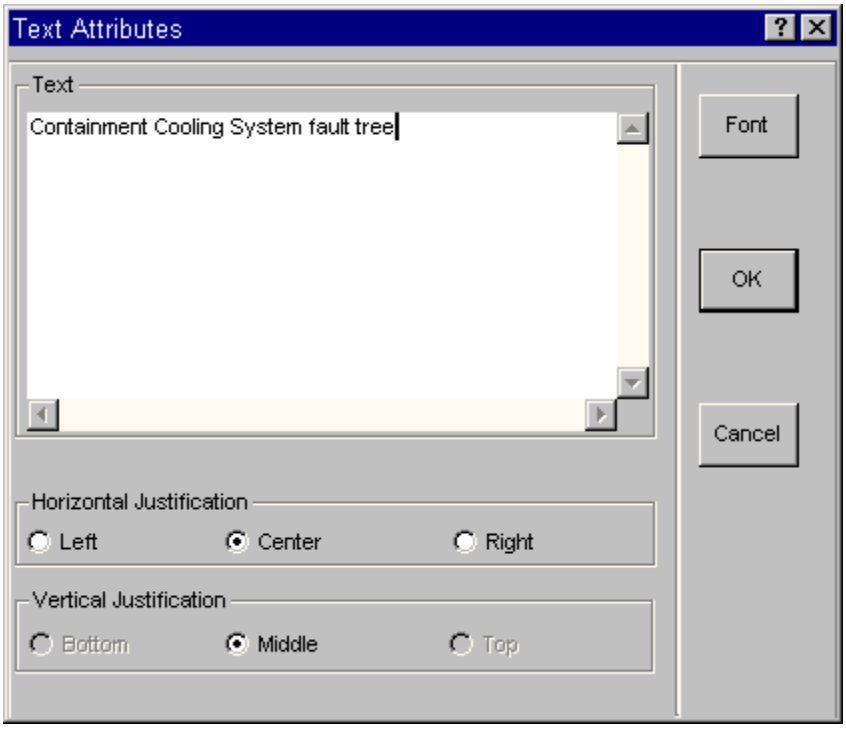
5.3.8.2 Adding Text

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.

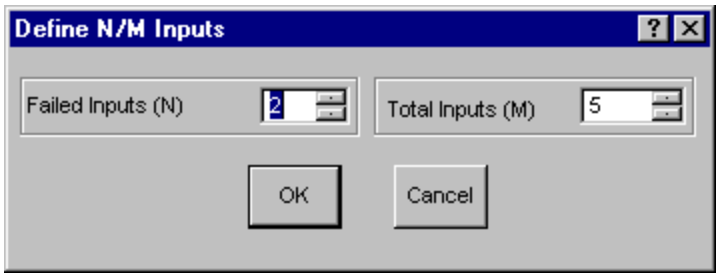
5.3.8.3 Adding An N/M Gate

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 LINE 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

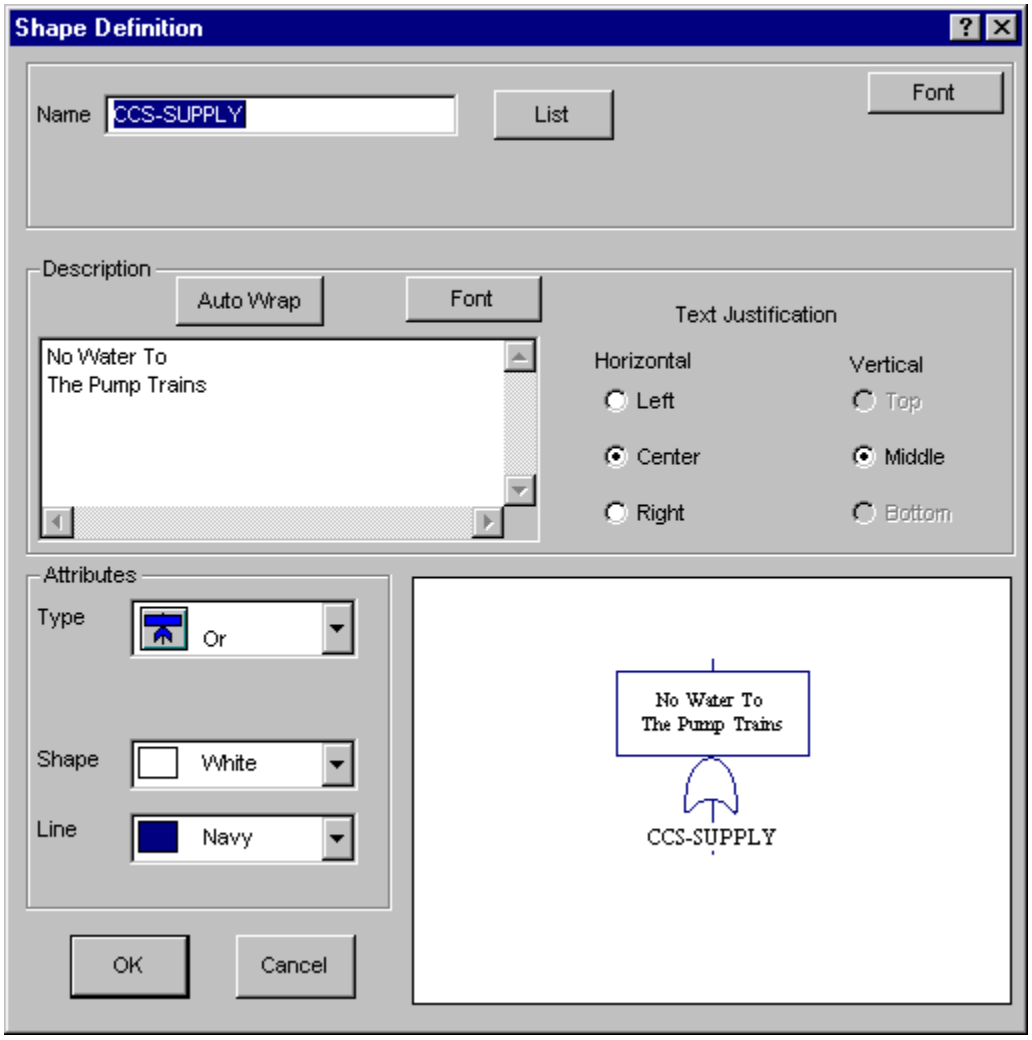
1. Select the object using the Pick cursor .

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 *Shape Definition* dialog without applying the changes.

OK - Close the *Shape Definition* 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 *Fault Tree Editor*. If changes have been made you will be queried if you want to save the file.

5.3.10.2 New

PURPOSE

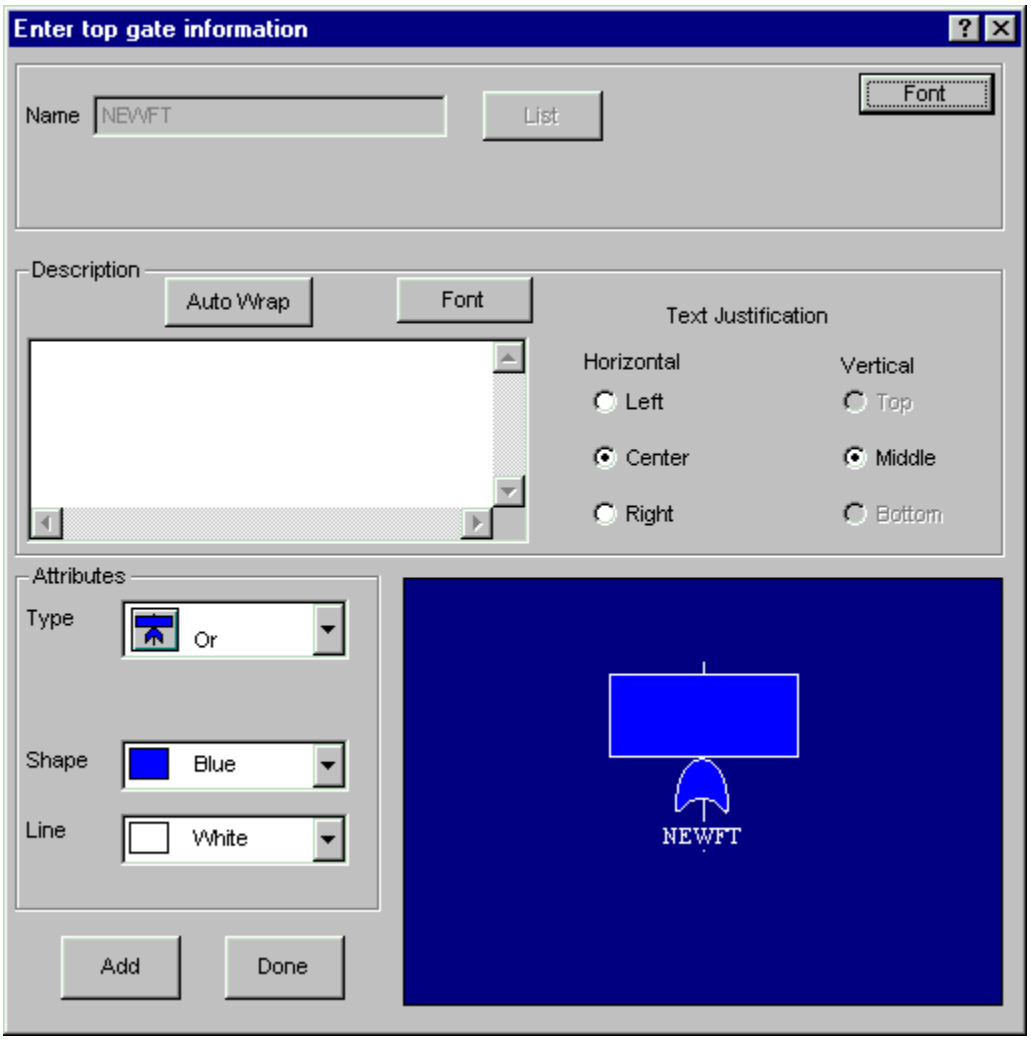
This option will allow you to clear the window and start a new diagram.

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.



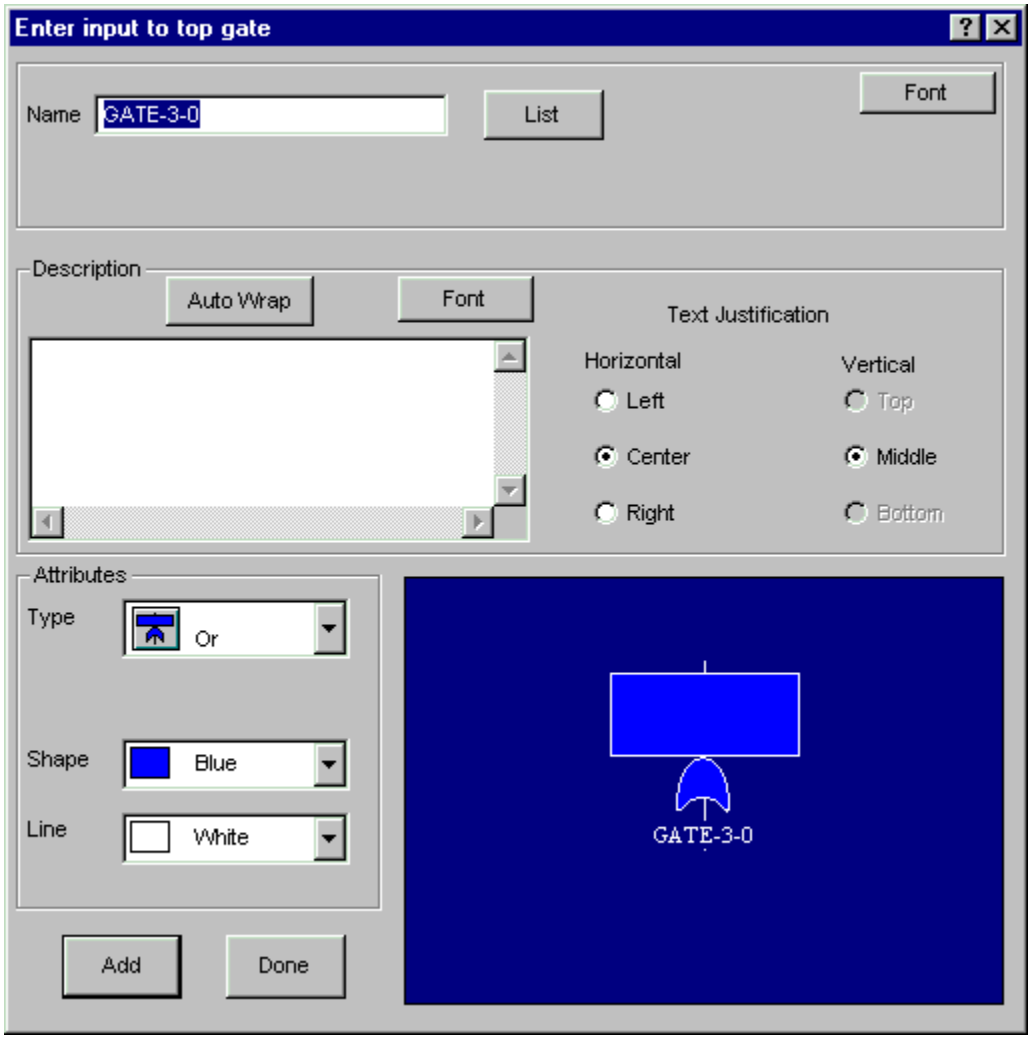
Add – Add the top gate to the information, and proceed to the Enter input to top gate dialog.
Done – Add the top gate to the diagram, close the *Enter Top Gate Information* dialog, and begin free form editing.

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.



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.

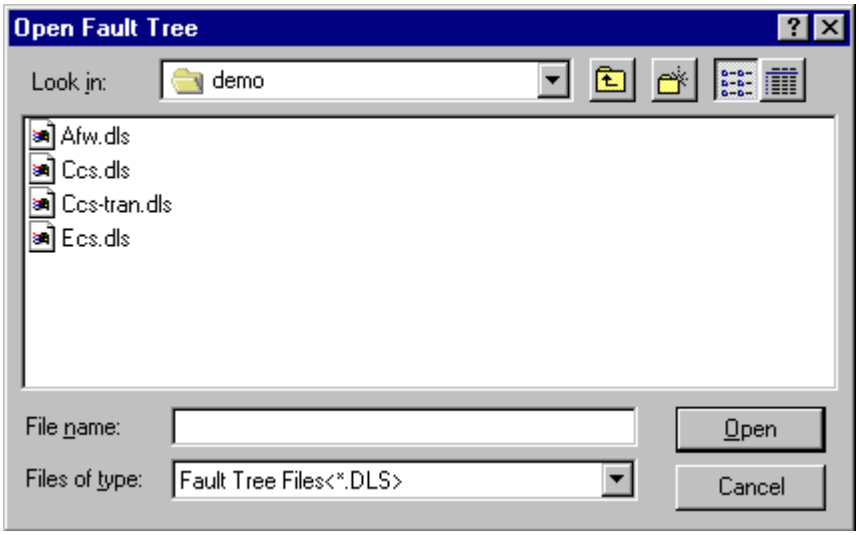
5.3.10.4 Open

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

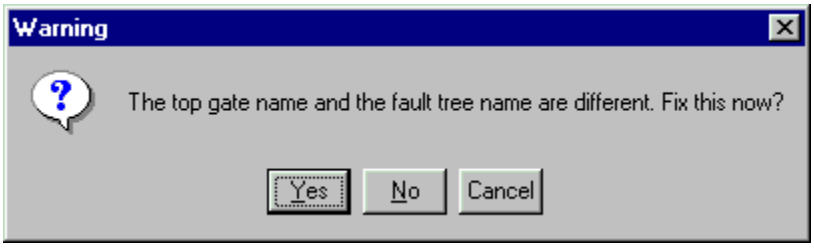
This dialog is displayed when you choose to save the current diagram to an already existing file.

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.

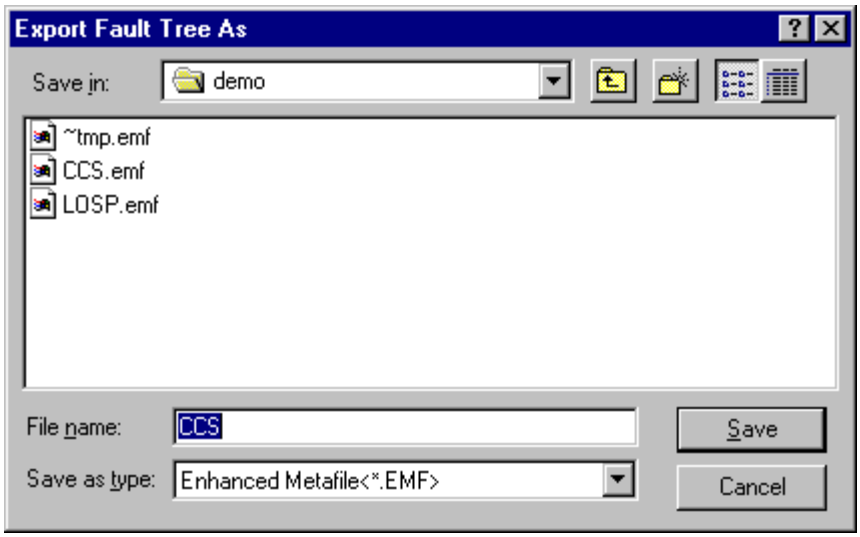
5.3.10.9 Export As

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 .

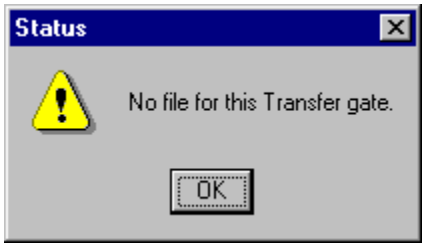
5.3.10.11 Forward Transfer

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.

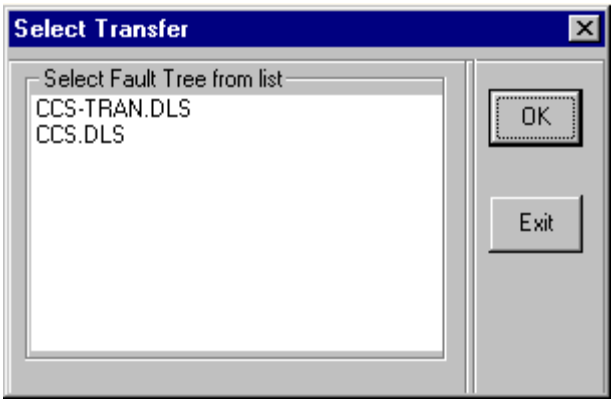
5.3.10.12 Backward Transfer

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.

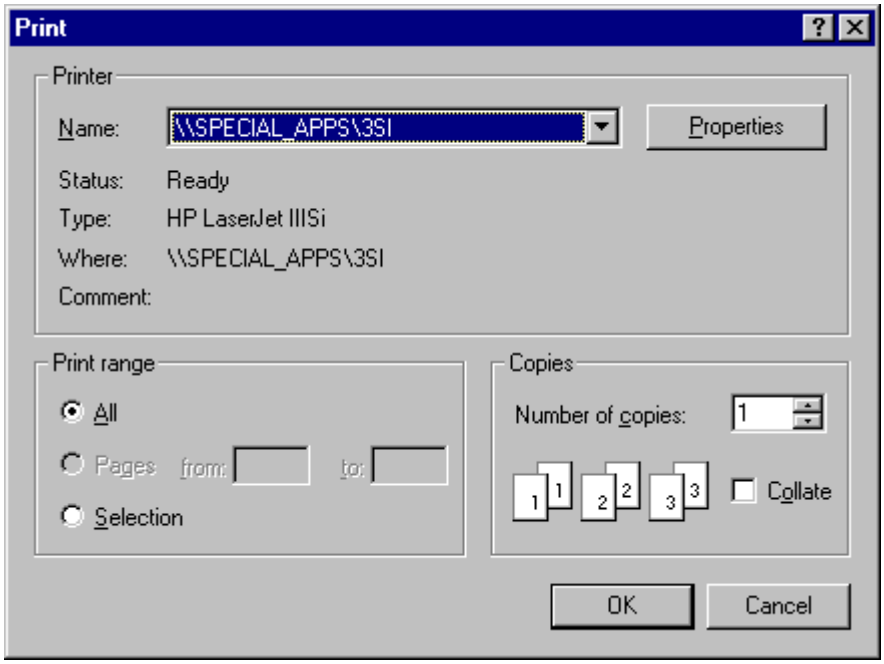
5.3.10.13 Print

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.

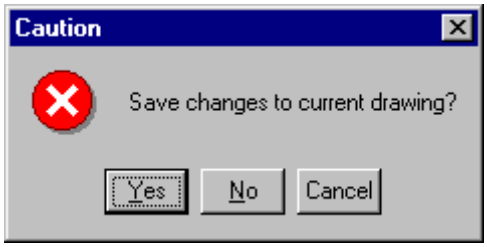


Name - List the printers that are set up for this computer.
Properties - Set-up options for the selected printer. Available options depend on the features of the printer.
Status - Condition of the selected printer.
Type - Kind of selected printer.
Where - Location of the selected printer.
Comment - Miscellaneous 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

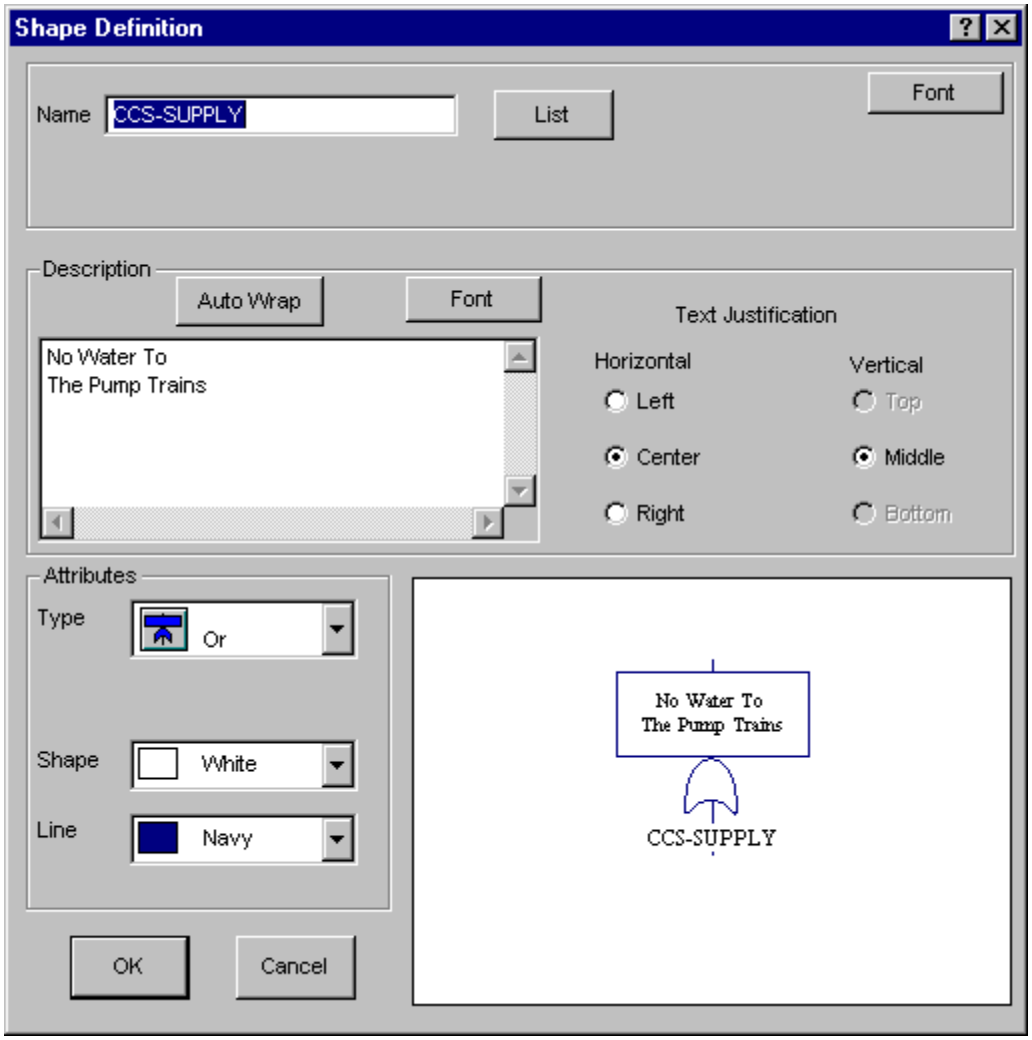
5.3.11.9.2 Modifying Objects

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.



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.

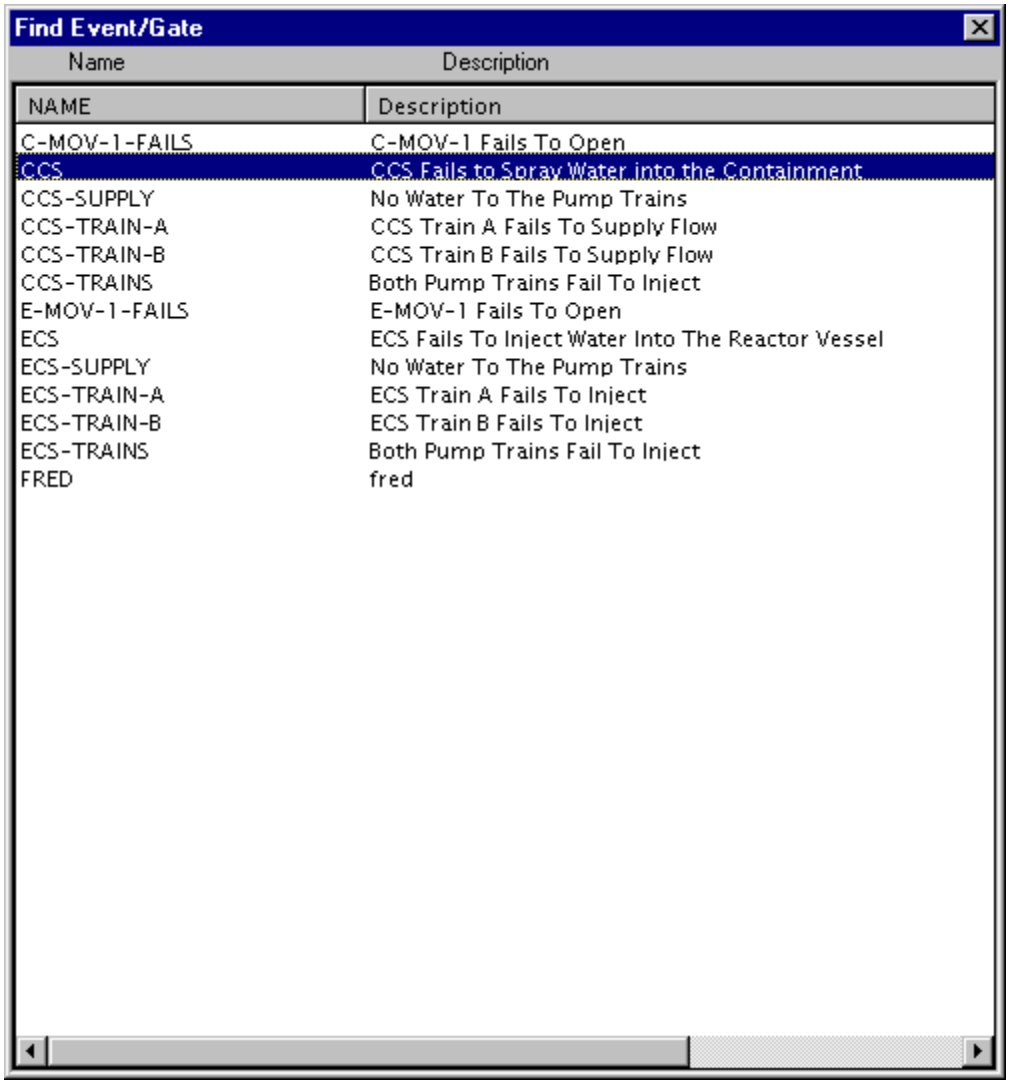
5.3.11.9.3 Listing Event/Gates

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.



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

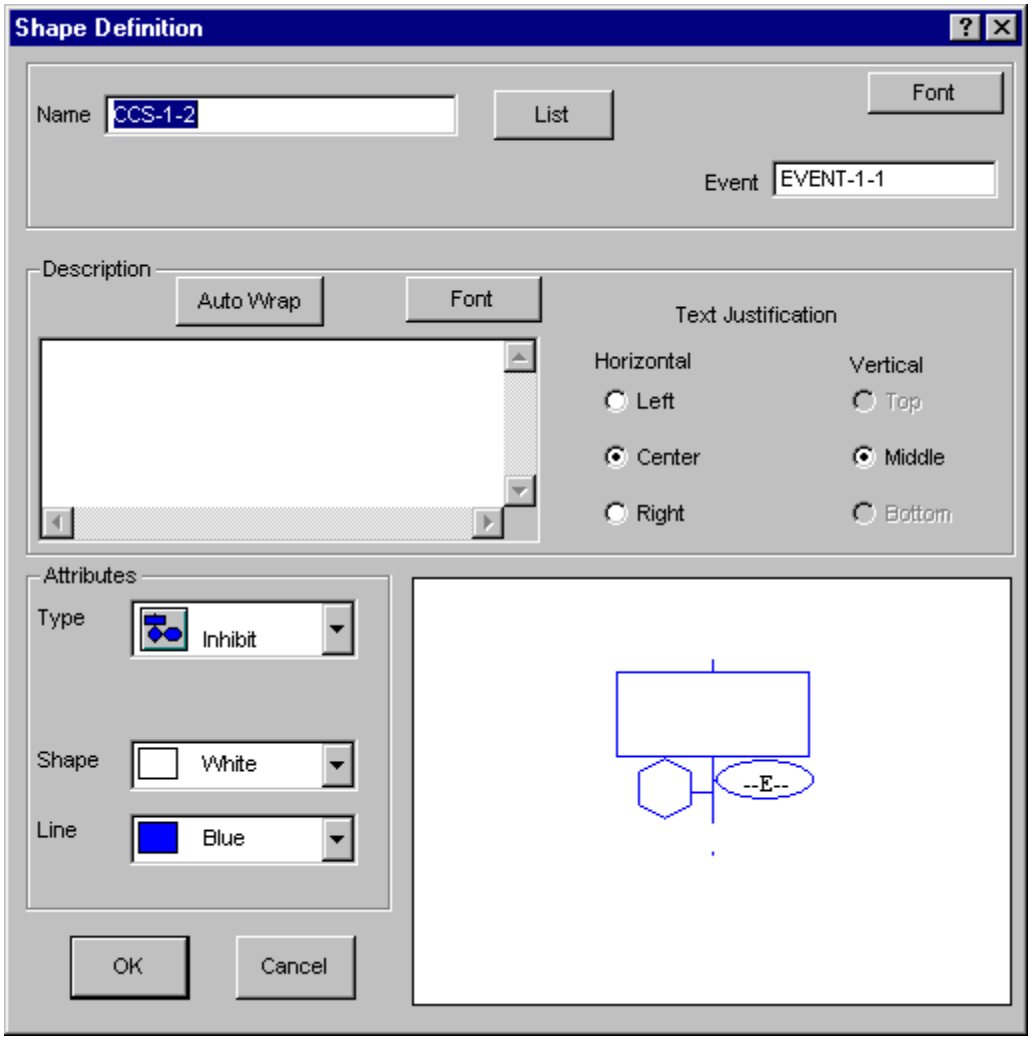
5.3.11.9.4 Modifying Inhibit Gates

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 *Shape Definition* dialog without applying the changes.

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

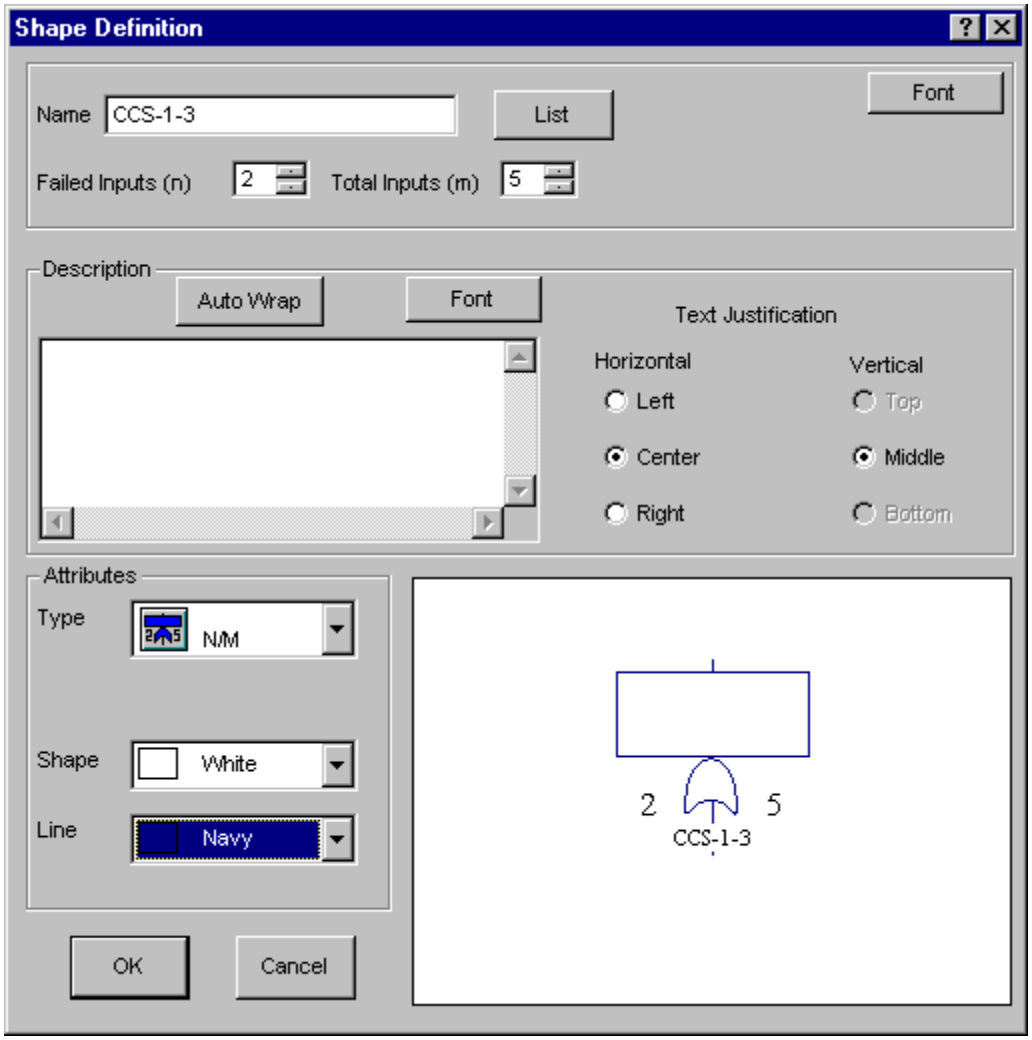
5.3.11.9.5 Modifying N/M Gates

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.



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

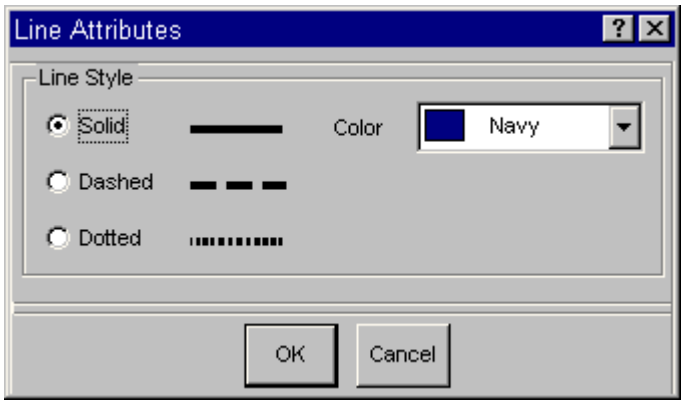
This option allows you to modify the attributes of the selected line in the diagram.

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

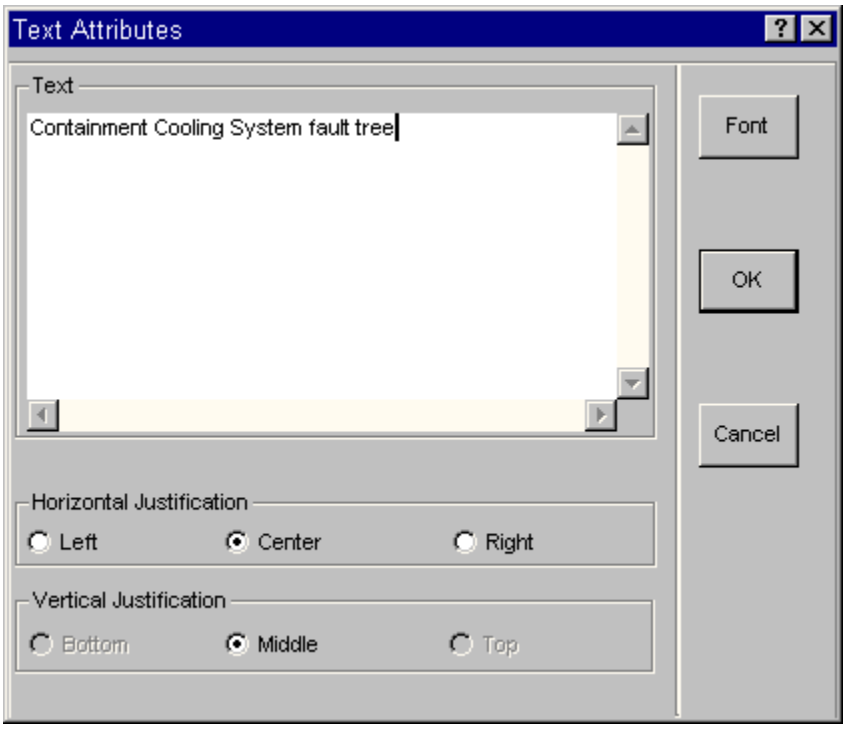
PURPOSE

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 *Text Attributes* dialog without applying the changes.
OK - Close the *Text Attributes* dialog and apply any changes.

5.3.11.9.8 Modifying Groups Of Objects

PURPOSE

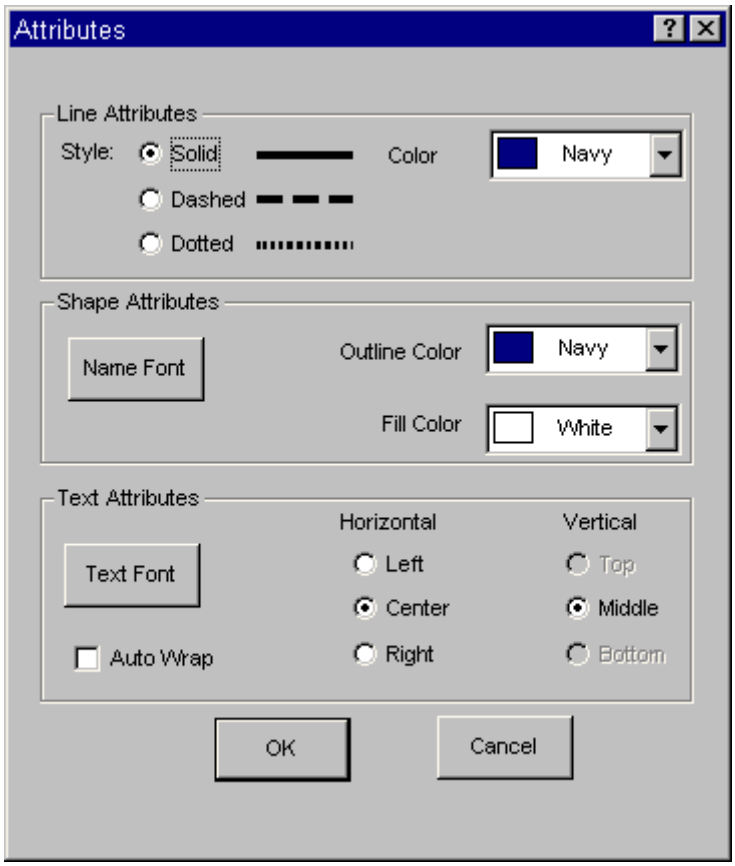
This option allows you to modify the attributes of any selected objects in the diagram. This dialog appears when multiple objects are selected simultaneously.
STEPS

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

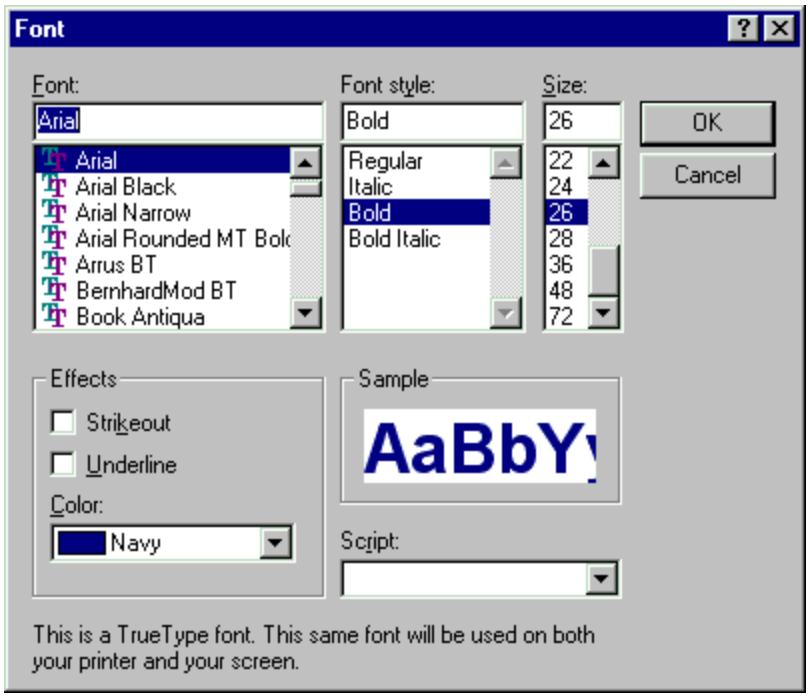
PURPOSE

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.

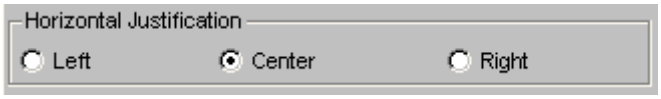
Each text object has a pick box that surrounds it called the text box. You can align text on the left or right sides of the text box or center text between the sides of the text box.

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

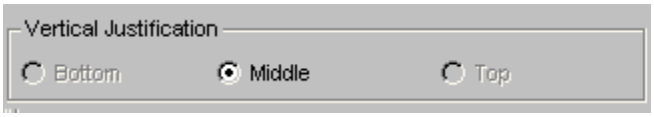
Allows you to change the vertical justification of text. This option is accessible from the *Preferences* dialog, the *Text Attributes* dialog, or the *Attributes* dialog.

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.

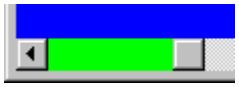
To move the viewing window up slightly:

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.

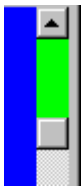
To move the viewing window to the left about one-eighth page:

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:

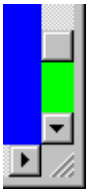
1. **Click** on bottom scroll bar between the right arrow and the thumb. The area to click in is highlighted in green in this example.
2. The viewing window will move to the right.

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

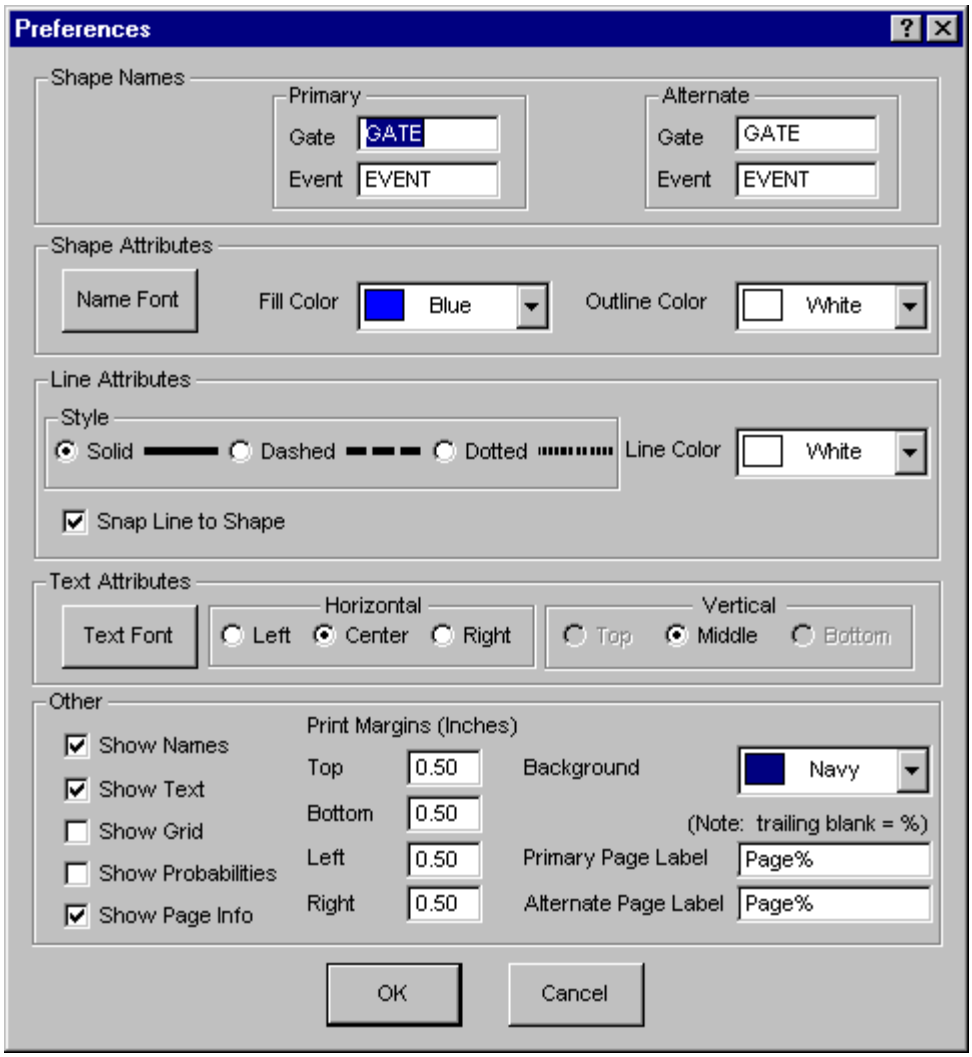
This option allows you to modify the preferences for the graphical *Fault Tree Editor*. The changes made here will be reflected in the default values in the **Utility | Define Constants | Fault Tree** option.

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 - Default prefix for the primary gate name.
Event Name - Default prefix for the primary event name.

Alternate

Gate Name - Default prefix for the alternate gate name.
Event Name - Default prefix for the alternate event name.

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

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

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

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

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

Snap Line to Shape - 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 - All text objects created following these changes will use the attributes selected here.

Text Font - The font attributes for text objects.

Horizontal - The horizontal alignment for text objects.

Vertical - The vertical alignment for text objects.

Other

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

Show Text - If checked, all descriptive text will be displayed.

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

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

Show Page Info – If checked, turns on the display of page information at the bottom of the diagram.

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

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

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

Alternate Page Label - 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

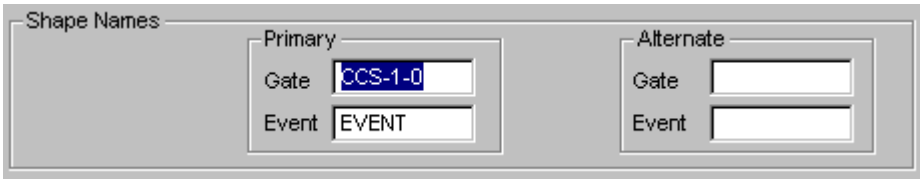
Define the usage of the default gate and event names in the *Preferences* dialog.

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.

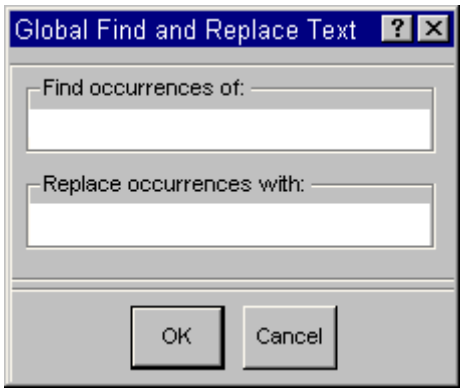
5.3.13.2 Global Find and Replace Text

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 - Enter the word or phrase you wish to replace

Replace occurrences with - Enter the replacement word or phrase.

OK - 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.

Cancel - Close the *Global Find and Replace Text* dialog without performing the search-and-replace operation.

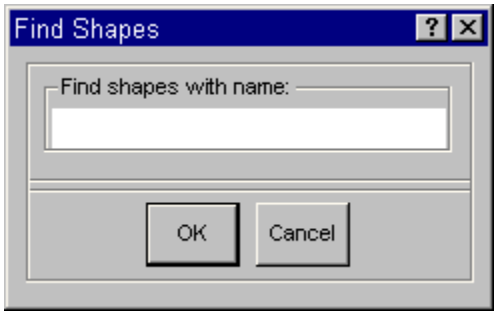
5.3.13.3 Find Name

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).

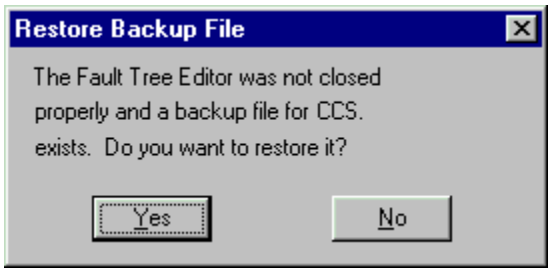
OK - Search for the shape whose name exactly matches the entered name and close the *Find Shapes* dialog. The shape matching the search criteria will be highlighted, if found.

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

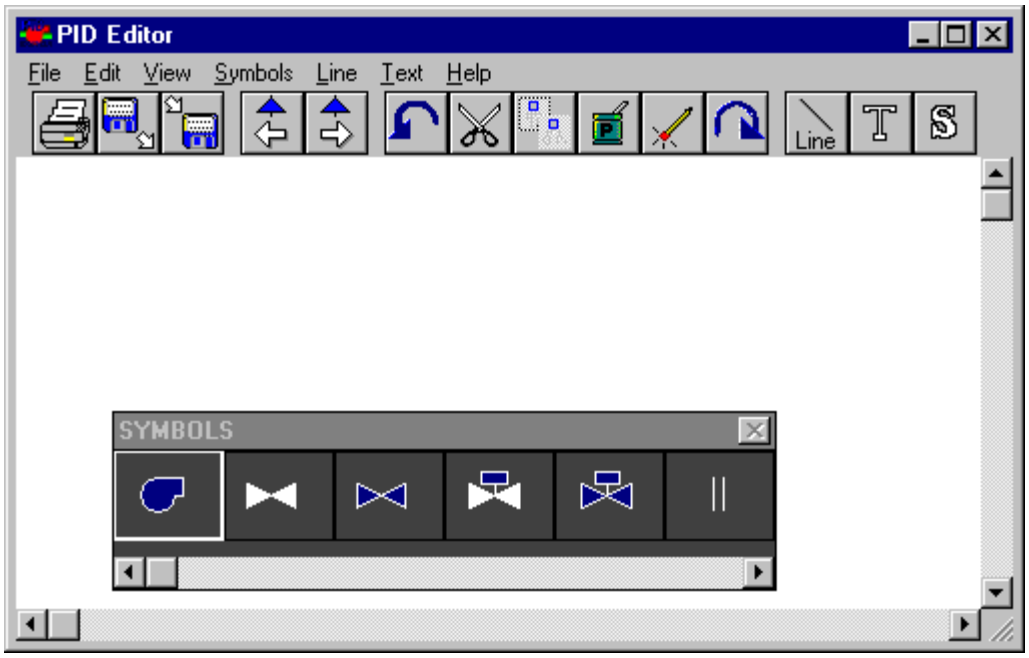
5.4.1 P&ID Graphics

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 *drag* 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)

gate valve open

gave valve closed

solenoid operated valve open

solenoid operated valve closed

flange

three-way valve

solenoid operated butterfly valve

diaphragm operated butterfly valve

diaphragm operated valve closed

resistor

orifice plate

solenoid operated

vertical drum

And gate

Nand gate

Or gate

Nor gate

basic event

house event

diaphragm operated valve open

angle valve open

check valve

heater

reducer

connector (vertical)

filter

diaphragm operated actuator

storage tank

angle valve (one side normally closed)

angle valve closed

connector (horizontal)

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 *P&ID Editor*. 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.

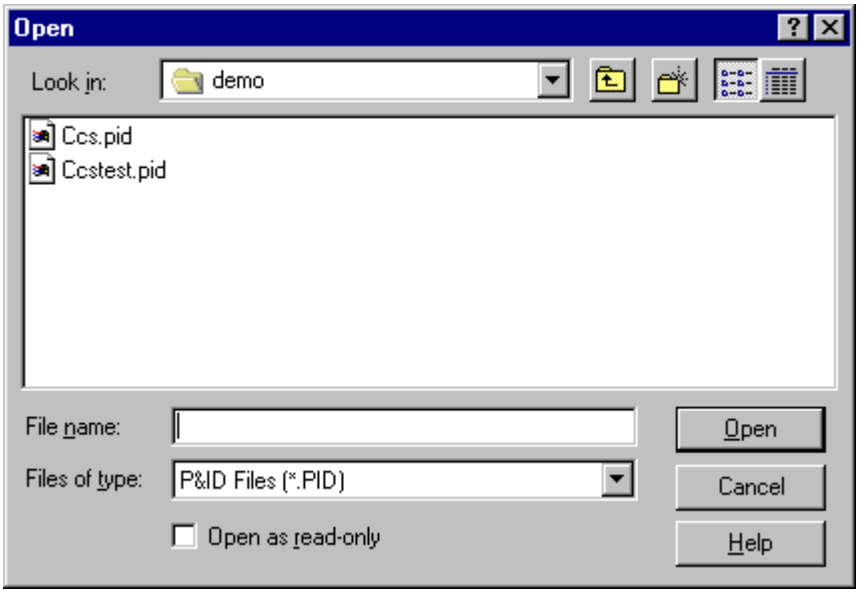
5.4.6.4 Open Dialog

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

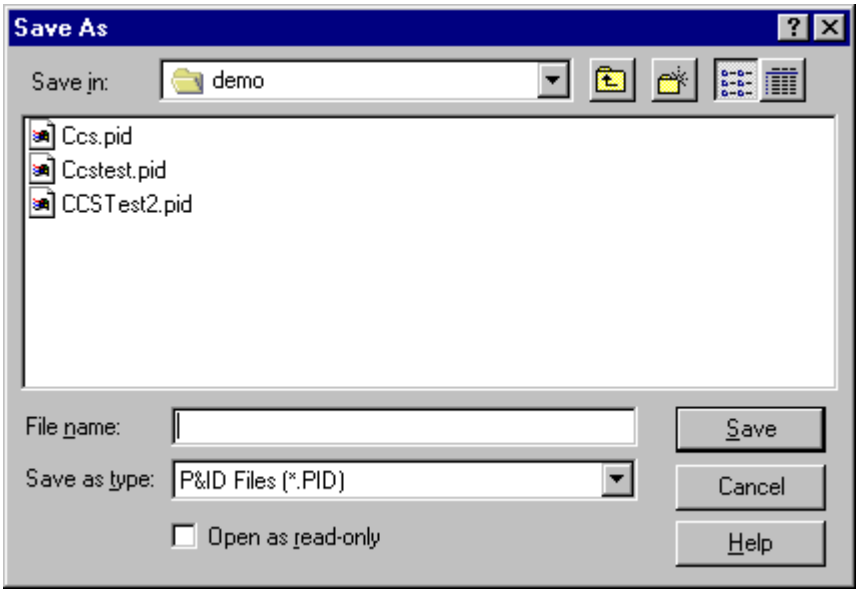
1. From the *P&ID Editor* menu select **File.**
2. Choose **Save as** from the menu
3. The *Save* common dialog will be displayed listing all the P&ID diagrams (.PID files) in the current project directory.
4. Enter the name of the file in the *File Name* field,

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.

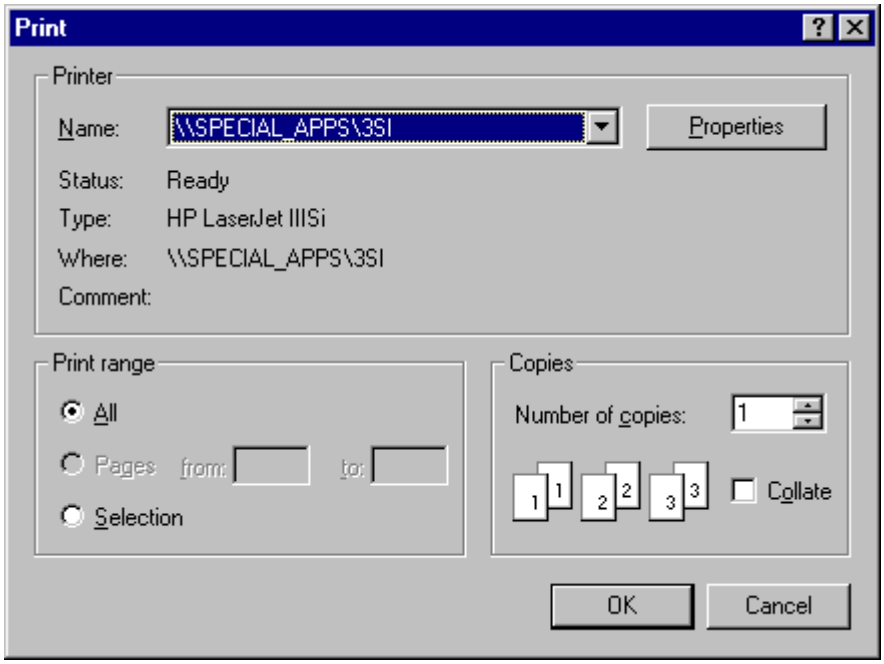
5.4.6.9 Print

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.

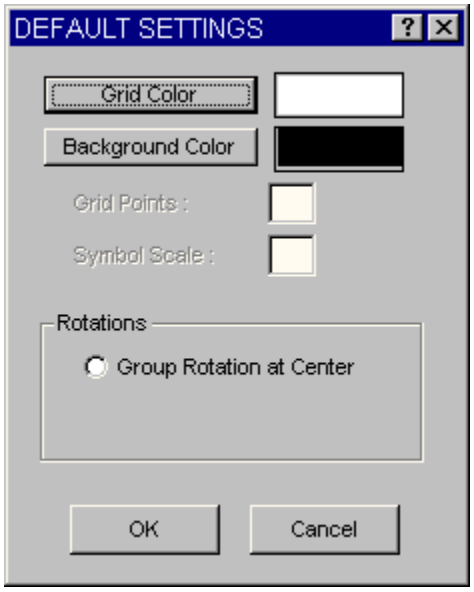
5.4.6.14 Defaults

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 *Default Settings* dialog.
Cancel - Close the *Default Settings* 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.

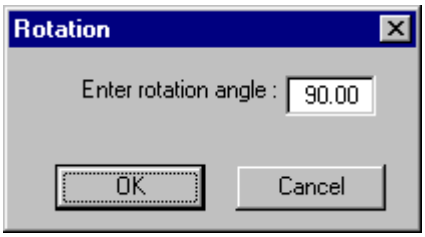
5.4.7.8 Rotate

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.

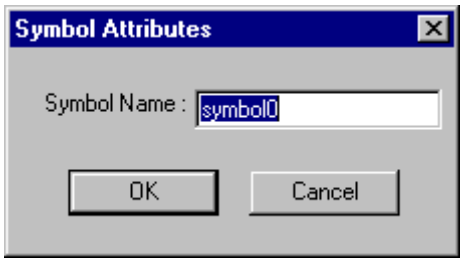
5.4.7.12 Symbol Name

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 of 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

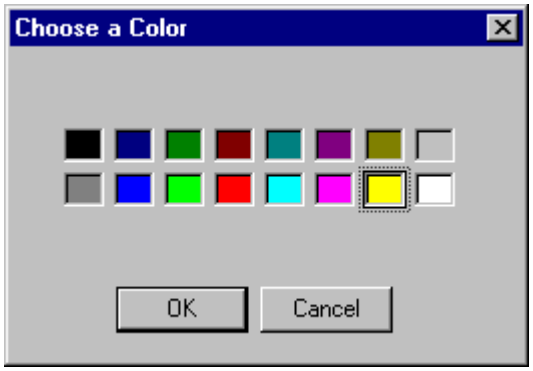
1. Select the desired line(s) in the diagram.
2. From the *P&ID Editor* menu select **Edit**.
3. Choose **Line Color** from the menu.
4. The *Choose a Color* dialog will be displayed.

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

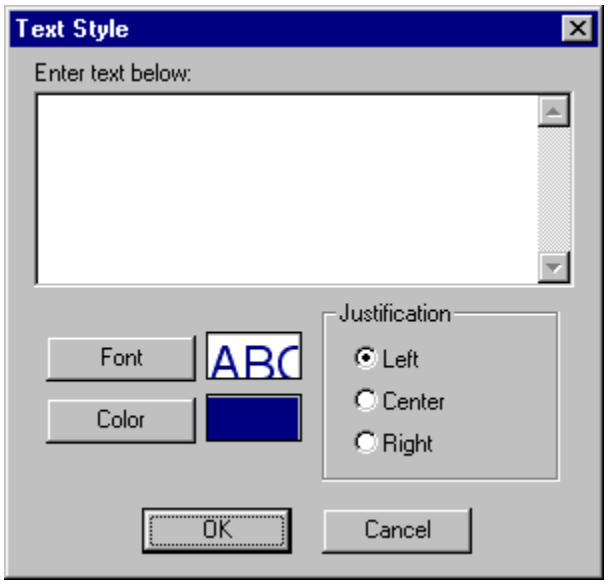
1. Select the desired line(s) in the diagram.
2. From the *P&ID Editor* menu select **Edit**.
3. Choose **Text Attributes** from the menu.
4. The *Text Style* dialog will be displayed.

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.

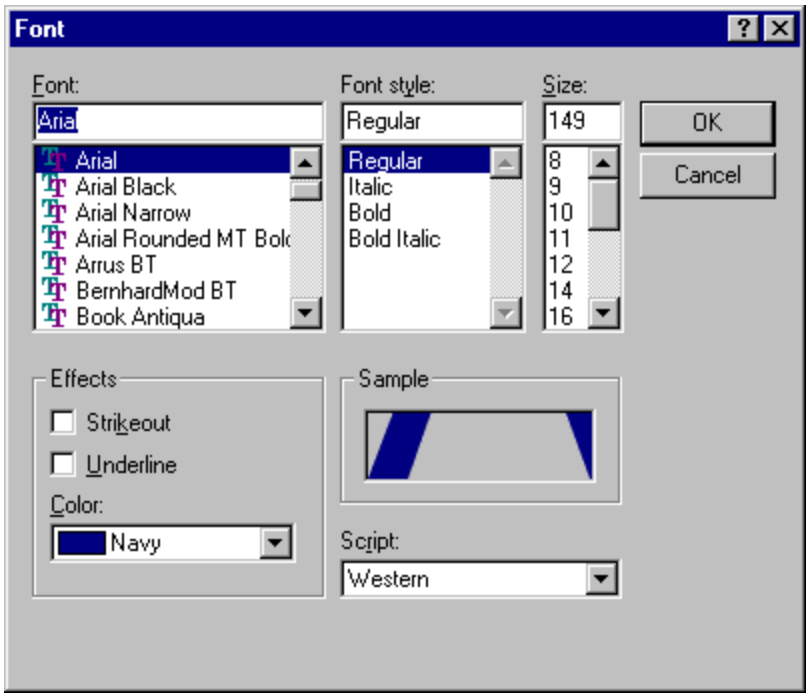
Justification
Left - Align the text to the left
Center - Align the text in the center
Right - Align the text to the right

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

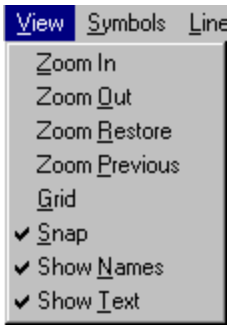
PURPOSE

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

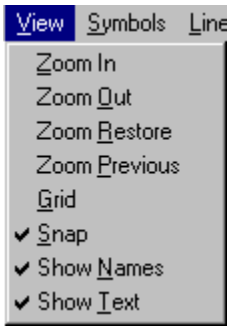
PURPOSE

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

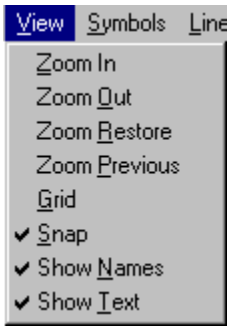
PURPOSE

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

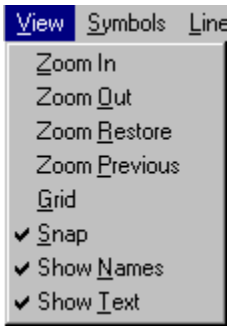
PURPOSE

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

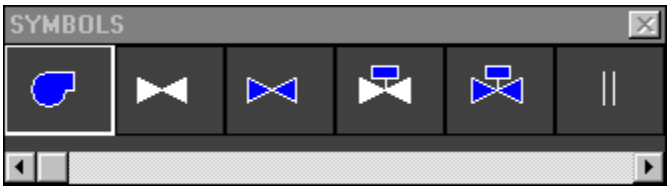
PURPOSE

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.

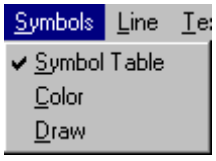
STEPS

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

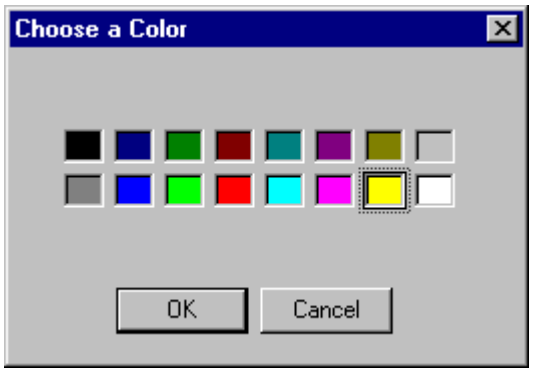
1. From the *P&ID Editor* menu select **Symbols**.
2. Choose **Color** from the menu. The *Choose a Color* dialog will be displayed.

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.

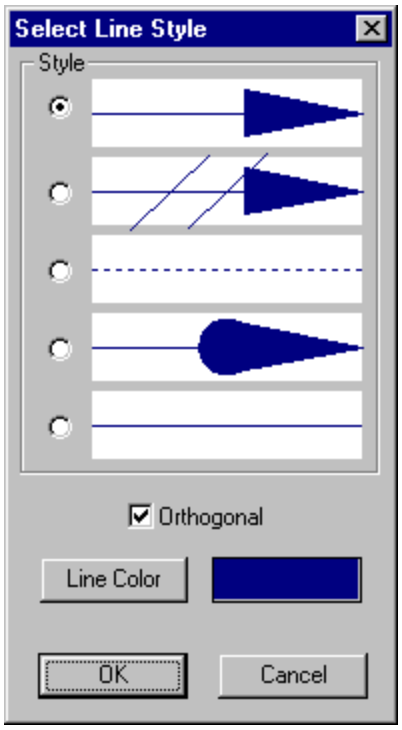
5.4.10.2 Line Style

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

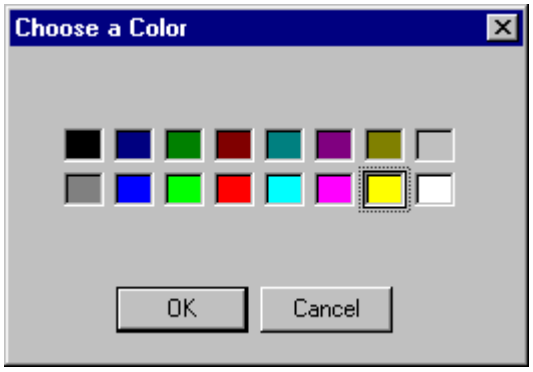
1. From the *P&ID Editor* menu select **Line**.
2. Choose **Color** from the menu.
3. The *Choose a Color* dialog will be displayed.

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.

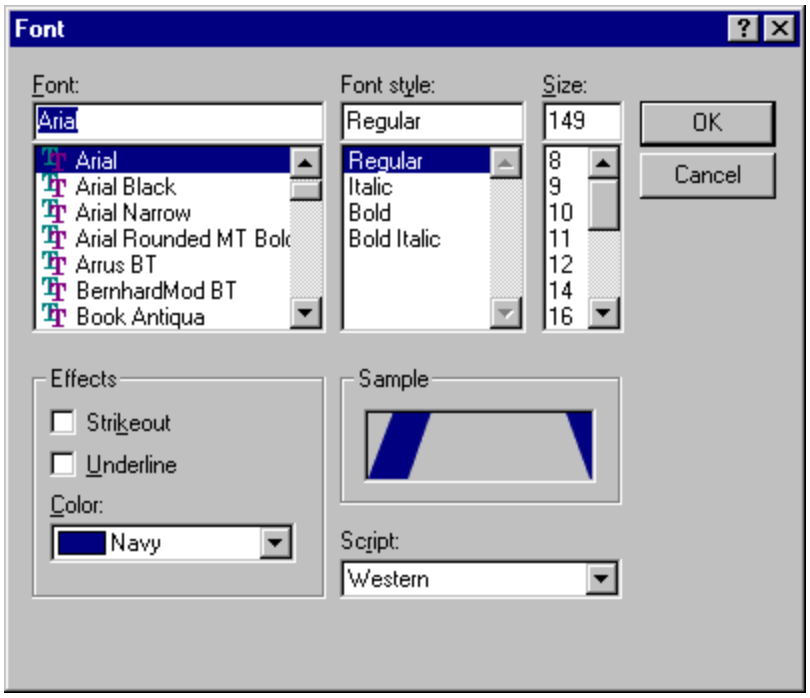
STEPS

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.

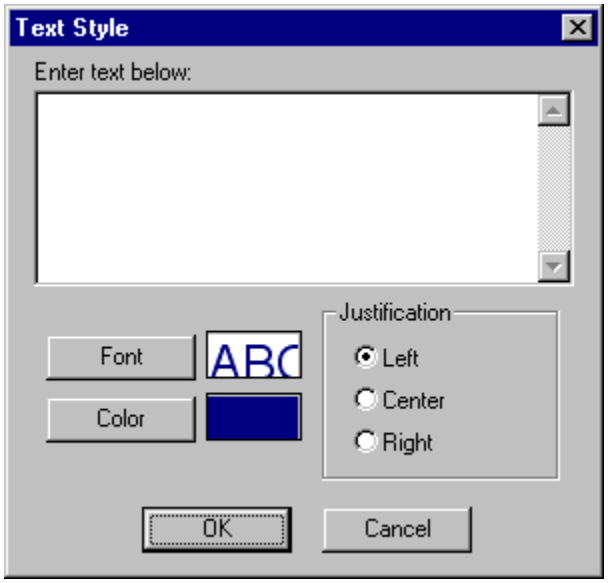
The cursor will change to the standard cursor when step 7 is complete.

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.

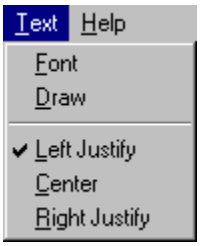
5.4.11.6 Left Justify

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.

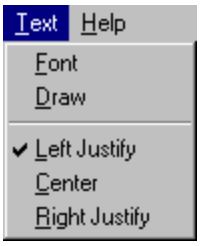
5.4.11.7 Center

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.

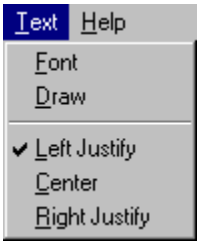
5.4.11.8 Right Justify

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.



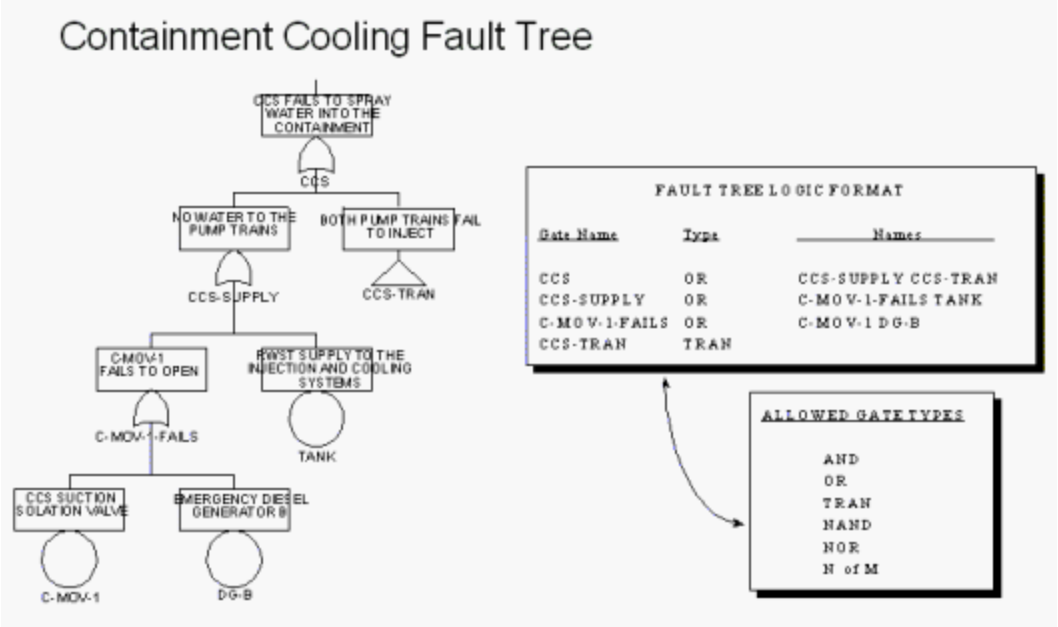
In the example of the **Text** menu shown here, the **Right Justify** option is NOT currently selected.

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.



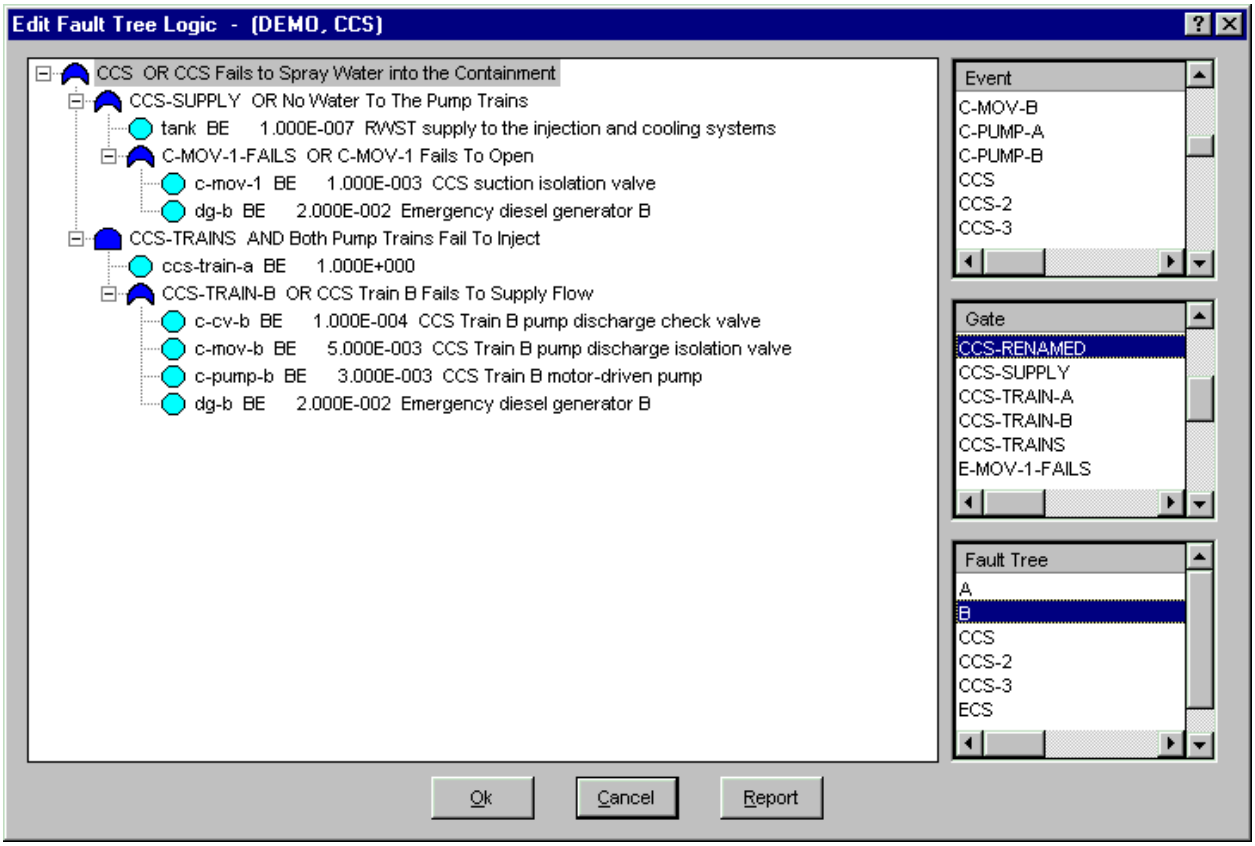
5.5.2 Fault Tree Logic Editor

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 – I nsert 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.

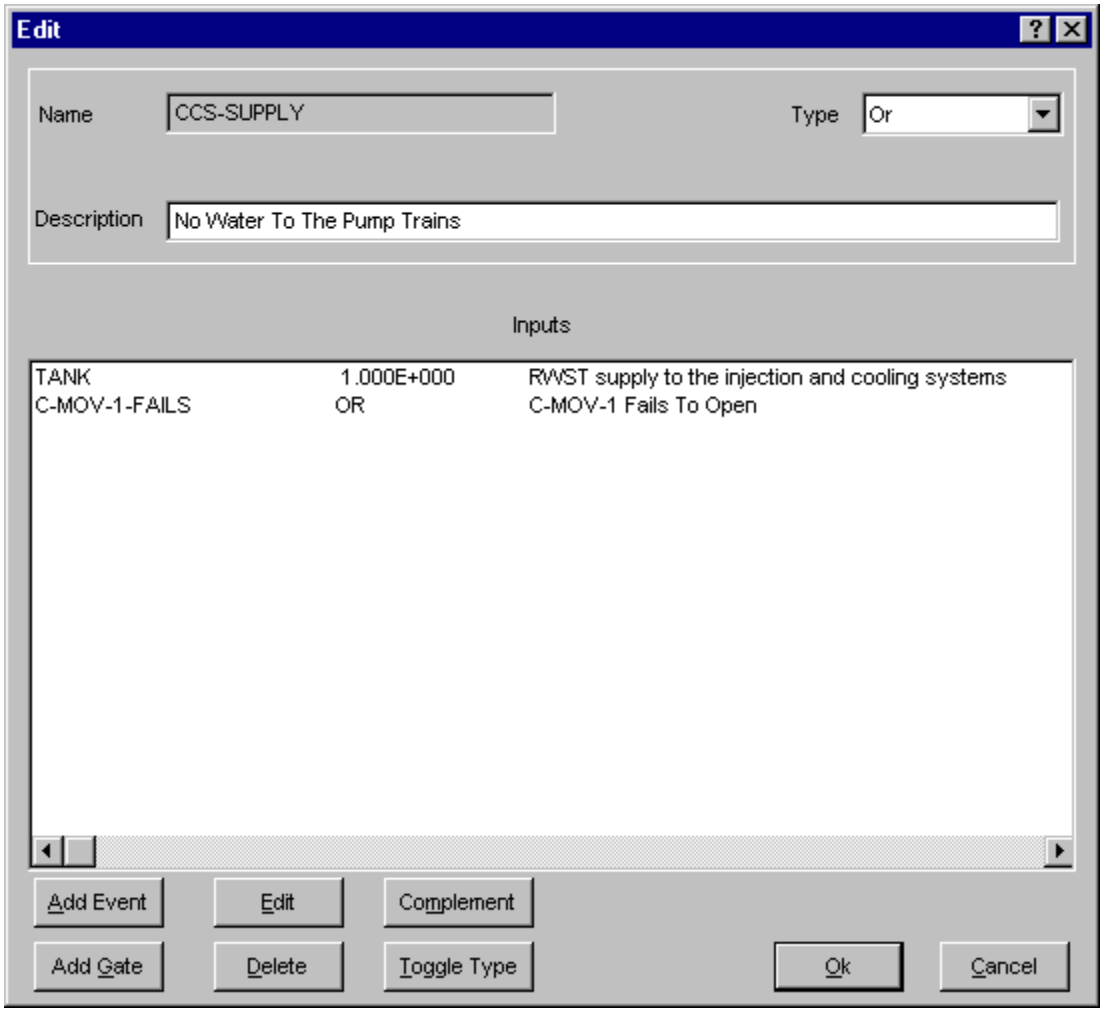
5.5.3 Modify Gate Logic

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.



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.

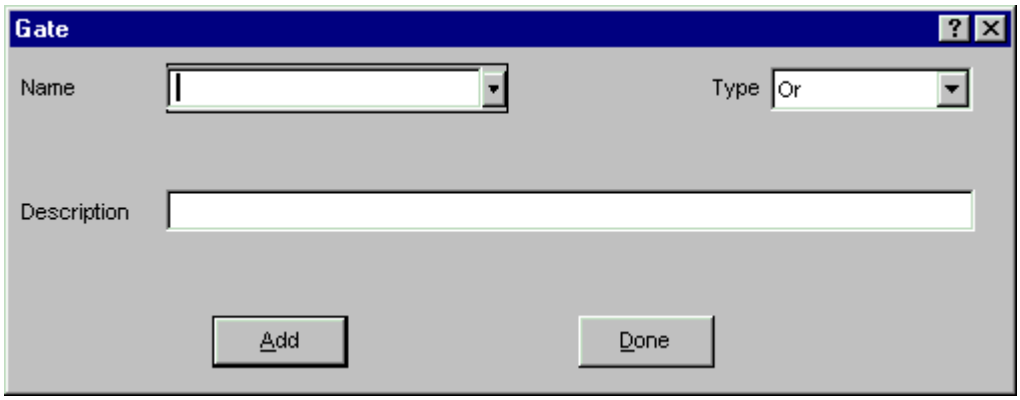
5.5.4 Add Gate as Input

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.

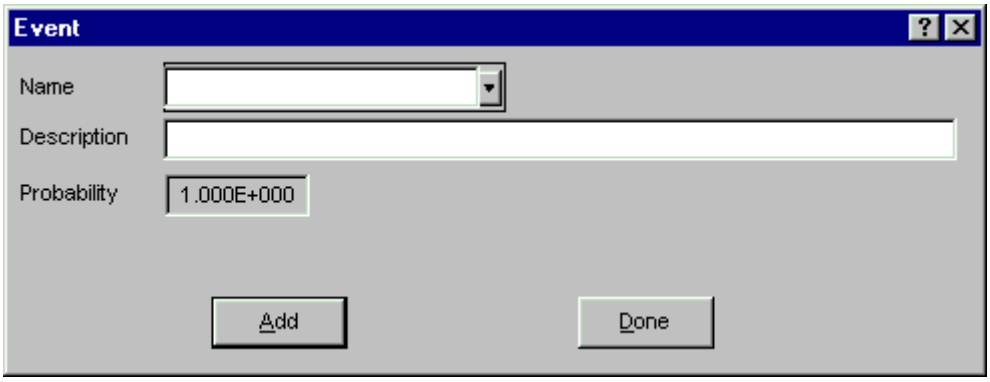
5.5.6 Add Event as Input

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.

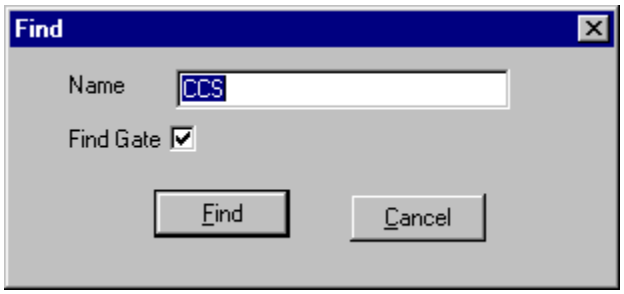
5.5.8 Find

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 *Find* 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.

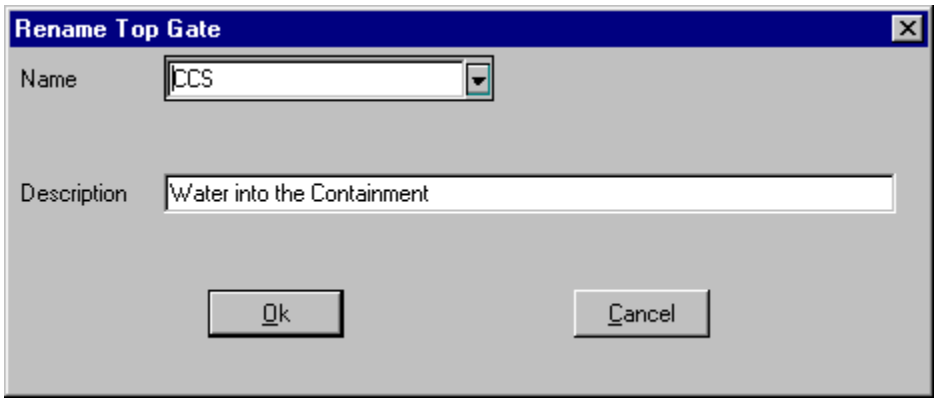
5.5.11 Rename Top

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.

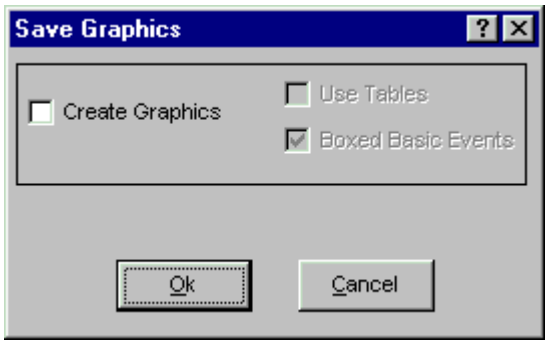
5.5.12 Save Logic

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 *Save Graphics* dialog without saving the logic but do not close the *Edit Fault Tree Logic* 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).

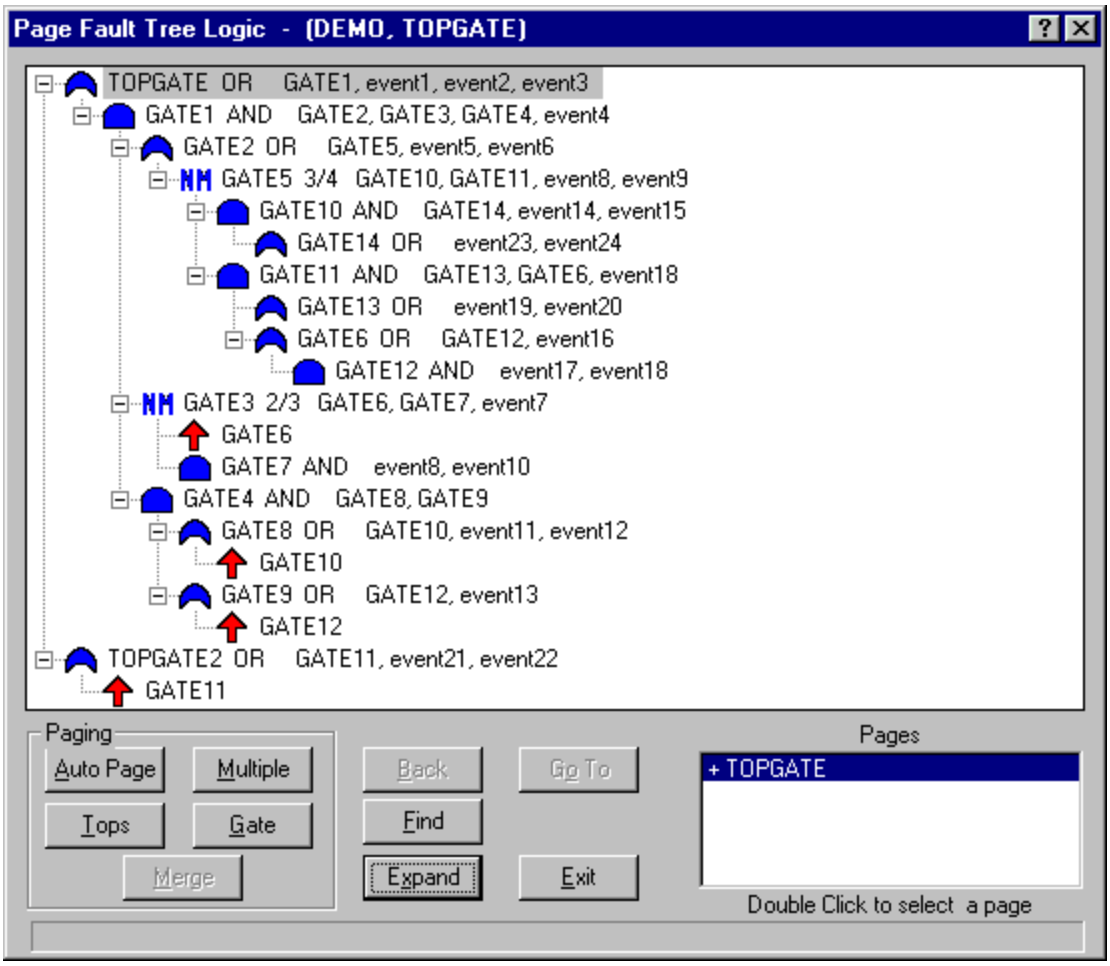
The fault tree shown below will be used to illustrate how the various Page Tree functions work. Examples described in the various Page Tree functions refer to this basic fault tree file, called TOPGATE.FTL.

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 *Page Fault Tree Logic* 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.

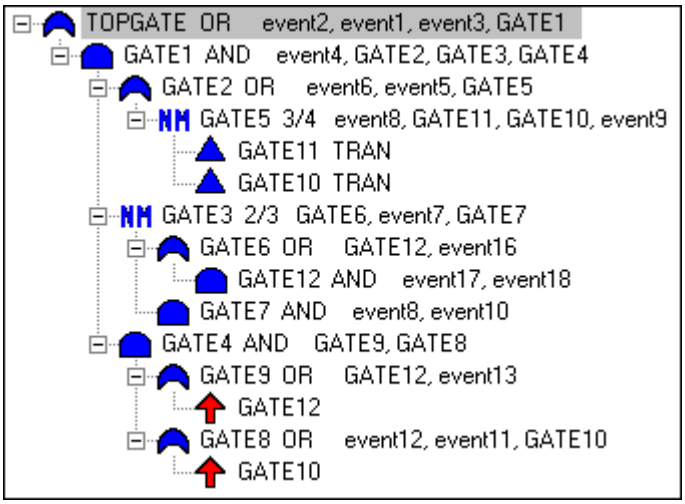
This option is enabled only when gates with multiple references are detected in the fault tree logic file.

STEPS

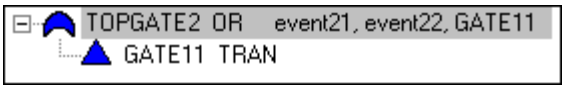
1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and choose **Page Tree**.
4. The *Page Fault Tree Logic* dialog will be displayed.
5. Choose the **Multiple** button.

EXAMPLE

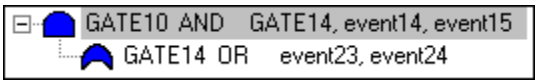
Using the example fault tree, the execution of the **Multiple** function results in four logic files: TOPGATE.FTL, TOPGATE2.FTL, GATE10.FTL and GATE11.FTL. Notice that the original fault tree logic file included two top events and four gates with multiple references. The two top event logic files have 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.



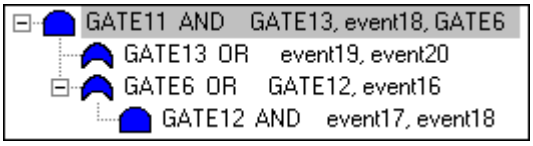
TOPGATE.FTL after the **Multiple** command.



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

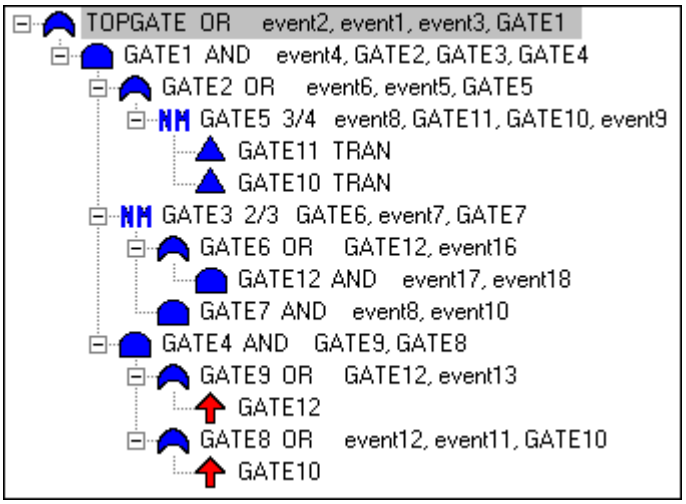
This option automatically separates the logic file into different fault trees by the top events. This option is enabled only when multiple tops in the logic are detected.

STEPS

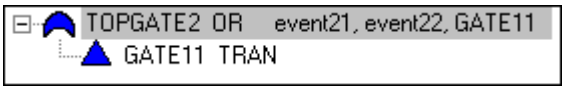
1. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and choose **Page Tree**.
4. The *Page Fault Tree Logic* dialog will be displayed.
5. Choose the **Tops** button.

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

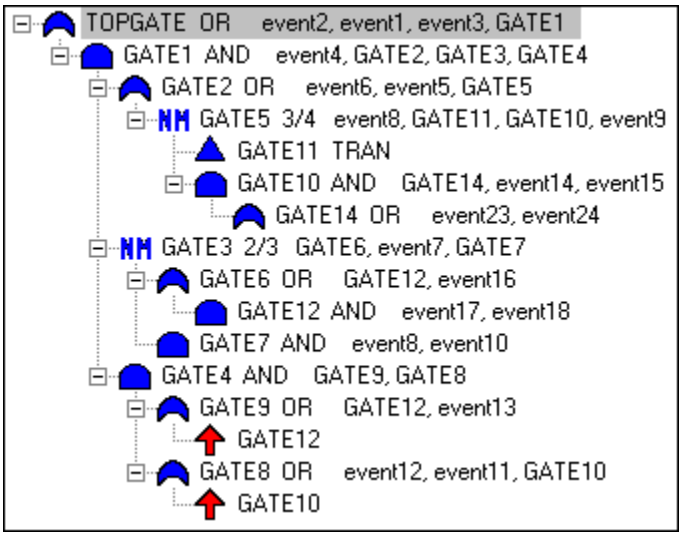
This option creates a separate fault tree logic file with the specified gate as the top event. Transfer gates will be inserted as appropriate so that the final linked logic is equivalent to the original logic.

STEPS

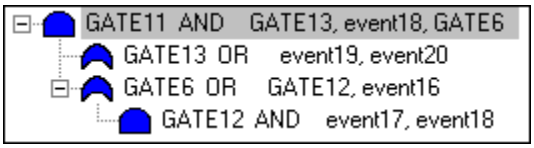
1. From the SAPHIRE menu select **Fault Tree**. The *Fault Tree List* dialog will be displayed.
2. Highlight the desired fault tree.
3. Right-click to invoke the pop-up menu and choose **Page Tree**. The *Page Fault Tree Logic* dialog will be displayed.
4. Highlight the desired gate.
5. Choose the **Gate** 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.

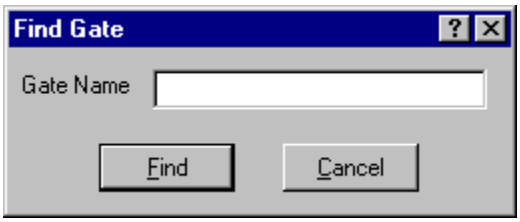
5.6.6 Page Tree - Find

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

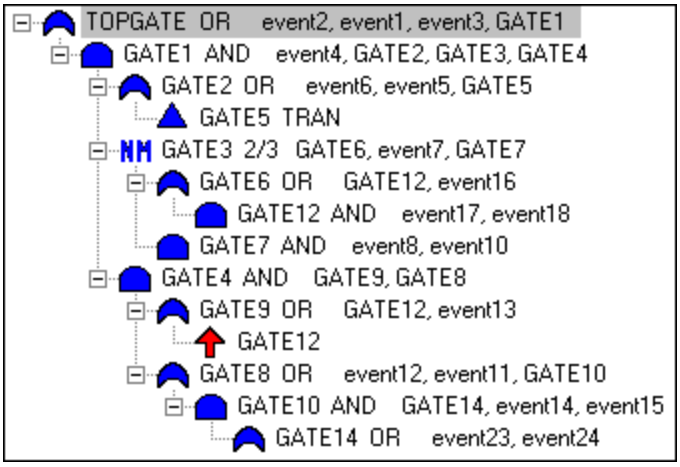
PURPOSE

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.

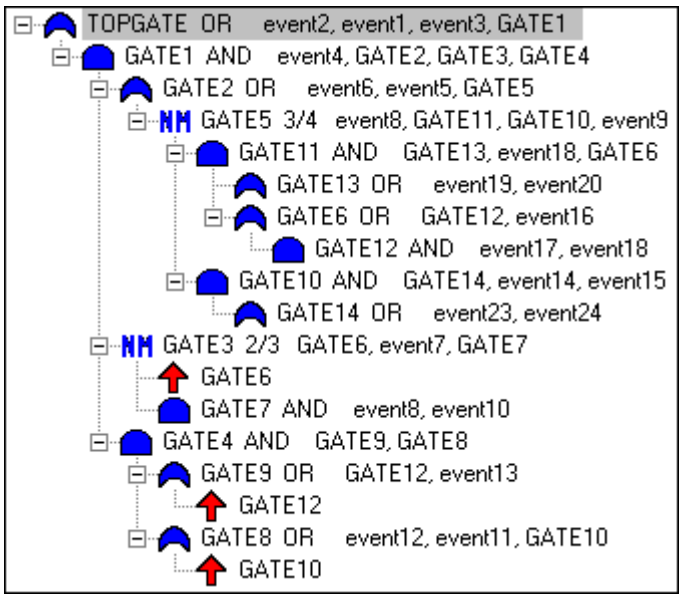
STEPS

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

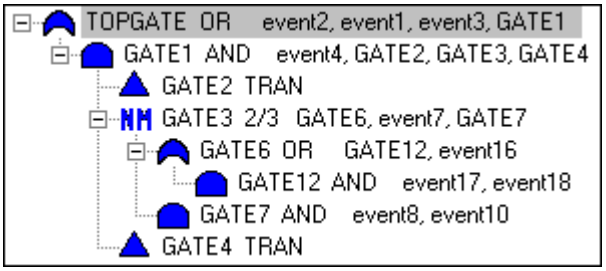
This option automatically breaks the fault tree into easily viewable segments. When this process is executed, the **Multiple** and **Tops** operations are performed automatically. Transfer gates will be inserted as appropriate so that the final linked logic is equivalent to the original logic. Generally, 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.

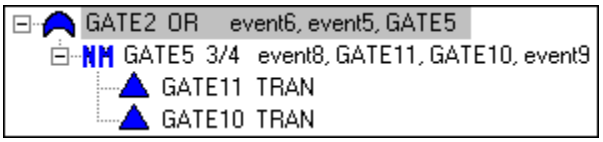
EXAMPLE

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.

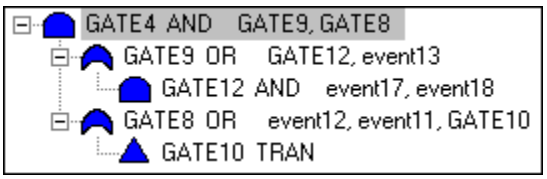


TOPGATE.FTL after the **Auto Page** command.

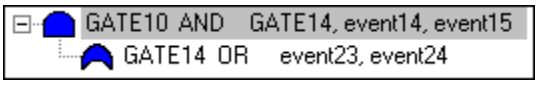
TOPGATE2.FTL after the **Auto Page** command.



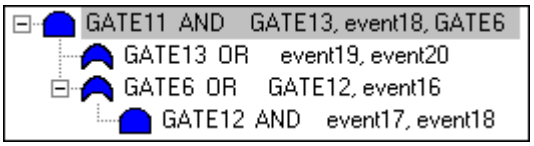
GATE2.FTL after the **Auto Page** command.



GATE4.FTL after the **Auto Page** command.



GATE10.FTL after the **Auto Page** command.

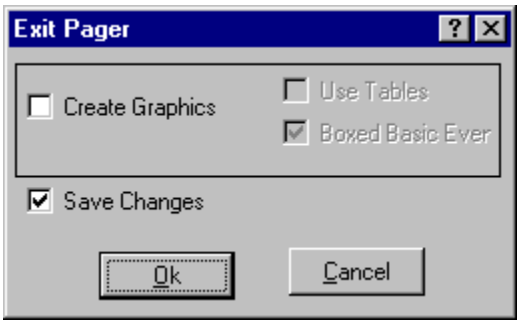


GATE11.FTL after the **Auto Page** command.

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

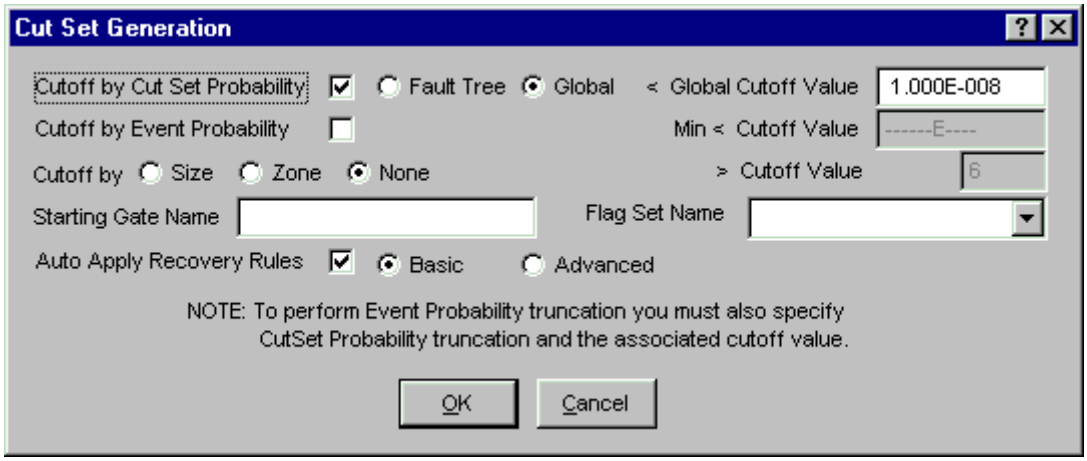
within the current project. Various options are provided to allow cut sets to be generated in various ways. You are given the opportunity to specify several cut set generation cutoff values that will be used to determine if a cut set is to be retained or discarded from the selected fault tree(s).

STEPS

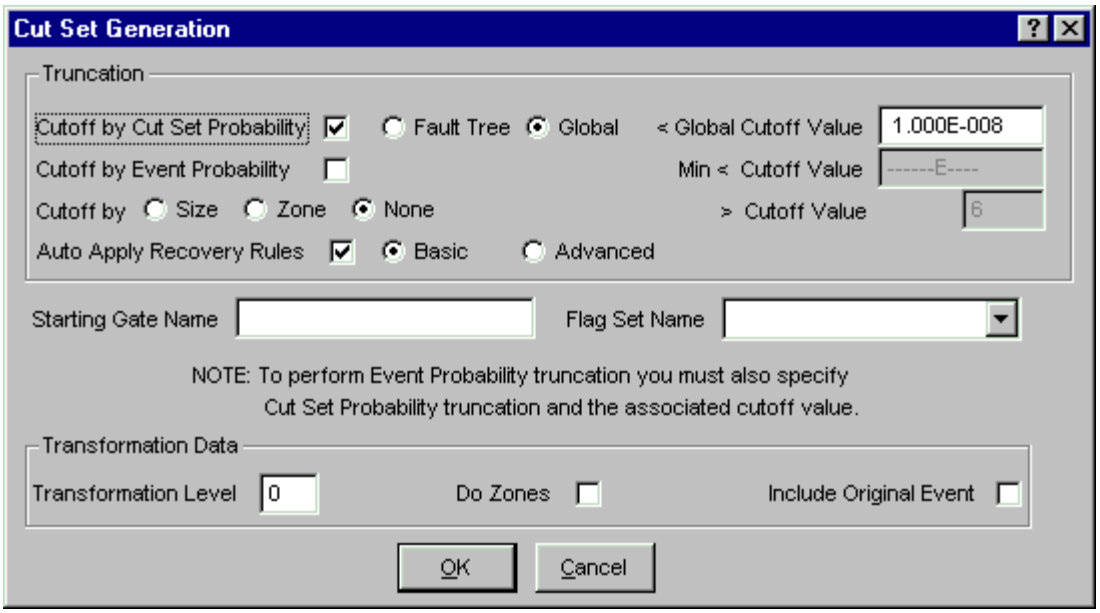
1. From the SAPHIRE menu select **Fault Tree**.
2. The *Fault Trees List* dialog will be displayed.
3. Highlight the desired fault tree(s).
4. Right-click to invoke the pop-up menu and choose **Solve**.

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 dialog below is displayed when any other Analysis Type is selected.



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 his 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

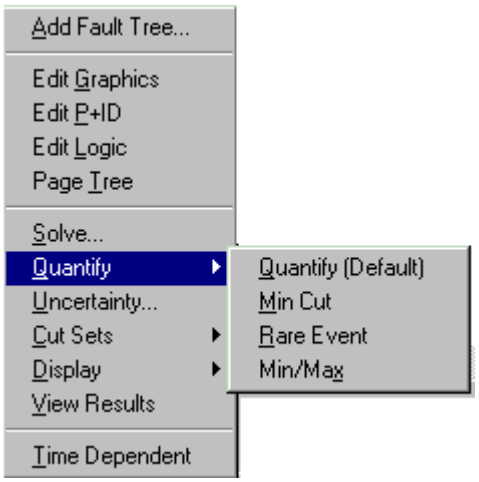
5.8.1 Quantifying Fault Trees

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 ∪ B ∪ 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).

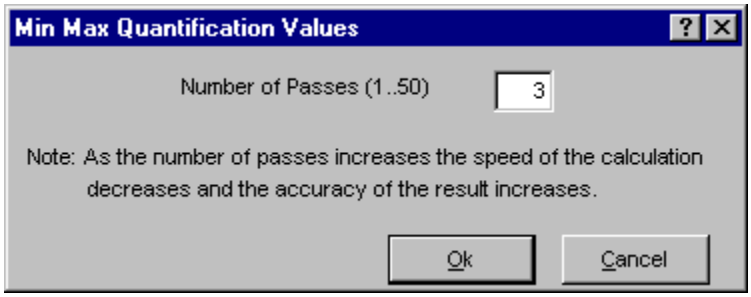
SEE TECHNICAL REFERENCE

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

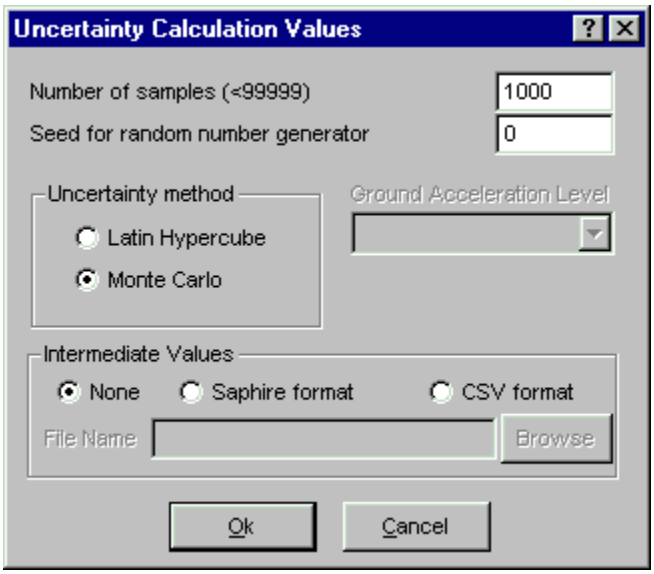
This option can estimate the variability (due to the uncertainties in the basic event probabilities) of either a fault tree top event probability or an event tree sequence frequency. To do this, SAPHIRE provides two sampling techniques: Monte Carlo simulation and Latin Hypercube simulation. In addition, 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 1.00000E+000 1.00000E+000
    2    2 1.00000E+000 1.00000E+000
    3    2 1.00000E+000 1.00000E+000
                 .
                 .
                 .
  500    2 1.00000E+000 1.00000E+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.

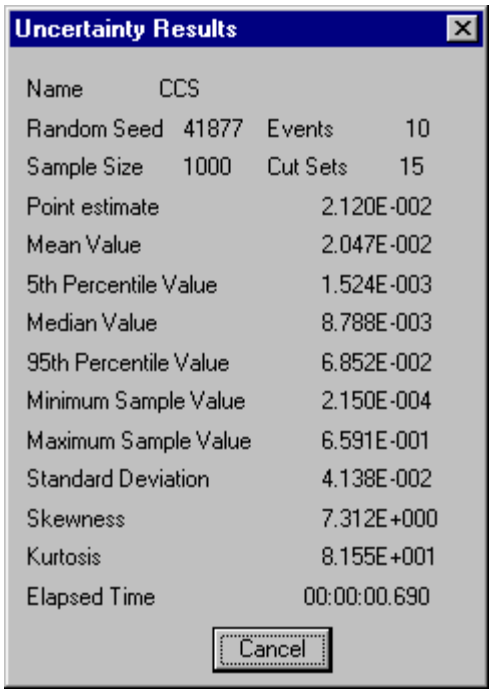
If an error occurs during the uncertainty analysis process, the process is terminated and a message box providing information about the specific error is displayed.

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)

Mean = (1/2) (b + a),
Variance = (1/12) $(b - a)^2$,

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 Γ(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

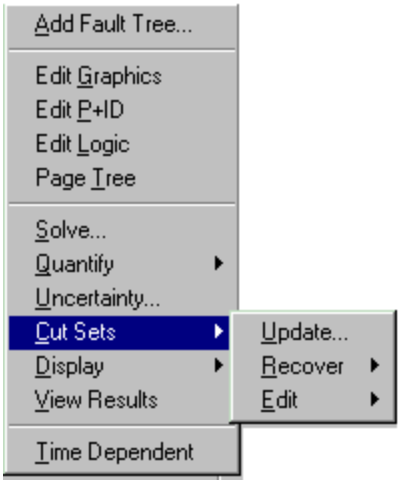
5.10.1 Fault Tree Cut Set Analysis

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

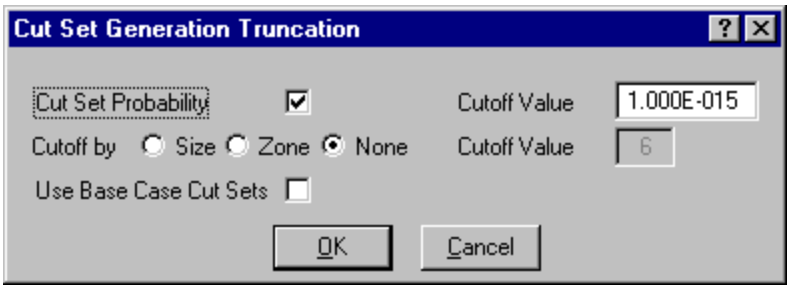
This option will update the current case cut sets for a selected fault tree (or sequence or end state) based on cut set generation cutoff values. You are given the opportunity to specify several cut set generation cutoff values that will be used to determine if a cut set is to be retained or discarded. 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

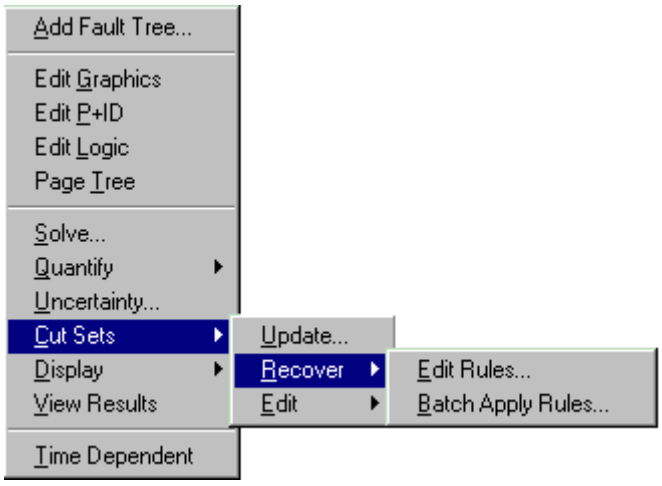
5.10.4.1 Recovering Fault Tree Cut Sets

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

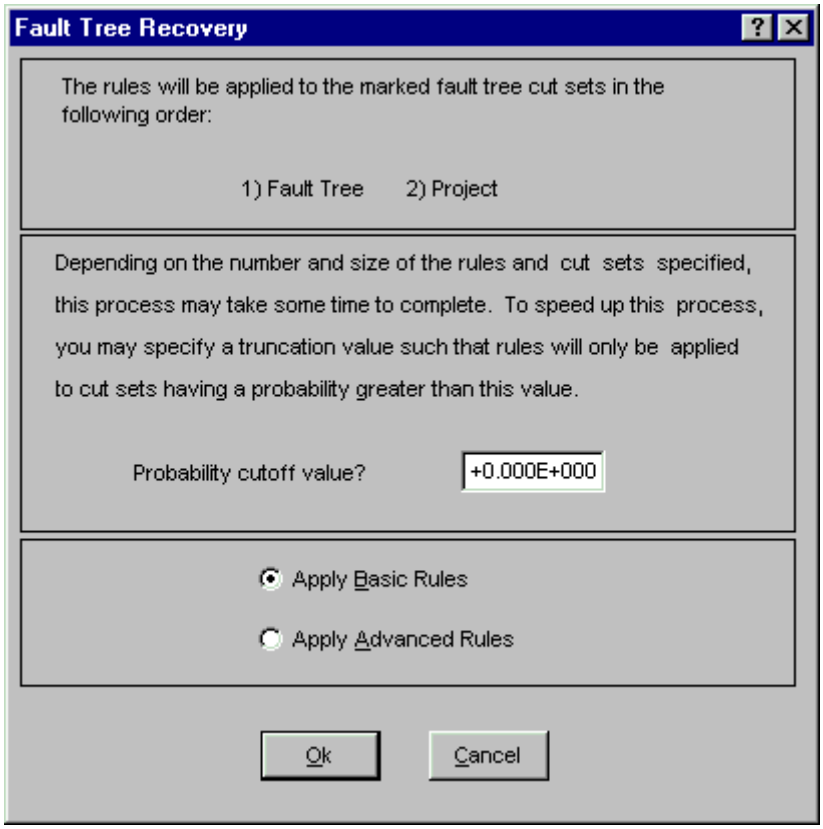
PURPOSE

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

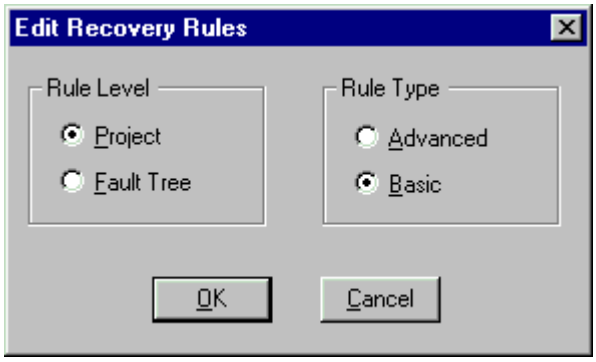
PURPOSE

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.

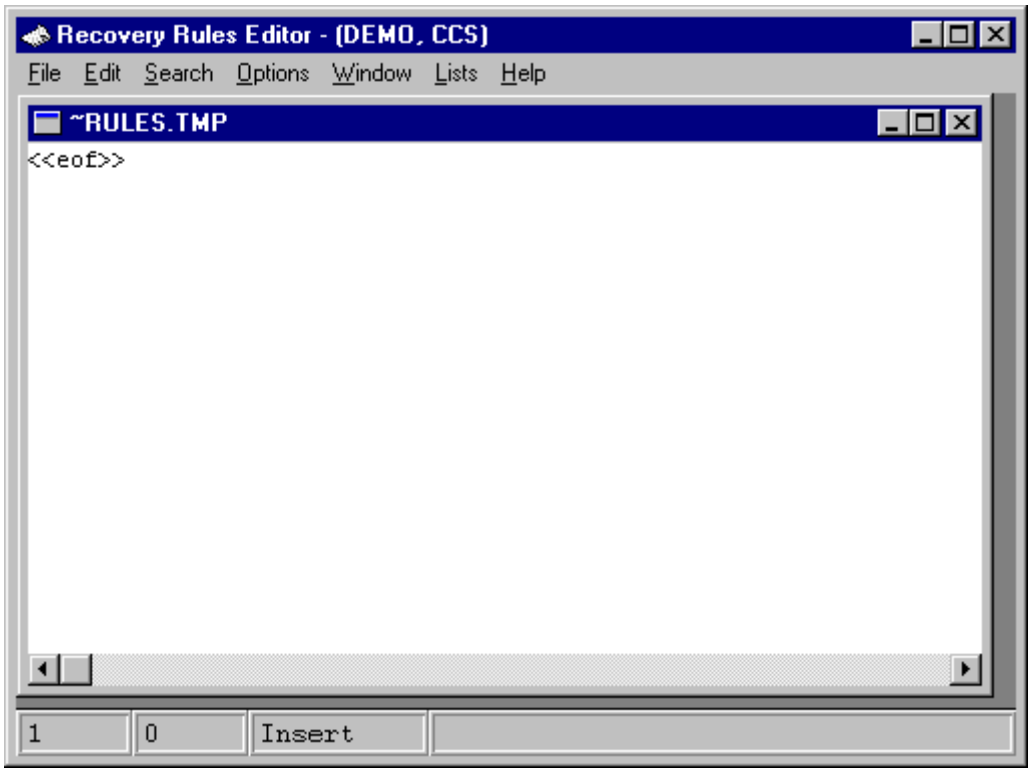
Recovery rules follow a format similar to the structure that is found in traditional programming languages (e.g., BASIC or PASCAL). As such, the ability exists to define "macros" and "if...then" type of structures. After creating or editing rules, SAPHIRE compiles the rules to check their validity. Alternatively, 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 *Editor* 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

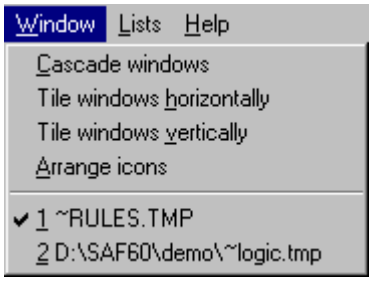
These options provide search and cursor positioning operations.

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

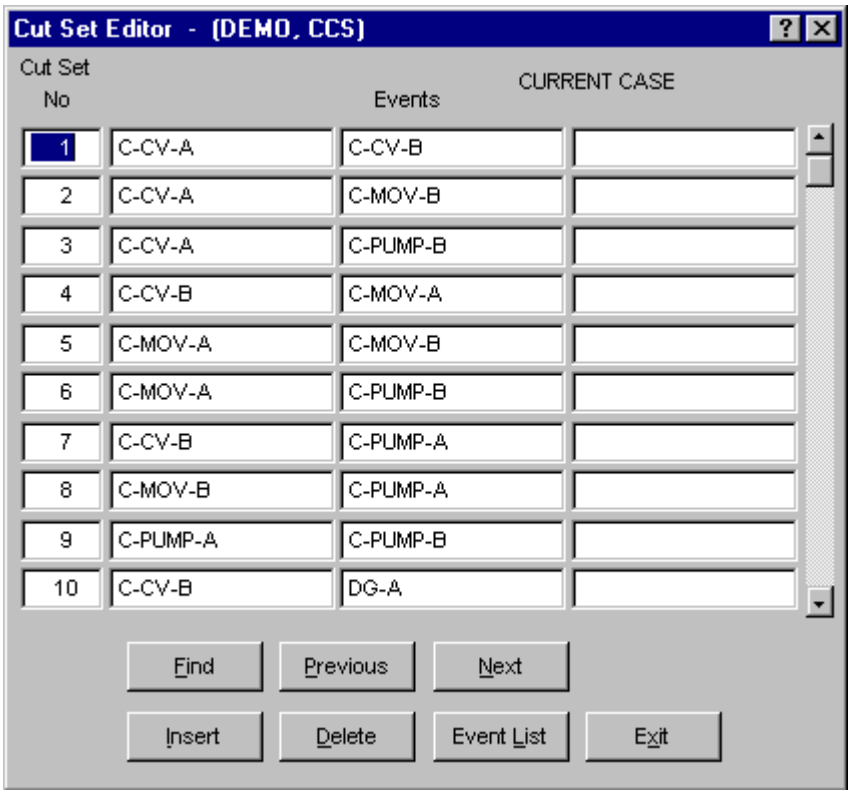
The *Cut Set Editor* provides you with the means to edit the fault tree (or sequence or end state) cut sets. SAPHIRE provides space for two sets of cut sets in the database: base case and current case. Whenever SAPHIRE generates cut sets, they are stored in the current case location. The user may save 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.



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.

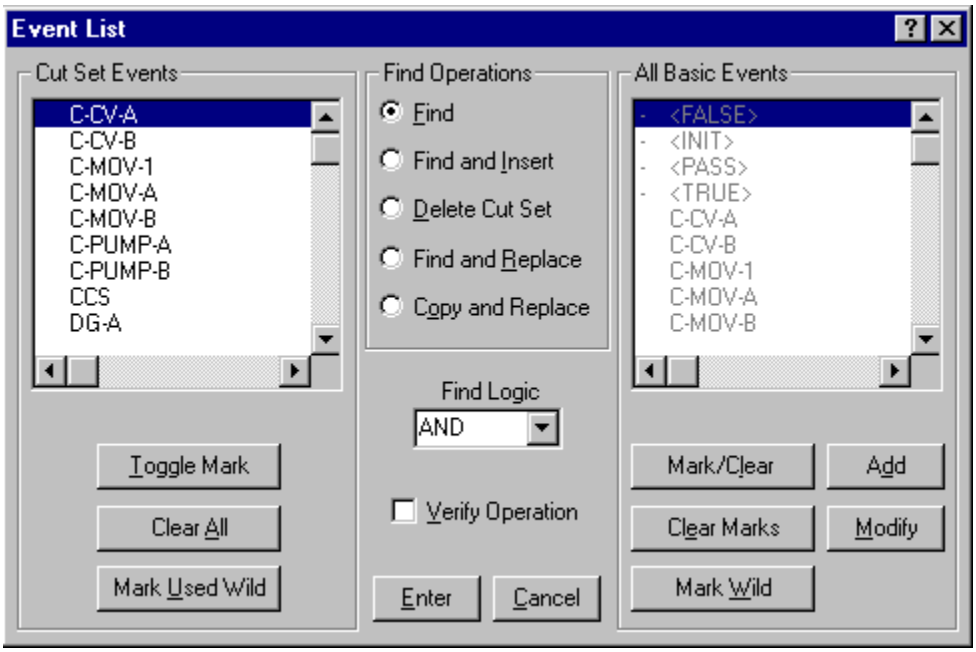
5.10.5.2 Find

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 *Event List* 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

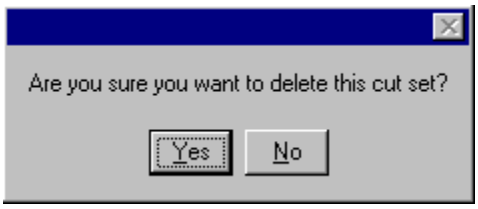
This option allows you to delete an existing cut set or basic event. If the I-bar is in a *Cut Set No* cell (i.e., the first column of cells on the *Cut Set Editor* dialog), then the entire cut set will be deleted. If the I-bar is in one of the *Events* cells, then the event in that cell will be removed 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.

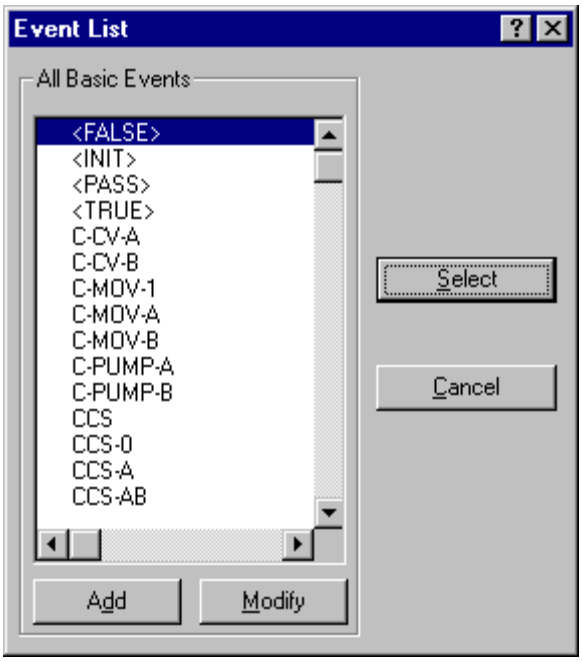
5.10.5.5 Event List

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

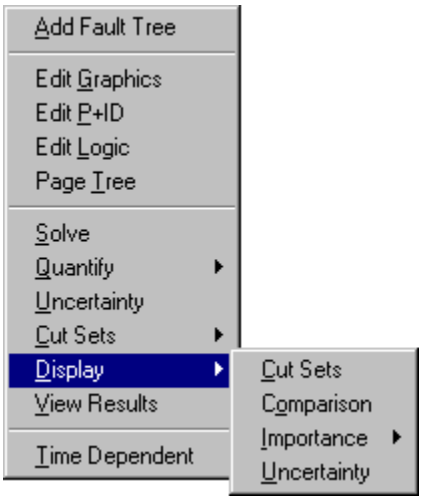
5.11.1 Displaying Fault Tree Results

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.

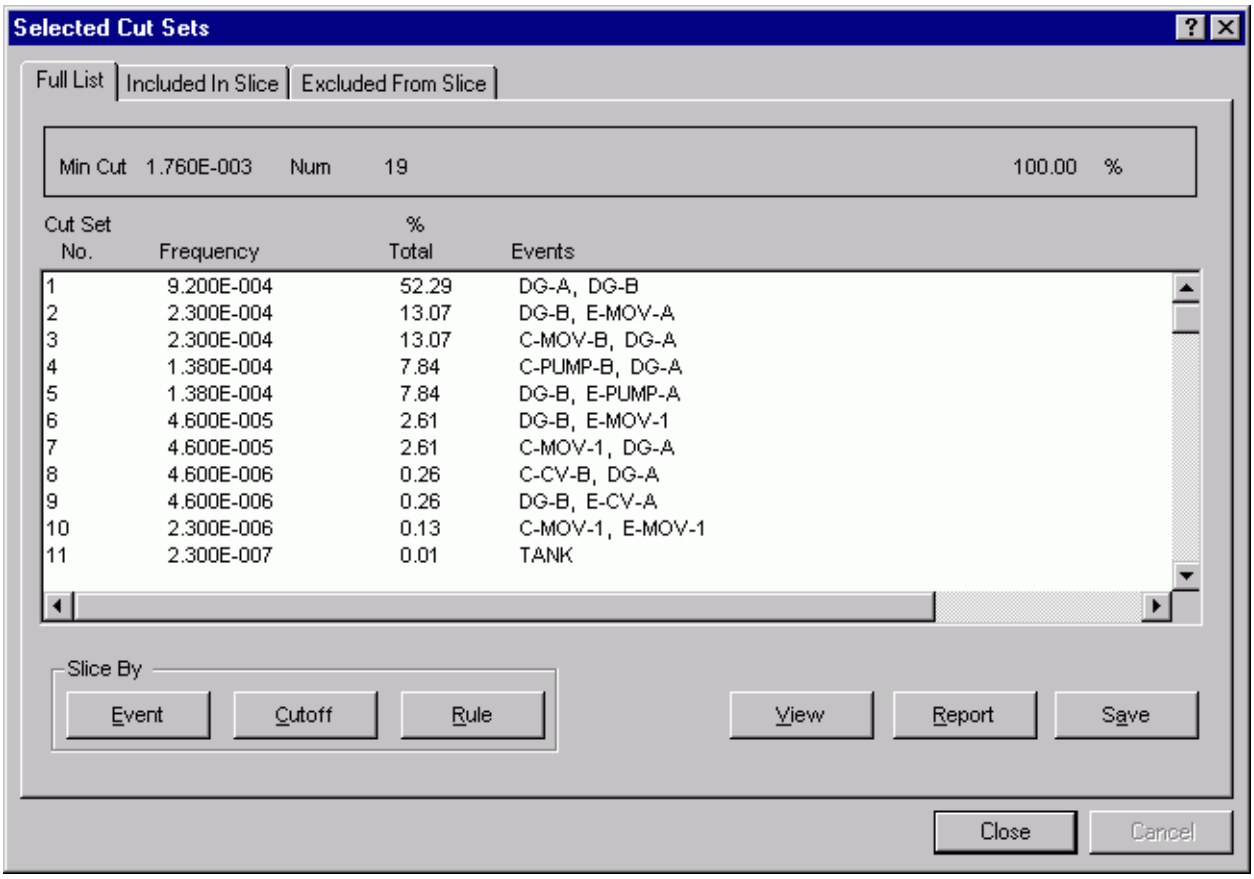
When the dialog is invoked, the fault tree (or sequence or end state) cut sets are shown. Displayed with each cut set is its associated percent of contribution to the minimal cut set upper bound, its probability (or, perhaps, frequency), and the event names that make up the cut sets. Also displayed are 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.



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 *Selected Cut Sets* dialog.

5.11.2.2 Path Search

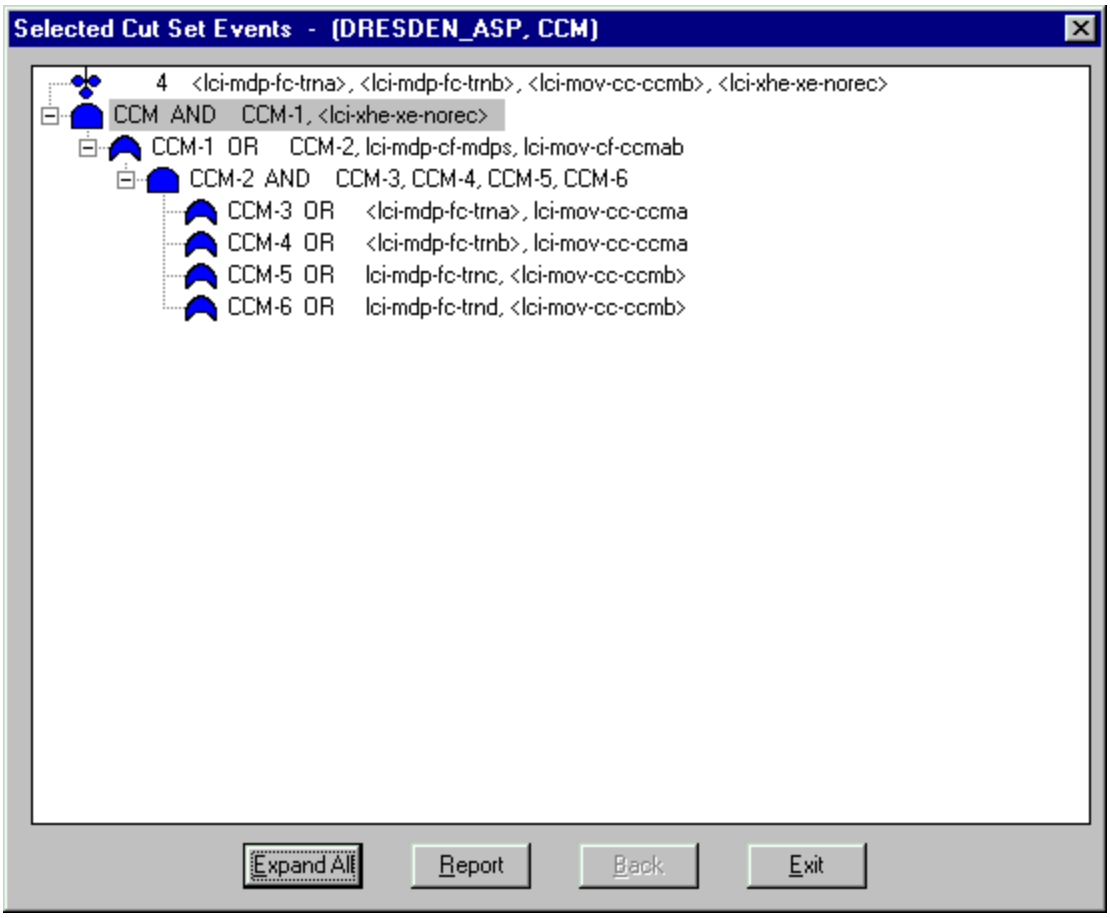
PURPOSE

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.

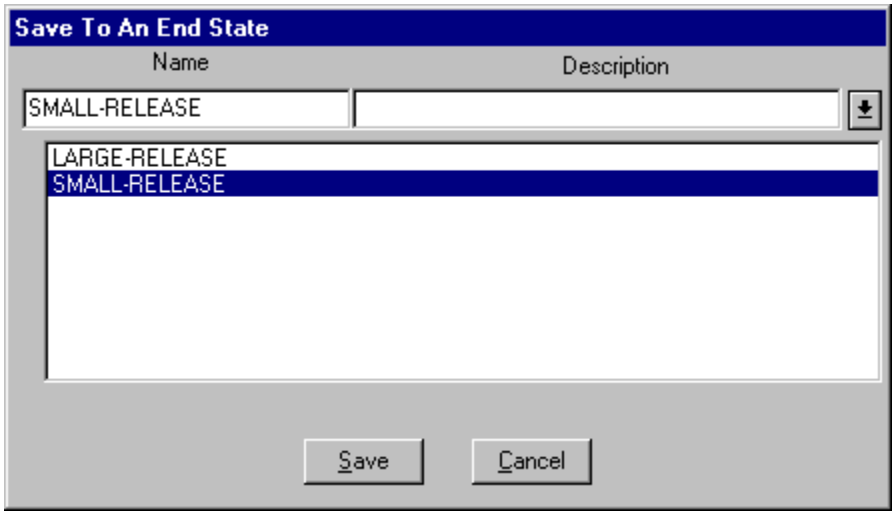
5.11.2.4 Save

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

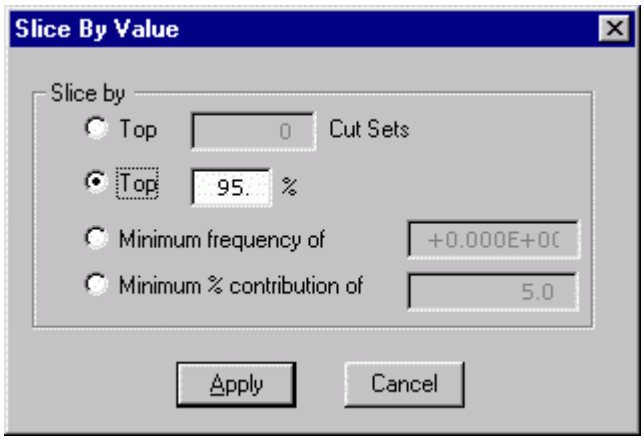
5.11.2.5.1 Slice By Cutoff

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

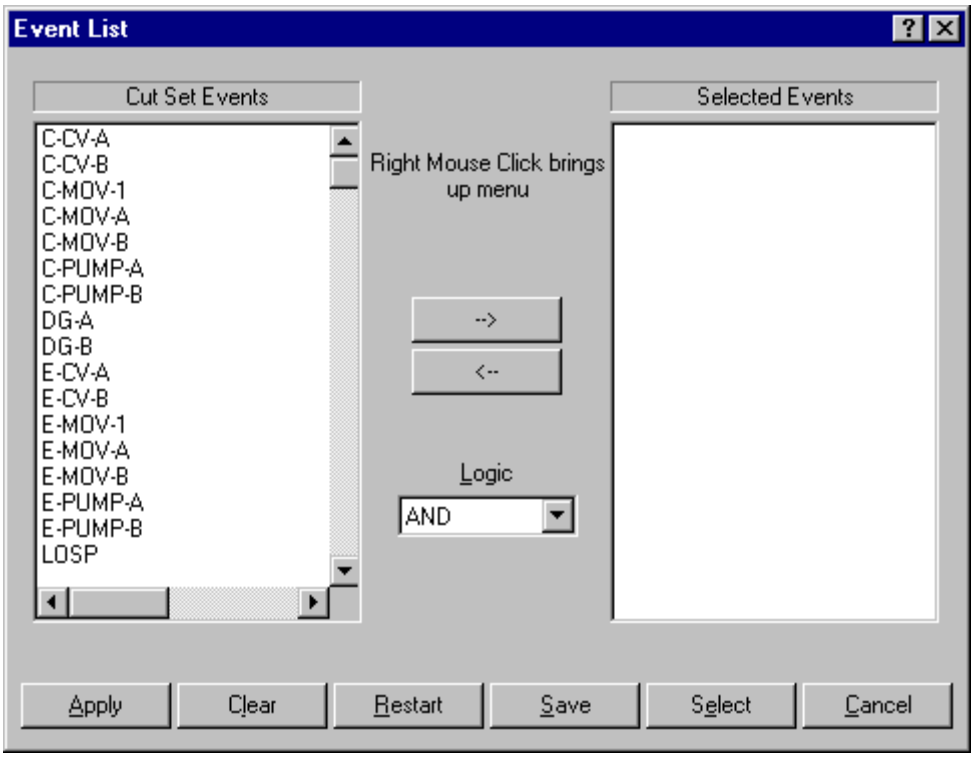
5.11.2.5.2.1 Slice By Event

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 *Selected Events* 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 *Selected Events* list (i.e., clear the qualification criteria).
Restart -	Restore the original cut sets and clear the qualification criteria. The *Event List* dialog will be closed and the *Included In List* and *Excluded From List* 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 *Selected Events* list.
Cancel -	Close the *Event List* 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

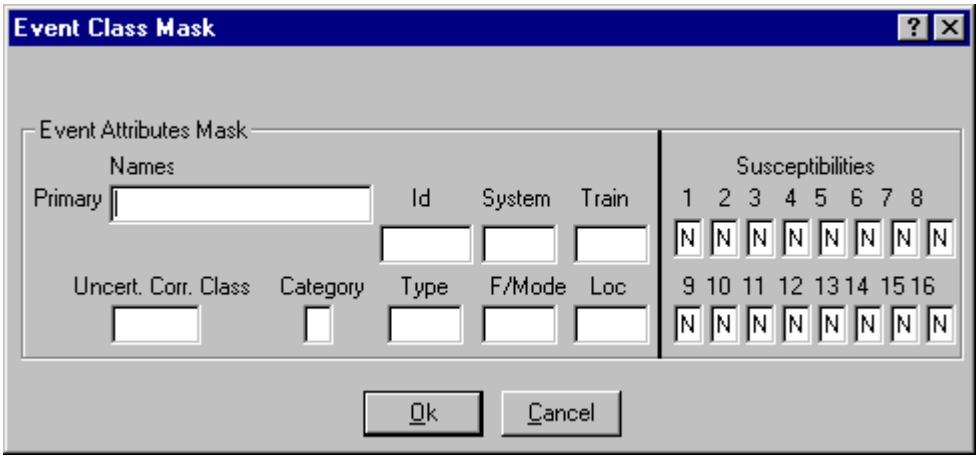
1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.

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.



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.

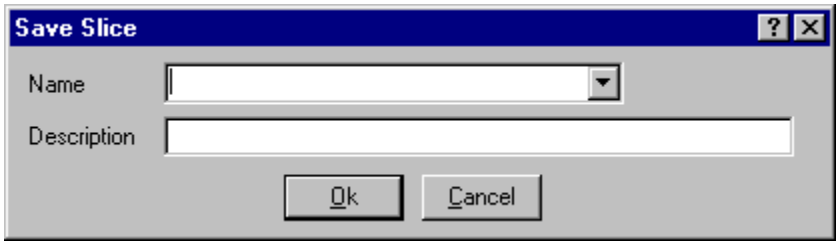
5.11.2.5.2.3 Save Slice

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 F**ault 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.

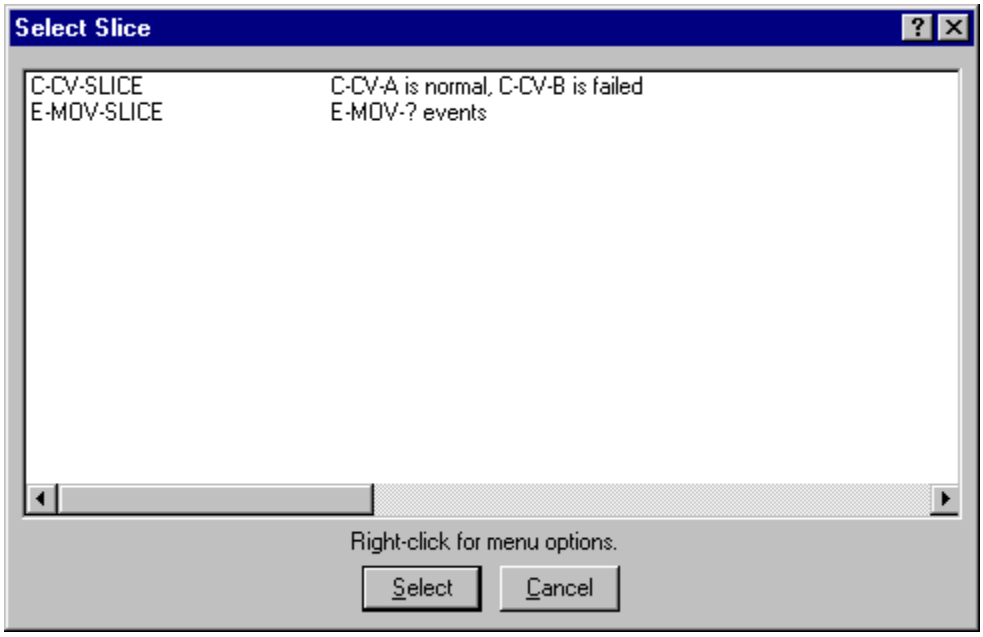
5.11.2.5.2.5 Select Slice

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.

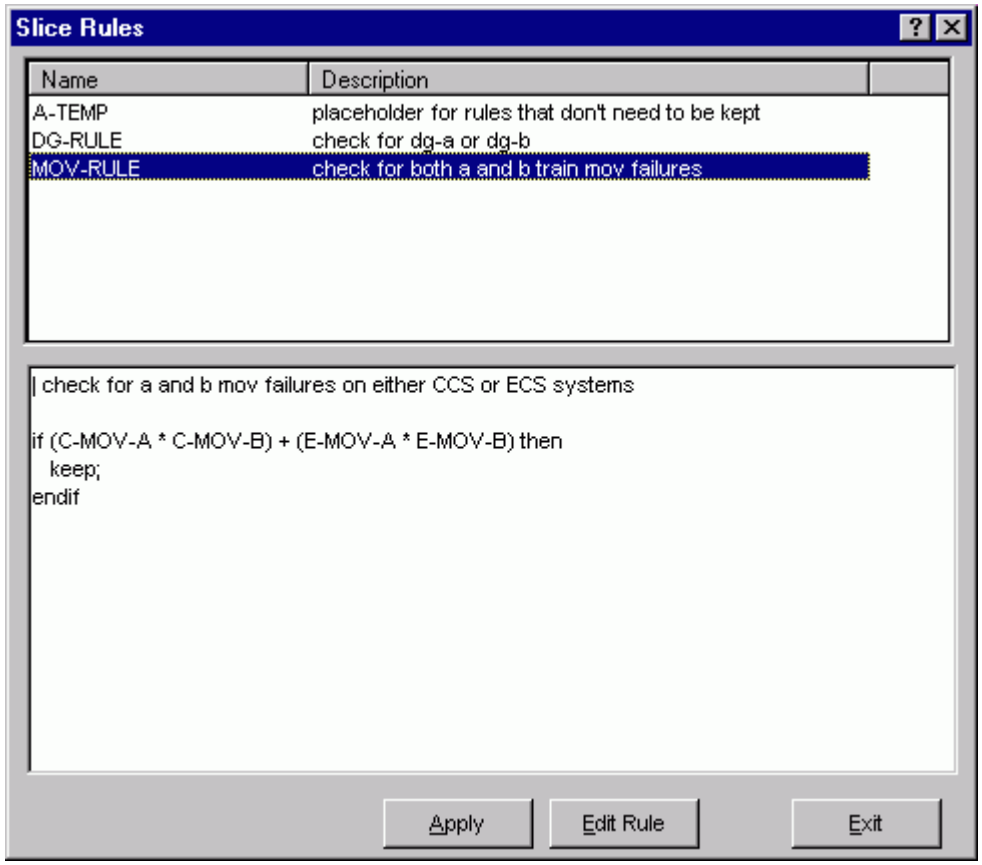
When the dialog is invoked, a list of slice rules is displayed. The highlighted rule is previewed in the bottom text area. To add/modify/delete a slice rule name and description, right click and select the appropriate menu option. To edit a rule, choose the **Edit Rule** button. To apply a rule to the 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.

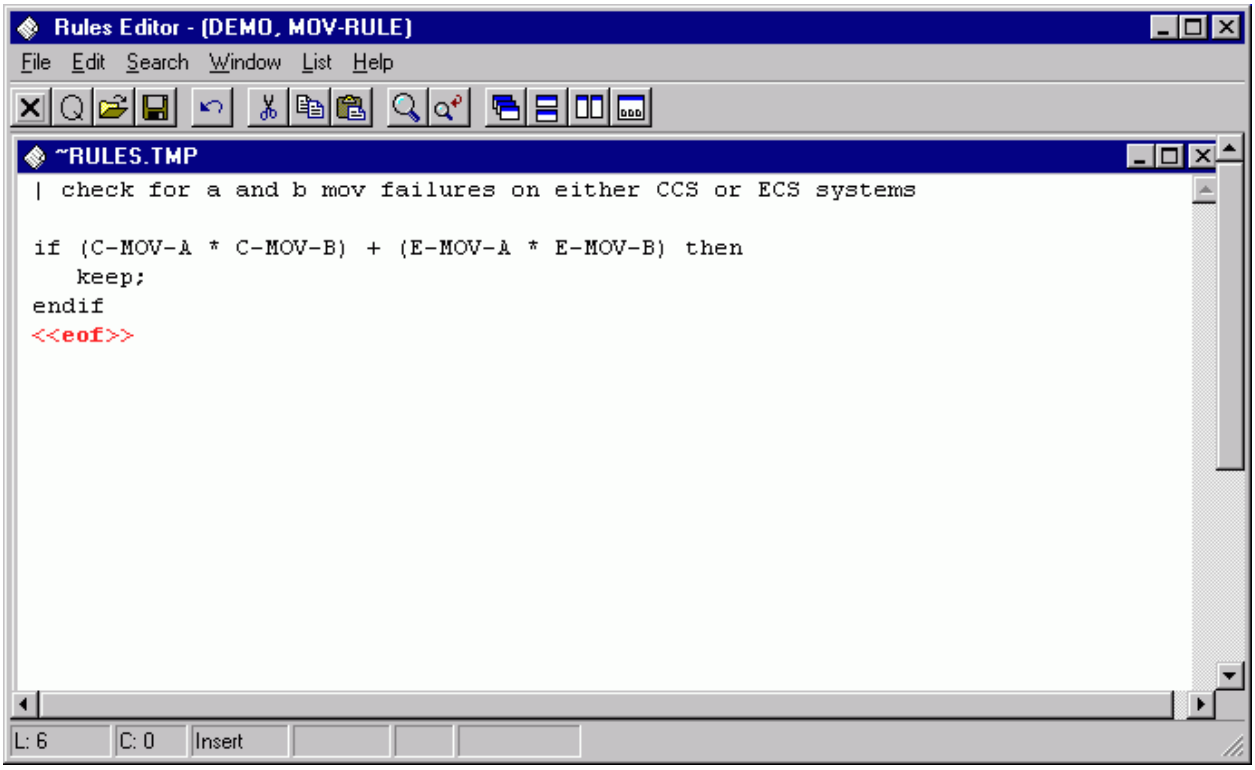
The slice rules are entered in a free-form text editor within SAPHIRE. The editor options and rule syntax are similar to that of SAPHIRE's recovery rules. However, unlike to recovery rules, slice rules are not tied to the fault tree, sequence(s) or end state(s) whose cut sets are currently displayed. (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 *Editor* 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

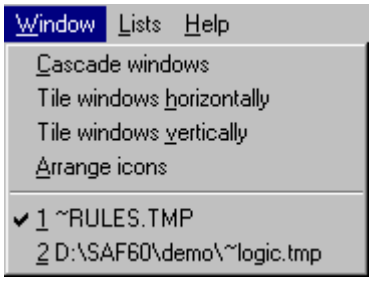
These options provide search and cursor positioning operations.

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

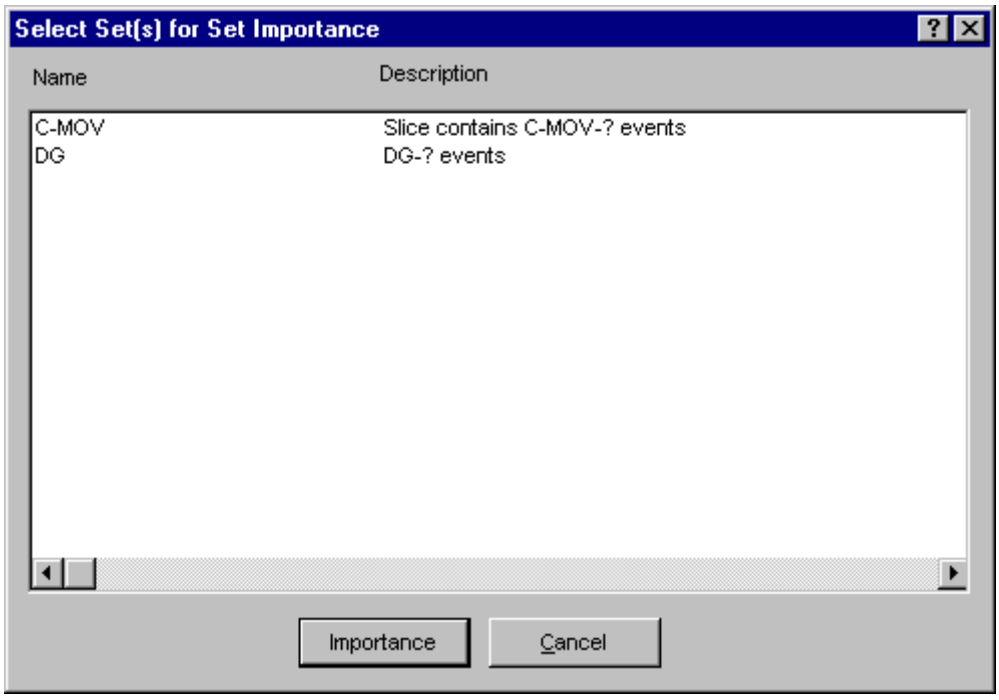
5.11.2.6.1 Sets Importance

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.

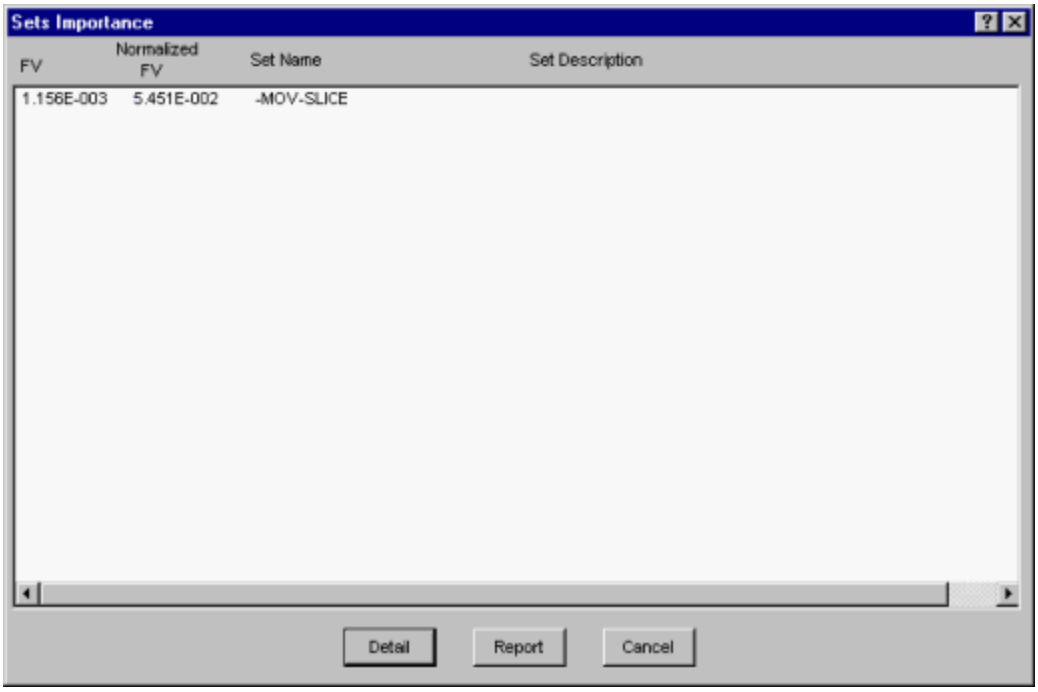
STEPS

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

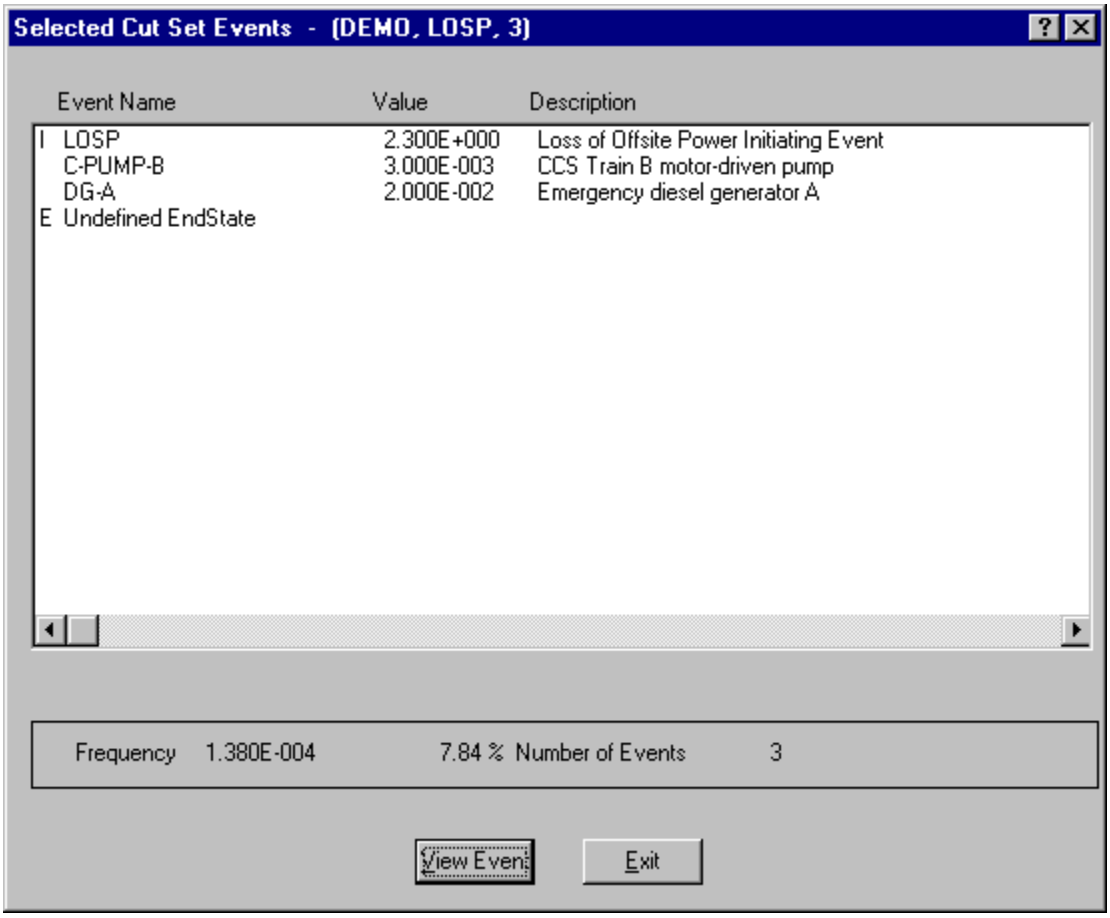
PURPOSE

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.



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.

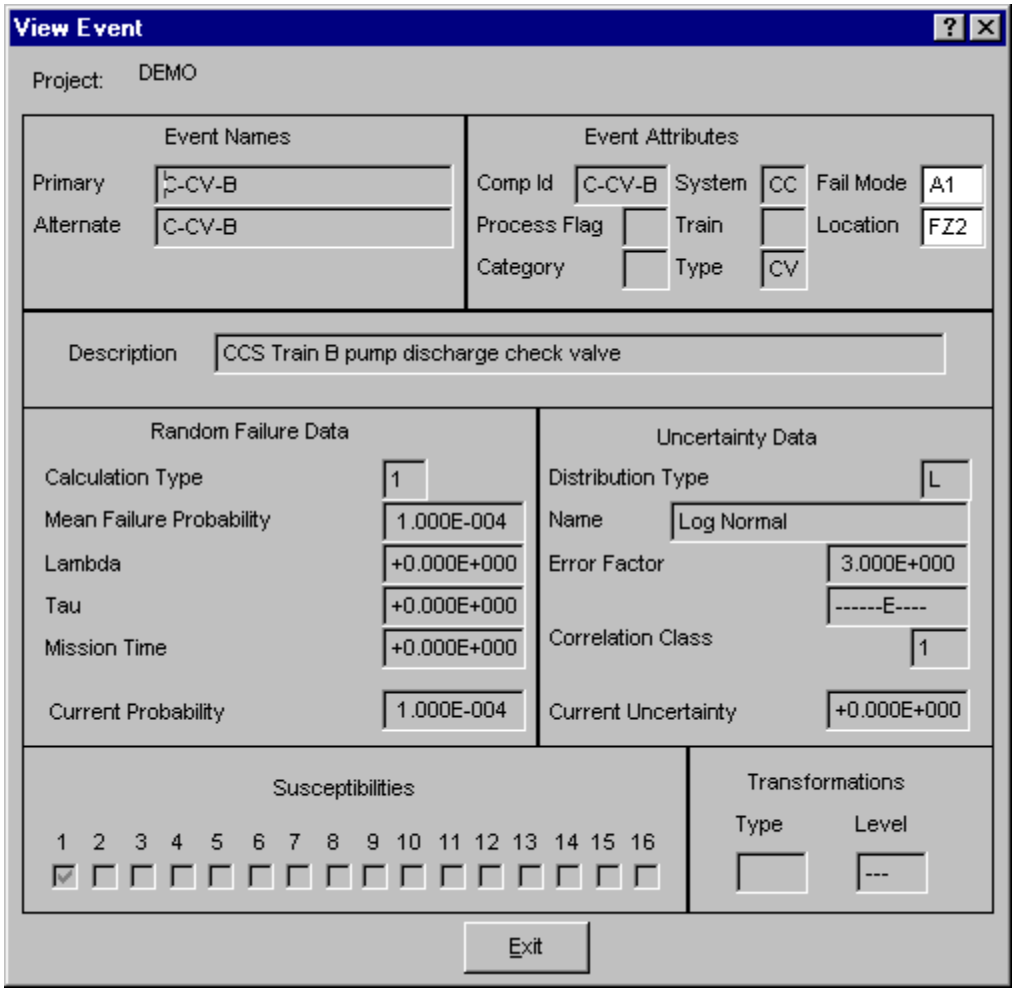
5.11.2.7.2 View Event

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.



Information on this dialog is for display only and cannot be modified.

5.11.2.8 Report Dialog

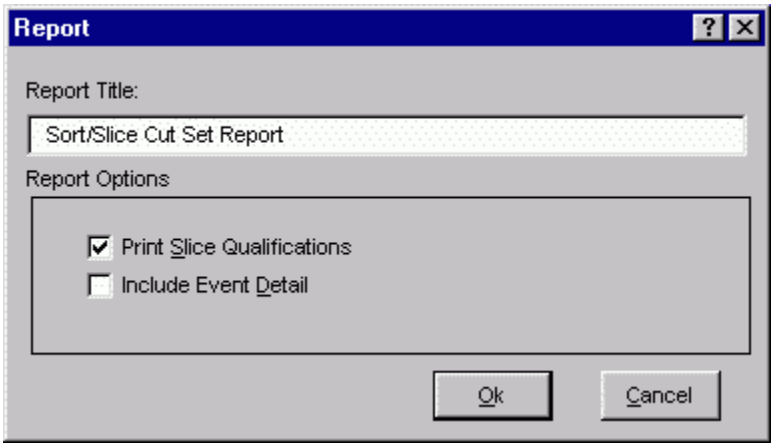
5.11.2.8.1 Cut Set Report

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.

5.11.3 Comparing Cut Sets

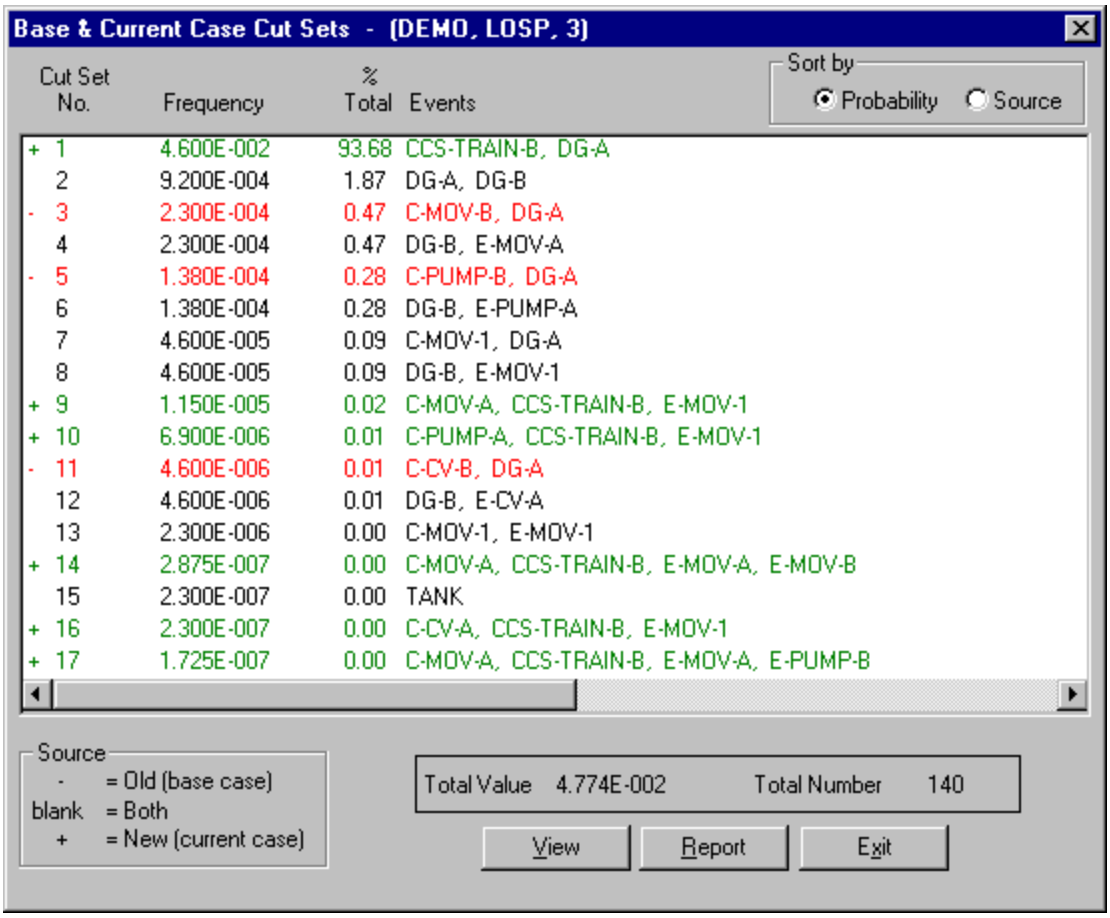
5.11.3.1 Cut Set Comparison

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.



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.

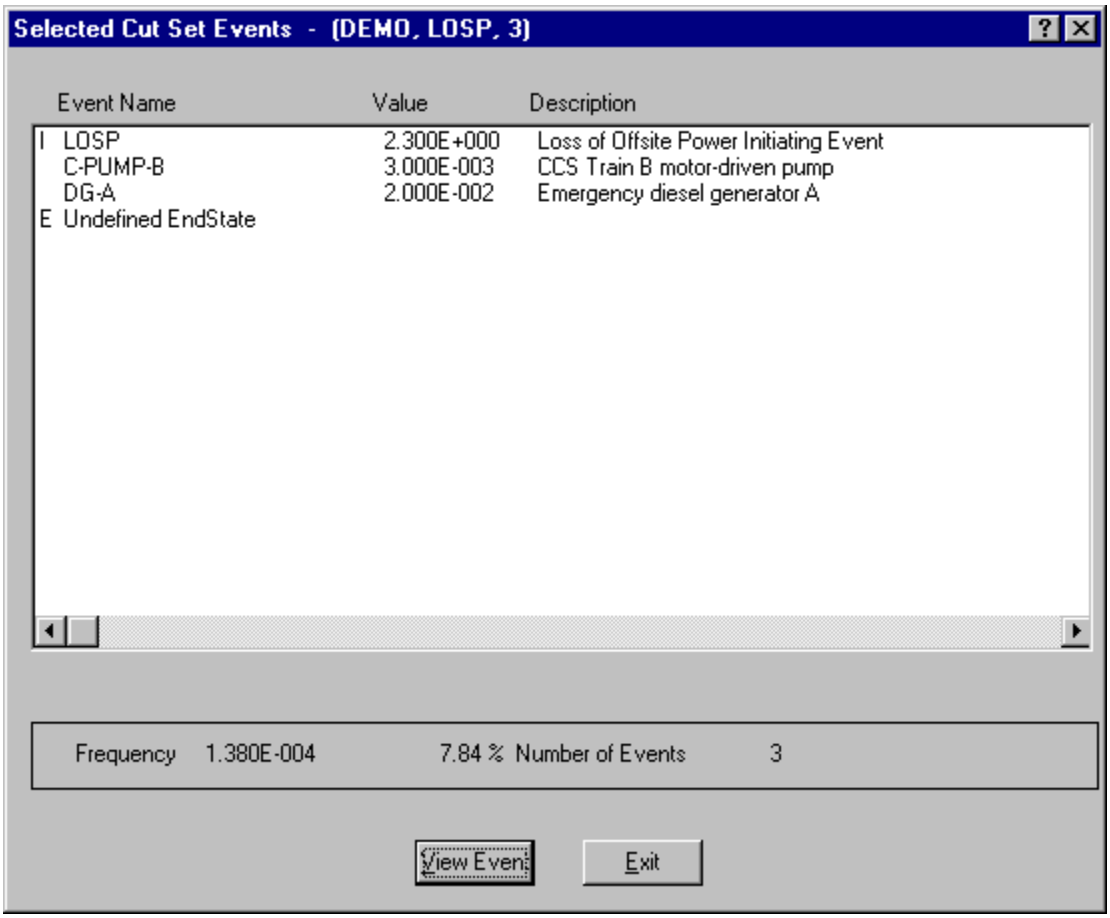
5.11.3.2 View Cut Set

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.



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.

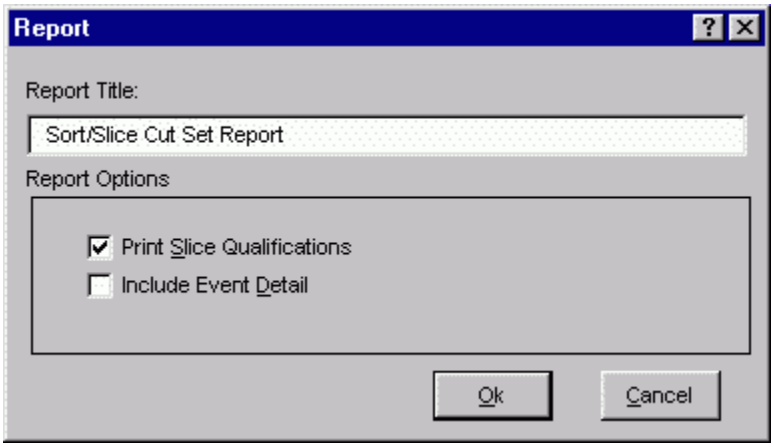
5.11.3.3 Cut Set Report

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

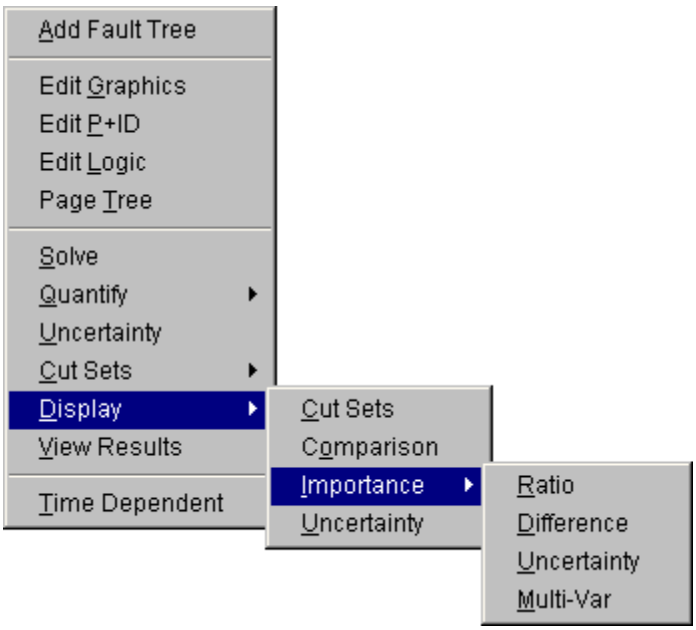
Importance measures provide "reliability-worth" information about basic events appearing in the cut sets for a fault tree or accident sequence. The "importance" for a basic event is essentially the event's contribution to the overall top event probability (for fault trees) or sequence frequency (for 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

$$\mathbf{FV = F(i)/F(x)}$$

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

$$\mathbf{FV = 1 - F(0)/F(x)}$$

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 or 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 ith basic event, and σ_i^2 is the variance of the uncertainty distribution for the ith 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 ith 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

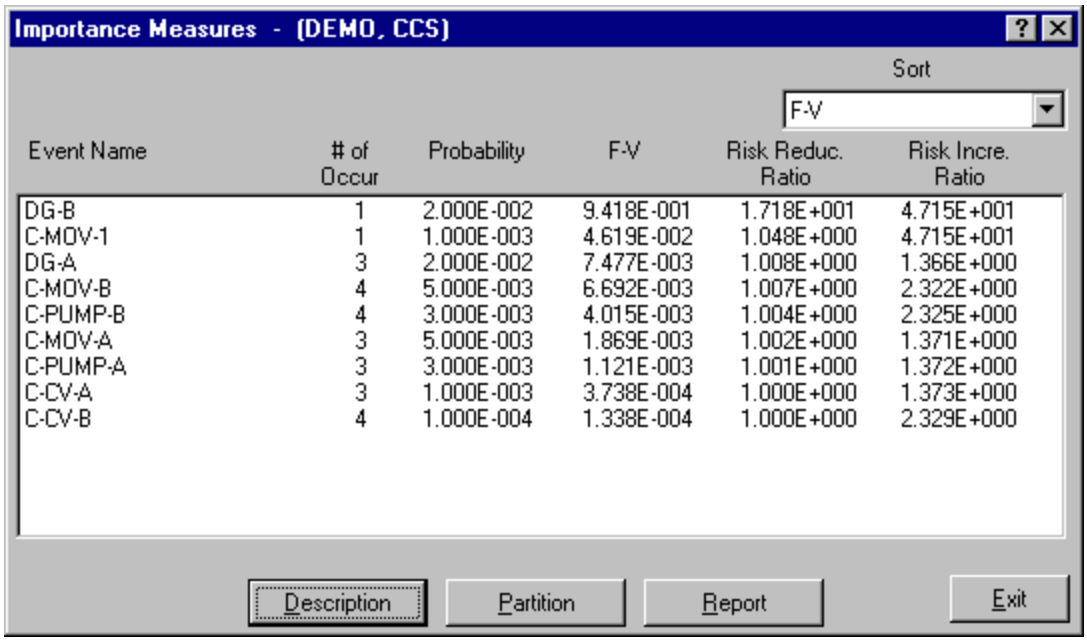
PURPOSE

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, Mult-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.



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.

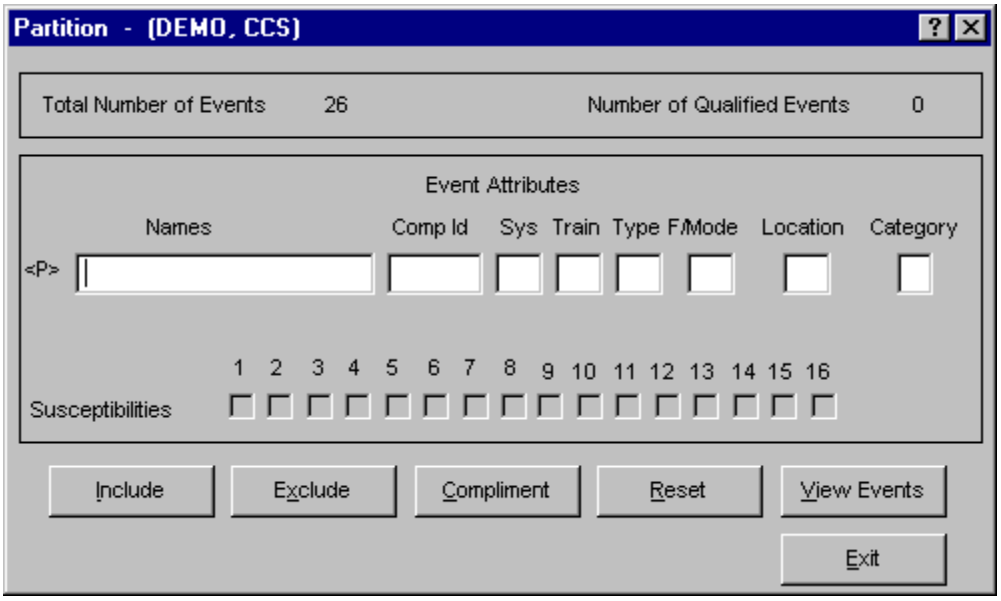
5.11.4.8.2 Importance Results Partition

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.



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.

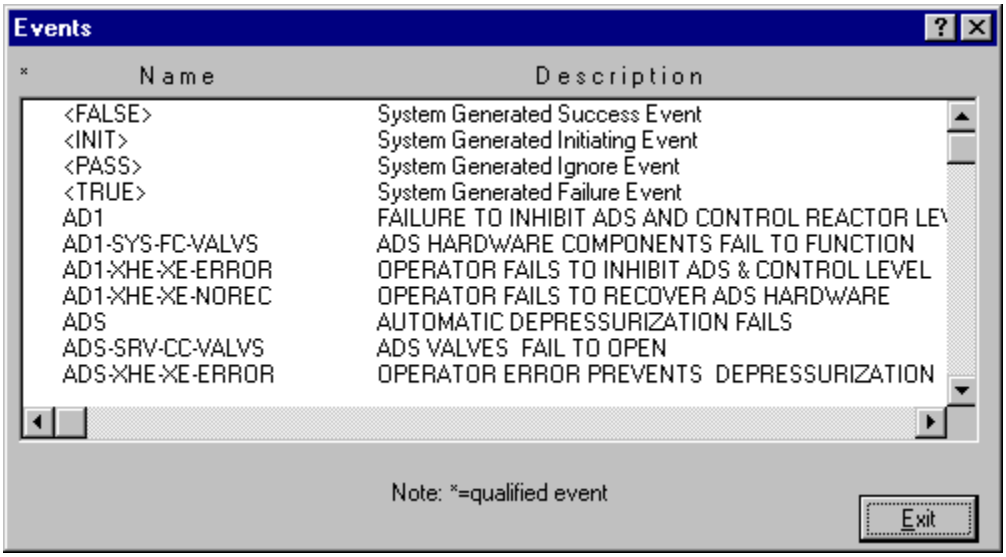
5.11.4.8.3 View Events

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

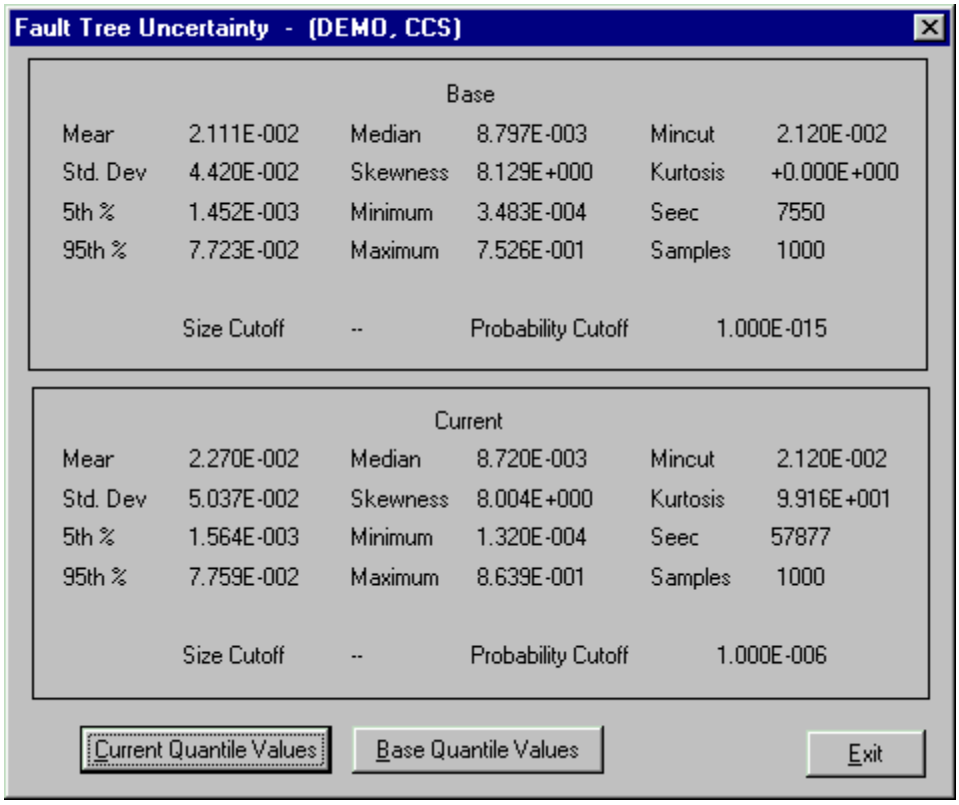
PURPOSE

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.



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.

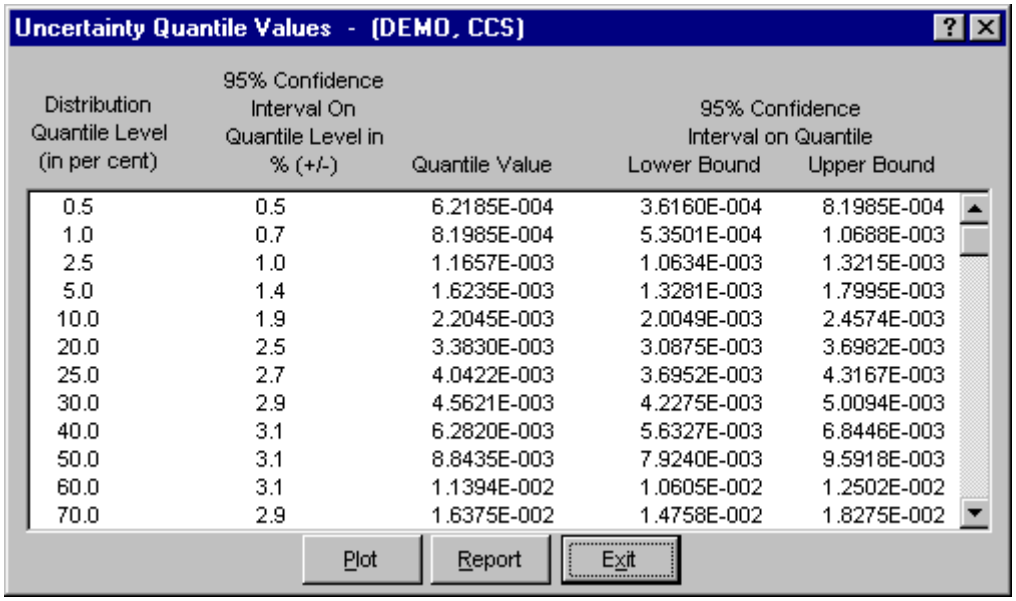
5.11.5.2 Uncertainty Quantile Values

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 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.

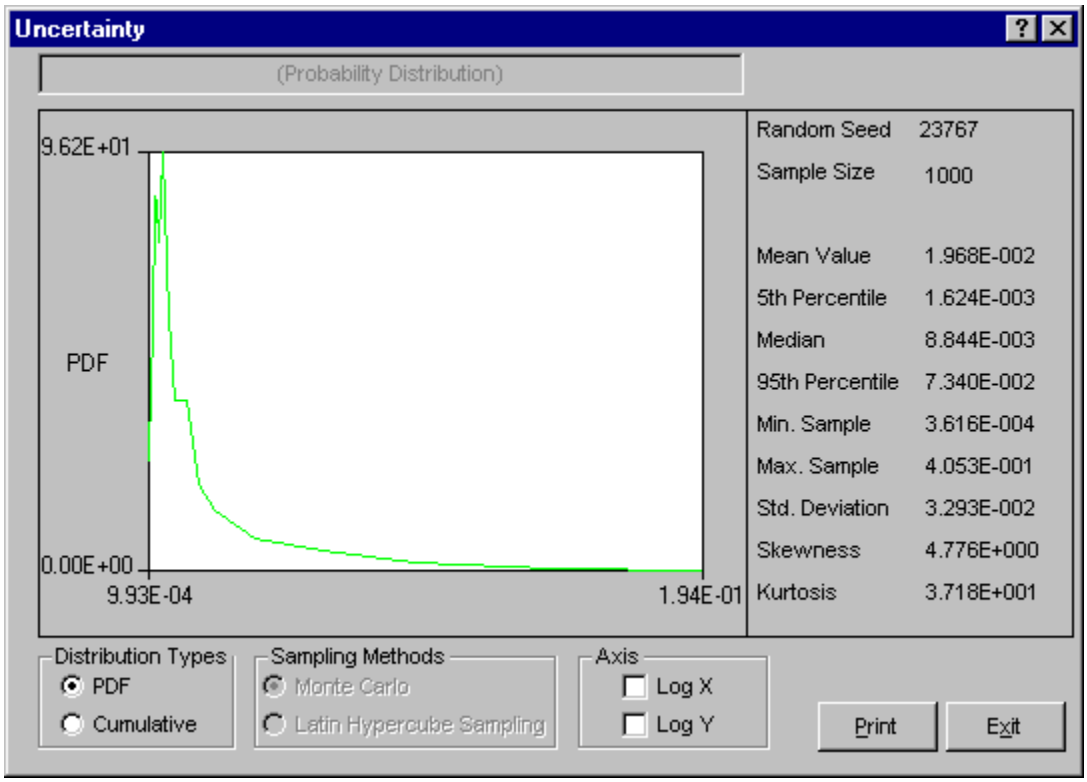
5.11.5.3 Plot Uncertainty Quantile Values

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

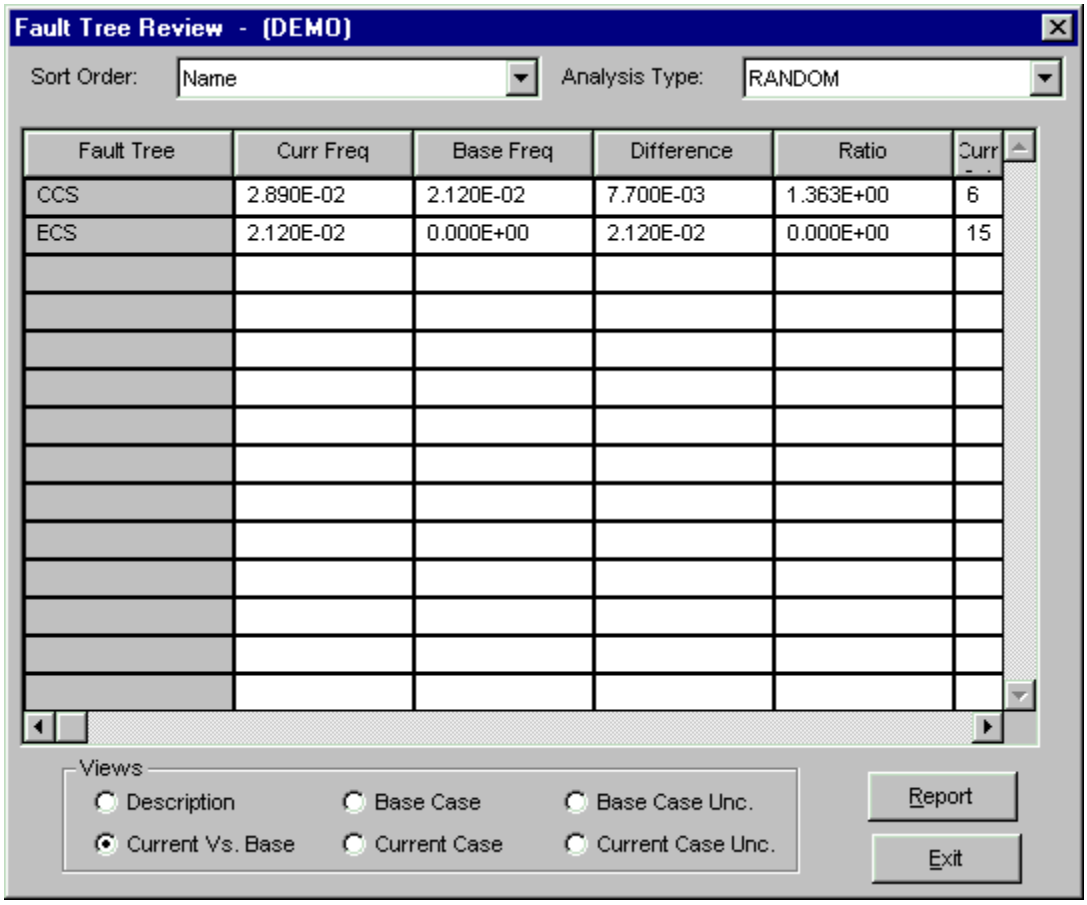
5.12.1 Viewing Fault Tree Data

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.



The selected fault trees are displayed in this dialog. The *Fault Tree* column contains the primary names of the fault trees. Other columns' titles and data vary based on the current "View".

Sort Order - Select from the drop-down list to sort results by Name, Base case min cut frequency, Current case min cut frequency, Delta min cut (base-current), Base case mean frequency, Current mean frequency, Delta mean frequency.

Report - Produces a report of the data currently displayed. The output can go to the *Report Viewer*, a printer, or a file.

Exit - Close the *Fault Tree Review* dialog.

5.12.2 View Options

Description - Includes the full description. (60 character maximum)

Current Vs. Base - Includes the current case cut set probability, base case cut set probability, the probability difference (current - base), ratio, current case cut set count, base case cut set count, the cut set count difference (current - base).

Base Case - Includes base case values for cut set probability, mean, 5th percentile, median, 95th percentile, probability truncation, and size truncation used when solving.

Current Case - Includes current case values for cut set probability, mean, 5th percentile, median, 95th percentile, probability truncation, and size truncation used when solving.

Base Case Uncertainty - Includes base case values for cut set probability, mean, 5th percentile, median, 95th 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, 5th percentile, median, 95th percentile, minimum, maximum, standard deviation, skewness, kurtosis, sample size, and random number seed.

5.13 Time Dependent Analysis

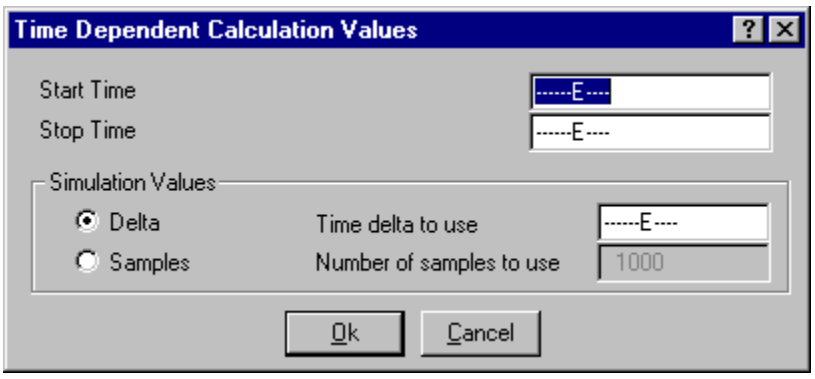
5.13.1 Time Dependent Analysis

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.



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.

6. EVENT TREE ANALYSIS

6.1 Event Tree Analysis

PURPOSE

An event tree is a model of relationships of failed or successful fault tree tops.

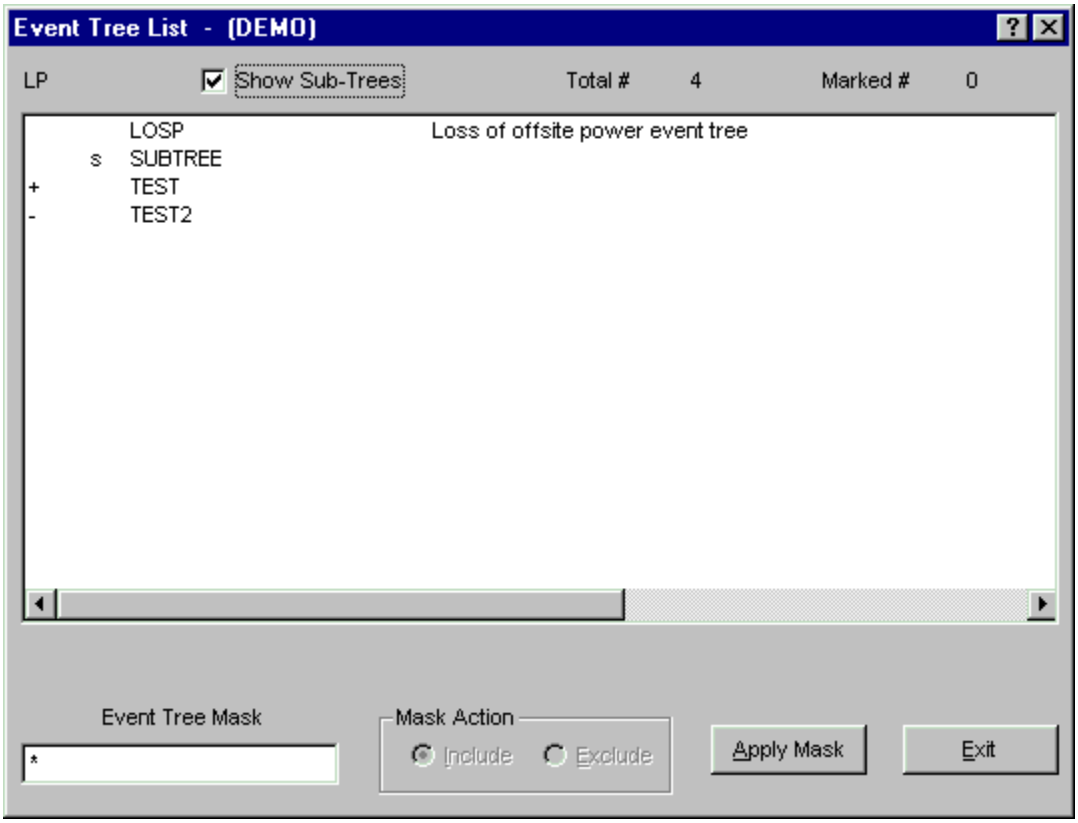
This option allows you to graphically build and edit event trees and edit sequence logic. The ability to define linkage and partition rules is also provided. The *Event Tree List* shows the event trees in the current project.

KEY TO FLAGS

Located to the right of each event tree is a set of flags that indicate the status of the event tree:
A "+" in the first column indicates that event tree linkage rules exist.
A "+" in the second column indicates event tree level partition rules exist.
A "-" in either column indicates that the respective rules exist but are not compiled.
An "**s**" indicates that an event tree is a sub-tree (a tree that is transferred to), rather than a front-line event tree.

STEPS

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



From this dialog, you can select event trees using the mouse or the Mask feature. The following functions may be accessed from the pop-up menu:

Show Sub-Trees -	When checked, include sub-trees in the list of event trees.
Pop-up Menu Options -	The following functions may be accessed from the pop-up menu.
Add Event Tree -	Add a new event tree record to the current project database.
Edit Graphics -	Build and edit event tree diagrams.
Edit Rules -	Define linkage rules.
Edit Partition Rules -	Define the end states to be associated with each cut set in a sequence.
Link Trees -	Generate sequence logic.
Edit End States -	Edit event tree sequences after an event tree has been created.

6.2 Event Tree Graphics

6.2.1 Event Tree Graphics

PURPOSE

This option allows you to construct or edit an event tree diagram from the graphical *Event Tree Editor*. An event tree is a model of relationships of failed or successful fault trees or tops. An event tree diagram is a graphical representation or picture of that model.

You may start building the diagram from scratch or from an existing file to generate or modify logic. The initiating event, basic events, sequences, and end states are tied to the SAPHIRE database. They are automatically added to the database as the event tree is being constructed. Various editing functions such as cut, paste, and copy along with file functions such as save and print are provided.

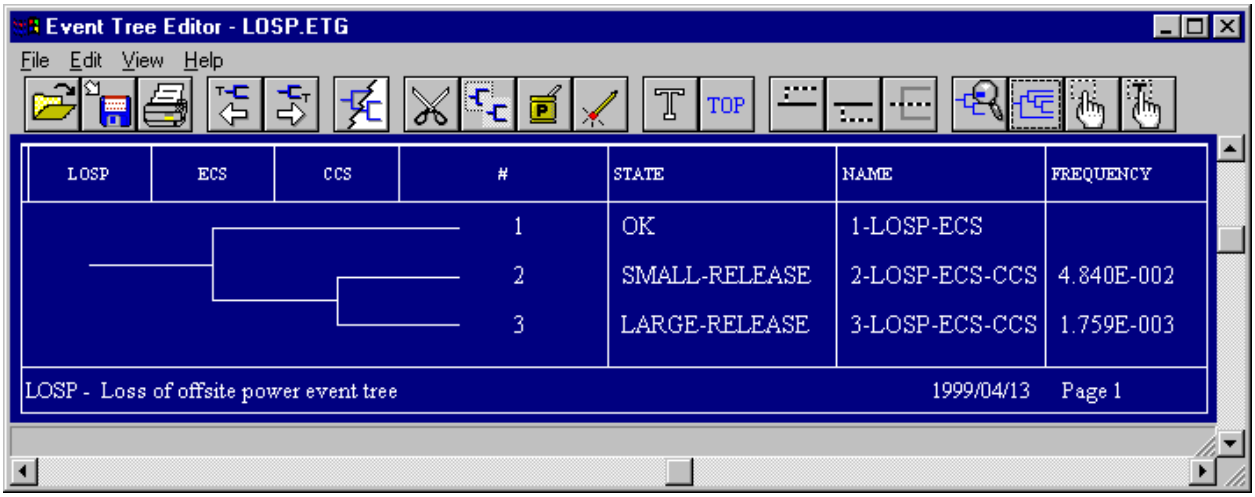
STEPS

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

   To create a new diagram:
   Do not highlight an event tree

   To edit an existing file:
   Highlight the desired event tree in the list

2. Right-click to invoke the pop-up menu and choose **Edit Graphics**. The *Event Tree Editor* will be displayed. The name of the current event tree will be displayed in the title bar.



Note that an up branch indicates success of the top event while a down branch indicates a failure of the top branch.

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 parameters such as zoom, refresh, etc.
Help - SAPHIRE on-line help.

Toolbar Buttons

	Open an event tree graphics file from disk.		Erase
	Save the event tree graphics file to disk.		Create a text object.
	Print the event tree graphics file.		Add a Top
	Backward transfer		Add branch above
	Forward transfer		Add branch below
	Page tree		Pass
	Cut		Zoom
	Copy		Fit to window
	Paste		Select the pick cursor
			Select the text pick cursor

6.2.2 Event Tree Graphics Definitions

PURPOSE

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

Object - The building blocks of an event tree diagram. They include tops or fault trees, sequence branches or paths (lines that indicate the failure and success of the tops), end states, and descriptive text. Each object has attributes that may include color, size, and height.

Pick Box - An invisible rectangle that surrounds each sequence branch, top and end state. It defines the area of the object where the mouse cursor must be to select the object.

Sequence Path - A sequence is a path through an event tree. Each sequence will have a unique number and can have a name, end state, and two other user-defined fields. The unique number will start at 1 and increment for every sequence that is added to the event tree. A sequence with only an initiator and one top will have two sequences: the top sequence will be sequence number 1, and the bottom sequence will be sequence number 2.

Branch Point - Directly beneath each top in the diagram is its branch point. A sequence is a line that connects one or more branch points. At these branch points, the sequence path line can continue as one line to the right (pass-through), or branch into two or more lines.

Branch - A path that begins at a branch point and continues to the right is a branch. All subsequent branches in a tree are included as a part of the branch.

Pass Through - A sequence path line that passes through a branch point without branching is a pass-through. This indicates that the corresponding top's success or failure has no impact on the sequence.

6.2.3 Event Tree Graphics - Mouse Usage

All mouse actions are defined in the SAPHIRE graphical *Event 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.

6.2.4 Selecting Objects

6.2.4.1 Selecting Objects

PURPOSE

Prior to manipulating (e.g., moving, copying, etc.) an object in an event tree diagram, that object or group of objects must be selected. By choosing the **Pick** button and thereby invoking the Pick cursor , you can select a branch , top , or end state .

6.2.4.2 Selecting a Branch

PURPOSE

This option describes how to select a branch.

STEPS

1. Invoke the Pick cursor by choosing the **Pick** button from the button bar.
2. Move the cursor on top of the branch you wish to select.
3. Click the mouse.
4. The branch will be redisplayed in the highlight color. The highlight color is defined as the inverse of the line color.

6.2.4.3 Selecting an End State

PURPOSE

This option describes how to select an end state.

STEPS

1. Invoke the Pick cursor by choosing the Pick button from the button bar.
2. Move the cursor on top of the end state you wish to select.
3. Click the mouse.
4. The end state will be surrounded by a pick box.

6.2.4.4 Selecting a Top or Fault Tree

PURPOSE

This option describes how to select a Top or Fault Tree.

STEPS

1. Invoke the Pick cursor by choosing the Pick button from the button bar.
2. Move the cursor on over the Top you wish to select.
3. Click the mouse.

4. The Top will be surrounded by a pick box.

6.2.4.5 Selecting Text

PURPOSE

This option describes how to select a Text object.

Because text is a free-floating object, its pick box can overlap those of Tops, Branches, or End States. Therefore, there is an order of selection. Because text has the lowest priority when selecting, there is a special text cursor that allows you to pick text that is superimposed on another object. If the 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 another object, you should follow the steps below.

STEPS

1. Invoke the Text Pick cursor by choosing the Text button button from the button bar.
2. Move the cursor over the text you wish to select.
3. Click the mouse.
4. The text will be surrounded by a pick box.

6.2.5 Adding and Modifying Objects

6.2.5.1 Add Top

PURPOSE

This option allows you to add a new top or fault tree to the current diagram.

STEPS

1. Choose the Top object button TOP from the button bar. The cursor will change to the Top cursor TOP.
2. Move the cursor to the top in the header that will follow the top you are adding. To add a top after the rightmost top, move the cursor to the right of the last top.
3. Click the mouse. The *Edit Event* dialog will be displayed

If you choose the **OK** button on the *Edit Event* dialog, the new top will be inserted into the diagram with all sequence paths passing through it.

6.2.5.2 Modify Top

PURPOSE

This option allows you to change the currently selected top or fault tree or its attributes.

STEPS

1. Select the top using the Pick cursor.
2. Right-click. The *Edit Event* dialog will be displayed.

6.2.5.3 Add Text

PURPOSE

This option allows you to add text to the diagram. Text can be "free-form" or attached to a branch, depending on the method selected.

STEPS

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

Note: The position of text added in this way is independent from the rest of the diagram. When the diagram is resized, the text may appear to move (actually, the text stays in place; the rest of the diagram moves). To add text to a relative position within the diagram, use the following steps.

STEPS

1. Select the branch where you wish to attach text.
2. Right-click to invoke the pop-up menu and select **Edit Text.**
3. The *Edit Text* dialog will be displayed.

Text added or modified in this way will be "attached" to the designated branch and will reposition itself to remain next to the branch whenever the branch moves.

6.2.5.4 Modify Text

PURPOSE

This option allows you to change existing text in the diagram.

STEPS

1. Select the desired text using the Text Pick cursor .
2. Right-click. The *Edit Text* dialog will be displayed.

   OR, if the text is attached to a branch, you may do the following:

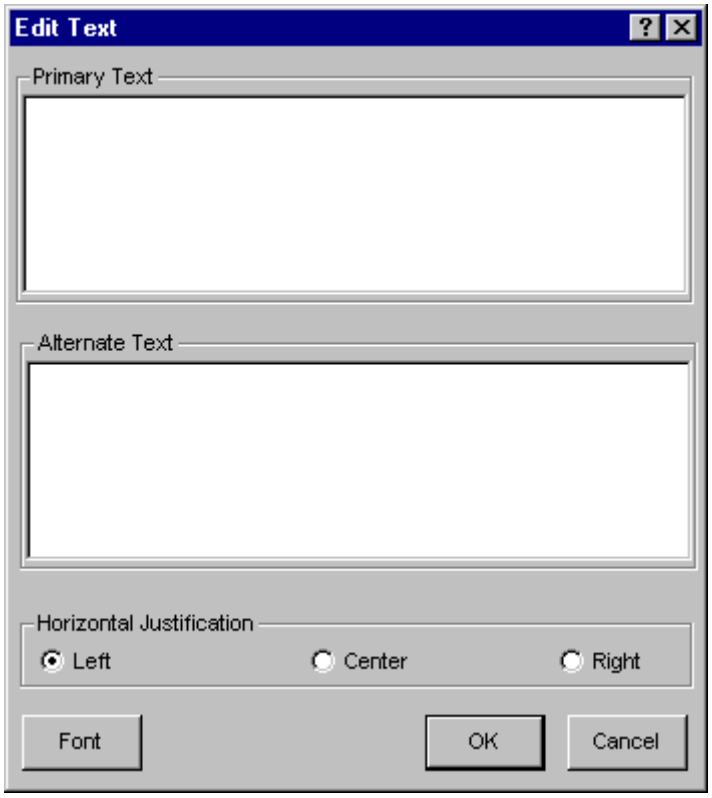
3. Select the branch containing the text you wish to edit.
4. Right-click to invoke the pop-up menu and select **Edit Text.** The *Edit Text* dialog will be displayed.

TIP: If the Edit Text dialog does not contain any text, then the text is not attached to the branch. In that case, use the first method to edit the text. If you would like to attach the text to the branch, first cut the text from the Edit Text dialog to the clipboard, then use the second method to bring up another Edit Text dialog, and finally, copy the text from the clipboard.

6.2.5.5 Edit Text Dialog

PURPOSE

This option allows you to set the attributes of a new text object or change the attributes of the currently selected text object. This dialog is displayed any time text is added or modified.



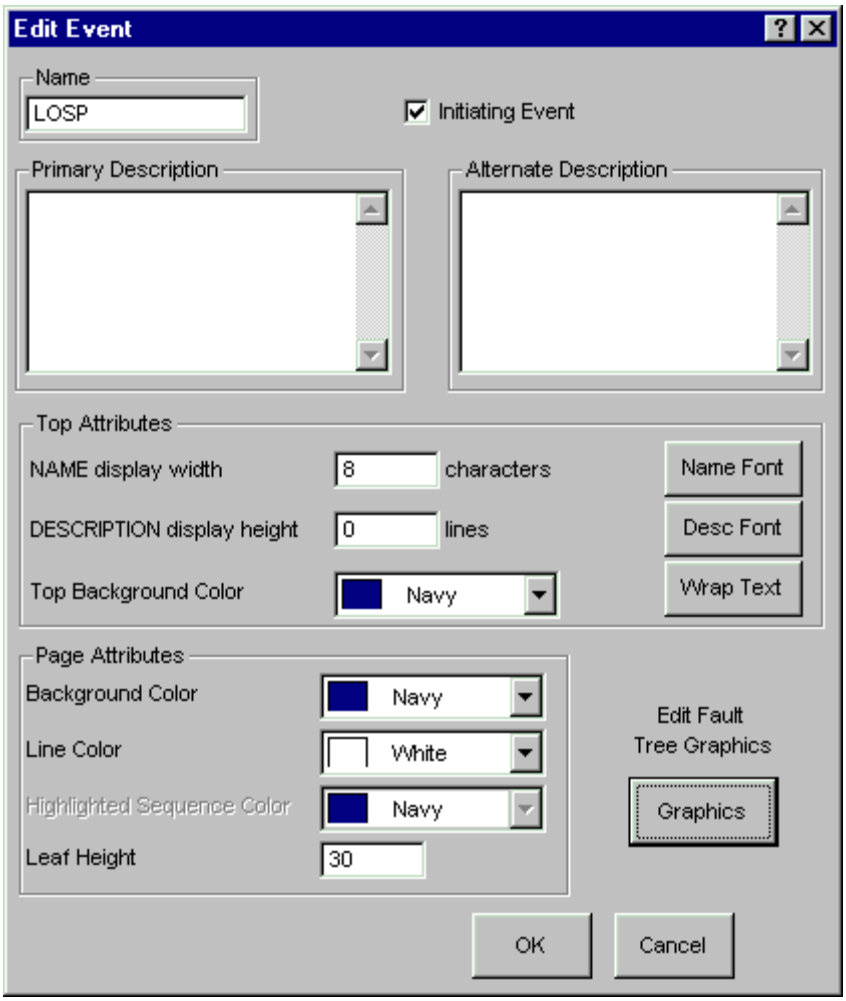
Primary Text -	Descriptive text for the event tree. Maximum of 600 alphanumeric, upper- and lowercase characters.
Alternate Text -	Descriptive text for the event tree. Maximum of 600 alphanumeric, upper- and lowercase characters. This feature allows text to be displayed and reported using a different locale. For this text to be displayed on reports instead of the Primary text, choose **Use alternate names for display** in the **Define Constants** option.
Horizontal Justification -	Set the horizontal alignment of the text.
Font -	Choose the font with which to display the text.
OK -	Close the *Edit Text* dialog and add or modify the text in the diagram.
Cancel -	Close the *Edit Text* dialog without adding or modifying the text in the diagram.

6.2.5.6 Edit Event

6.2.5.6.1 Edit Event Dialog

PURPOSE

This option allows you to set the attributes of a new event or change the attributes of the currently selected event. This dialog is displayed any time a top is added or modified .



OK - Apply the addition of or modifications to the top and close the *Edit Event* dialog.
Cancel - Close the *Edit Event* dialog without applying the addition of or modifications to the top.

6.2.5.6.2 Name

The name of the top. Maximum of 24 alphanumeric characters.

6.2.5.6.3 Description

Brief description of the top. Maximum of 80 alphanumeric, upper- and lowercase characters.

6.2.5.6.4 Initiating Event

Select this check box if the top is an initiating event. (Only enabled on the first or leftmost top.)

6.2.5.6.5 Wrap Text

Choose this button to automatically fit the text inside the description box, using the specified Description Display Height

6.2.5.6.6 Edit Fault Tree Graphic

Jump to the Fault Tree Graphic Editor to edit the fault tree graphic that corresponds to the event tree's selected top. The Event Tree Graphic Editor remains open, but is inaccessible until the fault tree editor is closed.

6.2.5.6.7 Highlighted Sequence Color

Select the color to be used for the highlighted sequence from the drop-down list. (Not yet available.)

6.2.6 Sequence Information Columns

6.2.6.1 Modify Sequence Column Location

PURPOSE

Change the location of a sequence information column in the diagram.

STEPS

1. Choose the Pick button .
2. Position the Pick cursor over the line to the left of the desired column.
3. The cursor will change to the Header cursor .
4. Drag the mouse to the desired location. The cursor will change to the Move Column cursor .
5. Release the mouse and the column will be moved to the new location.

6.2.6.2 Modify Sequence Information

6.2.6.2.1 Modify Sequence Information

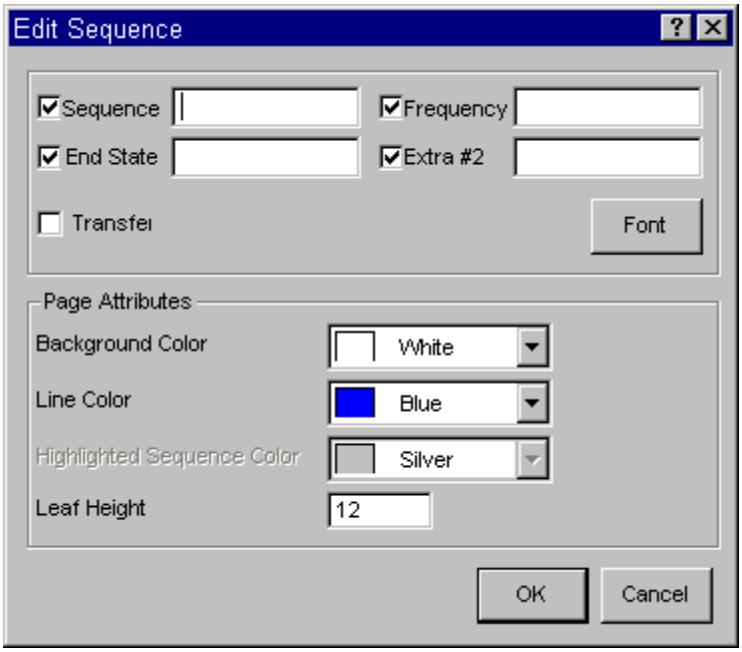
PURPOSE

This option allows you to change the data in the sequence information columns in the diagram.

Each sequence path has some additional information that can help define it. This information includes the name of the sequence, the end state of this sequence, its frequency, and a user-defined field. If the sequence continues through another event tree then the end state is the name of the transfer tree. You have an option to display this additional information and change its location.

STEPS

1. Select the desired sequence using the Pick cursor.
2. Right-click. The *Edit Sequence* dialog will be displayed.



OK - Close the *Edit Sequence* dialog and apply the changes the diagram.
Cancel - Close the *Edit Sequence* dialog without applying the changes to the diagram.

6.2.6.2.2 Sequence

The name of the sequence. Maximum of 24 alphanumeric characters. With both the check box to the left of this field selected ***and*** the **View | Show Sequence Names** option selected, the name in this field will be displayed.

6.2.6.2.3 End State

The name of the sequence end state. Maximum of 24 alphanumeric characters. With both the check box to the left of this field selected ***and*** the **View | Show End State Names** option selected, the name in this field will be displayed.

6.2.6.2.4 Frequency

Extra information column #1 for the sequence. Can contain the frequency for the sequence. Maximum 24 alphanumeric characters. With both the check box to the left of this field selected ***and*** the **View | Show Frequency** option selected, the data in this field will be displayed.

6.2.6.2.5 Extra #2

Extra information column #2 for the sequence. Maximum 24 alphanumeric characters. With both the check box to the left of this field selected ***and*** the **View | Show Extra-#2** option selected, the data in this field will be displayed.

6.2.6.2.6 Transfer

Check this box if the sequence continues in another event tree. The end state field contains the name of the transfer event tree.

6.2.6.3 Modify Sequence Column Header

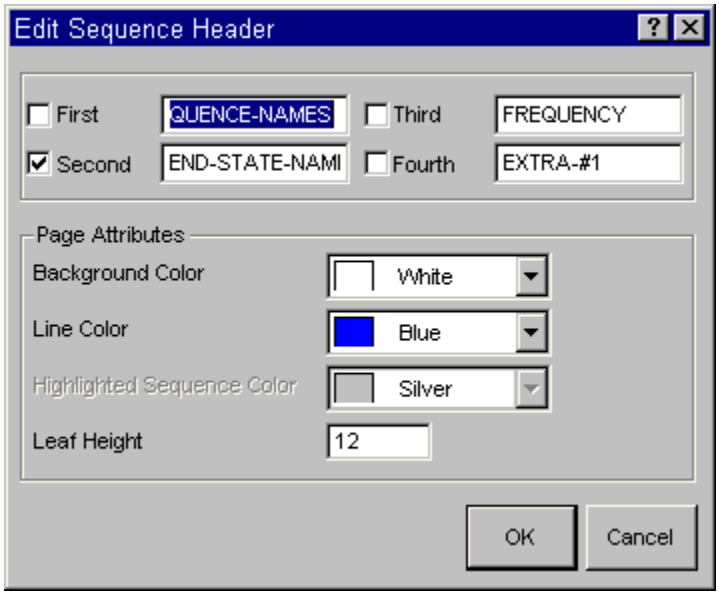
6.2.6.3.1 Modify Sequence Column Header

PURPOSE

Change the sequence information column headers in the diagram.

STEPS

1. Choose the Pick button .
2. Position the Pick cursor over the sequence column header area. (Ensure that a sequence is not currently selected or the *Edit Sequence* dialog will be displayed instead.)
3. Right-click. The *Edit Sequence Header* dialog will be displayed.



OK - Close the *Edit Sequence Header* dialog and apply the changes the diagram.
Cancel - Close the *Edit Sequence Header* dialog without applying the changes to the diagram.

6.2.6.3.2 First

The sequence column header. Maximum 24 alphanumeric characters. The data in this column will always contain the sequence names. Select the check box to the left of this field to display this column.

6.2.6.3.3 Second

The sequence end state column header. Maximum 24 alphanumeric characters. The data in this column will always contain the end state or transfer tree names. Select the check box to the left of this field to display this column.

6.2.6.3.4 Third

The header for the third sequence column. Maximum 24 alphanumeric characters. This column can contain whatever information you wish, however, options exist elsewhere in the program that will put the frequency of the sequence in this column. Select the check box to the left of this field to display this column.

6.2.6.3.5 Fourth

The header for extra information for the sequence. Maximum 24 alphanumeric characters. This column can contain whatever information you wish. Select the check box to the left of this field to display this column.

6.2.7 File Menu

6.2.7.1 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 -	Save the file in RTF, EMF, or WMF format.
Page Tree -	Copy the highlighted event tree branch to a new or existing diagram.
Forward Transfer -	Follow a transfer to another event tree.
Backward Transfer -	Display a previously viewed transfer.
Print -	Print the file in the current window.
Exit -	Terminate the *Event Tree Editor*. If changes have been made you will be queried if you want to save the file.

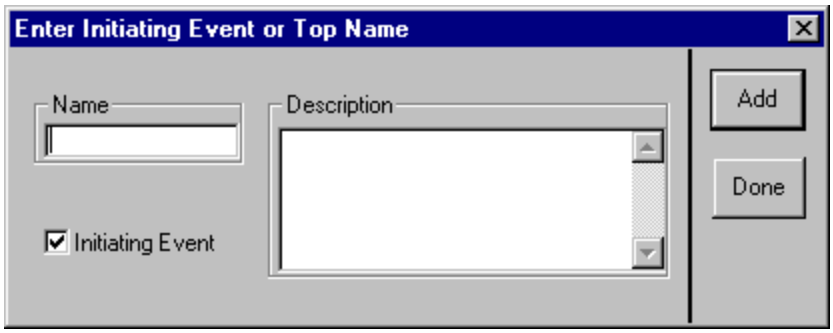
6.2.7.2 New

PURPOSE

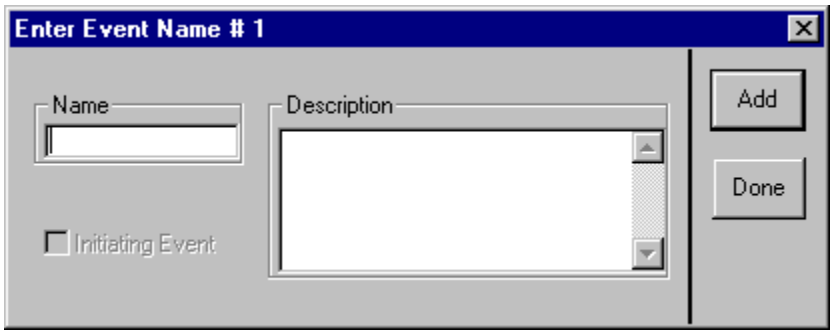
This option will allow you to clear the window and begin building a new diagram.

STEPS

1. From the *Event Tree Editor* menu select **File | New.** The *Initiating Event or Top Name* dialog will be displayed.



Name - The name of the top (basic event).
Description - The description the top (basic event).
Initiating Event - Select this check box if the top is an initiating event.
Add - Add the top to the top list. The *Event Name* dialog will be displayed.
Done - After entering at least two basic events, the *Event Name* dialog will be closed, the contents of the window will be initialized with the tops entered.



Enter data for each top to be included in the diagram, choosing **Add** after each entry. After adding the last top, choose the **Done** button.

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

6.2.7.3 Open

PURPOSE

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

STEPS

1. From the *Event Tree Editor* menu select **File | Open.**
   OR
2. Choose the **Open Diagram** button on the button bar.

3. The *Open Event Tree* common dialog will be displayed listing all the event tree diagrams (.EGT 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 ".ETG" files are listed.

Open - Open the highlighted diagram file and close the *Open Event Tree* dialog.

Cancel - Close the *Open Event Tree* dialog without selecting a different diagram.

Double-click - Open the diagram file and close the *Open Event 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.

6.2.7.4 Save

PURPOSE

This option will save any changes made in the current event 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 *Event Tree Editor* menu select **File | Save**.
   OR
2. Click the **Save Diagram** button on the button bar.
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 .

6.2.7.5 Saving Changes to a Different File

PURPOSE

This option will save any changes made in the current event 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 *Event Tree Editor* menu select **File**.
2. Choose **Save as** from the menu
3. The *Save Event Tree* common dialog will be displayed listing all the event tree diagrams (.ETG 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 .ETG files are listed.

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

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

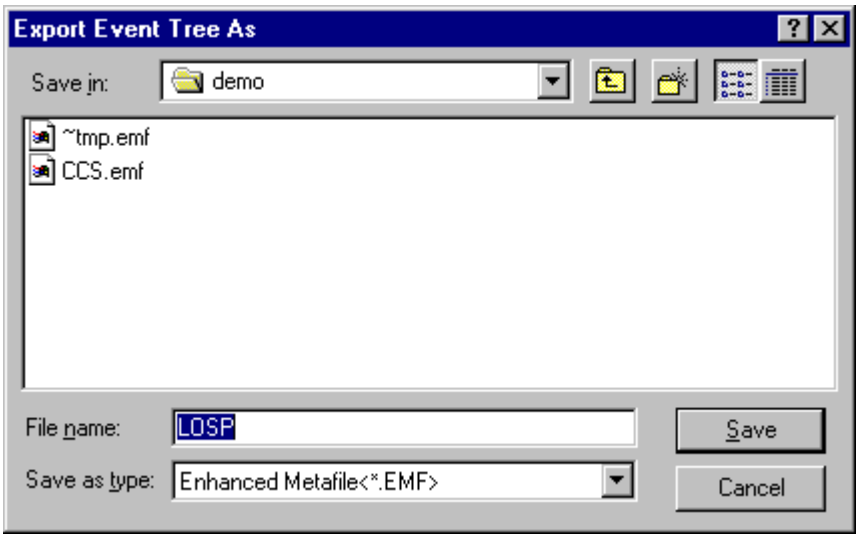
6.2.7.6 Export As

PURPOSE

This option will convert the event tree diagram to a file in Enhanced Metafile (EMF), Windows Metafile (WMF) format, or Rich Text Format (RTF).

STEPS

1. From the *Event Tree Editor* menu select **File**.
2. Choose **Export as** from the menu
3. The *Export Event Tree As* common dialog will be displayed listing all the EMF, WMF, OR RTF 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, only .EMF, .WMF, or .RTF files are listed.

Save - Save the current file in the *File name* field and close the *Export Event 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 Event Tree As* dialog.

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

6.2.7.7 Page Tree

PURPOSE

This option will allow you to copy the highlighted event tree branch to a new or existing diagram. The highlighted branch will be replaced in the current diagram with a straight pass-through of all the subsequent branch points and will transfer to the diagram you selected.

STEPS

1. Select the branch to be paged.
2. From the *Event Tree Editor* menu select **File**.
3. Choose **Page Tree** from the menu. The *Page Event Tree* dialog will be displayed.

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 branch 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 .ETG files are listed.

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

Double-click - Save the current branch to the file in the *File name* field and close the *Page Event Tree* dialog.

Cancel - Close the *Page Event Tree* dialog without saving the branch to a different file.

6.2.7.8 Forward Transfer

PURPOSE

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

STEPS

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

OR

7. If the selected branch is not a transfer, the *Status* dialog shown below will be displayed.

OK - Close the *Status* dialog.

6.2.7.9 Backward Transfer

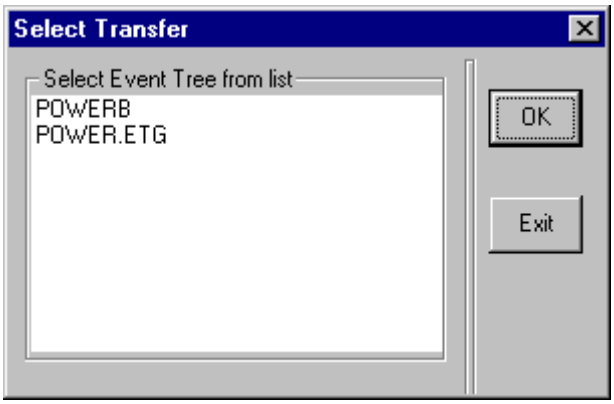
PURPOSE

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

STEPS

1. From the *Event Tree Editor* menu select **File | Backward**.
   OR
2. Choose the **Backward Transfer** button on the button bar. The *Select Transfer* dialog will be displayed.

3. 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.

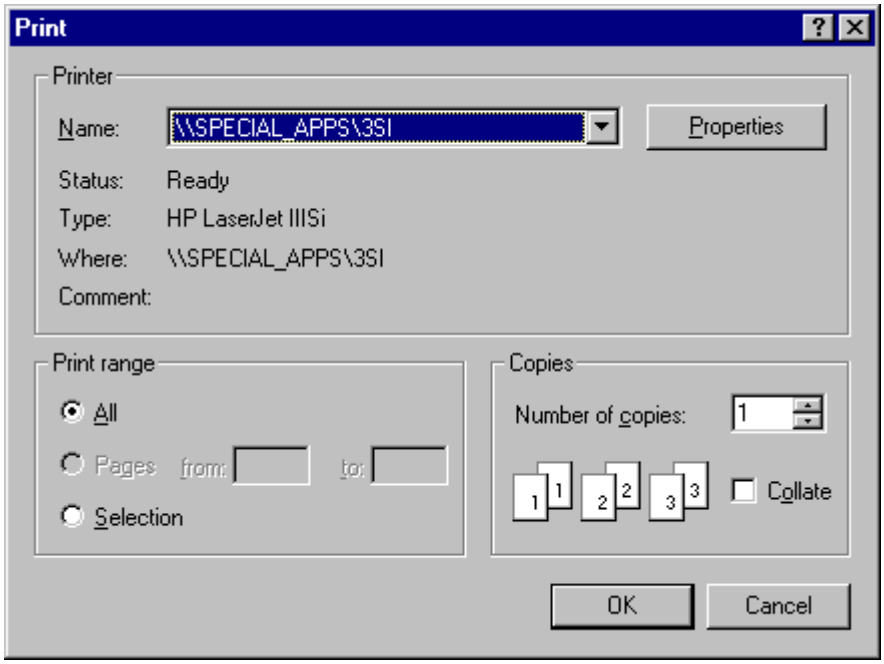
6.2.7.10 Print

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. 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.

6.2.8 Edit Menu

6.2.8.1 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.
Add Branch Above - Add a new branch above the currently selected branch.
Add Branch Below - Add a new branch below the currently selected branch.
Pass - Replace the selected branch with a straight Pass-Through.
Attributes - This menu item is for information only, indicating the action to perform (right-click) in order to invoke the appropriate attributes dialog.

6.2.8.2 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**.

The most recent action will be undone.

6.2.8.3 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.

6.2.8.4 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.

6.2.8.5 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.** The cursor is changed to the paste cursor .
5. Move the cursor to the location in the diagram where you wish to paste the object(s).
6. **Click** the mouse.

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

6.2.8.6 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.

6.2.8.7 Add Branch Above

PURPOSE

Add a new branch above the currently selected branch.

STEPS

1. Select the branch you wish to add a branch above.
2. From the *Event Tree Editor* menu select **Edit | Add Branch Above**.

   OR
3. Choose the **Add Branch Above** button on the button bar.

   OR
4. Right-click to invoke the pop-up menu and select **Add Branch Above**.

A new branch will appear in the event tree above the selected branch. This branch will pass-through all the tops to the right of the top being branched. The selected branch will remain highlighted.

6.2.8.8 Add Branch Below

PURPOSE

Add a new branch below the currently selected branch

STEPS

1. Select the branch you wish to add a branch below.
2. From the *Event Tree Editor* menu select **Edit | Add Branch Below**.

   OR
3. Choose the **Add Branch Below** button on the button bar.

   OR
4. Right-click to invoke the pop-up menu and select **Add Branch Above**.

A new branch will appear in the event tree below the selected branch. This branch will pass-through all the tops to the right of the top being branched. The selected branch will remain highlighted.

6.2.8.9 Pass

PURPOSE

Replace the selected branch with a straight Pass-Through.

STEPS

1. Select the branch you wish to change.
2. From the *Event Tree Editor* menu select **Edit | Pass**.
   OR
3. Choose the **Pass** button on the button bar.
   OR
4. Right-click to invoke the pop-up menu and select **Pass**.

The selected branch will be changed into a pass-through. This branch will pass-through all the tops to the right of the top being branched. The new pass-through branch will be highlighted.

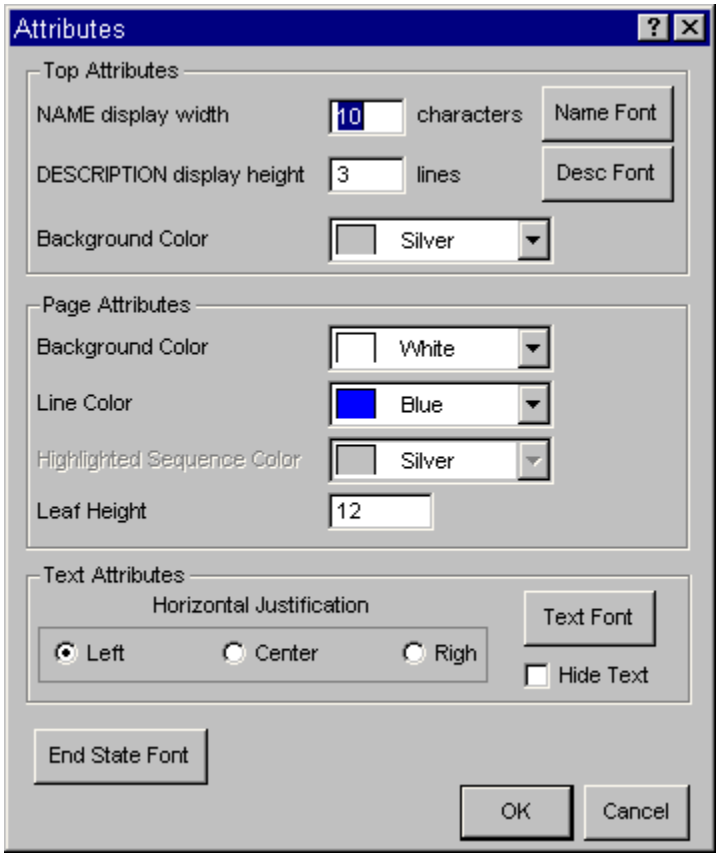
6.2.8.10 Attributes

PURPOSE

This dialog is used to set or change the attributes of the current graphical event tree. Changing these attributes does not affect the *Preferences*.

STEPS

1. Ensure that no object (e.g., branch, top, event, sequence information column) is selected.
2. Right-click on the *Event Tree Editor* window. The *Attributes* dialog will be displayed.



OK - Apply the changes and close the *Attributes* dialog.
Cancel - Close the *Attributes* dialog without applying the changes.

6.2.9 View Menu

6.2.9.1 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 branches, 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.

Show Sequence Names -	Display the sequence names column.
Show End State Names -	Display the end state names column.
Show Frequency -	Display the frequency (extra information #1) column.
Show Extra-#2 -	Display the extra information #2 column.
Show Grid -	Display the background grid.
Preferences -	Change the event tree graphical editor defaults.
Refresh -	Redraw the viewing window.
Zoom -	Enlarge or shrink a portion of the diagram.
View Normal -	Restore the view window to its original size.
Fit to Screen -	Adjust the diagram to fit inside the view window.
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.

6.2.9.2 Show Sequence Names

PURPOSE

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

This column will always contain the sequence names. By default, the sequence names column is the first column following the event tree branches and is therefore, referred to as the “first” column. The physical location of this column can be changed.

STEPS

1. From the *Event Tree Editor* menu select **View.**

2. Choose **Show Sequence Names** from the menu.

In the example of the **View** menu shown here, the **Show Sequence Names** option is NOT currently selected.

This toggle can also be set in the *Edit Sequence* dialog or the *Edit Sequence Header* dialog.

6.2.9.3 Show End State Names

PURPOSE

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

This column will always contain the sequence end state or transfer tree names. If the sequence continues through another event tree then the end state is the name of the transfer tree. By default, the end state names column is the second column following the event tree branches and is therefore, referred to as the "second" column. The physical location of this column can be changed.

STEPS

1. From the *Event Tree Editor* menu select **View.**
2. Choose **Show End State Names** from the menu.

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

This toggle can also be set in the *Edit Sequence* dialog or the *Edit Sequence Header* dialog.

6.2.9.4 Show Frequency

PURPOSE

This option allows you to display the extra information #1 column. If selected, a check mark to the left of this menu item will be displayed and the column will appear in the editor window. If deselected, there will not be a check mark next to the menu item and the column will not be displayed. This option acts as a toggle.

This column can be used for whatever information you wish, however, options exist elsewhere in the program that will put the frequency of this sequence in this column. By default, this is the third column following the event tree branches and is therefore, referred to as the “third” column. The physical location of this column can be changed.

STEPS

1. From the *Event Tree Editor* menu select **View.**
2. Choose **Show Frequency** from the menu.

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

This toggle can also be set in the *Edit Sequence* dialog or the *Edit Sequence Header* dialog.

6.2.9.5 Show Extra-#2

PURPOSE

This option allows you to display the extra information #2 column. If selected, a check mark to the left of this menu item will be displayed and the column will appear in the editor window. If deselected, there will not be a check mark next to the menu item and the column will not be displayed. This option acts as a toggle.

This column can be used for whatever information you wish. By default, this column is the fourth column following the event tree branches and is therefore, referred to as the “fourth” column. The physical location of this column can be changed .

STEPS

1. From the *Event Tree Editor* menu select **View.**
2. Choose **Show Extra-#2** from the menu.

In the example of the **View** menu shown here, the **Show Extra-#2** option is NOT currently selected.

This toggle can also be set in the *Edit Sequence* dialog or the *Edit Sequence Header* dialog.

6.2.9.6 Show Grid

PURPOSE

This option allows you to display a background grid to help align branches. If selected, a check mark to the left of this menu item will be displayed and the grid will appear on the background of the editor 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 *Event Tree Editor* menu select **View.**
2. Choose **Show Grid** from the menu.

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

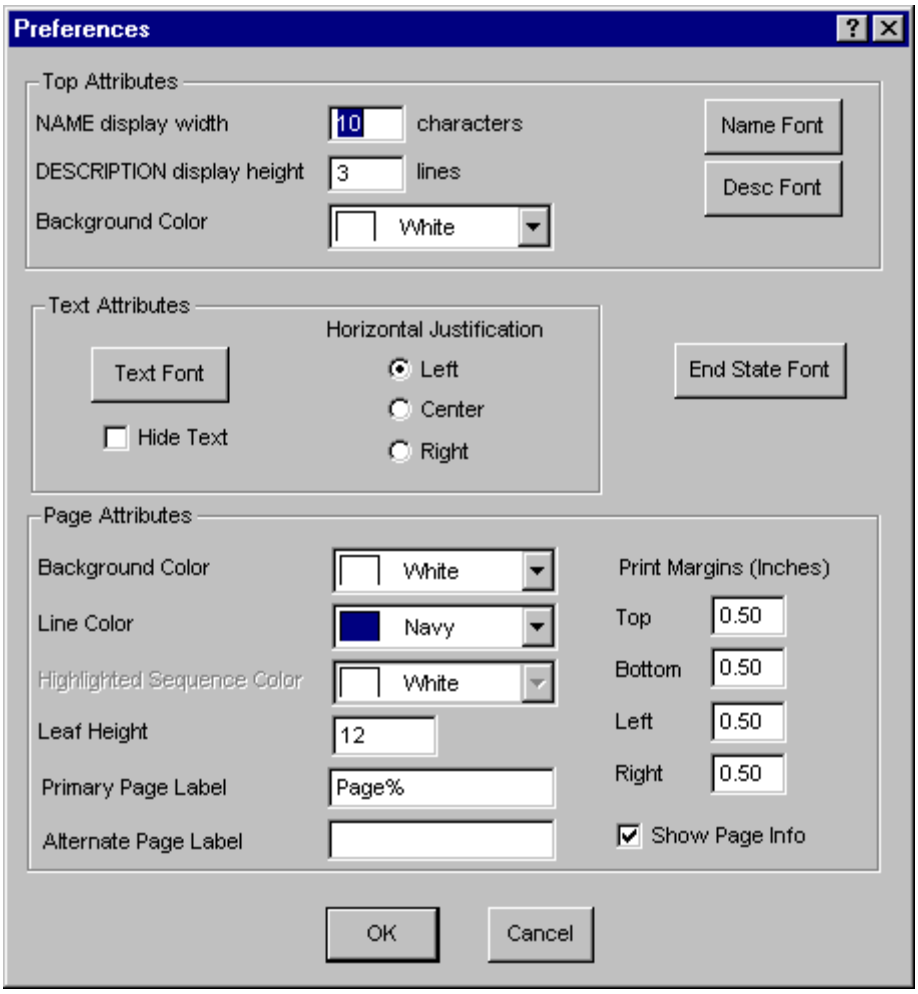
6.2.9.7 Preferences

PURPOSE

This option allows you to modify the preferred defaults for the graphical *Event Tree Editor*. The changes made here will be reflected in the default values in the **Utility | Define Constants | Event Tree** option. These changes affect only new graphical event trees and does not affect the *attributes* of existing ones.

STEPS

1. From the *Event Tree Editor* menu select **View.**
2. Choose **Preferences** from the menu.
3. The *Preferences* dialog will be displayed.



OK - Save the changes and close the *Preferences* dialog.
Cancel - Close the *Preferences* dialog without saving the changes.

6.2.9.8 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. The cursor is changed to the Zoom cursor .
4. 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%.

6.2.9.9 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.

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.

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.

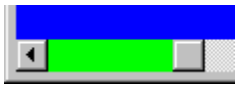
The viewing window will move up a little.

To move the viewing window down slightly:

1. **Click** on the down arrow in the scroll bar on the right hand side.

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.

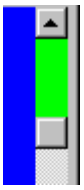
The viewing window will move to the left.

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.

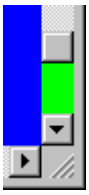
The viewing window will move to the right.

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

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.

The viewing window will move down.

6.2.9.10 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.

The initial position of the diagram is redisplayed.

6.2.9.11 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.**

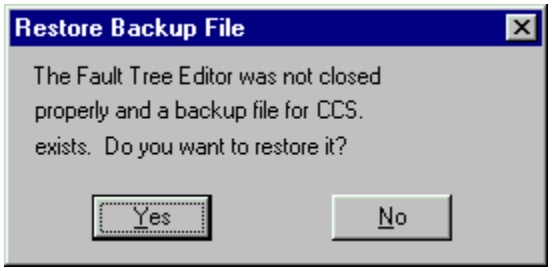
   OR
2. Select the **Fit to Window** button (FTE) from the toolbar.
   OR
3. Press the **Ctrl+F** key combination.

The diagram will be enlarged or reduced to fit inside the viewing window.

6.2.10 Timed Backup

6.2.10.1 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.

6.3 Linkage Rule Editor (Event Tree)

6.3.1 Linkage Rules Editor Menu

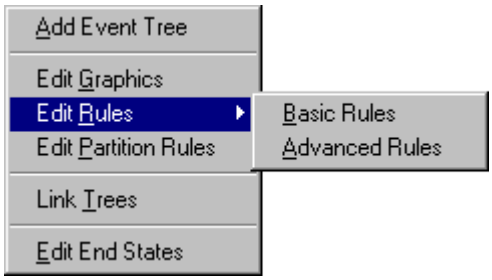
PURPOSE

This option allows you to specify linkage rules for an event tree. A linkage rule is a special case, an exception, or substitution to the normal sequence generation. Typically, these rules are used to replace default fault trees (i.e., top events) with substituted fault trees (or "split-fractions") based on logical conditions that are specified in the rules. During sequence logic generation the logic for a sequence is created as specified in the event tree logic, and then the linkage rules are applied.

For example, event tree A contains a sequence named SEQ-1. According to the strict logic of the event tree, the fault trees that make up SEQ-1's logic are SYS-1, SYS-2, SYS-3, and SYS-4. A linkage rule would enable you to replace all occurrences of SYS-4 in any sequence in the event tree with SYS-5. Alternatively, you may only want to replace SYS-4 with SYS-5 if and only if SYS-2 and SYS-3 are also present in the sequence logic.

STEPS

1. From the SAPHIRE menu select **Event Tree**. The *Event Tree List* dialog will be displayed.
2. Highlight the desired event tree in the list.
3. Right-click to invoke the pop-up menu and choose **Edit Rules**.



4. Choose either Basic Rules or Advanced Rules . The *Linkage Rules Editor* will be invoked.

6.3.2 Basic Linkage Rules Editor

PURPOSE

This is a free format line editor that provides you with an if-then-else logic structure. By default the editor assumes that a name is the name of a fault tree, if one exists. If a fault tree by the name does not exist then the editor assumes that the name is the name of a macro. If the user desires to change the default assumptions, then they can "cast" the names to something else by enclosing the name in parenthesis with a cast name preceding it. 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

Linkage Rules Editor Functions

6.3.3 Advanced Linkage 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 which 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.

Advanced rules can have different logic than the Basic Rules and are saved separately.

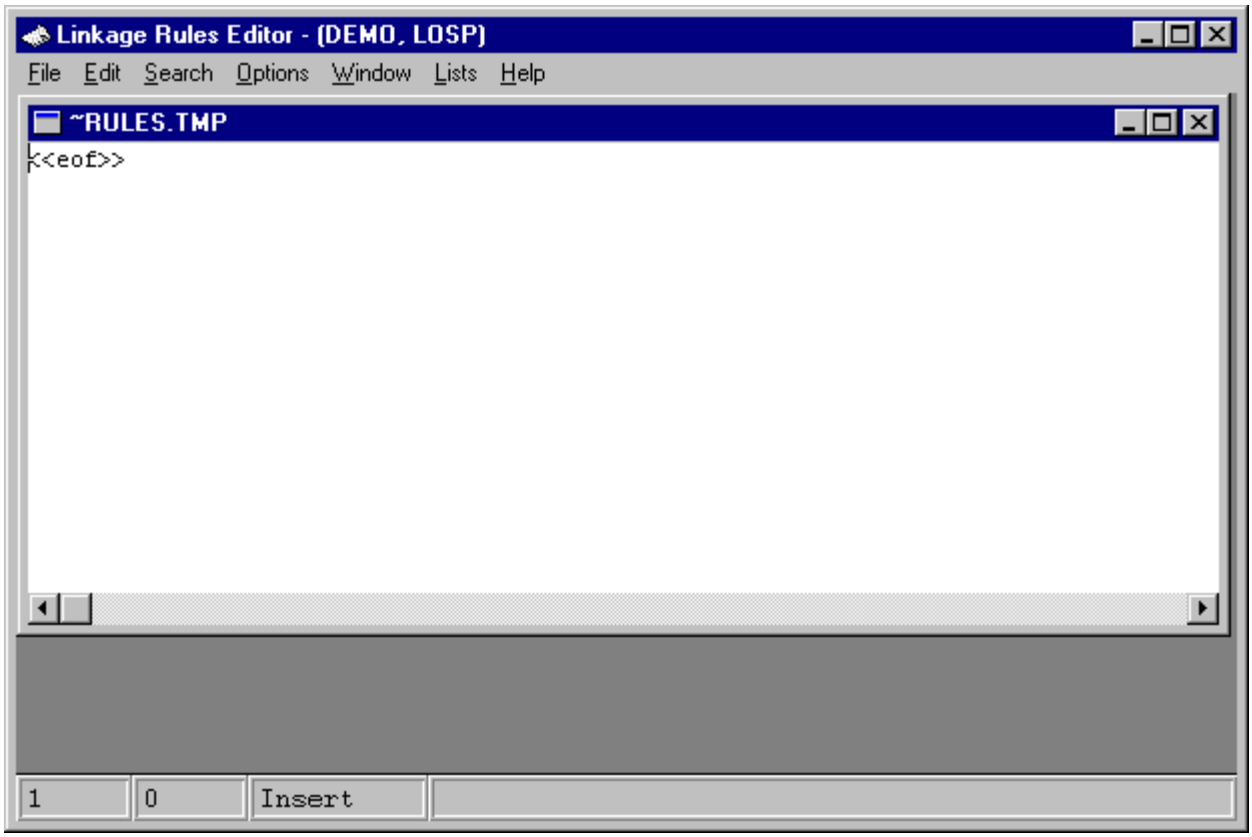
SEE

Linkage Rules Editor Functions

6.3.4 Linkage Rules Editor Functions

PURPOSE

The editor contains file management functions such as open, save, save as, print, import, etc. Editing functions such as cut, copy, paste, delete, undo, etc., are provided. Text format operations such as indent, capitalization, etc. are supplied. Search functions such as find, replace, set marker, goto marker, etc., are provided. Preference attributes such as undo levels, select font, shift size, show altered lines, etc., can be set. Also, window functions such as tile, cascade, and arrange icons can be set. Finally, list options that provide the ability to insert database items such as basic events, initiators, fault trees, flags, etc., are provided.



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.

6.3.5 File Menu

6.3.5.1 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 *Editor* session.

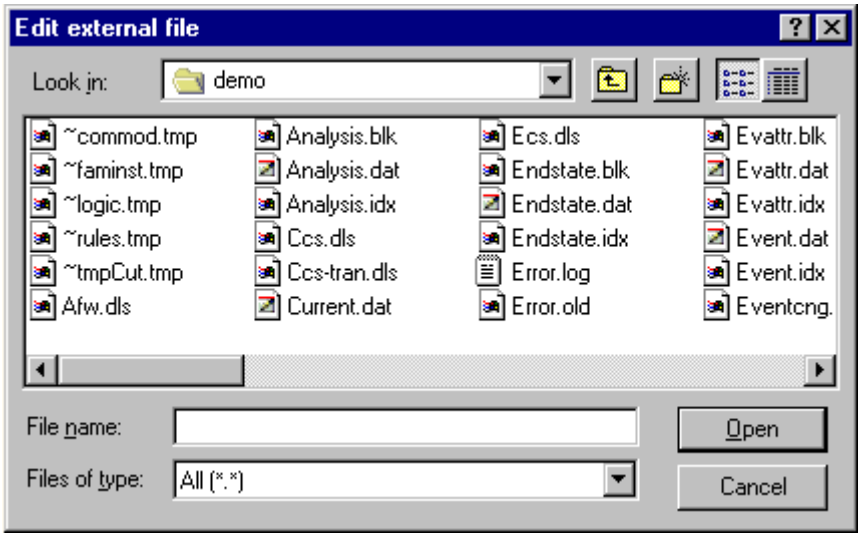
6.3.5.2 Open

PURPOSE

This option allows you to open an existing file into a new editing window within the *Linkage Rules Editor* or the *Event Tree Logic Editor*.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **File**.
2. Select the **Open** menu option. The Edit external file dialog will be displayed listing all of the files in the current project directory.



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.

Open - Open the selected file in a new window and close the *Edit external file* dialog.

Cancel - Close the *Edit external file* dialog without opening another file.

Double-click - Open the selected file in a new window and close the *Edit external file* dialog.

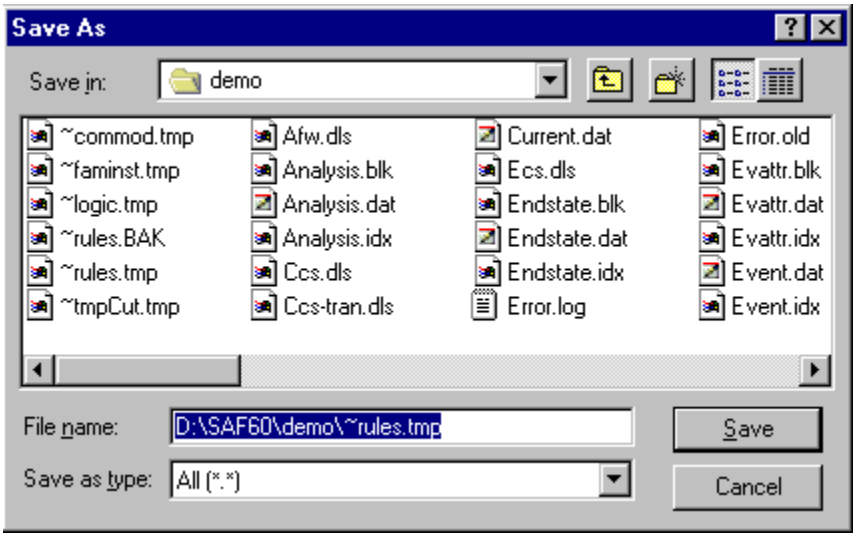
6.3.5.3 Save As

PURPOSE

This option allows you to save the file in the current editing window with a new file name.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **File**.
2. Select the **Save As** menu option. The Save As dialog will be displayed.



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 to 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.

Save - Save the data in the current editing window 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 As* dialog.

Cancel - Close the *Save As* dialog without performing the save operation.

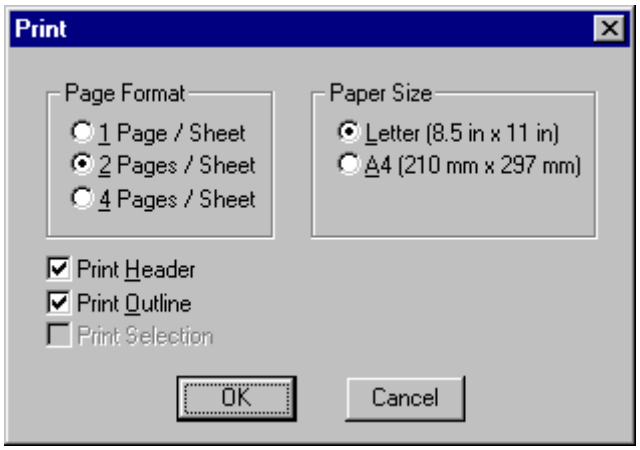
6.3.5.4 Print

PURPOSE

This option allows you to print the file in the current edit window to the default (Windows System) printer.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **File**.
2. Select the **Print** menu option. The Print dialog will be displayed.



***Page Format* -** Select the desired format option. A "page" of data is approximately 66 lines, including header information and outlines.

1 Page / Sheet - Prints one "page" of data on a single sheet of paper. The page is printed using the Portrait orientation (i.e., the short edge of the paper is horizontal).

2 Pages / Sheet - Prints two "pages" of data on a single sheet. The page is printed using the Landscape orientation (i.e., the long edge of the paper is horizontal).

4 Pages/ Sheet - Print four "pages" of data on a single sheet. The page is printed using the Landscape orientation.

***Paper Size* -** Select the size of the paper to print on.

Print Header - Include header information in the print-out. Header information includes the current date, the file name, and the page number. These items are printed across the top of the page, followed by a line, separating it from the data.

Print Outline - Outline each "page" in a rectangle. This is especially useful when using the 2 *Pages / Sheet* or *4 Pages / Sheet* options.

Print Selection - Print the currently highlighted data.

OK - Print the data to the Windows System Printer using the selected options and close the *Print* dialog.

Cancel - Close the *Print* dialog without printing the data.

6.3.5.5 Exit

PURPOSE

This option allows you to terminate the *Editor* session. The rules are automatically compiled upon exiting the *Editor*. If there is a compilation error, the *Editor* will be reopened with the current file and a message will be displayed in the editor's message bar.

STEPS

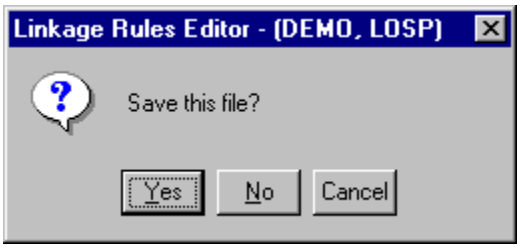
1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **File**.
2. Select the **Exit** menu option.

If changes have been made to the data, you will be prompted to save the file.

6.3.5.6 Save This File

PURPOSE

This dialog will appear any time you are closing the current editing window or exiting the *Editor* and changes to the file have not been saved (i.e., written to disk).



Yes - Save the changes made to the file in the current editing window and close the current editing window.

No - Do not save the changes made to the file in the current editing window and close the current editing window.

Cancel - Do not save the changes made to the file in the current editing window and do not close the current editing window.

6.3.6 Edit Menu

6.3.6.1 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.
Link edit Windows -

6.3.7 Search Menu

6.3.7.1 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.

6.3.7.2 Find

PURPOSE

This option allows you to search the text in the current window for the specified string. If the search criteria are met, the first string matching the criteria is highlighted.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Find** menu option. The Find dialog will be displayed.

Find What - The string of alphanumeric characters upon which the search is based (i.e., the "search string"). Type the text in the field or select from the drop-down list.

Match Whole Word Only - If this check box is selected, only the series of alphanumeric characters matching the search string and delimited by a space, comma, dash, period, etc. are located.

Match Case - If this check box is selected, only the series of alphanumeric characters matching the upper- and lowercase characters as entered in the *Find What* field are located (i.e., the search will be case-sensitive).

Direction

Up - Search the text from the current cursor position to the beginning or top of the text.

Down - Search the text from the current cursor position to the end or bottom of the text.

Find Next - Perform the search operation using the selected criteria. If the search is not successful, an information dialog will be displayed. If the search criteria are met, the *Find* dialog, shown below, will become active and the current *Find* dialog will be closed.

Cancel - Close the *Find* dialog without performing the search operation.

Find Next - Locate the next string matching the current search criteria.

Find Before - Locate the previous string matching the current search criteria.

Find After - Locate the next string matching the current search criteria.

Cancel - Close the *Find* dialog without performing the search operation.

6.3.7.3 Replace

PURPOSE

This option allows you to search the text in the current window for the specified string and replace it with another string. If the search criteria are met, the first string matching the criteria is highlighted.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Replace** menu option. The Replace dialog will be displayed.

Find What – The string of alphanumeric characters upon which the search is based (i.e., the "search string"). Type the text in the field or select from the drop-down list.

Replace With - The string of alphanumeric characters that will be substituted for the search string. Type the text in the field.

Match Whole Word Only - If this check box is selected, only the series of alphanumeric characters matching the search string and delimited by a space, comma, dash, period, etc. are located.

Match Case - If this check box is selected, only the series of alphanumeric characters matching the upper- and lowercase characters as entered in the *Find What* field are located (i.e., the search will be case-sensitive).

Direction

Up - Search the text from the current cursor position to the beginning or top of the text.

Down - Search the text from the current cursor position to the end or bottom of the text.

Find Next - Perform the search operation using the selected criteria. If the search is not successful, an information dialog will be displayed. If the search criteria are met, the Find/Replace again dialog will become active and the current *Replace* dialog will be closed..

Replace All - Find all occurrences matching the search criteria and automatically substitute with the "replace string."

Close - Close the *Replace* dialog without performing the search and replace operation.

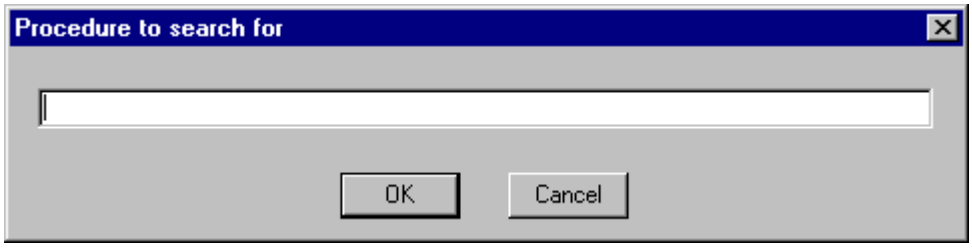
6.3.7.4 Find Procedure

PURPOSE

This option allows you to search the text in the current window for the specified procedure.

STEPS

1. From the Linkage Rules Editor, the Recovery Rules Editor, or the Partition Rules Editor menu select **Search**.
2. Select the **Find Procedure** menu option. The Procedure to search for dialog will be displayed.



OK - Locate the procedure matching the current search criteria.
Cancel - Close the *Procedure to search for* dialog without performing the search operation.

6.3.7.5 Find/Replace again

PURPOSE
This option allows you to search the text in the current window based on the previously defined search string and replace it with the previously defined replace string. If the search criteria are met, the first string matching the criteria is highlighted.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Find/Replace again** menu option. The Replace dialog will be displayed.

Find Next - Locate the next string matching the current search criteria. A substitution will not be made.
Replace - Substitute the replace string for the located search string and continue searching.
Replace All - Substitute the replace string for all occurrences matching the search criteria, beginning at the current cursor position.
Close - Close the *Replace* dialog without performing the search and replace operation.

NOTE: This dialog can also be invoked from the **Search | Replace | Find Next** menu options.

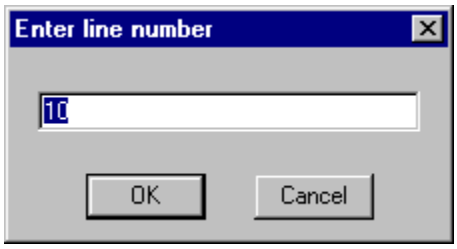
6.3.7.6 Find line number

PURPOSE

Position the cursor on the specified line number in the text in the current window.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Find line number** menu option.
3. The Enter line number dialog will be displayed.
4. Type the desired line number in the field.



OK - Position the cursor at the beginning of the desired line and close the dialog.
Cancel - Close the dialog without repositioning the cursor.

6.3.7.7 Goto Marker

PURPOSE

Position the cursor at the previously saved file position. Up to four marker positions can be retrieved for each editing window.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Goto Marker** menu option.
3. Choose one of the four marker positions available from the submenu.

In this example, two markers have been set at #1 and #3. After choosing one of the available markers, the cursor is positioned at the beginning of the line.

The marker positions are saved only during the current editing session.

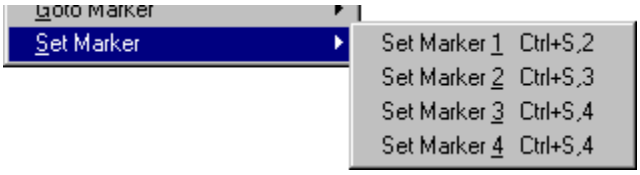
6.3.7.8 Set Marker

PURPOSE

Save the current file position for later retrieval. Up to four marker positions can be saved for each editing window.

STEPS

1. Position the cursor on the desired line of the text in the edit window.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
3. Select the **Set Marker** menu option.
4. Choose one of the four marker positions available from the submenu.



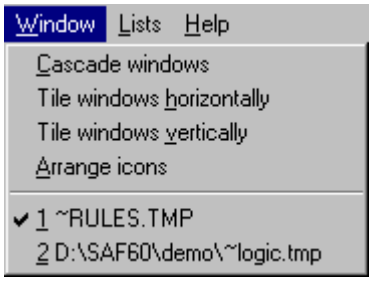
The marker positions are saved only during the current editing session.

6.3.8 Window Menu

6.3.8.1 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.

6.3.9 Lists Menu

6.3.9.1 Linkage Rules Lists

Selecting from the lists allows you to insert items in the editor. Any or all of the lists can be open simultaneously.

Macros -	Insert a macro name into the text.
Events -	Insert a basic event name into the text.
Initiators -	Insert an initiating event name into the text.
Fault Trees -	Insert a fault tree name into the text.
End States -	Insert an end state name into the text.
Event Trees -	Insert an event tree name into the text.
Flags -	Insert a flag set name into the text.

6.3.9.2 Macros

PURPOSE

This option allows you to insert a macro into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Macros** menu option. The *Macro List* dialog will be displayed.

4. Double-click on the desired macro name in the list. The selected name will be entered at the current cursor location.

The *Macro List* dialog will remain open in the application window during the current session unless explicitly closed.

6.3.9.3 Events

PURPOSE

This option allows you to insert a basic event name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Events** menu option. The *Event List* dialog will be displayed containing all of the basic events in the current family's database.

4. Double-click on the desired event name in the list. The selected name will be entered at the current cursor location.

The *Event List* dialog will remain open in the application window during the current session unless explicitly closed.

6.3.9.4 Initiators

PURPOSE

This option allows you to insert an initiating basic event name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Initiators** menu option. The *Initiator List* dialog will be displayed containing all of the basic events whose category attribute is set to "I" in the current family's database.

4. Double-click on the desired initiating event name in the list. The selected name will be entered at the current cursor location.

The *Initiator List* dialog will remain open in the application window during the current session unless explicitly closed.

6.3.9.5 Systems

PURPOSE

This option allows you to insert a fault tree name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.

3. Select the **Systems** menu option. The *System List* dialog will be displayed containing all of the fault trees in the current family's database.

4. Double-click on the desired fault tree name in the list. The selected name will be entered at the current cursor location.

The *System List* dialog will remain open in the application window during the current session unless explicitly closed.

6.3.9.6 End States

PURPOSE

This option allows you to insert an end state name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **End States** menu option. The *Endstate List* dialog will be displayed containing all of the end states in the current family's database.

4. Double-click on the desired end state name in the list. The selected name will be entered at the current cursor location.

The *Endstate List* dialog will remain open in the application window during the current session unless explicitly closed.

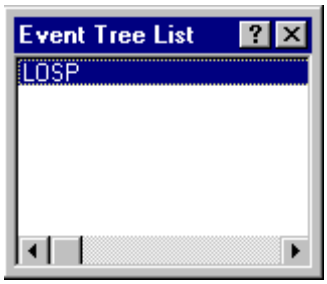
6.3.9.7 Event Trees

PURPOSE

This option allows you to insert an event tree name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Event Trees** menu option. The *Event Tree List* dialog will be displayed containing all of the event trees in the current family's database.



4. Double-click on the desired event tree name in the list. The selected name will be entered at the current cursor location.

The *Event Tree List* dialog will remain open in the application window during the current session unless explicitly closed.

6.3.9.8 Flags

PURPOSE

This option allows you to insert a flag set name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Flags** menu option. The *Flag List* dialog will be displayed containing all of the flag sets in the current family's database.

4. Double-click on the desired flag set name in the list. The selected name will be entered at the current cursor location.

The *Flag List* dialog will remain open in the application window during the current session unless explicitly closed.

6.4 Partition Rules Editor

6.4.1 Partition Rules Editor

PURPOSE

This editor allows you to define a set of rules that map the cut sets for a sequence to an end state. This is a free format, macro-based line editor that provides you with an if-then-else logic structure. If rules have already been defined they will be displayed in the edit window.

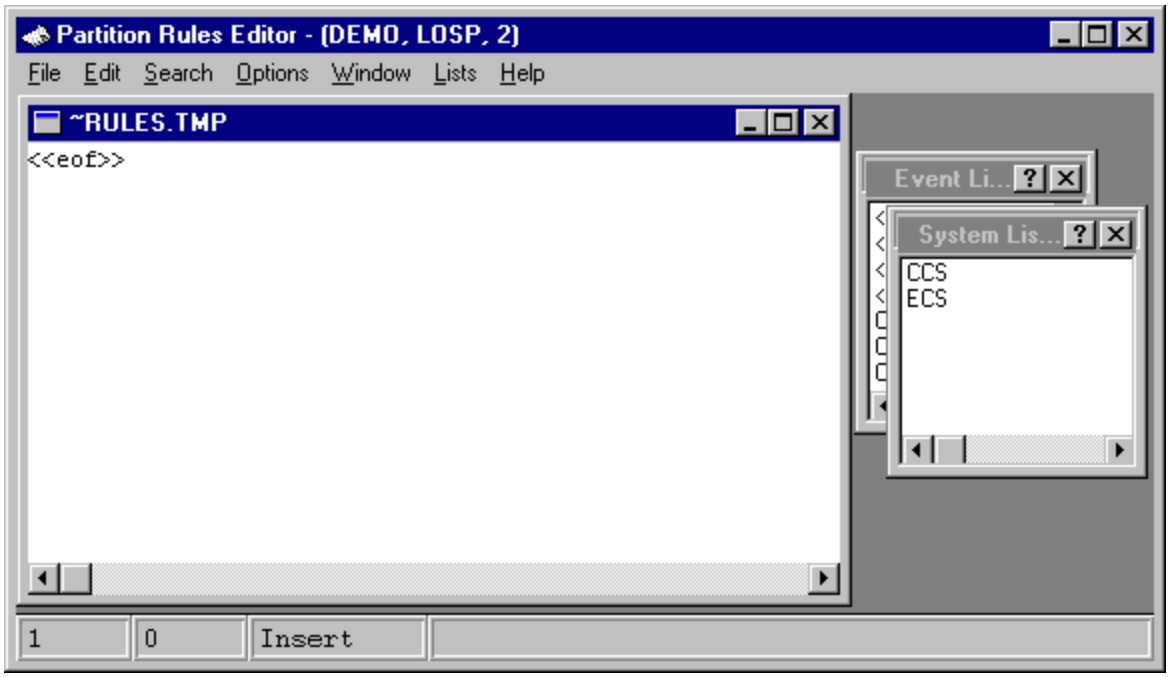
By default, the editor assumes that a name is the name of a basic event, if one exists in the database. If a basic event by the name does not exist then the editor assumes that the name is the name of a macro. If you want to change the default assumptions, then you can "cast" the names to something else by enclosing the name in parenthesis with a cast name preceding it.

There is no limit to the number of rules you may input to the editor. Each rule is processed in sequential order.

STEPS

1. From the SAPHIRE menu select **Sequence**. The *Sequences* dialog will be displayed.
2. Highlight the desired sequence(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets | Partition | 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.



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.

6.4.2 File Menu

6.4.2.1 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 *Editor* session.

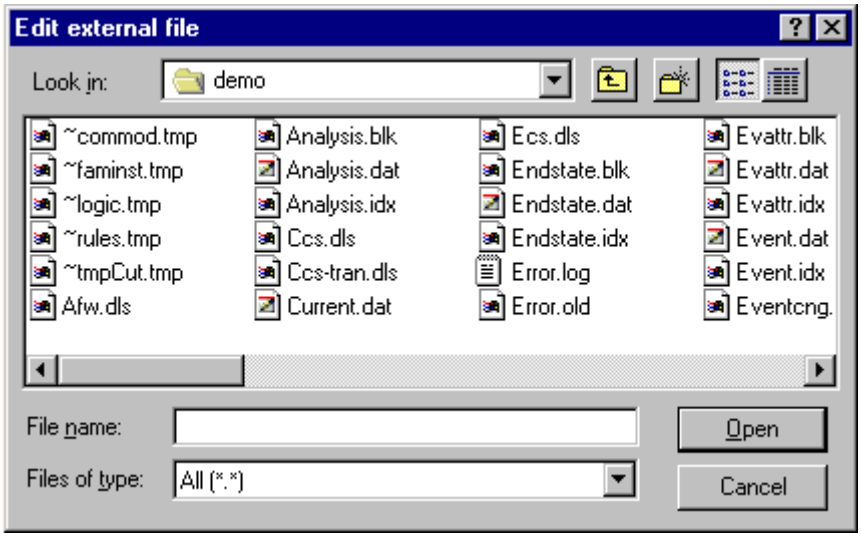
6.4.2.2 Open

PURPOSE

This option allows you to open an existing file into a new editing window within the *Linkage Rules Editor* or the *Event Tree Logic Editor*.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **File**.
2. Select the **Open** menu option.
3. The Edit external file dialog will be displayed listing all of the files in the current project directory.



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.

Open - Open the selected file in a new window and close the *Edit external file* dialog.

Cancel - Close the *Edit external file* dialog without opening another file.

Double-click - Open the selected file in a new window and close the *Edit external file* dialog.

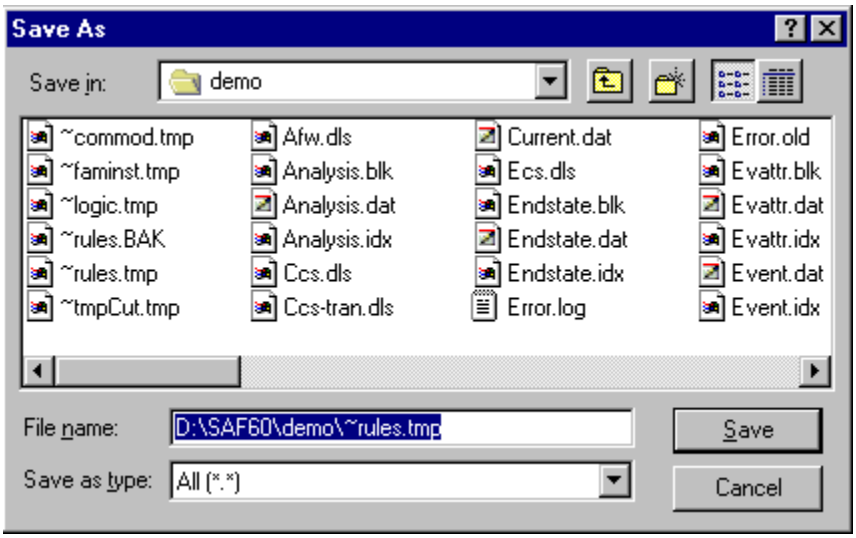
6.4.2.3 Save As

PURPOSE

This option allows you to save the file in the current editing window with a new file name.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **File**.
2. Select the **Save As** menu option. The Save As dialog will be displayed.



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 to 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.

Save - Save the data in the current editing window 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 As* dialog.

Cancel - Close the *Save As* dialog without performing the save operation.

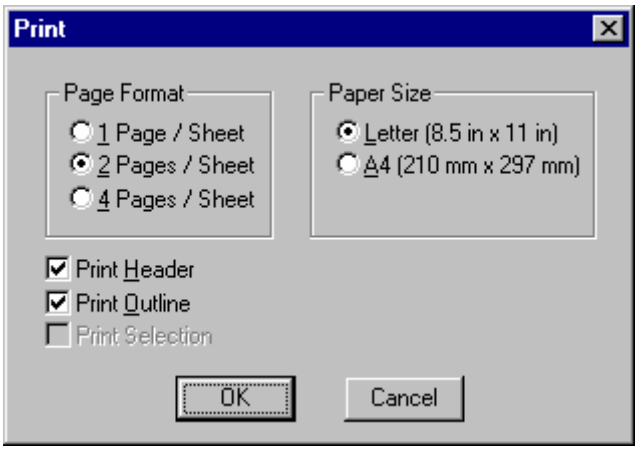
6.4.2.4 Print

PURPOSE

This option allows you to print the file in the current edit window to the default (Windows System) printer.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **File**.
2. Select the **Print** menu option. The Print dialog will be displayed.



Page Format - Select the desired format option. A "page" of data is approximately 66 lines, including header information and outlines.

1 Page / Sheet - Prints one "page" of data on a single sheet of paper. The page is printed using the Portrait orientation (i.e., the short edge of the paper is horizontal).

2 Pages / Sheet - Prints two "pages" of data on a single sheet. The page is printed using the Landscape orientation (i.e., the long edge of the paper is horizontal).

4 Pages/ Sheet - Print four "pages" of data on a single sheet. The page is printed using the Landscape orientation.

Paper Size - Select the size of the paper to print on.

Print Header - Include header information in the print-out. Header information includes the current date, the file name, and the page number. These items are printed across the top of the page, followed by a line, separating it from the data.

Print Outline - Outline each "page" in a rectangle. This is especially useful when using the 2 *Pages / Sheet* or *4 Pages / Sheet* options.

Print Selection - Print the currently highlighted data.

OK - Print the data to the Windows System Printer using the selected options and close the *Print* dialog.

Cancel - Close the *Print* dialog without printing the data.

6.4.2.5 Exit

PURPOSE

This option allows you to terminate the *Editor* session. The rules are automatically compiled upon exiting the *Editor*. If there is a compilation error, the *Editor* will be reopened with the current file and a message will be displayed in the editor's message bar.

STEPS

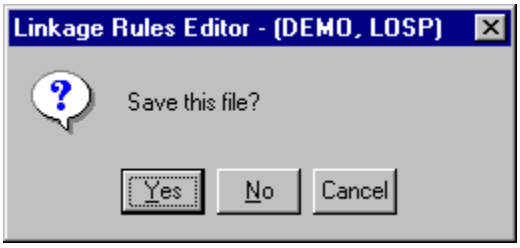
1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **File**.
2. Select the **Exit** menu option.

If changes have been made to the data, you will be prompted to save the file.

6.4.2.6 Save This File

PURPOSE

This dialog will appear any time you are closing the current editing window or exiting the *Editor* and changes to the file have not been saved (i.e., written to disk).



Yes - Save the changes made to the file in the current editing window and close the current editing window.
No - Do not save the changes made to the file in the current editing window and close the current editing window.
Cancel - Do not save the changes made to the file in the current editing window and do not close the current editing window.

6.4.3 Edit Menu

6.4.3.1 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.
Link edit Windows -	

6.4.4 Search Menu

6.4.4.1 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.

6.4.4.2 Find

PURPOSE

This option allows you to search the text in the current window for the specified string. If the search criteria are met, the first string matching the criteria is highlighted.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Find** menu option. The Find dialog will be displayed.

Find What - The string of alphanumeric characters upon which the search is based (i.e., the "search string"). Type the text in the field or select from the drop-down list.

Match Whole Word Only - If this check box is selected, only the series of alphanumeric characters matching the search string and delimited by a space, comma, dash, period, etc. are located.

Match Case - If this check box is selected, only the series of alphanumeric characters matching the upper- and lowercase characters as entered in the *Find What* field are located (i.e., the search will be case-sensitive).

Direction

Up - Search the text from the current cursor position to the beginning or top of the text.

Down - Search the text from the current cursor position to the end or bottom of the text.

Find Next - Perform the search operation using the selected criteria. If the search is not successful, an information dialog will be displayed. If the search criteria are met, the *Find* dialog, shown below, will become active and the current *Find* dialog will be closed..

Cancel - Close the *Find* dialog without performing the search operation.

Find Next - Locate the next string matching the current search criteria.
Find Before - Locate the previous string matching the current search criteria.
Find After - Locate the next string matching the current search criteria.
Cancel - Close the *Find* dialog without performing the search operation.

6.4.4.3 Replace

PURPOSE

This option allows you to search the text in the current window for the specified string and replace it with another string. If the search criteria are met, the first string matching the criteria is highlighted.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Replace** menu option. The Replace dialog will be displayed.

Find What - The string of alphanumeric characters upon which the search is based (i.e., the "search string"). Type the text in the field or select from the drop-down list.

Replace With - The string of alphanumeric characters that will be substituted for the search string. Type the text in the field.

Match Whole Word Only - If this check box is selected, only the series of alphanumeric characters matching the search string and delimited by a space, comma, dash, period, etc. are located.

Match Case - If this check box is selected, only the series of alphanumeric characters matching the upper- and lowercase characters as entered in the *Find What* field are located (i.e., the search will be case-sensitive).

Direction

Up - Search the text from the current cursor position to the beginning or top of the text.

Down - Search the text from the current cursor position to the end or bottom of the text.

Find Next - Perform the search operation using the selected criteria. If the search is not successful, an information dialog will be displayed. If the search criteria are met, the Find/Replace again dialog will become active and the current *Replace* dialog will be closed.

Replace All - Find all occurrences matching the search criteria and automatically substitute with the "replace string."

Close - Close the *Replace* dialog without performing the search and replace operation.

6.4.4.4 Find/Replace again

PURPOSE
This option allows you to search the text in the current window based on the previously defined search string and replace it with the previously defined replace string. If the search criteria are met, the first string matching the criteria is highlighted.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Find/Replace again** menu option. The Replace dialog will be displayed.

Find Next - Locate the next string matching the current search criteria. A substitution will not be made.
Replace - Substitute the replace string for the located search string and continue searching.
Replace All - Substitute the replace string for all occurrences matching the search criteria, beginning at the current cursor position.
Close - Close the *Replace* dialog without performing the search and replace operation.

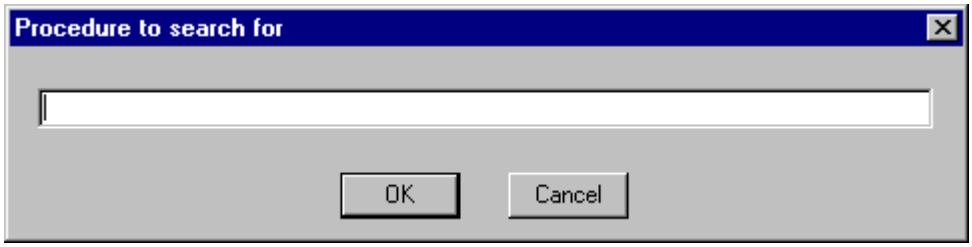
NOTE: This dialog can also be invoked from the **Search | Replace | Find Next** menu options.

6.4.4.5 Find Procedure

PURPOSE

This option allows you to search the text in the current window for the specified procedure.
STEPS

1. From the Linkage Rules Editor, the Recovery Rules Editor, or the Partition Rules Editor menu select **Search**.
2. Select the **Find Procedure** menu option. The Procedure to search for dialog will be displayed.



OK - Locate the procedure matching the current search criteria.
Cancel - Close the *Procedure to search for* dialog without performing the search operation.

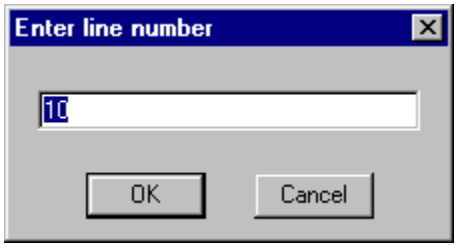
6.4.4.6 Find line number

PURPOSE

Position the cursor on the specified line number in the text in the current window.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Find line number** menu option.
3. The Enter line number dialog will be displayed.
4. Type the desired line number in the field.



OK - Position the cursor at the beginning of the desired line and close the dialog.
Cancel - Close the dialog without repositioning the cursor.

6.4.4.7 Goto Marker

PURPOSE

Position the cursor at the previously saved file position. Up to four marker positions can be retrieved for each editing window.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Goto Marker** menu option.
3. Choose one of the four marker positions available from the submenu.

In this example, two markers have been set at #1 and #3. After choosing one of the available markers, the cursor is positioned at the beginning of the line.

The marker positions are saved only during the current editing session.

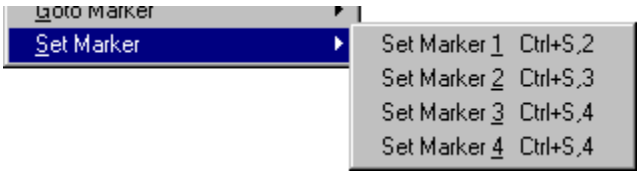
6.4.4.8 Set Marker

PURPOSE

Save the current file position for later retrieval. Up to four marker positions can be saved for each editing window.

STEPS

1. Position the cursor on the desired line of the text in the edit window.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
3. Select the **Set Marker** menu option.
4. Choose one of the four marker positions available from the submenu.



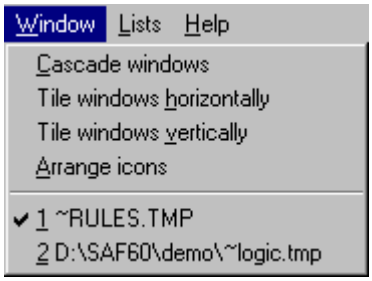
The marker positions are saved only during the current editing session.

6.4.5 Window Menu

6.4.5.1 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.

6.4.6 Lists Menu

6.4.6.1 Partition 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.
Fault Trees -	Select fault trees as top events and fault trees used to replace others instead of typing in the fault trees names.
End States -	Select end states used to replace others instead of typing in the end state names.
Event Trees -	Select event trees used to replace others instead of typing in the event tree names.

6.4.6.2 Macros

PURPOSE

This option allows you to insert a macro into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Macros** menu option. The *Macro List* dialog will be displayed.

4. Double-click on the desired macro name in the list. The selected name will be entered at the current cursor location.

The *Macro List* dialog will remain open in the application window during the current session unless explicitly closed.

6.4.6.3 Events

PURPOSE

This option allows you to insert a basic event name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Events** menu option. The *Event List* dialog will be displayed containing all of the basic events in the current family's database.

4. Double-click on the desired event name in the list. The selected name will be entered at the current cursor location.

The *Event List* dialog will remain open in the application window during the current session unless explicitly closed.

6.4.6.4 Initiators

PURPOSE

This option allows you to insert an initiating basic event name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Initiators** menu option. The *Initiator List* dialog will be displayed containing all of the basic events whose category attribute is set to "I" in the current family's database.

4. Double-click on the desired initiating event name in the list. The selected name will be entered at the current cursor location.

The *Initiator List* dialog will remain open in the application window during the current session unless explicitly closed.

6.4.6.5 Systems

PURPOSE

This option allows you to insert a fault tree name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Systems** menu option. The *System List* dialog will be displayed containing all of the fault trees in the current family's database.

4. Double-click on the desired fault tree name in the list. The selected name will be entered at the current cursor location.

The *System List* dialog will remain open in the application window during the current session unless explicitly closed.

6.4.6.6 End States

PURPOSE

This option allows you to insert an end state name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **End States** menu option. The *Endstate List* dialog will be displayed containing all of the end states in the current family's database.

4. Double-click on the desired end state name in the list. The selected name will be entered at the current cursor location.

The *Endstate List* dialog will remain open in the application window during the current session unless explicitly closed.

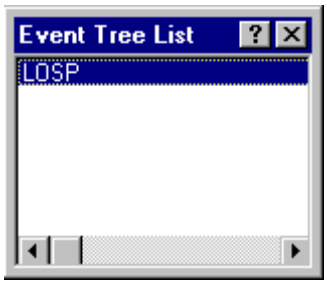
6.4.6.7 Event Trees

PURPOSE

This option allows you to insert an event tree name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Event Trees** menu option. The *Event Tree List* dialog will be displayed containing all of the event trees in the current family's database.



4. Double-click on the desired event tree name in the list. The selected name will be entered at the current cursor location.

The *Event Tree List* dialog will remain open in the application window during the current session unless explicitly closed.

6.5 Link Trees

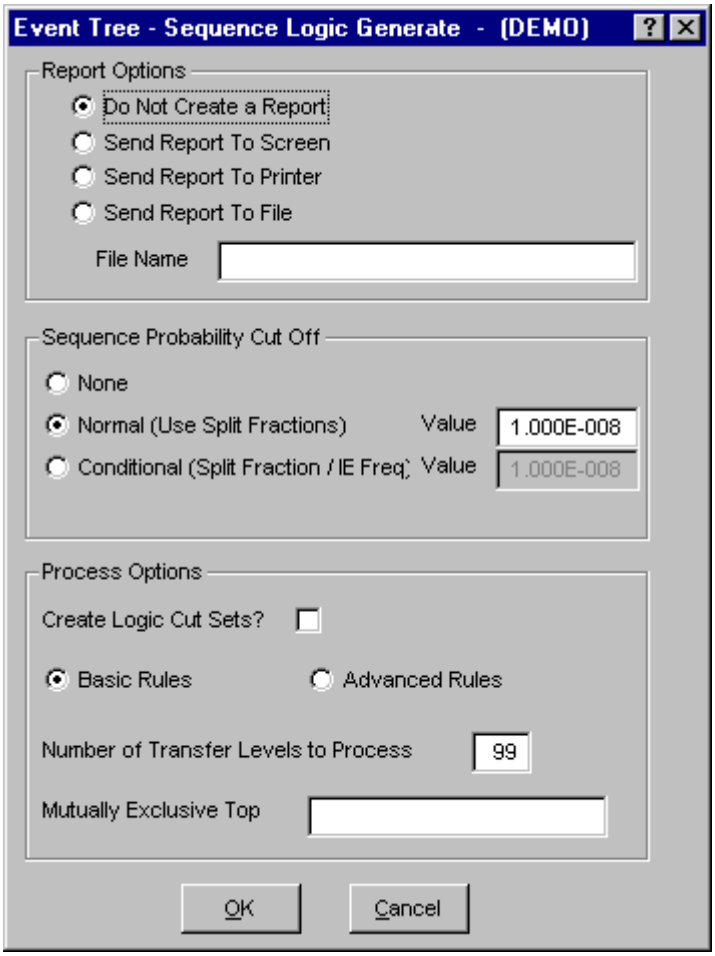
6.5.1 Linking Event Tree Sequences

PURPOSE

This option allows you to generate sequence logic using the event tree graphical files. During sequence generation the sequence logic is created as specified in the event tree logic, and then the linkage rules are applied.

STEPS

1. From the SAPHIRE menu select **Event Tree**. The *Event Tree List* dialog will be displayed.
2. Highlight the desired event tree(s) in the list.
3. Right-click to invoke the pop-up menu and choose **Link Trees**. The *Sequence Logic Generate* dialog will be displayed.



Report Options - The Sequence Generation report contains the generating details of the sequence.

Sequence Probability Cutoff – Select the type of probability cutoff to be performed, if any.

Create Logic Cut Sets? - Generate a sequence cut set when the sequence logic is generated.

Rules

Basic Rules – Use event tree linkage rules written using the basic if-then-else syntax.

Advanced Rules – Use event tree linkage rules written using the Modula-2 programming language.

Number of Transfer Levels to Process - Set the level of sub-tree tops contained in the sequences.

Mutually Exclusive Top - Specify a top to add to the sequence logic.

OK - Generate sequences based on the selected options.

Cancel - Terminate the process without generating the sequences.

6.5.2 The Sequence Generation Process

After sequence generation begins, a number of messages will be displayed in the message bar of the SAPHIRE window. One message displays the number of sequences being added or deleted. During this process, any new sequences are added and any sequences of the event tree that are no longer valid are removed. Another series of messages lists the name of the sequence being processed along with a running total of the number of good (i.e., valid) sequences processed and the total number of sequences processed. When complete, a final total of the number of sequences saved, the number of valid sequences encountered, and the number of sequences processed is displayed. If you choose to create a report, the name of the file containing the generating details of the sequence is displayed.

Invalid sequences can result in several ways.

1. The logic of an event tree may be such as to create sequences that have tops in them that are both failed and successful. These are invalid and are deleted.

2. The user may have modified the event tree logic, reducing the number of sequences for the tree. Sequences that existed previously are invalid, also.

3. Sequences that have an end state value of "OK," "SUCCESS" or begin with an "@" character are never generated by SAPHIRE.

6.5.3 Generate Options Dialog

6.5.3.1 Sequence Generation Report Options

The Sequence Generation report contains the listing of the sequences' names, the fault trees that make up the sequences, any substitutions of fault trees (based on the linkage rules), and any transfers to other event trees.

Do Not Create a Report -	No report is generated, but the sequences are generated.
Send Report To Screen -	Sends the report to the *Report Viewer*.
Send Report To Printer -	Sends the report to the Windows default printer.
Send Report To File -	Sends the report to the specified file name. A default name is provided, which can be changed by simply typing over the default name.

6.5.3.2 Sequence Probability Cut Off

Select the type of probability cutoff to be performed, if any. If the tops are independent, then the sequence logic can be truncated on probability. Each top is treated as a basic event with its probability assumed to be the value of its split-fraction. As the sequence logic is being created and each top is appended to the logic, the probability for the sequence can be checked to ensure that its probability is greater than the truncation value specified in the *Cut Off Value* field.

None –	Do not discard sequences when generating logic.
Normal –	Use the split fraction values as indicated above.

Conditional – Use the split-fraction values, but without considering the initiating event as part of the sequence probability (i.e., the initiating event probability = 1.0). This is initiating event value is used only during truncation, but not during quantification.

Cut Off Value - Enter the sequence probability truncation value. If either the *Normal* or *Conditional* radio button is selected, each sequence whose probability is less than the truncation probability is discarded and the logic is not followed.

6.5.3.3 Create Logic Cut Sets?

If you select this check box, sequence "cut sets" will be generated when the sequence logic is generated. Each top, whether failed or successful, is treated as a basic event and placed in a single "cut set" for the generated sequence. This technique is used to reproduce the "large event tree" methodology.

6.5.3.4 Basic Rules

Use the basic linkage rules for sequence logic generation. These rules were created using the Basic Linkage Rules Editor and can be different from those rules created using the Advanced Linkage Rules Editor.

6.5.3.5 Advanced Rules

Use the advanced linkage rules for sequence logic generation. These rules were created using the Advanced Linkage Rules Editor and can be different from those rules created using the Basic Linkage Rules Editor.

6.5.3.6 Number of Transfer Levels to Process

A level refers to a transfer to a sub-tree. The default value of 99 will generate sequences whose logic will contain all tops for all the sub-trees. If the level is set to less than 99, the generated sequences will contain only tops from sub-trees less than the specified level.

6.5.3.7 Mutually Exclusive Top

Optionally specify a top to add to the sequence logic. This top will be displayed in the logic as a complemented fault tree and will be treated accordingly when the sequence is solved. The purpose is to provide a method of removing illegal combinations of events.

Note that this option has been superceded by the incorporation of recovery rules.

6.6 Edit End States (Sequence Logic)

6.6.1 Edit Event Tree End States

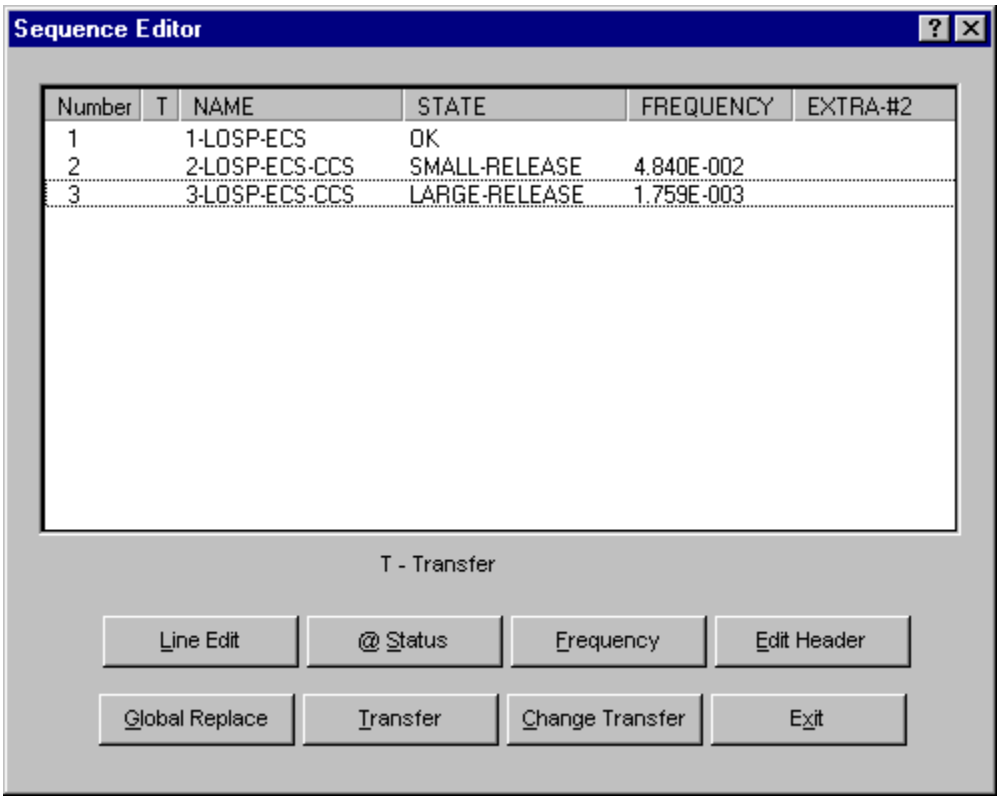
PURPOSE

This option allows you to view or modify event tree sequence information after an event tree has been created.

STEPS

1. From the SAPHIRE menu select **Event Tree**. The *Event Tree List* dialog will be displayed.
2. Highlight the desired event tree in the list.
3. Right-click to invoke the pop-up menu and choose **Edit End States**.
4. The *Sequence Editor* dialog will be displayed showing all the sequence names and end states defined for the selected event tree.

NOTE: Any changes made to sequence and end state names using this option, will automatically be updated throughout the database, including the event tree graphical (.ETG) file (i.e., the corresponding drawing will be updated).



Line Edit - Edit the data displayed one line at a time.
@Status - Toggle the current state of a sequence (i.e., sequence will be generated or ignored).
Frequency - Display the frequencies or min cut upper bound values associated with the selected sequence.
Edit Header - Change the headers that appear across the top of the columns.
Global Replace - Replace a specified string at every occurrence with another string
Transfer - Follow the transfer of the selected sequence to sub-trees.
Change Transfer - Turn on or off transfer points.
Exit - Terminate the sequence logic editor.

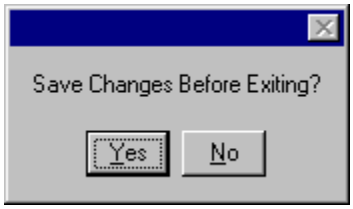
6.6.2 Exit Sequence Logic Editor

PURPOSE

This option closes the *Sequence Editor* dialog and allows you to save any changes made.

STEPS

1. From the SAPHIRE menu select **Event Tree**. The *Event Tree List* dialog will be displayed.
2. Highlight the desired event tree in the list.
3. Right-click to invoke the pop-up menu and choose **Edit End States**. The *Sequence Editor* dialog will be displayed.
4. Make desired changes to the logic.
5. Choose the **Exit** button. You will be prompted to save the changes before exiting.



Yes - Save the changes to the sequence logic. The corresponding event tree graphical (.ETG) file will be updated with the changes at this time.
No - Do not save the changes to the sequence logic.

NOTE: You will not be prompted with this dialog if no changes were made to the sequence logic.

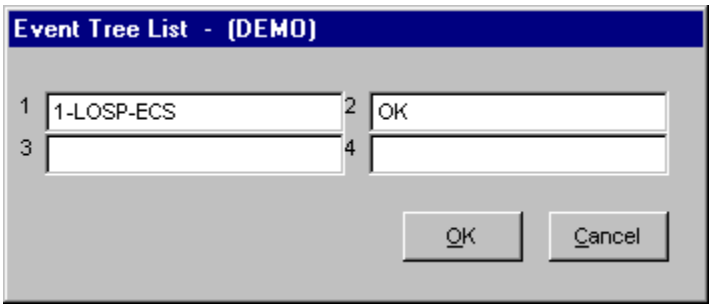
6.6.3 Line Edit

PURPOSE

This option allows you to edit the data displayed one line at a time, including sequence names, sequence end state names, sequence frequencies.

STEPS

1. From the SAPHIRE menu select **Event Tree**. The *Event Tree List* dialog will be displayed.
2. Highlight the desired event tree in the list.
3. Right-click to invoke the pop-up menu and choose **Edit End States**. The *Sequence Editor* dialog will be displayed.
4. Highlight the desired sequence and choose the **Line Edit** button.
5. The *Line Edit* dialog will be displayed with the sequence information.



You may change any of the fields displayed by simply typing over the existing data. . These changes made are not saved until you exit the *Sequence Editor* dialog. At that time, you will be asked whether or not you wish to save all changes made before exiting.

OK - Exit and show the changes made.
Cancel - Exit without showing the changes made. These changes will not be saved when you exit the *Sequence Editor* dialog.

6.6.4 @Status

PURPOSE

This option allows you to toggle the current state of a sequence (i.e., sequence will be generated or ignored). An "@" means that the corresponding sequence will not be generated; it will be ignored. (Remember that "successful" sequences are not generated when OK or SUCCESS is present in the *End State* column, or when the @Status has been assigned.)

STEPS

1. From the SAPHIRE menu select **Event Tree**. The *Event Tree List* dialog will be displayed.
2. Highlight the desired event tree in the list.
3. Right-click to invoke the pop-up menu and choose **Edit End States**. The *Sequence Editor* dialog will be displayed.
4. Highlight the desired the sequence whose status is to be changed and choose the **@Status** button.

Depending on the current status, an "@" will appear or disappear in front of the end state name.

6.6.5 Frequency

PURPOSE

This option will display the frequencies or minimal cut set upper bound values associated with the selected sequence. The values displayed are the results of the last time the sequences were solved. Frequency values are NOT recalculated using this option.

STEPS

1. From the SAPHIRE menu select **Event Tree**. The *Event Tree List* dialog will be displayed.
2. Highlight the desired event tree in the list.
3. Right-click to invoke the pop-up menu and choose **Edit End States**. The *Sequence Editor* dialog will be displayed.
4. Highlight the desired sequence(s) and choose the **Frequency** button.

The *EXTRA-#1* column will be renamed to *FREQUENCY* and the corresponding frequencies will be displayed. You may now invoke the Line Edit command to modify frequencies, if desired.

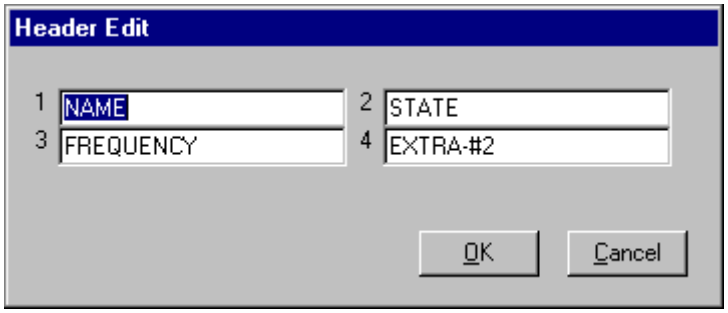
6.6.6 Edit Header

PURPOSE

This option allows you to change the headers that appear across the top of the columns (note*: EXTRA-#2* is a user-defined field).

STEPS

1. From the SAPHIRE menu select **Event Tree**. The *Event Tree List* dialog will be displayed.
2. Highlight the desired event tree in the list.
3. Right-click to invoke the pop-up menu and choose **Edit End States**. The *Sequence Editor* dialog will be displayed.
4. Choose the Edit Header button. The *Header Edit* dialog will be displayed.



To make changes, simply type over the existing header. These changes made are not saved until you exit the *Sequence Editor* dialog. At that time, you will be asked whether or not you wish to save all changes made before exiting.

OK - Exit and show the changes made.
Cancel - Exit without showing the changes made. These changes will not be saved when you exit the *Sequence Editor* dialog.

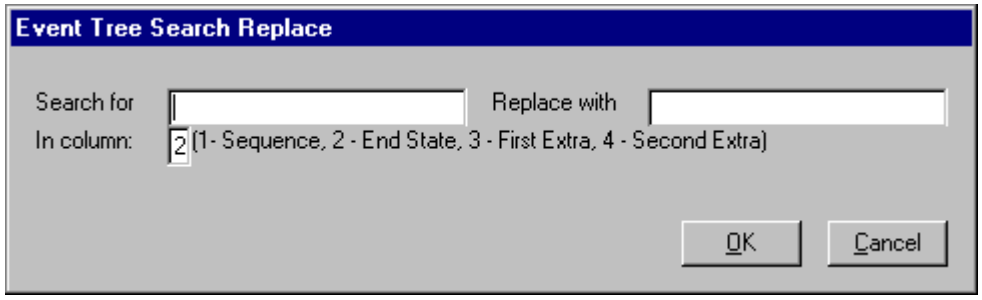
6.6.7 Global Replace

PURPOSE

This option allows you to replace a specified string at every occurrence with another string.

STEPS

1. From the SAPHIRE menu select **Event Tree**. The *Event Tree List* dialog will be displayed.
2. Highlight the desired event tree in the list.
3. Right-click to invoke the pop-up menu and choose **Edit End States**. The *Sequence Editor* dialog will be displayed.
4. Choose the **Global Replace** button. The *Event Tree Search Replace* dialog will be displayed.
5. Enter the string for which to search in the *Search for* field.
6. Enter the replacement string in the *Replace with* field.
7. Select the column (1, 2, 3, or 4) on which to perform the search.



If the search string is found, all occurrences of the search string will be replaced by the string specified in the *Replace with* field. If the string is not found, the message, "No such string found" will be displayed in message bar of the SAPHIRE window and the *Event Tree Search Replace* dialog will be closed.

6.6.8 Transfer

PURPOSE

This option will allow you specify event tree transfers (to sub-trees), control the status of event tree transfers, and transfer to sub-trees within the editor.

STEPS

1. From the SAPHIRE menu select **Event Tree**. The *Event Tree List* dialog will be displayed.
2. Highlight the desired event tree in the list.
3. Right-click to invoke the pop-up menu and choose **Edit End States**. The *Sequence Editor* dialog will be displayed.
4. Highlight the desired sequence and choose the **Transfer** button.

If changes were made to the current event tree, you will be asked if you wish to save those changes before following the transfer.

The *Sequence Editor* dialog will be displayed with the name of the transfer tree appearing the *Event Tree* box.

After desired changes are made to this event tree, choosing the **Exit** button closes this dialog. The *Sequence Editor* dialog will be redisplayed with the previous event tree sequences listed.

6.6.9 Change Transfer

PURPOSE

This option works as a toggle switch to turn on and off transfer points. If the sequence was marked as a transfer to an event tree sub-tree, this option will turn off the transfer. If the sequence was not marked as a transfer, it turns on the transfer. (The sub-tree name is then entered in the *End State* column.) A "T" appears in the column in front of the sequence names.

STEPS

1. From the SAPHIRE menu select **Event Tree**. The *Event Tree List* dialog will be displayed.
2. Highlight the desired event tree in the list.
3. Right-click to invoke the pop-up menu and choose **Edit End States**. The *Sequence Editor* dialog will be displayed.
4. Highlight the desired sequence and choose the **Change Transfer** button.

7. SEQUENCE ANALYSIS

7.1 Sequence Analysis

PURPOSE

When developing a risk assessment code, accident sequence analysis must also be considered. Accident sequences are defined in SAPHIRE by developing event trees . Once an event tree has been developed, the sequence logic from the event tree can be generated. The sequence logic is the list of systems that succeed or fail during this accident sequence. These system failures and successes are top events of fault trees. This logic is used by SAPHIRE to generate the cut sets for the sequence.

This option provides the means to recalculate sequence values after event failure data and/or cut sets have been modified. The *Sequences* dialog shows all sequences, ordered by event tree name and sequence name, in the current project.

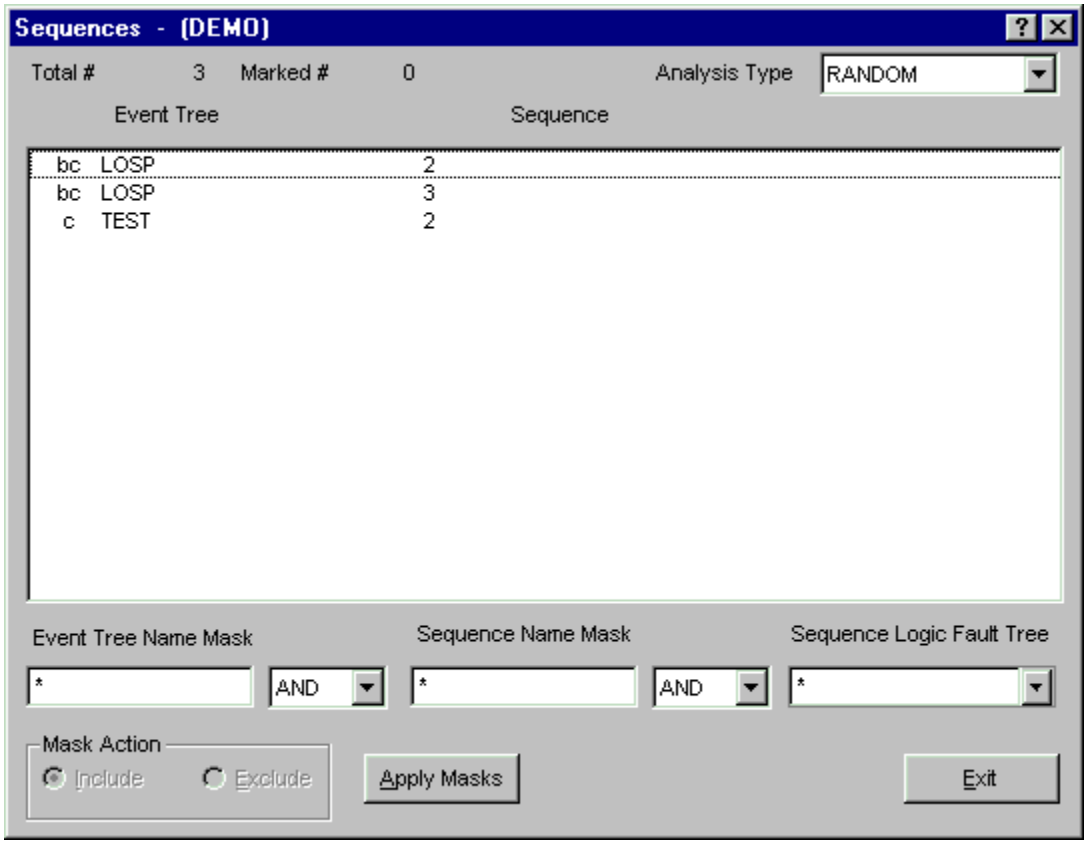
KEY TO FLAGS

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

b - base case cut sets exist for the selected analysis type
c - current case cut sets exist for the selected analysis type

STEPS

1. From the SAPHIRE menu select **Sequence**. The *Sequences* dialog will be displayed.



From this dialog, you can select sequences using the mouse or the Mask feature. The analysis type can be selected from the drop-down list. Additionally, the following functions may be accessed from the pop-up menu:

Solve -	Generate cut sets for a sequence based on cut set generation cut off values.
Quantify -	Calculate a new minimum cut set upper bound for sequence cut sets using current data values (using event data changes and current case cut sets).
Uncertainty -	Perform uncertainty analysis on a sequence using either the Monte Carlo or Latin Hypercube simulation technique.
Cut Sets -	Perform various operations on sequence cut sets: Update, Prune, Recover, Edit.
Display -	Display the results of sequence analyses in various report forms.
View -	View sequence analysis information and compare base case and current case minimal cut set upper bound results.
Time Dependent -	Perform time dependent sequence analysis.

7.2 Sequence Mask Feature

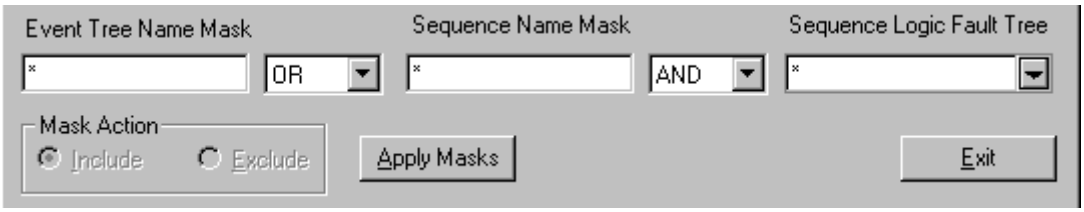
PURPOSE

This feature facilities selection of event tree sequences in the list by matching criteria in the three *mask* fields in combination with the selected logic operations.

The wildcard characters asterisk (*) and question mark (?) can be used in any of the mask fields. 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.

STEPS

1. Specify the event tree name criterion, if any.
2. Choose the logic operator from the drop-down list.
3. Specify the sequence name criterion, if any.
4. Choose the logic operator from the drop-down list.
5. Specify the fault tree name criterion, if any.
6. Choose the desired mask action.
7. Choose the **Apply Masks** button. All sequences matching the specified qualification criteria will be selected or deselected, depending on the current mask action.
8. Right-click to invoke the pop-up menu and select the desired operation, or repeat steps 1 through 7 to select/deselect additional sequences based on another set of qualification criteria.



The graphic here shows the mask fields as they appear when the *Sequences* dialog is initially invoked.

Event Tree Name Mask - Used to specify the desired event tree(s) by name. An asterisk will allow all event trees to be considered.

Sequence Name Mask - Used to specify the desired sequence(s) by name. An asterisk will allow all sequences to be considered.

Sequence Logic Fault Tree - Used to specify the desired fault tree(s) that are used in the sequence logic by fault tree name. A specific fault tree can be selected from the drop-down list by clicking on the down arrow to the right of this field. All fault trees in the current project will be listed.

Logic Operators - Two logic operator drop-down lists are available, each providing two options: AND and OR. The selected logical operation for the drop-down list on the left is applied to the event tree name and sequence name criteria. The selected logical operation for the drop-down list on the right is applied to the sequence name and sequence logic fault tree mask criteria.

AND - Choosing this option tells SAPHIRE that *both* sets of qualification criteria in the applicable mask fields must be met.

OR - Choosing this option tells SAPHIRE that *either* set of qualification criteria in the applicable mask fields may be met.

Mask Action

Include - The sequences that match the qualification criteria will be selected.

Exclude - The sequences that match the qualification criteria will be deselected.

Apply Masks - Search for the sequences that match the qualification criteria and apply the selected mask action.

7.3 Sequence Mask Examples

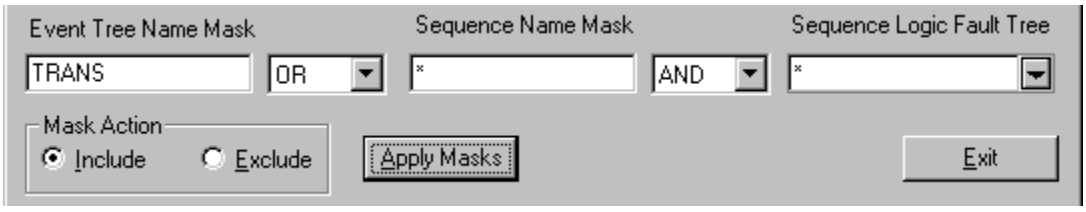
PURPOSE

Provide examples for using the sequence mask feature. The BYRON_ASP project is used in these examples.

Example 1 STEPS

To select all sequences in the TRANS event tree:

1. Enter "TRANS" in the *Event Tree Name Mask* field.
2. Choose the AND logic operation (default value).
3. Enter "*" in the *Sequence Name Mask* field (default value).
4. Choose the AND logic operation (default value).
5. Enter "*" in the *Sequence Logic Fault Tree* field (default value).
6. Choose the **Include** radio button.
7. Choose **Apply Masks**.

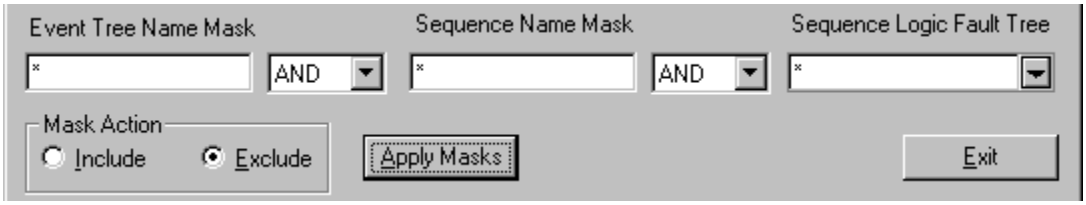


All 13 of the TRANS event tree sequences will be selected. Note the *Marked #* indicator at the top of the *Sequences* dialog.

Example 2 STEPS

To deselect all sequences:

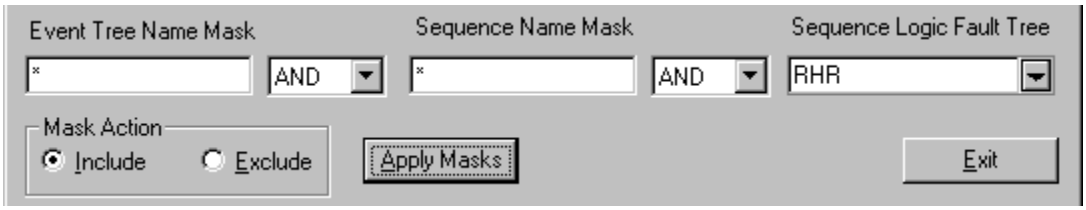
1. Enter an asterisk in each of the mask fields.
2. Choose **Exclude**.
3. Choose **Apply Masks**.



Example 3 STEPS

To select all sequences that include the RHR fault tree in their logic:

1. Leave all fields with default values, unless otherwise specified. ("*" in the *Event Tree Name Mask* and *Sequence Name Mask* fields, AND logical operators selected.)
2. Enter "RHR" in the *Sequence Logic Fault Tree* field (or select it from the drop-down list).
3. Choose the **Include** radio button.
4. Choose **Apply Masks**.



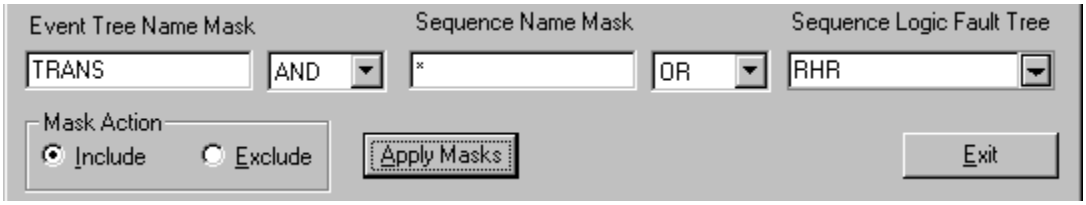
11 sequences will be selected – Three LOOP, two SGTR, three SLOCA, and three TRANS. If the Example 2 steps had been skipped, 21 sequences would have been selected – the 13 TRANS in addition to the three LOOP, two SGTR, and three SLOCA.

Example 4 STEPS

To select all sequences in the TRANS event tree along with all sequences that include the RHR fault tree in their logic (examples 1 and 3 without performing two separate mask operations):

1. Deselect all sequences (Example 2).

2. Enter “TRANS” in the *Event Tree Name Mask* field.
3. Choose the AND logic operation.
4. Enter “*” in the *Sequence Name Mask* field.
5. Choose the **OR** logic operation.
6. Enter “RHR” in the *Sequence Logic Fault Tree* field.
7. Choose the **Include** radio button.
8. Choose **Apply Masks**.

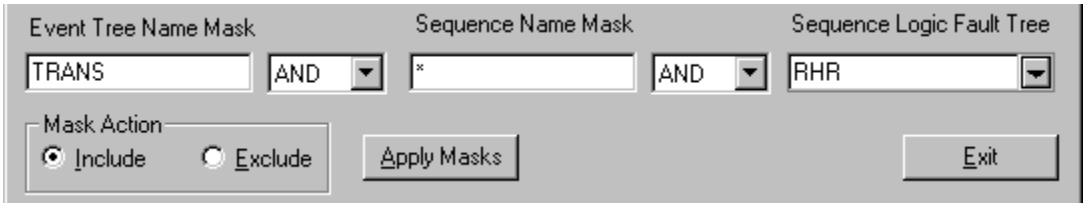


The 21 sequences, discussed above will be selected.

Example 5 STEPS

To select only those sequences in the TRANS event tree that include the RHR fault tree in their logic:

1. Deselect all sequences (Example 2).
2. Enter “TRANS” in the *Event Tree Name Mask* field.
3. Choose the AND logic operation.
4. Enter “*” in the *Sequence Name Mask* field.
5. Choose the **AND** logic operation.
6. Enter “RHR” in the *Sequence Logic Fault Tree* field.
7. Choose the **Include** radio button.
8. Choose **Apply Masks**.



Three sequences will be selected. Note: The only difference between Example 4 and Example 5 is the logical operator selection in STEP 5.

7.4 Solving Sequences

7.4.1 Solving Sequences

PURPOSE

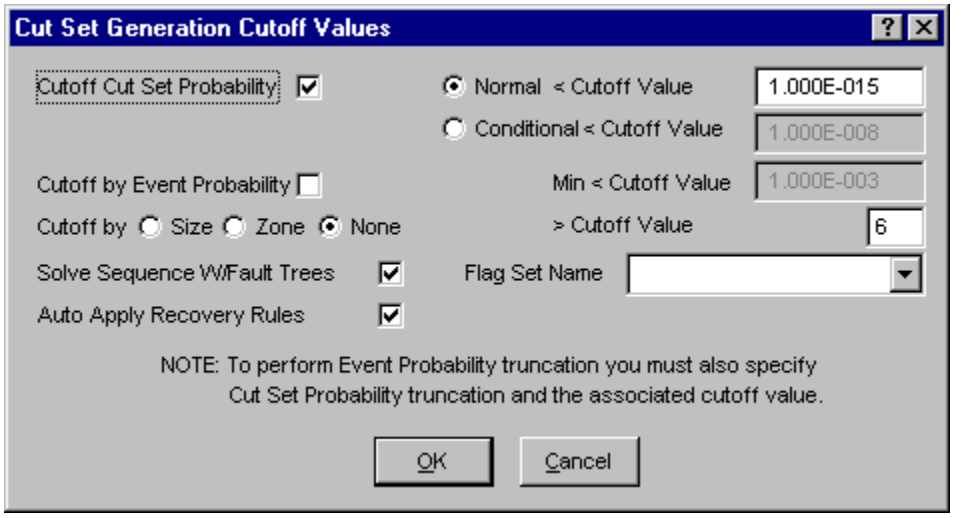
This option allows you to generate the cut sets for selected sequence(s) based on cut set generation cutoff values. You are given the opportunity to specify several cut set generation cutoff values that will be used to determine if a cut set is to be retained or discarded from the selected sequence(s). You are given the ability to generate cut sets for a selected sequence, a group of sequences, or all sequences within the current project.

STEPS

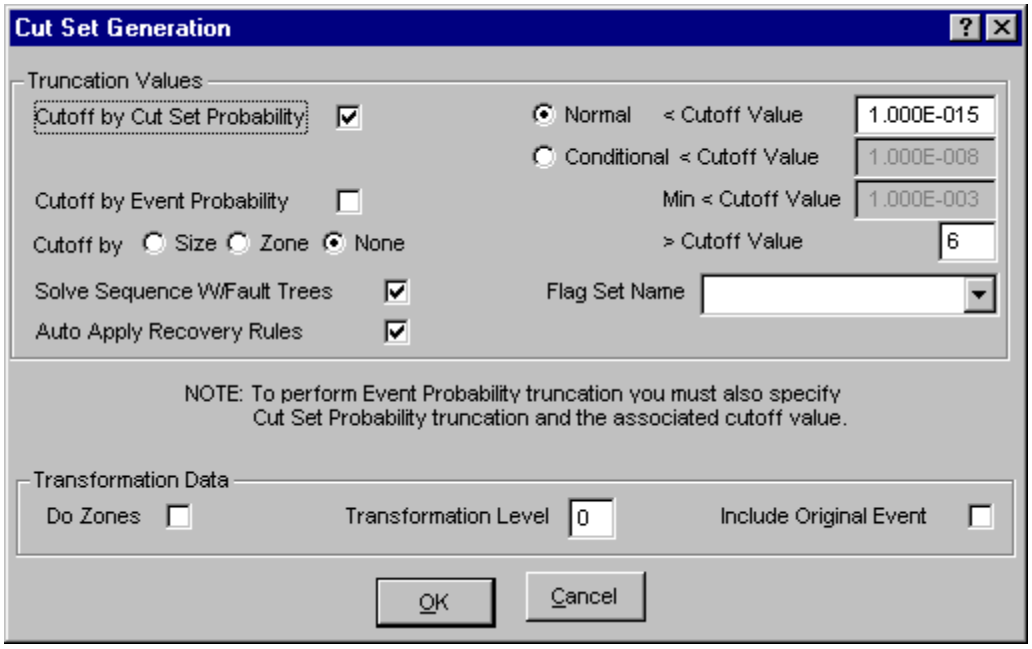
1. From the SAPHIRE menu select **Sequence**. The *Sequences* dialog will be displayed.
2. Highlight the desired sequence(s) and right-click to invoke the pop-up menu.
3. Choose **Solve**.

Whether you are generating cut sets for a single sequence, a group of sequences, or for all sequences the *Cut Set Generation* dialog will be displayed.

The dialog below is displayed when the Analysis Type is "Random".



The dialog below is displayed when any other Analysis Type is selected.



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 < *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.

Solve Sequence W/Fault Trees - Use the fault trees to solve the tree; otherwise the fault tree cut sets are used.

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.

Do Zones - If checked, perform zone transformation during cut set generation.

Transformation Level - An integer 0 -255 which indicates the default level of substitution for the transformations to be performed.

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 *Sequences List* dialog is updated to show the letter "c" in front of the sequence(s) with current case cut sets.

7.4.2 Cut Set Generation Dialog

7.4.2.1 Cutoff By Cut Set Probability

If you select this check box and choose the:

Normal radio button - Only those 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.

Conditional radio button - Only those cut sets whose product for all of its event probabilities, excluding the initiating event probability, is greater than or equal to the value in the <*Cutoff Value* field will be kept.

All other cut sets will be removed.

If you deselect this check box, then the probability for the cut set will be irrelevant for determining if the cut set should be retained or discarded.

7.4.2.2 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 his option, SAPHIRE will also perform the quantification.

7.4.2.3 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.

7.4.2.4 Solve Sequence W/Fault Trees

If you check this box, then fault tree logic will be used. If the box is unchecked, previously generated fault tree cut sets will be used.

7.4.2.5 Flag Set Name

This option allows the user to specify changes to the flags for each sequence without having to regenerate the failure data each time. The fault tree logic is pruned before it is solved, dependent on these flags.

Select the desired flag set, if any, from the drop-down list. If this field is left blank, then SAPHIRE checks to see if there is a default setting for this sequence. The default can be set using the **Modify | Event Trees | Sequences** menu options. If there is a default setting, then SAPHIRE uses it; otherwise, SAPHIRE uses no flags.

If you specify a flag set, 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.

7.5 Quantifying Sequences

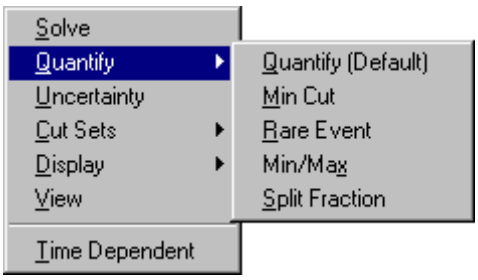
7.5.1 Quantifying Sequences

PURPOSE

The quantification process will re-quantify the cut sets using current data values (event change sets and current case cut sets) for a selected sequence, for a group of sequences, or for all of the sequences within the current project. The new value is saved with the current case cut sets for the selected sequence.

STEPS

1. From the SAPHIRE menu select **Sequence**. The *Sequences* dialog will be displayed.
2. Highlight the desired sequence(s) and right-click to invoke the pop-up menu.
3. Choose **Quantify**, then one of the sub-menu options.



Quantify (Default) – Re-quantify using the quantification method for the specified sequence. This is selected in the **Modify | Event Trees | Sequences** 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.

Split Fraction - Quantify the cut sets using the min cut upper bound values that have been calculated for each successful or failed fault tree in this sequence.

If the selected quantification method differs from the sequence(s) default, a warning box with the message, "The chosen quantification method was different from the Sequence 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 sequence was selected, upon completion of the quantification process, the results are displayed in the *Quantification Results* dialog. Choose **Ok** to close the dialog.

7.5.2 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 ∪ B ∪ 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

7.5.3 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.

SEE TECHNICAL REFERENCE

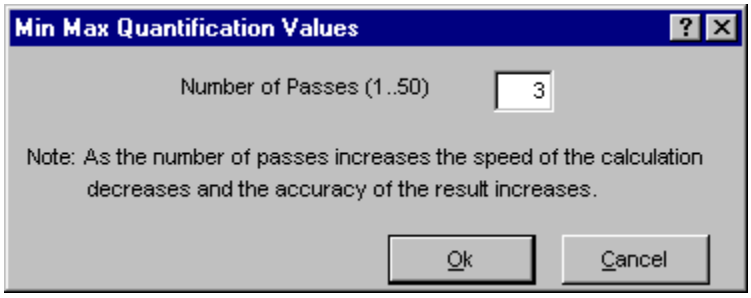
Rare Event

7.5.4 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 ∪ B ∪ 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 value
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

7.5.5 Split Fraction

This option allows you to quantify the sequence cut sets using the min cut upper bound values that have been calculated for each successful or failed fault tree which make up this sequence. This option does not generate cut sets and is usually used to give you a quick approximation of the actual result. The actual results may be obtained by generating cut sets and quantifying these cut sets.

7.6 Uncertainty Analysis

7.6.1 Uncertainty Analysis

PURPOSE

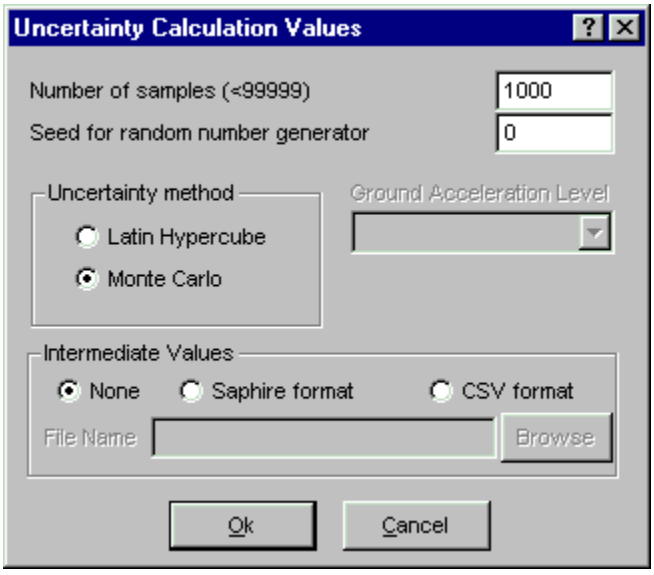
This option can estimate the variability (due to the uncertainties in the basic event probabilities) of either a fault tree top event probability or an event tree sequence frequency. To do this, SAPHIRE provides two sampling techniques: Monte Carlo simulation and Latin Hypercube simulation. In addition, 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**. 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.



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.

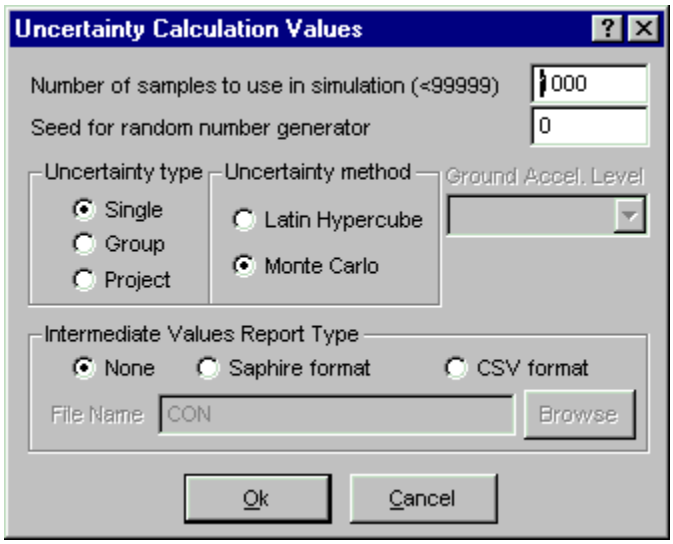
Ground Acceleration Level - If seismic uncertainty is selected, a ground level acceleration must be provided. This indicates the acceleration rate at which the component will always fail. The user can select to process all G-levels combined, all G-levels separately, or a specified G-level only.

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.

7.6.2 Uncertainty Analysis for Multiple Sequences

When multiple sequences are selected for processing, you may combine results using the group or project option. All options are the same as the dialog for uncertainty analysis for single sequences, with the addition of the *Uncertainty type* group.



Single - Obtain uncertainty analysis results for each marked sequence separately. This data will be saved in the database for the selected sequence.

Group - Obtain uncertainty analysis results for marked sequences as a group. Group uncertainty results are not saved in the database. These results are not available from the **Display** option.

Project - Obtain uncertainty analysis results for the sequences in the project. This data will be saved in the database for the current project.

7.6.3 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 1.00000E+000 1.00000E+000
    2    2 1.00000E+000 1.00000E+000
    3    2 1.00000E+000 1.00000E+000
                 .
                 .
                 .
  500    2 1.00000E+000 1.00000E+000
```

7.6.4 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.

7.6.5 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.

7.6.6 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.

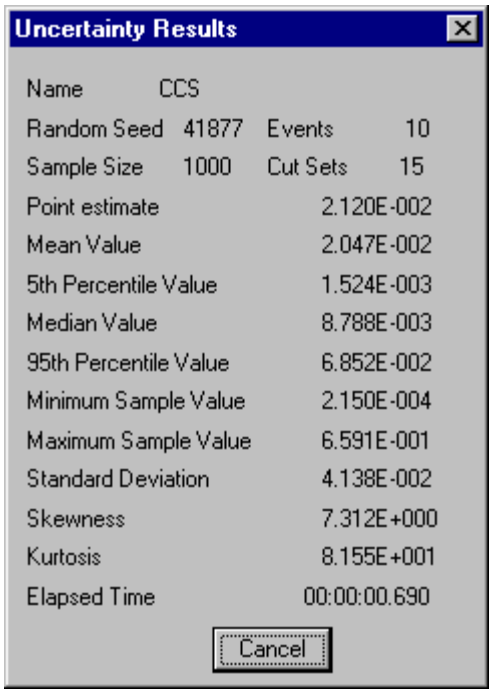
If an error occurs during the uncertainty analysis process, the process is terminated and a message box providing information about the specific error is displayed.

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.

7.6.7 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.

7.6.8 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.

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.

7.7 Sequence Cut Set Analysis

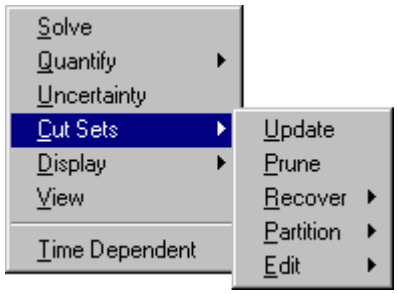
7.7.1 Sequence Cut Set Analysis

PURPOSE

This option provides the ability to perform a variety of analysis functions on the sequence cut sets.

STEPS

1. From the SAPHIRE menu select **Sequence**. The *Sequences* dialog will be displayed.
2. Highlight the desired sequence(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 selected sequence(s) based on cut set generation cutoff values.
Prune - Eliminate cut sets from selected sequence(s) that contains events that conflict in some way with one another.
Recover -Modify cut sets by adding recovery actions to them.
Partition-Define the end states to be associated with each cut set in a sequence.
Edit - Modify the base case/current sequence cut sets.

7.7.2 Updating Cut Sets

PURPOSE

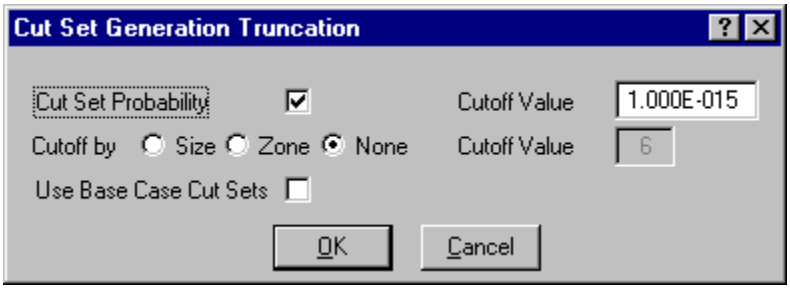
This option will update the current case cut sets for a selected fault tree (or sequence or end state) based on cut set generation cutoff values. You are given the opportunity to specify several cut set generation cutoff values that will be used to determine if a cut set is to be retained or discarded. 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.

7.7.3 Cut Set Generation Truncation

7.7.3.1 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.

7.7.3.2 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.

7.7.3.3 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.

7.7.4 Recovering Sequence Cut Sets

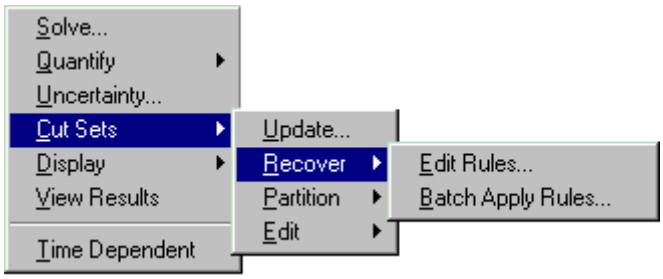
7.7.4.1 Recovering Sequence Cut Sets

PURPOSE

The "recovery" option allows the user to post-process cut sets by modifying them according to a pre-defined set of rules. You can recover a selected event or events based on sequence, applied, or derived 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 **Sequence**. The *Sequences* dialog will be displayed.
2. Highlight the desired sequence(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 sequence.
Apply Batch - Apply all rules currently defined to the highlighted sequences.

7.7.4.2 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.

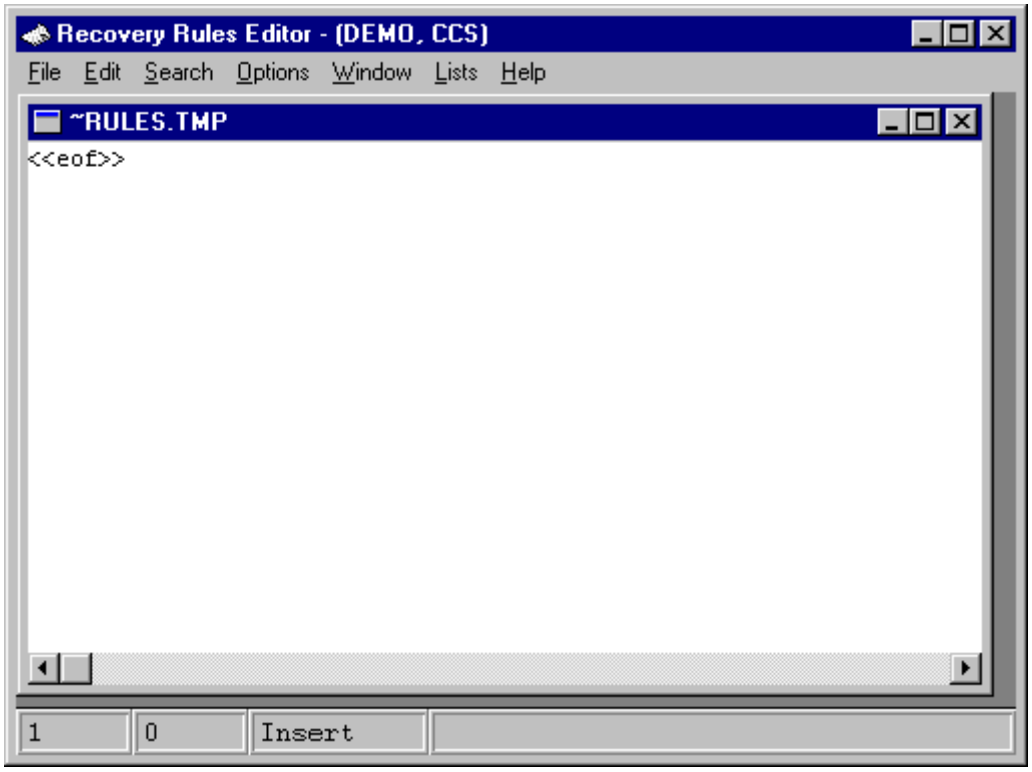
Recovery rules follow a format similar to the structure that is found in traditional programming languages (e.g., BASIC or PASCAL). As such, the ability exists to define "macros" and "if...then" type of structures. After creating or editing rules, SAPHIRE compiles the rules to check their validity. Alternatively, 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.

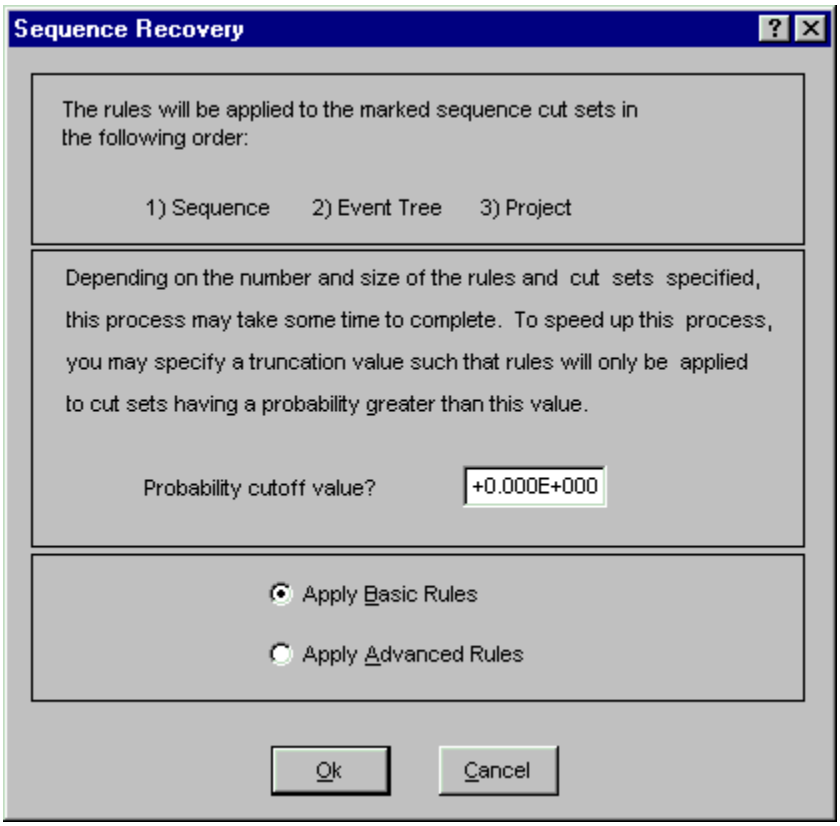
PURPOSE

This option allows you to apply all rules currently defined to the highlighted sequences.

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 **Sequence**. The *Sequences* dialog will be displayed.
2. Highlight the desired sequence(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets | Recover**.
4. Select the **Apply Batch** sub-menu option. The *Sequence 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 *Sequence Recovery* dialog without applying rules.

7.7.4.3 Sequence Recovery Options

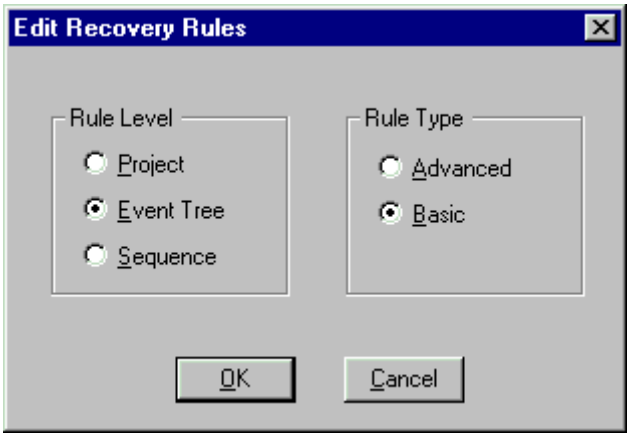
PURPOSE

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.

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 **Sequence**. The *Sequences List* dialog will be displayed.
2. Highlight the desired sequence(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets | Recover | Edit Rules**. 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.

Event Tree - Edit rules whose scope you wish to apply only to the sequences of the highlighted event tree.

Sequence - Edit rules whose scope you wish to apply only to the sequences of the highlighted sequence. (Not generally recommended, because these rules may be deleted during future event tree linking.)

Rule Type

Advanced - Edit rules using the advanced recovery rules language.

Basic - Edit rules using the basic recovery rules language.

OK - Create and modify sequence recovery rules.

Cancel - Close the *Edit Recovery Rules* dialog without editing any rules.

7.7.4.4 Basic Recovery Rule 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.

7.7.4.5 Advanced Recovery Rule 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/event tree/sequence 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.

7.7.5 Partitioning Sequence Cut Sets

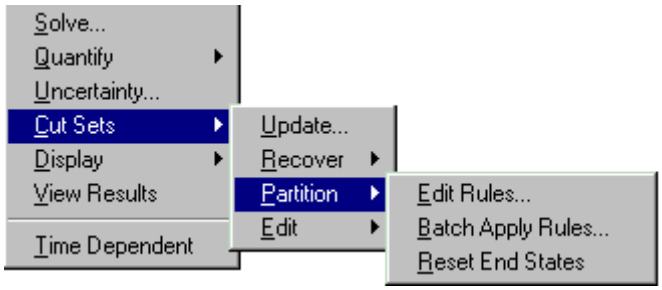
7.7.5.1 Partitioning Sequence Cut Sets

PURPOSE

This option allows you to define the end states to be associated with each cut set in an accident sequence. You can define a set of rules that map the cut sets for a sequence to a particular end state. The rules are defined using the Partition Rules Editor.

STEPS

1. From the SAPHIRE menu select **Sequence**. The *Sequences* dialog will be displayed.
2. Highlight the desired sequence(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets | Partition**.
4. Select one of the sub-menu options



Edit Rules - Define cut set partitioning rules for individual sequences.
Apply Batch - Apply the currently defined **partition rules to the selected sequence(s).**
Reset End States - Clear the sequences created by the partitioning rule.

Once the rules have been defined, they need to be applied . Rules are applied sequentially; that is, project rules, followed by event tree rules, and finally sequence rules. If rules conflict, the latest applied rule will take precedence over earlier ones. After you have entered the partitioning rules and applied them, you must then "gather" cut sets for the various end states that you have defined.

7.7.5.2 Apply Batch

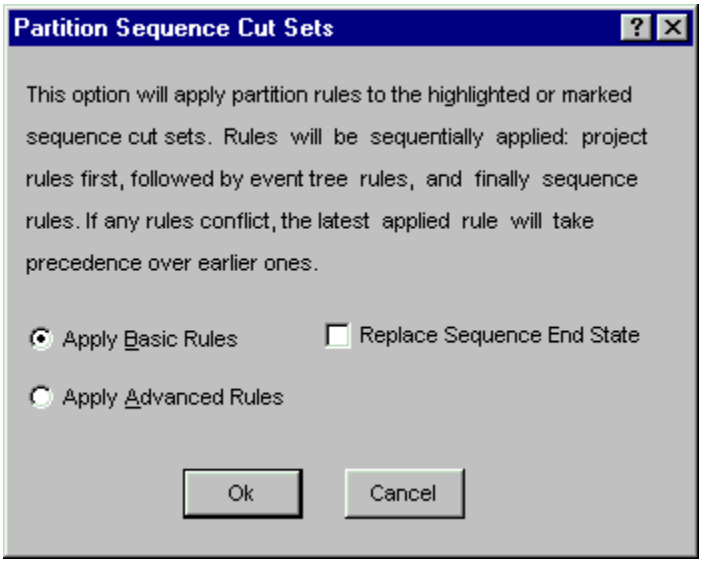
PURPOSE

This option actually applies the partition rules to the selected sequence cut sets. Rules are sequentially applied; that is, project rules, followed by event tree rules, and finally sequence rules. If rules conflict, the latest applied rule will take precedence over earlier ones.

STEPS

1. From the SAPHIRE menu select **Sequence**.
2. The *Sequences* dialog will be displayed.
3. Highlight the desired sequence(s) and right-click to invoke the pop-up menu.
4. Choose **Cut Sets | Partition**.

5. Select the **Apply Batch** sub-menu option. The *Partition Sequence Cut Sets* 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.

Replace Sequence End State - Replace the end state at the sequence level, rather than at the cut set level.

Ok - Apply the rules to the selected sequence cut sets.

Cancel - Close the *Partition Sequence Cut Sets* dialog without applying rules.

7.7.5.3 Reset End States

PURPOSE

This option clears the sequence end states created by the partitioning rules. By performing this function, the sequence end state cross-reference map is set to blank. However, cut sets will still appear in the end states until the end state is removed, or gathered again. By clearing the cross-reference map, the end state can be removed, if desired, from the end states listed by using the **Modify | End States** option.

STEPS

1. From the SAPHIRE menu select **Sequence**. The *Sequences* dialog will be displayed.
2. Highlight the desired sequence(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets | Partition**.

4. Select the **Reset End States** sub-menu option. The message, "Reset complete," will be displayed in the status bar of the SAPHIRE window.

7.7.5.4 Partition Rule Edit Options

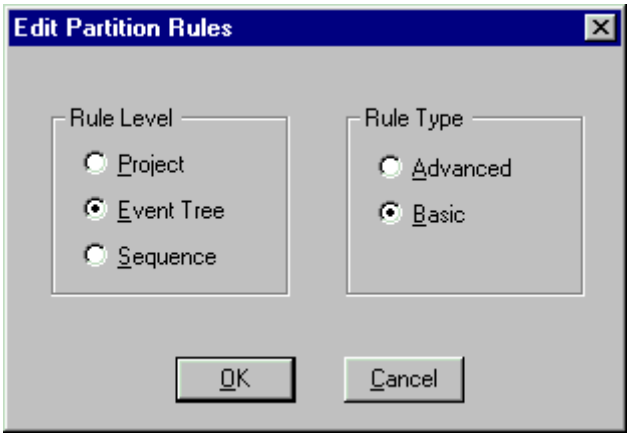
PURPOSE

The "partition" option allows the user to post-process cut sets by assigning an end state to each cut set according to a pre-defined set of rules. The user constructs partition rules to be applied to each cut set which then define the end state to be assigned. The rules are constructed using the same editor that is used for event tree rules definition, and recovery rule 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 sequence, all sequences belonging to an event tree, or for all sequences, depending on the *Rule Level* selected.

STEPS

1. From the SAPHIRE menu select **Sequence**. The *Sequences List* dialog will be displayed.
2. Highlight the desired sequence(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets | Partition | Edit Rules**.
4. The *Edit Partition Rules* dialog will be displayed.



Rule Level

Project - Edit rules whose scope you wish to apply to all or multiple event tree sequences across the project.

Event Tree - Edit rules whose scope you wish to apply only to the sequences of the highlighted event tree.

Sequence - Edit rules whose scope you wish to apply only to the sequences of the highlighted sequence. (Not generally recommended, because these rules may be deleted during future event tree linking.)

Rule Type

Advanced - Edit rules using the advanced recovery rules language.
Basic - Edit rules using the basic recovery rules language.

OK - Create and modify sequence recovery rules.
Cancel - Close the *Edit Partition Rules* dialog without editing any rules.

7.7.5.5 Basic Partition Rule 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.

7.7.5.6 Advanced Partition Rule 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/event tree/sequence or 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.

7.7.5.7 Partition Rules Editor

7.7.5.7.1 Partition Rules Editor

PURPOSE

This editor allows you to define a set of rules that map the cut sets for a sequence to an end state. This is a free format, macro-based line editor that provides you with an if-then-else logic structure. If rules have already been defined they will be displayed in the edit window.

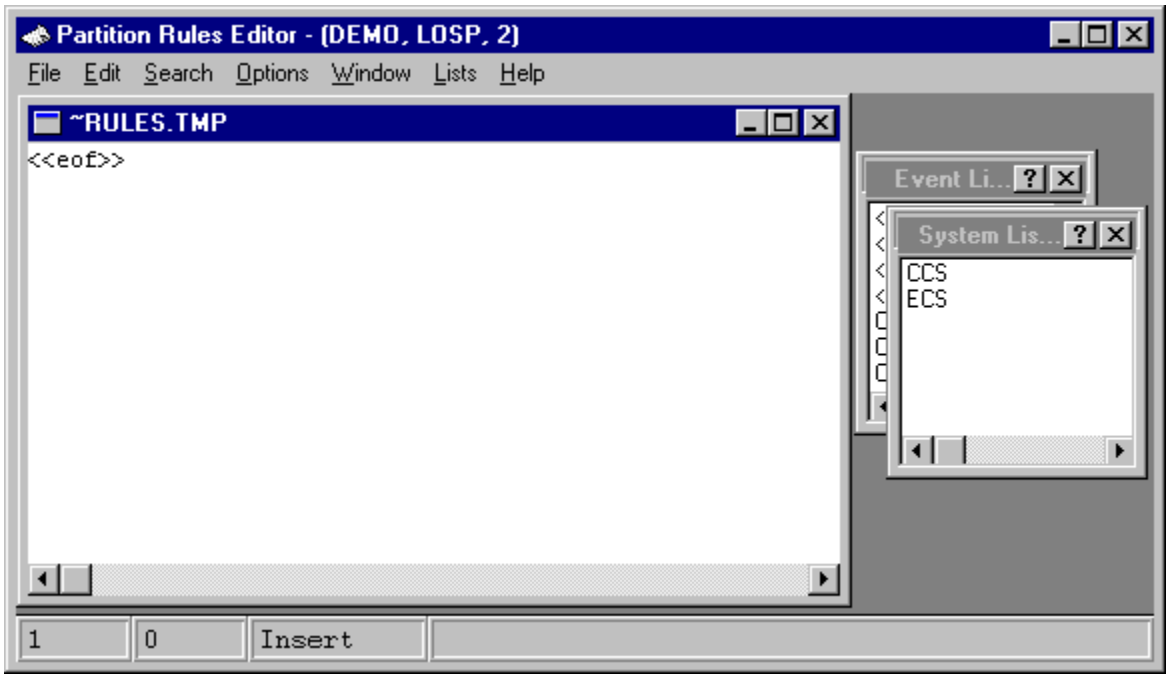
By default, the editor assumes that a name is the name of a basic event, if one exists in the database. If a basic event by the name does not exist then the editor assumes that the name is the name of a macro. If you want to change the default assumptions, then you can "cast" the names to something else by enclosing the name in parenthesis with a cast name preceding it.

There is no limit to the number of rules you may input to the editor. Each rule is processed in sequential order.

STEPS

1. From the SAPHIRE menu select **Sequence**. The *Sequences* dialog will be displayed.
2. Highlight the desired sequence(s) and right-click to invoke the pop-up menu.
3. Choose **Cut Sets | Partition | 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.



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.

7.7.5.7.2 File Menu

7.7.5.7.2.1 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 *Editor* session.

7.7.5.7.2.2 Open

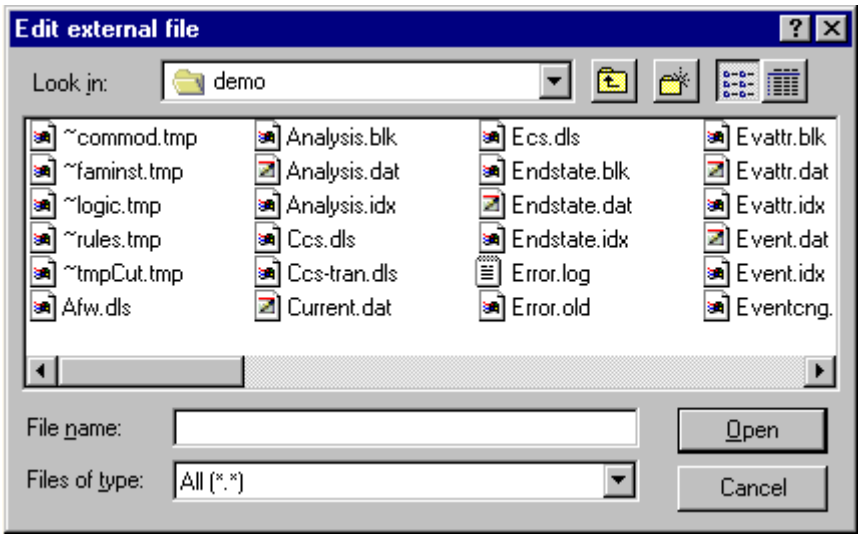
PURPOSE

This option allows you to open an existing file into a new editing window within the *Linkage Rules Editor* or the *Event Tree Logic Editor*.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **File**.
2. Select the **Open** menu option.

The Edit external file dialog will be displayed listing all of the files in the current project directory.



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.

Open - Open the selected file in a new window and close the *Edit external file* dialog.

Cancel - Close the *Edit external file* dialog without opening another file.

Double-click - Open the selected file in a new window and close the *Edit external file* dialog.

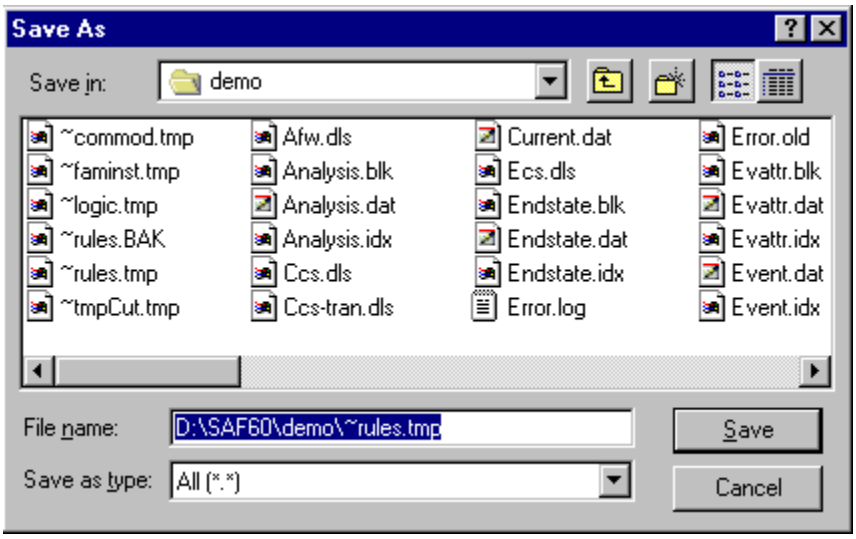
7.7.5.7.2.3 Save As

PURPOSE

This option allows you to save the file in the current editing window with a new file name.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **File**.
2. Select the **Save As** menu option. The Save As dialog will be displayed.



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 to 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.

Save - Save the data in the current editing window 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 As* dialog.

Cancel - Close the *Save As* dialog without performing the save operation.

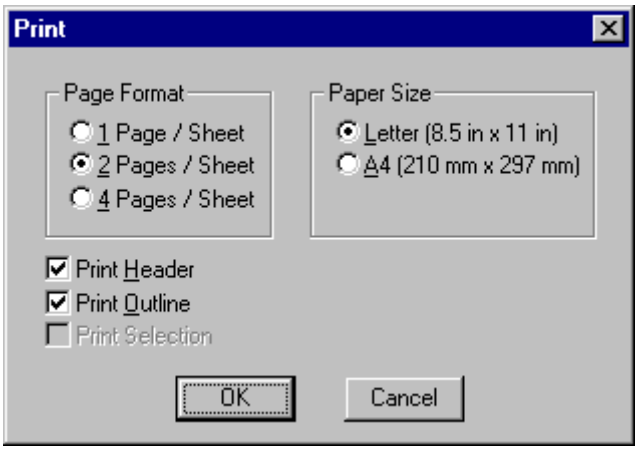
7.7.5.7.2.4 Print

PURPOSE

This option allows you to print the file in the current edit window to the default (Windows System) printer.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **File**.
2. Select the **Print** menu option. The Print dialog will be displayed.



Page Format - Select the desired format option. A "page" of data is approximately 66 lines, including header information and outlines.

- **1 Page / Sheet** - Prints one "page" of data on a single sheet of paper. The page is printed using the Portrait orientation (i.e., the short edge of the paper is horizontal).
- **2 Pages / Sheet** - Prints two "pages" of data on a single sheet. The page is printed using the Landscape orientation (i.e., the long edge of the paper is horizontal).
- **4 Pages/ Sheet** - Print four "pages" of data on a single sheet. The page is printed using the Landscape orientation.

Paper Size - Select the size of the paper to print on.

Print Header - Include header information in the print-out. Header information includes the current date, the file name, and the page number. These items are printed across the top of the page, followed by a line, separating it from the data.

Print Outline - Outline each "page" in a rectangle. This is especially useful when using the 2 *Pages / Sheet* or *4 Pages / Sheet* options.

Print Selection - Print the currently highlighted data.

OK - Print the data to the Windows System Printer using the selected options and close the *Print* dialog.

Cancel - Close the *Print* dialog without printing the data.

7.7.5.7.2.5 Exit

PURPOSE

This option allows you to terminate the *Editor* session. The rules are automatically compiled upon exiting the *Editor*. If there is a compilation error, the *Editor* will be reopened with the current file and a message will be displayed in the editor's message bar.

STEPS

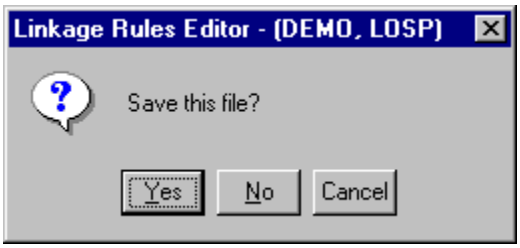
1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **File**.
2. Select the **Exit** menu option.

If changes have been made to the data, you will be prompted to save the file.

7.7.5.7.2.6 Save This File

PURPOSE

This dialog will appear any time you are closing the current editing window or exiting the *Editor* and changes to the file have not been saved (i.e., written to disk).



Yes - Save the changes made to the file in the current editing window and close the current editing window.
No - Do not save the changes made to the file in the current editing window and close the current editing window.
Cancel - Do not save the changes made to the file in the current editing window and do not close the current editing window.

7.7.5.7.3 Edit Menu

7.7.5.7.3.1 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.

7.7.5.7.4 Search Menu

7.7.5.7.4.1 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.

7.7.5.7.4.2 Find

PURPOSE

This option allows you to search the text in the current window for the specified string. If the search criteria are met, the first string matching the criteria is highlighted.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Find** menu option. The Find dialog will be displayed.

Find What - The string of alphanumeric characters upon which the search is based (i.e., the "search string"). Type the text in the field or select from the drop-down list.

Match Whole Word Only - If this check box is selected, only the series of alphanumeric characters matching the search string and delimited by a space, comma, dash, period, etc. are located.

Match Case - If this check box is selected, only the series of alphanumeric characters matching the upper- and lowercase characters as entered in the *Find What* field are located (i.e., the search will be case-sensitive).

Direction

Up - Search the text from the current cursor position to the beginning or top of the text.

Down - Search the text from the current cursor position to the end or bottom of the text.

Find Next - Perform the search operation using the selected criteria. If the search is not successful, an information dialog will be displayed. If the search criteria are met, the *Find* dialog, shown below, will become active and the current *Find* dialog will be closed..

Cancel - Close the *Find* dialog without performing the search operation.

Find Next - Locate the next string matching the current search criteria.

Find Before - Locate the previous string matching the current search criteria.

Find After - Locate the next string matching the current search criteria.

Cancel - Close the *Find* dialog without performing the search operation.

7.7.5.7.4.3 Replace

PURPOSE

This option allows you to search the text in the current window for the specified string and replace it with another string. If the search criteria are met, the first string matching the criteria is highlighted.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Replace** menu option. The Replace dialog will be displayed.

Find What - The string of alphanumeric characters upon which the search is based (i.e., the "search string"). Type the text in the field or select from the drop-down list.

Replace With - The string of alphanumeric characters that will be substituted for the search string. Type the text in the field.

Match Whole Word Only - If this check box is selected, only the series of alphanumeric characters matching the search string and delimited by a space, comma, dash, period, etc. are located.

Match Case - If this check box is selected, only the series of alphanumeric characters matching the upper- and lowercase characters as entered in the *Find What* field are located (i.e., the search will be case-sensitive).

Direction

Up - Search the text from the current cursor position to the beginning or top of the text.

Down - Search the text from the current cursor position to the end or bottom of the text.

Find Next - Perform the search operation using the selected criteria. If the search is not successful, an information dialog will be displayed. If the search criteria are met, the Find/Replace again dialog will become active and the current *Replace* dialog will be closed..

Replace All - Find all occurrences matching the search criteria and automatically substitute with the "replace string."

Close - Close the *Replace* dialog without performing the search and replace operation.

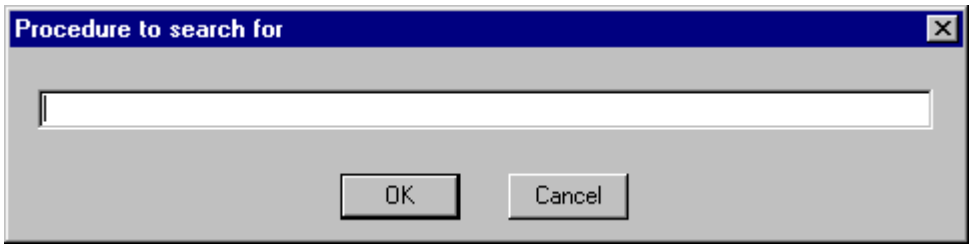
7.7.5.7.4.4 Find Procedure

PURPOSE

This option allows you to search the text in the current window for the specified procedure.

STEPS

1. From the Linkage Rules Editor, the Recovery Rules Editor, or the Partition Rules Editor menu select **Search**.
2. Select the **Find Procedure** menu option. The Procedure to search for dialog will be displayed.



OK - Locate the procedure matching the current search criteria.
Cancel - Close the *Procedure to search for* dialog without performing the search operation.

7.7.5.7.4.5 Find/Replace again

PURPOSE

This option allows you to search the text in the current window based on the previously defined search string and replace it with the previously defined replace string. If the search criteria are met, the first string matching the criteria is highlighted.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Find/Replace again** menu option. The Replace dialog will be displayed.

Find Next - Locate the next string matching the current search criteria. A substitution will not be made.
Replace - Substitute the replace string for the located search string and continue searching.
Replace All - Substitute the replace string for all occurrences matching the search criteria, beginning at the current cursor position.
Close - Close the *Replace* dialog without performing the search and replace operation.

NOTE: This dialog can also be invoked from the **Search | Replace | Find Next** menu options.

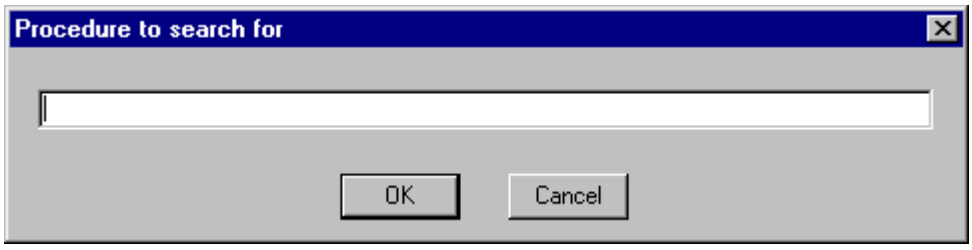
7.7.5.7.4.6 Find Procedure

PURPOSE

This option allows you to search the text in the current window for the specified procedure.

STEPS

1. From the Linkage Rules Editor, the Recovery Rules Editor, or the Partition Rules Editor menu select **Search**.
2. Select the **Find Procedure** menu option. The Procedure to search for dialog will be displayed.



OK - Locate the procedure matching the current search criteria.
Cancel - Close the *Procedure to search for* dialog without performing the search operation.

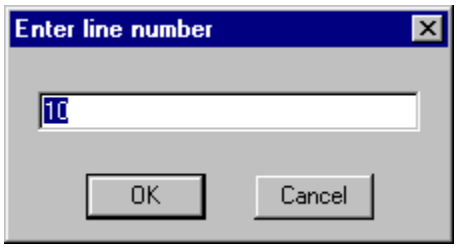
7.7.5.7.4.7 Find line number

PURPOSE

Position the cursor on the specified line number in the text in the current window.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Find line number** menu option.
3. The Enter line number dialog will be displayed.
4. Type the desired line number in the field.



OK - Position the cursor at the beginning of the desired line and close the dialog.
Cancel - Close the dialog without repositioning the cursor.

7.7.5.7.4.8 Goto Marker

PURPOSE

Position the cursor at the previously saved file position. Up to four marker positions can be retrieved for each editing window.

STEPS

1. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
2. Select the **Goto Marker** menu option.
3. Choose one of the four marker positions available from the submenu.

In this example, two markers have been set at #1 and #3. After choosing one of the available markers, the cursor is positioned at the beginning of the line.

The marker positions are saved only during the current editing session.

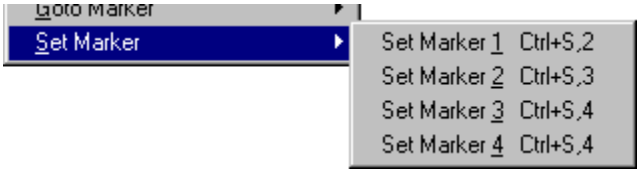
7.7.5.7.4.9 Set Marker

PURPOSE

Save the current file position for later retrieval. Up to four marker positions can be saved for each editing window.

STEPS

1. Position the cursor on the desired line of the text in the edit window.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Search**.
3. Select the **Set Marker** menu option.
4. Choose one of the four marker positions available from the submenu.



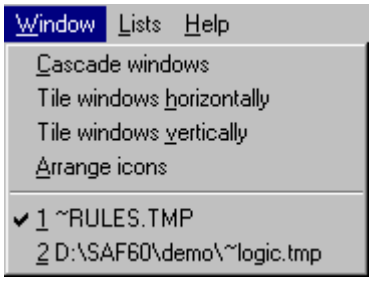
The marker positions are saved only during the current editing session.

7.7.5.7.5 Window Menu

7.7.5.7.5.1 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.

7.7.5.7.6 Lists Menu

7.7.5.7.6.1 Partition 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.
Fault Trees -	Select fault trees as top events and fault trees used to replace others instead of typing in the fault trees names.
End States -	Select end states used to replace others instead of typing in the end state names.
Event Trees -	Select event trees used to replace others instead of typing in the event tree names.

7.7.5.7.6.2 Macros

PURPOSE

This option allows you to insert a macro into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Macros** menu option. The *Macro List* dialog will be displayed.

Double-click on the desired macro name in the list. The selected name will be entered at the current cursor location.

The *Macro List* dialog will remain open in the application window during the current session unless explicitly closed.

7.7.5.7.6.3 Events

PURPOSE

This option allows you to insert a basic event name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Events** menu option. The *Event List* dialog will be displayed containing all of the basic events in the current family's database.

4. Double-click on the desired event name in the list. The selected name will be entered at the current cursor location.

The *Event List* dialog will remain open in the application window during the current session unless explicitly closed.

7.7.5.7.6.4 Initiators

PURPOSE

This option allows you to insert an initiating basic event name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Initiators** menu option. The *Initiator List* dialog will be displayed containing all of the basic events whose category attribute is set to "I" in the current family's database.

4. Double-click on the desired initiating event name in the list. The selected name will be entered at the current cursor location.

The *Initiator List* dialog will remain open in the application window during the current session unless explicitly closed.

7.7.5.7.6.5 Systems

PURPOSE

This option allows you to insert a fault tree name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Systems** menu option. The *System List* dialog will be displayed containing all of the fault trees in the current family's database.

4. Double-click on the desired fault tree name in the list. The selected name will be entered at the current cursor location.

The *System List* dialog will remain open in the application window during the current session unless explicitly closed.

7.7.5.7.6.6 End States

PURPOSE

This option allows you to insert an end state name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **End States** menu option. The *Endstate List* dialog will be displayed containing all of the end states in the current family's database.

4. Double-click on the desired end state name in the list. The selected name will be entered at the current cursor location.

The *Endstate List* dialog will remain open in the application window during the current session unless explicitly closed.

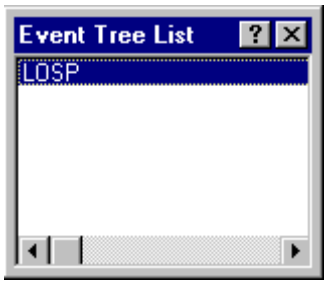
7.7.5.7.6.7 Event Trees

PURPOSE

This option allows you to insert an event tree name into the text of the current edit window.

STEPS

1. Place the cursor at the desired location in the text.
2. From the Linkage Rules Editor or the Event Tree Logic Editor menu select **Lists**.
3. Select the **Event Trees** menu option. The *Event Tree List* dialog will be displayed containing all of the event trees in the current family's database.



4. Double-click on the desired event tree name in the list. The selected name will be entered at the current cursor location.

The *Event Tree List* dialog will remain open in the application window during the current session unless explicitly closed.

7.7.6 Editing Sequence Cut Sets

7.7.6.1 Editing Cut Sets

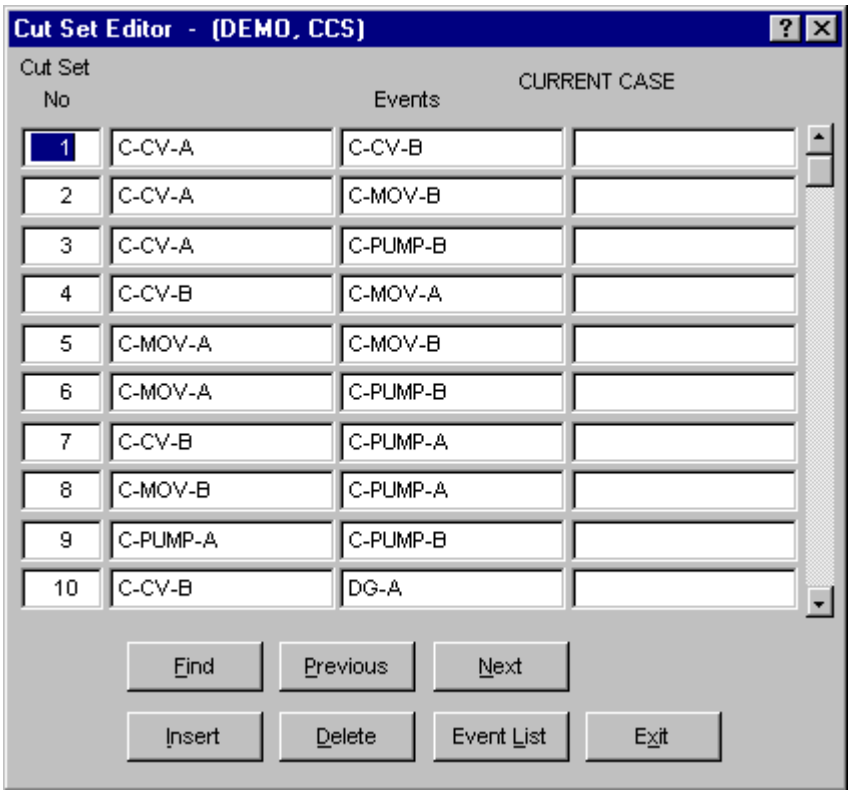
PURPOSE

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. The *Cut Set Editor* dialog will be displayed.



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.

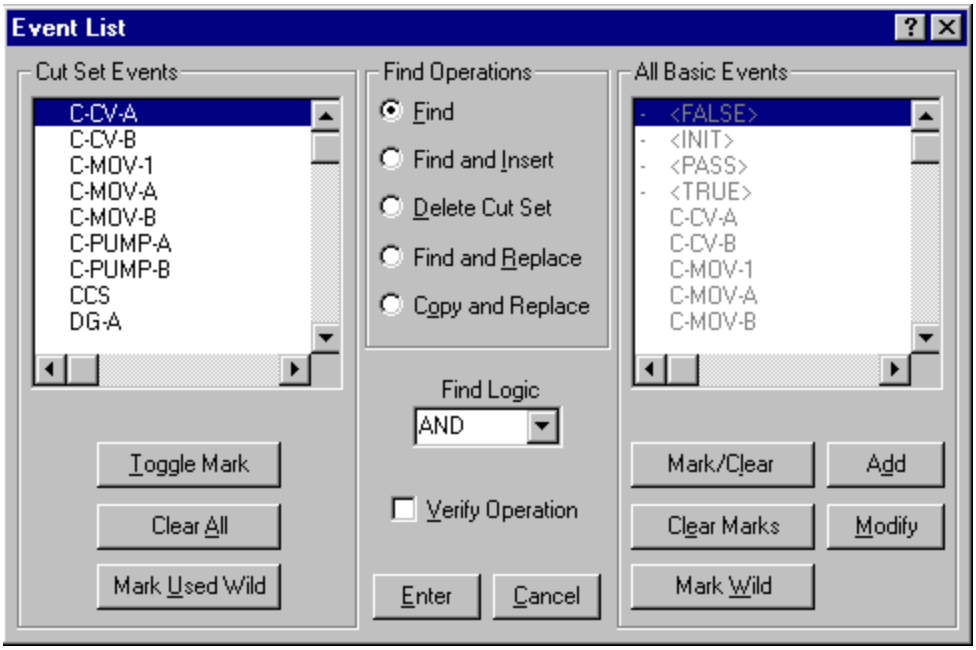
7.7.6.2 Find

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. The *Cut Set Editor* dialog will be displayed.
5. Choose the **Find** button. 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 *Event List* dialog.

7.7.6.3 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. The *Cut Set Editor* dialog will be displayed.
5. Place the cursor in the desired cell and choose the **Insert** button.

7.7.6.4 Delete

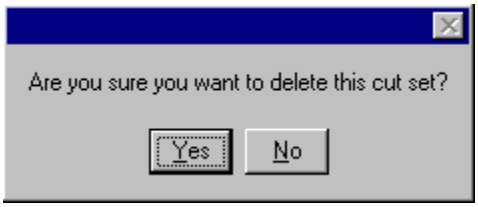
PURPOSE

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. The *Cut Set Editor* dialog will be displayed.
5. 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.

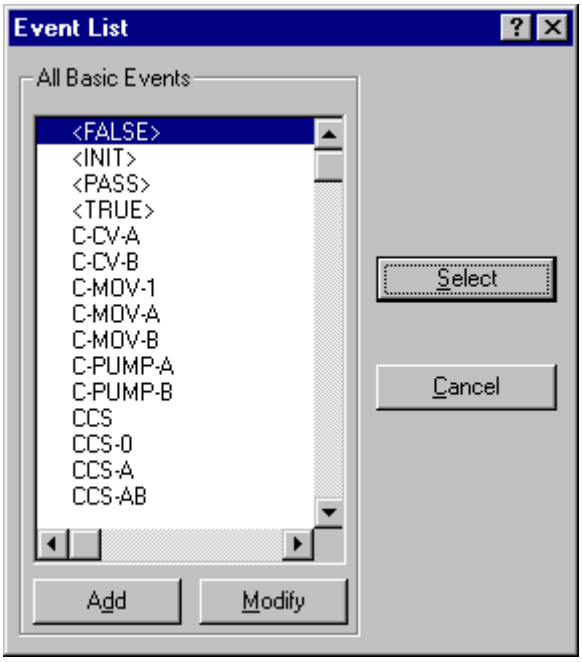
7.7.6.5 Event List

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. The *Cut Set Editor* dialog will be displayed.
5. Place the cursor in the desired *Event* cell.
6. 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.

7.8 Displaying Sequence Results

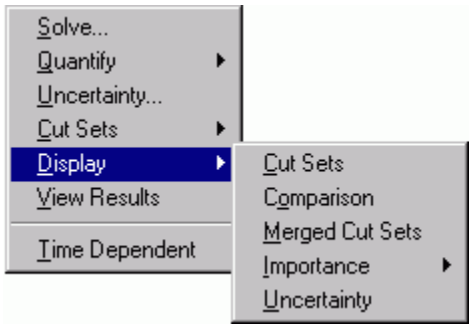
7.8.1 Displaying Sequence Results

PURPOSE

This option displays the results of sequence analysis functions. You can view the current case cut sets and uncertainty analysis results, and perform importance measure analysis.

STEPS

1. From the SAPHIRE menu select **Sequence**. The *Sequences* dialog will be displayed.
2. Highlight the desired sequence and right-click to invoke the pop-up menu.
3. Choose **Display,** then the desired sub-menu option.



Cut Sets - Display the sequences' cut sets, their percent of contribution to the sequence, the frequency, and the event names that make up the cut sets.

Comparison - Display the sequences' base and current cut sets, their percent of contribution to the sequence, the frequency, and the event names that make up the cut sets.

Merged Cut Sets - Display cut sets from a level 2 sequence merged with its corresponding level 1 cut sets. (Available only when a single sequence is selected.)

Importance - Perform and display "reliability-worth" information about the basic events in the cut sets.

Uncertainty - Display uncertainty analysis results.

7.8.2 Displaying Cut Sets

7.8.2.1 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.

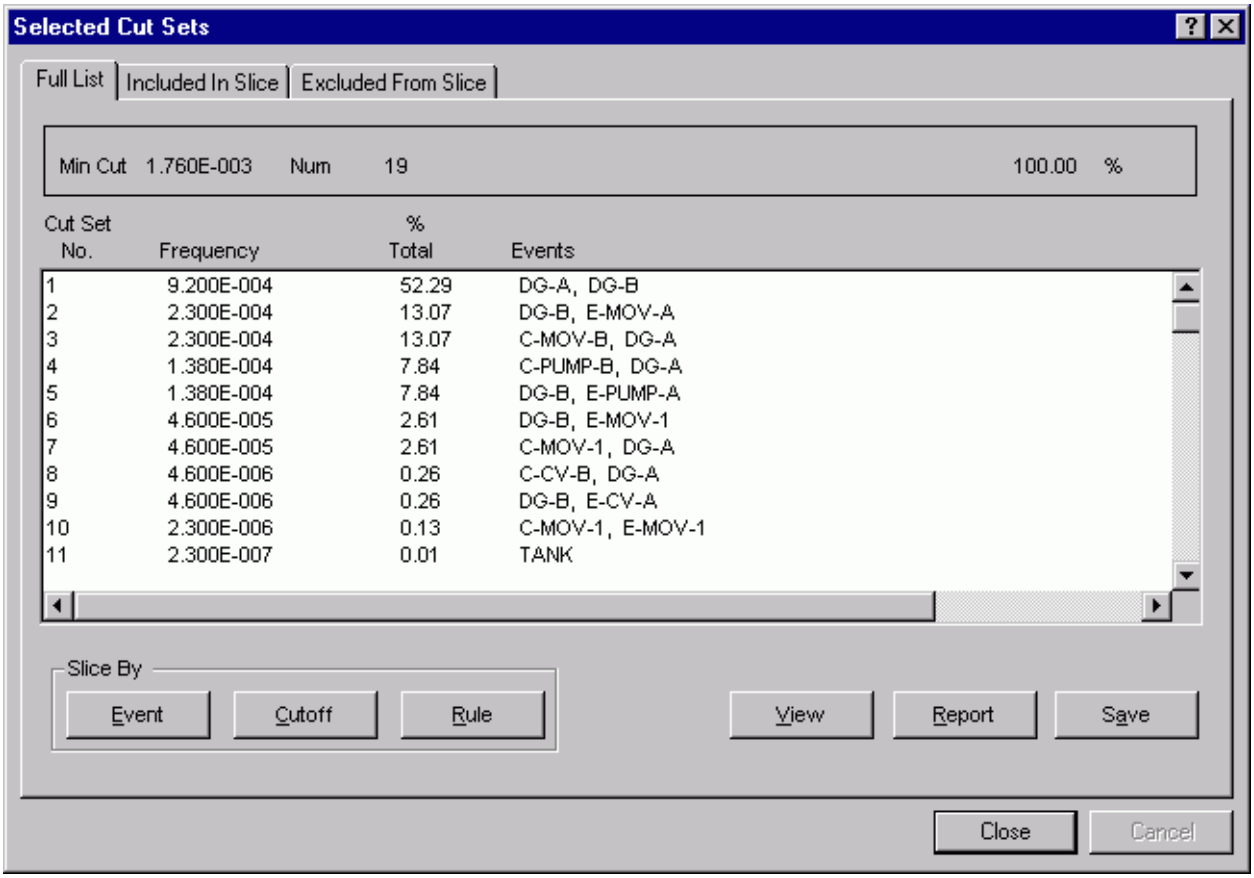
When the dialog is invoked, the fault tree (or sequence or end state) cut sets are shown. Displayed with each cut set is its associated percent of contribution to the minimal cut set upper bound, its probability (or, perhaps, frequency), and the event names that make up the cut sets. Also displayed are 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. The *Selected Cut Sets* dialog will be displayed.



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 *Selected Cut Sets* dialog.

7.8.2.2 Path Search

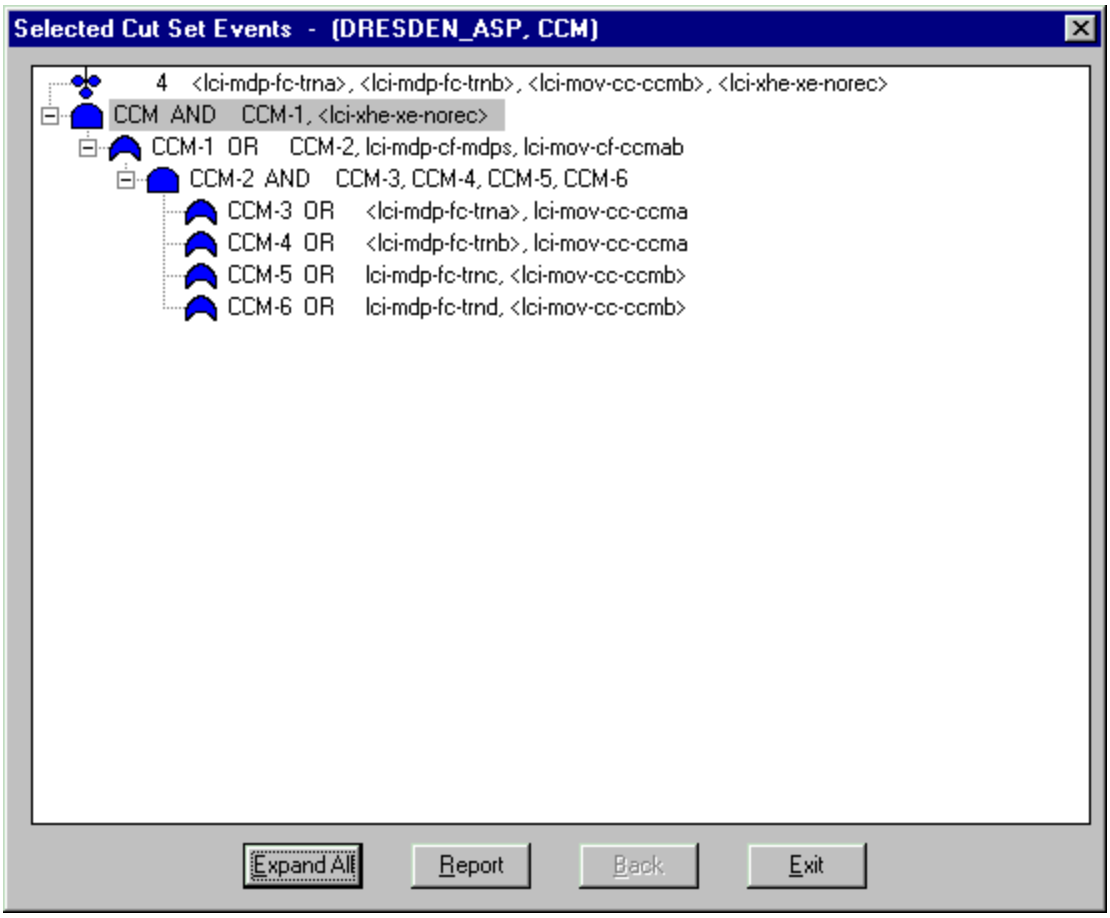
PURPOSE

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. 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.

7.8.2.3 Slice Options

7.8.2.3.1 Slicing Cut Sets

PURPOSE

The *Selected Cut Sets* dialog displays the current case cut sets for the selected fault tree/sequences/end state. The cut sets can be viewed as a whole, or "sliced" into two lists, according to a user defined set of criteria. The three tabbed pages on the dialog present 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.

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. This list will be empty until the user qualifies the data.

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. This list will also be empty until the user qualifies the data.

A user slices (qualifies) cut sets according to one of several methods: Slice By Event, Slice By Cutoff, and/or Slice By Rule.

Note - To clear the qualification criteria (i.e., clear the *Included in List* and *Excluded From List*), choose the **Slice By Event | Restart** 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.
3. Choose **Display | Cut Sets**. The *Selected Cut Sets* dialog will be displayed.
4. Choose one of the *Slice By* buttons. Define the qualification criteria using the selected method.

7.8.2.3.2 Slice By Event

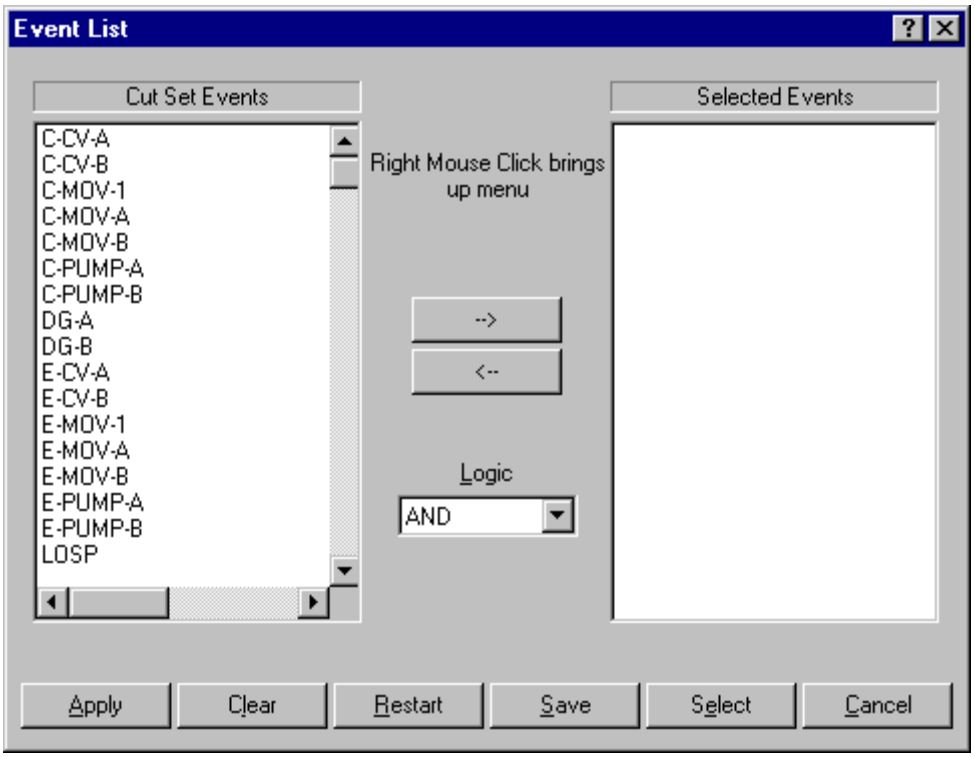
7.8.2.3.2.1 Slice By Event

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. 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 *Selected Events* 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 *Selected Events* list (i.e., clear the qualification criteria).
Restart -	Restore the original cut sets and clear the qualification criteria. The *Event List* dialog will be closed and the *Included In List* and *Excluded From List* 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 *Selected Events* list.
Cancel -	Close the *Event List* dialog without applying the qualification criteria.

7.8.2.3.2.2 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.

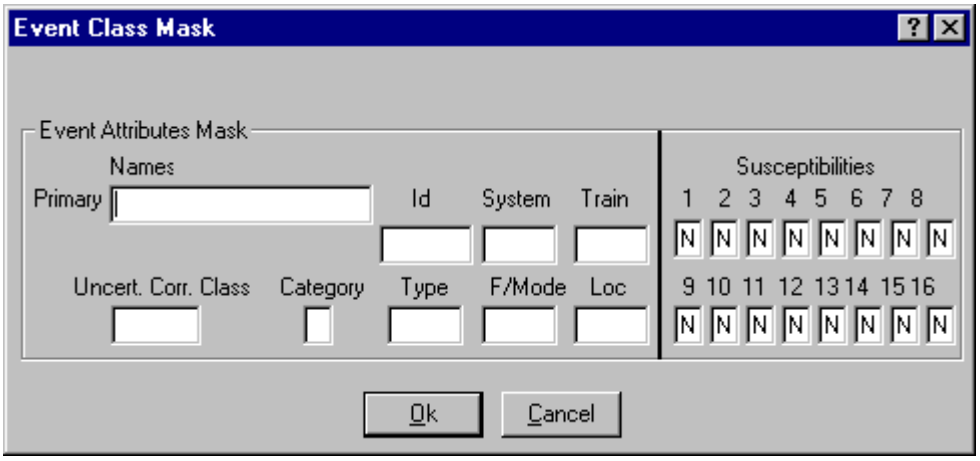
To access from the **Slice#1**

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.
4. The *Event Class Mask* dialog will be displayed.



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.

7.8.2.3.2.3 Save Slice

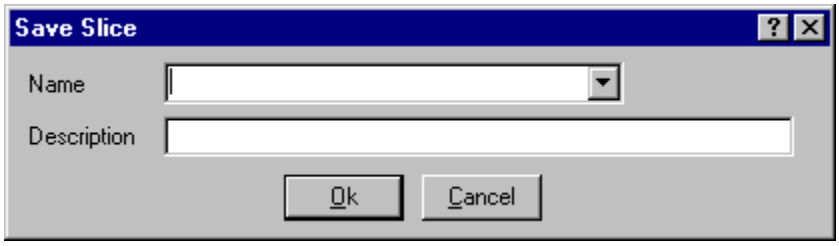
PURPOSE

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 F**ault 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.

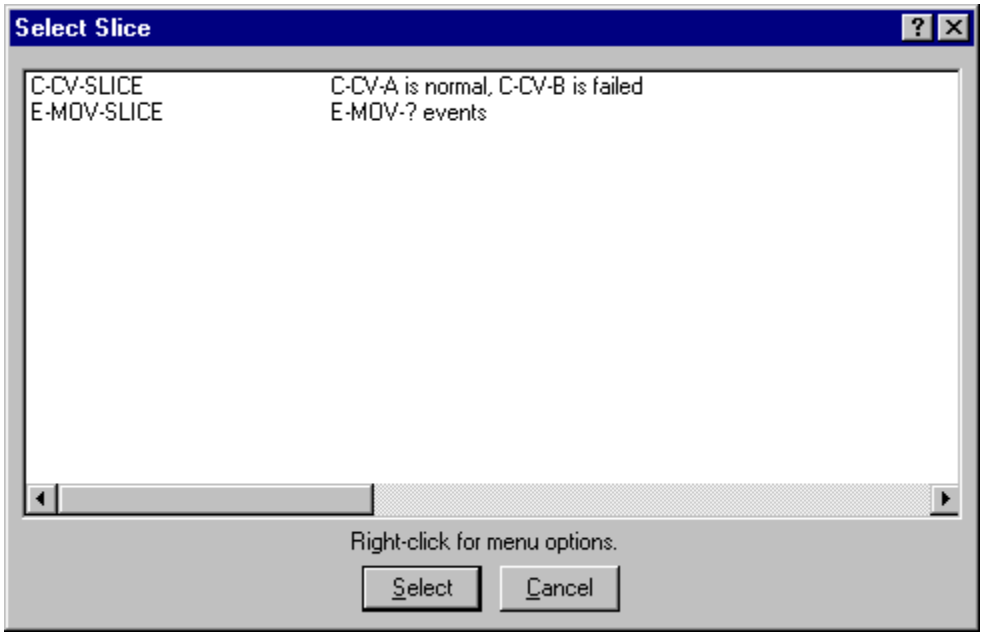
7.8.2.3.2.4 Select Slice

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.

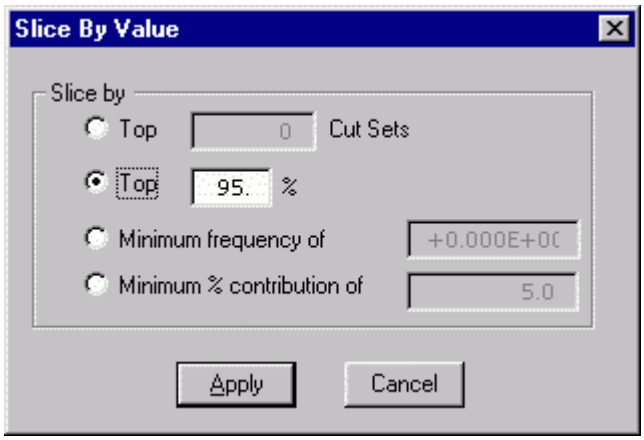
7.8.2.3.3 Slice By Cutoff

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. 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.

7.8.2.3.4 Slice By Rule

7.8.2.3.4.1 Slice By Rule

PURPOSE

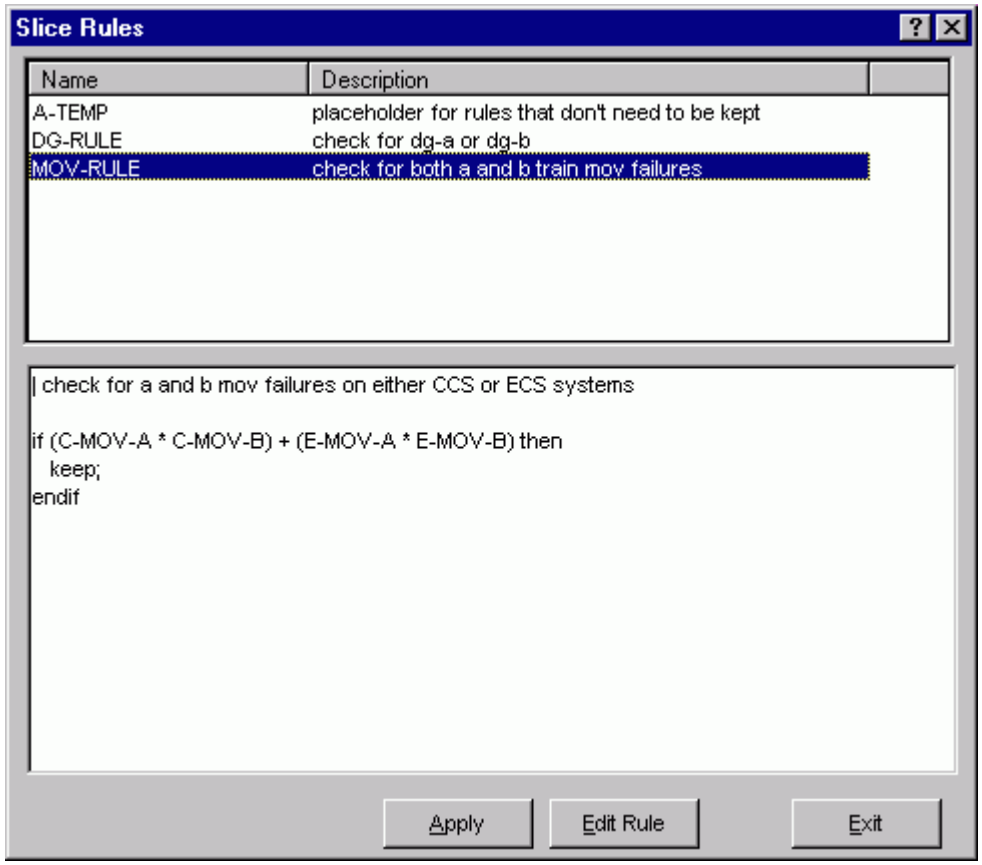
This option provides the ability to divide the original cut set list into two subsets (slices) – qualified and unqualified cut sets. This is accomplished by defining one or more rules to evaluate whether or not a cut set is qualified. The rules provide the ability to qualify cut sets using logical expressions, 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.

7.8.2.3.4.2 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.

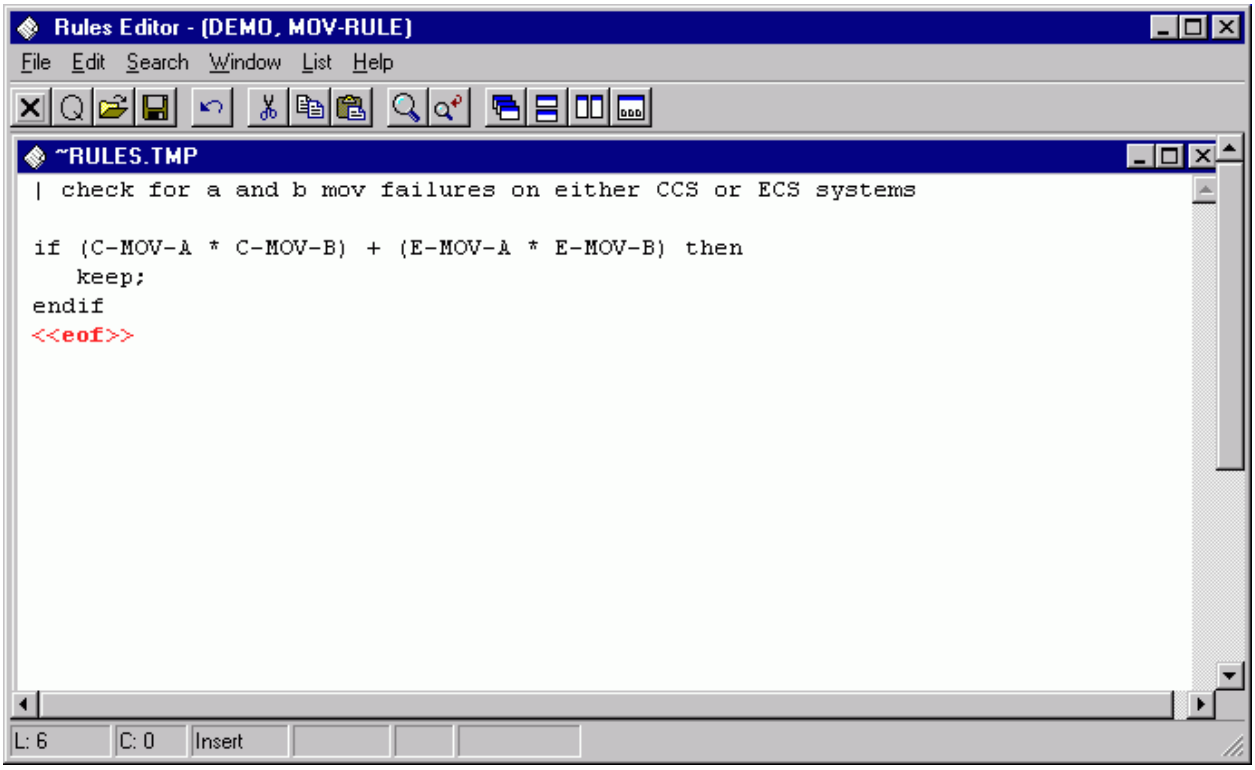
The slice rules are entered in a free-form text editor within SAPHIRE. The editor options and rule syntax are similar to that of SAPHIRE's recovery rules. However, unlike to recovery rules, slice rules are not tied to the fault tree, sequence(s) or end state(s) whose cut sets are currently displayed. (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.

7.8.2.3.4.3 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 *Editor* session.

7.8.2.3.4.4 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.

7.8.2.3.4.5 Editor Search Functions

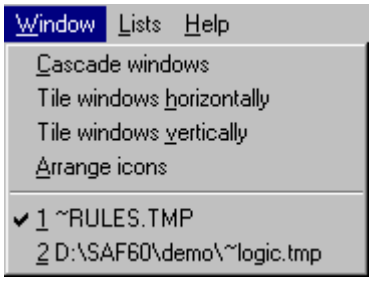
These options provide search and cursor positioning operations.

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.

7.8.2.3.4.6 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.

7.8.2.3.4.7 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.

7.8.2.3.4.8 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.

7.8.2.4 View Option

7.8.2.4.1 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

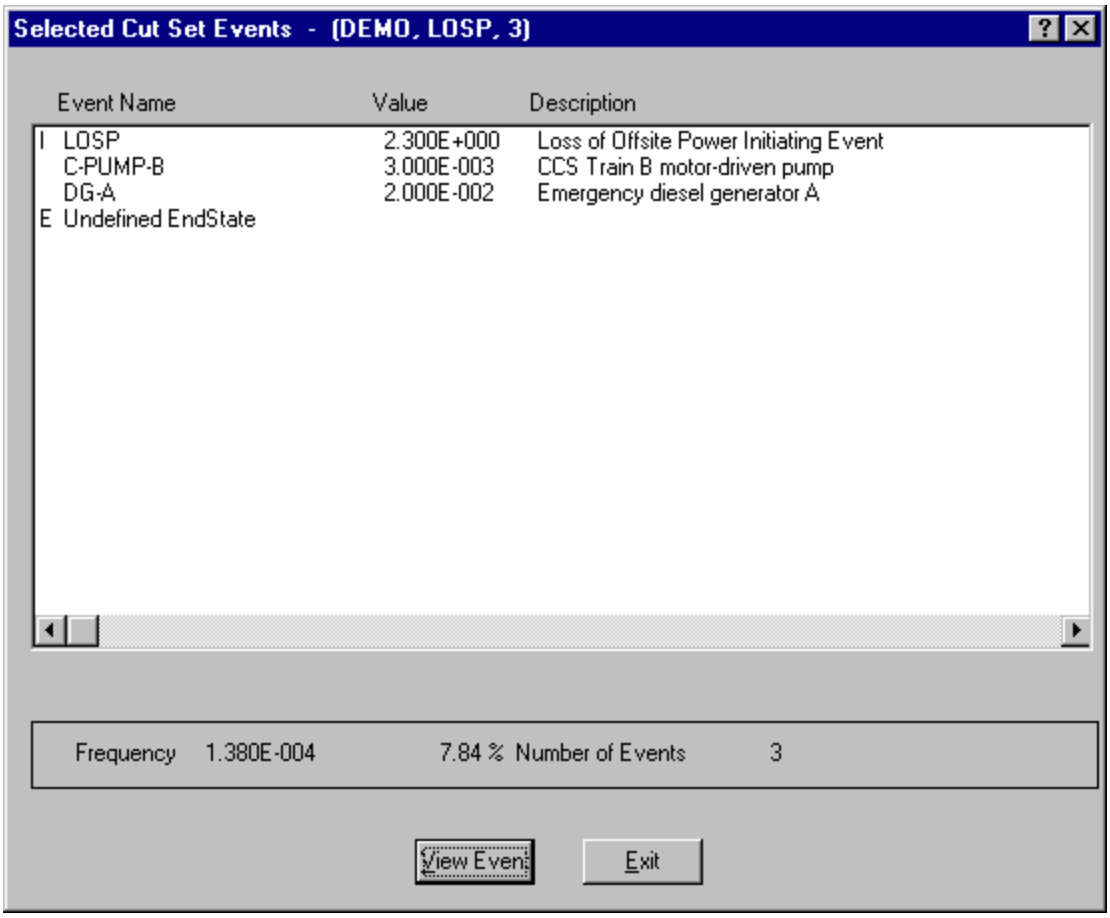
1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.

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.



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.

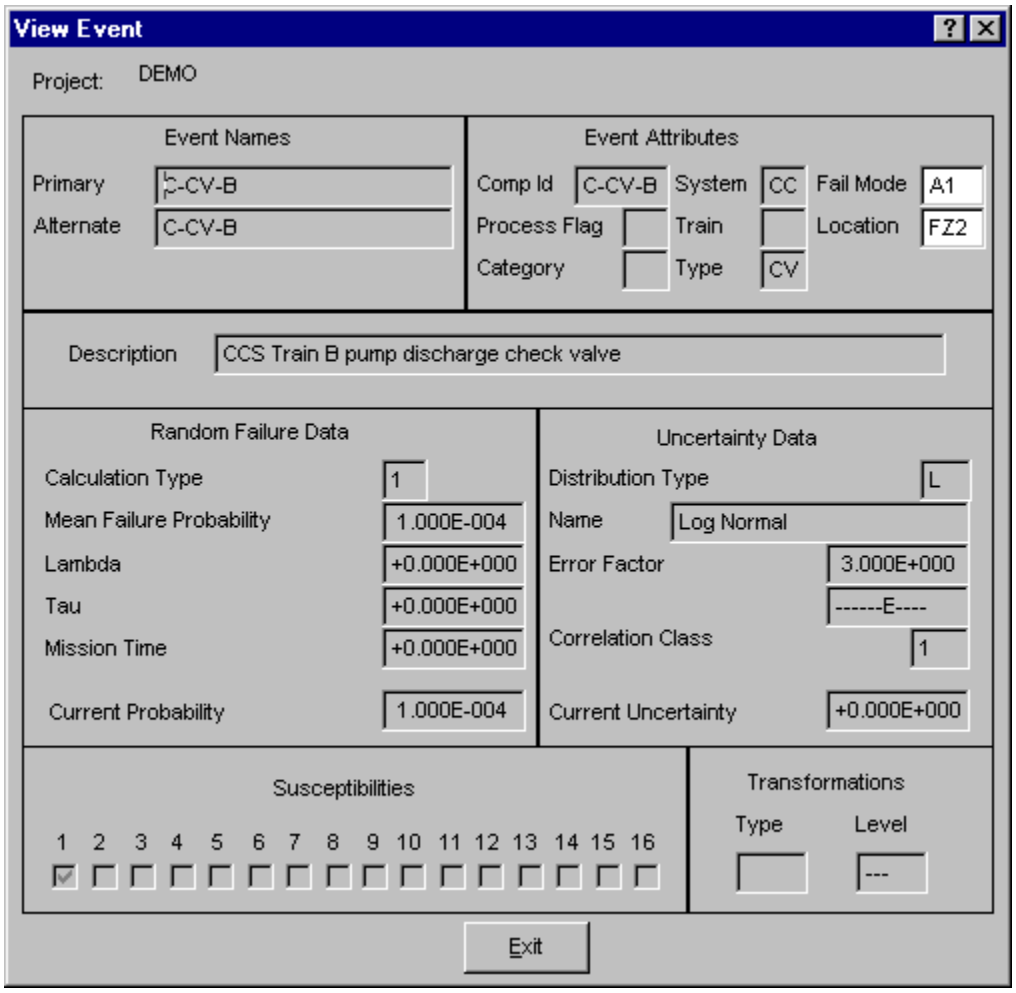
7.8.2.4.2 View Event

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.



Information on this dialog is for display only and cannot be modified.

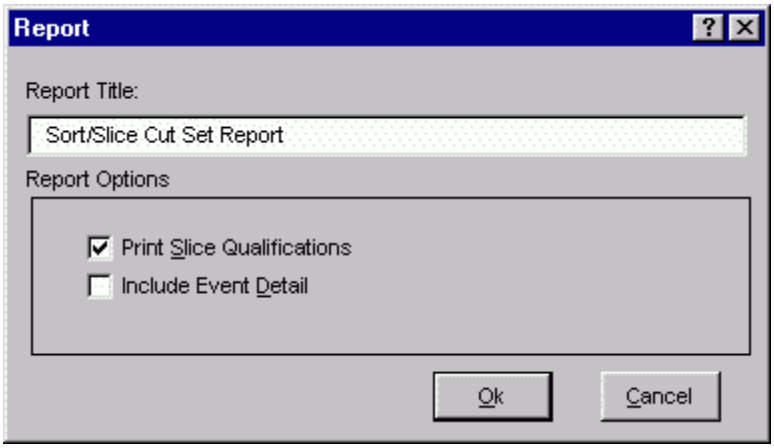
7.8.2.5 Cut Set Report

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.

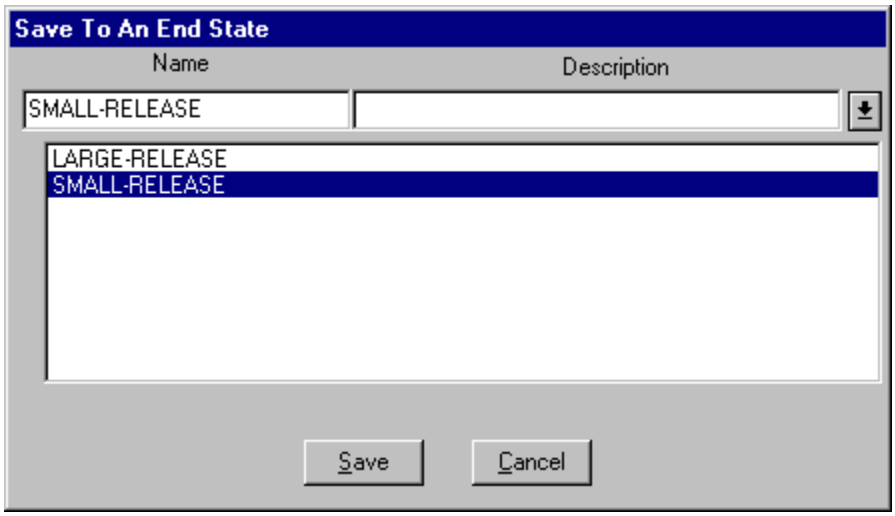
7.8.2.6 Save

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.

7.8.3 Comparing Cut Sets

7.8.3.1 Cut Set Comparison

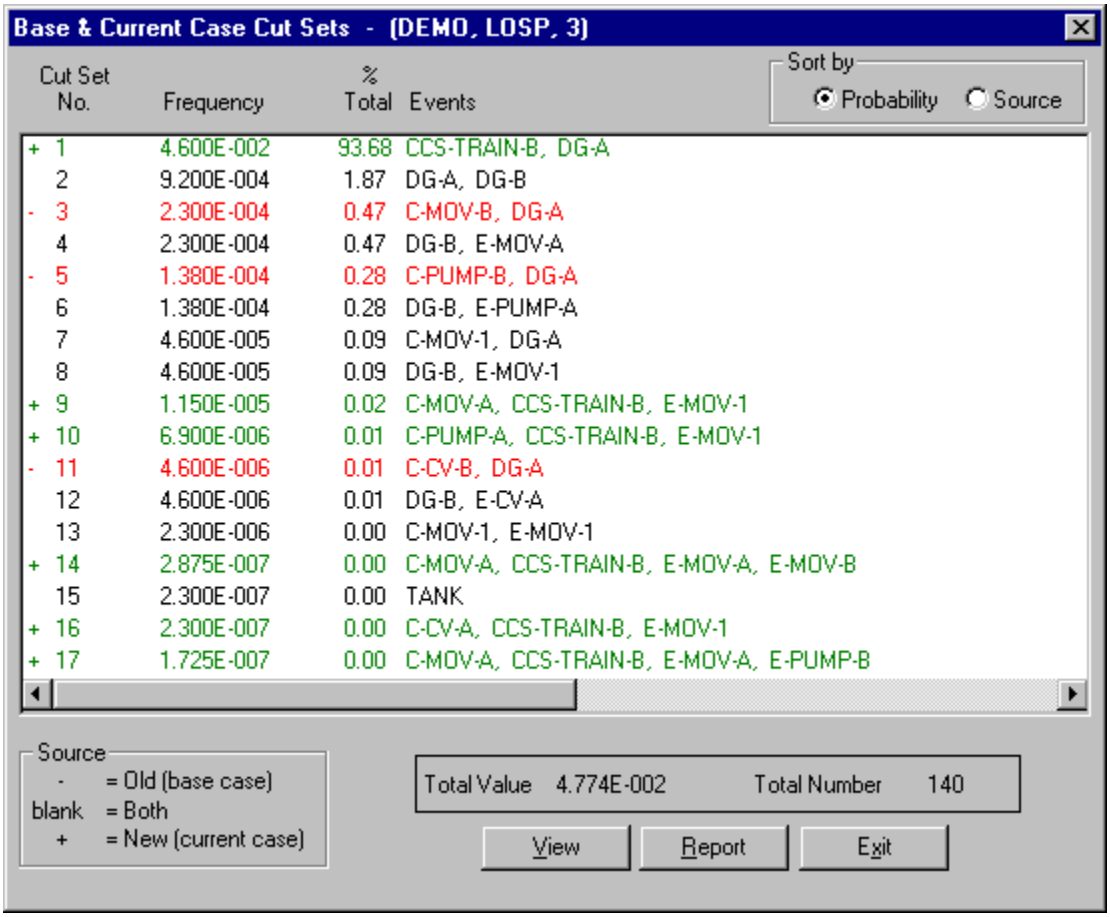
PURPOSE

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.



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.

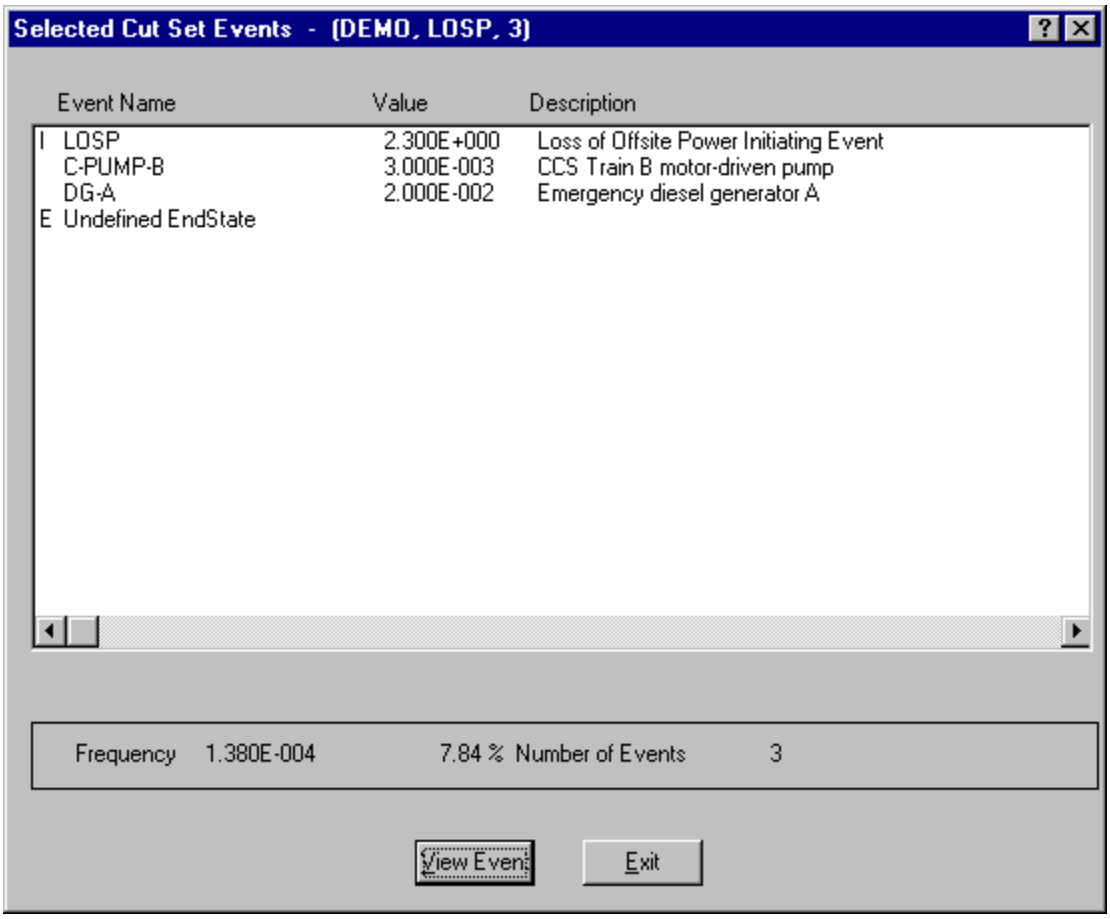
7.8.3.2 View Cut Set

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.



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.

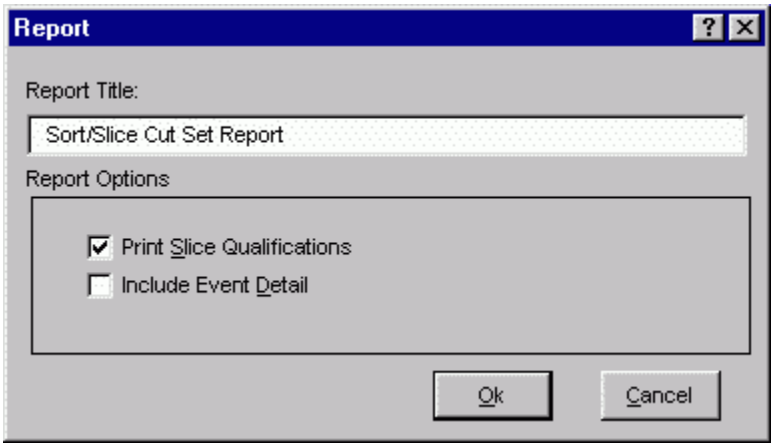
7.8.3.3 Cut Set Report

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.

7.8.4 Displaying Merged Cut Sets

7.8.4.1 Merged Cut Sets

PURPOSE

This option is provided for (and is meaningful only to) projects that perform level two analysis. It provides a mechanism for viewing level two sequence cut sets merged (combined) with the corresponding level one sequence cut sets.

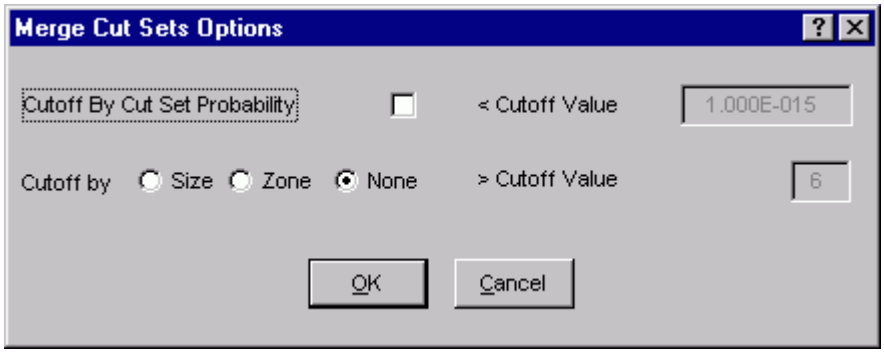
This option will only appear as a pop-up menu option when a single sequence is highlighted. Results will be available only for valid level two sequences. A valid level two sequence is defined as a sequence that 1) contains (level two) cut sets, and 2) has an initiator of the same name as an end state which contains level 1 cut sets.

The cut sets from the level two sequence will be multiplied with the cut sets from the corresponding level one end state to produce the merged cut sets. The combined cut sets will be minimized prior to display.

STEPS

1. From the SAPHIRE menu select **Sequence**. The *Sequences* list dialog will be displayed.
2. Highlight the desired level 2 sequence and right-click to invoke the pop-up menu.
3. Choose **Display,** then the **Merged Cut Sets** sub-menu option. The *Merge Cut Sets Options* dialog will be displayed.
4. Select the desired Merge options, and choose OK.

If valid cut sets for both level two and level one are located, the *Selected Cut Sets* dialog will be displayed, containing the merged cut set results.



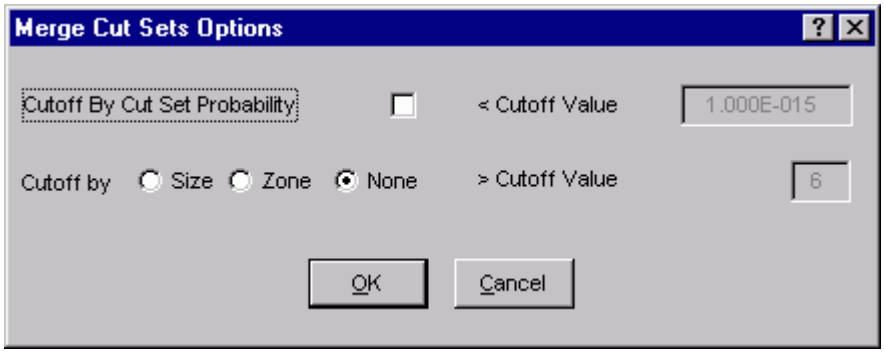
7.8.4.2 Merge Cut Set Options

PURPOSE

This option allows you to specify the cut set probability and size cutoff values desired when a cut set merge is performed.

STEPS

1. From the SAPHIRE menu select **Sequence**. The *Sequences* list dialog will be displayed.
2. Highlight the desired level 2 sequence and right-click to invoke the pop-up menu.
3. Choose **Display,** then the **Merged Cut Sets** sub-menu option. The *Merge Cut Sets Options* 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** 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 < *Cutoff Value* field.

Cutoff by - 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.

7.8.4.3 Merge Cut Sets Example

PURPOSE

This topic illustrates the merge cut sets process. Cut sets from level one end states are multiplied with the level two sequences. When common events cause non-minimal cut sets, the cut sets are automatically reduced to their minimal terms.

The following examples assume a level two project contains the following items:

Suppose the level two project contained two level one sequences "L1-SEQ-1A" and "L1-SEQ-1B", both of which have "PDS-X" as an end state, and "INIT-1" as an initiator. The level two event tree would then also be called "PDS-X", having an initiating event also called "PDS-X".

Assume the level two event tree has a single sequence called "L2-SEQ-2X".

Example 1

Suppose sequence L1-SEQ-1A contains a single cut set, EV-1A * EV-1B (with initiator INIT-1).

Suppose sequence L1-SEQ-1B contains a single cut set, EV-1C (with initiator INIT-1).

Then the cut sets for end state PDS-X would be

EV-1A * EV-1B +
EV-1C

Suppose the level two sequence L2-SEQ-2A contained two cut sets, EV-2X + EV-2Y (with initiator PDS-X).

Then the merged cut sets for L2-SEQ-1 would be (all with initiator INIT-1).

EV-1A * EV-1B * EV-2X +
EV-1C * EV-2X +
EV-1A * EV-1B * EV-2Y
EV-1C * EV-2Y

Example 2

Suppose sequence L1-SEQ-1A contains a single cut set, EV-1A * EV-1B (with initiator INIT-1).

Suppose sequence L1-SEQ-1B contains a single cut set, EV-M (with initiator INIT-1).

Then the cut sets for end state PDS-X would be

EV-1A * EV-1B +
EV-M

Suppose the level two sequence L2-SEQ-2A contained two cut sets, EV-2X + EV-M (with initiator PDS-X).

Then the merged cut sets for L2-SEQ-1 would be (all with initiator INIT-1).

EV-1A * EV-1B * EV-2X +
EV-M

Because the level one and level two cut sets share a common event, EV-M, the multiplied cut sets become non-minimal; so SAPHIRE automatically reduces the terms prior to display.

7.8.4.4 Level Two Analysis

PURPOSE

This topic briefly describes the level two analysis process.

STEPS

1. Create a level one event tree as usual.

2. Assign plant damage end states either manually or via partition rules using the general format

   if ...some criteria... then
   globalPartition="PDS-name1"

   transfer = "Level-2-Event-Tree-Name1"

   else

   ...

   endif

3. If partition rules were created to assign end states, apply the partition rules. During the partition process, an end state, event tree, and initiating event, all sharing the same name, will each be created, if necessary, for each end state defined with the globalPartition statement. The partition rule will automatically create event tree logic consisting of the initiating event of the same name, and a single "Pass" sequence that transfers to the level two event tree specified by the transfer statement. The initiating event will have a Calc Type of "E", which means it will use the current min cut upper bound of the end state as its frequency. If end states were assigned manually, the corresponding event tree and initiating event must also be created manually.

4. Solve the level one sequences.

5. Gather the plant damage end states to collect the level one cut sets.

6. Generate current event data to assure that the level two initiator reflects the plant damage state min cut upper bound.

7. Create the logic for the level two transfer tree; link, and solve the level two sequences.

8. View the level one and level two cut sets merged, if desired.

7.8.5 Displaying Importance Results

7.8.5.1 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.

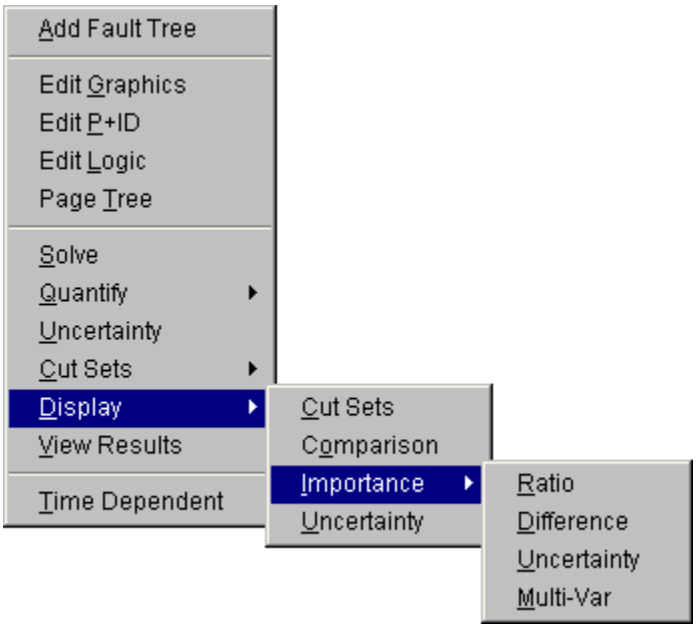
STEPS

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.

7.8.5.2 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

$$\mathbf{FV = F(i)/F(x)}$$

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

$$\mathbf{FV = 1 - F(0)/F(x)}$$

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.

7.8.5.3 Birnbaum Importance (B)

This indicates the sensitivity of the minimal cut set upper bound with respect to a change in the basic event probability.

$$\mathbf{B = F(1) - F(0)}$$

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.

7.8.5.4 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 or 0.0 (typically if the corresponding component never failed).

$$\mathbf{RRR = F(x)/F(0)}$$

$$\mathbf{RRI = F(x) - F(0)}$$

Note the similarity between RRI and FV; the relative importance ranking of basic events will be the same for the two importance measures.

7.8.5.5 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.

7.8.5.6 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 ith basic event, and σ_i^2 is the variance of the uncertainty distribution for the ith 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 ith 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.

7.8.5.7 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.”

7.8.5.8 Importance Measures Dialog

7.8.5.8.1 Importance Measures Results

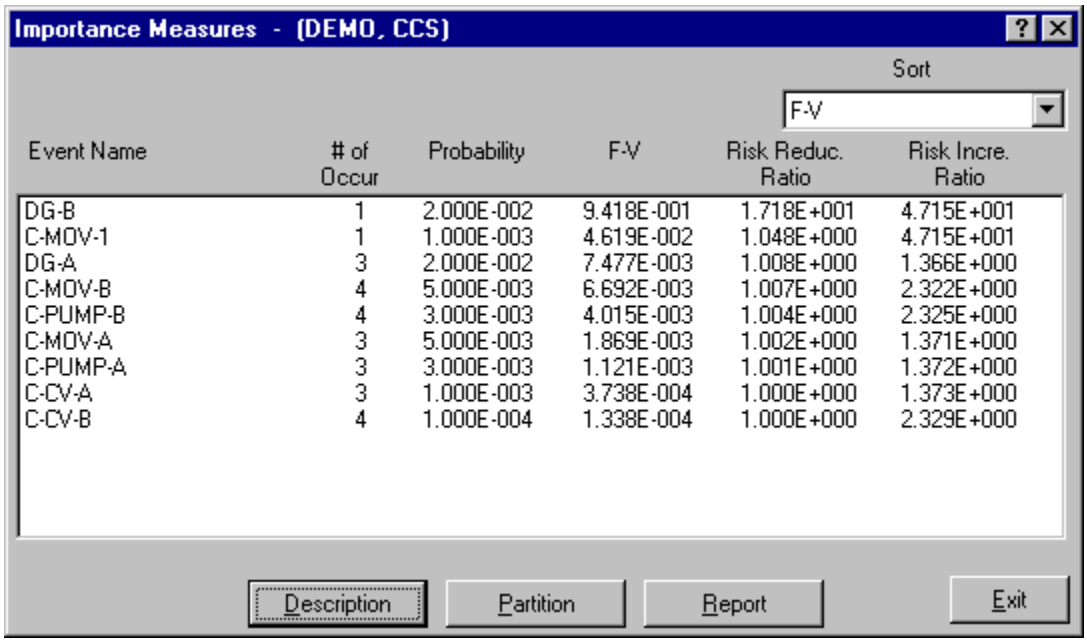
PURPOSE

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, Mult-Var**.
5. 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.



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.

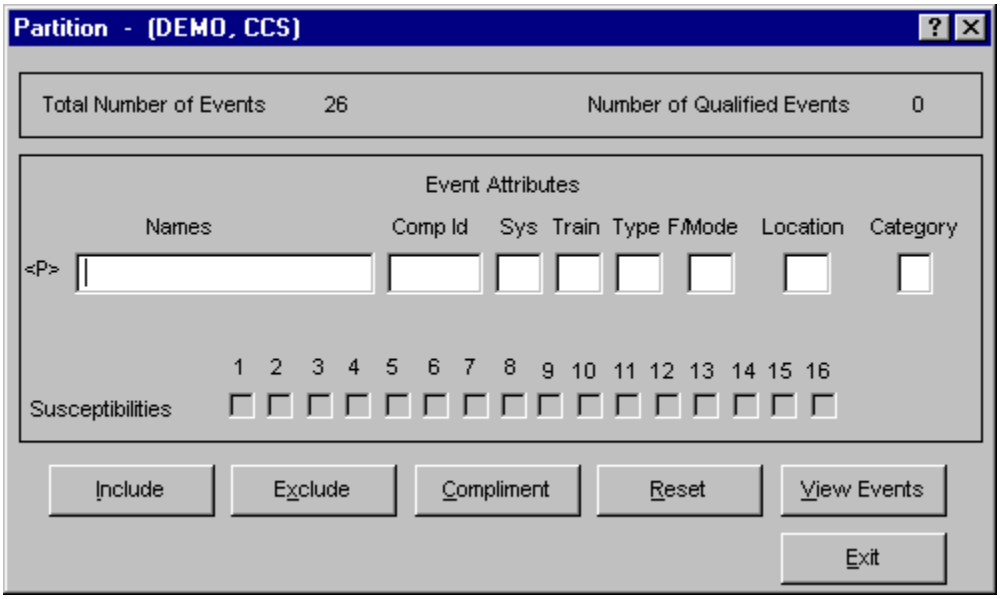
7.8.5.8.2 Importance Results Partition

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.



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.

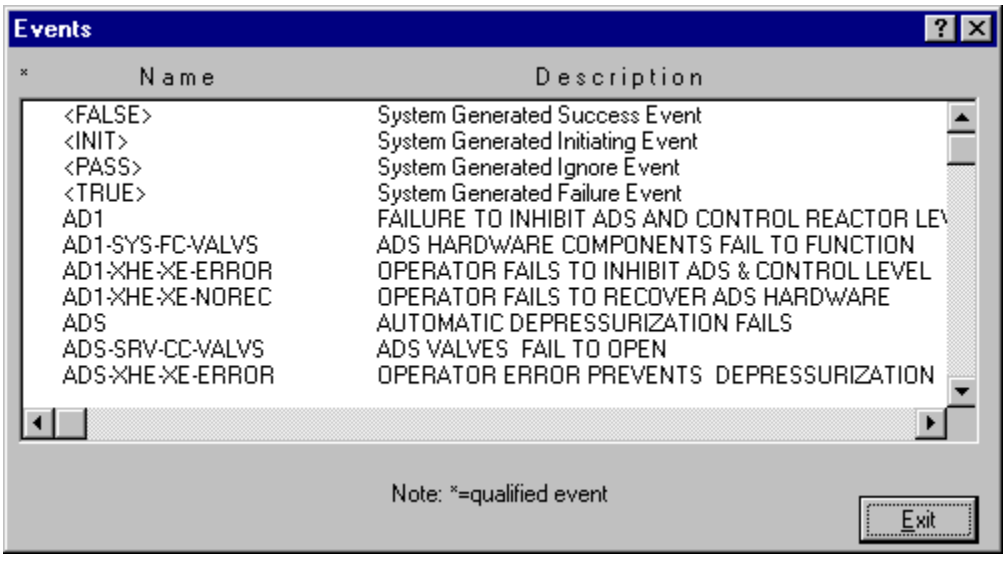
7.8.5.8.3 View Events

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.

7.8.6 Displaying Uncertainty

7.8.6.1 Displaying Uncertainty Results

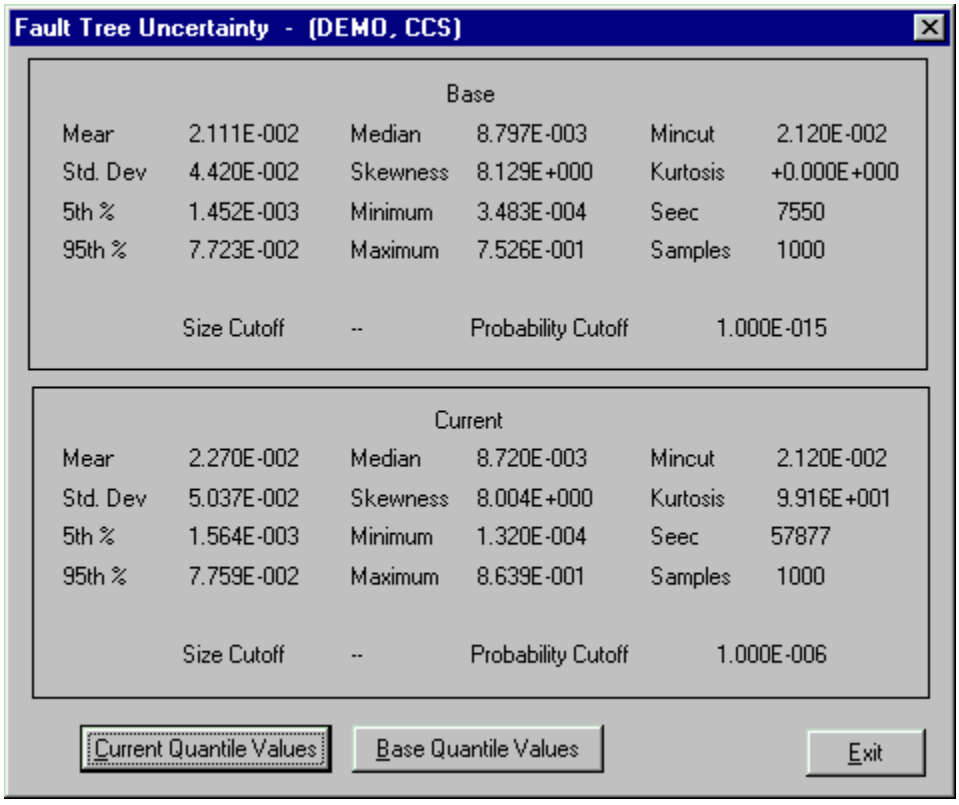
PURPOSE

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.



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.

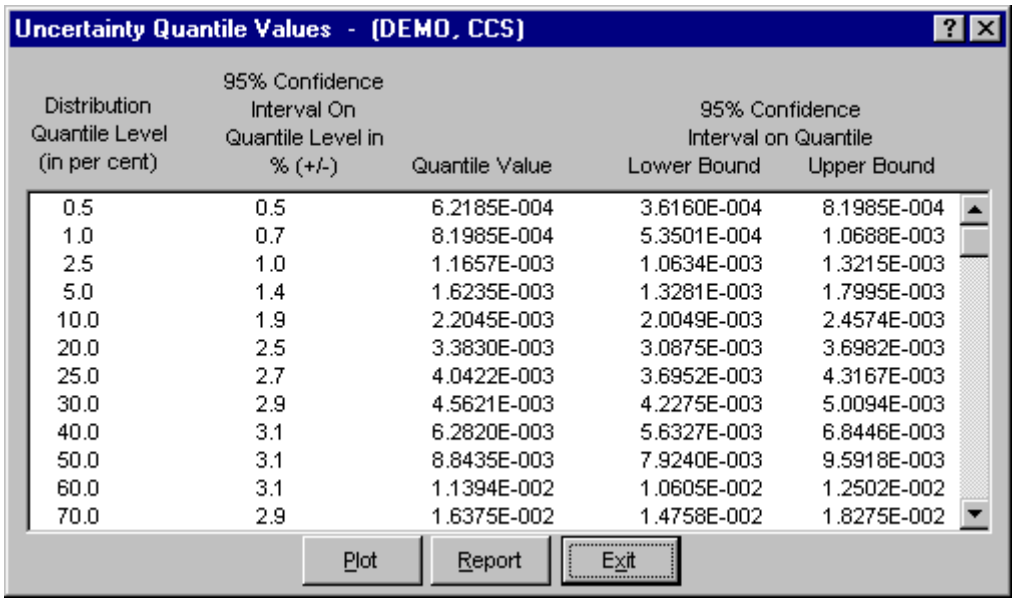
7.8.6.2 Uncertainty Quantile Values

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 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.

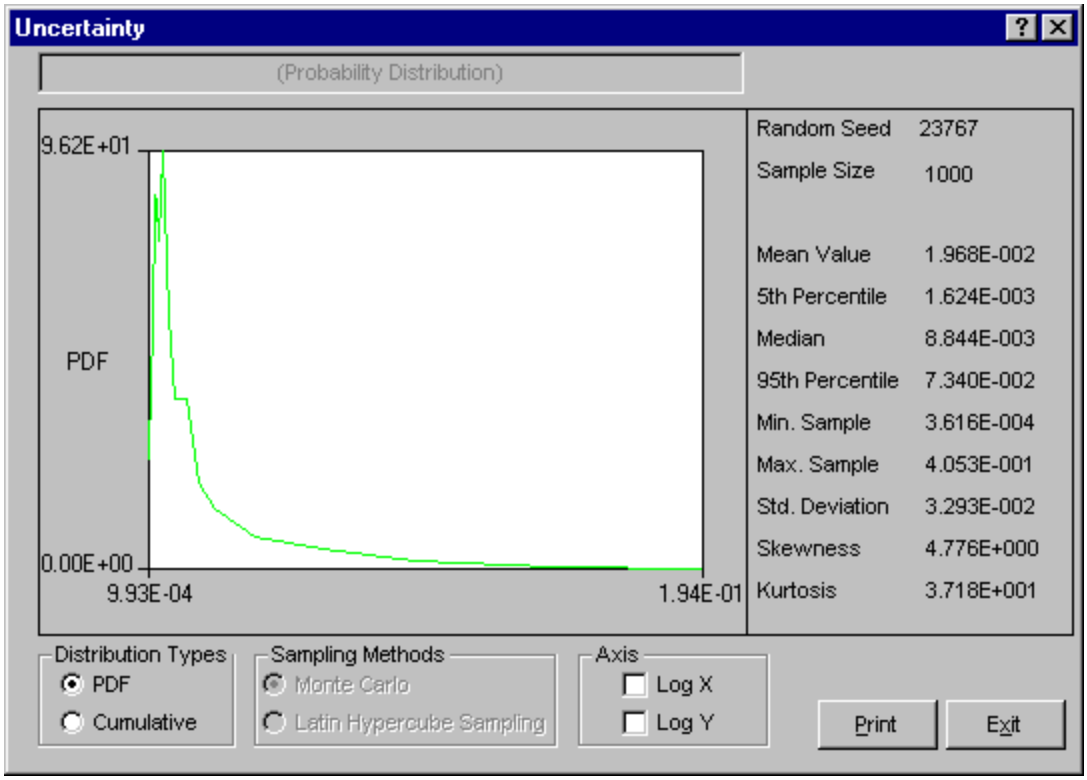
7.8.6.3 Plot Uncertainty Quantile Values

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.

7.8.6.4 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.

7.8.6.5 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.

7.8.6.6 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.

7.9 Viewing Sequences

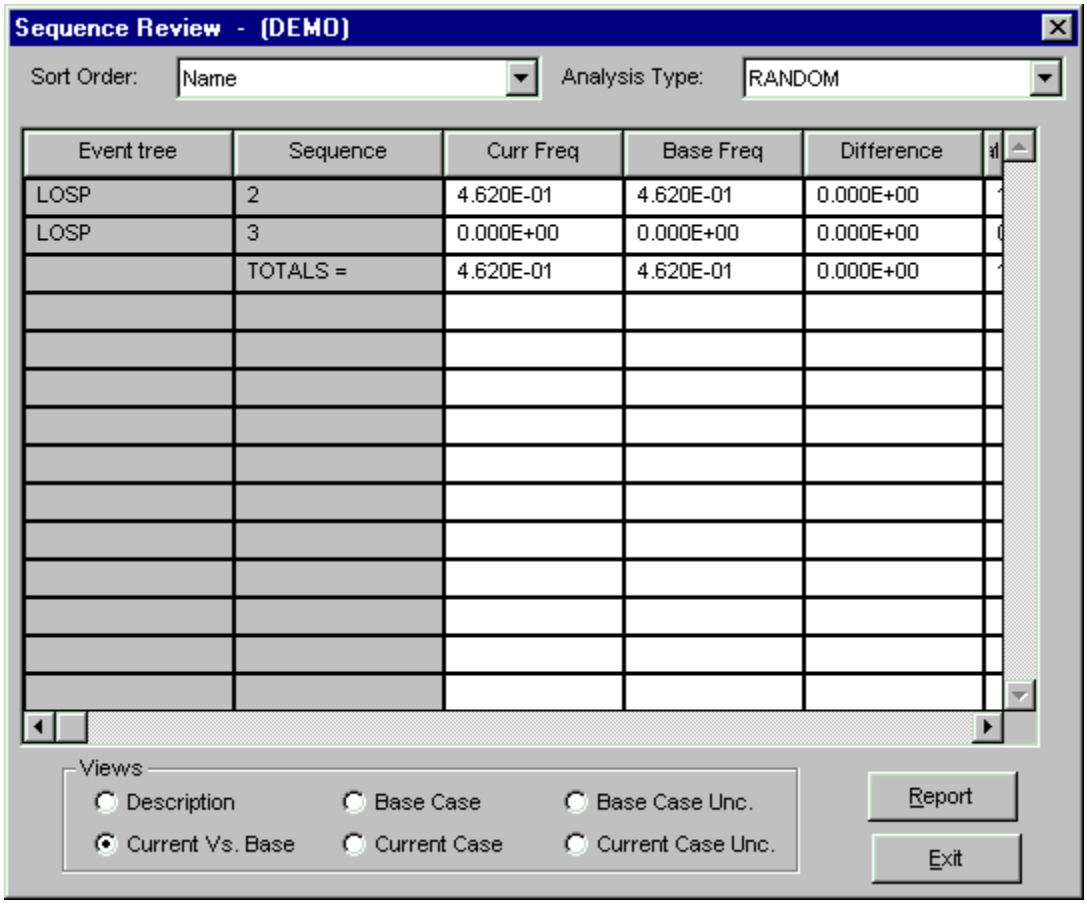
7.9.1 Viewing Sequence Data

PURPOSE

This option presents the sequence analyses in various report forms. One or more sequences can be viewed using this option.

STEPS

1. From the SAPHIRE menu select **Sequence**. The *Sequences* dialog will be displayed.
2. Highlight the desired sequence(s) and right-click to invoke the pop-up menu.
3. Choose **View Results** from the menu. The *Sequence Review* dialog will be displayed.



The selected sequences are displayed in this dialog. The *Sequence* column contains the sequences' primary names. Other columns' titles and data vary depending on the selected "View".

The last row in the grid show the summation totals of applicable columns.

Report - Produce a report of the data currently displayed.
Exit - Close the *Sequence Review* dialog.

7.9.2 View Options

Description - Includes the full description. (60 character maximum)

Current Vs. Base - Includes the current case cut set probability, base case cut set probability, the probability difference (current - base), ratio, current case cut set count, base case cut set count, the cut set count difference (current - base).

Base Case - Includes base case values for cut set probability, mean, 5th percentile, median, 95th percentile, probability truncation, and size truncation used when solving.

Current Case - Includes current case values for cut set probability, mean, 5th percentile, median, 95th percentile, probability truncation, and size truncation used when solving.

Base Case Uncertainty - Includes base case values for cut set probability, mean, 5th percentile, median, 95th 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, 5th percentile, median, 95th percentile, minimum, maximum, standard deviation, skewness, kurtosis, sample size, and random number seed.

7.10 Time Dependent Analysis

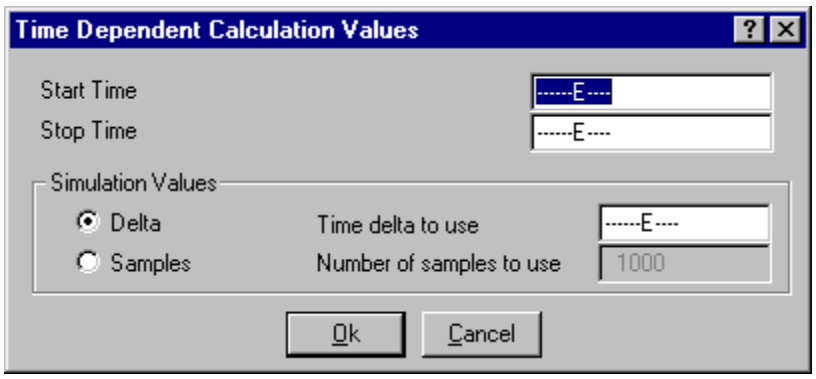
7.10.1 Time Dependent Analysis

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.



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.

8. END STATE ANALYSIS

8.1 End State Analysis

PURPOSE

This option provides the means to recalculate end state values after events and/or cut sets have been modified. The *End State List* dialog shows all end states defined for the current project, ordered by end state name.

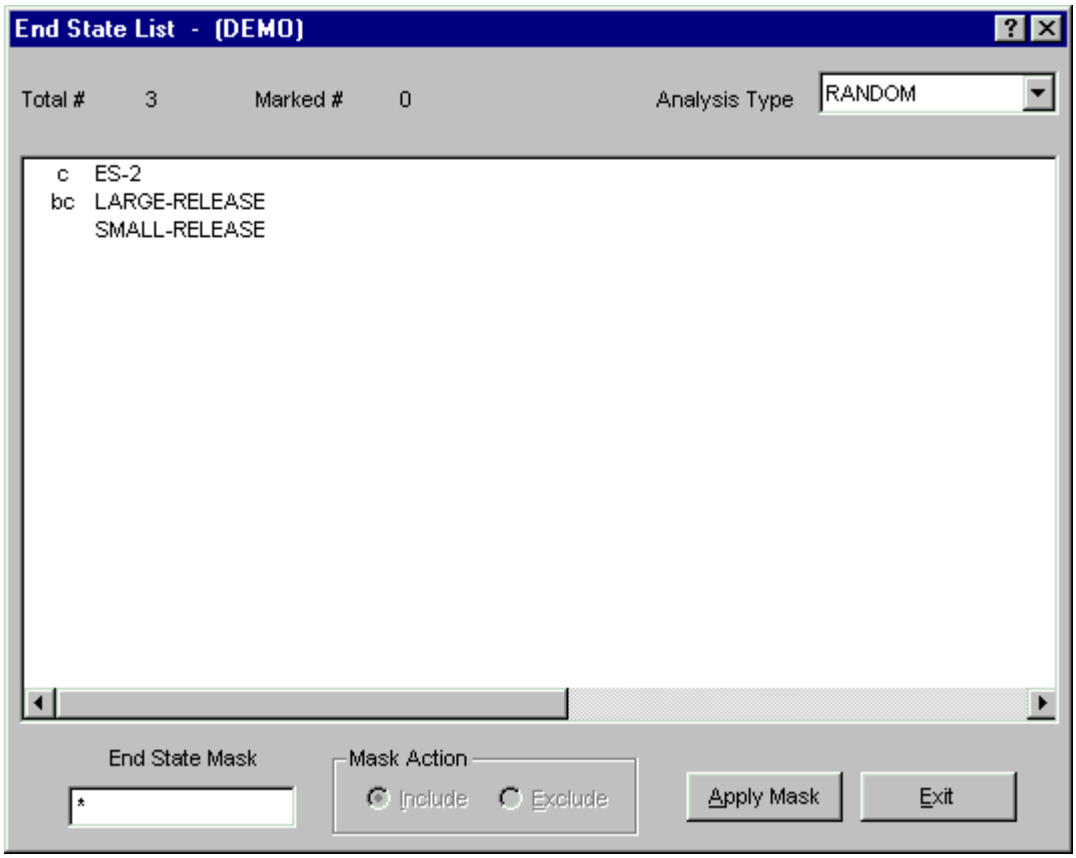
KEY TO FLAGS

Located to the right of each end state is a set of flags that indicate the status of the end state:

b - base case cut sets exist for the selected analysis type
c - current case cut sets exist for the selected analysis type

STEPS

1. From the SAPHIRE menu select **End State**. The *End State List* dialog will be displayed.



From this dialog, you can select end states using the mouse or the Mask feature . The analysis type can be selected from the drop-down list. Additionally, the following functions may be accessed from the pop-up menu:

Gather - Gather the cut sets for a selected end state based on cut set generation cutoff values.

Quantify - Calculate a new minimum cut set upper bound for cut sets using current data values (using event data changes and current case cut sets).

Uncertainty - Perform uncertainty analysis on an end state using either the Monte Carlo or Latin Hypercube simulation technique.

Cut Sets - Perform various operations on end state cut sets: Update, Prune, Recover, Edit.

Display - Presents the analyses in various report forms.

View Results - View end state analysis information and compare base case and current case minimal cut set upper bound results.

8.2 Gathering End States

8.2.1 Gathering End States

PURPOSE

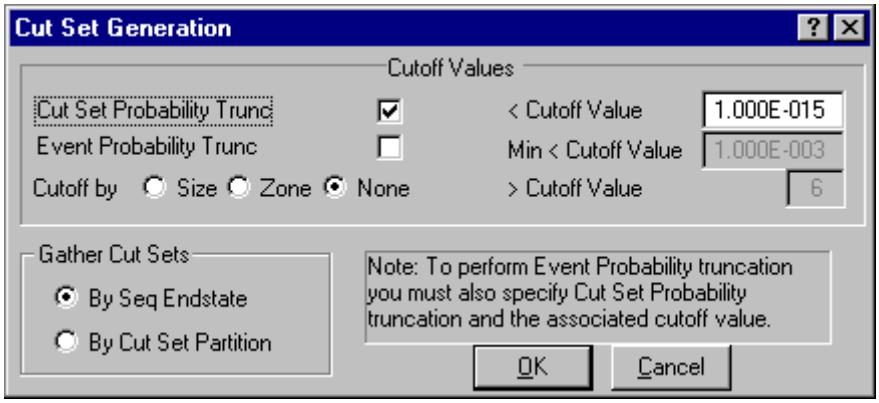
This option allows you to *gather* the cut sets for a selected end state based on cut set generation cutoff values. You are given the opportunity to specify several cut set generation cutoff values that will be used to determine if a cut set is to be retained or discarded from the selected end state.

You are given the ability to generate cut sets for a selected end state, a group of end states, or all end states within the current project.

STEPS

1. From the SAPHIRE menu select **End State**. The *End State List* dialog will be displayed.
2. Highlight the desired end state(s) and right-click to invoke the pop-up menu.
3. Choose **Gather**.

Whether you are gathering cut sets for a single end state, a group of end states, or for all end states, the *Cut Set Generation* 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** 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 < *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.

Gather Cut Sets - Used for determining the method for gathering cut sets.

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. 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 *End State List* dialog is updated to show the letter "c" in front of the end state(s) with current case cut sets.

8.2.2 Cut Set Probability Trunc

If you select this check box, then the only 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.

If you deselect this check box, then the probability for the cut set will be irrelevant for determining if the cut set should be retained or discarded.

8.2.3 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 his option, SAPHIRE will also perform the quantification.

8.2.4 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.

8.2.5 Gather Cut Sets

This option allows you to select which method to use for gathering cut sets.

By Seq Endstate - Gather cut sets by the end state assigned to each sequence (via the event tree graphic editor).

By Cut Set Partition - The end state of each cut set will be used for gathering. (via end state partition rules).

8.3 Quantifying End States

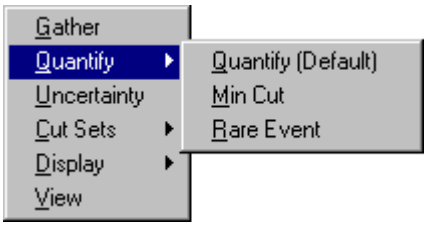
8.3.1 Quantifying End States

PURPOSE

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

STEPS

1. From the SAPHIRE menu select **End State**. The *End State List* dialog will be displayed.
2. Highlight the desired end state(s) and right-click to invoke the pop-up menu.
3. Choose **Quantify**, then one of the sub-menu options.



Quantify (Default) – Re-quantify using the quantification method for the specified end state. This is selected in the **Modify | End State** 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.

If the selected quantification method differs from the end state's default, a warning dialog with the message, "The chosen quantification method was different from the End State 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 end state was selected, upon completion of the quantification process, the results are displayed in the *Quantification Results* dialog. Choose **Ok** to close the dialog.

8.3.2 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 ∪ B ∪ 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

8.3.3 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.

SEE TECHNICAL REFERENCE

Rare Event

8.4 Uncertainty Analysis

8.4.1 Uncertainty Analysis

PURPOSE

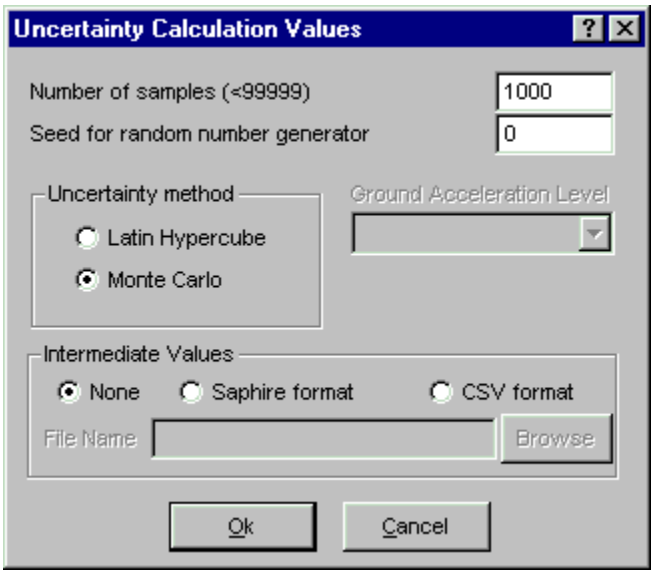
This option can estimate the variability (due to the uncertainties in the basic event probabilities) of either a fault tree top event probability or an event tree sequence frequency. To do this, SAPHIRE provides two sampling techniques: Monte Carlo simulation and Latin Hypercube simulation. In addition, 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**. 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.



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.

8.4.2 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 1.00000E+000 1.00000E+000
    2    2 1.00000E+000 1.00000E+000
    3    2 1.00000E+000 1.00000E+000
                 .
                 .
                 .
  500    2 1.00000E+000 1.00000E+000
```

8.4.3 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.

8.4.4 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.

8.4.5 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.

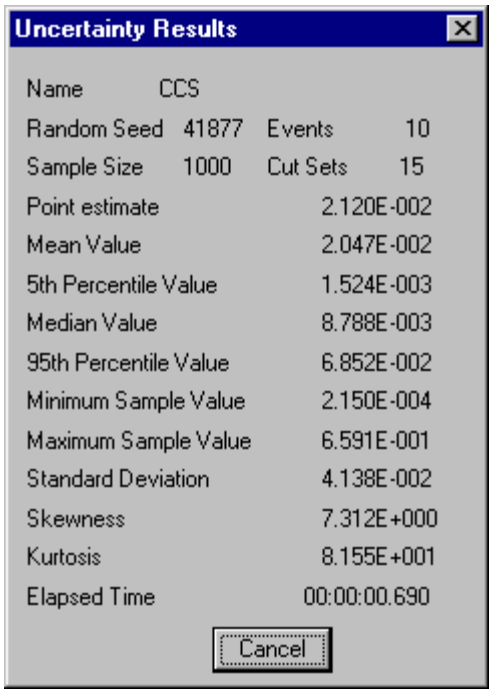
If an error occurs during the uncertainty analysis process, the process is terminated and a message box providing information about the specific error is displayed.

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.

8.4.6 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.

8.4.7 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.

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.

8.5 End State Cut Set Analysis

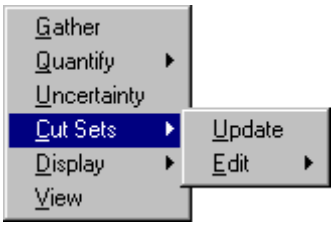
8.5.1 End State Cut Set Analysis

PURPOSE

This option provides the ability to perform a variety of analysis functions on the end state cut sets.

STEPS

1. From the SAPHIRE menu select **End State**. The *End State List* dialog will be displayed.
2. Highlight the desired end state(s) and right-click to invoke the pop-up menu.
3. Choose **Quantify**, then one of the sub-menu options.



Update - Update the current cut sets for selected end state(s) based on cut set generation cutoff values.

Edit - Modify the base case/current end state cut sets.

8.5.2 Updating Cut Sets

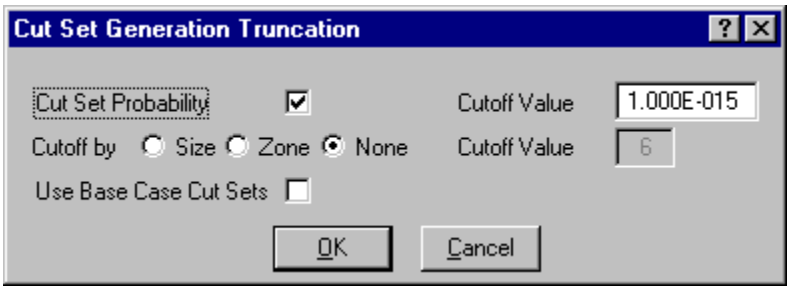
PURPOSE

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.

8.5.3 Cut Set Generation Truncation

8.5.3.1 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.

8.5.3.2 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.

8.5.3.3 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.

8.5.4 Editing End State Cut Sets

8.5.4.1 Editing Cut Sets

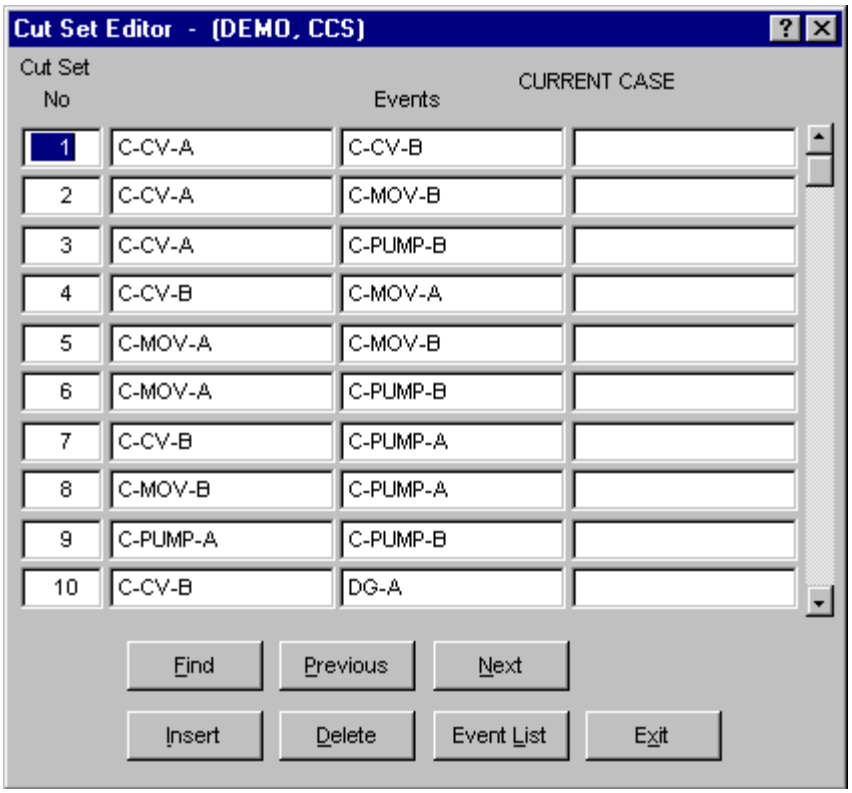
PURPOSE

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. The *Cut Set Editor* dialog will be displayed.



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.

8.5.4.2 Find

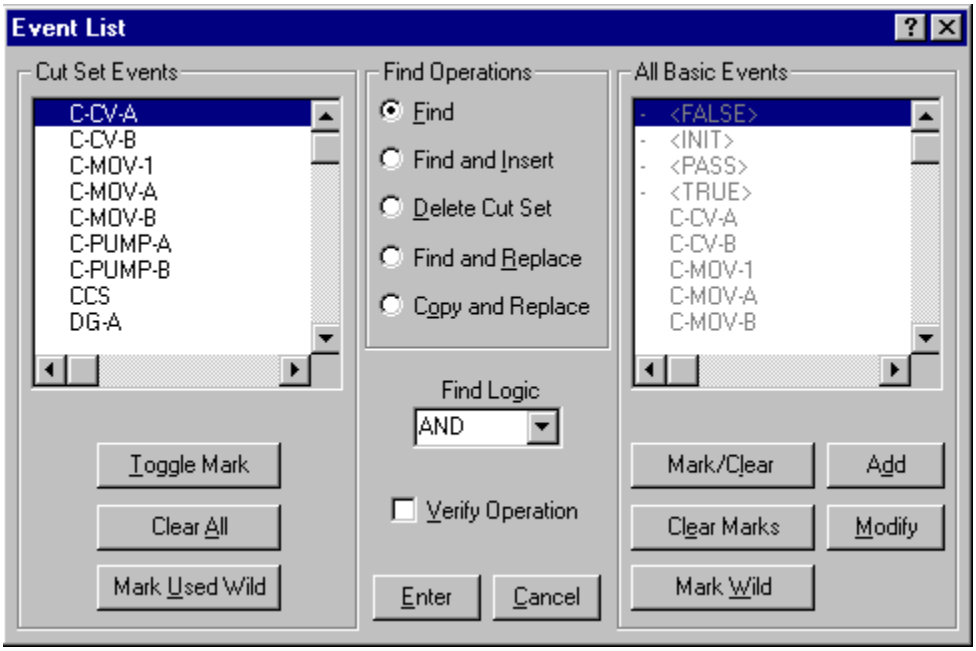
PURPOSE

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. The *Cut Set Editor* dialog will be displayed.
5. Choose the **Find** button. 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 *Event List* dialog.

8.5.4.3 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. The *Cut Set Editor* dialog will be displayed.
5. Place the cursor in the desired cell and choose the **Insert** button.

8.5.4.4 Delete

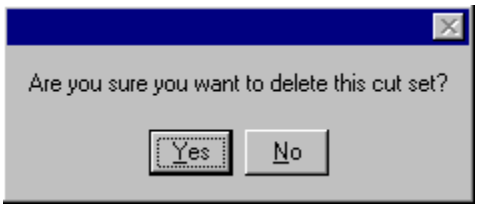
PURPOSE

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. The *Cut Set Editor* dialog will be displayed.
5. 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.

8.5.4.5 Event List

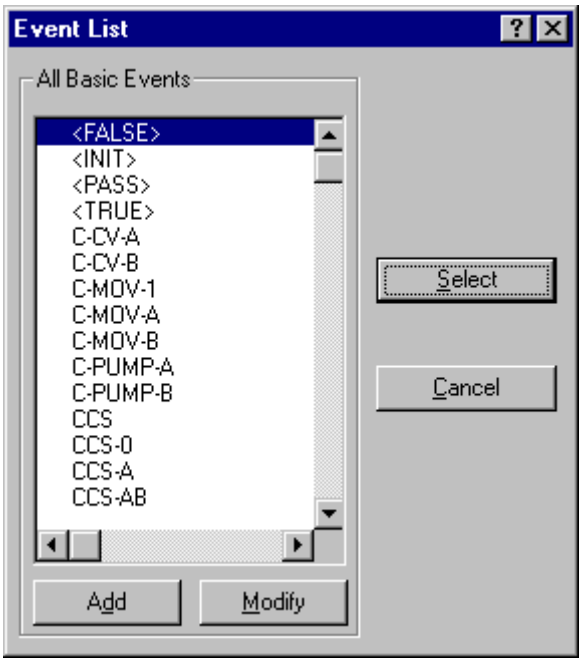
PURPOSE

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. The *Cut Set Editor* dialog will be displayed.
5. Place the cursor in the desired *Event* cell.

6. 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.

8.6 Displaying End State Results

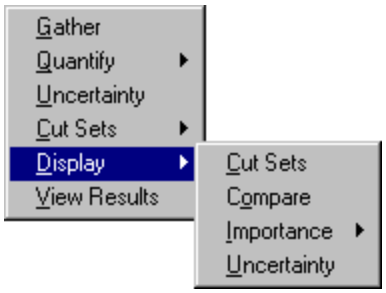
8.6.1 Displaying End State Results

PURPOSE

This option displays the results of end state analysis functions. You can view the current case cut sets and uncertainty analysis results, and perform importance measure analyses.

STEPS

1. From the SAPHIRE menu select **End State**. The *End State List* dialog will be displayed.
2. Highlight the desired end state(s) and right-click to invoke the pop-up menu.
3. Choose **Display**, then one of the sub-menu options.



Cut Sets - Display the end states' cut sets, their percent of contribution to the end state, the frequency, and the event names that make up the cut sets.

Comparison - Display the end states' base and current cut sets, their percent of contribution to the end state, 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.

8.6.2 Displaying Cut Sets

8.6.2.1 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.

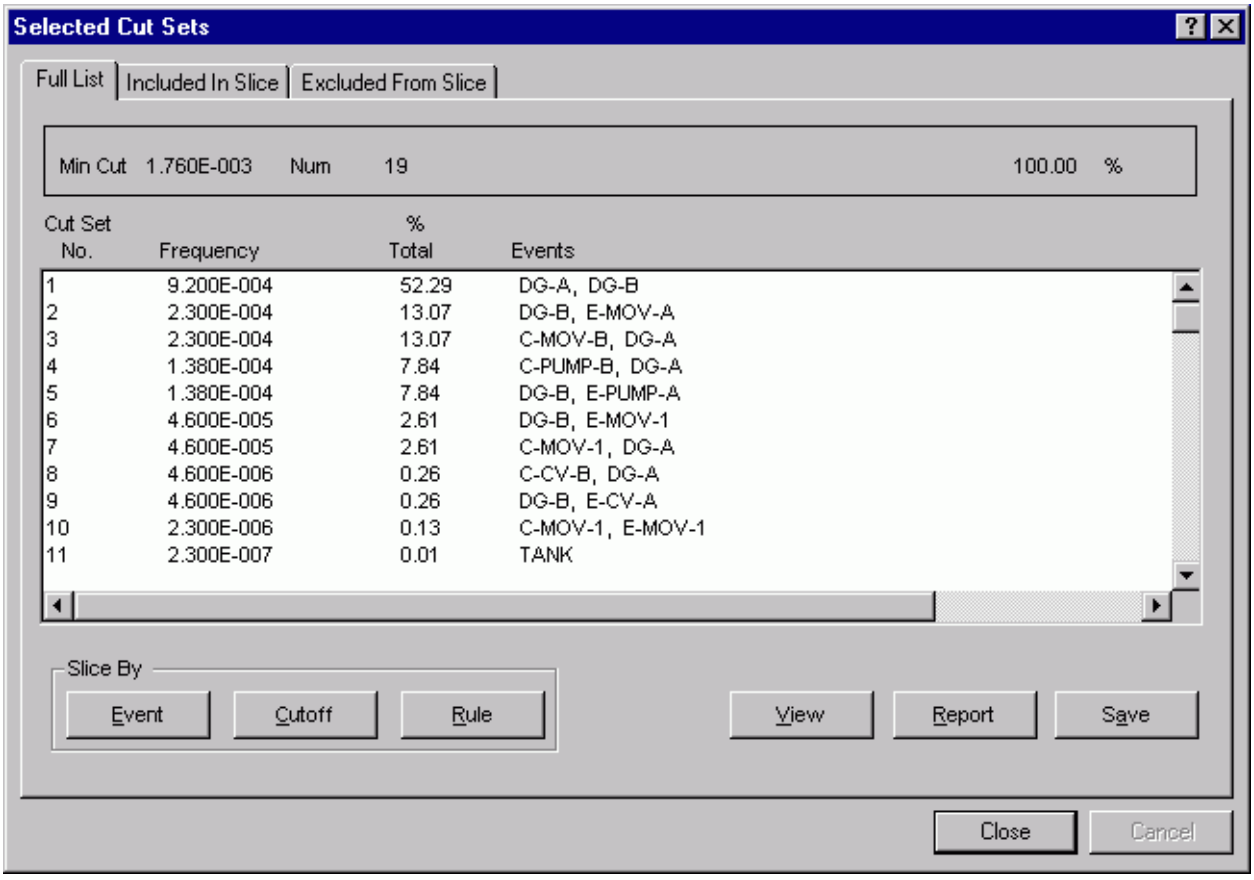
When the dialog is invoked, the fault tree (or sequence or end state) cut sets are shown. Displayed with each cut set is its associated percent of contribution to the minimal cut set upper bound, its probability (or, perhaps, frequency), and the event names that make up the cut sets. Also displayed are 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. The *Selected Cut Sets* dialog will be displayed.



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 *Selected Cut Sets* dialog.

8.6.2.2 Path Search

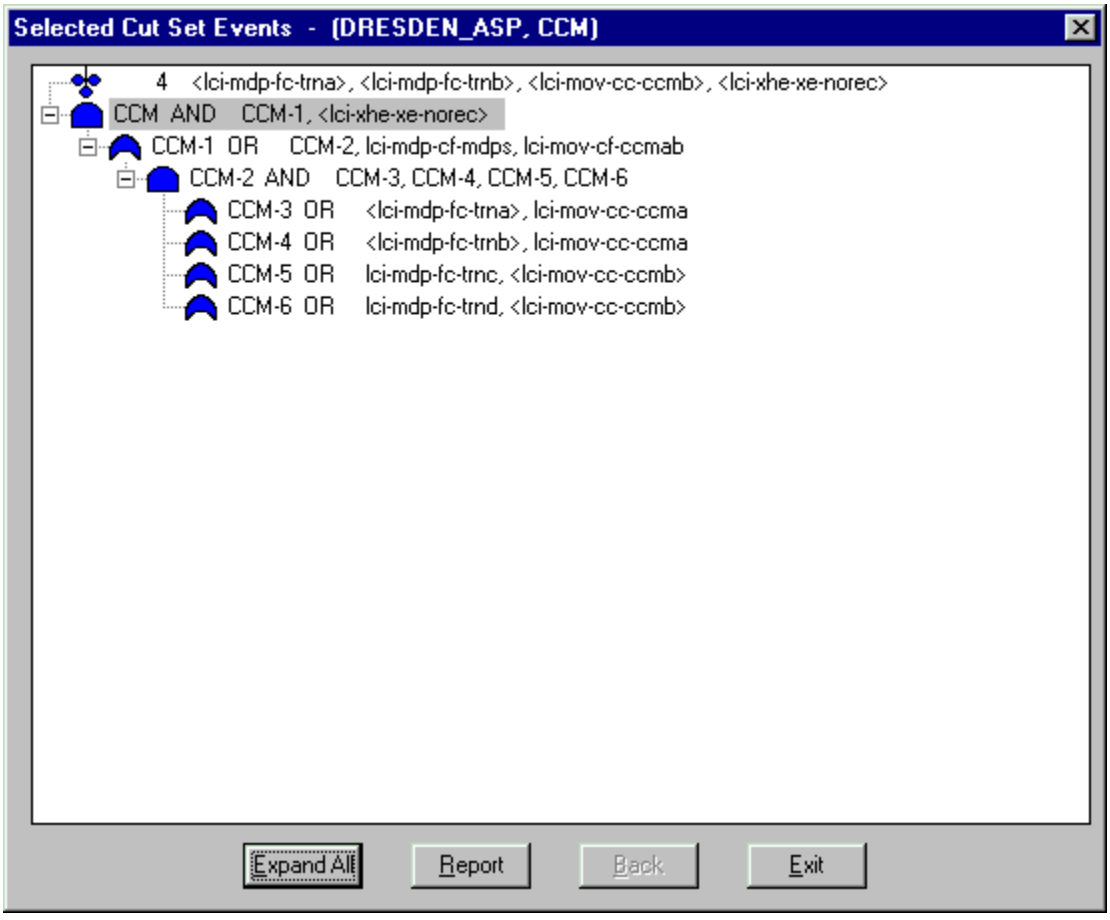
PURPOSE

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. 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.

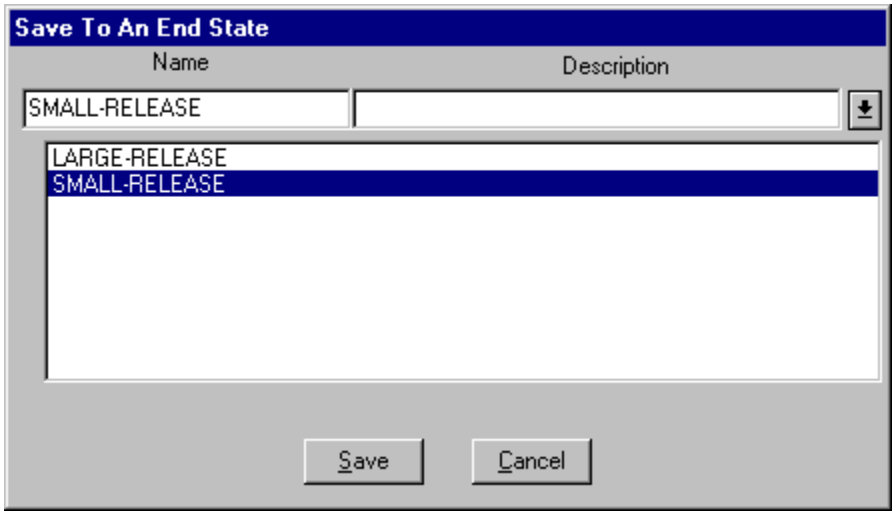
8.6.2.3 Save

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.

8.6.2.4 Slice Option

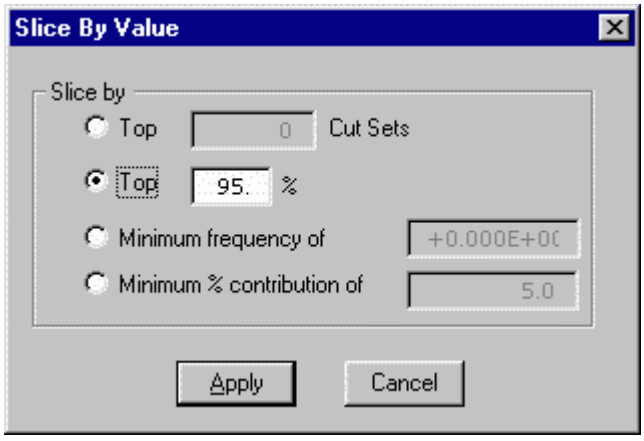
8.6.2.4.1 Slice By Cutoff

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. 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.

8.6.2.4.2 Slice By Event

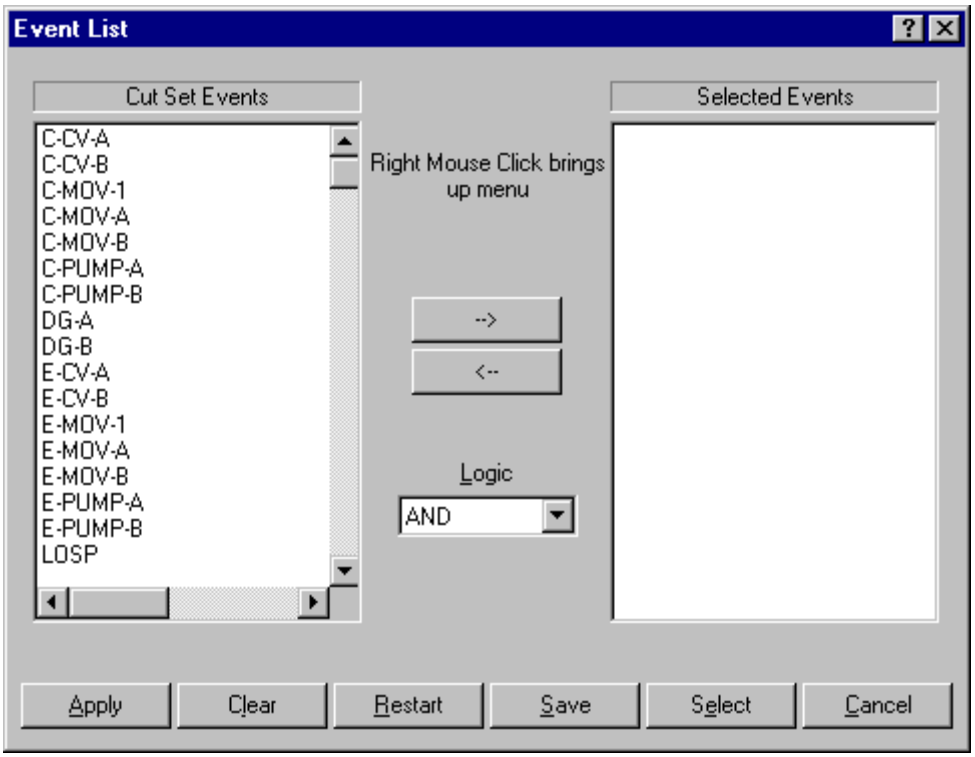
8.6.2.4.2.1 Slice By Event

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. 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 *Selected Events* 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 *Selected Events* list (i.e., clear the qualification criteria).
Restart - Restore the original cut sets and clear the qualification criteria. The *Event List* dialog will be closed and the *Included In List* and *Excluded From List* 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 *Selected Events* list.
Cancel - Close the *Event List* dialog without applying the qualification criteria.

8.6.2.4.2.2 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

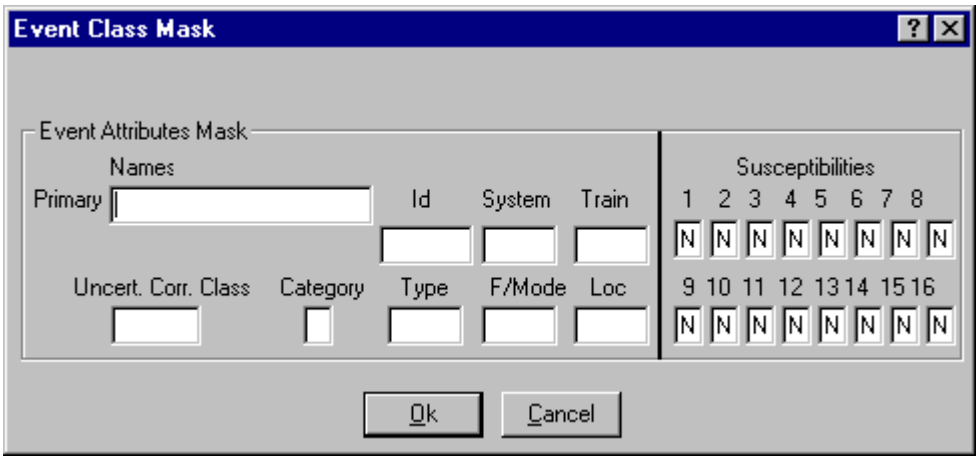
1. From the SAPHIRE menu select **Fault Tree/Sequence/End State**. The *Fault Tree List/Sequences/End State List* dialog will be displayed.
2. Highlight the desired list item and right-click to invoke the pop-up menu.

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.
4. The *Event Class Mask* dialog will be displayed.



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.

8.6.2.4.2.3 Save Slice

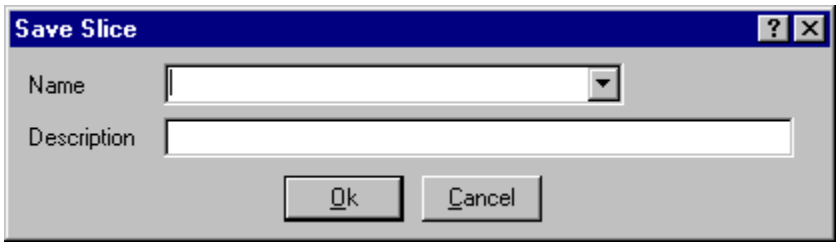
PURPOSE

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 F**ault 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.

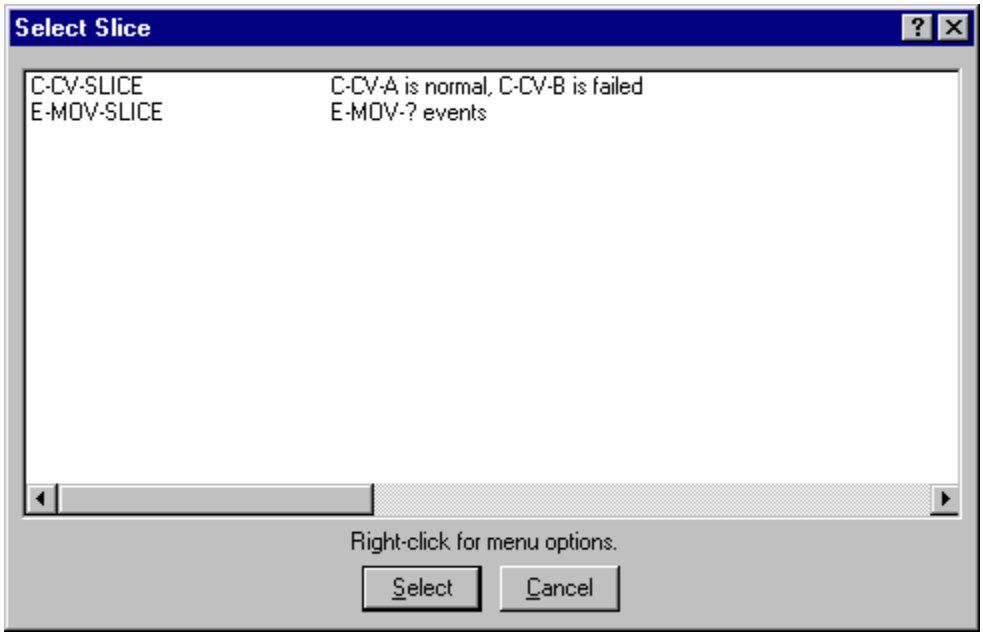
8.6.2.4.2.4 Select Slice

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.

8.6.2.4.3 Slice By Rule

8.6.2.4.3.1 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.

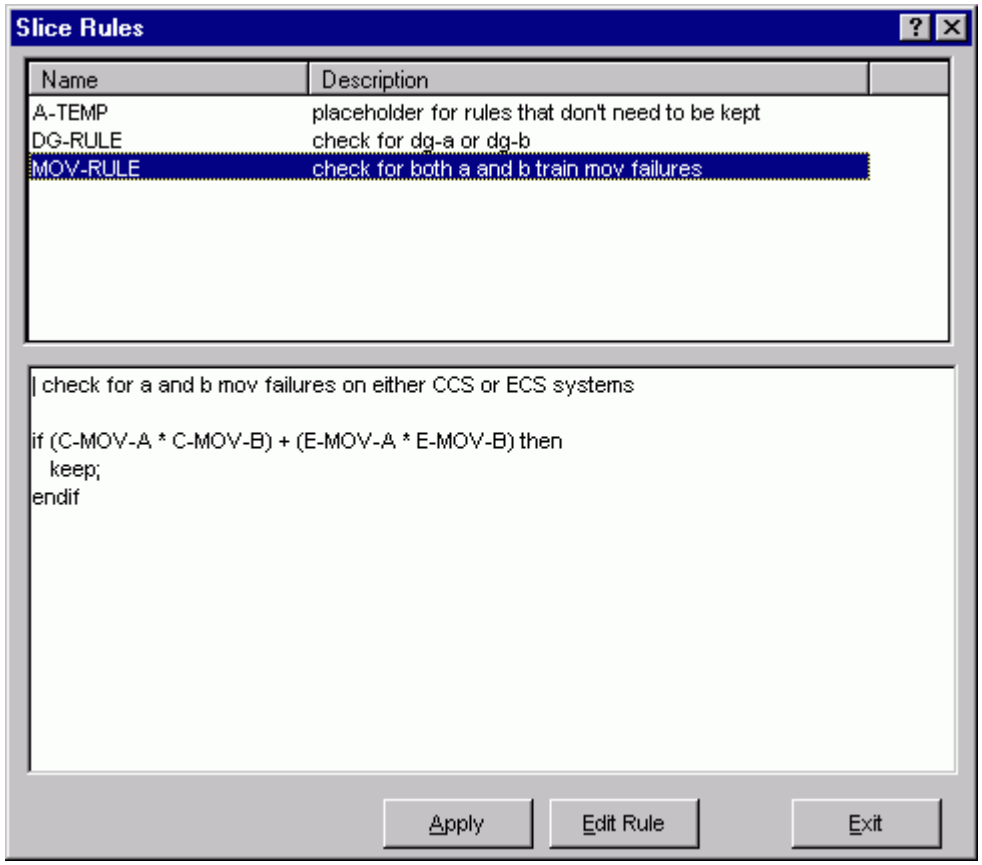
When the dialog is invoked, a list of slice rules is displayed. The highlighted rule is previewed in the bottom text area. To add/modify/delete a slice rule name and description, right click and select the appropriate menu option. To edit a rule, choose the **Edit Rule** button. To apply a rule to the 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.

8.6.2.4.3.2 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.

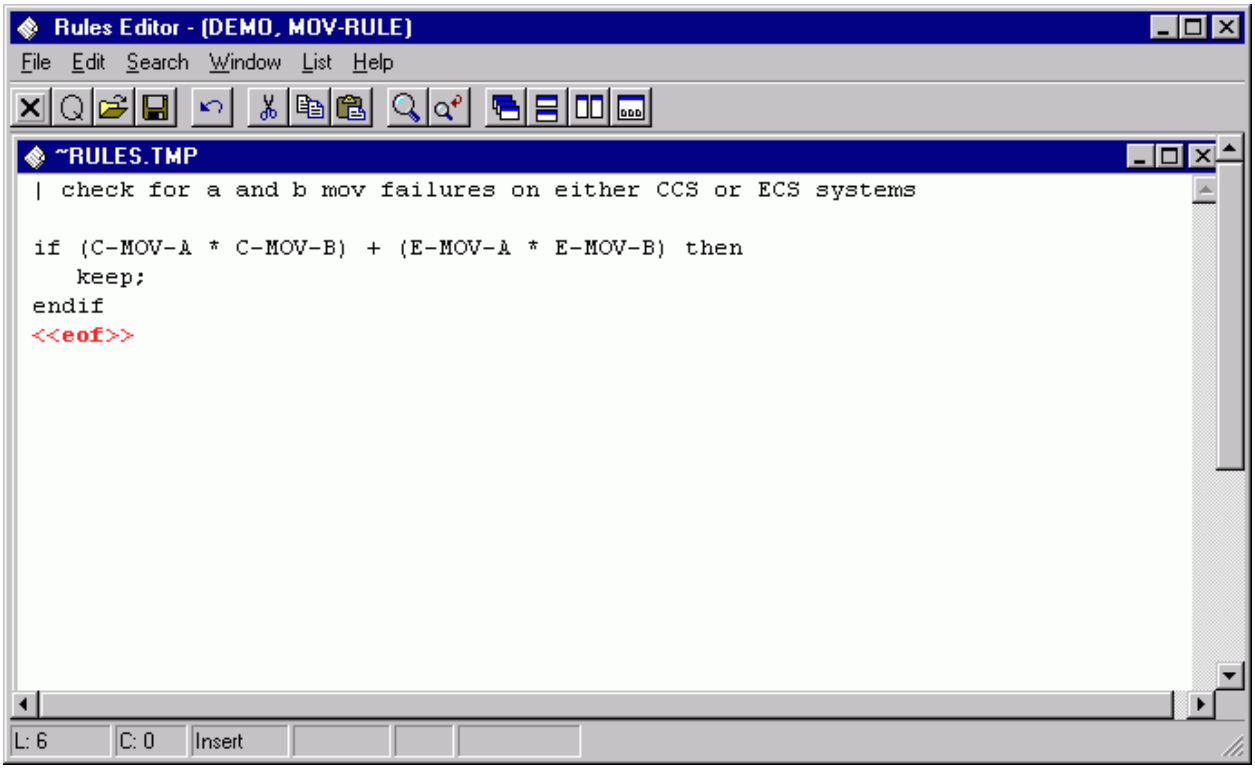
The slice rules are entered in a free-form text editor within SAPHIRE. The editor options and rule syntax are similar to that of SAPHIRE's recovery rules. However, unlike to recovery rules, slice rules are not tied to the fault tree, sequence(s) or end state(s) whose cut sets are currently displayed. (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.

8.6.2.4.3.3 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 *Editor* session.

8.6.2.4.3.4 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.

8.6.2.4.3.5 Editor Search Functions

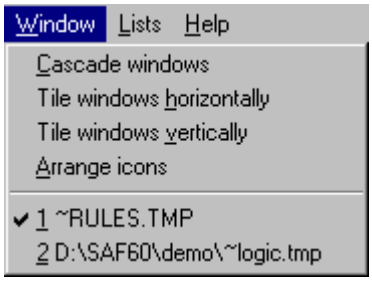
These options provide search and cursor positioning operations.

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.

8.6.2.4.3.6 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.

8.6.2.4.3.7 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.

8.6.2.4.3.8 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.

8.6.2.5 Importance

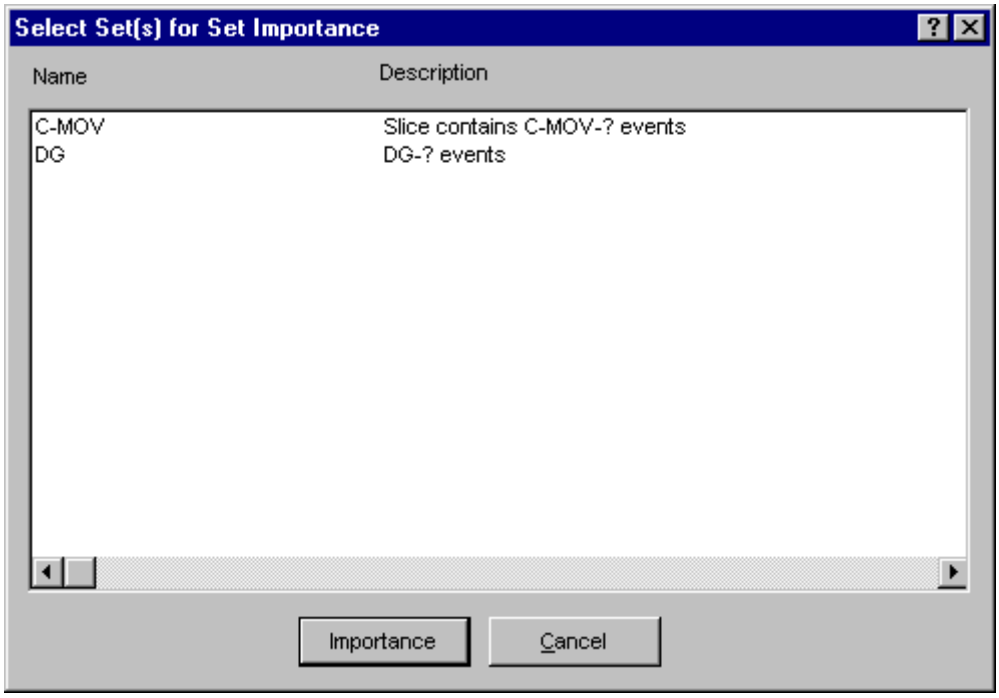
8.6.2.5.1 Sets Importance

PURPOSE

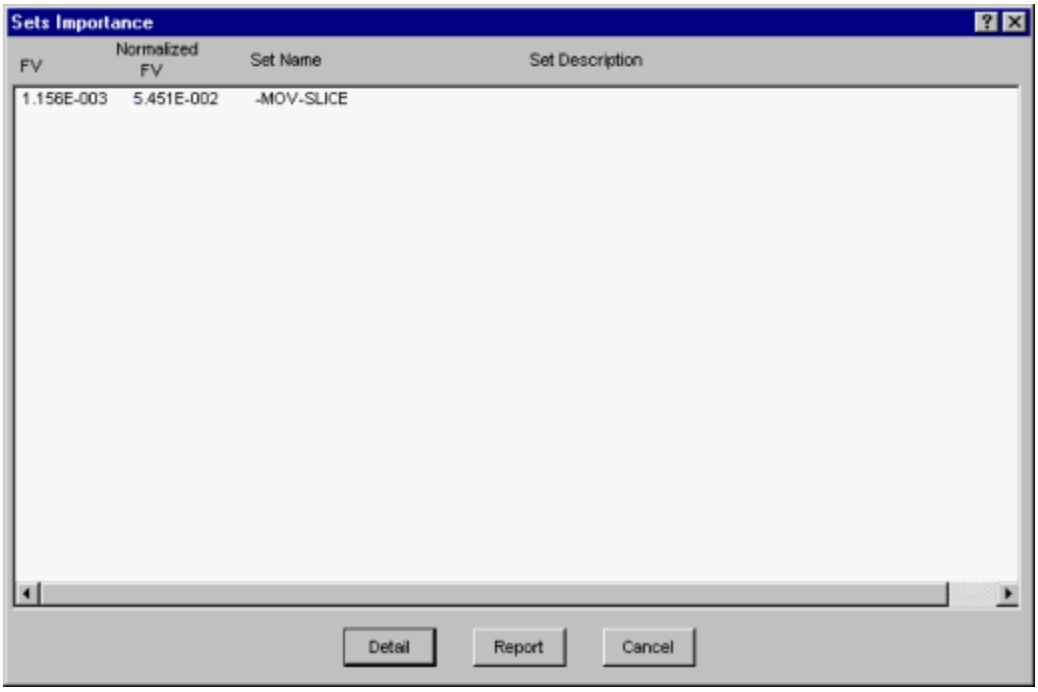
This option displays the Fussell-Vesely importance of the selected set(s) of cut sets including interactions among the events. The selected sets are previously saved slices.

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.

8.6.2.6 View Option

8.6.2.6.1 View Cut Set

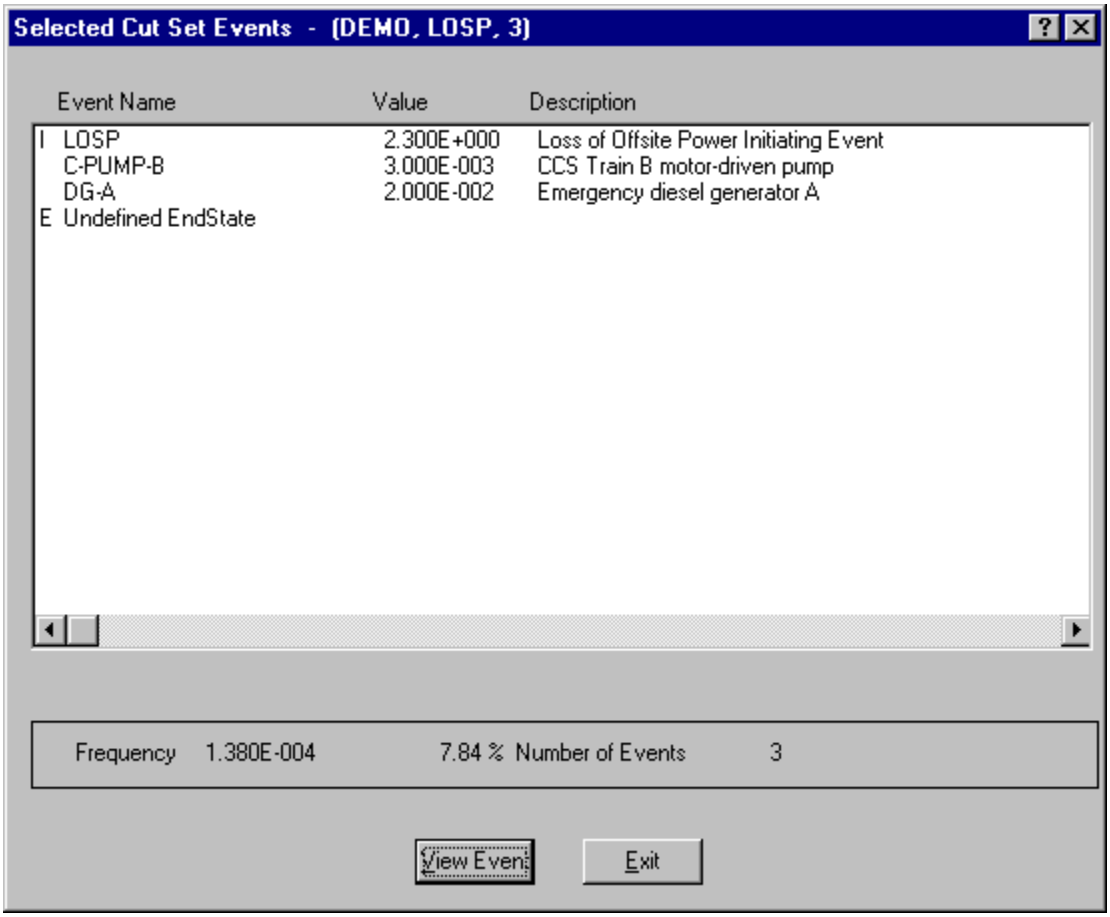
PURPOSE

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.



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.

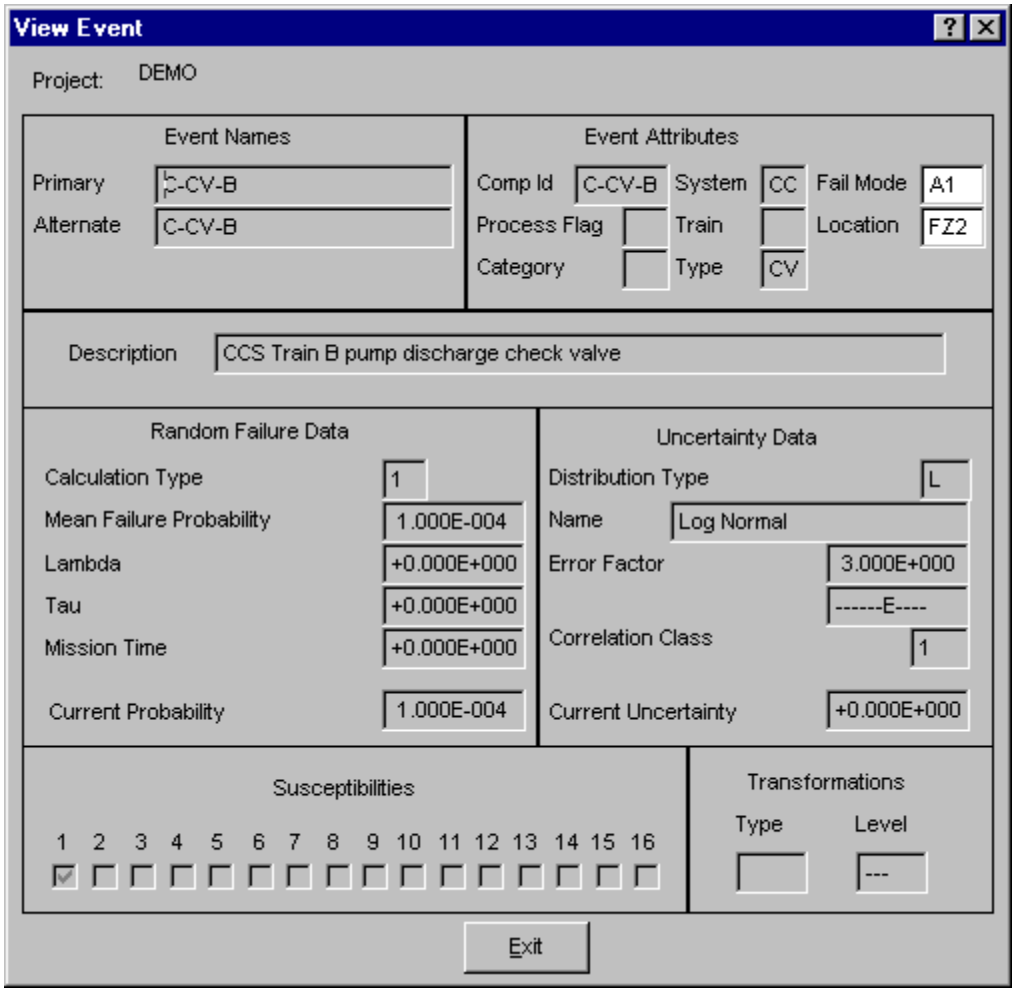
8.6.2.6.2 View Event

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.



Information on this dialog is for display only and cannot be modified.

8.6.2.7 Report Dialog

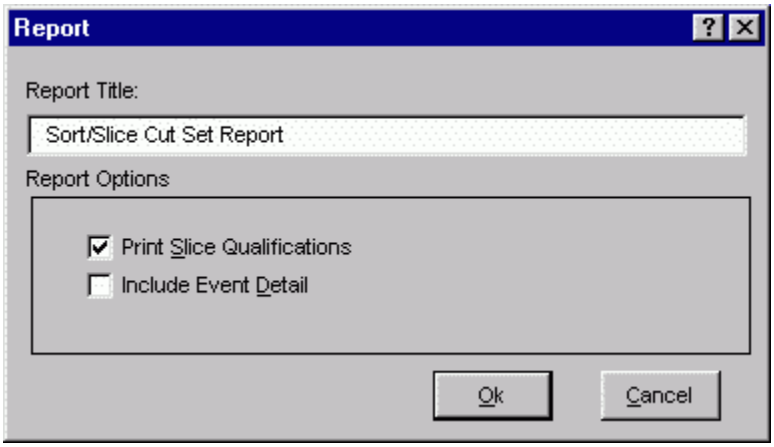
8.6.2.7.1 Cut Set Report

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.

8.6.3 Comparing Cut Sets

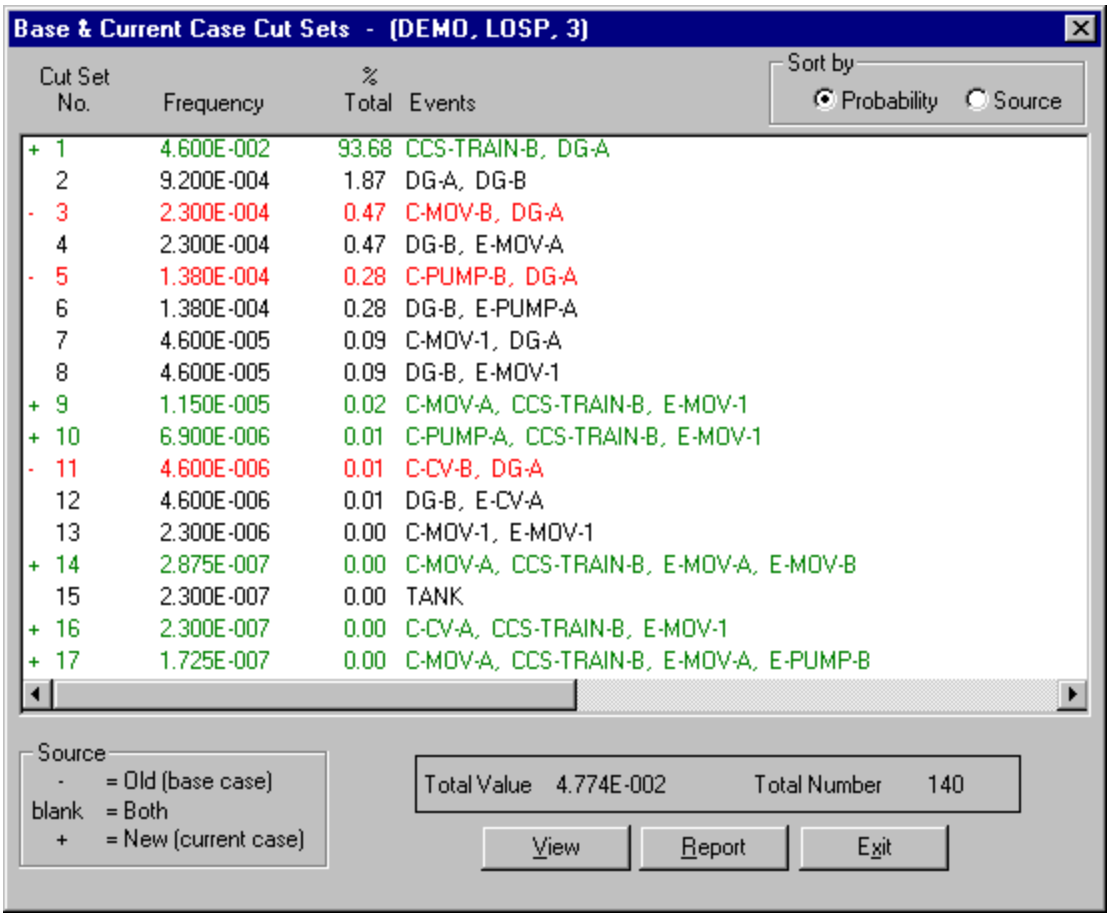
8.6.3.1 Cut Set Comparison

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.



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.

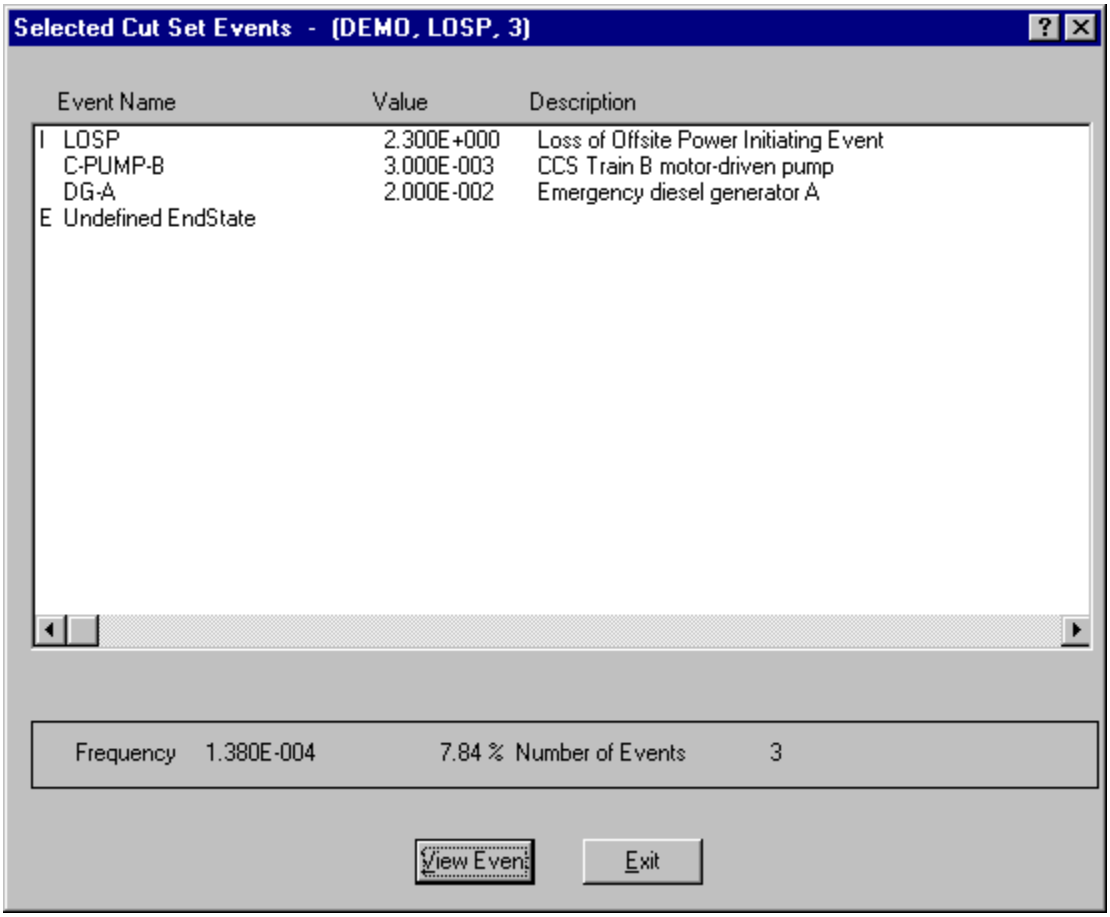
8.6.3.2 View Cut Set

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.



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.

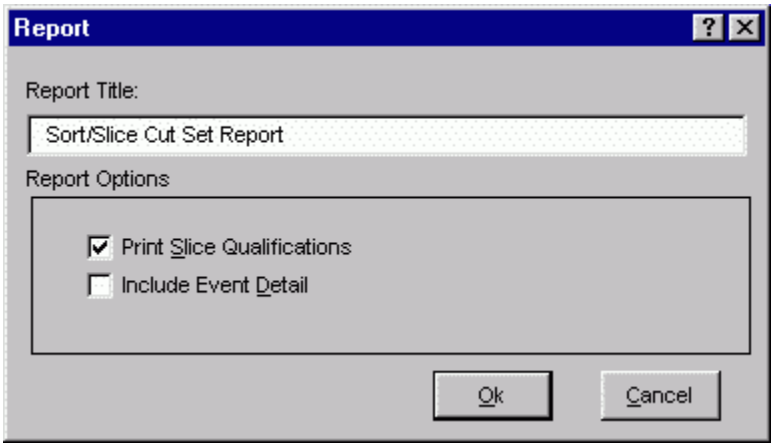
8.6.3.3 Cut Set Report

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.

8.6.4 Displaying Importance Results

8.6.4.1 Importance Measures

PURPOSE

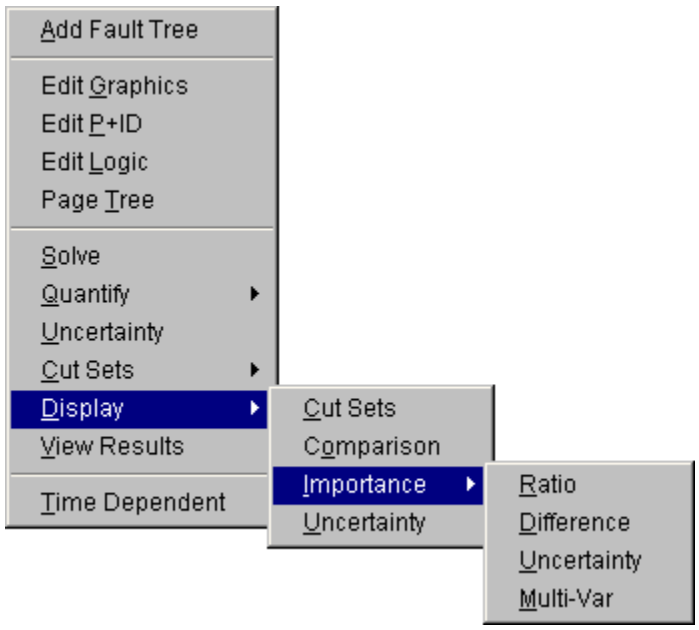
Importance measures provide "reliability-worth" information about basic events appearing in the cut sets for a fault tree or accident sequence. The "importance" for a basic event is essentially the event's contribution to the overall top event probability (for fault trees) or sequence frequency (for 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.

8.6.4.2 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

$$\mathbf{FV = F(i)/F(x)}$$

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

$$\mathbf{FV = 1 - F(0)/F(x)}$$

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.

8.6.4.3 Birnbaum Importance (B)

This indicates the sensitivity of the minimal cut set upper bound with respect to a change in the basic event probability.

$$\mathbf{B = F(1) - F(0)}$$

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.

8.6.4.4 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 or 0.0 (typically if the corresponding component never failed).

$$\mathbf{RRR = F(x)/F(0)}$$

$$\mathbf{RRI = F(x) - F(0)}$$

Note the similarity between RRI and FV; the relative importance ranking of basic events will be the same for the two importance measures.

8.6.4.5 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.

$$\mathbf{RIR = F(1)/F(x)}$$

$$\mathbf{RII = F(1) - F(x)}$$

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.

8.6.4.6 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 ith basic event, and σ_i^2 is the variance of the uncertainty distribution for the ith 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 ith 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.

8.6.4.7 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.”

8.6.4.8 Importance Measures Dialog

8.6.4.8.1 Importance Measures Results

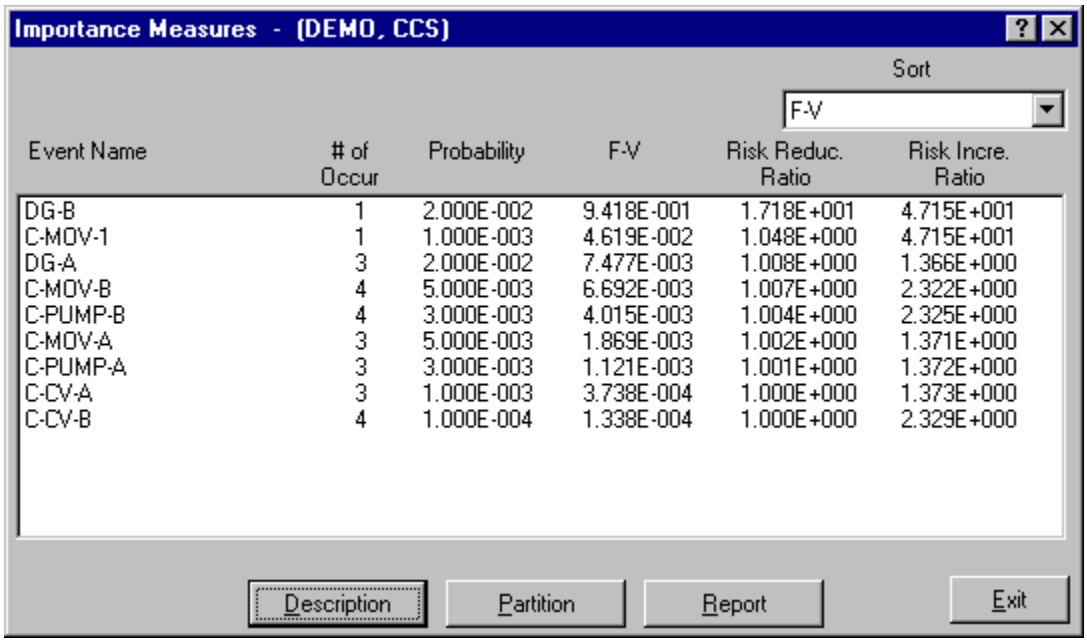
PURPOSE

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, Mult-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.



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.

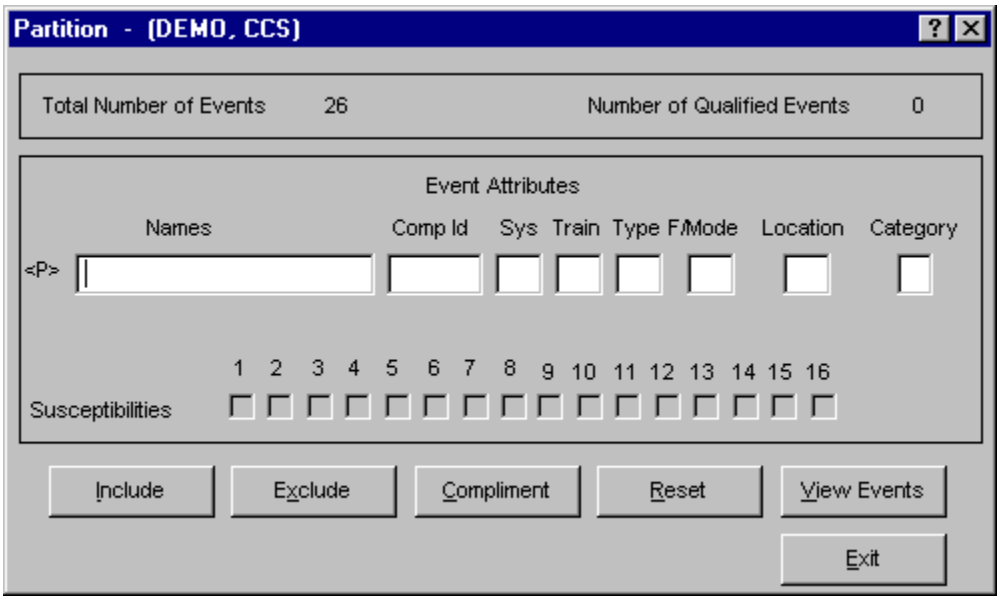
8.6.4.8.2 Importance Results Partition

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.



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.

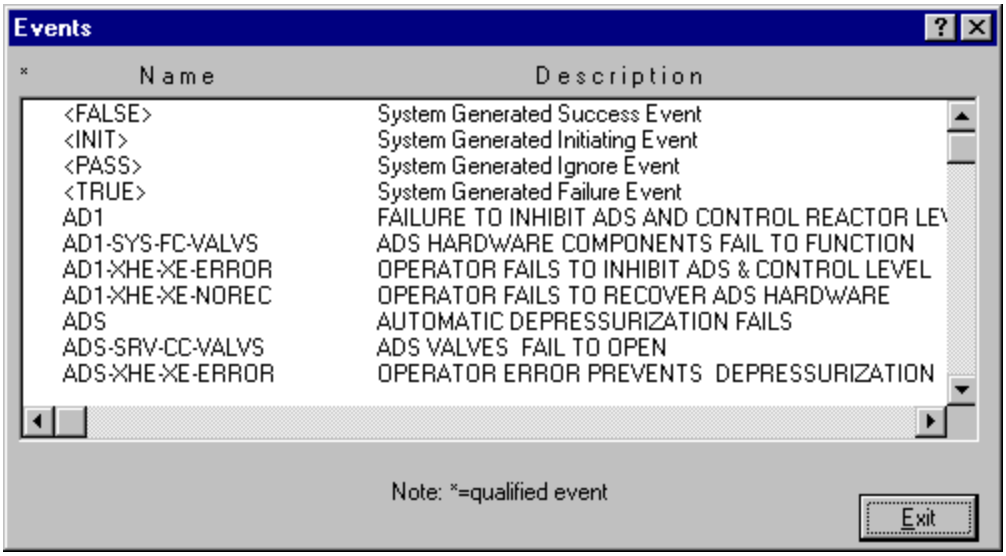
8.6.4.8.3 View Events

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..

8.6.5 Displaying Uncertainty

8.6.5.1 Displaying Uncertainty Results

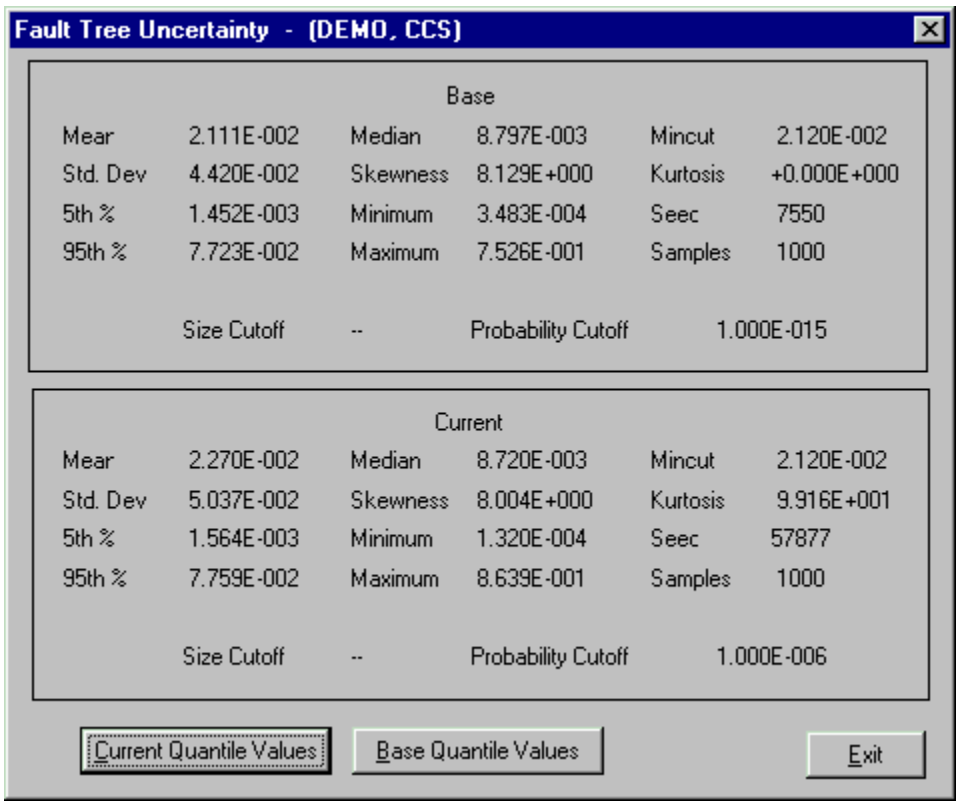
PURPOSE

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.



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.

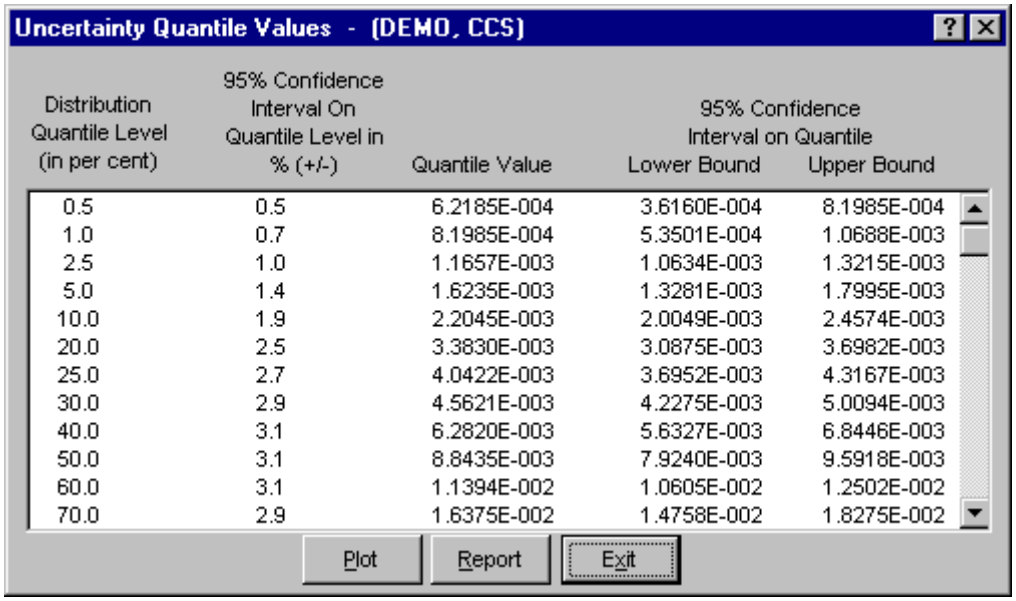
8.6.5.2 Uncertainty Quantile Values

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 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.

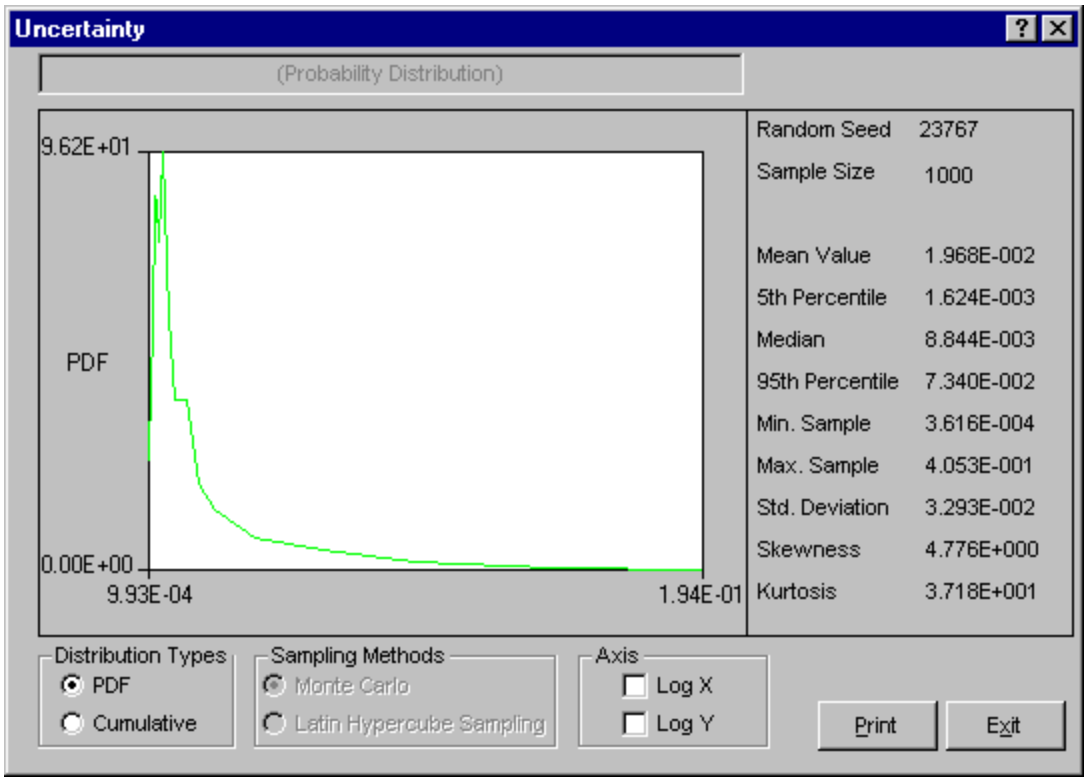
8.6.5.3 Plot Uncertainty Quantile Values

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.

8.6.5.4 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.

8.6.5.5 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.

8.6.5.6 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.

8.7 Viewing End States

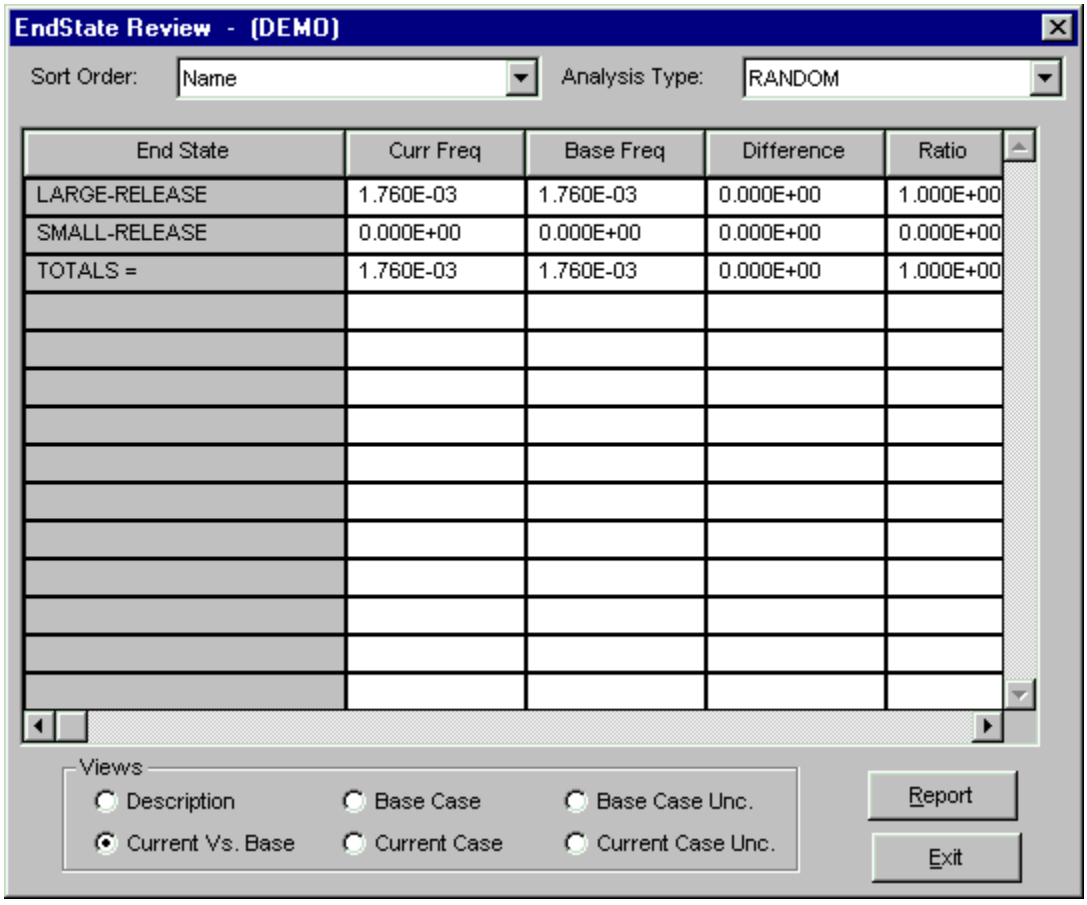
8.7.1 Viewing End States

PURPOSE

This option presents the end state analyses in various report forms. One or more end states can be viewed using this option.

STEPS

1. From the SAPHIRE menu select **End State**. The *End State List* dialog will be displayed.
2. Highlight the desired end state(s) and right-click to invoke the pop-up menu.
3. Choose **View Results** from the menu. The *EndState Review* dialog will be displayed.



The selected end states are displayed in this dialog. The *End State* column contains the end states' primary names. Other columns' titles and data vary depending on the selected "View".

The last row in the grid show the summation totals of applicable columns.

Report - Produce a report of the data currently displayed. The output can go to the *Report Viewer*, a printer, or a file.

Exit - Close the *EndState Review* dialog.

8.7.2 View Options

Description - Includes the full description. (60 character maximum)

Current Vs. Base - Includes the current case cut set probability, base case cut set probability, the probability difference (current - base), ratio, current case cut set count, base case cut set count, the cut set count difference (current - base).

Base Case - Includes base case values for cut set probability, mean, 5th percentile, median, 95th percentile, probability truncation, and size truncation used when solving.

Current Case - Includes current case values for cut set probability, mean, 5th percentile, median, 95th percentile, probability truncation, and size truncation used when solving.

Base Case Uncertainty - Includes base case values for cut set probability, mean, 5th percentile, median, 95th 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, 5th percentile, median, 95th percentile, minimum, maximum, standard deviation, skewness, kurtosis, sample size, and random number seed.

9. MODIFYING THE DATA BASE

9.1 Modifying the Data Base

PURPOSE

This option allows you to modify SAPHIRE database files.

STEPS

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

After selecting an option from the menu, a dialog containing a list of all records for the selected data type appears. In general, the functions: add, copy, modify, and delete are then available from a pop-up menu. Some of the dialogs have additional options accessible by choosing the appropriate button.

9.2 Modifying Project Data

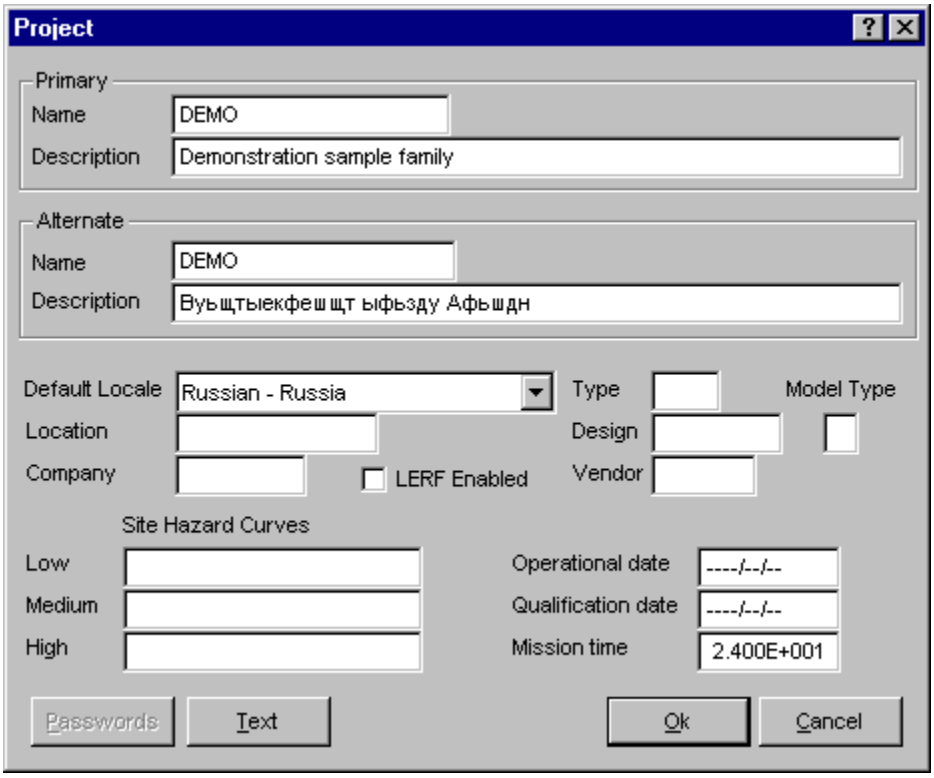
9.2.1 Project Data Entry Dialog

PURPOSE

The *Project* dialog allows you to modify project data.

STEPS

1. From the menu select **Modify**.
2. Choose **Project** from the menu. The *Project* dialog is displayed.



Ok - Save the modified project record and close the dialog.
Cancel - Close the dialog without saving.

9.2.2 Name

This is a required field. 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.

9.2.3 Type

This is a user-defined field used to classify the facility under study. A maximum of 3 characters (uppercase, alphanumeric) may be entered.

9.2.4 Location

This is a user-defined field used to specify the geographical location of the facility under study. A maximum of 10 characters (uppercase, alphanumeric) may be entered.

9.2.5 Design

This is a user-defined field used to identify the facility's design type. A maximum of 10 characters (uppercase, alphanumeric) may be entered. This field may contain embedded blanks.

9.2.6 Model Type

This field is used to identify the model solution type for this facility. An "N" indicates that this is a normal model. An "A" indicates that this is an ASP model. You may specify you own model designation or leave the field blank.

9.2.7 Company

This is user-defined field used to identify the company responsible for the facility. A maximum of 10 characters (alphanumeric) may be entered. This field may contain embedded blanks.

9.2.8 Vendor

This is a five-character, uppercase, alphanumeric field used to identify the company that built the facility.

9.2.9 LERF Enabled

Indicates that the model has been developed for use in Large Early Release Frequency (LERF) study. The "LERF" option in GEM allows a user to select an existing initiating event assessment or condition assessment (or make a new one), but evaluate the assessment using a LERF end state gather instead of the core damage sequences. GEM has been designed to look specifically for sequences labeled "PDS-" (either on the event tree graphic or created via event tree partition rules). As such, the plant model must be designed such that only LERF sequences are assigned to end states beginning with "PDS-" for the correct LERF results to be generated.

9.2.10 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.2.11 Default Locale

Set the default or primary locale for this project. The locales listed are those that are loaded into memory when your computer is started. To add locales, see International SAPHIRE .

9.2.12 Site Hazard Curves

This is a 24-character field that identifies histograms to be used as hazard curves. Low, Medium and High histograms represent the differing views about susceptibility to earthquakes.

9.2.13 Operational Date

This is the date the facility became operational. The format for this field is YYYY/MM/DD.

9.2.14 Qualification Date

This is the qualification date of the facility. The format for this field is YYYY/MM/DD.

9.2.15 Mission Time

The default mission time for this project.

9.3 Modifying Event Tree Data

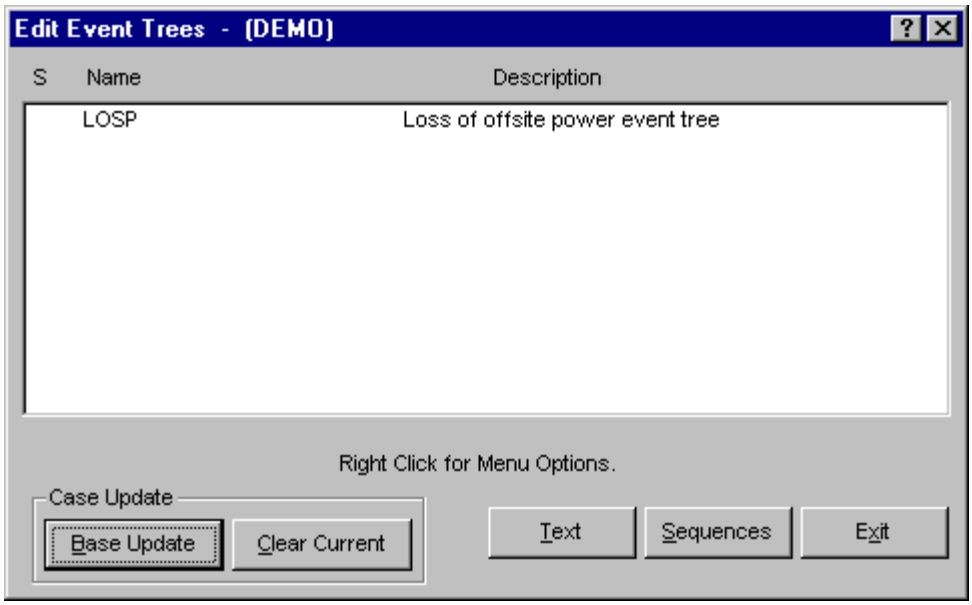
9.3.1 Event Trees

PURPOSE

This option allows you to add, modify, copy, or delete event tree data records, or associated text. Additionally, you can update selected event tree base case data or clear selected event tree current case data. You can add, modify, copy or delete sequence data records associated with the selected event tree.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Event Trees** from the menu. The *Edit Event Trees* dialog is displayed, listing all of the event trees belonging to the current project.
3. Highlight the desired event tree.
4. Right-click to invoke the pop-up menu or choose the desired button.



Pop-up Menu Options

Add -	Add a new event tree record to the database.
Copy -	Create a new event tree record by copying an existing one.
Modify -	Edit the selected event tree record.
Delete -	Delete the selected event tree record(s).
Graphics-	Edit the graphical picture of the event tree.
Reset –	Delete all the sequences that belong to the selected event tree.

Button Options

Base Update -	Update selected event tree base case data. The *Base Case Update* dialog will have slightly different wording than the dialog in this example.
Clear Current -	Clear selected event tree current case data. **The *Clear Current Case* dialog will** have slightly different wording than the dialog in this example.
Text -	View and edit the descriptive text associated with the selected event tree.
Sequences -	Add, modify, copy or delete sequence data records.
Exit -	Close the *Edit Event Trees* dialog.

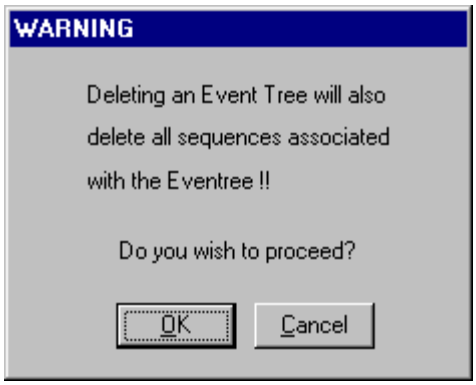
9.3.2 Delete An Event Tree

PURPOSE

This option allows you to delete an event tree record and associated sequence records from the database.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Event Trees** from the menu. The *Edit Event Trees* dialog is displayed.
3. Highlight the event tree you wish to delete.
4. Right-click to invoke the pop-up menu and choose **Delete**. A warning dialog will appear, allowing you to cancel the deletion at this point.



OK - Continue the delete operation. Once you choose **OK** at the warning screen to continue with the deletion process, another warning dialog is shown. You will be prompted to choose **Yes** or **No.** Upon choosing the **Yes** button, the selected event tree record and all sequence records associated with the event tree will be deleted from the database.

Cancel - Terminate the delete operation.

NOTE: You cannot delete a sub-tree (if it is used by another event tree) using this option.

9.3.3 Base Case Update

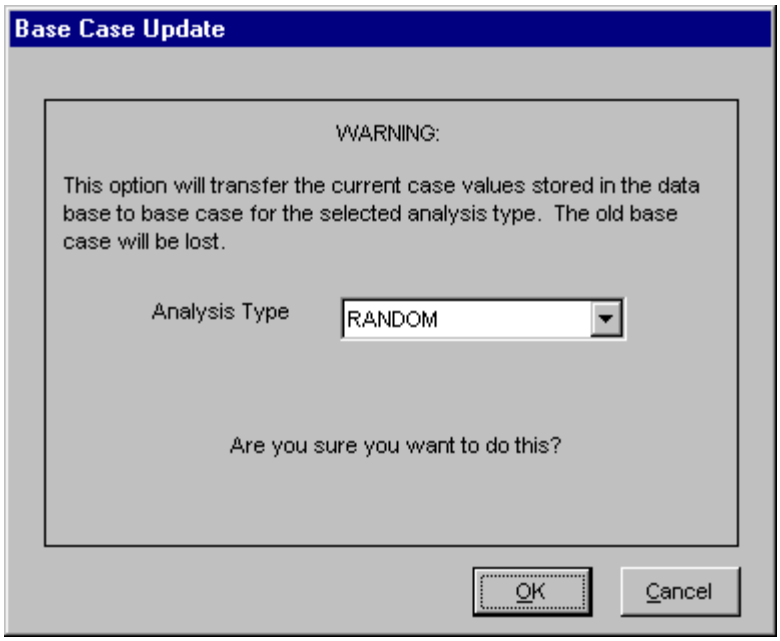
PURPOSE

This option allows you to overwrite all base case (original) data with the current case data for the selected analysis type. If you choose to update the base data, four operations will occur. (1) The base case cut sets will be overwritten with the current case cut sets. (2) The base case uncertainty results will be overwritten with the current case uncertainty results. (3) The base case uncertainty quantile values will be overwritten with the quantile values from the current case. (4) The base case minimum cut set upper bound will be overwritten with the current case minimum cut set upper bound. As a note of caution, the original base case results will be overwritten if this option is executed!

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Event Trees**. The *Edit Event Trees* dialog is displayed.
   OR
3. Choose **Event Trees | Sequences**. The Edit Sequences dialog is displayed.
   OR
4. Choose **Fault Trees**. The Edit Fault Trees dialog is displayed.
   OR
5. Choose **End States**. The Edit End State dialog is displayed.
6. Highlight the desired list item.
7. Choose the **Base Update** button. The *Base Case Update* dialog will be displayed.

You will be prompted for confirmation before performing the update. In addition, you must select the analysis type from the drop-down list.



OK - Cause the current case data to overwrite the base case data. Upon completion of this process, a message, "Base case update complete" will be displayed in the message bar of the SAPHIRE window.

Cancel - Terminate the update operation.

9.3.4 Clear Current Case

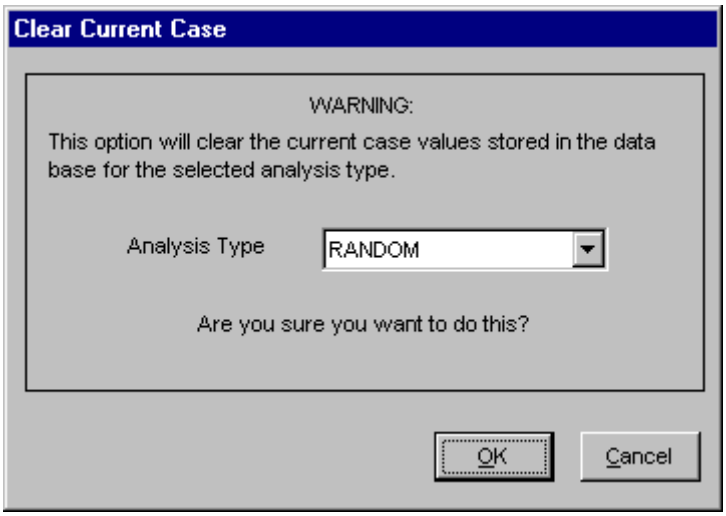
PURPOSE

This option deletes all current case information for the specified analysis type. All SAPHIRE calculations use data stored in the current case for sensitivity and event analysis, and cut set generation results are stored in the current case.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Event Trees**. The *Edit Event Trees* dialog is displayed.
   OR
3. Choose **Event Trees | Sequences**. The Edit Sequences dialog is displayed.
   OR
4. Choose **Fault Trees**. The Edit Fault Trees dialog is displayed.
   OR
5. Choose **End States**. The Edit End State dialog is displayed.
6. Highlight the desired list item.
7. Choose the **Clear Current** button. The *Clear Current Case* dialog will be displayed.

You will be prompted for confirmation before performing the clear operation. In addition, you must select the analysis type from the drop-down list.



OK - Cause the current case data to be deleted. Upon completion of this procsss, a message, "Current Case Cleared…" will be displayed in the message bar of the SAPHIRE window.

Cancel - Terminate the clear current case process.

9.3.5 Database Text

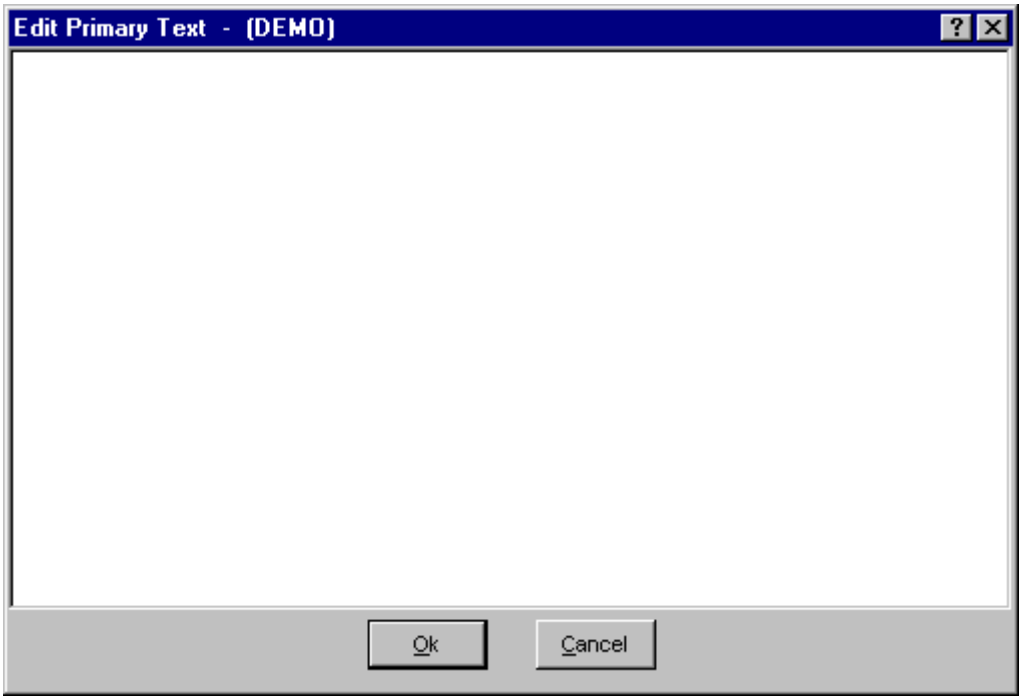
PURPOSE

This option allows you to view and edit the descriptive text associated with a specific record. The Primary text option is generally used for text in the desired primary language. The Alternate text option is generally used for information entered in the secondary language using a different alphabet (locale).

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record whose text you wish to modify.
4. Choose the **Text** button. The *Select Text Type* dialog is displayed.
5. Choose **Primary** or **Alternate**. The *Text* dialog is displayed.

Initially, the first 18 lines of the text block are displayed. If there are more lines of text, the vertical scroll bar will be available. In the example here, the Primary text dialog is displayed.



Page Down - Presents the next 18 lines of text.
Page Up - Presents the previous 18 lines of text.
Ctrl Page Down- Places the cursor at the end of the last line of text currently visible.
Ctrl Page Up - Places the cursor at the beginning of the first line of text currently visible.
Ctrl- ← - Moves the cursor left to the beginning of the word on the current line.
Ctrl- → - Moves the cursor right to the beginning of the word on the current line.
Home - Places the cursor in front of the first character of the current line.
Ctrl-Home - Places the cursor at the beginning of the text block.
End - Places the cursor behind the last character of the current line.
Ctrl-End - Places the cursor at the end of the text block.
Insert - Works as a toggle. Initially, the editor is in "insert" mode – existing characters are pushed to the right as you type. Pressing the **Insert** key toggles to "overwrite" mode – existing characters are over written as you type.
Delete - Deletes the character to the right of the current cursor position; or deletes the currently highlighted text.
Ctrl-Delete - Deletes the characters from the current cursor position to the beginning of the following word.
Backspace - Deletes the character to the left of the current cursor position; or deletes the currently highlighted text.
Ctrl-C - Copies highlighted text to the clipboard.
Ctrl-V - Pastes clipboard text at the current cursor position.
Ctrl-X - Cuts highlighted text to the clipboard.

The editor does not automatically line wrap; therefore, you must use <Enter> to establish each new line of text.

Ok - Save the new or modified text and close the *Text* dialog.
Cancel - Close the *Text* dialog without saving changes. You will be prompted with the dialog shown below.

Yes - Close the *Text* dialog without saving changes.
No - Save the new or modified text and close the *Text* dialog.

9.3.6 Event Tree Data Entry Dialog

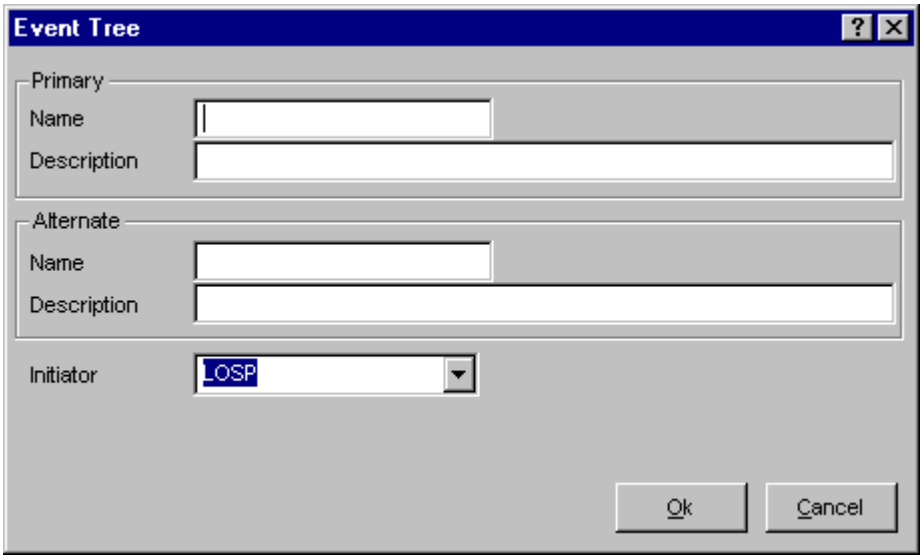
PURPOSE

The *Add/Modify Event Tree* dialog allows you to enter or modify event tree data.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Event Trees** from the menu. The *Edit Event Trees* dialog is displayed.
3. Highlight the event tree you wish to edit or copy. (Skip this step if adding a new event tree record.)
4. Right-click to invoke the pop-up menu and choose **Add**, **Copy**, or **Modify**.

   OR
5. From the SAPHIRE menu select **Event Tree**. The *Event Tree List* dialog will be displayed.
6. Right-click to invoke the pop-up menu and select **Add Event Tree**.



Ok - Save the new or modified event tree record and close the dialog.
Cancel - Close the dialog without saving.

9.3.7 Event Tree Data Entry Dialog

9.3.7.1 Name

This is a required field. 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.

9.3.7.2 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.3.7.3 Initiating Event Name

This is the current event tree's initiating event. The drop-down list contains all initiating events in the current project. Choose an initiating event from the drop-down list or enter a new one.

9.3.8 Edit Sequences Dialog

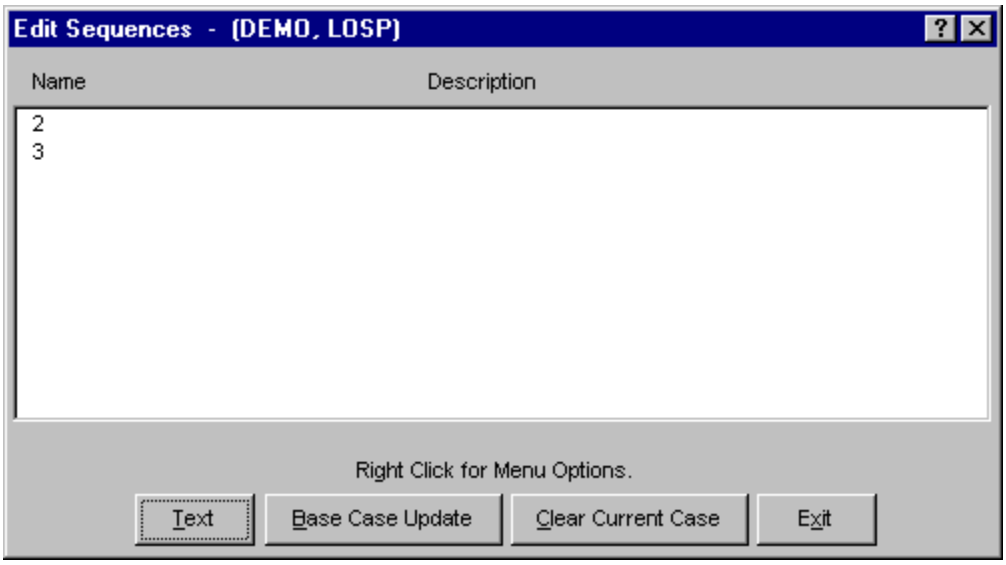
9.3.8.1 Sequences

PURPOSE

This option allows you to add, modify, copy, or delete data records, or text for the sequences associated with an event tree. Additionally, you can update selected sequence base case data or clear selected sequence current case data.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Event Trees** from the menu. The *Edit Event Trees* dialog is displayed.
3. Highlight the desired event tree and choose the **Sequences** button.
4. The *Edit Sequences* dialog will be displayed listing all of the sequences associated with the selected event tree.
5. Highlight the desired sequence.
6. Right-click to invoke the pop-up menu or choose the desired button.



Pop-up Menu Options

Add -	Add a new sequence record to the database.
Copy -	Create a new sequence record by copying an existing one.
Modify -	Edit the selected sequence record.
Delete -	Delete the selected sequence record(s).

Button Options

Text -	View and edit the descriptive text associated with the selected sequence.
Base Case Update -	Update selected sequence base case data.
Clear Current Case -	Clear selected sequence current case data.
Exit -	Close the *Edit Sequences* dialog.

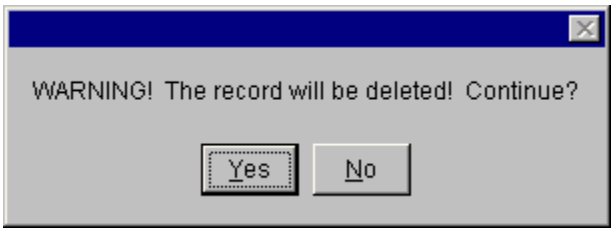
9.3.8.2 Delete Record

PURPOSE

This option allows you to delete the highlighted record from the database.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record you wish to delete.
4. Right-click to invoke the pop-up menu and choose **Delete**. A warning dialog will be displayed, allowing you to cancel the deletion at this point.



Yes - Continue the delete operation. The selected record will be deleted from the database. The message, "Record deleted," is displayed in the message bar of the SAPHIRE window.
No - Cancel the delete operation. The selected record will NOT be deleted from the database.

9.3.8.3 Database Text

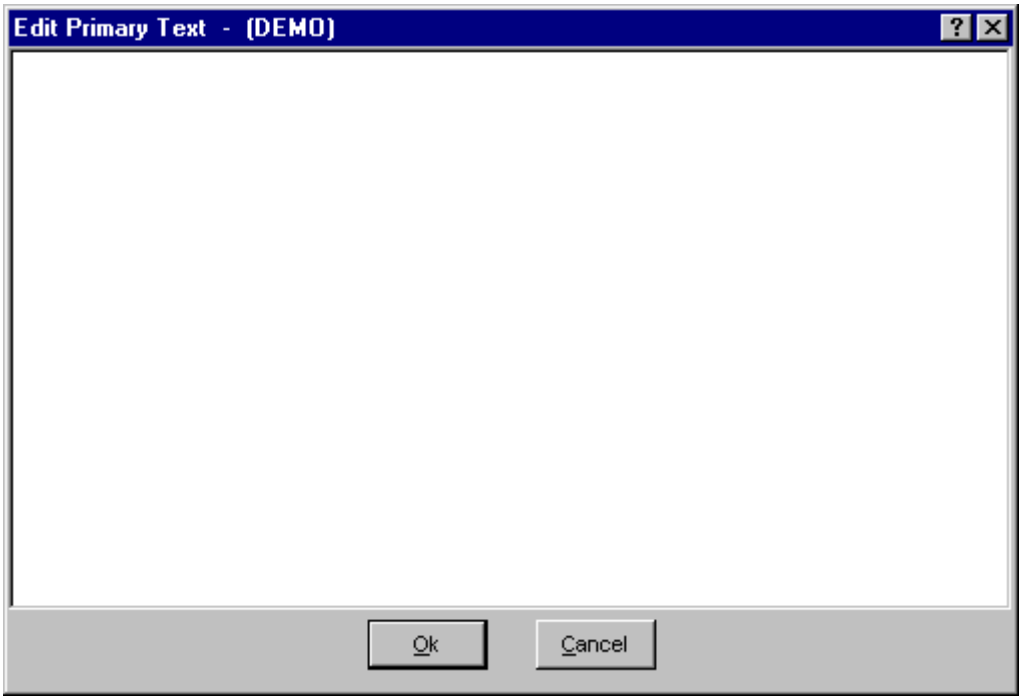
PURPOSE

This option allows you to view and edit the descriptive text associated with a specific record. The Primary text option is generally used for text in the desired primary language. The Alternate text option is generally used for information entered in the secondary language using a different alphabet (locale).

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record whose text you wish to modify.
4. Choose the **Text** button. The *Select Text Type* dialog is displayed.
5. Choose **Primary** or **Alternate**. The *Text* dialog is displayed.

Initially, the first 18 lines of the text block are displayed. If there are more lines of text, the vertical scroll bar will be available. In the example here, the Primary text dialog is displayed.



Page Down - Presents the next 18 lines of text.
Page Up - Presents the previous 18 lines of text.
Ctrl Page Down- Places the cursor at the end of the last line of text currently visible.
Ctrl Page Up Places the cursor at the beginning of the first line of text currently visible.
Ctrl- ← - Moves the cursor left to the beginning of the word on the current line.
Ctrl- → - Moves the cursor right to the beginning of the word on the current line.
Home - Places the cursor in front of the first character of the current line.
Ctrl-Home - Places the cursor at the beginning of the text block.
End - Places the cursor behind the last character of the current line.
Ctrl-End - Places the cursor at the end of the text block.
Insert - Works as a toggle. Initially, the editor is in "insert" mode – existing characters are pushed to the right as you type. Pressing the **Insert** key toggles to "overwrite" mode – existing characters are over written as you type.
Delete - Deletes the character to the right of the current cursor position; or deletes the currently highlighted text.
Ctrl-Delete - Deletes the characters from the current cursor position to the beginning of the following word.
Backspace - Deletes the character to the left of the current cursor position; or deletes the currently highlighted text.
Ctrl-C - Copies highlighted text to the clipboard.
Ctrl-V - Pastes clipboard text at the current cursor position.
Ctrl-X - Cuts highlighted text to the clipboard.

The editor does not automatically line wrap; therefore, you must use <Enter> to establish each new line of text.

Ok - Save the new or modified text and close the *Text* dialog.

Cancel - Close the *Text* dialog without saving changes. You will be prompted with the dialog shown below.

Yes - Close the *Text* dialog without saving changes.
No - Save the new or modified text and close the *Text* dialog.

9.3.8.4 Base Case Update

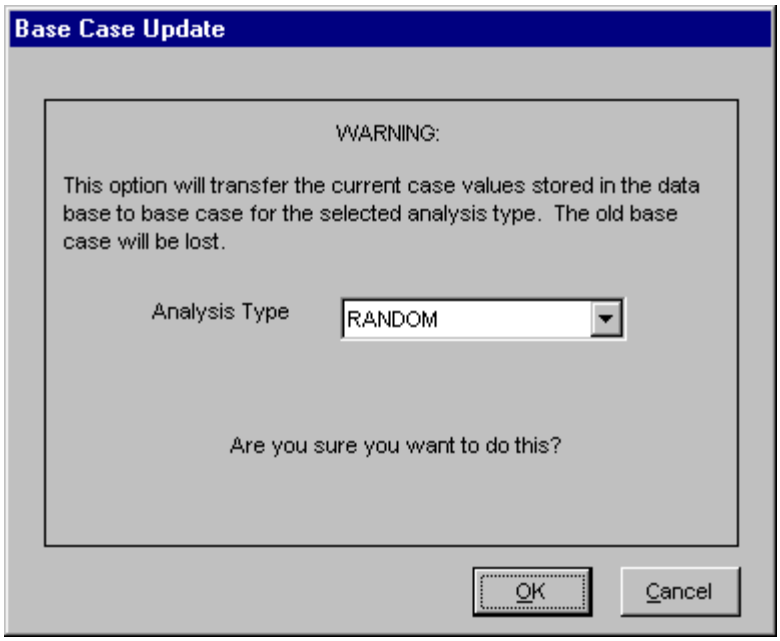
PURPOSE

This option allows you to overwrite all base case (original) data with the current case data for the selected analysis type. If you choose to update the base data, four operations will occur. (1) The base case cut sets will be overwritten with the current case cut sets. (2) The base case uncertainty results will be overwritten with the current case uncertainty results. (3) The base case uncertainty quantile values will be overwritten with the quantile values from the current case. (4) The base case minimum cut set upper bound will be overwritten with the current case minimum cut set upper bound. As a note of caution, the original base case results will be overwritten if this option is executed!

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Event Trees**. The *Edit Event Trees* dialog is displayed.
   OR
3. Choose **Event Trees | Sequences**. The Edit Sequences dialog is displayed.
   OR
4. Choose **Fault Trees**. The Edit Fault Trees dialog is displayed.
   OR
5. Choose **End States**. The Edit End State dialog is displayed.
6. Highlight the desired list item.
7. Choose the **Base Update** button. The *Base Case Update* dialog will be displayed.

You will be prompted for confirmation before performing the update. In addition, you must select the analysis type from the drop-down list.



OK - Cause the current case data to overwrite the base case data. Upon completion of this process, a message, "Base case update complete" will be displayed in the message bar of the SAPHIRE window.

Cancel - Terminate the update operation.

9.3.8.5 Clear Current Case

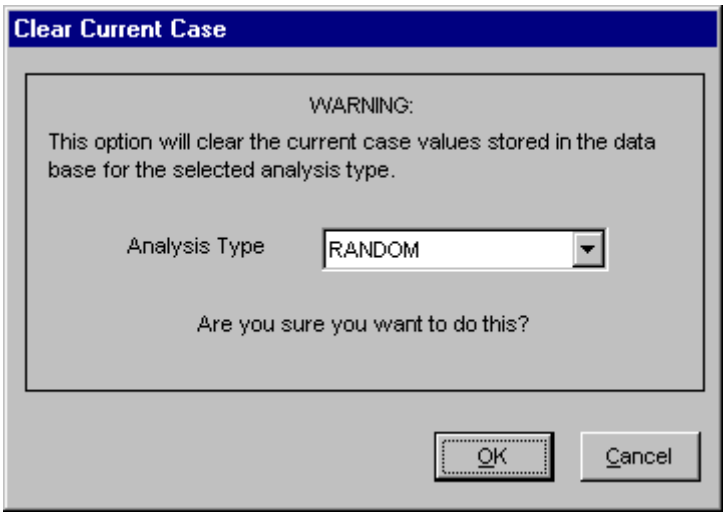
PURPOSE

This option deletes all current case information for the specified analysis type. All SAPHIRE calculations use data stored in the current case for sensitivity and event analysis, and cut set generation results are stored in the current case.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Event Trees**. The *Edit Event Trees* dialog is displayed.
   OR
3. Choose **Event Trees | Sequences**. The Edit Sequences dialog is displayed.
   OR
4. Choose **Fault Trees**. The Edit Fault Trees dialog is displayed.
   OR
5. Choose **End States**. The Edit End State dialog is displayed.
6. Highlight the desired list item.
7. Choose the **Clear Current** button. The *Clear Current Case* dialog will be displayed.

You will be prompted for confirmation before performing the clear operation. In addition, you must select the analysis type from the drop-down list.



OK - Cause the current case data to be deleted. Upon completion of this procsss, a message, "Current Case Cleared…" will be displayed in the message bar of the SAPHIRE window.

Cancel - Terminate the clear current case process.

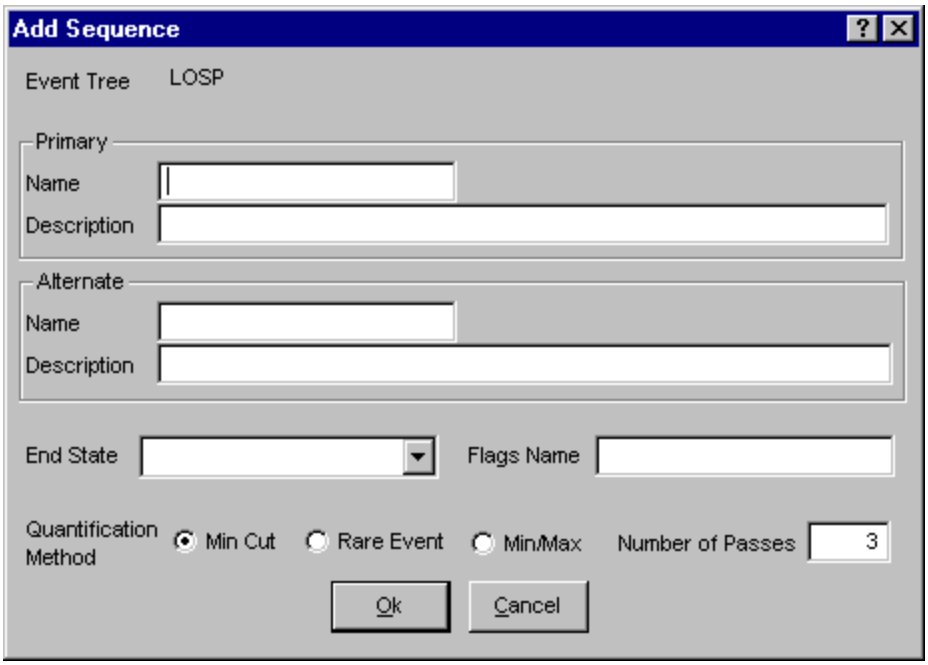
9.3.8.6 Sequence Data Entry Dialog

PURPOSE

The *Add/Modify Sequence* dialog allows you to enter or modify sequence data.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Event Trees** from the menu. The *Edit Event Trees* dialog is displayed.
3. Highlight the desired event tree and
4. Choose the **Sequences** button. The *Edit Sequences* dialog will be displayed.
5. Highlight the sequence you wish to edit or copy. (Skip this step if adding a new sequence record.)
6. Right-click to invoke the pop-up menu and choose **Add**, **Copy**, or **Modify**.



Ok - Save the new or modified sequence record and close the dialog.
Cancel - Close the dialog without saving.

9.3.8.7 Sequence Data Entry Dialog

9.3.8.7.1 Name

This is a required field. 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.

9.3.8.7.2 End State

This is a 24-character uppercase, alphanumeric field used to identify the end state. Select an end state from the drop-down list.

9.3.8.7.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.3.8.7.4 Flags Name

This is a 24-character uppercase, alphanumeric field used to identify a flag set. Embedded blanks are not allowed. The flag set contains flags to be used when generating cut sets for this sequence. SAPHIRE uses this default flag set name to modify or prune the fault tree logic for this sequence before it is solved (see Sequence Analysis). Enter a flag name or leave blank.

9.3.8.7.5 Quantification Method

Choose the default quantification method for this sequence/fault tree/end state. If the **Min/Max** radio button is chosen, you must also enter the **Number of Passes** (from 1 to 10).

9.4 Modifying Fault Tree Data

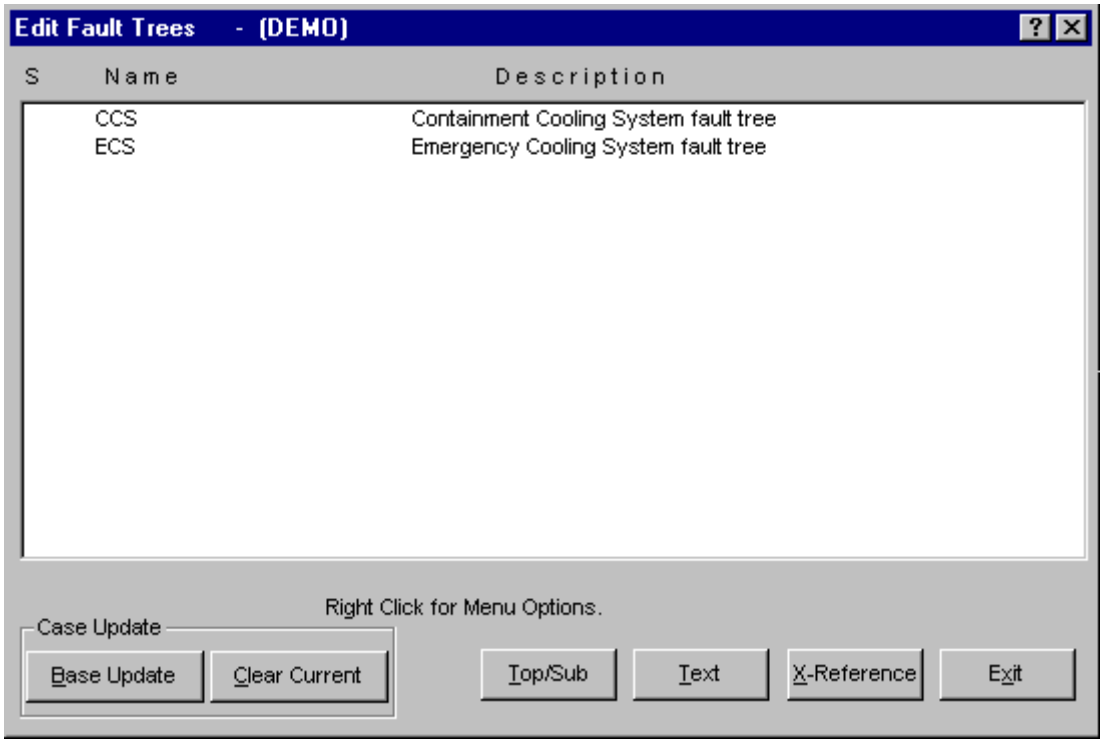
9.4.1 Fault Trees

PURPOSE

This option allows you to add, modify or delete fault tree data records. When modifying an existing fault tree record, you can also enter current case mincut upper bound values for each of the 16 analysis types.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Fault Trees** from the menu. The *Edit Fault Trees* dialog is displayed, listing all of the fault trees belonging to the current project.
3. Highlight the desired fault tree.
4. Right-click to invoke the pop-up menu or choose the desired button.



Pop-up Menu Options

Add - Add a new fault tree record to the current project database.
Copy - Create a new fault tree record by copying an existing one.
Modify - Edit the selected fault tree record.
Delete - Delete the selected fault tree record(s).
Graphics - Edit the graphical picture associated with the selected fault tree record.
Logic - Edit the logic associated with the selected fault tree record.

Button Options

Base Update - Update selected fault tree base case data.
Clear Current - Clear selected fault tree current case data.
Top/Sub – If the fault tree is a top, change it to a sub-tree or alternately, if the fault tree is a sub-tree, change it to a top.
Text - View and edit the descriptive text associated with the selected fault tree.
X-Reference – Display the cross-reference map of the highlighted fault tree.
Exit - Close the *Edit Fault Trees* dialog.

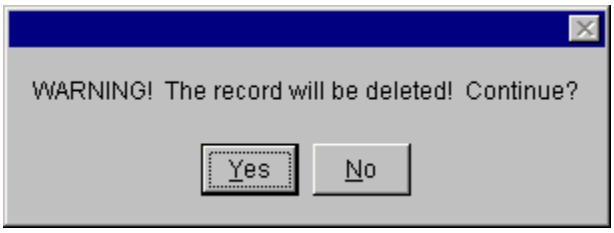
9.4.2 Delete Fault Tree

PURPOSE

This option allows you to delete the highlighted fault tree from the database.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Fault Trees** from the menu. The *Edit Fault Trees* dialog is displayed.
3. Highlight the fault tree you wish to delete.
4. Right-click to invoke the pop-up menu and choose **Delete**. A warning dialog will be displayed, allowing you to cancel the deletion at this point.



Yes - Continue the delete operation. The selected fault tree will be deleted from the database. The message, "Record deleted," will be displayed in the message bar of the SAPHIRE window.
No - Cancel the delete operation.

NOTE: SAPHIRE will not allow you to delete a fault tree that is used by another **fault tree**.

9.4.3 Base Case Update

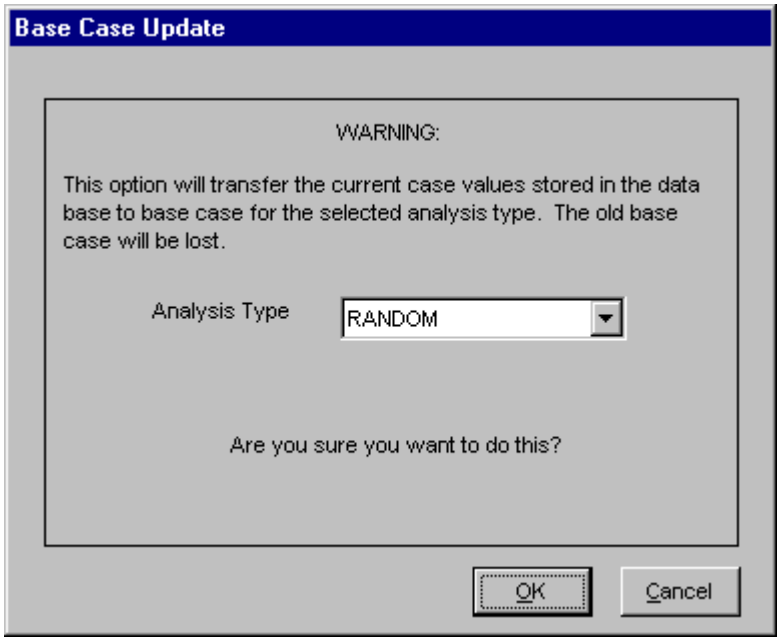
PURPOSE

This option allows you to overwrite all base case (original) data with the current case data for the selected analysis type. If you choose to update the base data, four operations will occur. (1) The base case cut sets will be overwritten with the current case cut sets. (2) The base case uncertainty results will be overwritten with the current case uncertainty results. (3) The base case uncertainty quantile values will be overwritten with the quantile values from the current case. (4) The base case minimum cut set upper bound will be overwritten with the current case minimum cut set upper bound. As a note of caution, the original base case results will be overwritten if this option is executed!

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Event Trees**. The *Edit Event Trees* dialog is displayed.
   OR
3. Choose **Event Trees | Sequences**. The Edit Sequences dialog is displayed.
   OR
4. Choose **Fault Trees**. The Edit Fault Trees dialog is displayed.
   OR
5. Choose **End States**. The Edit End State dialog is displayed.
6. Highlight the desired list item.
7. Choose the **Base Update** button. The *Base Case Update* dialog will be displayed.

You will be prompted for confirmation before performing the update. In addition, you must select the analysis type from the drop-down list.



OK - Cause the current case data to overwrite the base case data. Upon completion of this process, a message, "Base case update complete" will be displayed in the message bar of the SAPHIRE window.

Cancel - Terminate the update operation.

9.4.4 Clear Current Case

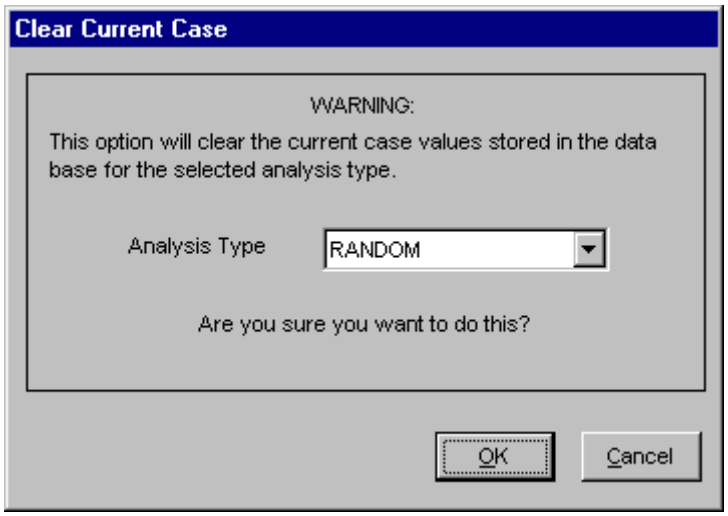
PURPOSE

This option deletes all current case information for the specified analysis type. All SAPHIRE calculations use data stored in the current case for sensitivity and event analysis, and cut set generation results are stored in the current case.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Event Trees**. The *Edit Event Trees* dialog is displayed.
   OR
3. Choose **Event Trees | Sequences**. The Edit Sequences dialog is displayed.
   OR
4. Choose **Fault Trees**. The Edit Fault Trees dialog is displayed.
   OR
5. Choose **End States**. The Edit End State dialog is displayed.
6. Highlight the desired list item.
7. Choose the **Clear Current** button. The *Clear Current Case* dialog will be displayed.

You will be prompted for confirmation before performing the clear operation. In addition, you must select the analysis type from the drop-down list.



OK - Cause the current case data to be deleted. Upon completion of this procsss, a message, "Current Case Cleared…" will be displayed in the message bar of the SAPHIRE window.

Cancel - Terminate the clear current case process.

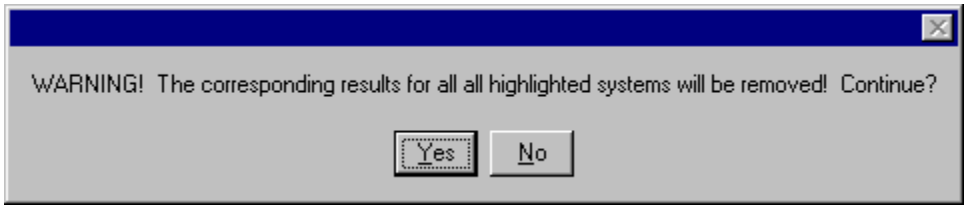
9.4.5 Top/Sub-tree Convert

PURPOSE

This option allows you to convert the highlighted fault tree from a top to a sub-tree, or a sub-tree to a top. This option acts as a toggle. If the selected fault tree is being used by a sequence, it cannot be converted to a sub-tree.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Fault Trees** from the menu. The *Edit Fault Trees* dialog is displayed.
3. Highlight the fault tree you wish to convert.
4. Choose the **Top/Sub** button. A warning dialog will be displayed, allowing you to cancel the conversion at this point.



Yes - Continue the conversion operation. The selected fault tree will be converted from its current type.
No - Cancel the conversion operation.

NOTE: When a top fault tree is converted to a sub-tree, the analysis results will be deleted.

9.4.6 Database Text

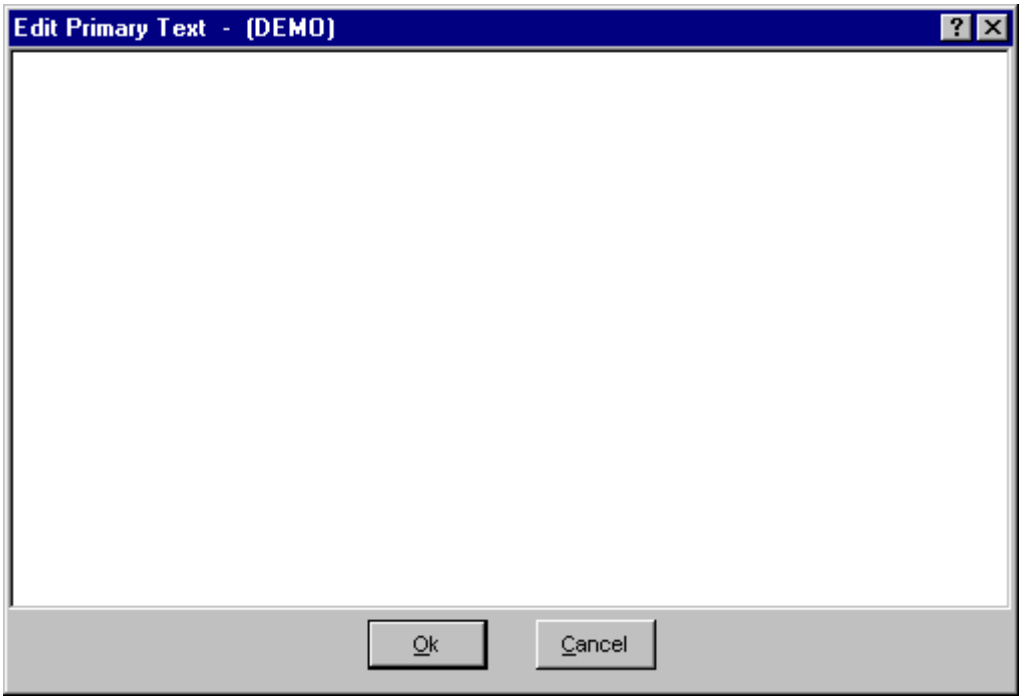
PURPOSE

This option allows you to view and edit the descriptive text associated with a specific record. The Primary text option is generally used for text in the desired primary language. The Alternate text option is generally used for information entered in the secondary language using a different alphabet (locale).

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record whose text you wish to modify.
4. Choose the **Text** button. The *Select Text Type* dialog is displayed.
5. Choose **Primary** or **Alternate**. The *Text* dialog is displayed.

Initially, the first 18 lines of the text block are displayed. If there are more lines of text, the vertical scroll bar will be available. In the example here, the Primary text dialog is displayed.



Page Down - Presents the next 18 lines of text.
Page Up-Presents the previous 18 lines of text.
Ctrl Page Down-Places the cursor at the end of the last line of text currently visible.
Ctrl Page Up - Places the cursor at the beginning of the first line of text currently visible.
Ctrl- ← - Moves the cursor left to the beginning of the word on the current line.
Ctrl- → - Moves the cursor right to the beginning of the word on the current line.
Home - Places the cursor in front of the first character of the current line.
Ctrl-Home - Places the cursor at the beginning of the text block.
End - Places the cursor behind the last character of the current line.
Ctrl-End - Places the cursor at the end of the text block.
Insert - Works as a toggle. Initially, the editor is in "insert" mode – existing characters are pushed to the right as you type. Pressing the **Insert** key toggles to "overwrite" mode – existing characters are over written as you type.
Delete - Deletes the character to the right of the current cursor position; or deletes the currently highlighted text.
Ctrl-Delete - Deletes the characters from the current cursor position to the beginning of the following word.
Backspace - Deletes the character to the left of the current cursor position; or deletes the currently highlighted text.
Ctrl-C - Copies highlighted text to the clipboard.
Ctrl-V - Pastes clipboard text at the current cursor position.
Ctrl-X - Cuts highlighted text to the clipboard.

The editor does not automatically line wrap; therefore, you must use <Enter> to establish each new line of text.

Ok - Save the new or modified text and close the *Text* dialog.

Cancel - Close the *Text* dialog without saving changes. You will be prompted with the dialog shown below.

Yes - Close the *Text* dialog without saving changes.
No - Save the new or modified text and close the *Text* dialog.

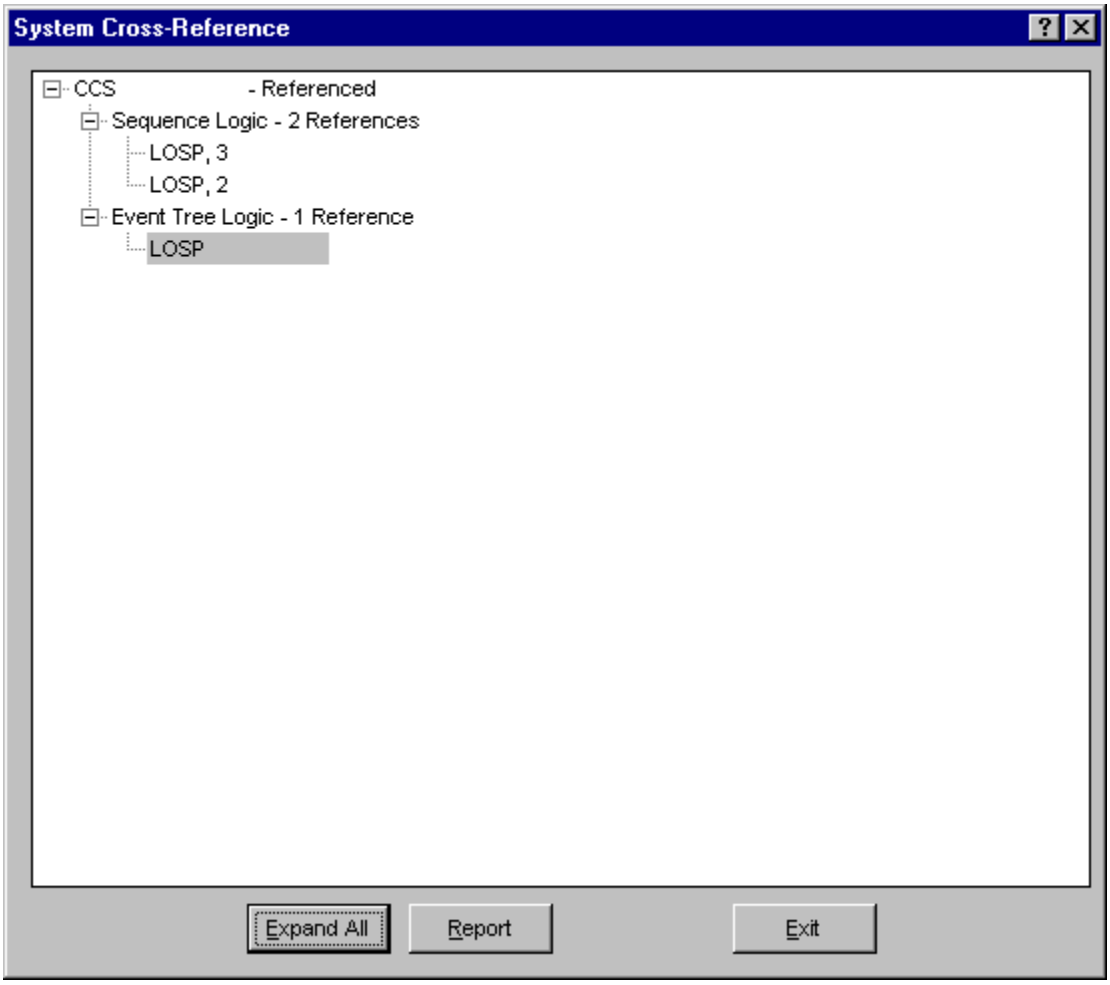
9.4.7 Fault Tree Cross-reference

PURPOSE

This option displays a cross-reference map of the highlighted fault tree. This cross-reference map displays the sequence logic and event tree logic in which the fault tree is used.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Fault Trees** from the menu. The *Edit Fault Trees* dialog is displayed.
3. Highlight the fault tree you wish to convert.
4. Choose the **X-Reference** button. The *System Cross-reference* dialog will be displayed.



⊞- Indicates that the item can be expanded to display more information. Click on this symbol to expand the item.

⊟- Indicates that the item is fully expanded. Click on this symbol to collapse the item.

Expand All - Expand all items in the cross-reference map.

Report - Generate the cross-reference report for the fault tree.

Exit - Close the *System Cross-reference* dialog.

9.4.8 Add Fault Tree Dialog

9.4.8.1 Add Fault Tree

PURPOSE

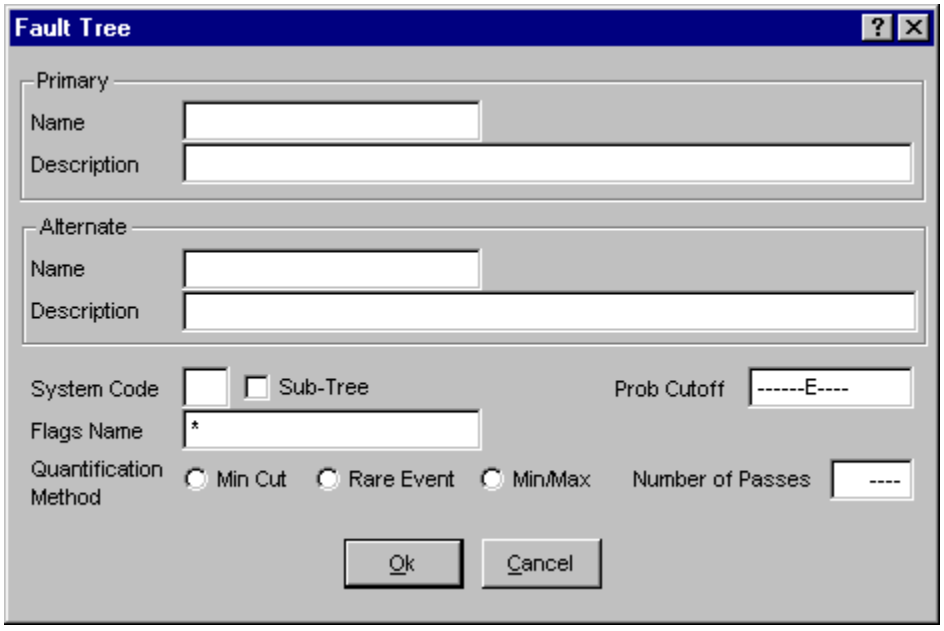
The *Add Fault Tree* dialog allows you to enter data for a new fault tree record.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Fault Trees** from the menu. The *Edit Fault Trees* dialog is displayed.
3. Right-click to invoke the pop-up menu and choose **Add**.

   OR

4. From the SAPHIRE menu select **Fault Tree**. The *Fault Trees List* dialog will be displayed.
5. Right-click to invoke the pop-up menu and choose **Add Fault Tree**.



Ok - Add the new fault tree record to the database. When complete, the *Add Fault Tree* dialog will be closed and the message, "Record added," will be displayed in the message bar of the SAPHIRE dialog.

Cancel - The fault tree record is not saved or added to the database.

9.4.8.2 Name

This is a required field. 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.

9.4.8.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.4.8.4 Fault Tree Code

This is a three-character, uppercase, alphanumeric field used to identify the graphic diagram display of the fault tree.

9.4.8.5 Sub-tree

Check this box if this is a sub-tree. Leave unchecked if not.

9.4.8.6 Prob Cutoff

The default probability cutoff value for the fault tree. Use scientific notation. When solving fault trees, this value is used when the **Cutoff by Cut Set Probability** box is checked in the *Cut Set Generation* dialog. If no value is entered here and the **Cutoff by Cut Set Probability** box is checked, then the value entered in the **Global Cutoff Value** field of that dialog will be used.

9.4.8.7 Flags Name

This is a 24-character uppercase, alphanumeric field used to identify a flag set. Embedded blanks are not allowed. The flag set contains flags to be used when generating cut sets for the fault tree. SAPHIRE uses this default flag set name to modify or prune the logic for the fault tree before it is solved (see Fault Tree Analysis). Enter a flag name or leave blank.

9.4.8.8 Quantification Method

Choose the default quantification method for this sequence/fault tree/end state. If the **Min/Max** radio button is chosen, you must also enter the **Number of Passes** (from 1 to 10).

9.4.9 Modify Fault Tree Dialog

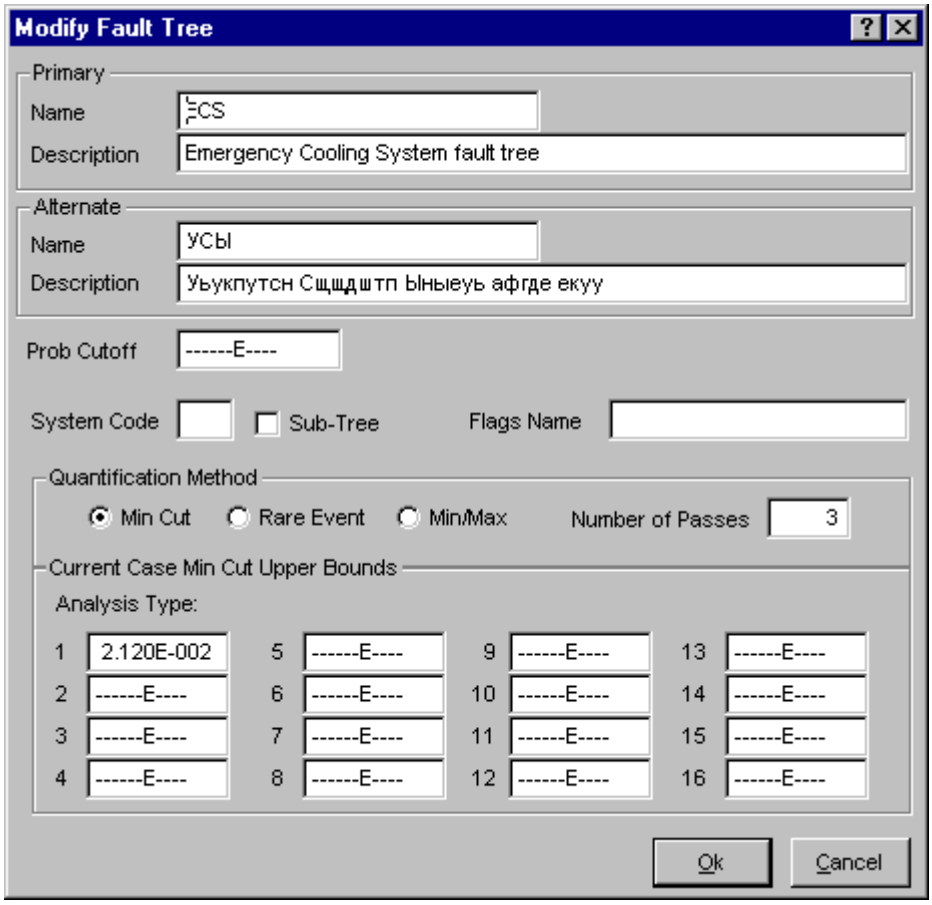
9.4.9.1 Modify Fault Tree

PURPOSE

The *Modify Fault Tree* dialog allows you to modify fault tree record data.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Fault Trees** from the menu. The *Edit Fault Trees* dialog is displayed.
3. Highlight the fault tree you wish to edit.
4. Right-click to invoke the pop-up menu and choose **Modify**.



Ok - Save the changes made to the fault tree record. When complete, the *Modify Fault Tree* dialog will be closed and the message, "Record modified," will be displayed in the message bar of the SAPHIRE dialog.

Cancel - The changes to the fault tree record are not saved.

9.4.9.2 Name

This is a required field. 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.

9.4.9.3 Prob Cutoff

The default probability cutoff value for the fault tree. Use scientific notation. When solving fault trees, this value is used when the **Cutoff by Cut Set Probability** box is checked in the *Cut Set Generation* dialog. If no value is entered here and the **Cutoff by Cut Set Probability** box is checked, then the value entered in the **Global Cutoff Value** field of that dialog will be used.

9.4.9.4 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.4.9.5 Fault Tree Code

This is a three-character, uppercase, alphanumeric field used to identify the graphic diagram display of the fault tree.

9.4.9.6 Sub-tree

Check this box if this is a sub-tree. Leave unchecked if not.

9.4.9.7 Flags Name

This is a 24-character uppercase, alphanumeric field used to identify a flag set. Embedded blanks are not allowed. The flag set contains flags to be used when generating cut sets for the fault tree. SAPHIRE uses this default flag set name to modify or prune the logic for the fault tree before it is solved (see Fault Tree Analysis). Enter a flag name or leave blank.

9.4.9.8 Quantification Method

Choose the default quantification method for this sequence/fault tree/end state. If the **Min/Max** radio button is chosen, you must also enter the **Number of Passes** (from 1 to 10).

9.4.9.9 Current Case Min Cut Upper Bounds

Optionally specify the minimal cut set upper bound for each analysis type.

9.5 Modifying End State Data

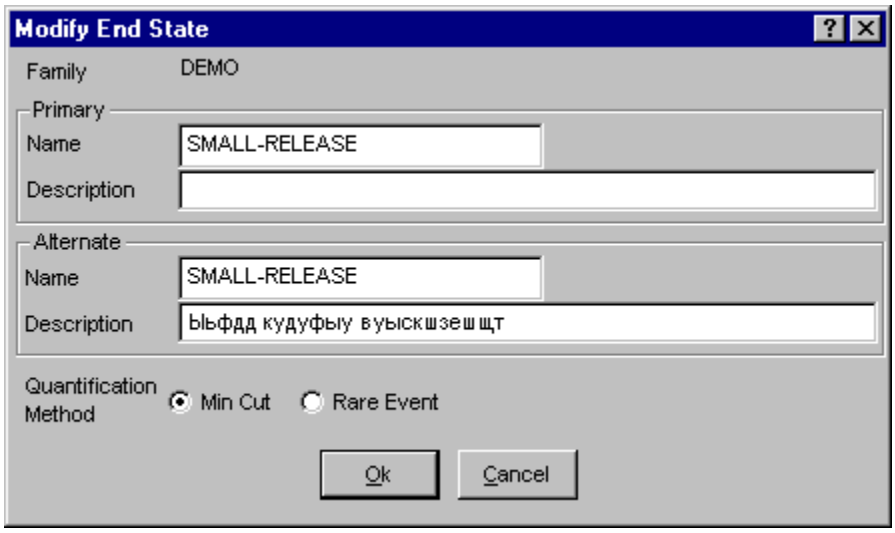
9.5.1 End States

PURPOSE

This option allows you to add, modify, or delete the end state data records, or associated text. Additionally, you can update selected end state base case data or clear selected end state current case data. You can also delete all unused end state records from the database.

STEPS

1. From the SAPHIRE menu select **Modify**.
2 Choose **End States** from the menu. The *Edit End State* dialog is displayed, listing all of the end states belonging to the current project.
3. Highlight the desired end state.
4. Right-click to invoke the pop-up menu or choose the desired button.



Pop-up Menu Options

Add - Add a new end state record to the current project database. When complete, the message, "Record added," is displayed in the message bar of the SAPHIRE window.

Copy - Create a new end state record by copying an existing one.

Modify - Edit the selected end state record. When complete, the message, "Record modified," is displayed in the message bar of the SAPHIRE window.

Delete - Delete the selected end state record(s**).**

Button Options

Base Update - Update selected end state base case data.

Clear Current - Clear selected end state current case data.

Edit Text - View and edit the descriptive text associated with the selected end state.

X-Ref - Display the cross-reference map of the highlighted end state.

Remove Unused - Delete all unused end state records.

Show Unused – Show all unused end state records. The unused end states are indicated by a dash (-) to the left of the end state name.

Exit - Close the *Edit End State* dialog.

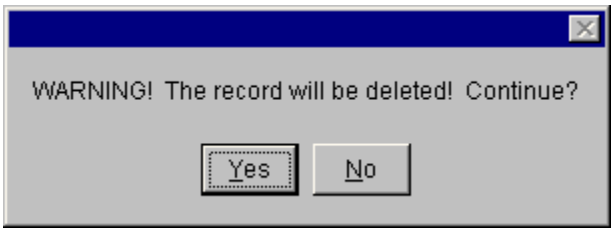
9.5.2 Delete Record

PURPOSE

This option allows you to delete the highlighted record from the database.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record you wish to delete.
4. Right-click to invoke the pop-up menu and choose **Delete**. A warning dialog will be displayed, allowing you to cancel the deletion at this point.



Yes - Continue the delete operation. The selected record will be deleted from the database. The message, "Record deleted," is displayed in the message bar of the SAPHIRE window.

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

9.5.3 Base Case Update

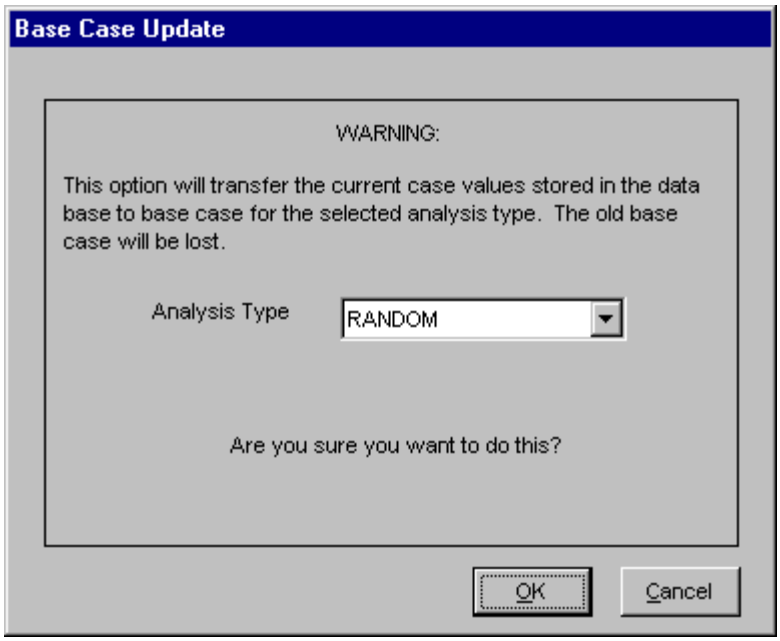
PURPOSE

This option allows you to overwrite all base case (original) data with the current case data for the selected analysis type. If you choose to update the base data, four operations will occur. (1) The base case cut sets will be overwritten with the current case cut sets. (2) The base case uncertainty results will be overwritten with the current case uncertainty results. (3) The base case uncertainty quantile values will be overwritten with the quantile values from the current case. (4) The base case minimum cut set upper bound will be overwritten with the current case minimum cut set upper bound. As a note of caution, the original base case results will be overwritten if this option is executed!

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Event Trees**. The *Edit Event Trees* dialog is displayed.
   OR
3. Choose **Event Trees | Sequences**. The Edit Sequences dialog is displayed.
   OR
4. Choose **Fault Trees**. The Edit Fault Trees dialog is displayed.
   OR
5. Choose **End States**. The Edit End State dialog is displayed.
6. Highlight the desired list item.
7. Choose the **Base Update** button. The *Base Case Update* dialog will be displayed.

You will be prompted for confirmation before performing the update. In addition, you must select the analysis type from the drop-down list.



OK - Cause the current case data to overwrite the base case data. Upon completion of this process, a message, "Base case update complete" will be displayed in the message bar of the SAPHIRE window.

Cancel - Terminate the update operation.

9.5.4 Clear Current Case

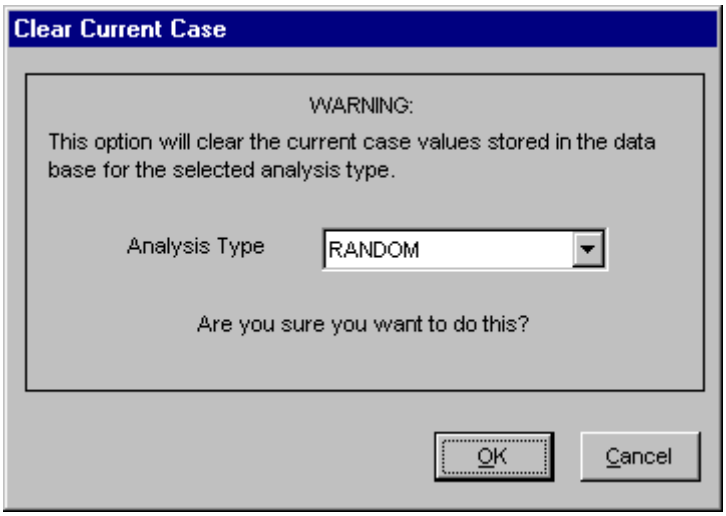
PURPOSE

This option deletes all current case information for the specified analysis type. All SAPHIRE calculations use data stored in the current case for sensitivity and event analysis, and cut set generation results are stored in the current case.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Event Trees**. The *Edit Event Trees* dialog is displayed.
   OR
3. Choose **Event Trees | Sequences**. The Edit Sequences dialog is displayed.
   OR
4. Choose **Fault Trees**. The Edit Fault Trees dialog is displayed.
   OR
5. Choose **End States**. The Edit End State dialog is displayed.
6. Highlight the desired list item.
7. Choose the **Clear Current** button. The *Clear Current Case* dialog will be displayed.

You will be prompted for confirmation before performing the clear operation. In addition, you must select the analysis type from the drop-down list.



OK - Cause the current case data to be deleted. Upon completion of this procsss, a message, "Current Case Cleared…" will be displayed in the message bar of the SAPHIRE window.

Cancel - Terminate the clear current case process.

9.5.5 Database Text

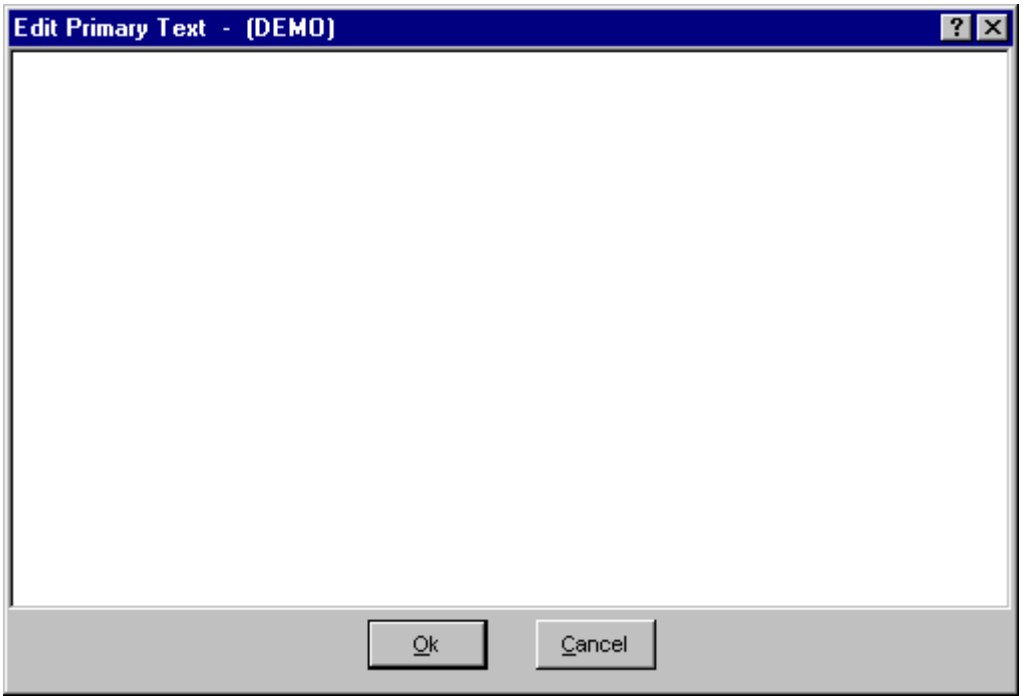
PURPOSE

This option allows you to view and edit the descriptive text associated with a specific record. The Primary text option is generally used for text in the desired primary language. The Alternate text option is generally used for information entered in the secondary language using a different alphabet (locale).

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record whose text you wish to modify.
4. Choose the **Text** button. The *Select Text Type* dialog is displayed.
5. Choose **Primary** or **Alternate**. The *Text* dialog is displayed.

Initially, the first 18 lines of the text block are displayed. If there are more lines of text, the vertical scroll bar will be available. In the example here, the Primary text dialog is displayed.



Page Down- Presents the next 18 lines of text.
Page Up-Presents the previous 18 lines of text.
Ctrl Page Down-Places the cursor at the end of the last line of text currently visible.
Ctrl Page Up- Places the cursor at the beginning of the first line of text currently visible.
Ctrl- ← **-** Moves the cursor left to the beginning of the word on the current line.
Ctrl- → **-** Moves the cursor right to the beginning of the word on the current line.
Home - Places the cursor in front of the first character of the current line.
Ctrl-Home - Places the cursor at the beginning of the text block.
End - Places the cursor behind the last character of the current line.
Ctrl-End - Places the cursor at the end of the text block.
Insert - Works as a toggle. Initially, the editor is in "insert" mode – existing characters are pushed to the right as you type. Pressing the **Insert** key toggles to "overwrite" mode – existing characters are over written as you type.
Delete - Deletes the character to the right of the current cursor position; or deletes the currently highlighted text.
Ctrl-Delete - Deletes the characters from the current cursor position to the beginning of the following word.
Backspace - Deletes the character to the left of the current cursor position; or deletes the currently highlighted text.
Ctrl-C - Copies highlighted text to the clipboard.
Ctrl-V - Pastes clipboard text at the current cursor position.
Ctrl-X - Cuts highlighted text to the clipboard.

The editor does not automatically line wrap; therefore, you must use <Enter> to establish each new line of text.

Ok - Save the new or modified text and close the *Text* dialog.

Cancel - Close the *Text* dialog without saving changes. You will be prompted with the dialog shown below.

Yes - Close the *Text* dialog without saving changes.
No - Save the new or modified text and close the *Text* dialog.

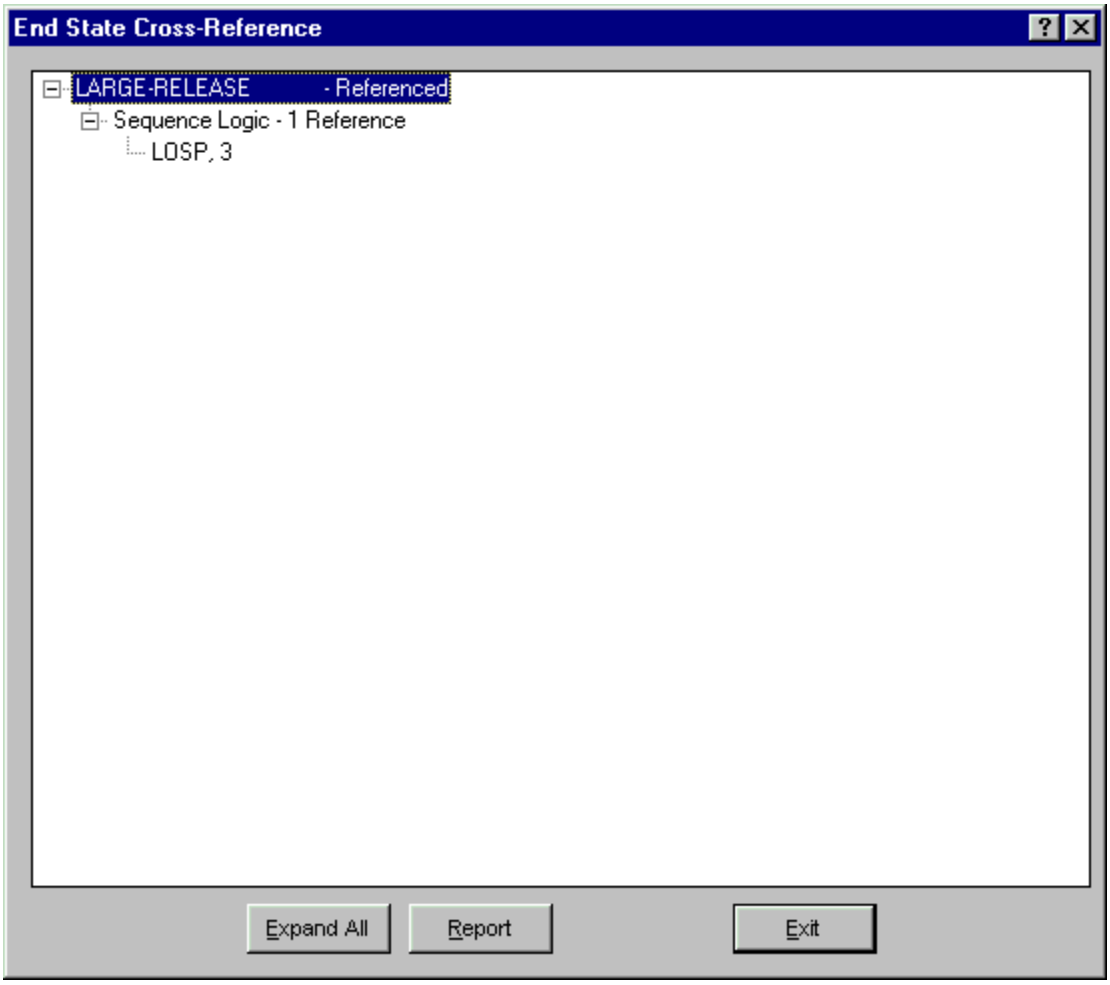
9.5.6 Cross Reference

PURPOSE

This option displays a cross-reference map of the highlighted end state. This cross-reference map will show the sequence logic, and cut sets in which the end state is used. For each sequence in which the end state is used, base and/or current case cut sets will be listed for each analysis type.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **End States** from the menu. The *Edit End States* dialog is displayed.
3. Highlight the desired end state.
4. Choose the **Cross-reference** button. The *End State Cross-reference* dialog is displayed.



⊞-	Indicates that the item can be expanded to display more information. Click on this symbol to expand the item.
⊟-	Indicates that the item is fully expanded. Click on this symbol to collapse the item.
Expand All -	Expand all items in the cross-reference map.
Report -	Generate the cross-reference report for the end state.
Exit -	Close the *End State Cross-reference* dialog.

9.5.7 Remove Unused End States

PURPOSE

This option allows you to delete all unused end state records from the data base.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **End States** from the menu. The *Edit End State* dialog is displayed.
3. Choose the **Remove Unused** button. A warning dialog will appear, allowing you to cancel the operation at this point.

Choose the check box if you wish to delete unused event trees and basic events of the same name when you perform this operation.

OK - Continue the remove operation. The unused end state records will be deleted from the database.

Cancel - Terminate the delete operation.

9.5.8 End State Data Entry Dialog

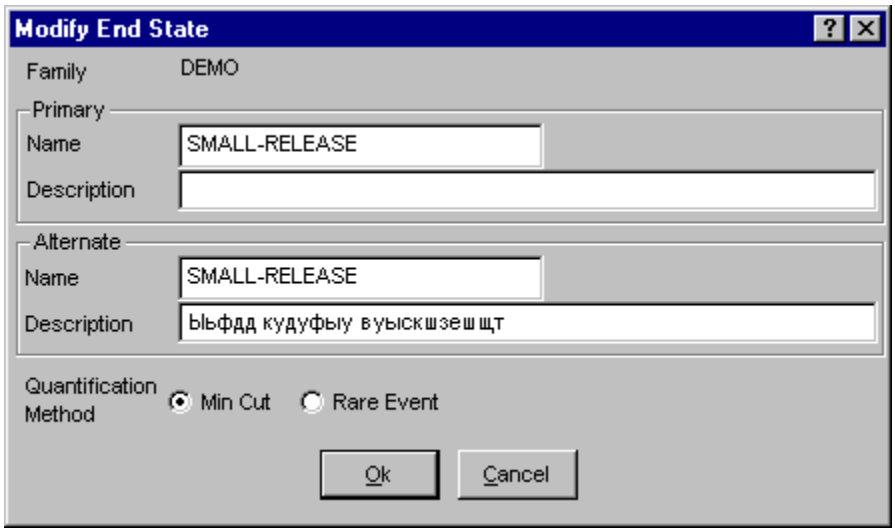
9.5.8.1 End State Data Entry

PURPOSE

The *Add/Modify End State* dialog allows you to enter or modify end state data.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose End States from the menu. The *Edit End State* dialog is displayed.
3. Highlight the end state you wish to edit or copy. (Skip this step if adding a new end state record.)
4. Right-click to invoke the pop-up menu and choose **Add**, **Copy** or **Modify**.



Ok - Save the new or modified end state and close the dialog.
Cancel - Close the dialog without saving.

9.5.8.2 Name

This is a required field. 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.

9.5.8.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.5.8.4 Quantification Method

Choose the default quantification method for this sequence/fault tree/end state. If the **Min/Max** radio button is chosen, you must also enter the **Number of Passes** (from 1 to 10).

9.6 Modifying Basic Event Data

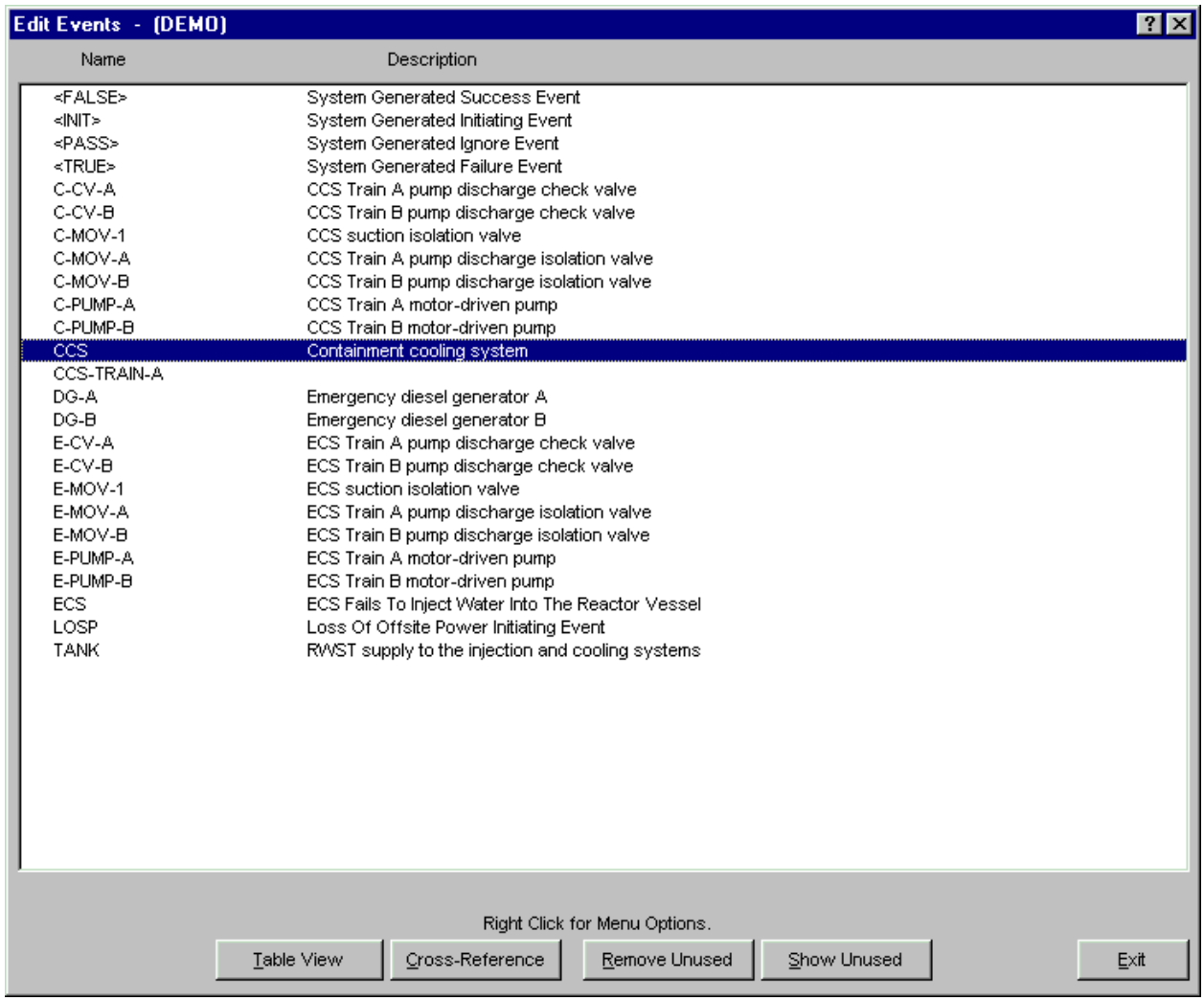
9.6.1 Basic Events

PURPOSE

This option allows you to add, modify, or delete the basic event data records. Deletion of all unused basic event records is also provided.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Basic Events** from the menu. The *Edit Events* dialog is displayed, listing all of the basic events belonging to the current project.
3. Highlight the desired event.
4. Right-click to invoke the pop-up menu or choose the desired button.



Pop-up Menu Options

Add - Add a new basic event record to the current project database. When complete, the message, "Record added," is displayed in the message bar of the SAPHIRE window.

Copy - Create a new basic event record by copying an existing one.

Modify - Edit the selected basic event record. When complete, the message, "Record modified," is displayed in the message bar of the SAPHIRE window.

Delete - Delete the selected basic event record(s). Only unused events will be deleted.

Button Options

Table View - Display fields of the selected event records in a table format.

Cross-reference - Display the cross-reference map of the highlighted event.

Remove Unused - Delete all unused basic event records.

Show Unused – Show all unused basic event records. The unused basic events are indicated by a dash (-) to the left of the basic event name.

Exit - Close the *Edit Events* dialog.

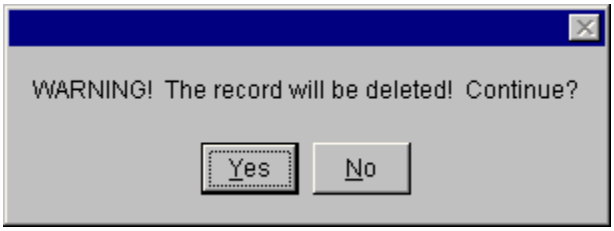
9.6.2 Delete Record

PURPOSE

This option allows you to delete the highlighted record from the database.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record you wish to delete.
4. Right-click to invoke the pop-up menu and choose **Delete**. A warning dialog will be displayed, allowing you to cancel the deletion at this point.



Yes - Continue the delete operation. The selected record will be deleted from the database. The message, "Record deleted," is displayed in the message bar of the SAPHIRE window.
No - Cancel the delete operation. The selected record will NOT be deleted from the database.

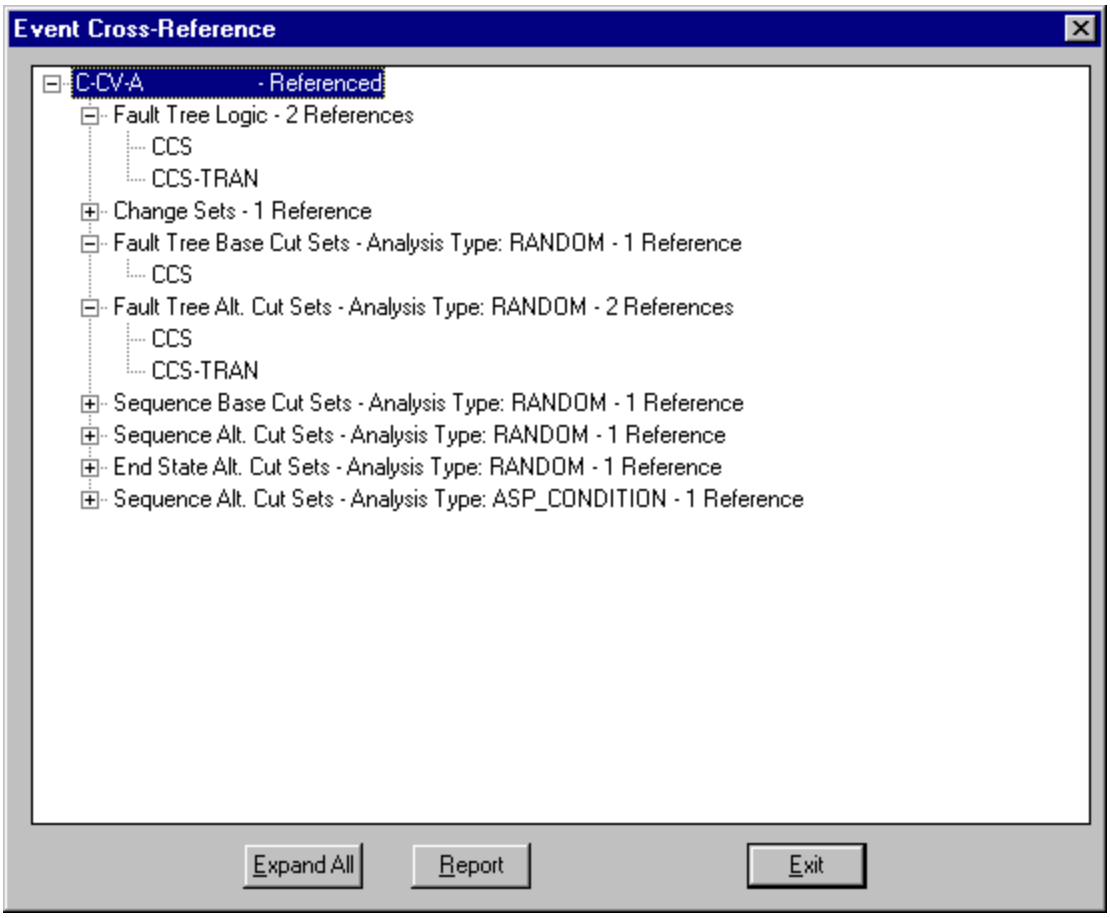
9.6.3 Basic Event Cross-reference

PURPOSE

This option displays a cross-reference map of the highlighted basic event. This cross-reference map will show the fault tree logic, change sets, and cut sets in which the basic event is used. For each fault tree, sequence and/or end state in which the basic event is used, base and/or current case cut sets will be listed for each analysis type.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Basic Events** from the menu. The *Edit Events* dialog is displayed.
3. Highlight the desired event.
4. Choose the **Cross-reference** button. The *Event Cross-reference* dialog is displayed.



⊞- Indicates that the item can be expanded to display more information. Click on this symbol to expand the item.

⊟- Indicates that the item is fully expanded. Click on this symbol to collapse the item.

Expand All - Expand all items in the cross-reference map.

Report - Generate the cross-reference report for the basic event.

Exit - Close the *Event Cross-reference* dialog.

9.6.4 Remove Unused Event

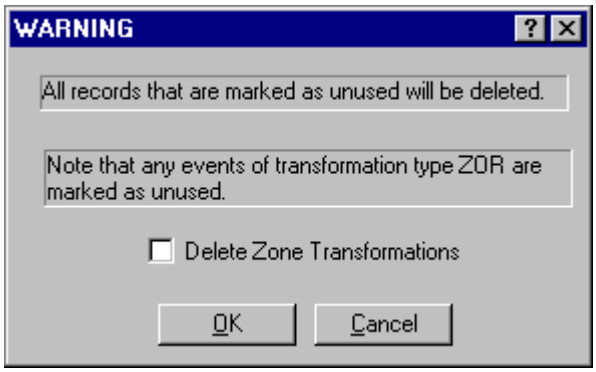
PURPOSE

This option looks at all references to an event in the current project and deletes any events that are not referenced by anything.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Basic Events** from the menu. The *Edit Events* dialog is displayed.
3. Choose the **Remove Unused** button.

A warning dialog will be displayed informing you that all records that are marked as unused will be deleted.



Delete Zone Transformations - By checking this box, events of transformation type ZOR will also be deleted.
OK - Continue the deletion process.
Cancel - Terminate without deleting the unused events.

9.6.5 Table View

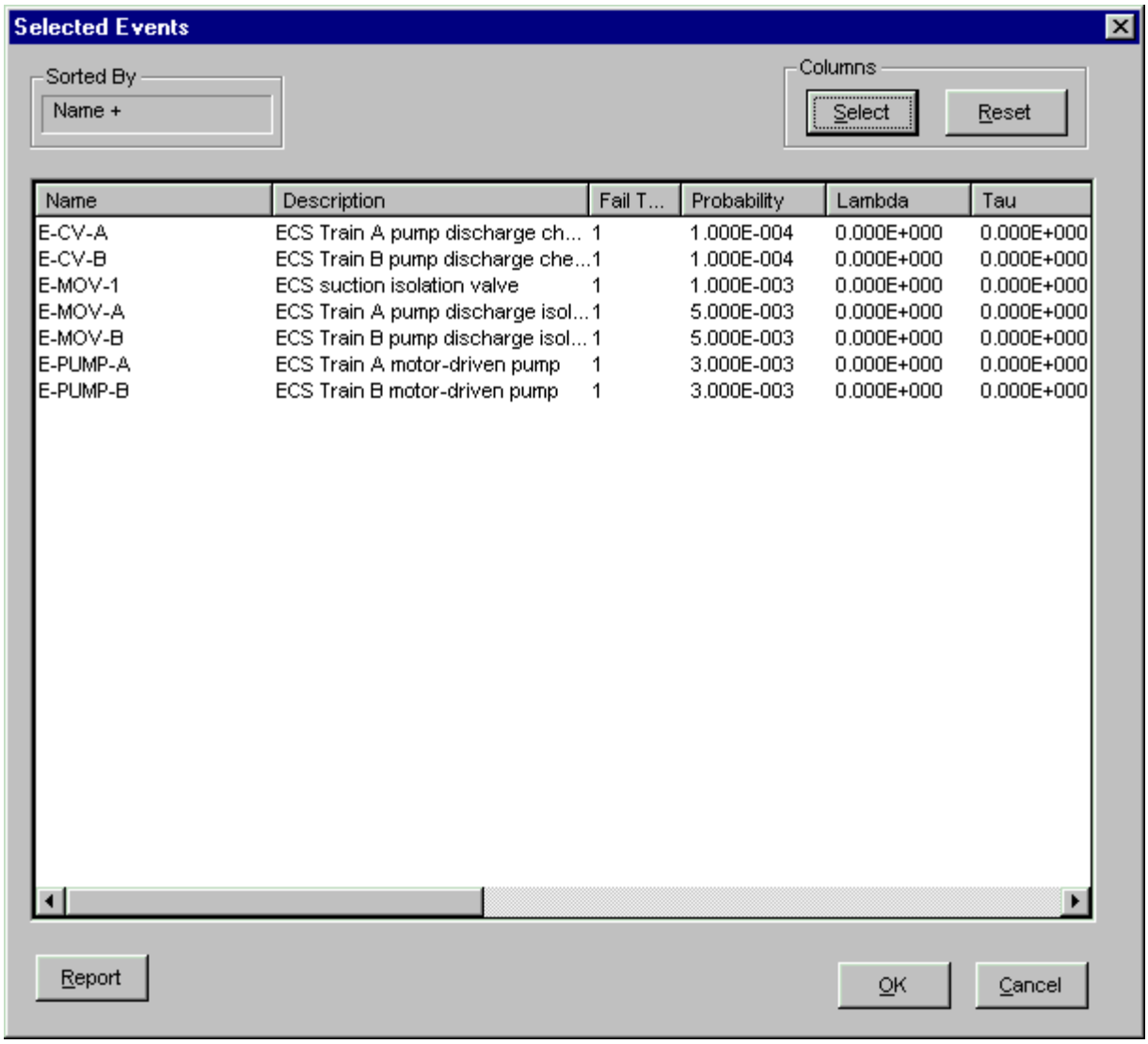
9.6.5.1 Table View

PURPOSE

This option allows you to view selected basic event details in a table format.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Basic Events** from the menu. The *Edit Events* dialog is displayed.
3. Highlight the desired events to include in the table.
4. Choose the **Table View** button.



Sorted By - Indicates the name of the column the data is currently sorted by. A plus (+) indicates ascending order. A minus (-) indicates descending order.

Click Column - Sort the table by the selected column. Additional clicks on the same column toggle the sort between ascending and descending order.

Resize Column - Move the mouse cursor to a column divider. The cursor will change to the Move Column cursor . Click and hold the left mouse button. Drag the mouse left or right to resize the column. Release the mouse when the desired width is obtained.

Columns

Select - Display the Select Columns to Display dialog.

Reset - Reset the column display to the SAPHIRE default.

Pop-up Menu Option

Modify - Edit the selected event record. When complete, the message, "Record modified," is displayed in the message bar of the SAPHIRE window.

Button Options

Report - Create a report of the current table. The selected fields, order, and width will match the currently selected options for display. The report will be a table in RTF format. If you select a report preview, whatever program the operating system has associated with RTF files (such as Word, WordPerfect, Wordpad, etc), will be invoked to display the report.

OK - Close the *Selected Events* dialog. Retain the current column settings until SAPHIRE is closed.

Cancel - Close the *Selected Events* dialog. Do not retain the current column settings.

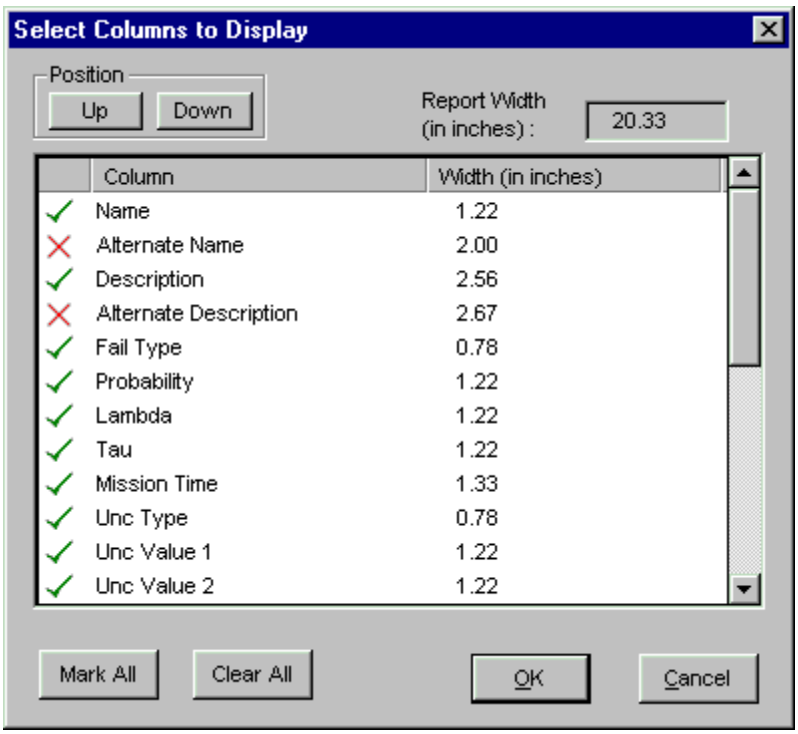
9.6.5.2 Select Columns

PURPOSE

This option allows you to select the columns to display in a table format. It also reports the current width of each column in inches so a report of desirable width can be created.

STEP

1. From the *Selected Events* dialog, press the *Column* **Select** button.
2. A list of basic event field names appears in the order they are to be displayed in the ***Selected Events*** dialog (and report option).
3. Field can be included or excluded from display by clicking on the first column of each field. Fields can be reordered by selecting the **Up** and **Down** *Position* buttons.
4. The current width of each column is displayed along with a total displayed width. This information is provided to help you create a custom view that can be attractively printed to a report. (Each field width can be modified from the *Selected Events* dialog by using the mouse to resize the column width.)



✓ - Indicates that the field will be included in the table view. Click on this symbol to toggle the status.

✗ - Indicates that the field will be excluded from the table view. Click on this symbol to toggle the status.

Position

Up- Each time you press the Up button, the selected field will move up one position in the list. (The field column in the table view will be moved left.)

Down- Each time you press the Down button, the selected field will move down one position in the list. (The field column in the table view will be moved right.)

Button Options

Mark All - Include all available fields in the table view.

Clear All - Exclude all available fields in the table view.

OK - Close the *Select Columns to Display* dialog. Return to the Selected Events dialog using the selected column settings to display the events.

Cancel - Close the *Select Columns to Display* dialog. Do not use the selected column settings; instead, use the previously selected column settings.

Note : Some of the fields available for reporting in SAPHIRE are multi-purpose fields, and thus may have a somewhat generic name. For example, the meaning of *Unc Value 1* **#1***Unc Type* field. If the *Unc Type* field is "L" for Log Normal, then *Unc Value 1* will be an Error Factor, and *Unc Value 2* will be unused. Similarly, if the field *Trans Type*contains an "A", "O", or "Z", it indicates the event is a transformation event with respective types "And", "Or", or "Zor"; but a "Y" value actually indicates a compound event; and a value "T" indicates a template event.

9.6.6 Basic Event Property Sheet

9.6.6.1 Event Page

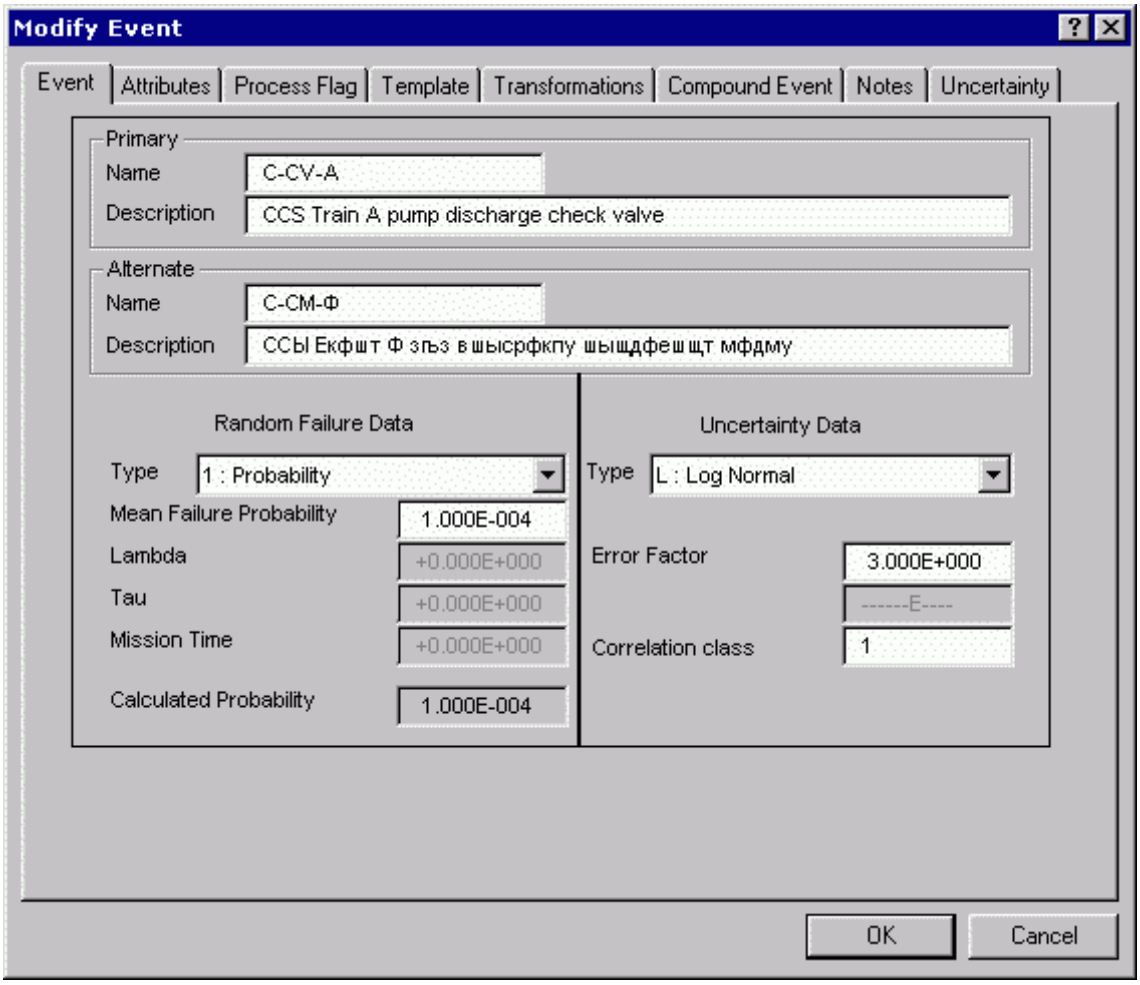
9.6.6.1.1 Basic Event Data Entry

PURPOSE

The *Add/Modify Event* property sheet allows you to enter or modify basic event data. This property sheet contains six tabs containing information pertaining to basic events, grouped by related properties. To edit the desired properties click on the tab.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Basic Events** from the menu. The *Edit Events* dialog is displayed.
3. Highlight the event you wish to edit or copy. (Skip this step if adding a new basic event record.)
4. Right-click to invoke the pop-up menu and choose **Add**, **Modify**, or **Copy**.



OK - Save the new or modified basic event and close the dialog.
Cancel - Close the dialog without saving.

9.6.6.1.2 Primary Name

The Primary name is the fundamental name used in the fault trees and event trees. A unique Primary name must be specified for every basic event in the logic models. 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.

9.6.6.1.3 Alternate Name

The Alternate name, which can be different than the Primary name, can be used to report cut set results. If a name is not entered, the primary name will be copied to this field. This feature allows cut sets to be reported using a different naming scheme that is more descriptive or using another locale. For this name to be displayed in lists and on reports instead of the Primary name, choose **Use alternate names for display** in the **Define Constants** option. A maximum of 24 uppercase, alphanumeric characters may be entered in this field. Embedded blanks are not allowed.

9.6.6.1.4 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.6.6.1.5 Alternate Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information. This feature allows descriptions to be displayed and reported using a different naming scheme or another locale. For this description to be displayed in lists and on reports instead of the Primary description, choose **Use alternate names for display** in the **Define Constants** option.

9.6.6.1.6 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 - 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 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 + (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 $P = \Phi[\ln(g/a)/Br]$.

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 $P = \Phi [\ln(g/a)/Br]$.

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).

9.6.6.1.7 Mean Failure Probability

Enter the probability that a component will fail between t and t + Δt given that no failure has occurred before time t (use scientific notation).

9.6.6.1.8 Lambda

Enter the event's failure rate per hour (use scientific notation).

9.6.6.1.9 Tau

Enter the average time to repair in hours (use scientific notation).

9.6.6.1.10 Mission Time

Enter the mission time in hours (use scientific notation). The mission time is the period of time that a component is required to operate in order to characterize the component operation as being successful.

An example would be for a pump that must run for 24 hours after a particular initiating event occurs. The mission time for this case would be 24 hours.

9.6.6.1.11 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 entrophy , and
seismic.

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.

9.6.6.1.12 Value 1

Enter the first parameter of the distribution, if one is required.

9.6.6.1.13 Value 2

Enter the second parameter of the distribution, if one is required.

9.6.6.1.14 Correlation Class

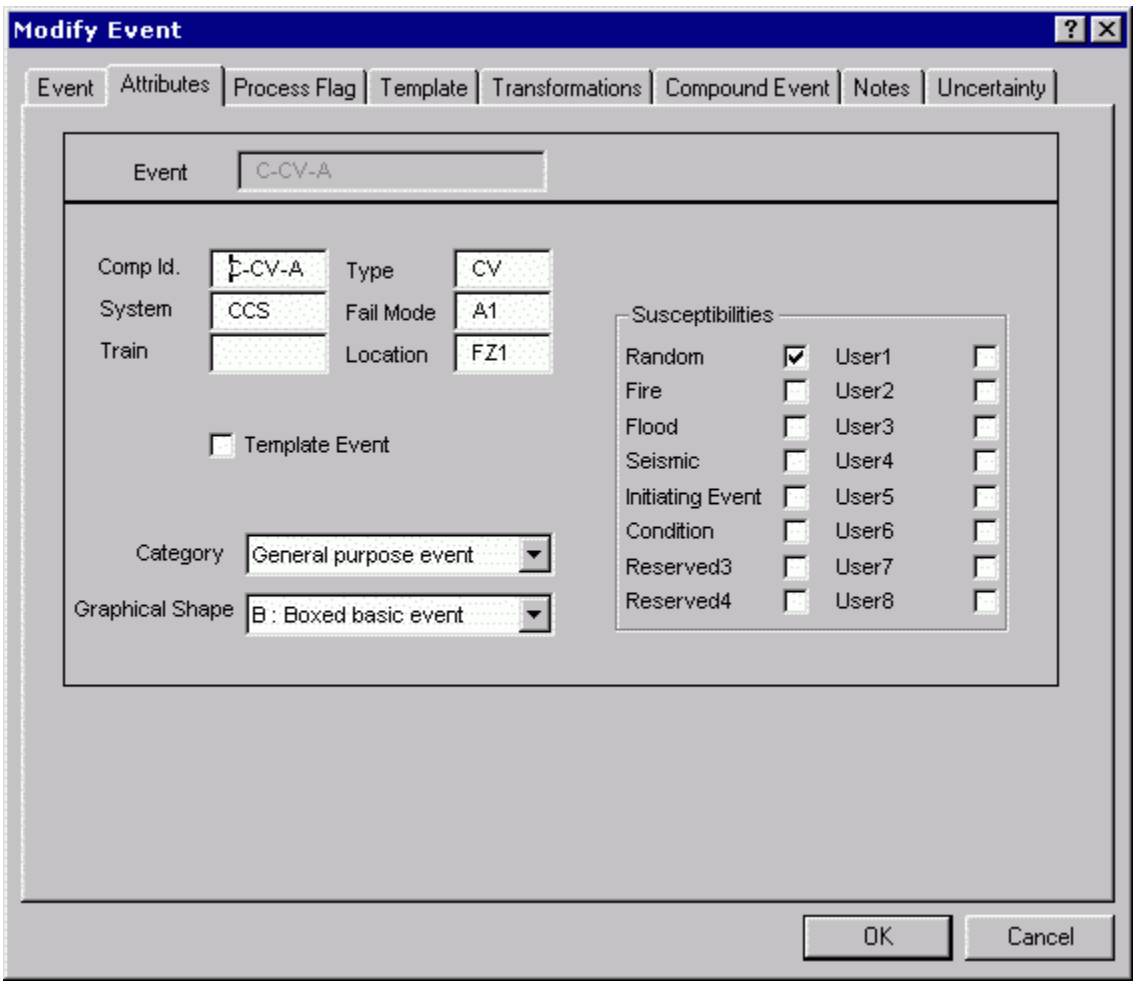
Used to account for data dependencies among like events in the database. Enter up to 24 uppercase, alphanumeric values. A blank correlation class indicates that there are no data dependencies. When running the uncertainty analyses, the same sample value will be used for all basic events with the same correlation class.

9.6.6.2 Attributes Page

9.6.6.2.1 Basic Event Data - Attributes

PURPOSE

Basic event attributes define the traits of the event. These traits can be used to group the events, for example, in change set processing.



Ok - Save the new or modified basic event and close the dialog.
Cancel - Close the dialog without saving.

9.6.6.2.2 Comp Id

Component Identifier. Enter up to seven (7) alphanumeric characters to identify a component by a unique designator. This is usually part of the component label (e.g., DG01). No embedded blanks are allowed.

9.6.6.2.3 System

Enter up to three (3) alphanumeric characters to identify the system containing the component.

9.6.6.2.4 Train

Enter up to two (2) alphanumeric characters to identify the train containing the component.

9.6.6.2.5 Type

Enter the event type attribute.

9.6.6.2.6 Fail Mode

Enter up to two (2) alphanumeric characters to identify the failure mode for the component.

9.6.6.2.7 Location

Enter up to three (3) alphanumeric characters to identify the physical location for the component.

9.6.6.2.8 Category

Select the from the drop-down list to specify the category or use of the event.

General purpose event - This is the default and is appropriate for must basic events.
'I' - Initiating event - Any initiating events should be identified with this category designation. The event tree editor will automatically enter an 'I' when the user specifies that the first event is an initiating event.
'H' - Hazard event - This is a special calculation type assigned to histogram bins for hazard analysis.
'R' - Recovery event - Events with this category designation will be listed in a list of recovery events used in the Recovery Rules editor

9.6.6.2.9 Susceptibilities

The susceptibility flags indicate whether or not the event is susceptible to a specific kind of failure. There are 16 susceptibilities as defined below:

Random (default)
Fire
Flood

Seismic
Initiating Event
Condition
Reserved 3 (Reserved for internal use)
Reserved 4 (Reserved for internal use)
User1 – User 8 (User-defined)

Susceptibility flags must be checked for the event to be considered susceptible to a specific type of failure. All events are susceptible to random failure regardless of the random flag's value.

9.6.6.2.10 Template Event

Checking this box flags the event as a template event. A template event can used by other events to inherit the template event's field values. This box cannot be unchecked if any other events in the project reference it as a template.

9.6.6.2.11 Graphical Shape

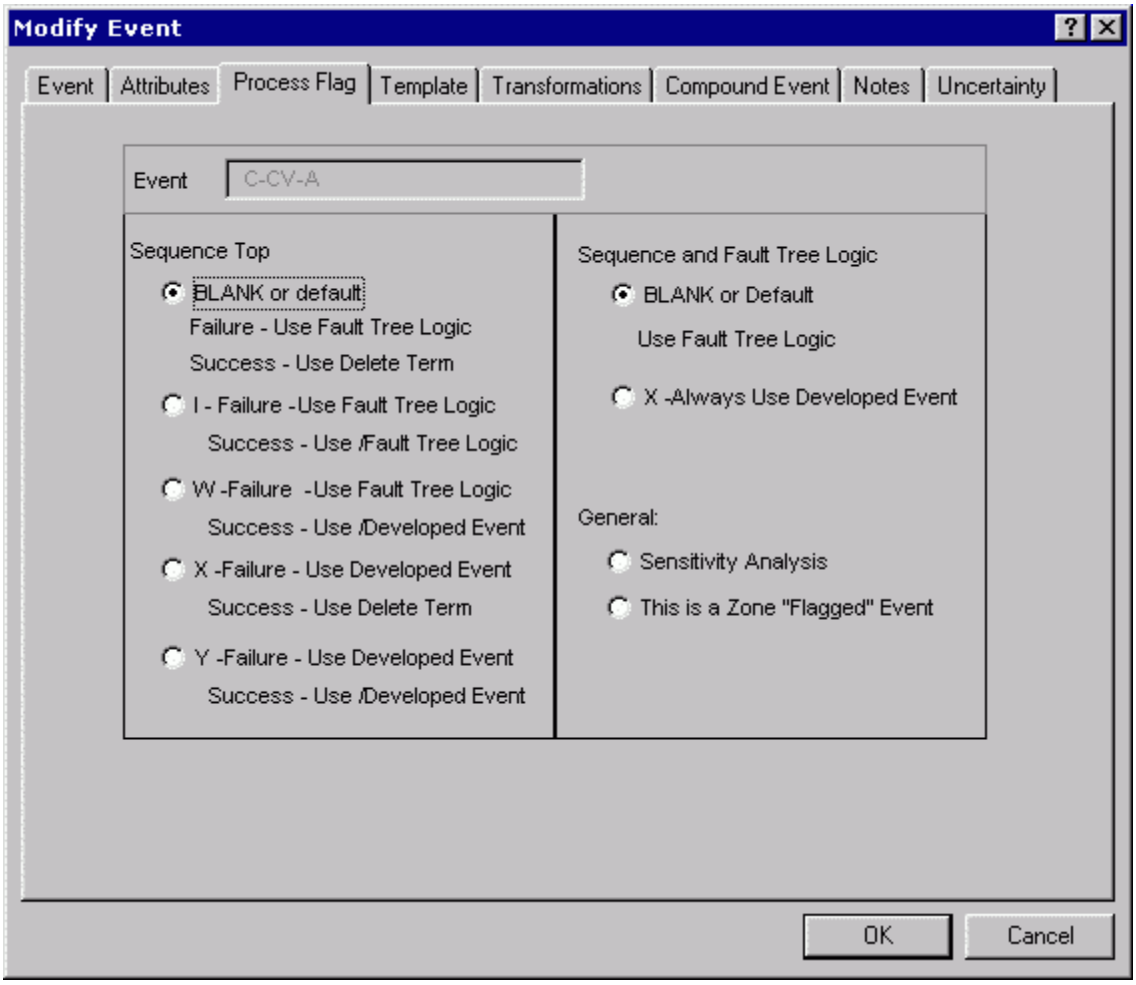
The graphical shape selected here will determine what basic event shape will be used in the Alpha-to-Graphics conversion. Select the graphical shape (e.g., basic event, boxed basic event, etc.) for this event from the drop-down list. The "Default" shape uses the shape selected at the time the conversion is done.

9.6.6.3 Process Flag Page

9.6.6.3.1 Basic Event Data - Process Flag

PURPOSE

The process flag specifies if certain processes should take special note of the selected event. Select one of the available values:



Ok - Save the new or modified basic event and close the dialog.
Cancel - Close the dialog without saving.

9.6.6.3.2 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).

9.6.6.3.3 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.

9.6.6.3.4 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.

9.6.6.3.5 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.

9.6.6.3.6 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.

9.6.6.3.7 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.

9.6.6.3.8 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.

9.6.6.4 Template Page

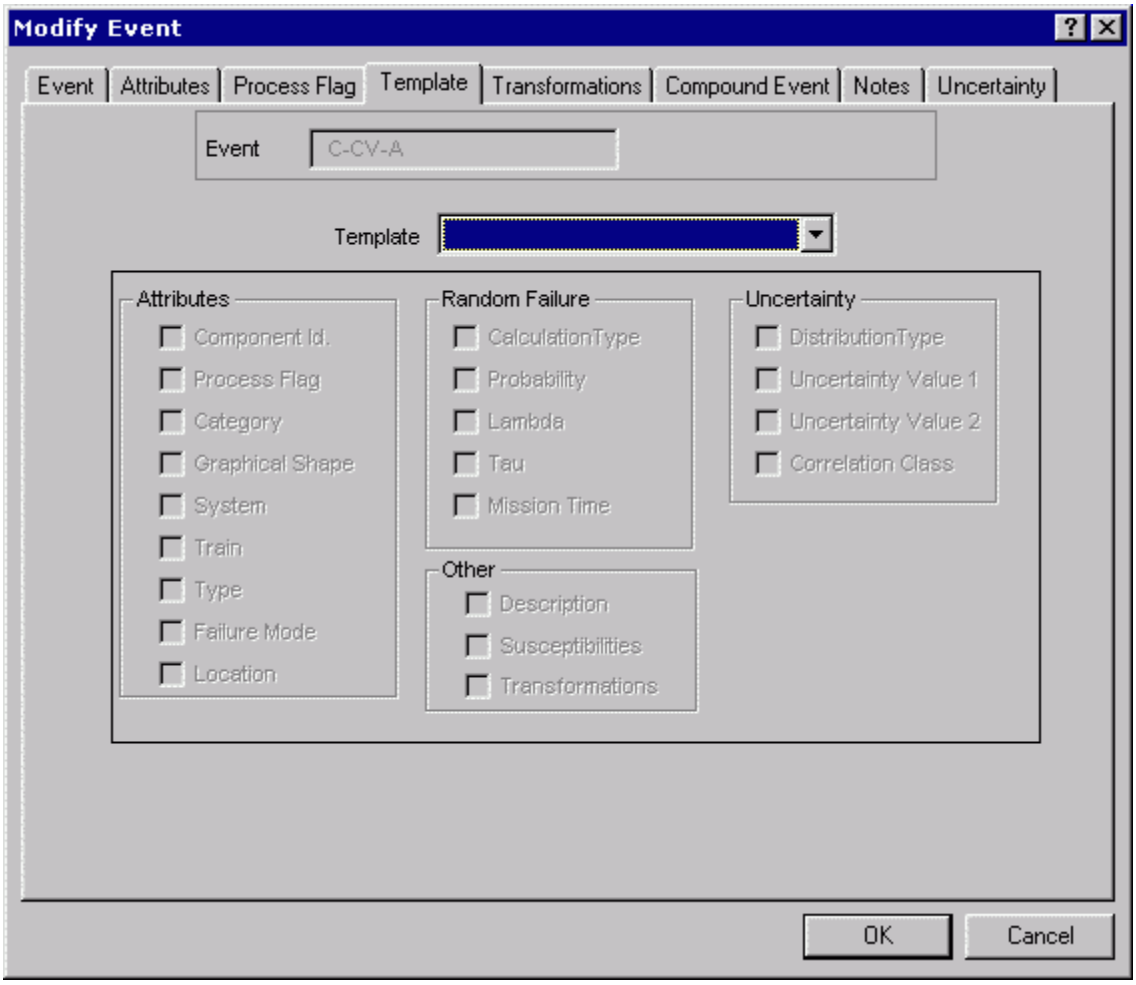
9.6.6.4.1 Basic Event Data - Template

PURPOSE

A template event is a basic event that can be used to define all or part of other basic events. Using templates can simplify the process of adding or updating a series of events which have common values.

When an event is marked as a template (from the Attributes page), the check boxes on the Template tab are enabled. All fields that are checked will be available to the events that use the template.

When a template event is selected from the template combo box, the check boxes below will be enabled, allowing you to mark the attributes, failure data, and uncertainty data that will be copied from the template event. By default all of the template's values will be copied to the basic event. A check mark indicates that the template event's value will be used.



Ok - Save the new or modified basic event and close the dialog.
Cancel - Close the dialog without saving.

9.6.6.4.2 Template Name

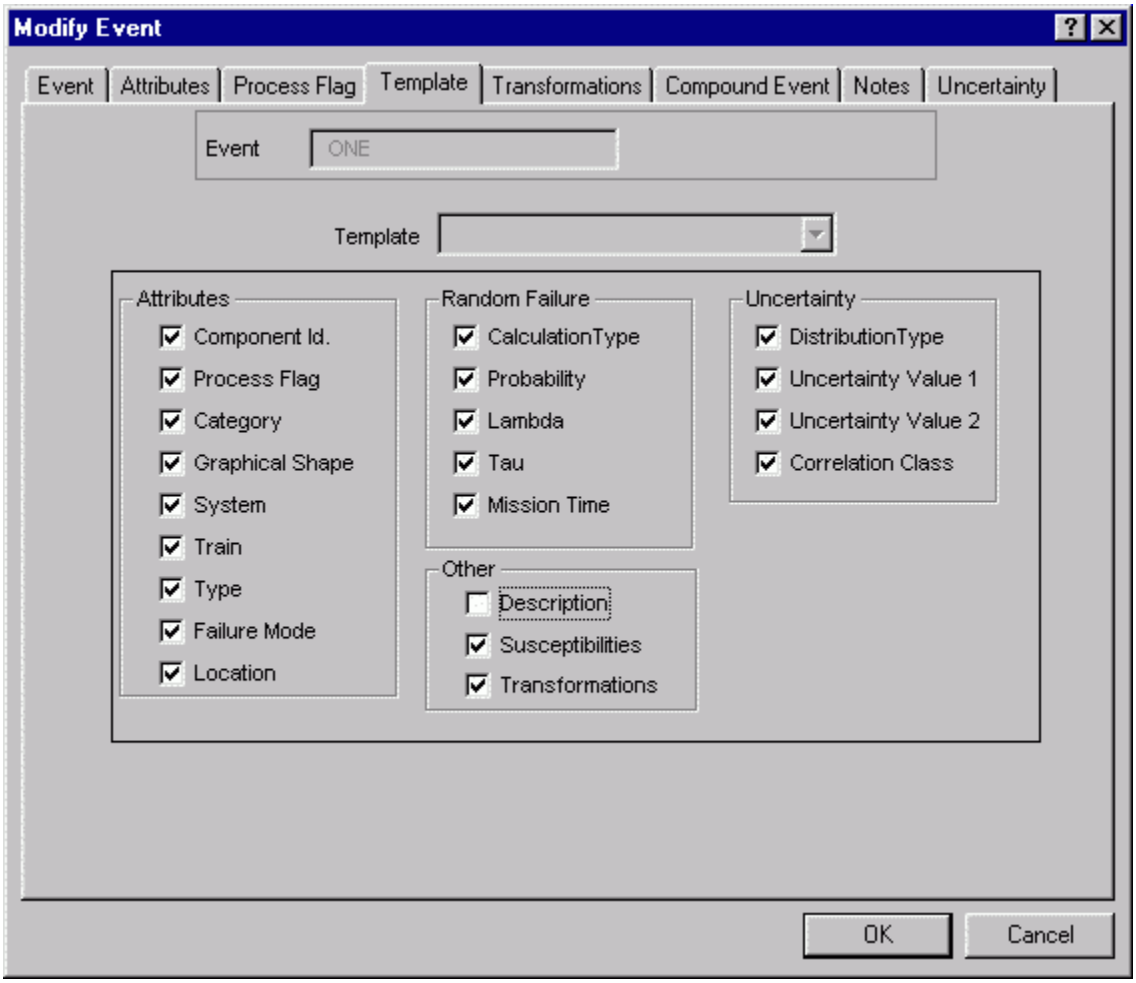
If you wish to use another event's information as a template for this basic event, select the name of the event from the drop-down list. Then choose the Template tab to select the desired characteristics.

9.6.6.4.3 Template Example

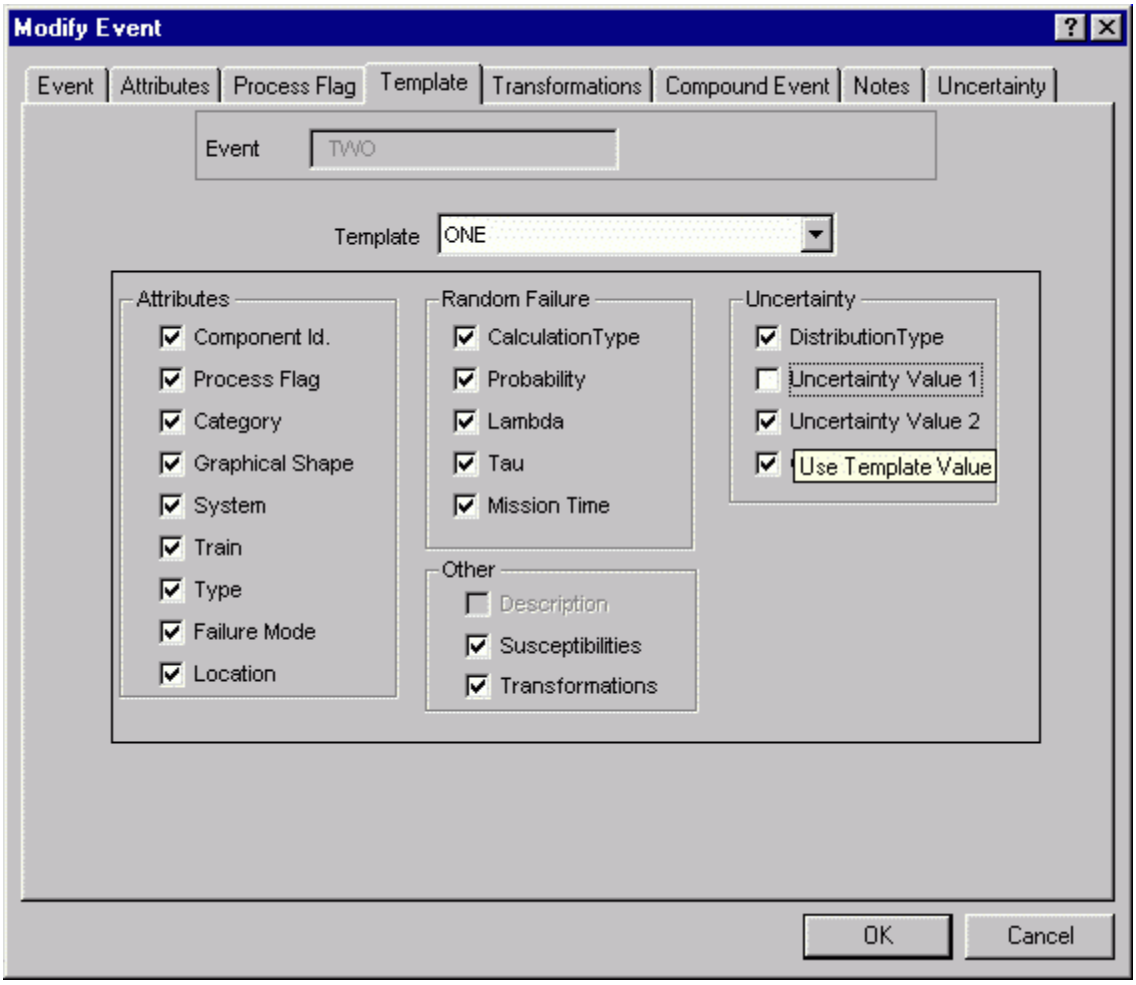
Once a template basic event is defined, SAPHIRE has the capability to apply the template's values to all the basic events that reference it. This is accomplished by allowing you to specify a basic event as a template for other basic events in the database. Template events cannot reference other template events. Any basic event (except one designated as a template event) can be set up to use a template event. If a template event is chosen, the basic event can use all or part of the template's values. Whenever the template event's values are changed, all of the events that reference that template event will be modified to reflect that change.

The generation of current event data works with template events as well. Change sets are first applied to all template events and then to all non-template events. The change sets will be applied to the non-template events after all the template values have been loaded into them.

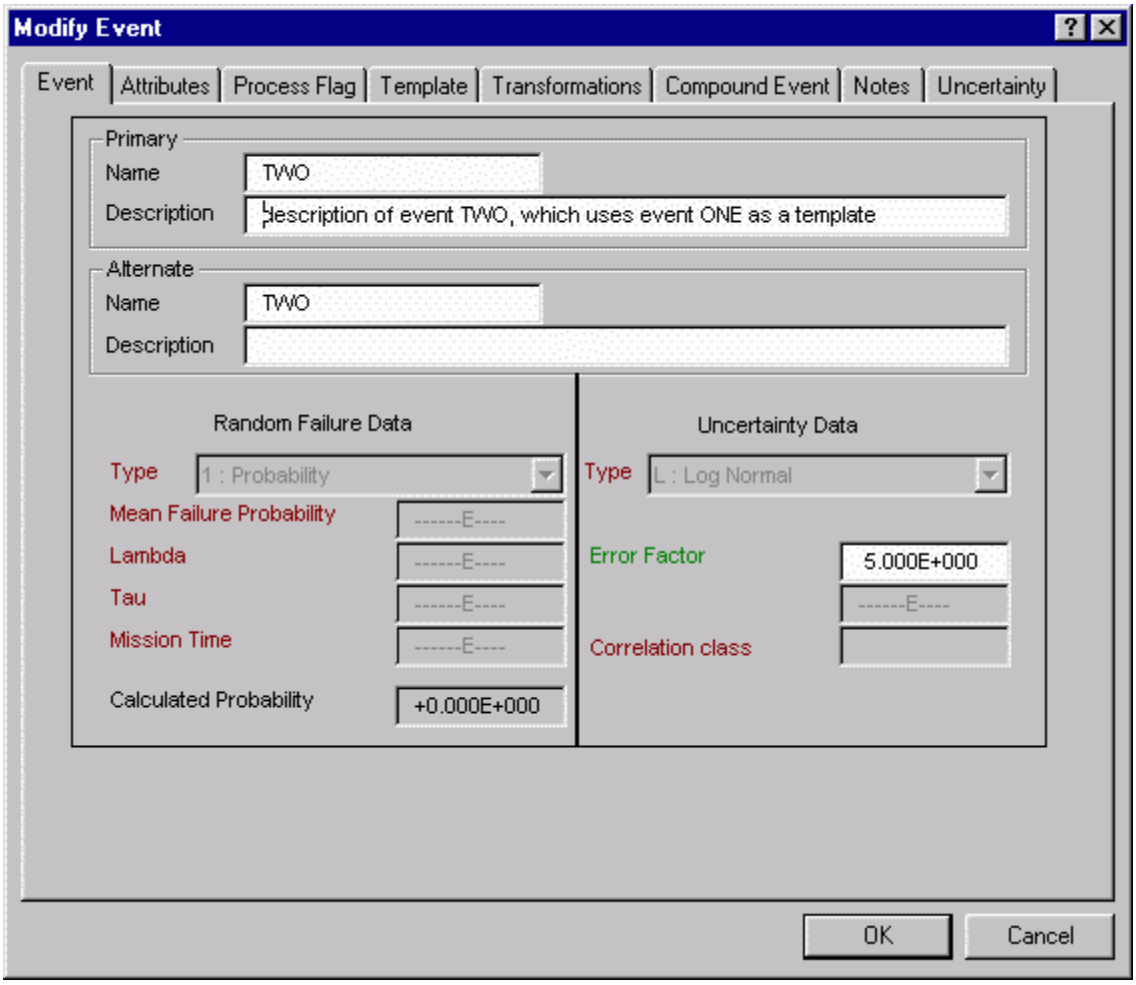
Event ONE is defined as a template event. All values of Event One are available to be copied to events that references this one, except the *Description* field, which was unchecked for this example to demonstrate how to remove a field from a template.



Event TWO references the template event ONE. All of the available values (the *Description* field is disabled because the template did not "share" this field) from the template event are copied into event TWO, with the exception of the *Uncertainty Value 1* field, which was unchecked for this example to demonstrate how to override a template value.



On the **Event** tab of the TWO event, the fields derived from the template are disabled and labeled in red to indicate that they cannot be edited. Because the *Uncertainty Value 1* field was unchecked on the **Template** page, the *Error Factor* label is displayed in green, indicating that its value, (even though it is available from the template) can be overridden. The *Description* field is displayed normally, because the template event did not make that field available for use.



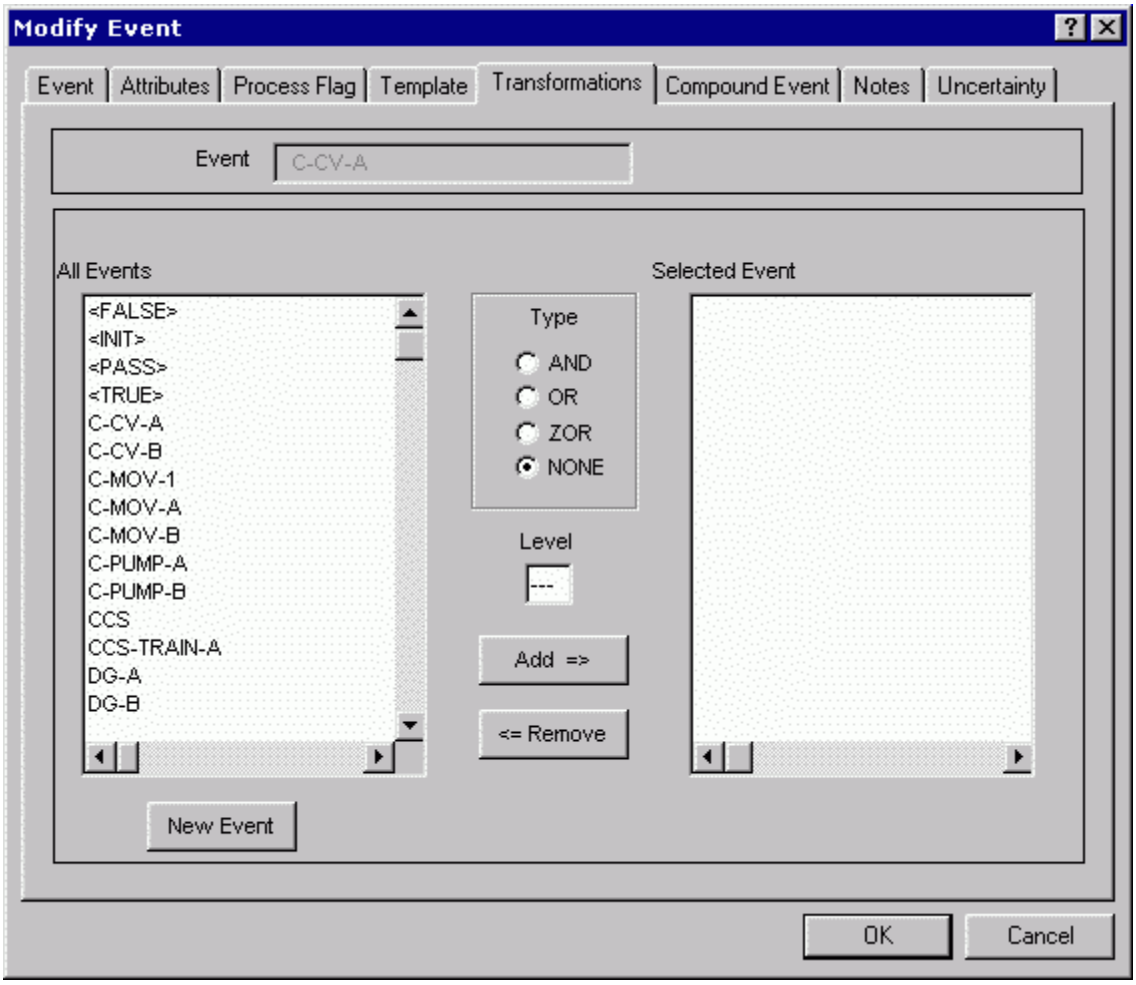
9.6.6.5 Transformations Page

9.6.6.5.1 Basic Event Transformations

PURPOSE

A transformation is a replacement or addition of basic event(s) inside the fault tree logic. During the transformation process, an event is replaced by a series of events; or, if any event exists then another set of events is added to the logic. Transformations occur when a zone flagged event is encountered.

The list on the left of the dialog displays all basic events defined for the current project. The list on the right displays the events that have been marked as replacements for the current event.



Add - Add the highlighted event in the *All Events* list to the *Selected Events* list.
Remove - Remove the highlighted event from the *Selected Events* list.
Ok - Save the new or modified basic event and close the dialog.
Cancel - Close the dialog without saving.

9.6.6.5.2 Transformation - Type

This field indicates the required behavior of the collective events. Enter one of the following:

AND = All included events must fail. Event is replaced with an AND gate, with all marked events as inputs.

OR = Any included events must fail. Event is replaced with an OR gate with all marked events as inputs.

ZOR = Events make up the zone. If any events in the list fail, all events fail.

9.6.6.5.3 Transformation – Level

Enter an integer between 0 and 255 indicating the level of substitution for the transformation.

9.6.6.5.4 Transformation Example

Once transformations are defined, SAPHIRE has the capability to automatically perform event transformations during fault tree analysis. This is accomplished by allowing you to specify a transformation for each basic event in the database. This transformation can be one of three types, AND, OR, or ZOR and can define an optional level number. You may also specify a list a basic events that make up the transformation. When a fault tree is solved, you can specify that the logic for the fault tree be transformed by replacing each event that has a transformation defined for it by a gate with the events in the transformation as inputs. A simple example fault tree is as follows:

TOP	AND	GATE1, GATE2
GATE1	OR	EVENT1, EVENT2
GATE2	AND	EVENT1, EVENT3

You may then specify the following event transformations:

EVENT1	OR	LOC1, LOC2, LOC3, CABLE1
EVENT2	OR	LOC2, LOC4, CABLE2
CABLE1	OR	LOC4, LOC5
CABLE2	OR	LOC5, LOC6, LOC7

The CABLE events may represent the locations a cable passes through. The OR transformation type indicates that the specified event is to be replaced by an OR gate with the locations as inputs. You can then choose to expand the transformations resulting in the following logic:

TOP	AND	GATE1, GATE2
GATE1	OR	TRAN1, TRAN2
GATE2	AND	TRAN1, TRAN3
TRAN1	OR	LOC1, LOC2, LOC3, CABLE1, EVENT1
TRAN2	OR	LOC2, LOC4, CABLE2, EVENT2
CABLE1	OR	LOC4, LOC5
CABLE2	OR	LOC5, LOC6, LOC7

This logic is then reduced by combining like gate types to the following:

TOP	AND	GATE1, GATE2
GATE1	OR	TRAN1, TRAN2
GATE2	AND	TRAN1, TRAN3
TRAN1	OR	LOC1, LOC2, LOC3, LOC4, LOC5, EVENT1
TRAN2	OR	LOC2, LOC4, LOC5, LOC6, LOC7, EVENT2

When this fault tree is solved, the result is a list of cut sets in terms of independent failure events and locations. You can also choose to do a zone transformation by defining the locations that map to a particular zone. A zone or ZOR transformation as it is defined in the following example, effectively takes groups of locations and maps them into a single zone. Assuming you specified the following zone transformations:

ZONE1	ZOR	LOC1, LOC2
ZONE2	ZOR	LOC3, LOC4, LOC5
ZONE3	ZOR	LOC6, LOC7

Then the previous fault tree would be transformed into the following logic.

TOP	AND	GATE1, GATE2
GATE1	OR	TRAN1, TRAN2
GATE2	AND	TRAN1, TRAN3
TRAN1	OR	ZONE1, ZONE2, EVENT1
TRAN2	OR	ZONE1, ZONE2, ZONE3, EVENT2

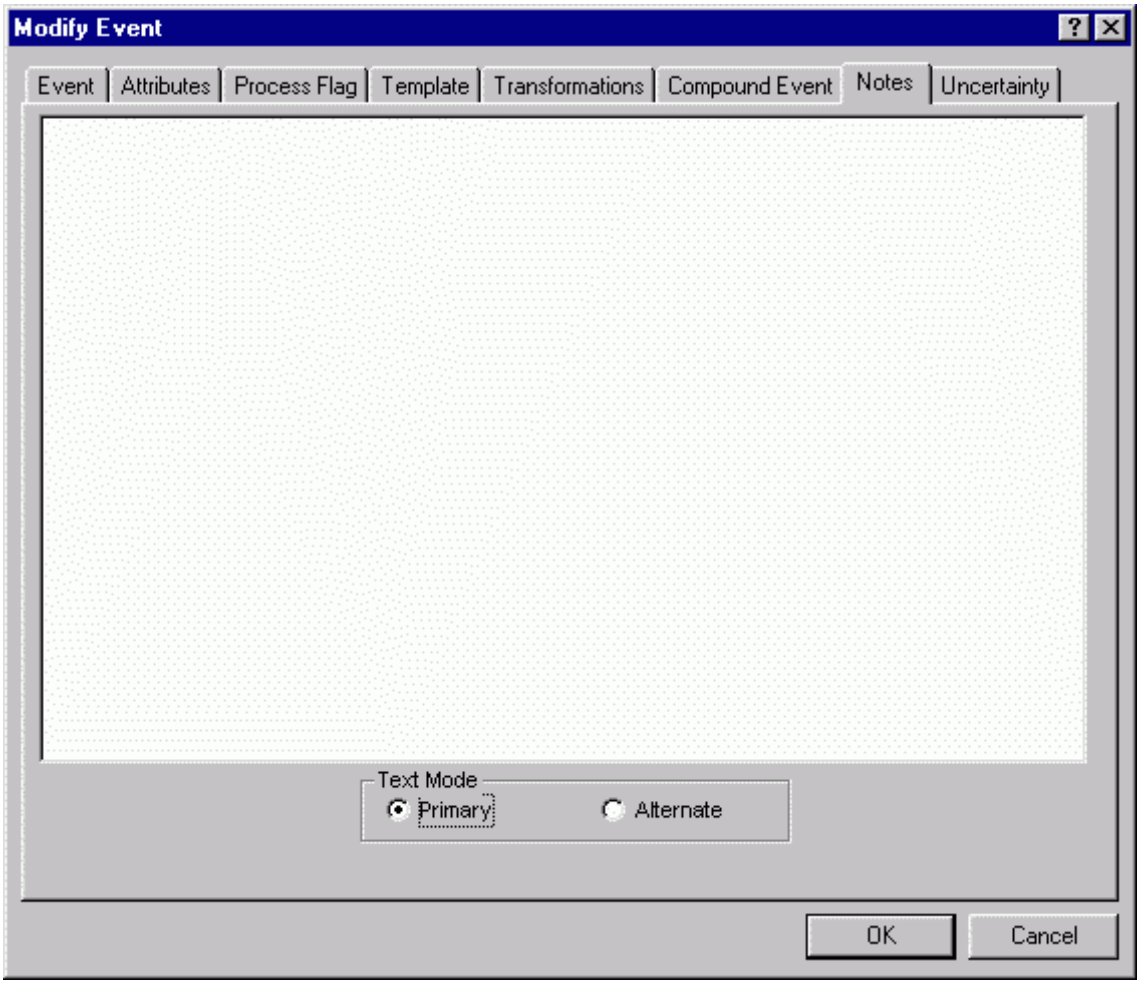
This logic is obtained by replacing any occurrence of an input to a ZOR transformation by the name representing the transformation. Thus, you can map logic in terms of locations to logic in terms of zones, where a zone represents a collection of locations.

The susceptibility flags for each event are used to control which transformation are to be applied for a particular analysis type. For instance, if you want an event transformation to apply to a Fire analysis, then you must specify that the particular event is susceptible to Fire by checking fire susceptibility attribute.

9.6.6.6 Basic Event Data - Notes

PURPOSE

This option allows you to view and edit the descriptive text associated with a specific record. The Primary text option is generally used for text in the desired primary language. The Alternate text option is generally used for information entered in the secondary language using a different alphabet (locale).



Ok - Save the new or modified basic event and close the dialog.
Cancel - Close the dialog without saving.

9.6.6.7 Compound Event Page

9.6.6.7.1 Basic Event Data – Compound Event

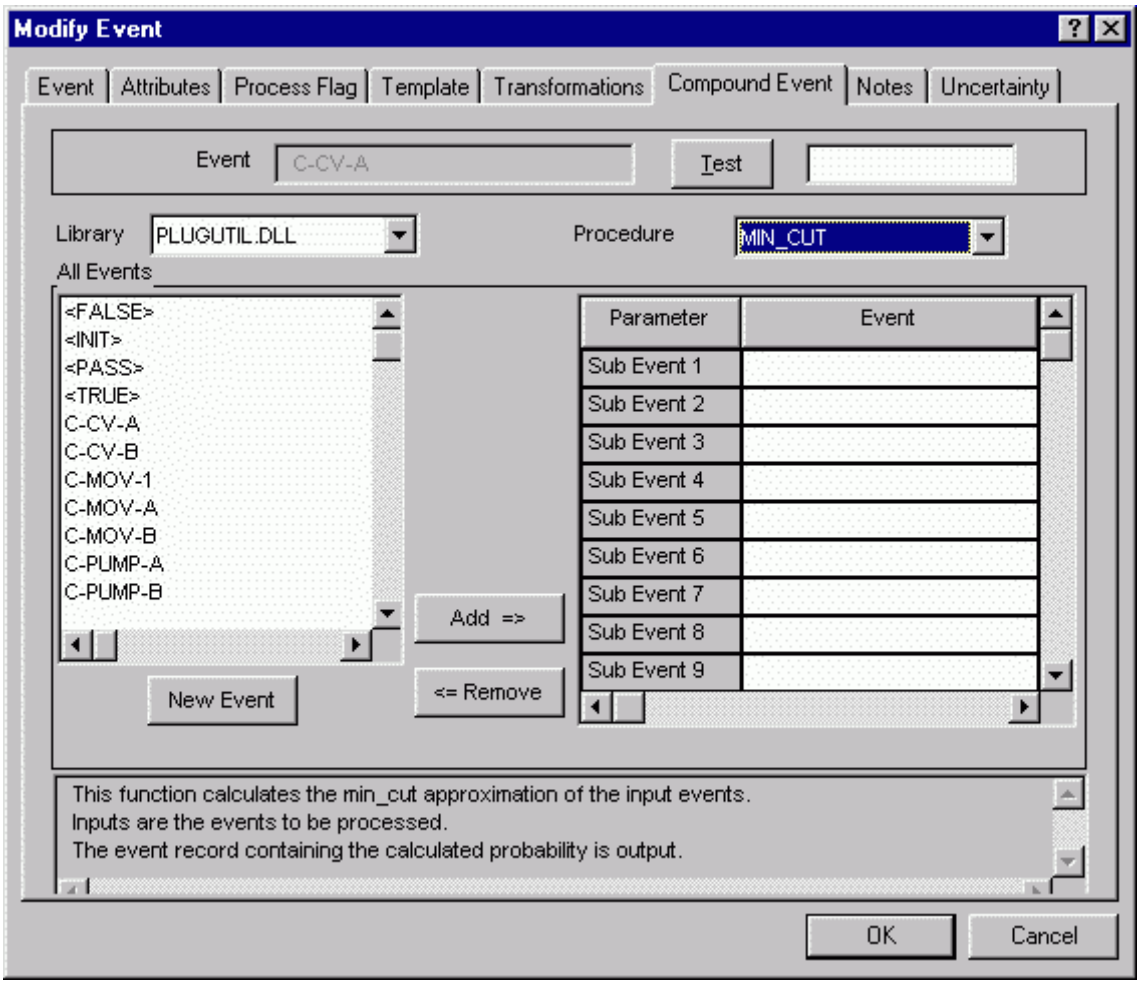
PURPOSE

A compound event's probability is defined by some combination of inputs, formulas, and other basic events.

STEPS

1. From the SAPHIRE menu select **Modify | Basic Events**. The *Edit Events* dialog is displayed.

2. Highlight the event you wish to edit or copy. (Skip this step if adding a new basic event record.)
3. Right-click to invoke the pop-up menu and choose **Add**, **Modify**, or **Copy**. The *Modify Event* dialog will be displayed.
4. Choose the *Attributes* tab.
5. Select the **Compound Event** radio button in the *Special Use Flags* group. The *Compound Event* tab will appear.
6. Choose the *Compound Event* tab.



To calculate the compound event's probability, you must first select a SAPHIRE Dynamic Link Library (DLL) file from the *Library* drop-down list. Once the DLL is selected, choose a procedure from the *Procedure* drop-down list. After the desired procedure is selected, a list of appropriate parameters will be displayed in the *Parameter* column of *Selected Event* list. Choose an event from the *All Events* list for each parameter in the *Selected Event* list.

The *All Events* list on the left of the dialog displays all basic events defined for the current project. The *Selected Event* list on the right displays the events that have been selected as parameters for the selected DLL library procedure.

Test - Calculate the compound event's probability based on the selected procedure and parameters. The basic event's probability values are applied at the end of the generate change set process.

Add - The highlighted event in the *All Events* list will be associated with the highlighted parameter in the *Selected Event* list.

Remove-The highlighted event in the *Selected Event* list will be removed from the list.

Ok - Save the new or modified basic event and close the dialog.

Cancel - Close the dialog without saving.

9.6.6.7.2 Library

The SAPHIRE Dynamic Link Libraries (DLLs) are provided during installation of SAPHIRE code. They contain one or more procedures used for calculating a compound event's probability.

9.6.6.7.3 Procedure

Contains the formula and defines the parameters used for calculating a compound event's probability. Found in a selected SAPHIRE DLL.

9.6.6.7.4 Parameters

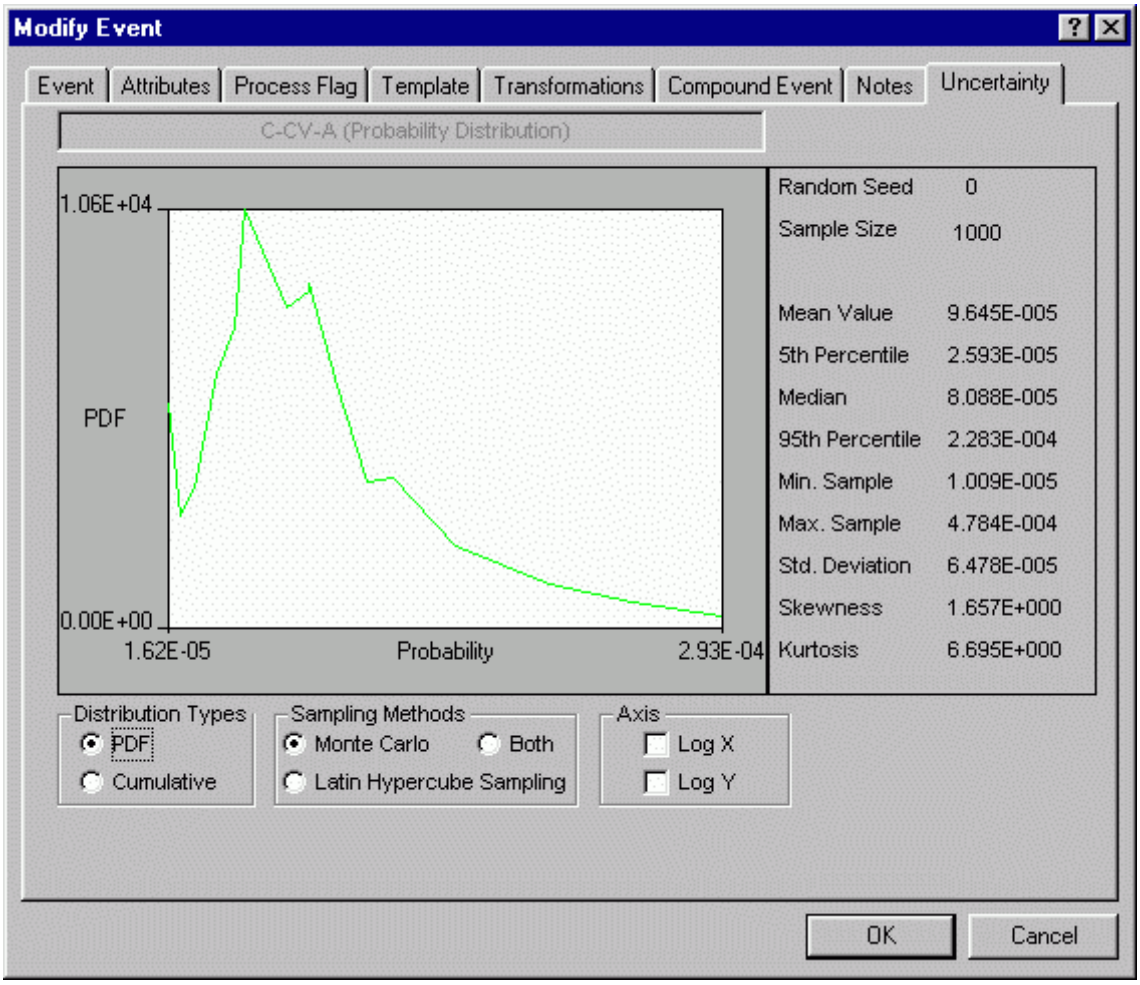
The input values to a procedure used for calculating a compound event's probability. Select the parameter in the *Selected Event* list, then the desired event from the *All Events* list. The selected event's base probability value is used as the input parameter value.

9.6.6.8 Uncertainty Page

9.6.6.8.1 Basic Event Data - Uncertainty

PURPOSE

This property sheet page shows a graphical representation of the uncertainty distribution defined by the failure and uncertainty values.



Ok - Save the new or modified basic event and close the dialog.
Cancel - Close the dialog without saving.

9.6.6.8.2 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.

9.6.6.8.3 Sampling Methods

Select the desired sampling method for uncertainty calculation:

Monte Carlo -	(Default) - 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.
Both -	Displays a graph that will have two lines. One line is based on Monte Carlo Sampling of the defined uncertainty distribution and the other line is based on Latin Hypercube Sampling of the defined uncertainty distribution.

9.6.6.8.4 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.

9.7 Modifying Attribute Data

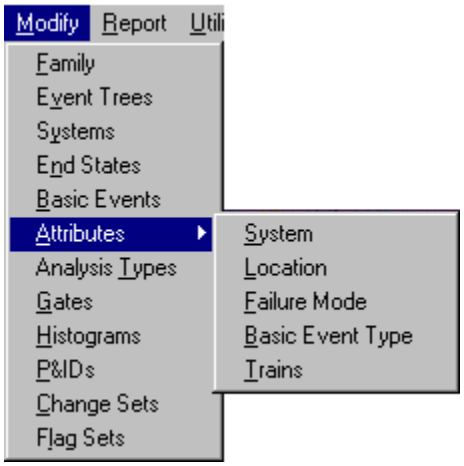
9.7.1 Attributes

PURPOSE

This option allows you to edit records of the five attribute types in the current project: Systems, Locations, Failure Modes, Basic Event Types, and Trains. The dialogs and operations are consistent for each of the five attribute categories, therefore, a generic discussion is provided. The Locations category has been used in the example graphics.

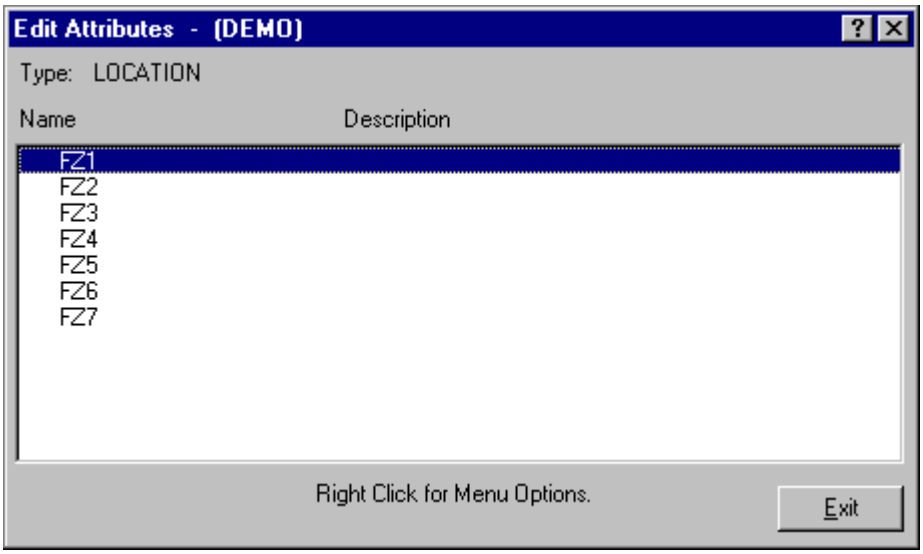
STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Attributes** from the menu.
3. Select the desired sub-menu option. The *Edit Attributes* dialog will be displayed listing all of the records of the selected attribute type. The selected attribute category is displayed in the *Type* field.



4. Highlight the desired list item.
5. Right-click to invoke the pop-up menu or choose the **Exit** button.

The example here shows the Location attribute records.



Pop-up Menu Options

Add - Add a new attribute record to the current project database. When complete, the message, "Record added," is displayed in the message bar of the SAPHIRE window.

Copy - Create a new attribute record by copying an existing one.

Modify - Edit the selected attribute record. When complete, the message, "Record modified," is displayed in the message bar of the SAPHIRE window.

Delete - Delete the selected attribute record(s**)**.

Button Option

Exit - Close the *Edit Attributes* dialog.

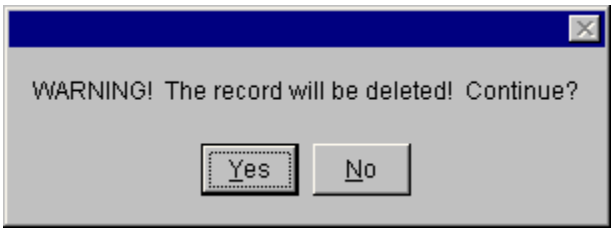
9.7.2 Delete Record

PURPOSE

This option allows you to delete the highlighted record from the database.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record you wish to delete.
4. Right-click to invoke the pop-up menu and choose **Delete**. A warning dialog will be displayed, allowing you to cancel the deletion at this point.



Yes - Continue the delete operation. The selected record will be deleted from the database. The message, "Record deleted," is displayed in the message bar of the SAPHIRE window.

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

9.7.3 Attribute Data Entry Dialog

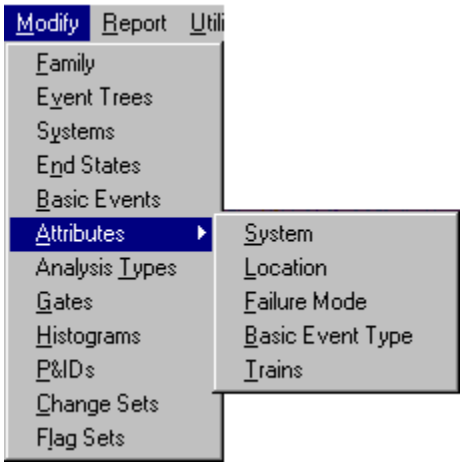
9.7.3.1 Attribute Data Entry

PURPOSE

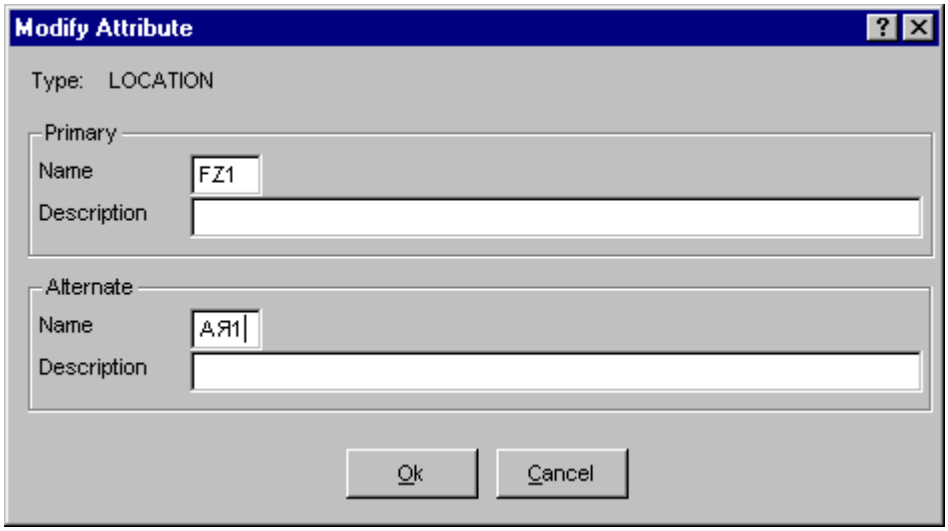
The *Add/Modify Attribute* dialog allows you to enter or modify attribute data. The selected attribute category is displayed in the *Type* field.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Attributes** from the menu.
3. Select the desired sub-menu option. The *Modify Attributes* dialog will be displayed. The selected attribute category is displayed in the *Type* field.



4. Highlight the list item you wish to edit or copy. (Skip this step if adding a new record.)
5. Right-click to invoke the pop-up menu and choose **Add**, **Copy**, or **Modify**.



Ok - Save the new or modified attribute and close the dialog.
Cancel - Close the dialog without saving.

9.7.3.2 Attribute Name

This is a required field. A maximum of 5 uppercase, alphanumeric characters may be entered (embedded blanks are not allowed). The name should be descriptive so it can be readily identified.

9.7.3.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.8 Modifying Analysis Type Data

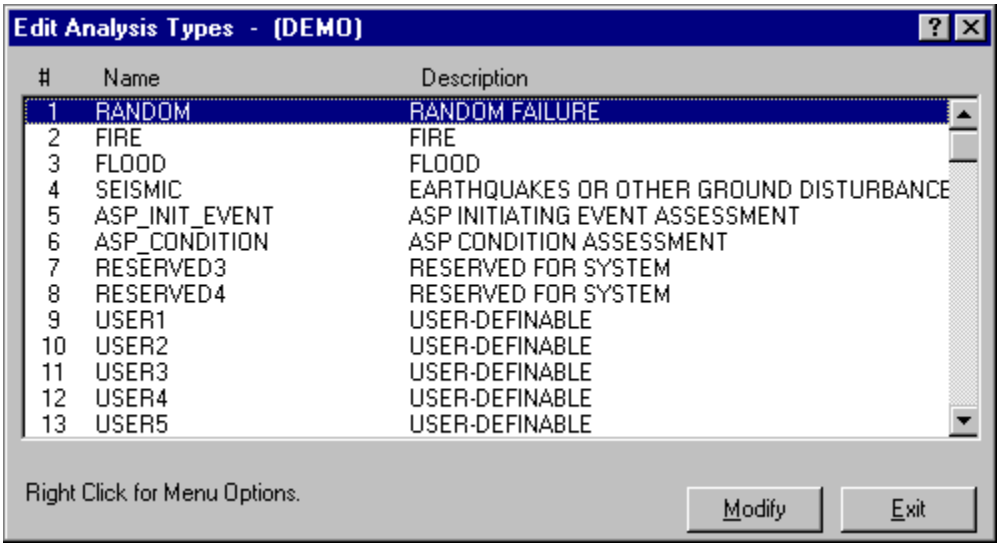
9.8.1 Analysis Types

PURPOSE

This option allows you to modify analysis types. SAPHIRE offers eight predefined analysis types and eight user-defined analysis types. You cannot edit the name of the eight predefined analysis types, but you can edit the description. You can modify both the name and description of the eight user-defined analysis types.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Analysis Types** from the menu. The *Edit Analysis Types* dialog is displayed, listing the 16 analysis types belonging to the current project.
3. Highlight the desired analysis type.
4. Choose the **Modify** button.



Modify - Edit the selected analysis type record. When complete, the message, "Record modified," is displayed in the message bar of the SAPHIRE window.

Exit - Close the *Edit Analysis Types* dialog.

9.8.2 Analysis Type Data Entry Dialog

9.8.2.1 Analysis Type Data Entry

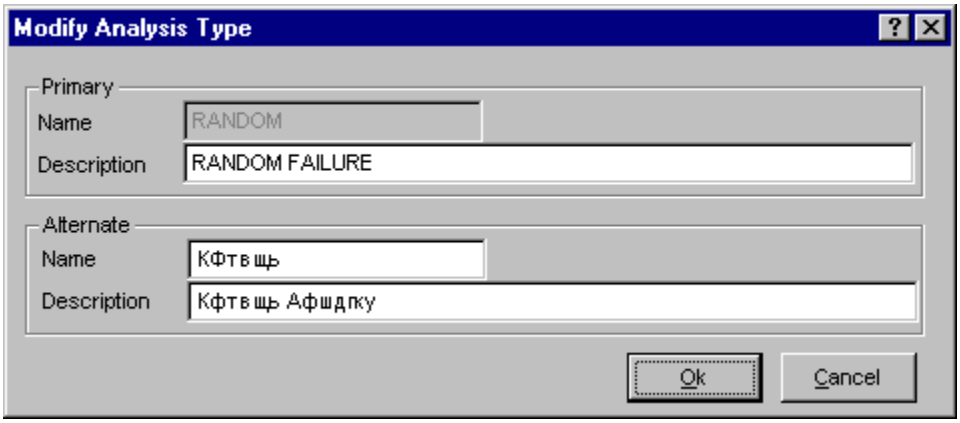
PURPOSE

The *Modify Analysis Type* dialog allows you to edit analysis type data.

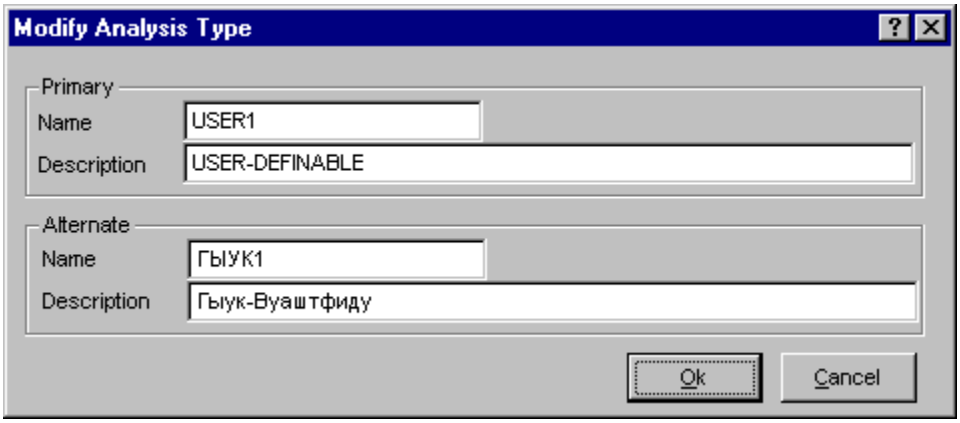
STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Analysis Types** from the menu. The *Edit Analysis Types* dialog is displayed, listing the 16 analysis types belonging to the current project.
3. Highlight the desired analysis type.
4. Choose the **Modify** button.

You can edit only the description of the eight predefined analysis types. As shown here, the *Name* field is not accessible for modification:



You can modify both the name and descriptions of the eight user-defined analysis types. As shown below, both fields are accessible for modification:



Ok - Save the modified analysis type and close the dialog.
Cancel - Close the dialog without saving.

9.8.2.2 Name

This is a required field. 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.

9.8.2.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.9 Modifying Gate Data

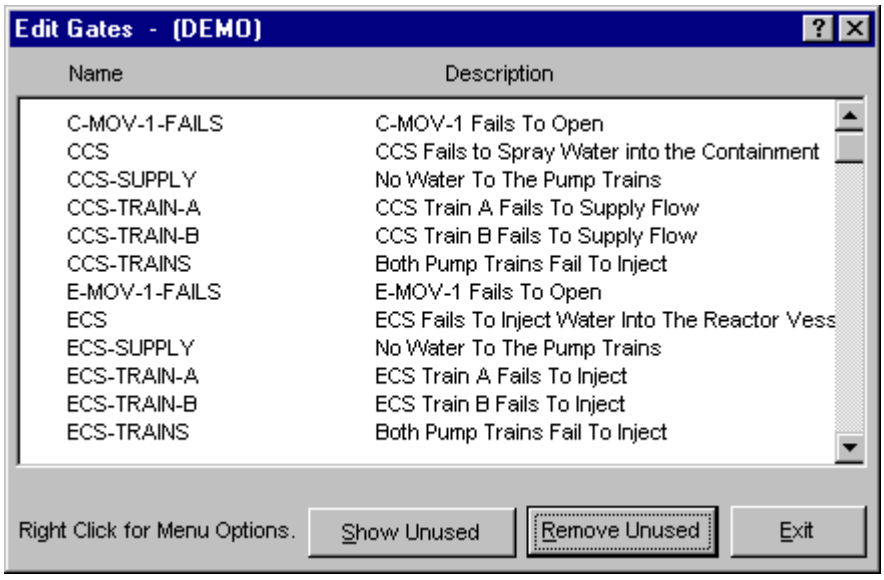
9.9.1 Gates

PURPOSE

This option allows you to add, modify, or delete the gate data records.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Gates** from the menu. The *Edit Gates* dialog is displayed, listing all of the gates belonging to the current project.
3. Highlight the desired gate.
4. Right-click to invoke the pop-up menu or choose the desired button.



Pop-up Menu Options

Add - Add a new gate record to the current project database. When complete, the message, "Record added," is displayed in the message bar of the SAPHIRE window.

Copy - Create a new gate record by copying an existing one.

Modify - Edit the selected gate record. When complete, the message, "Record modified," is displayed in the message bar of the SAPHIRE window.

Delete - Delete the selected gate record(s**).**

Button Options

Show Unused – Show all unused gates. The unused gates are indicated by a dash (-) to the left of the gate name.

Remove Unused Gates - Immediately delete all unused gate records.

Exit - Close the *Edit Gates* dialog.

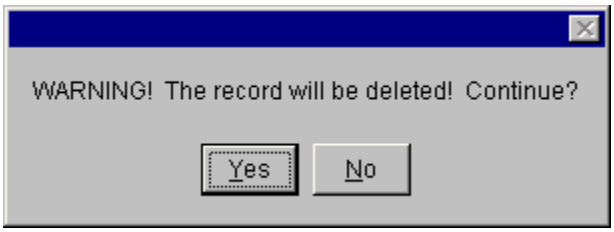
9.9.2 Delete Record

PURPOSE

This option allows you to delete the highlighted record from the database.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record you wish to delete.
4. Right-click to invoke the pop-up menu and choose **Delete**. A warning dialog will be displayed, allowing you to cancel the deletion at this point.



Yes - Continue the delete operation. The selected record will be deleted from the database. The message, "Record deleted," is displayed in the message bar of the SAPHIRE window.

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

9.9.3 Gate Data Entry Dialog

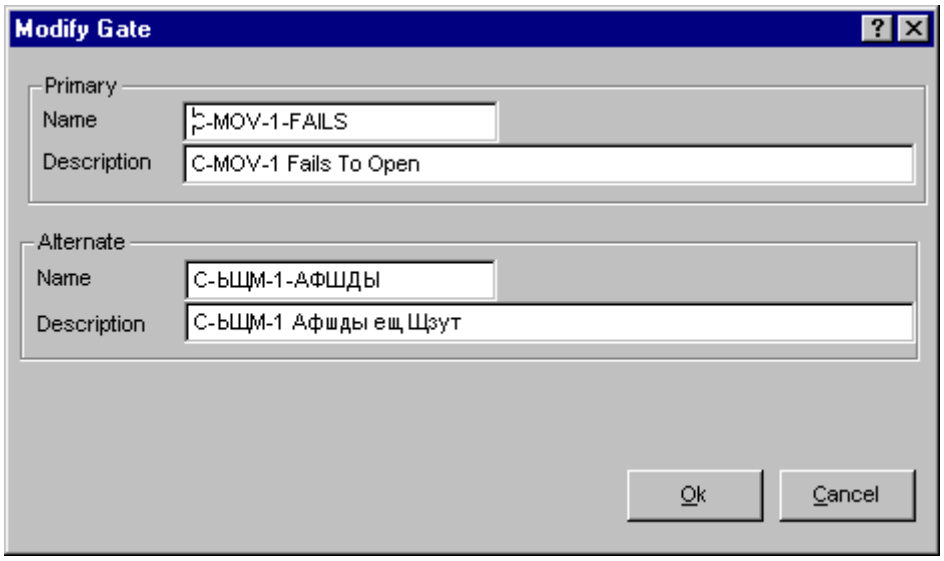
9.9.3.1 Gate Data Entry

PURPOSE

The *Add/Modify Gate* dialog allows you to enter or modify gate data.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Gates** from the menu. The *Edit Gates* dialog is displayed.
3. Highlight the gate you wish to edit or copy. (Skip this step if adding a new gate.)
4. Right-click to invoke the pop-up menu and choose **Add**, **Copy**, or **Modify**.



Ok - Save the new or modified gate and close the dialog.
Cancel - Close the dialog without saving.

9.9.3.2 Name

This is a required field. 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.

9.9.3.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.9.3.4 Type

Select the gate type from the drop-down list or enter your own of the type N/M.

AND - The output occurs if all inputs occur.
OR - The output occurs if any of the inputs occur.
TRAN - Transfer gate. This is a link to other logic structures.
NAND - Negation of an AND gate. The output occurs if any one of the inputs does not occur.
NOR - Negation of an OR gate. The output occurs if none of the inputs occur.
N of M - N/M gate. N of M input events must occur. Enter the N range from 2 to 9 and M range N< M.

9.10 Modifying Histogram Data

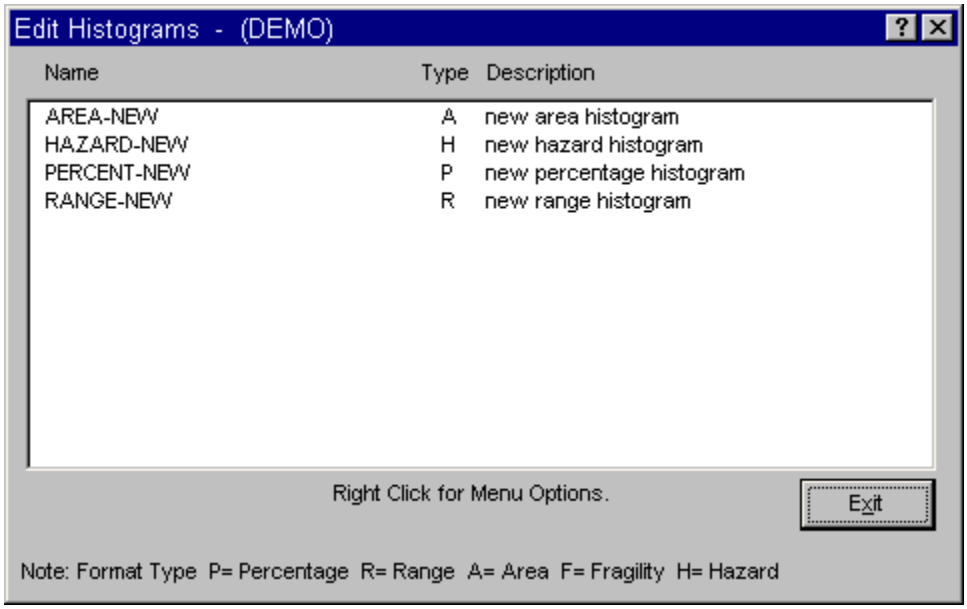
9.10.1 Histograms

PURPOSE

This option allows you to add, modify, or delete user-defined histogram records. This is a useful option for allowing you to input your own distribution for a variable that cannot be expressed with one of the predefined uncertainty distribution types.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Histograms** from the menu. The *Edit Histograms* dialog is displayed, listing all of the currently existing histograms with their associated format type.
3. Highlight the desired histogram.
4. Right-click to invoke the pop-up menu or choose the **Exit** button.



Pop-up Menu Options

Add - Add a new histogram record to the current project database. When complete, the message, "Record added," is displayed in the message bar of the SAPHIRE window.

Copy - Create a new histogram record by copying an existing one. The data entry dialog is dependent on the histogram's format.

Modify - Edit the selected histogram record. The data entry dialog is dependent on the histogram's format. When complete, the message, "Record modified," is displayed in the message bar of the SAPHIRE window.

Delete - Delete the selected histogram record(s**).**

Button Option

Exit - Close the *Edit Histograms* dialog.

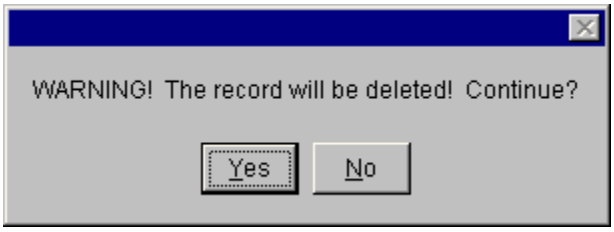
9.10.2 Delete Record

PURPOSE

This option allows you to delete the highlighted record from the database.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record you wish to delete.
4. Right-click to invoke the pop-up menu and choose **Delete**. A warning dialog will be displayed, allowing you to cancel the deletion at this point.



Yes - Continue the delete operation. The selected record will be deleted from the database. The message, "Record deleted," is displayed in the message bar of the SAPHIRE window.

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

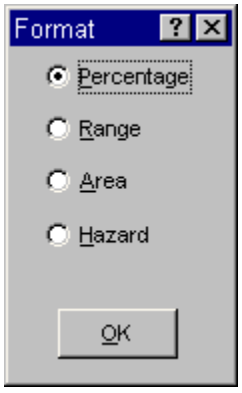
9.10.3 Add Histograms

PURPOSE

This option allows you to create a user-defined distribution type.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Histograms** from the menu. The *Edit Histograms* dialog is.
3. Right-click to invoke the pop-up menu and choose the **Add** option. The *Format* dialog is displayed.



From the *Format* dialog, you are given the choice of adding the histogram data in either a percentage, range, area, or hazard format.

9.10.4 Percentage Format Dialog

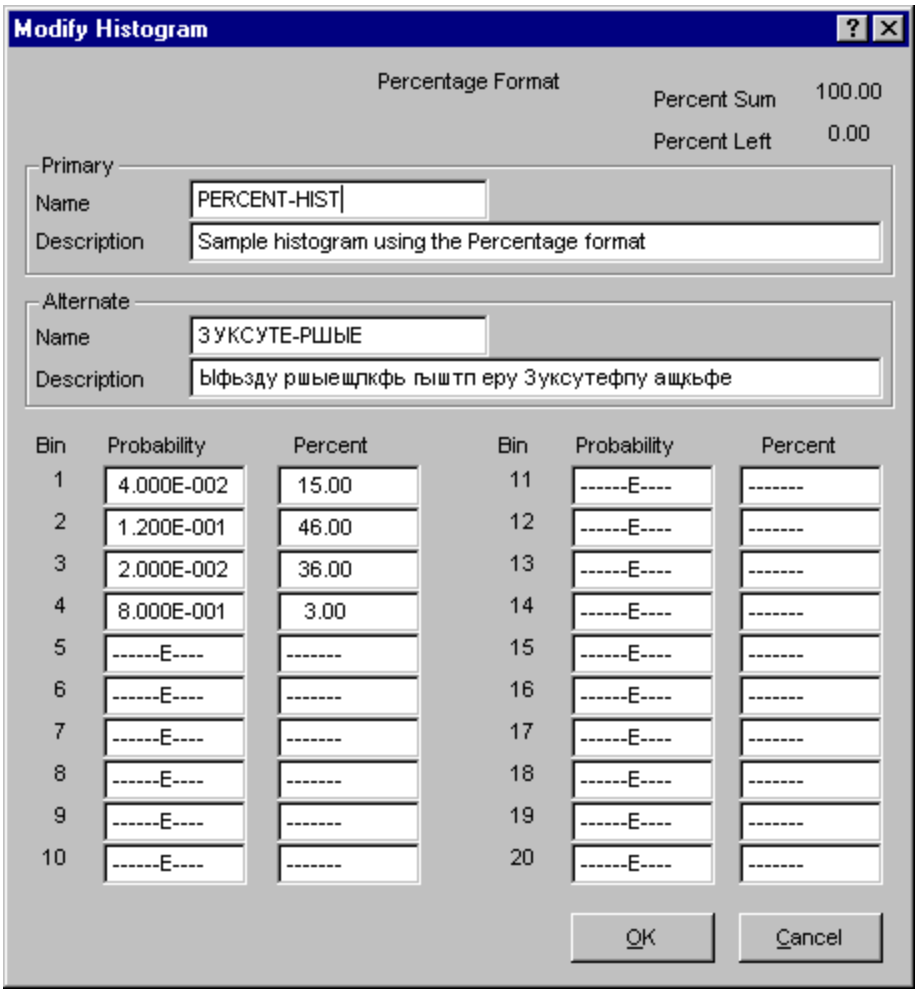
9.10.4.1 Percentage Histogram

PURPOSE

The *Add/Modify Histogram* dialog allows you to enter or modify percentage histogram data. On this dialog, type in a name and a description for the percentage histogram. Enter the percentages for the histogram along with the corresponding probabilities.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Histograms** from the menu. The *Edit Histograms* dialog is displayed.
3. Highlighted the histogram, designated by *Type* "P", that you wish to edit or copy. (Skip this step if adding a new histogram.)
4. Right-click to invoke the pop-up menu and choose **Add**, **Copy**, or **Modify**. The *Percentage Format* dialog is displayed.



The example here demonstrates how to enter a percentage histogram, given that 15% of the data points have a probability of 0.04, 46% of the data points have a probability of 0.12, 36% of the data points have a probability of 0.02, and the remaining 3% of the data points have a probability of 0.8.

The sum of the percentages entered must total 100%, in order for the histogram to be accepted as a valid percentage histogram. In the upper right-hand area of the dialog is a box that shows the current sum of the percentages that have been input and the remaining percentage needed to reach the 100% total.

NOTE: This format is a discrete distribution on the values entered. The percents give the degree of belief of each value.

Ok - Save the new or modified histogram and close the dialog.
Cancel - Close the dialog without saving the histogram.

9.10.4.2 Name

This is a required field. 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.

9.10.4.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.10.4.4 Percent

The percentage of data points that will have the failure probability value that is entered in this bin. The sum of the percentages in the bins must total 100%.

9.10.4.5 Probability

The failure probability value.

9.10.5 Range Format Dialog

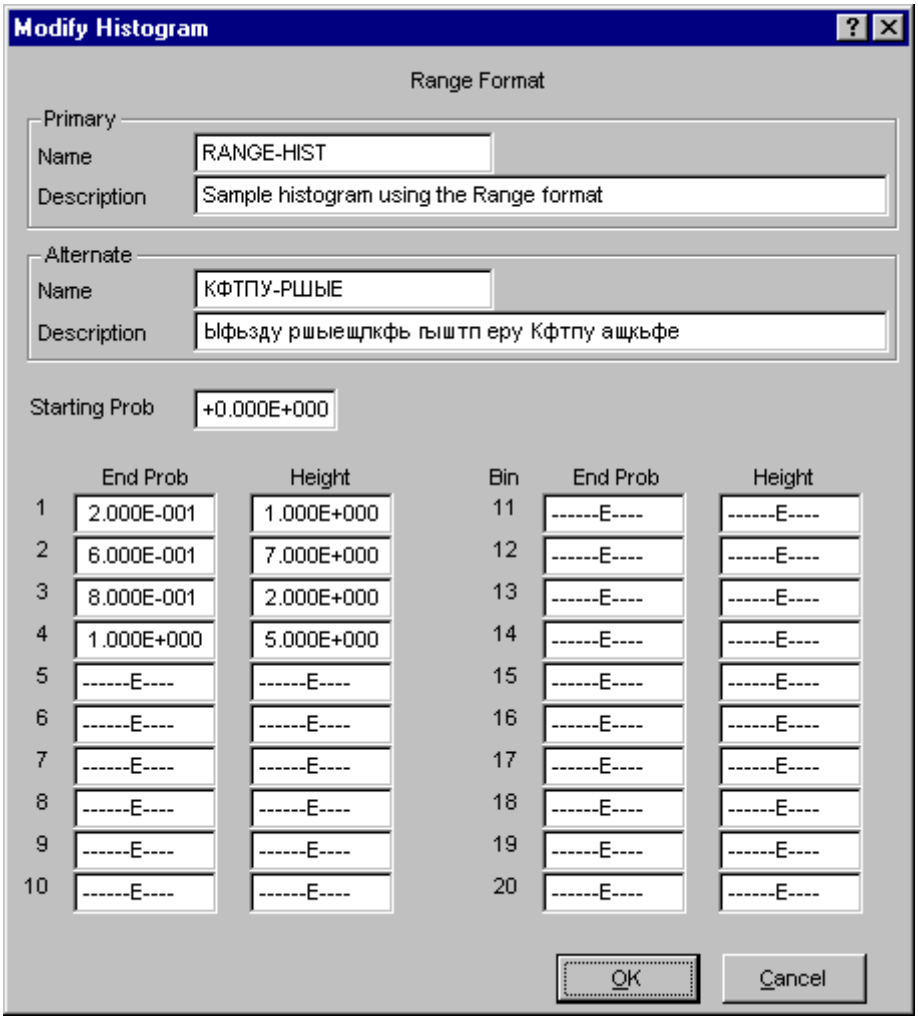
9.10.5.1 Range Histogram

PURPOSE

On this dialog, type in a name and description for the range histogram. Then, enter the starting probability point, the ending probability point, and the height associated with the first bin of the histogram. Next, for each successive bin of the histogram, an ending probability point and a height should be entered. There is a maximum of 20 bins allowed for each range histogram.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Histograms** from the menu. The *Edit Histograms* dialog is displayed.
3. Highlighted the histogram, designated by *Type* "R", that you wish to edit or copy. (Skip this step if adding a new histogram.)
4. Right-click to invoke the pop-up menu and choose **Add**, **Copy**, or **Modify**. The *Range Format* dialog is displayed.



This is an example of inputting a range histogram whose data points lie on the closed interval of 0.0 and 1.0. The height associated with the data points on the subinterval of 0.0 to 0.2 is 10.0 (Bin 1), the height for the subinterval of 0.2 to 0.6 is 70.0 (Bin 2), the height for the subinterval of 0.6 to 0.8 is 20.0 (Bin 3), and the height for the last subinterval of 0.8 to 1.0 is 5.0 (Bin 4).

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

Ok - Save the new or modified histogram and close the dialog.
Cancel - Close the dialog without saving the histogram.

9.10.5.2 Name

This is a required field. 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.

9.10.5.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.10.5.4 Starting Probability

The starting probability for the area or range. This value must <= 1.0.

9.10.5.5 End Probability

The end probability value defining the subinterval between the starting probabilty (if this is Bin 1) or the previous bin's end probability.

9.10.5.6 Height

The height associated with the data points on the subinterval for this bin.

9.10.6 Area Format Dialog

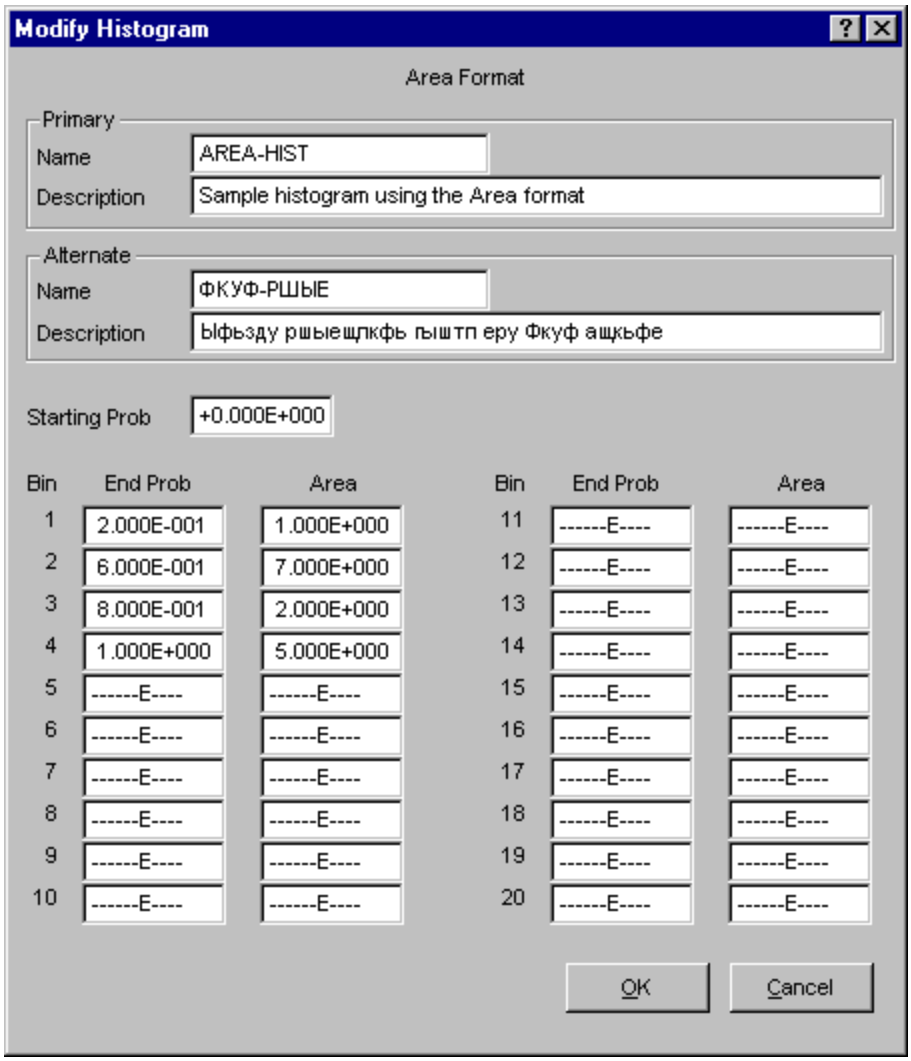
9.10.6.1 Area Histogram

PURPOSE

On this dialog, type in a name and description for the area histogram. Then enter the starting probability point, the ending probability point, and the area associated with the first bin of the histogram. Next, for each successive bin of the histogram, an ending probability point and an area should be entered. There is a maximum of 20 bins allowed for each area histogram.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Histograms** from the menu. The *Edit Histograms* dialog is displayed.
3. Highlighted the histogram, designated by *Type* "A", that you wish to edit or copy. (Skip this step if adding a new histogram.)
4. Right-click to invoke the pop-up menu and choose **Add**, **Copy**, or **Modify**. The *Area Format* dialog is displayed.



This is an example of inputting an area histogram whose data points lie on the closed interval of 0.0 and 1.0. The area associated with the data points on the subinterval of 0.0 to 0.2 is 10.0 (Bin 1), the area for the subinterval of 0.2 to 0.6 is 70.0 (Bin 2), the area for the subinterval of 0.6 to 0.8 is 20.0 (Bin 3), and the area for the last subinterval of 0.8 to 1.0 is 5.0 (Bin 4). SAPHIRE normalizes the area of each bin so the sum of the areas equals 1.0.

Ok - Save the new or modified histogram and close the dialog
Cancel - Close the dialog without saving the histogram.

9.10.6.2 Name

This is a required field. 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.

9.10.6.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.10.6.4 Starting Probability

The starting probability for the area or range. This value must <= 1.0.

9.10.6.5 End Probability

The end probability value defining the subinterval between the starting probabilty (if this is Bin 1) or the previous bin's end probability.

9.10.6.6 Area

The area associated with the data points on the subinterval for this bin.

9.10.7 Fragility Format Dialog

9.10.7.1 Name

This is a required field. 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.

9.10.7.2 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.10.7.3 Acceleration

The ground acceleration level value for this bin.

9.10.7.4 Frequency

The frequency of occurrence (i.e., likelihood per year) for this bin.

9.10.8 Hazard Format Dialog

9.10.8.1 Hazard Histogram

PURPOSE

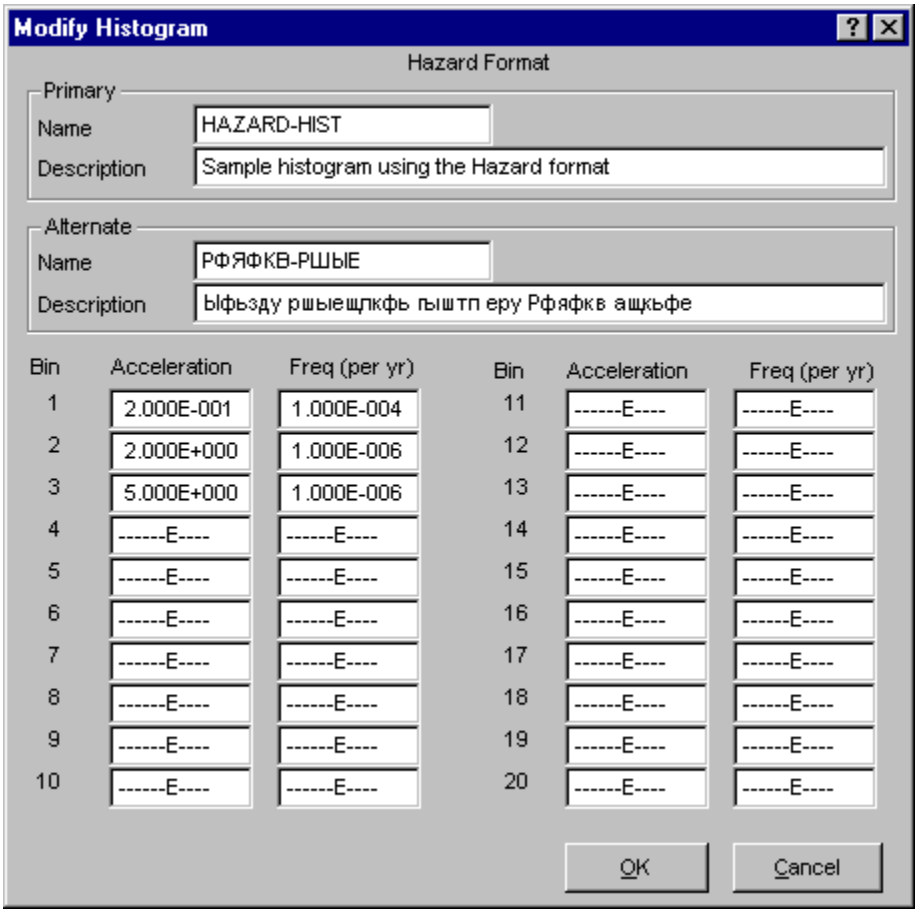
The Hazard histogram option is used to enter the site seismic hazard curve data for seismic analysis. This data consists of a table of values representing the G-level (ground acceleration level) and associated frequency of occurrence (i.e., likelihood per year). Note, the hazard histogram consists of discrete values.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Histograms** from the menu. The *Edit Histograms* dialog is displayed.

3. Highlighted the histogram, designated by *Type* "H", that you wish to edit or copy. (Skip this step if adding a new histogram.)
4. Right-click to invoke the pop-up menu and choose **Add**, **Copy**, or **Modify**. The *Hazard Format* dialog is displayed.

On this dialog, type in a name and description for the hazard histogram. Then enter the acceleration G-level and the frequency associated with the first bin of the histogram. Next, for each successive bin of the histogram, a G-level and a frequency value can be entered. There is a maximum of 20 bins allowed for each hazard histogram.



This is an example of entering a hazard histogram. The frequency associated with each G-level is G-level 0.2, frequency 1.0E-4, G-level 2.0, frequency 1.0E-6, G-level 5.0, frequency 1.0E-6.

Ok - Save the new or modified histogram and close the dialog
Cancel - Close the dialog without saving the histogram.

SAPHIRE will use each acceleration bin and its associated frequency to quantify the seismic models. Note that the seismic models can be quantified using a single acceleration bin, using all acceleration bins separately, or using all acceleration bins and combining the results.

Multiple Hazard histograms can be defined, but only one histogram can be used at a time during quantification. The histogram to be used is identified in the **Modify | Project** option.

9.10.8.2 Name

This is a required field. 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.

9.10.8.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.10.8.4 Acceleration

The ground acceleration level value for this bin.

9.10.8.5 Frequency

The frequency of occurrence (i.e., likelihood per year) for this bin.

9.11 Modifying P&ID Data

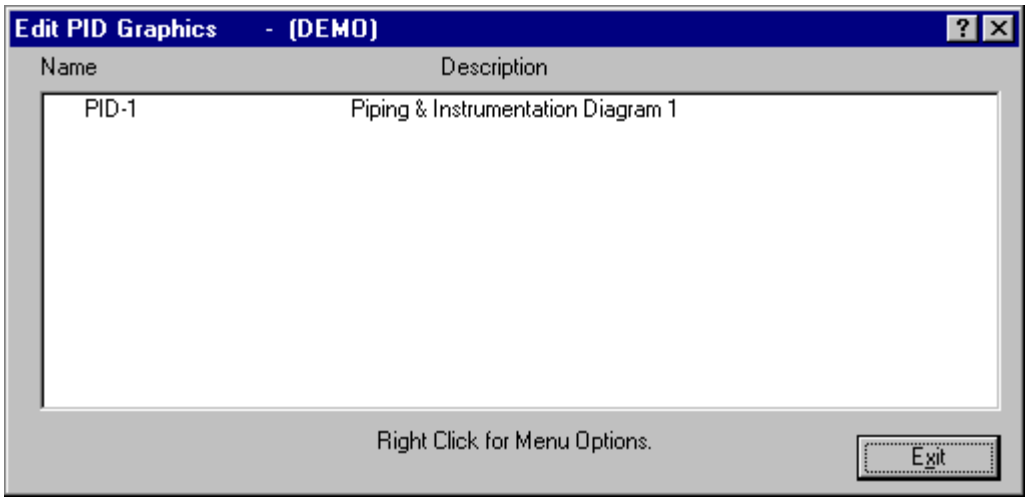
9.11.1 P&IDs

PURPOSE

This option allows you to edit Piping & Instrumentation Diagram (P&ID) graphic records.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **P&IDs** from the menu. The *Edit PID Graphics* dialog is displayed listing all of the PID graphics belonging to the current project.
3. Highlight the desired P&ID graphic.
4. Right-click to invoke the pop-up menu or choose the **Exit** button.



Pop-up Menu Options

Add - Add a new P&ID record to the current project database. When complete, the message, "Record added," is displayed in the message bar of the SAPHIRE window.

Copy - Create a new P&ID record by copying an existing one.

Modify - Edit the selected P&ID record. When complete, the message, "Record modified," is displayed in the message bar of the SAPHIRE window.

Delete - Delete the selected P&ID record(s**)**.

Button Option

Exit - Close the *Edit PID Graphics* dialog.

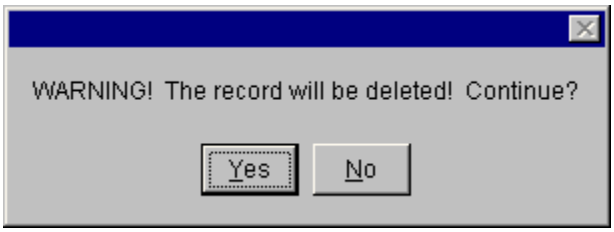
9.11.2 Delete Record

PURPOSE

This option allows you to delete the highlighted record from the database.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record you wish to delete.
4. Right-click to invoke the pop-up menu and choose **Delete**. A warning dialog will be displayed, allowing you to cancel the deletion at this point.



Yes - Continue the delete operation. The selected record will be deleted from the database. The message, "Record deleted," is displayed in the message bar of the SAPHIRE window.

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

9.11.3 P&ID Data Entry Dialog

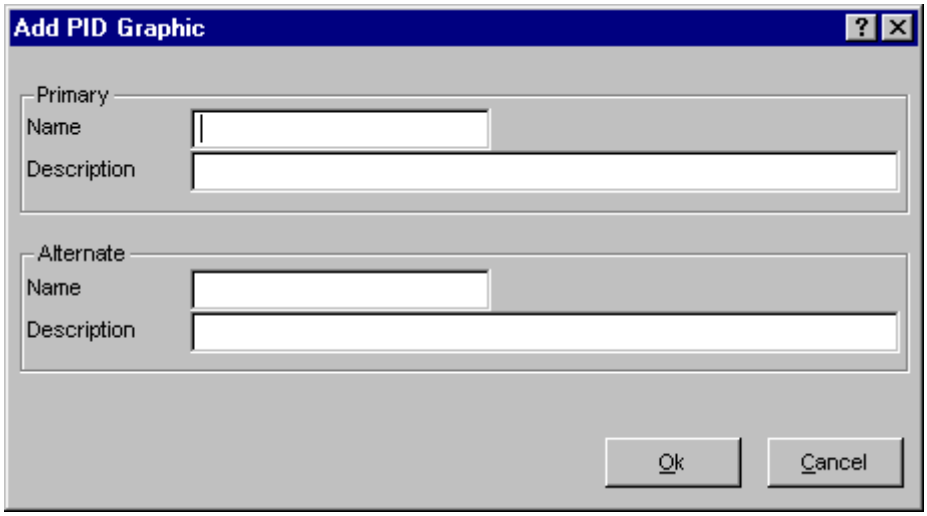
9.11.3.1 P&ID Data Entry

PURPOSE

The *Add/Modify PID Graphic* dialog allows you to enter or modify P&ID data.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose P&IDs from the menu. The *Edit PID Graphics* dialog is displayed.
3. Highlight the P&ID graphic you wish to edit or copy. (Skip this step if adding a new record.)
4. Right-click to invoke the pop-up menu and choose **Add**, **Copy**, or **Modify**.



Ok - Save the newly created P&ID record or changes made to the existing record, and close the dialog

Cancel - Close the dialog without saving the changes.

9.11.3.2 Name

This is a required field. 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.

9.11.3.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.12 Modifying Change Set Data

9.12.1 Change Sets

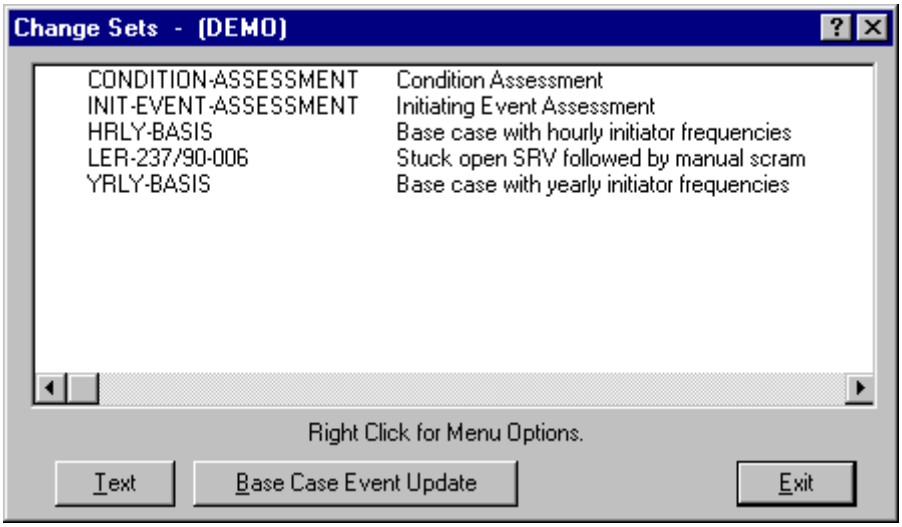
PURPOSE

This option allows you to add, modify, delete, or copy change set records. You cannot edit the probability or class changes of event data in the change set using this option.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Change Sets** from the menu. The *Change Sets* dialog is displayed, listing all of the change sets belonging to the current project.
3. Highlight the desired change set.
4. Right-click to invoke the pop-up menu or choose the desired button.

The *Change Sets* dialog lists the change sets by marked order, then set type. First, all marked change sets are listed, then the condition assessments are listed alphabetically, followed by initiating event assessments (alphabetically), and finally, the change sets.



Pop-up Menu Options

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.

Copy - Create a new change set record by copying an existing one.

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**).**

Button Options

Text - View and edit the descriptive text associated with the selected change set.

Base Case Event Update - Overwrite the base case data values stored in the database with the current data values for each basic event.

Exit - Close the *Change Sets* dialog.

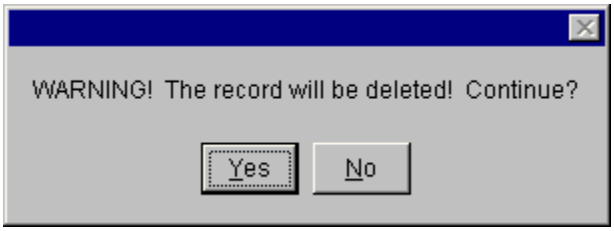
9.12.2 Delete Record

PURPOSE

This option allows you to delete the highlighted record from the database.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record you wish to delete.
4. Right-click to invoke the pop-up menu and choose **Delete**. A warning dialog will be displayed, allowing you to cancel the deletion at this point.



Yes - Continue the delete operation. The selected record will be deleted from the database. The message, "Record deleted," is displayed in the message bar of the SAPHIRE window.

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

9.12.3 Database Text

PURPOSE

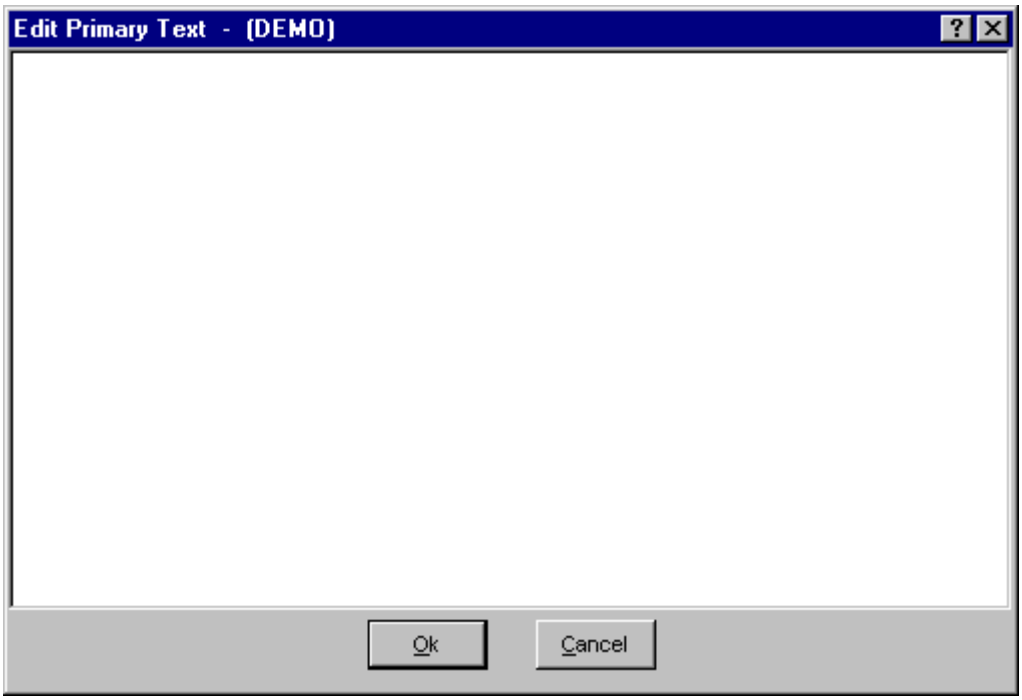
This option allows you to view and edit the descriptive text associated with a specific record. The Primary text option is generally used for text in the desired primary language. The Alternate text option is generally used for information entered in the secondary language using a different alphabet (locale).

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.

3. Highlight the record whose text you wish to modify.
4. Choose the **Text** button. The *Select Text Type* dialog is displayed.
5. Choose **Primary** or **Alternate**. The *Text* dialog is displayed.

Initially, the first 18 lines of the text block are displayed. If there are more lines of text, the vertical scroll bar will be available. In the example here, the Primary text dialog is displayed.



Page Down- Presents the next 18 lines of text.
Page Up- Presents the previous 18 lines of text.
Ctrl Page Down- Places the cursor at the end of the last line of text currently visible.
Ctrl Page Up- Places the cursor at the beginning of the first line of text currently visible.
Ctrl- ← - Moves the cursor left to the beginning of the word on the current line.
Ctrl- → - Moves the cursor right to the beginning of the word on the current line.
Home - Places the cursor in front of the first character of the current line.
Ctrl-Home - Places the cursor at the beginning of the text block.
End - Places the cursor behind the last character of the current line.
Ctrl-End - Places the cursor at the end of the text block.
Insert - Works as a toggle. Initially, the editor is in "insert" mode – existing characters are pushed to the right as you type. Pressing the **Insert** key toggles to "overwrite" mode – existing characters are over written as you type.
Delete - Deletes the character to the right of the current cursor position; or deletes the currently highlighted text.
Ctrl-Delete - Deletes the characters from the current cursor position to the beginning of the following word.
Backspace - Deletes the character to the left of the current cursor position; or deletes the currently highlighted text.
Ctrl-C - Copies highlighted text to the clipboard.

Ctrl-V - Pastes clipboard text at the current cursor position.
Ctrl-X - Cuts highlighted text to the clipboard.

The editor does not automatically line wrap; therefore, you must use <Enter> to establish each new line of text.

Ok - Save the new or modified text and close the *Text* dialog.
Cancel - Close the *Text* dialog without saving changes. You will be prompted with the dialog shown below.

Yes - Close the *Text* dialog without saving changes.
No - Save the new or modified text and close the *Text* dialog.

9.12.4 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.)

9.12.5 Add Change Set Dialog

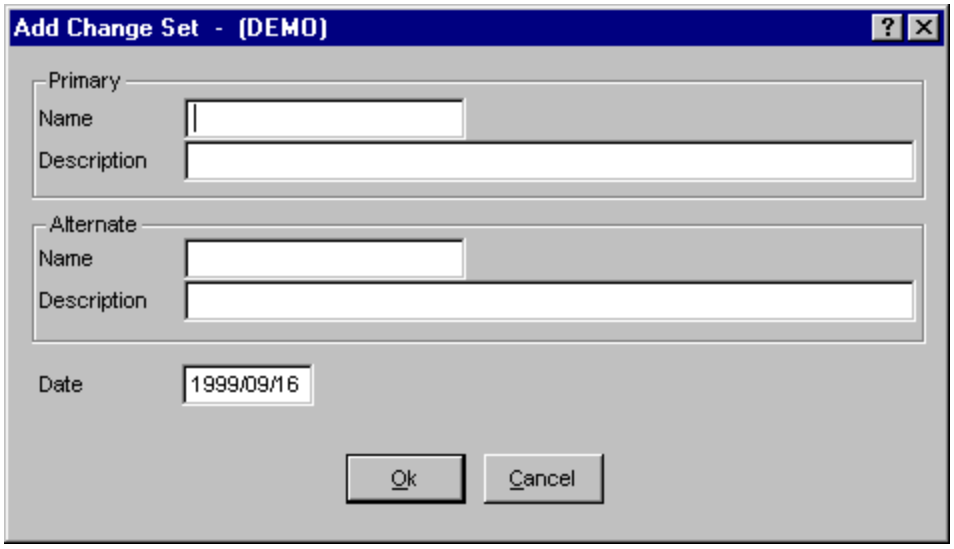
9.12.5.1 Adding a Change Set

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.



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.

9.12.5.2 Name

This is a required field. 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.

9.12.5.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.12.5.4 Date

This is the creation date of the change set. It can be modified to reflect the modification date. The format for this field is YYYY/MM/DD.

9.12.6 Copy Change Set Dialog

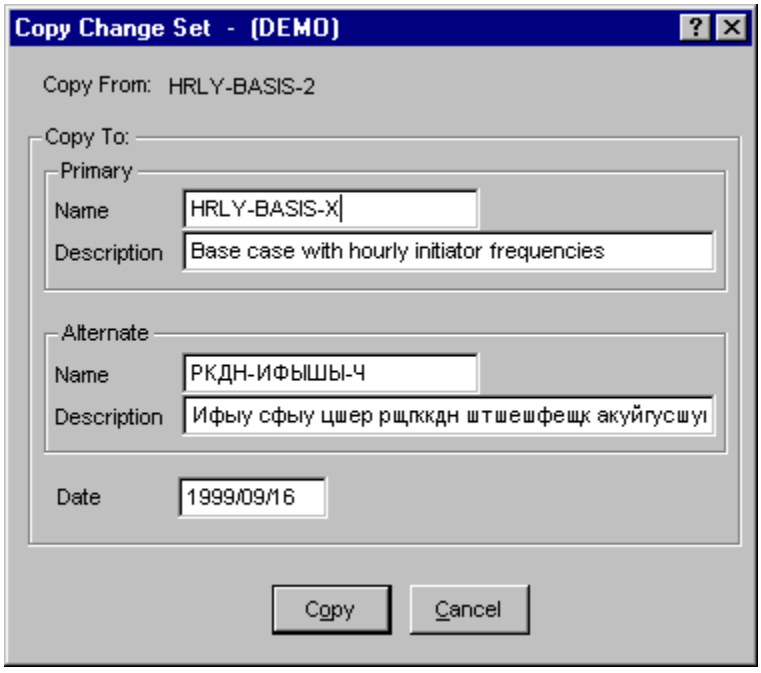
9.12.6.1 Copying a Change Set

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 - 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.

9.12.6.2 Name

This is a required field. 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.

9.12.6.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.12.6.4 Date

This is the creation date of the change set. It can be modified to reflect the modification date. The format for this field is YYYY/MM/DD.

9.12.7 Modify Change Set Dialog

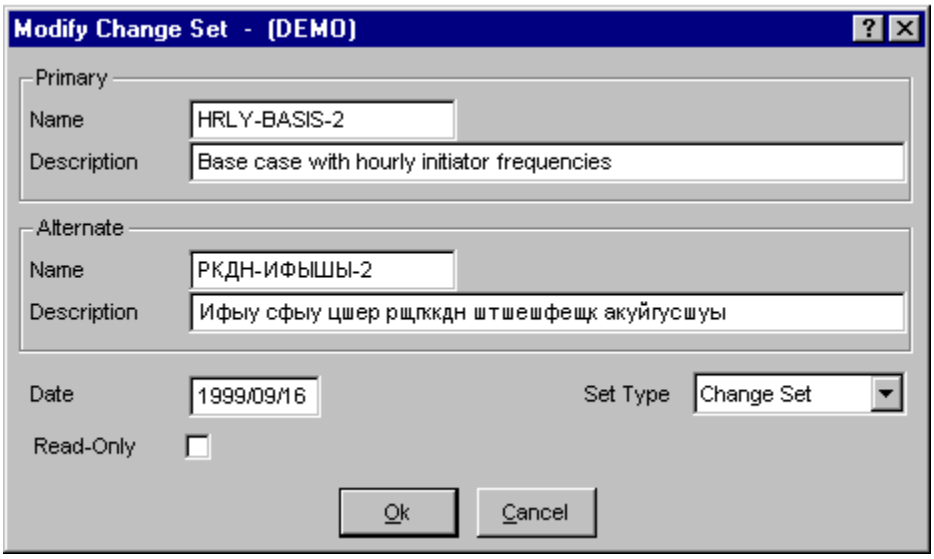
9.12.7.1 Modifying a Change Set

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.



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.

9.12.7.2 Name

This is a required field. 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.

9.12.7.3 Set Type

Select a change set type from the drop-down list.

Change Set - A user-defined set of changes that will be applied to the base case data when event data is transferred to the current case. Multiple change sets can be defined and applied singly or in combination.

Initiating Event- A special type of change set used specifically to evaluate an operational occurrence associated with an observed initiating event and other equipment failures, unavailabilities, or degradations.

Condition - A special type of change set used specifically to evaluate an operational occurrence in which no initiating event has taken place, but equipment failures, unavailabilities, or degradations have reduced reliability.

Flag Set - 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: either house flag changes to the calculation type or process type changes. NOTE: If a change set type is altered to a flag set, it will be displayed in the *Flag Sets* dialog after the *Change Sets* dialog is closed.

9.12.7.4 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.12.7.5 Date

This is the creation date of the change set. It can be modified to reflect the modification date. The format for this field is YYYY/MM/DD.

9.12.7.6 Read-only

This flag, if checked, indicates that the event data cannot be changed (in the **Generate | Single/Class** option). If you wish to make event data modifications, this box must be unchecked.

9.12.8 Base Update Dialog

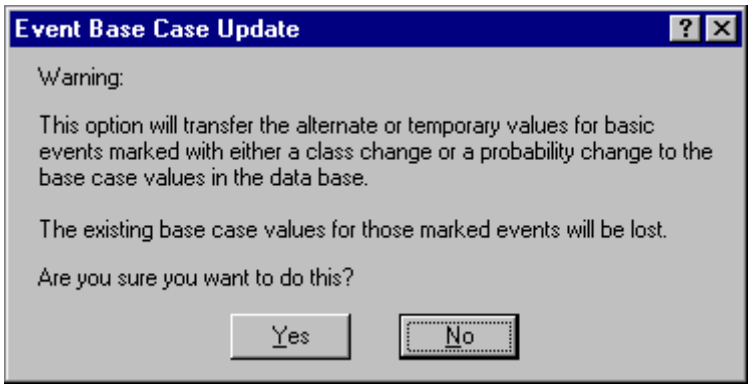
9.12.8.1 Base Case Event Update

PURPOSE

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

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Change Sets** from the menu.
3. Highlight the desired change set(s).
4. Choose the **Base Case Event Update** button. The *Event Base Case Update* dialog is displayed.



This dialog is to ensure that you wish to update the base case values with the marked change set(s).

Yes - When you choose this button, the *Set Mission Time* dialog will be displayed. After entering the mission time, the base case values will be overwritten.

No - Terminate the process and close the *Event Base Case Update* dialog.

In order to perform a base case update, at least one change set must be marked and data generated. This option transfers the current values for the basic events marked either with a probability change or a class change in a change set to the base case values. The existing base case values will be overwritten. Any event in the change set that does not have either a class change or probability change associated with it will maintain its existing base case data.

9.12.8.2 Mission Time

Enter the mission time, using scientific notation, in hours.

9.13 Modifying Flag Set Data

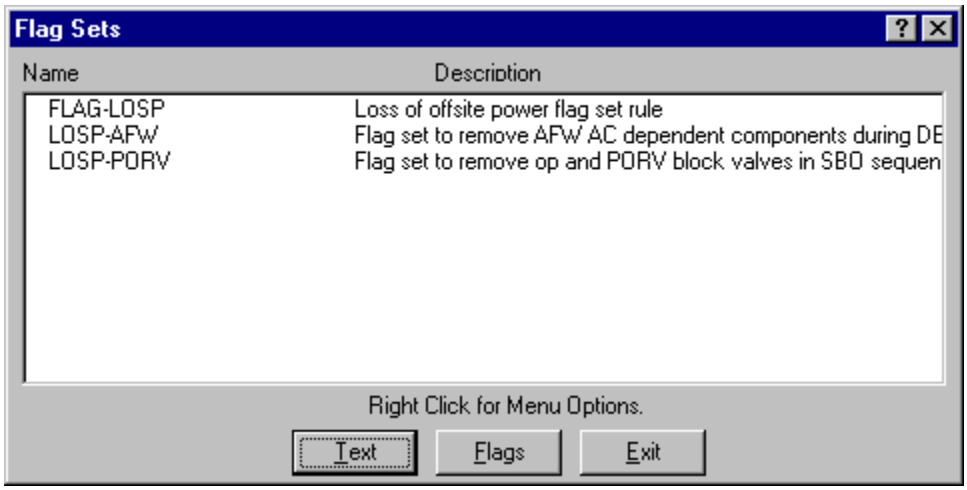
9.13.1 Flag Sets

PURPOSE

This option allows you to add, modify, delete, or copy flag set records. 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.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Flag Sets** from the menu. The *Flag Sets* dialog is displayed, listing all of the flag sets belonging to the current project.
3. Highlight the desired flag set.
4. Right-click to invoke the pop-up menu or choose the desired button.



Pop-up Menu Options

Add - Create a new flag set record in the current project database. When complete, the message, "Record added," is displayed in the message bar of the SAPHIRE window.

Copy - Create a new flag set record by copying an existing one.

Modify - Edit the selected flag set record. When complete, the message, "Record modified," is displayed in the message bar of the SAPHIRE window.

Delete - Delete the selected flag set record(s**).**

Button Options

Text - View and edit the descriptive text associated with the selected flag set.

Flags - Add or modify basic event data in the flag set.

Exit - Close the *Flag Sets* dialog.

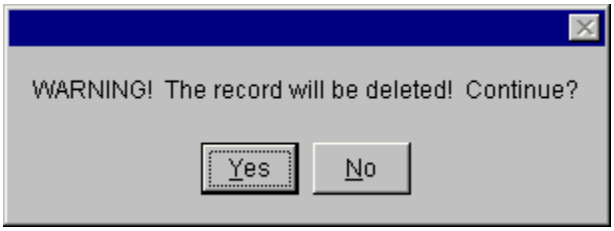
9.13.2 Delete Record

PURPOSE

This option allows you to delete the highlighted record from the database.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record you wish to delete.
4. Right-click to invoke the pop-up menu and choose **Delete**. A warning dialog will be displayed, allowing you to cancel the deletion at this point.



Yes - Continue the delete operation. The selected record will be deleted from the database. The message, "Record deleted," is displayed in the message bar of the SAPHIRE window.

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

9.13.3 Database Text

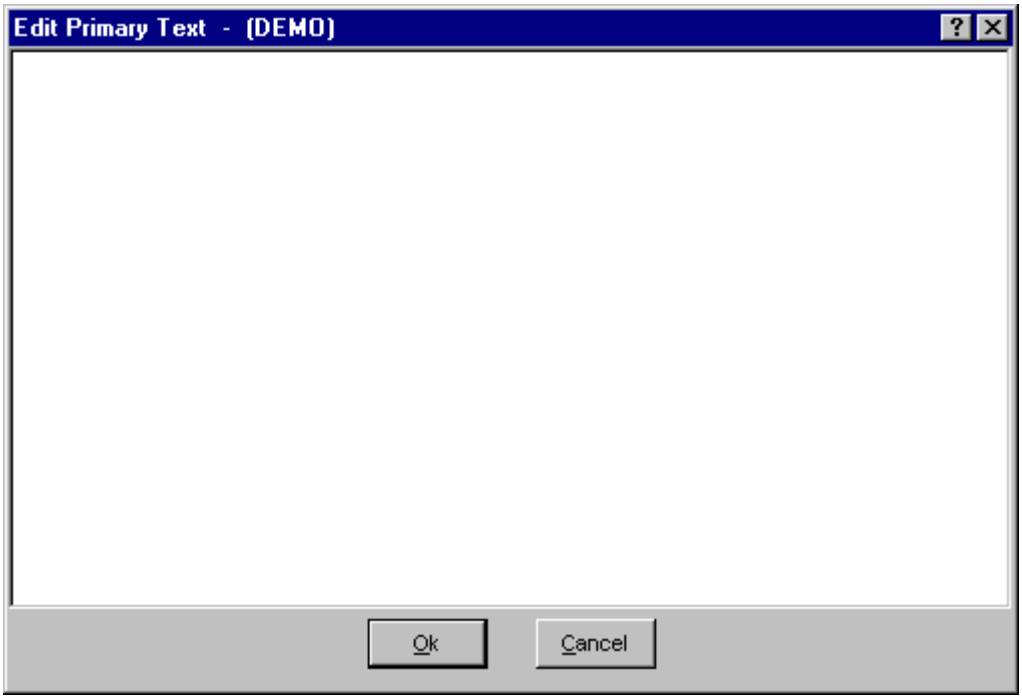
PURPOSE

This option allows you to view and edit the descriptive text associated with a specific record. The Primary text option is generally used for text in the desired primary language. The Alternate text option is generally used for information entered in the secondary language using a different alphabet (locale).

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose the desired option from the menu.
3. Highlight the record whose text you wish to modify.
4. Choose the **Text** button. The *Select Text Type* dialog is displayed.
5. Choose **Primary** or **Alternate**. The *Text* dialog is displayed.

Initially, the first 18 lines of the text block are displayed. If there are more lines of text, the vertical scroll bar will be available. In the example here, the Primary text dialog is displayed.



Page Down- Presents the next 18 lines of text.
Page Up- Presents the previous 18 lines of text.
Ctrl Page Down- Places the cursor at the end of the last line of text currently visible.
Ctrl Page Up- Places the cursor at the beginning of the first line of text currently visible.
Ctrl- ← - Moves the cursor left to the beginning of the word on the current line.
Ctrl- → - Moves the cursor right to the beginning of the word on the current line.
Home - Places the cursor in front of the first character of the current line.
Ctrl-Home - Places the cursor at the beginning of the text block.
End - Places the cursor behind the last character of the current line.
Ctrl-End - Places the cursor at the end of the text block.
Insert - Works as a toggle. Initially, the editor is in "insert" mode – existing characters are pushed to the right as you type. Pressing the **Insert** key toggles to "overwrite" mode – existing characters are over written as you type.
Delete - Deletes the character to the right of the current cursor position; or deletes the currently highlighted text.

Ctrl-Delete - Deletes the characters from the current cursor position to the beginning of the following word.

Backspace - Deletes the character to the left of the current cursor position; or deletes the currently highlighted text.

Ctrl-C - Copies highlighted text to the clipboard.

Ctrl-V - Pastes clipboard text at the current cursor position.

Ctrl-X - Cuts highlighted text to the clipboard.

The editor does not automatically line wrap; therefore, you must use <Enter> to establish each new line of text.

Ok - Save the new or modified text and close the *Text* dialog.

Cancel - Close the *Text* dialog without saving changes. You will be prompted with the dialog shown below.

Yes - Close the *Text* dialog without saving changes.

No - Save the new or modified text and close the *Text* dialog.

9.13.4 Add Flag Set Dialog

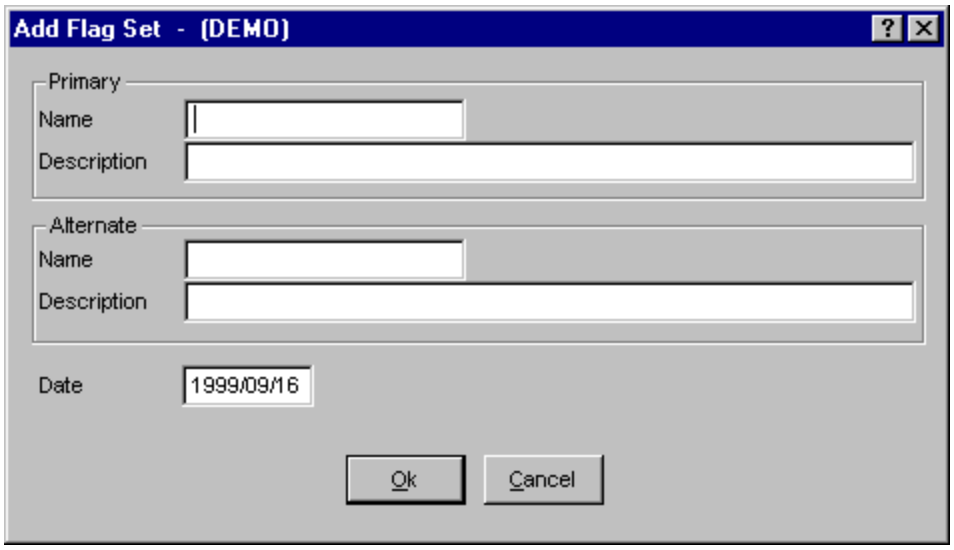
9.13.4.1 Adding a Flag Set

PURPOSE

The *Add Flag Set* dialog allows you to create a new flag set record.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Flag Sets** from the menu. The *Flag Sets* dialog is displayed.
3. Right-click to invoke the pop-up menu and choose **Add**.



Ok - Save the new flag set, and close the dialog.
Cancel - Close the dialog without saving.

By default the set type is a *Flag Set* and the *Read-only* attribute is not selected. If you wish to alter the set type or read-only attribute, you must **Modify** the flag set.

9.13.4.2 Name

This is a required field. 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.

9.13.4.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.13.4.4 Date

This is the creation date of the change set. It can be modified to reflect the modification date. The format for this field is YYYY/MM/DD.

9.13.5 Copy Flag Set Dialog

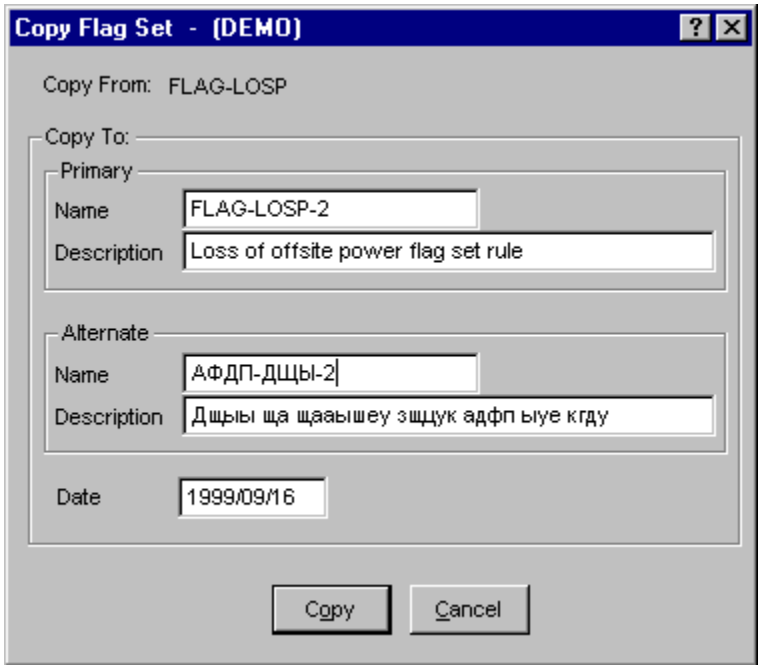
9.13.5.1 Copying A Flag Set

PURPOSE

The *Copy Flag Set* dialog will be displayed, allowing you to create a new flag set record based on the highlighted one. The original flag set name is displayed in the *Copy From:* field. You MUST enter a unique name for the new flag set.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Flag Sets** from the menu. The *Flag Sets* dialog is displayed.
3. Highlight the flag set you wish to copy.
4. Right-click to invoke the pop-up menu and choose **Copy**.



Copy - Save the new flag set, and close the dialog.
Cancel - Close the dialog without saving.

The set type and read-only flag of the source (original) flag set will be duplicated in the destination (new) flag set along with the basic event data changes.

9.13.5.2 Name

This is a required field. 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.

9.13.5.3 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.13.5.4 Date

This is the creation date of the change set. It can be modified to reflect the modification date. The format for this field is YYYY/MM/DD.

9.13.6 Modify Flag Set Dialog

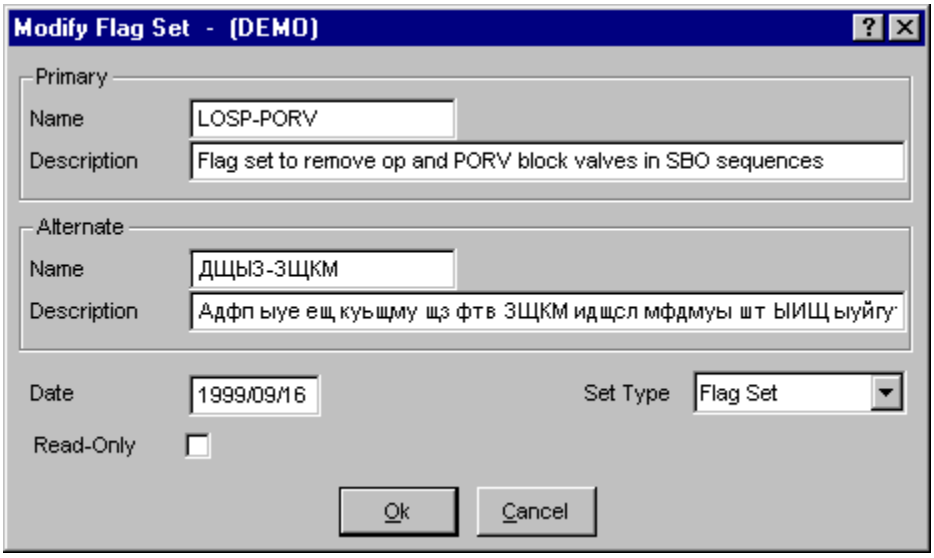
9.13.6.1 Modifying a Flag Set

PURPOSE

The *Modify Flag Set* dialog allows you to edit flag set record data.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Flag Sets** from the menu. The *Flag Sets* dialog is displayed.
3. Highlight the flag set you wish to edit.
4. Right-click to invoke the pop-up menu and choose **Modify**.



Ok - Save the modified flag set and close the dialog
Cancel - Close the dialog without saving the modifications.

9.13.6.2 Name

This is a required field. 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.

9.13.6.3 Set Type

Select a change set type from the drop-down list.

Change Set - A user-defined set of changes that will be applied to the base case data when event data is transferred to the current case. Multiple change sets can be defined and applied singly or in combination.

Initiating Event- A special type of change set used specifically to evaluate an operational occurrence associated with an observed initiating event and other equipment failures, unavailabilities, or degradations.

Condition - A special type of change set used specifically to evaluate an operational occurrence in which no initiating event has taken place, but equipment failures, unavailabilities, or degradations have reduced reliability.

Flag Set - 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: either house flag changes to the calculation type or process type changes. NOTE: If a change set type is altered to a flag set, it will be displayed in the *Flag Sets* dialog after the *Change Sets* dialog is closed.

9.13.6.4 Description

This is a 120-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information.

9.13.6.5 Date

This is the creation date of the change set. It can be modified to reflect the modification date. The format for this field is YYYY/MM/DD.

9.13.6.6 Read-only

This flag, if checked, indicates that the event data cannot be changed (in the **Generate | Single**/**Class** option). If you wish to make event data modifications, this box must be unchecked.

9.13.7 Flag Set Event Data

9.13.7.1 Flag Set Event Data

PURPOSE

Edit or add house flag changes to the calculation type or process type.

Changes to the probability of failure (e.g., change the probability from 2E-3 to 1E-1) for events in a Flag Set cannot be made. Only the event changes of TRUE, FALSE, IGNORE, or process flags can be used in a SAPHIRE Flag Set. The changes that are made can then be applied to specified fault trees or sequences for use during fault tree or event tree analysis. The changes applied to basic event data may be for a single event or a group of events.

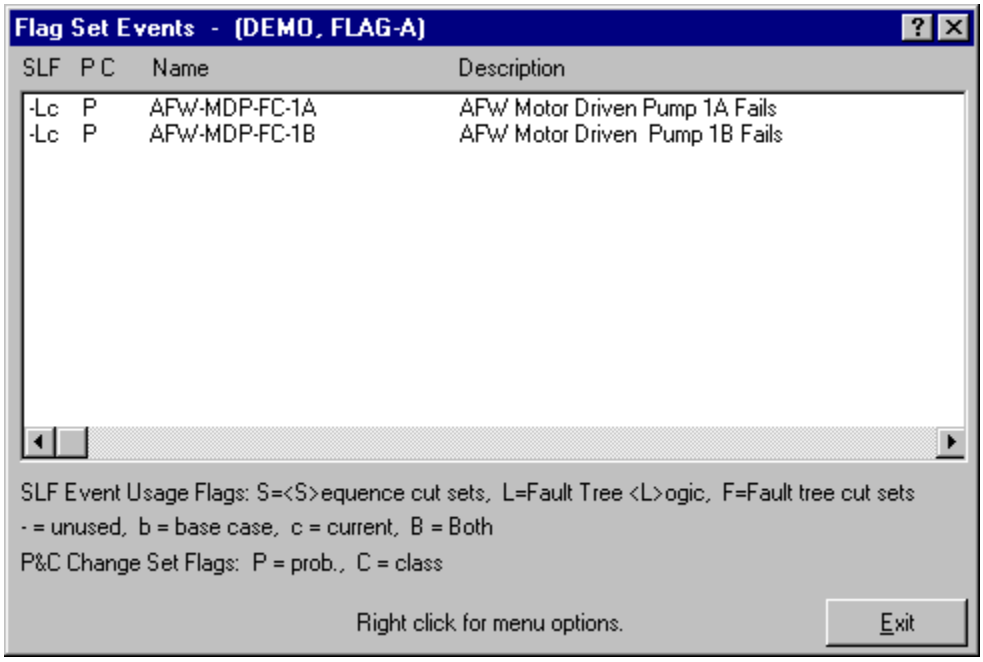
STEPS

1. From the SAPHIRE menu select **Modify**.

2. Choose **Flag Sets** from the menu.
3. Highlight the desired flag set.
4. Choose the **Flags** button. The *Flag Set Events* dialog is displayed.

This dialog lists the event name and description of each event in the flag set. In addition, the dialog shows the event usage flags. The usage column (i.e., SLY) 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 (Y).

The change set flag indicates if the event has been marked for a probability (single) change ("P"), a class change ("C") or both ("c"). Because only calculation or process type changes are allowed in flag sets, this flag will always be a "P." The flag set name is shown in the title bar of this dialog.



Pop-up Menu Options

Add - Add basic event(s) with flag changes to this flag set.
Modify - Modify basic event(s) flag changes in this flag set.
Reset - Reset changes for selected event(s) back to the base case values.

Button Option

Exit - Closes the *Flag Set Events* dialog.

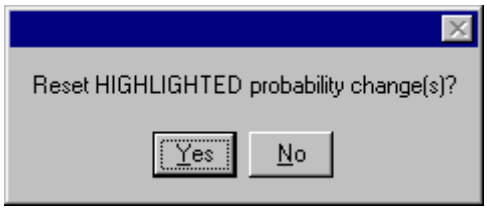
9.13.7.2 Reset Event Data

PURPOSE

This function allows you to reset changes for selected event(s) back to the base case values.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Flag Sets** from the menu.
3. From the *Flag Sets* dialog, highlight the desired flag set.
4. Choose the **Flags** button.
5. From the *Flag Set Events* dialog, highlight the desired basic event(s).
6. Right click to invoke the pop-up menu and choose the **Reset** option.



Yes - Set the changed events back to the base case values.
No - Cancel the reset operation. The changes to the basic events will remain.

9.13.7.3 Add/Modify Flag Set Event Data

PURPOSE

This function allows you to modify the event data house flag changes to the calculation type or process type. This can then be applied to specified fault trees or sequences for use during fault tree or event tree analysis. The changes applied to basic event data may be for a single event or a group of events.

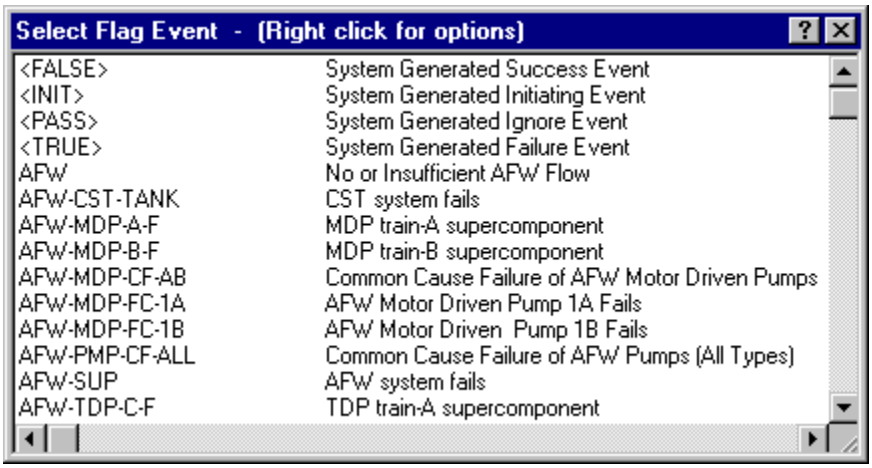
STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Flag Sets** from the menu.
3. From the *Flag Sets* dialog, highlight the desired flag set.
4. Choose the **Flags** button.

STEPS

To add event change:

1. From the *Flag Set Events* dialog, right-click to invoke the pop-up menu.
2. Choose the **Add** option. The *Select Flag Event* dialog will be displayed.



3. Highlight the event(s) to be added to the flag set.
4. Right-click to invoke the pop-up menu and choose the **Add** option.

STEPS

To modify event change:

1. From the *Flag Set Events* dialog, highlight the desired basic event(s).
2. Right-click to invoke the pop-up menu and choose the **Modify** option.

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

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

9.13.7.4 Event Probability Flags - Single

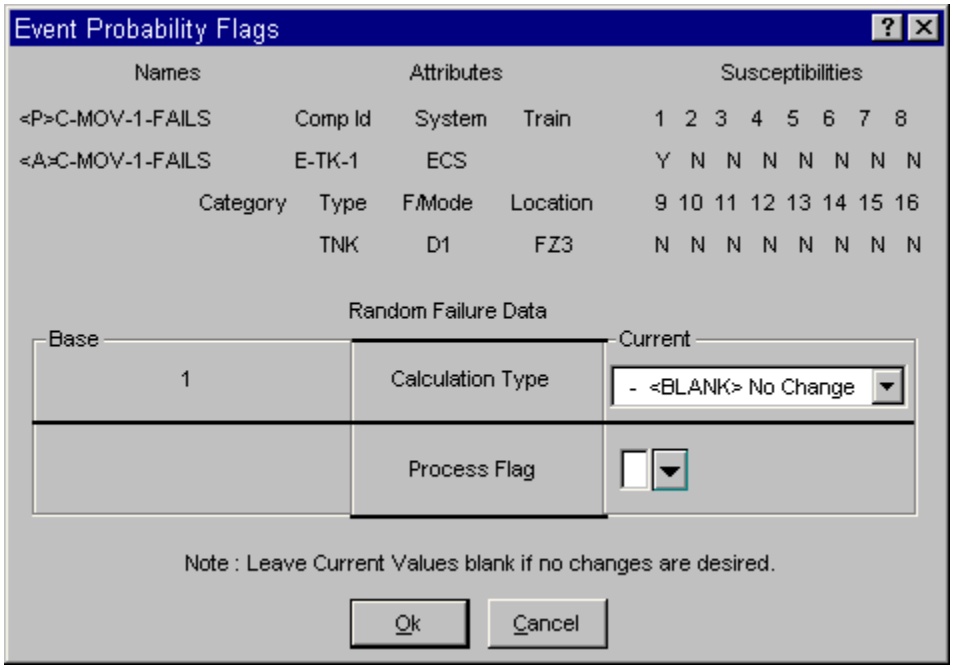
PURPOSE

This function allows you to modify the current random failure data for the selected basic event.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Flag Sets** from the menu.
3. From the *Flag Sets* dialog, highlight the desired flag set.

4. Choose the **Flags** button.
5. From the *Flag Set Events* dialog, highlight the basic event, if modifying
6. Right-click to invoke the pop-up menu and choose either **Add** or **Modify**. The *Event Probability Flags* dialog for a single event is displayed.



Calculation Type-Select from the drop-down list:

Blank (No Change)
T - House Event (failed, probability = 1.0)
F - House Event (successful, probability = 0.0)
I - Ignore this event (remove it from the logic)

Process Flag – Click on the down arrow button to the right of the field. The *Process Flag* dialog will be invoked.

Ok - Apply the change and close the *Event Probability Flags* dialog.

Cancel - Close the *Event Probability Flags* dialog without applying the change.

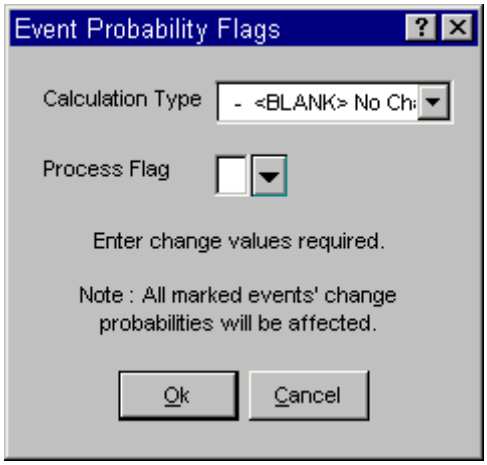
9.13.7.5 Event Probability Flags - Group

PURPOSE

This function allows you to modify the current random failure data for a group of selected basic events.

STEPS

1. From the SAPHIRE menu select **Modify**.
2. Choose **Flag Sets** from the menu.
3. From the *Flag Sets* dialog, highlight the desired flag set.
4. Choose the **Flags** button.
5. From the *Flag Set Events* dialog, highlight the basic events, if modifying
6. Choose either the **Add** or **Modify** option. The *Event Probability Flags* dialog for a group of events is displayed.



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

Calculation Type-Select from the drop-down list:

Blank (No Change)
T - House Event (failed, probability = 1.0)
F - House Event (successful, probability = 0.0)
I - Ignore this event (remove it from the logic)

Process Flag – Click on the down arrow button to the right of the field. The *Process Flag* dialog will be invoked.

Ok - Apply the change and close the *Event Probability Flags* dialog.

Cancel - Close the *Event Probability Flags* dialog without applying the change.

10. REPORTING ON THE DATABASE

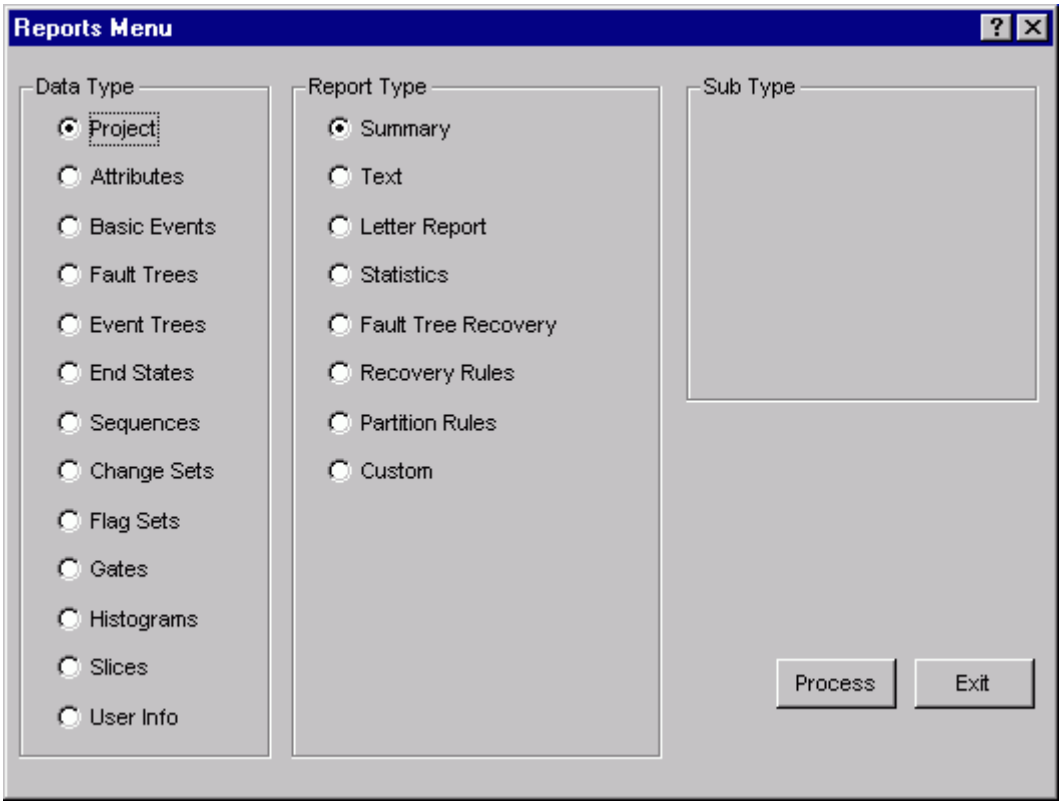
10.1 Reporting on the Data Base

PURPOSE

This option allows you to obtain information about the current project. Various reports can be generated for the following data types: project, attributes, basic events, fault trees, event trees, end states, sequences, gates, histograms, and user information. The reports include options such as summary, cross-reference, and text information. The dialogs and operations are similar for each of the report data types, therefore, a generic discussion is provided here.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. From this dialog, select a specific report by choosing a radio button from each group (*Data Type, Report Type*, and *Sub Type*, if necessary).

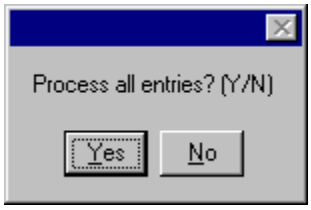


3. After a specific report has been selected, choose the **Process** button. A dialog containing the list of records associated with the selected report type will be displayed.
4. Select the desired records or process all records.
5. Choose the button on the dialog to generate the report. Often times this button is labeled **Continue** or it may be for a specific type of report, such as, **Summary**. The Report Viewer will display the report

In addition to report type-specific information, each report will contain the report title and the date and time generated. Where applicable it will also contain the currently selected project name, selected case (base or current), and page numbers.

10.2 Process All Entries

Most of the report options supply a dialog with a list box for selecting specific records to be included in the report. If you do not highlight any of the records in the list box, and choose one of the options (with the exception of the Exit option), you will be prompted with the following dialog:



Yes - Generate the report and include all records in the current project database.
No - Do not generate the report. You will have the opportunity to select specific records from the list.

10.3 Report Dialog

10.3.1 Report Output

PURPOSE

Select a format and output destination for a previewed report.

This option allows you send a copy of the currently previewed report to an alternate destination, including a word processor (choose the *Rich Text Format*), browser (choose the *HTML Format*), or text editor (choose the *Ascii Delimited* format).

You may open the formatted report using the program associated with selected format option (*Print Preview* destination), send the formatted report directly to your default Windows printer (*Print (Default Printer)* destination), or send it directly to a file (*File* destination).

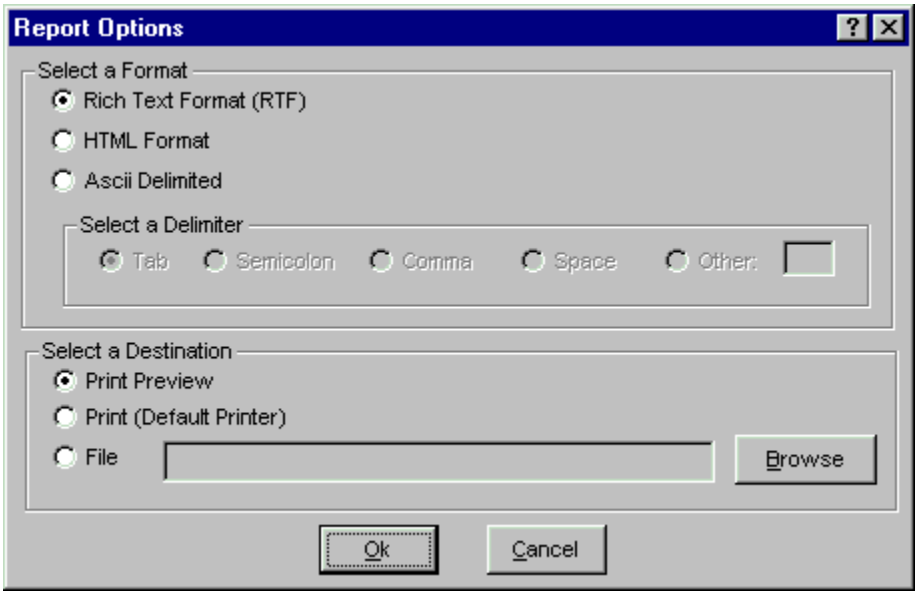
NOTE

SAPHIRE will use the default application associated with the selected format (*RTF, HTML*, or *Ascii*/TXT) to preview or print the report. The *Print Preview* option will behave the same way as if you selected the *File* destination, and then double-clicked the resulting file from Windows Explorer.

To successfully use the RTF option, the word processor associated with the RTF extension must support RTF tables. Word processors such as Word and WordPerfect support both RTF and RTF tables, while WordPad may support basic RTF, but not RTF tables. If you do not have a word processor that supports RTF tables, you should select a different format. If you have a word processor that you know supports RTF tables, but SAPHIRE is not using that application to preview the RTF report, see your Windows

documentation or system adminstrator for information on how to associate that word processor with the RTF file format.

Similarly, HTML formatted reports will be previewed using your system specified browser (usually Internet Explorer or Netscape); and Ascii delimited reports will be previewed using the default application associated with TXT files.



Select a Format

Rich Text Format (RTF) - Format the report data as RTF. This option is selected by default.

HTML Format - Format the report data as HTML.

Ascii Delimited - Format the report data as Ascii text. Each column will be separated by the character indicated by the *Select a Delimiter* option.

Select a Delimiter - For the Ascii Delimited format, select Tab, Semicolon, Space, or Other as the column separator character. If Other is selected, indicate the character to use in the adjacent text box.

Select a Destination

Print Preview - Show the report, using the default viewer for the selected format. This option is selected by default.

Printer (Default Printer) - Print the report in the selected format directly to your Windows system default printer.

File - Save the report to a file. If the path is not included with the file name, the report file will be saved in the current project directory.

Browse - Open the Select Directory dialog to choose a directory.

OK - Generate the report.

Cancel - Close the *Report* dialog without generating a report.

10.3.2 Using the Report Viewer

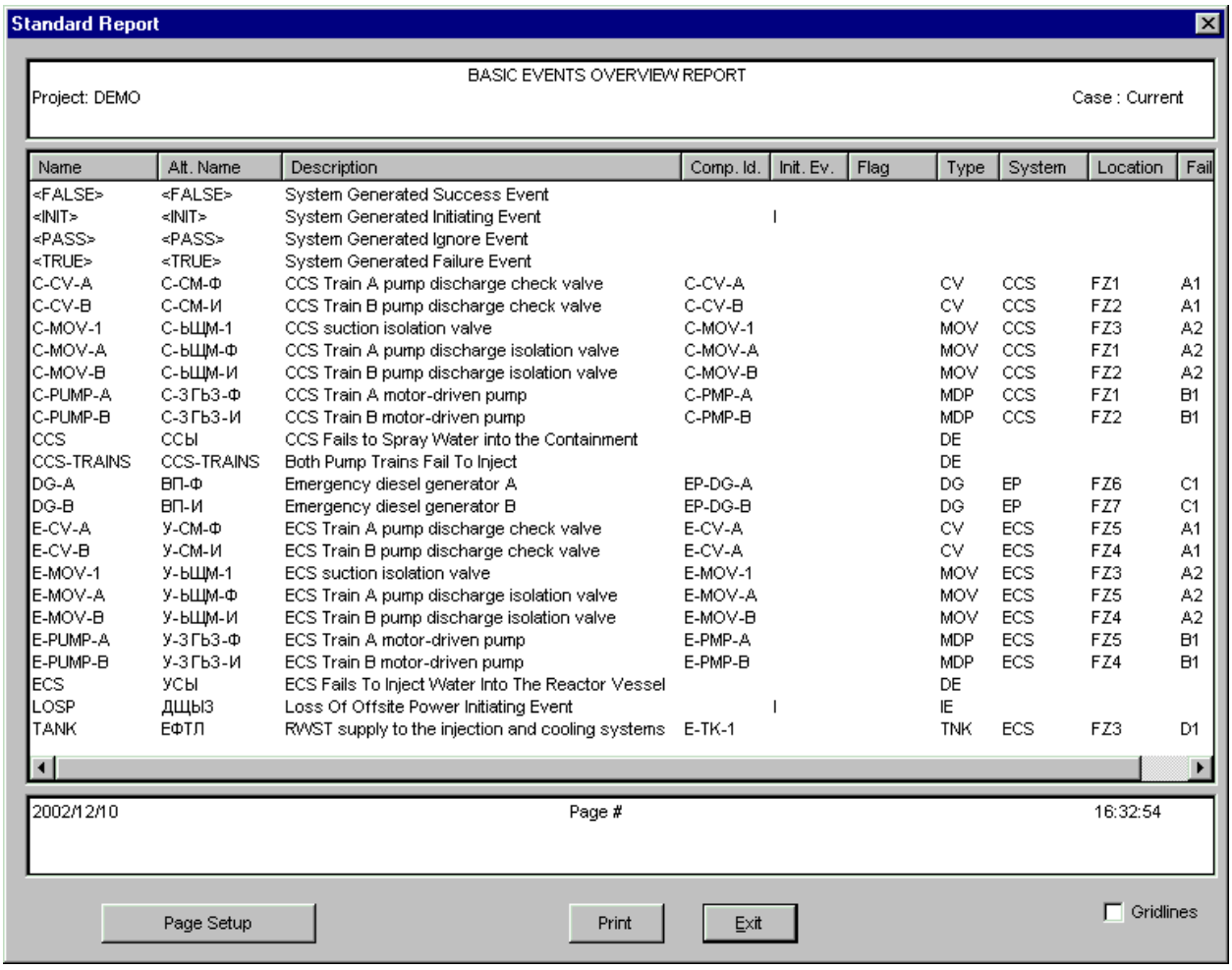
10.3.2.1 Report Viewer

PURPOSE

The *Standard Report* window allows you to scroll through data generated by selected report options.

STEPS

1. From one of the *Report Menu* options, choose the desired data type, report type, and, if available, sub type.
2. A list of the desired data type items (i.e., Basic Events, Fault Trees, etc), will appear in a list dialog. Select the items you want to appear in the report and choose the *Continue* button. The *Standard Report* window will be invoked.



Name	Alt. Name	Description	Comp. Id.	Init. Ev.	Flag	Type	System	Location	Fail
<FALSE>	<FALSE>	System Generated Success Event							
<INIT>	<INIT>	System Generated Initiating Event		I					
<PASS>	<PASS>	System Generated Ignore Event							
<TRUE>	<TRUE>	System Generated Failure Event							
C-CV-A	С-СМ-Ф	CCS Train A pump discharge check valve	C-CV-A			CV	CCS	FZ1	A1
C-CV-B	С-СМ-И	CCS Train B pump discharge check valve	C-CV-B			CV	CCS	FZ2	A1
C-MOV-1	С-ЬЩМ-1	CCS suction isolation valve	C-MOV-1			MOV	CCS	FZ3	A2
C-MOV-A	С-ЬЩМ-Ф	CCS Train A pump discharge isolation valve	C-MOV-A			MOV	CCS	FZ1	A2
C-MOV-B	С-ЬЩМ-И	CCS Train B pump discharge isolation valve	C-MOV-B			MOV	CCS	FZ2	A2
C-PUMP-A	С-ЗГЬЗ-Ф	CCS Train A motor-driven pump	C-PMP-A			MDP	CCS	FZ1	B1
C-PUMP-B	С-ЗГЬЗ-И	CCS Train B motor-driven pump	C-PMP-B			MDP	CCS	FZ2	B1
CCS	ССЫ	CCS Fails to Spray Water into the Containment				DE			
CCS-TRAINS	CCS-TRAINS	Both Pump Trains Fail To Inject				DE			
DG-A	ВП-Ф	Emergency diesel generator A	EP-DG-A			DG	EP	FZ6	C1
DG-B	ВП-И	Emergency diesel generator B	EP-DG-B			DG	EP	FZ7	C1
E-CV-A	У-СМ-Ф	ECS Train A pump discharge check valve	E-CV-A			CV	ECS	FZ5	A1
E-CV-B	У-СМ-И	ECS Train B pump discharge check valve	E-CV-A			CV	ECS	FZ4	A1
E-MOV-1	У-ЬЩМ-1	ECS suction isolation valve	E-MOV-1			MOV	ECS	FZ3	A2
E-MOV-A	У-ЬЩМ-Ф	ECS Train A pump discharge isolation valve	E-MOV-A			MOV	ECS	FZ5	A2
E-MOV-B	У-ЬЩМ-И	ECS Train B pump discharge isolation valve	E-MOV-B			MOV	ECS	FZ4	A2
E-PUMP-A	У-ЗГЬЗ-Ф	ECS Train A motor-driven pump	E-PMP-A			MDP	ECS	FZ5	B1
E-PUMP-B	У-ЗГЬЗ-И	ECS Train B motor-driven pump	E-PMP-B			MDP	ECS	FZ4	B1
ECS	УСЫ	ECS Fails To Inject Water Into The Reactor Vessel				DE			
LOSP	ДЩЫЗ	Loss Of Offsite Power Initiating Event		I		IE			
TANK	ЕФТЛ	RWST supply to the injection and cooling systems	E-TK-1			TNK	ECS	FZ3	D1

Columns may be resized by positioning the mouse cursor over the border between two column headings, clicking and dragging the cursor left or right to expand or contract the display width of the report.

Page Setup - Open the Report Settings dialog to specify the desired report settings, such as fonts and margins.

Print - Open the Report Options dialog to send a copy of the report to a printer, file, or other application.

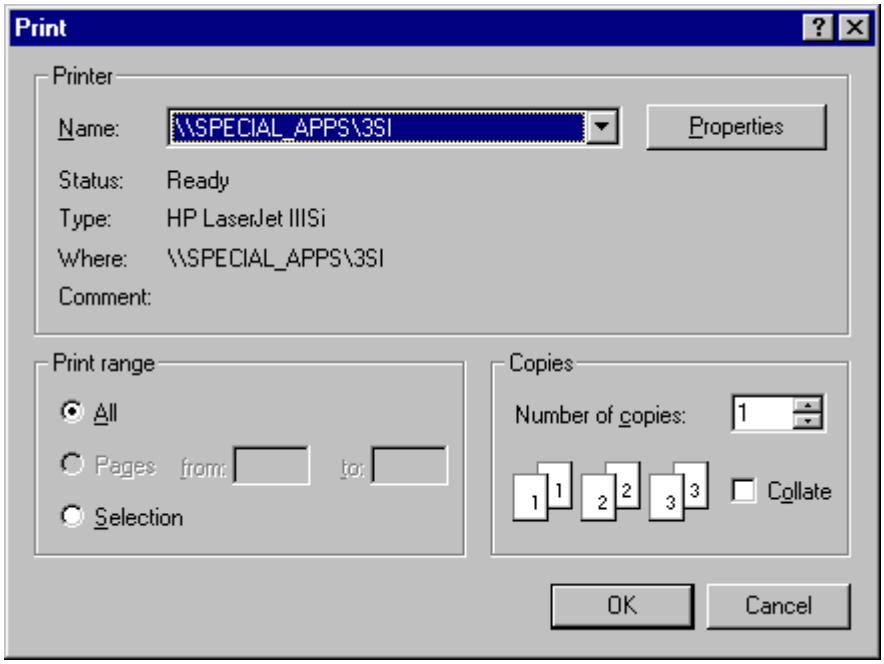
Exit - Close the *Standard Report* window

Gridlines - Checked and unchecked, this option displays grid lines between each cell in the report.

10.3.2.2 Print Dialog

PURPOSE

Set printing options, such as, printer, page range, number of copies, etc. before printing the current file.



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.

10.3.2.3 Report Settings

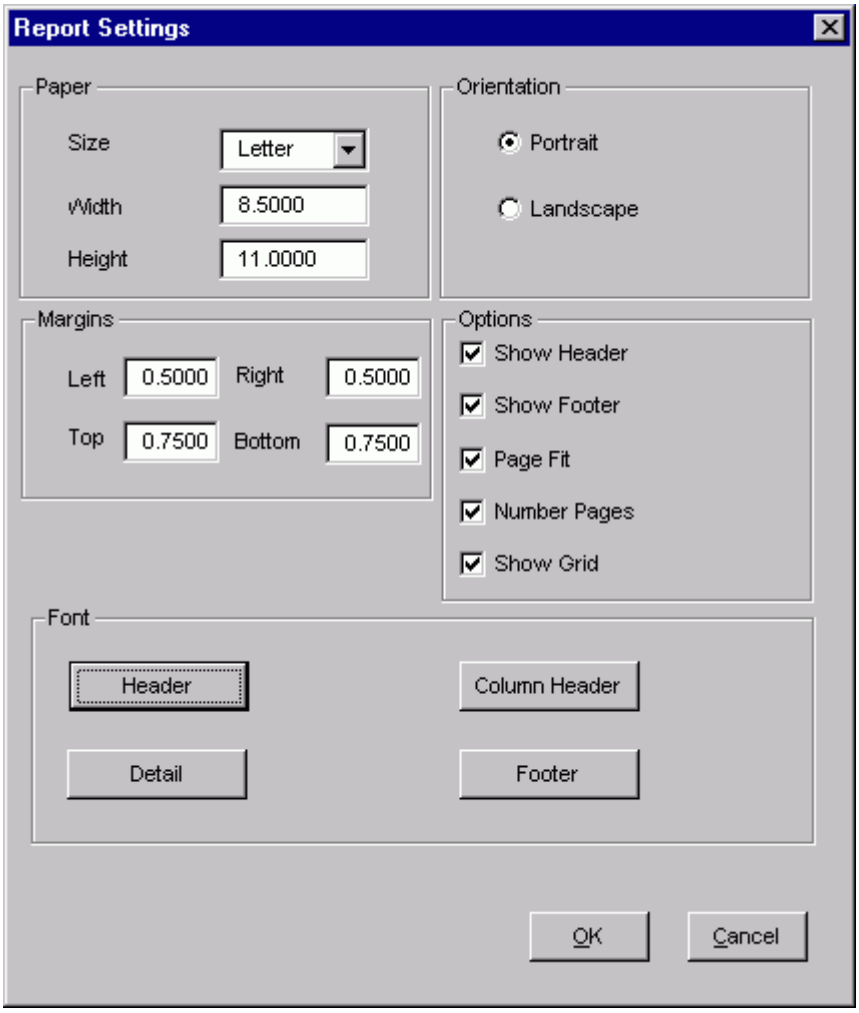
PURPOSE

This option allows you to modify general characteristics of a report.

The Report Viewer allows you to inspect the contents of the report, but does not reflect the settings available here. When a report is printed, via the Report Options dialog, an output format is selected, and where applicable, the output format will honor the settings selected here. Note that not all settings are applicable to each of the report formats available. For example, HTML output will utilize font information, but not utilize paper or orientation settings. ASCII format will not utilize the paper, margin, orientation, or font information.

STEPS

1. From one of the *Report Menu* options, choose the desired data type, report type, and, if available, sub type.
2. A list of the desired data type items (i.e., Basic Events, Fault Trees, etc), will appear in a list dialog. Select the items you want to appear in the report and choose the *Continue* button.
3. The *Standard Report* window will be invoked.
4. Press the *Report Settings* button.



Paper - Set the desired paper size, height, and width.
Orientation - Select the desired paper orientation.
Options - Turn the header, footer, page numbering, page fit, and grid options on (checked) or off (unchecked).
Margins - Set the left, right, top, and bottom margins for the report.
Font - Select the font characteristics for the header, column header, detail, and footer areas of the report.

Ok - Apply the selected settings to the report, and return to the report viewer.
Cancel - Return to the report viewer without changing any report settings.

10.3.2.4 Report Options

PURPOSE

This option sends a copy of the current report to a printer, file, or other application. The report can be sent in a variety of formats, including rich text format (RTF), HTML, and ASCII.

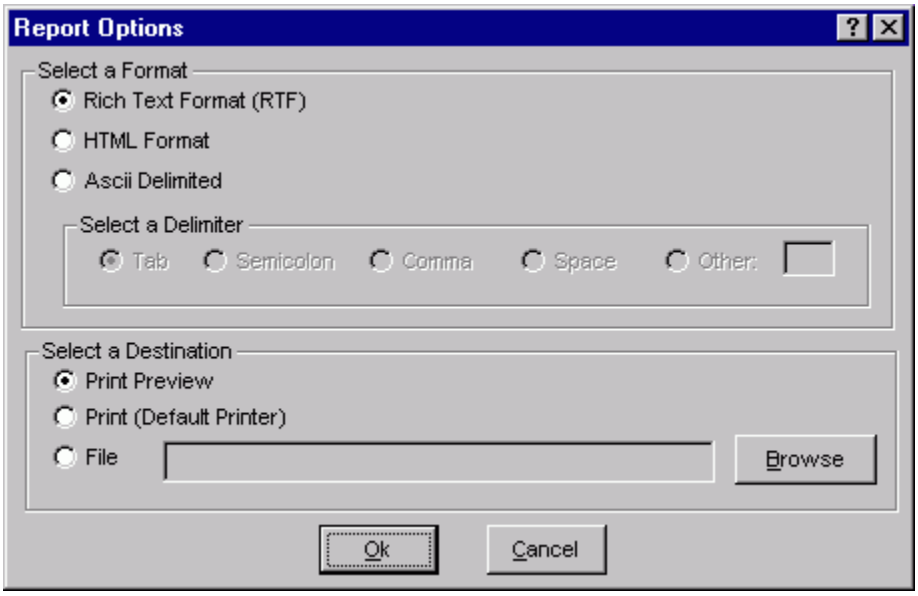
The *Print Preview* option sends the report data to an external editor or viewer such as Microsoft Word or Internet Explorer, where you may then manipulate the report using the receiving application's native features. The *Print (Default Printer)* option uses the same application as the print preview option to print the report directly to your default printer. The *File* option sends the report data in the selected format directly to a file of your choosing. Any software application that supports that format can then be used to view or edit the report.

Note: In order to print or preview data in a particular format, you must have software installed on your computer that supports that format. To print or preview RTF data, you must have an editor or viewer that supports the RTF file format, such as Microsoft Word, WordPerfect, or WordPad. Likewise, to print or preview HTML data, you must have software such as Internet Explorer or Netscape. For ASCII data, you must have Notepad, WordPad, or another text editor available. The typical Windows operating system installation includes basic software to support each of the given file types.

If your system includes multiple software applications that support a particular format, SAPHIRE will invoke the program associated by default with that format's file extension. (The ASCII text format has a TXT file extension.) To access the report data via an application other than the default association, save the report data to a file destination, and then use the desired application to open the file. To change the default association of a file extension, see your Windows help system, or contact your help desk.

STEPS

1. From one of the *Report Menu* options, choose the desired data type, report type, and, if available, sub type.
2. A list of the desired data type items (i.e., Basic Events, Fault Trees, etc), will appear in a list dialog. Select the items you want to appear in the report and choose the *Continue* button.
3. The *Standard Report* window will be invoked.
4. Press the *Print* button.



Select a Format

Rich Text Format (RTF)- Output the report to the selected destination in RTF format.

HTML Format - Output the report to the selected destination in HTML format.

ASCII Delimited - Output the report to the selected destination in ASCII format. Within each line of data, items will be separated by the selected delimiter.

Select a Delimiter - When ASCII formatted output is selected, use this option to select the report cell delimiter character. Choose from commonly used delimiters such as *tab, semicolon, comma,* or *space*, or select *Other* and type the desired ASCII character delimiter into the adjacent field.

Select a Destination

Print Preview - Preview the report in the selected output format. SAPHIRE will invoke whatever program your system has associated with the selected file type.

Print (default printer) - Send the report in the selected output format directly to your system's default printer. *Hint: If you prefer to send the report to a printer that is not the default, choose the Print Preview option, and print from the associated application.*

File - Send the report output in the selected format directly to the file indicated in the adjacent field.

Browse - Choose the folder and file name to send the report to when the *File* destination is selected.

10.4 Custom Reports Dialog

10.4.1 Custom Reports

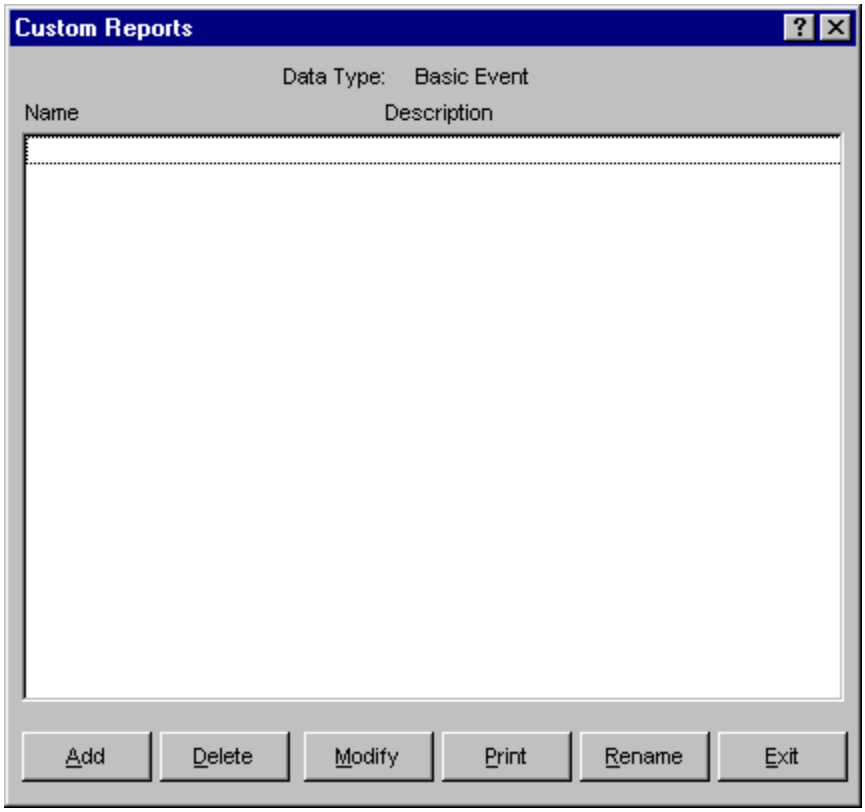
PURPOSE

This option allows you to obtain information about the selected data type (e.g., project, fault tree, basic event, etc.) on an ad-hoc basis. Multiple ad-hoc reports can be created and saved in the SAPHIRE database.

The dialogs and operations are similar for each of the report data types, therefore, a generic discussion is provided here.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the desired *Data Type* and **Custom** *Report Type* radio buttons.
3. Choose the **Process** button. The *Custom Reports* dialog will be displayed with a list of all existing custom reports for the selected data type.



Add - Create a new custom report record.
Delete - Delete an existing custom report record.
Modify - Edit an existing custom report record. When you choose this button, the *Custom Report Field Selection* dialog will be displayed.
Print - View the selected custom report. When you choose this button, the *Report Viewer* is invoked.
Rename - Rename the existing custom report record.
Exit - Close the *Custom Reports* dialog.

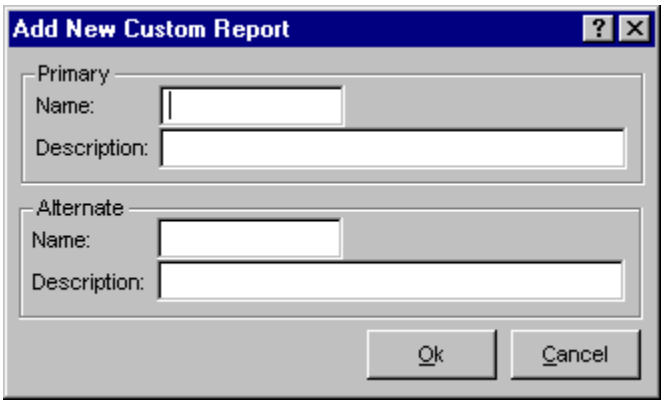
10.4.2 Add Custom Report

PURPOSE

Create a new custom report record in the SAPHIRE database.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the desired *Data Type* and **Custom** *Report Type* radio buttons.
3. Choose the **Process** button. The *Custom Reports* dialog will be displayed listing all existing custom reports for the selected data type.
4. Choose the **Add** button. The *Add New Custom Report* dialog will be displayed.



Primary Name – Required field. A maximum of 8 uppercase, alphanumeric may be entered to uniquely identify the report. The name should be descriptive so that the report can be readily identified. The name must be unique for the selected data type, but can be duplicated in other data types. For example you could have a report named "MYREPORT" for the Fault Tree data type and a report with the same name for the basic event data type.

Primary Description – This is a 30-character, uppercase or lowercase, alphanumeric field that provides brief descriptive information. Data entry in this field is optional.

Alternate Name – Optional field. A maximum of 8 uppercase, alphanumeric characters may be entered. Embedded blanks are not allowed. If a name is not entered, the primary name will be copied to this field. This feature allows names to be displayed and reported using a different naming scheme or another locale. For this name to be displayed in lists and on reports instead of the Primary name, choose **Use alternate names for display** in the **Define Constants** option.

Alternate Description – This is a 30-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information. This feature allows descriptions to be displayed and reported using a different naming scheme or another locale. For this description to be displayed in lists and on reports instead of the Primary description, choose **Use alternate names for display** in the **Define Constants** option.

Ok - Add the report record to the database. Upon pressing this button the *Custom Report Field Selection* dialog will be displayed. In order for this record to be added to the database, you must choose the **Save** button when complete.

Cancel - Close the *Add New Custom Report* dialog without adding a new record.

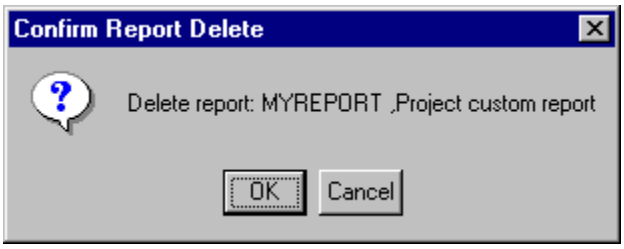
10.4.3 Delete Custom Report

PURPOSE

Delete the selected custom report record from the SAPHIRE database.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Choose the desired *Data Type* and **Custom** *Report Type* radio buttons.
3. Choose the **Process** button. The *Custom Reports* dialog will be displayed listing all existing custom reports for the selected data type.
4. Highlight the desired report.
5. Choose the **Delete** button. The *Confirm Report Delete* dialog will be displayed.



Ok - Delete the report record and close the *Confirm Report Delete* dialog.
Cancel - Close the *Confirm Report Delete* dialog without deleting the report.

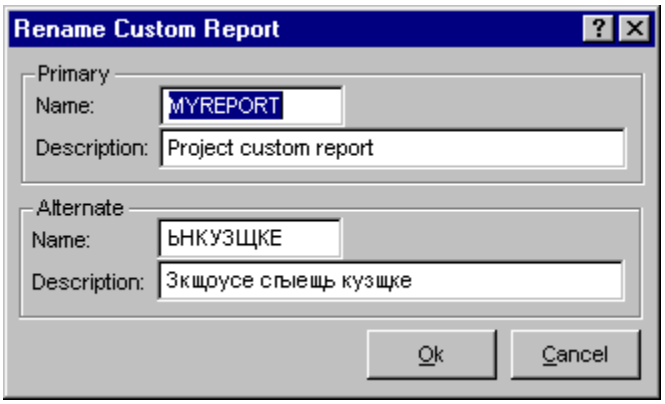
10.4.4 Rename Custom Report

PURPOSE

Change the name or description of the selected custom report.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Choose the desired *Data Type* and **Custom** *Report Type* radio buttons.
3. Choose the **Process** button. The *Custom Reports* dialog will be displayed listing all existing custom reports for the selected data type.
4. Highlight the desired report.
5. Choose the **Rename** button. The *Rename Custom Report* dialog will be displayed.



Primary Name - Required field. A maximum of 8 uppercase, alphanumeric may be entered to uniquely identify the report. The name should be descriptive so that the report can be readily identified. The name must be unique for the selected data type, but can be duplicated in other data types. For example you could have a report named "MYREPORT" for the Fault Tree data type and a report with the same name for the basic event data type.

Primary Description – This is a 30-character, uppercase or lowercase, alphanumeric field that provides brief descriptive information. Data entry in this field is optional.

Alternate Name – Optional field. A maximum of 8 uppercase, alphanumeric characters may be entered. Embedded blanks are not allowed. If a name is not entered, the primary name will be copied to this field. This feature allows names to be displayed and reported using a different naming scheme or another locale. For this name to be displayed in lists and on reports instead of the Primary name, choose **Use alternate names for display** in the **Define Constants** option.

Alternate Description – This is a 30-character, uppercase or lowercase, alphanumeric field that provides brief, descriptive information. This feature allows descriptions to be displayed and reported using a different naming scheme or another locale. For this description to be displayed in lists and on reports instead of the Primary description, choose **Use alternate names for display** in the **Define Constants** option.

Ok - Save the changes made to the report name and/or description.

Cancel - Close the *Rename Custom Report* dialog without changing the record.

10.4.5 Custom Report Field Selection Dialog

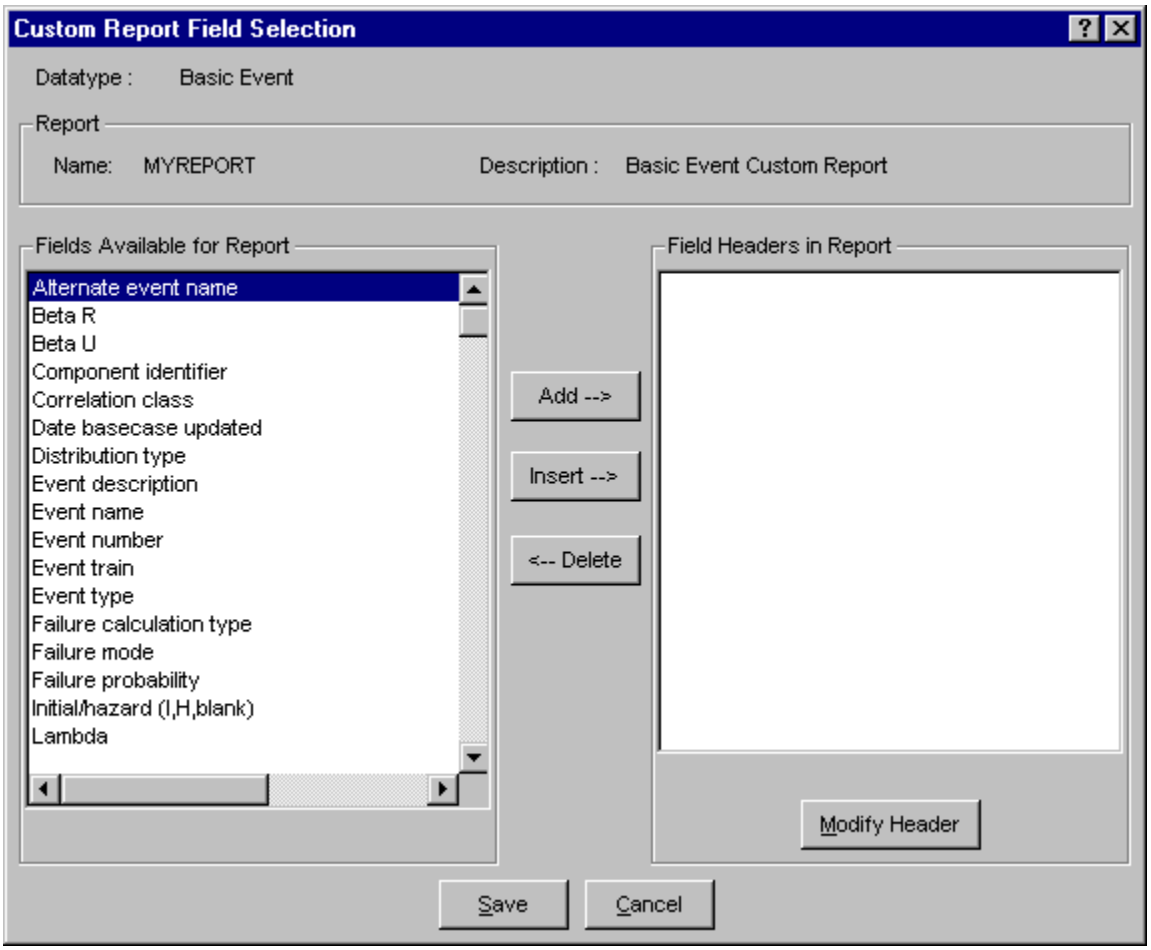
10.4.5.1 Custom Report Field Selection Dialog

PURPOSE

This option allows you to add or remove fields in the custom report. The field header names may also be modified.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Choose the desired *Data Type* and **Custom** *Report Type* radio buttons.
3. Choose the **Process** button. The *Custom Reports* dialog will be displayed listing all existing custom reports for the selected data type.
4. Choose the **Add** or **Modify** button. The *Custom Report Field Selection* dialog will be displayed.



Fields Available for Report - List of all fields available for inclusion in the report, based on the selected data type.

Field Headers in Report - List of fields currently included in the report. The order of the headers and the header name displayed in this list will be used for generating the report.

Add - The highlighted field in the *Fields Available* list will be included in the report. The selected field's report header will be displayed at the bottom of the *Field Headers* list.

Insert - The highlighted field in the *Fields Available* list will be inserted in front of the currently highlighted header in the *Field Headers* list.

Delete - Remove the highlighted header from the *Field Headers* list.

Modify Header - Change the name of the highlighted header.

Save - Save the changes made and close the *Custom Report Field Selection* dialog.

Cancel - Close the *Custom Report Field Selection* dialog without saving changes. When adding a new report, if you choose this button, the report record will not be saved in the database.

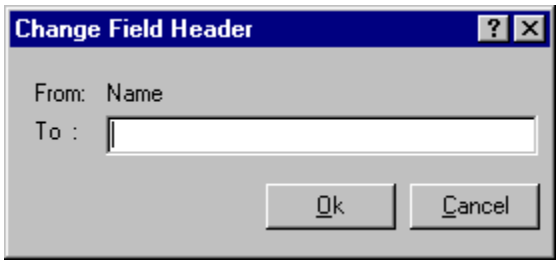
10.4.5.2 Change Field Header Dialog

PURPOSE

This option allows you to modify the selected field header name.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Choose the desired *Data Type* and **Custom** *Report Type* radio buttons.
3. Choose the **Process** button. The *Custom Reports* dialog will be displayed listing all existing custom reports for the selected data type.
4. Choose the **Add** or **Modify** button. The *Custom Report Field Selection* dialog will be displayed.
5. Highlight an item in the *Field Headers in Report* list.
6. Choose the **Modify Header** button.



From - The current field header.

To - Enter the new field header.

Ok - Save the modification and close the *Change Field Header* dialog.

Cancel - Close the *Change Field Header* without saving the modification.

10.5 Project Reports Dialog

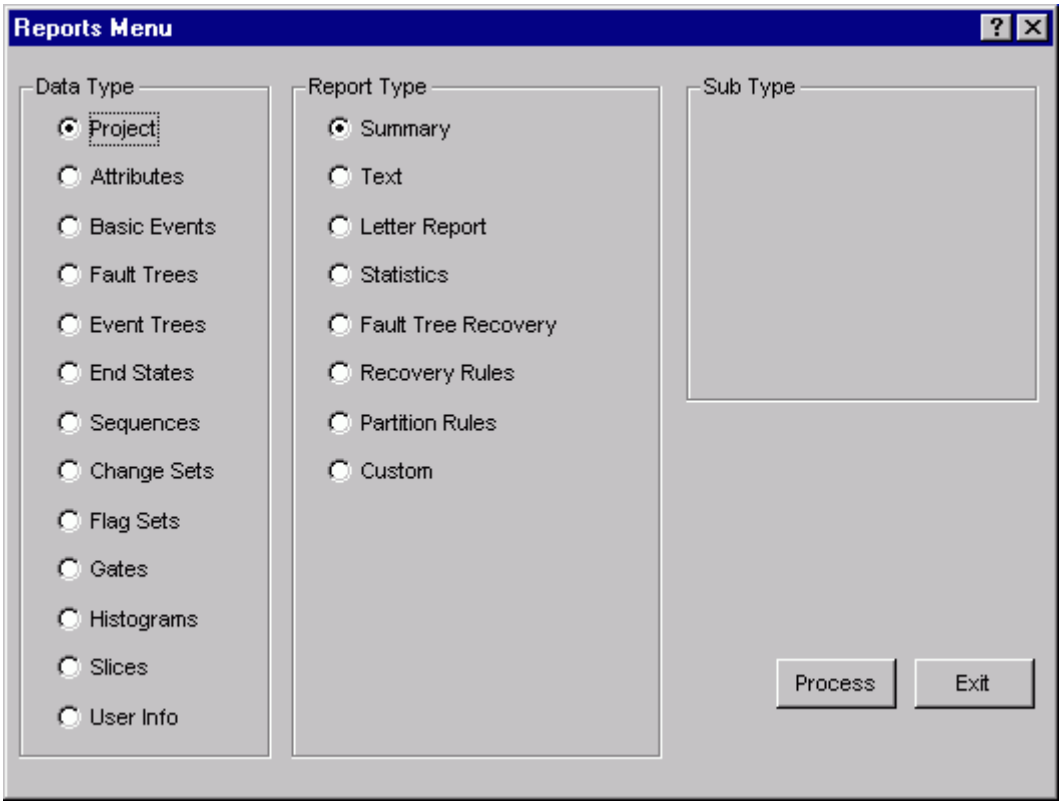
10.5.1 Project Reports

PURPOSE

This option allows you to generate a variety of project reports.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Project** *Data Type* and the desired *Report Type* radio buttons.
3. Choose the **Process** button. The Report Viewer will display the report.



Report Type

Summary - Generate a summary report listing the current project name and its associated description.

Text - Generate a report containing the descriptive text associated with the selected project.

Letter Report - Generate a report containing the contents of the README.DOC file in the current project's directory.

Statistics - This report contains the total number of fault trees, subtrees, basic events, gates, attributes, event trees, sequences, end states, histograms, P&IDs, and change sets defined for the current project.

Fault Tree Recovery - This report outputs a listing of the recovery rule logic that applies to all fault trees, project-wide. Choose the **Basic** or **Advanced** radio button to indicate the desired rule type.

Recovery Rules - This report outputs a listing of the recovery rule logic that applies to all sequences, project-wide. Choose the **Basic** or **Advanced** radio button to indicate the desired rule type.

Partition Rules - This report outputs a listing of the partition rule logic that applies to all sequences, project-wide. Choose the **Basic** or **Advanced** radio button to indicate the desired rule type.

Custom - Create or select a user-defined report relating to project level descriptive information.

Process - Display the selected report.

Exit - This option closes the *Reports Menu* dialog.

10.6 Attribute Reports

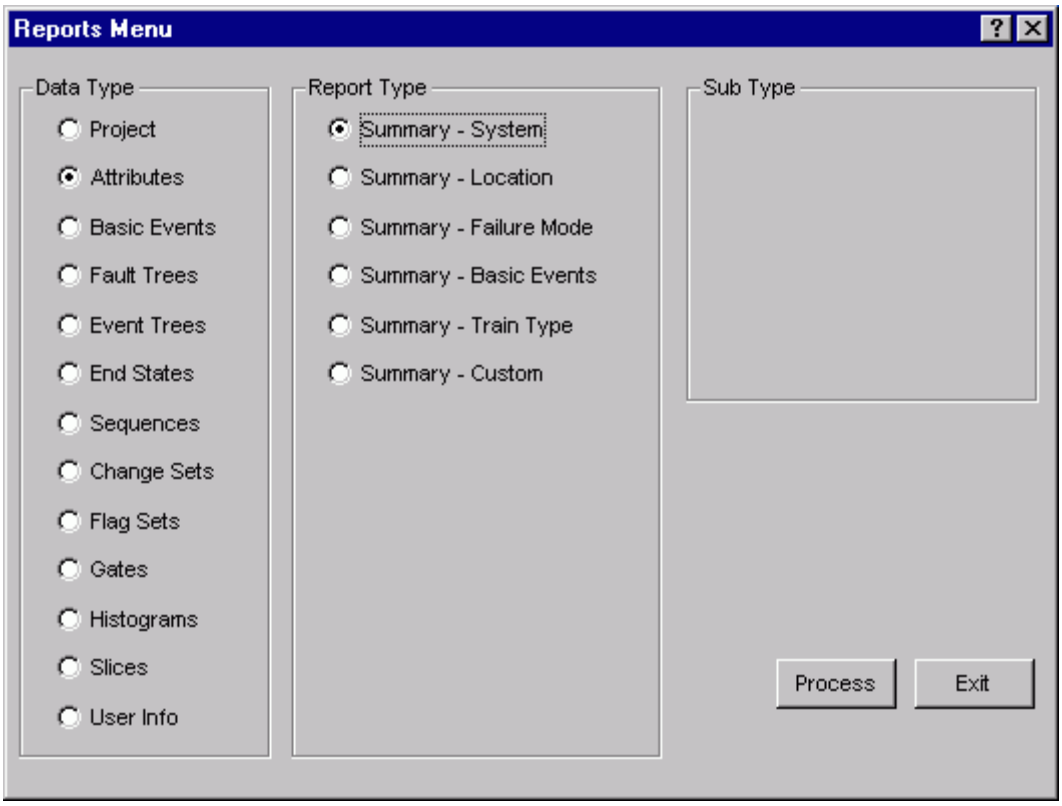
10.6.1 Attributes

PURPOSE

This option allows you to generate a variety of attribute summary reports. These include reports based on system, location, failure mode, basic event type, and train attributes. Each report contains the name and description for all records of the specified attribute type in the current project.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Attributes** *Data Type* and one of the *Report Type* radio buttons.
3. Choose the **Process** button. The Report Viewer will display the report.



Process - Display the selected report.
Exit - This option closes the *Reports Menu* dialog.

10.7 Basic Event Reports

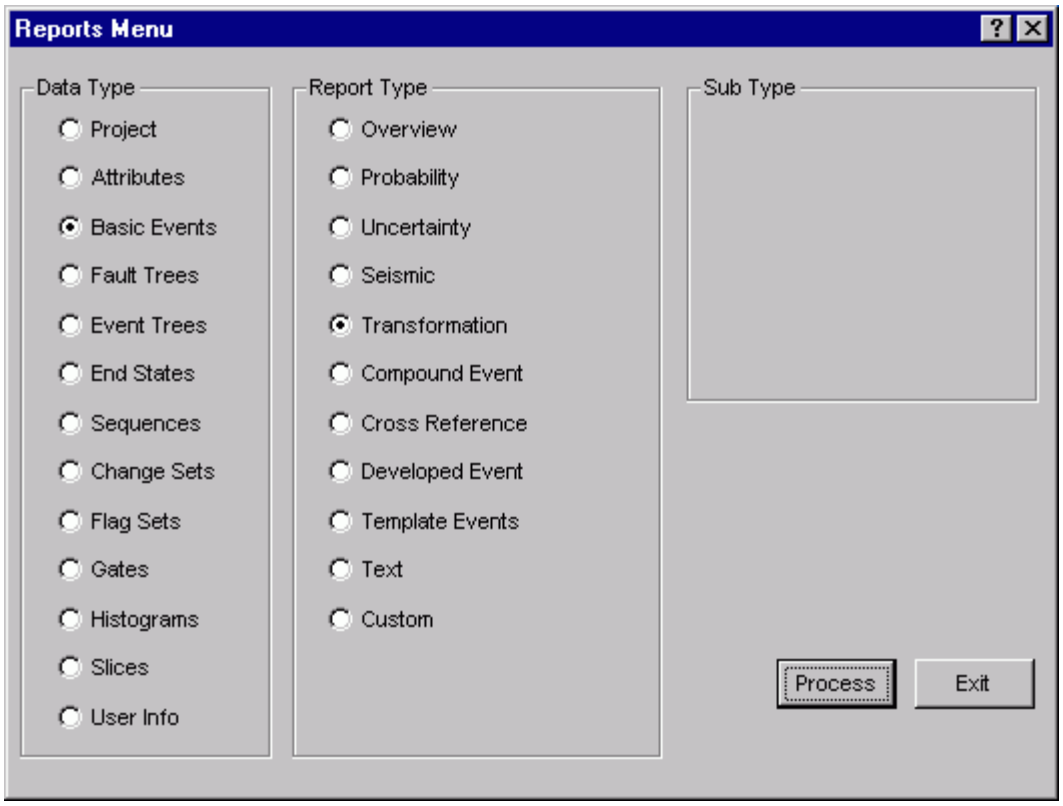
10.7.1 Basic Events

PURPOSE

The basic event report option allows you to generate overview, probabilities, uncertainty data, seismic data, transformation data, compound event data, template information, text, and cross reference reports.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Basic Events** *Data Type* and one of the *Report Type* radio buttons.
3. Choose the **Process** button. A list of the basic events in the project will be displayed.
4. Highlight the desired basic event(s).
5. Choose the appropriate buttons to generate the report. The Report Viewer will display the report.



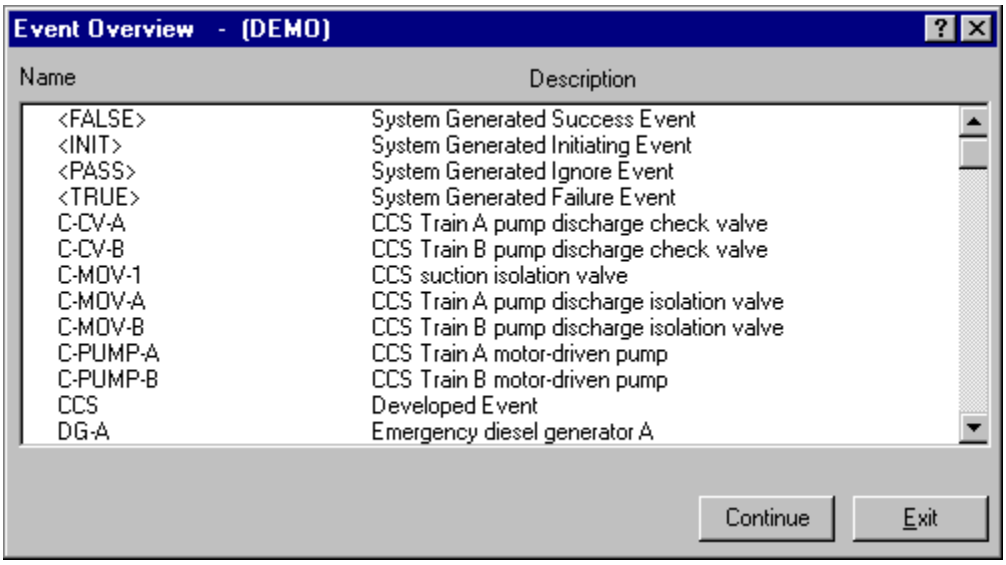
10.7.2 Basic Event Overview

PURPOSE

This option generates a basic event summary report. The overview report includes the basic event number, primary and secondary name, component type and ID, system location, and attribute fail mode.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Basic Events** *Data Type* and the **Overview** *Report Type* radio buttons.
3. Choose the **Process** button. The *Event Overview* dialog will be displayed.
4. Highlight the desired basic event(s) or process all records.
5. Choose the **Continue** button. The Report Viewer will display the report.



Continue - Generate the basic event summary report. The *Report* Viewer will be displayed.
Exit - Close the *Event Overview* dialog without generating a report.

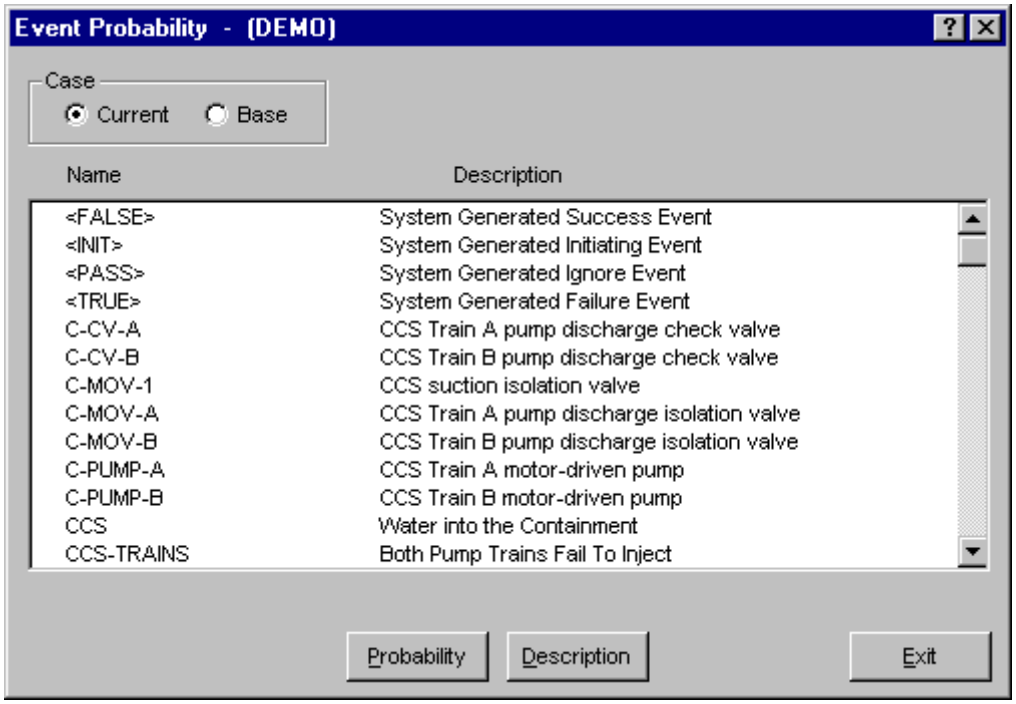
10.7.3 Basic Event Probability Report

PURPOSE

This option allows you to generate a basic event probability report. The probability report shows the event number, primary name, failure calculation type, mean probability, and event lambda and tau values for selected events.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Basic Events** *Data Type* and the **Probability** *Report Type* radio buttons.
3. Choose the **Process** button. The *Event Probability* dialog will be displayed.
4. Highlight the desired basic event(s) or process all records.
5. Select the desired *Case* radio button.
6. Choose **Probability** or **Description** button. The Report Viewer will display the report.



Case

Current - Use current case values for all calculations. This is the default.
Base - Use base case values for all calculations.

Probability - Generate the report based on the event selections. This report shows the event number, primary name, calculation type, mean probability, and lambda and tau values. The Report Viewer will display the report.

Description - Generate the Probability report, but also include the description for each event selected. The Report Viewer will display the report.

Exit - Close the *Event Probability* dialog without generating a report.

10.7.4 Basic Event Uncertainty Report

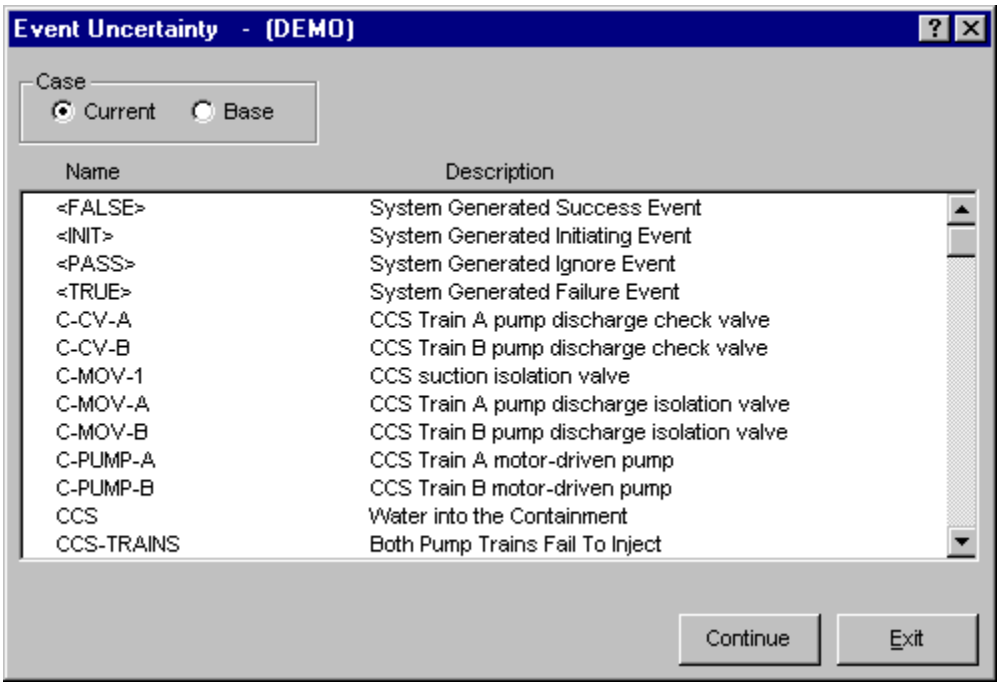
PURPOSE

This option allows you to generate a basic event uncertainty report. The report shows the event number, primary name, distribution type, mean probability, uncertainty value, and correlation class.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Basic Events** *Data Type* and the **Uncertainty** *Report Type* radio buttons.
3. Choose the **Process** button. The *Event Uncertainty* dialog will be displayed.
4. Highlight the desired basic event(s) or process all records.

5. Select the desired *Case* radio button.
6. Choose the **Continue** button. The Report Viewer will display the report.



Case

Current - Use current case values for all calculations. This is the default.
Base - Use base case values for all calculations.

Continue - Generate the report based on event selections. The Report Viewer will display the report.

Exit - Close the *Event Uncertainty* dialog without generating a report.

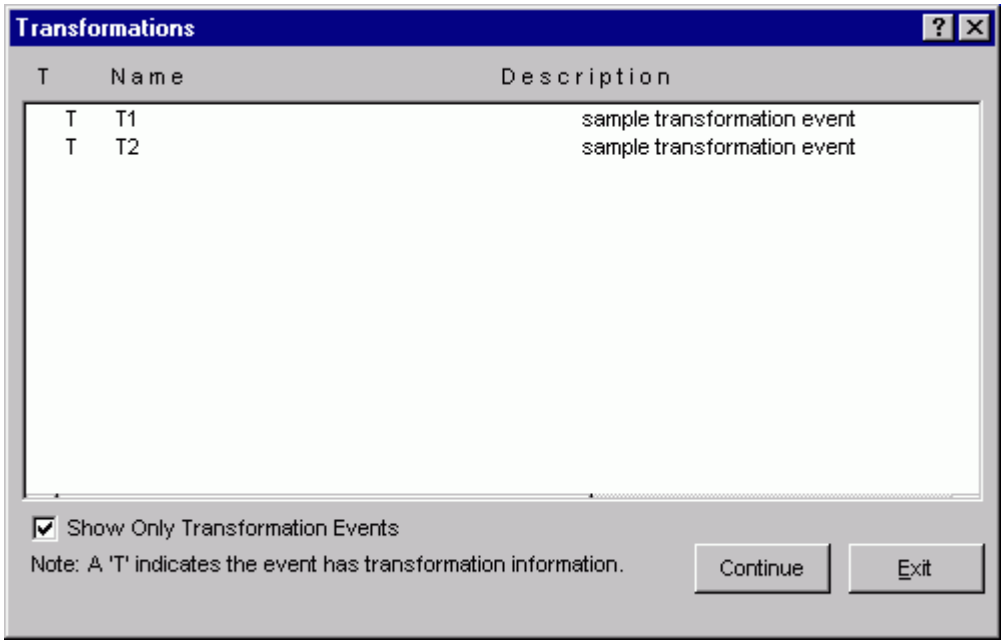
10.7.5 Transformations Report

PURPOSE

This option allows you to generate the event transformation reference report. The report shows the event number and name, event type, level, susceptibilities, and any referenced events.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Basic Events** *Data Type* and the **Transformation** *Report Type* radio buttons.
3. Choose the **Process** button. The *Transformations* dialog will be displayed. A "T" to the left of the event name indicates that the event contains transformations.
4. Highlight the desired basic event(s) or process all listed records.
5. Choose the **Continue** button. The Report Viewer will display the report.



Show Only Transformation Events - The check box toggles the event list to display either all events in the project, or only those events that have transformations associated with them.

Continue - Generate the basic event transformation report. The Report Viewer will display the report.

Exit - Close the *Transformations* dialog without generating a report.

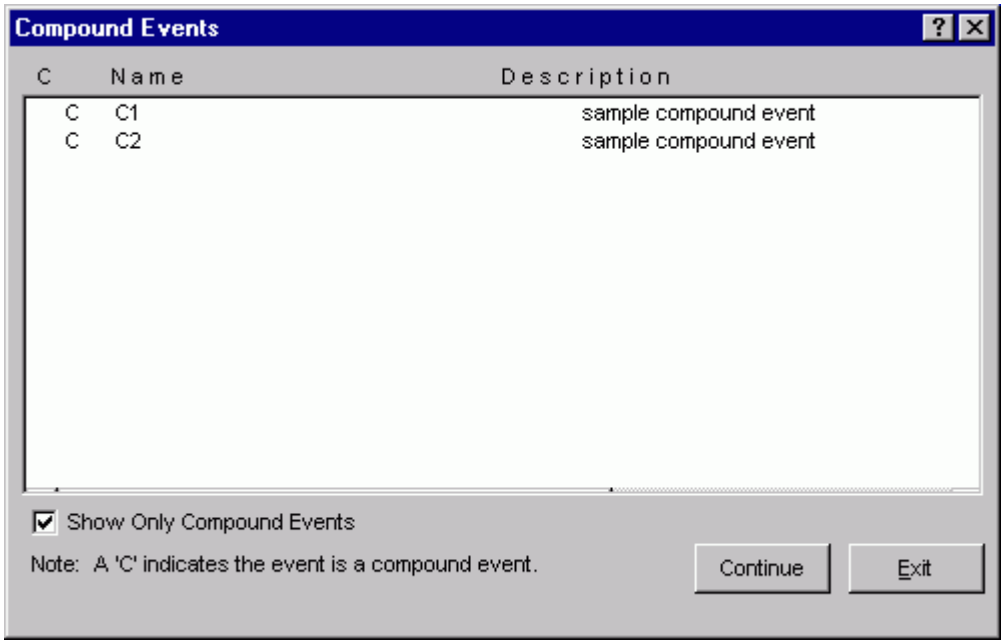
10.7.6 Compound Event Report

PURPOSE

This option allows you to generate the compound event reference report. The report shows the event name, plug-in library, function, and event inputs.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Basic Events** *Data Type* and the **Compound Event** *Report Type* radio buttons.
3. Choose the **Process** button. The *Compound Events* dialog will be displayed. A "C" to the left of the event name indicates that the event contains compound event information.
4. Highlight the desired basic event(s) or process all listed records.
5. Choose the **Continue** button. The Report Viewer will display the report.



Show Only Compound Events - The check box toggles the event list to display either all events in the project, or only those events that contain compound event information.

Continue - Generate the compound event report. The Report Viewer will display the report.

Exit - Close the *Compound Events* dialog without generating a report.

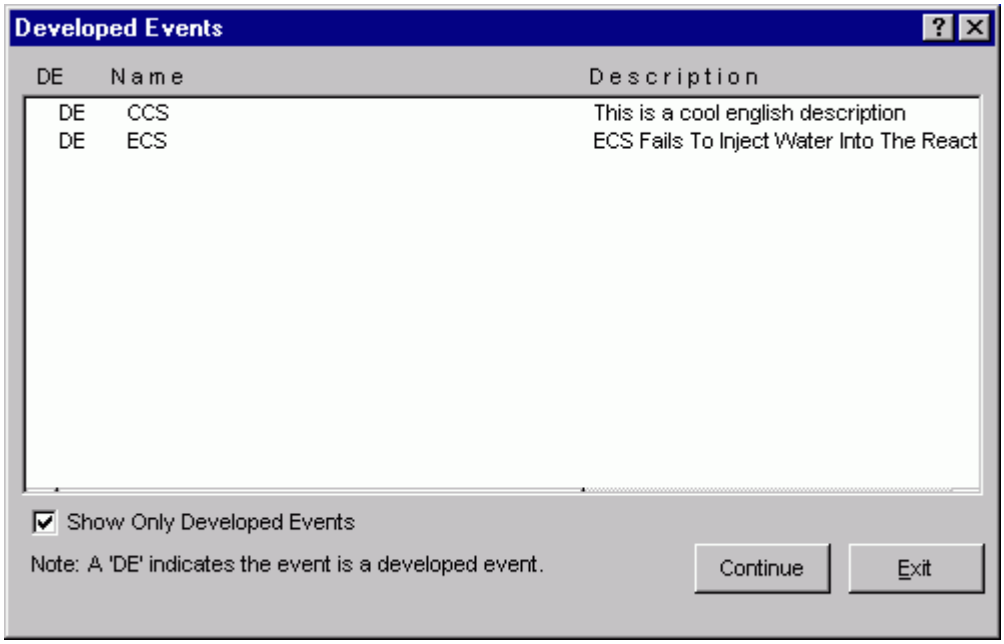
10.7.7 Developed Event Report

PURPOSE

This option allows you to generate the developed event report. The report shows the event name, base and current case calculation type, probability, and flag information. It also lists the fault trees that reference the developed event.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Basic Events** *Data Type* and the **Developed Events** *Report Type* radio buttons.
3. Choose the **Process** button. The *Transformations* dialog will be displayed. A "DE" to the left of the event name indicates that the event is classified as a developed event.
4. Highlight the desired basic event(s) or process all listed records.
5. Choose the **Continue** button. The Report Viewer will display the report.



Show Only Developed Events - The check box toggles the event list to display either all events in the project, or only those events that are developed events.

Continue - Generate the developed event report. The Report Viewer will display the report.

Exit - Close the *Developed Events* dialog without generating a report.

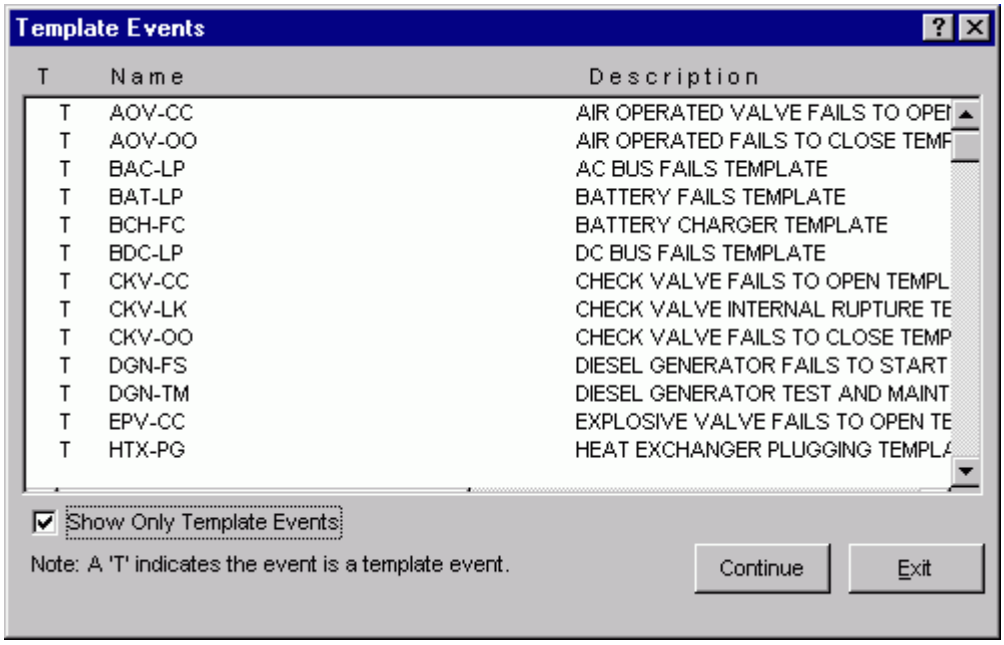
10.7.8 Template Event Report

PURPOSE

This option allows you to generate the template event reference report. The report shows the template event name, and a list of all basic events that reference the template.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Basic Events** *Data Type* and the **Template Events** *Report Type* radio buttons.
3. Choose the **Process** button. The *Template Events* dialog will be displayed. A "T" to the left of the event name indicates that the event contains template event information.
4. Highlight the desired basic event(s) or process all listed records.
5. Choose the **Continue** button. The Report Viewer will display the report.



Show Only Template Events - The check box toggles the event list to display either all events in the project, or only those events that are designated as template events.

Continue - Generate the template event report. The Report Viewer will display the report.

Exit - Close the *Template Events* dialog without generating a report.

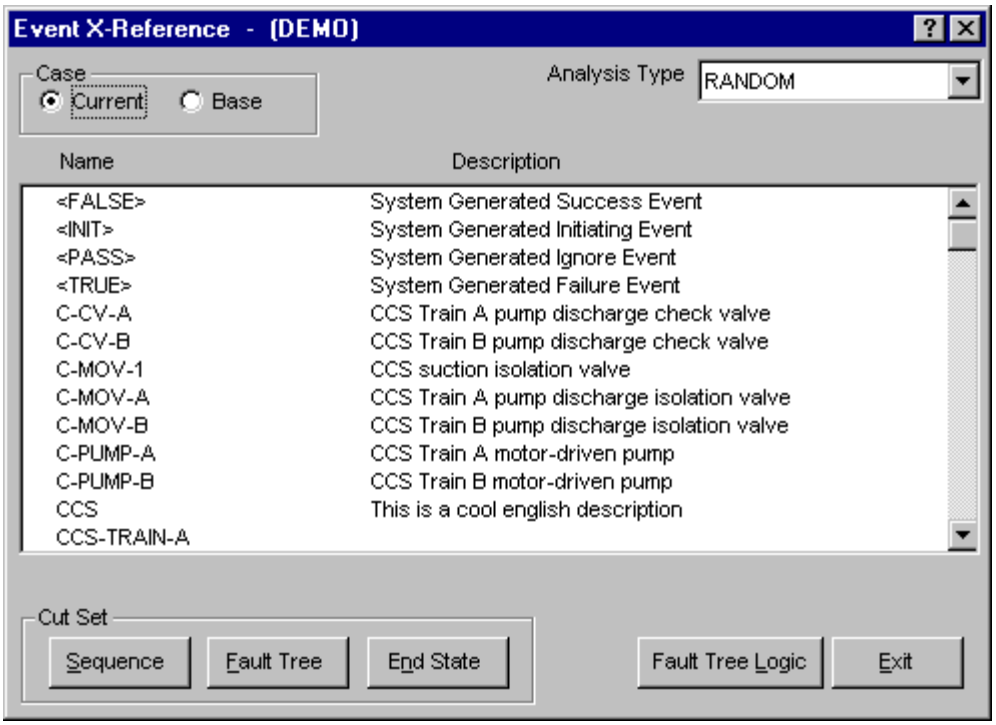
10.7.9 Basic Event Cross Reference Report

PURPOSE

This option generates a basic event cross reference report.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Basic Events** *Data Type* and the **Cross Reference** *Report Type* radio buttons.
3. Choose the **Process** button. The *Event X-Reference* dialog will be displayed.
4. Highlight the desired basic event(s) or process all records.
5. Select the desired *Case* radio button.
6. Select the desired analysis type from the drop-down list.
7. Choose the desired *report type* button. The Report Viewer will display the report.



Case

Current - Use current case values for all calculations. This is the default.

Base - Use base case values for all calculations.

Sequence - Produce an event to sequence cut set cross-reference report. The report will include the event number, event name and associated event tree and sequence names.

Fault Tree - Produce an event to fault tree cut set cross-reference report. The report includes the event number, the event name and the corresponding fault tree name.

End State - Produce an event to end state cut set cross-reference report. The report includes the event number, the event name and the corresponding end state cut set name(s).

Fault Tree Logic-Produce an event to fault tree logic cross-reference report. The report includes the event number, the event name and the corresponding fault tree names.

Exit - Close the *Event X-Reference* dialog without generating a report.

After report options have been selected and the button chosen, the *Report* dialog will be displayed and the output destination for the report must be specified.

10.7.10 Seismic Events

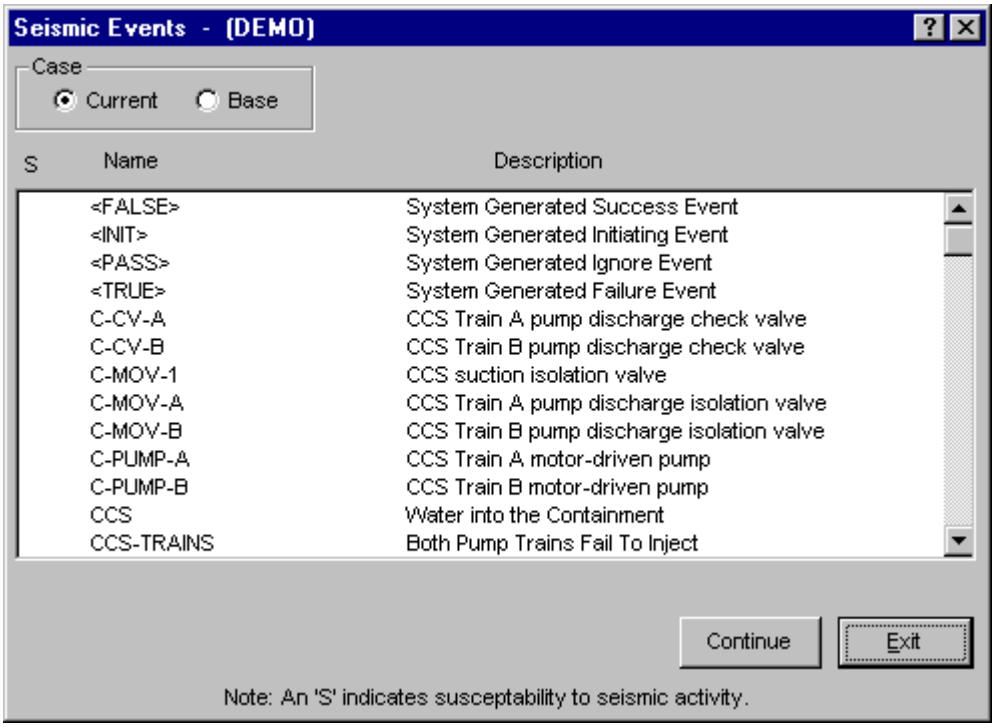
10.7.10.1 Seismic

PURPOSE

This option allows you to generate a seismic event report. The report shows the primary event name, fragility, beta R, beta U, and HCLPF values for all seismic events.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Basic Events** *Data Type* and the **Seismic** *Report Type* radio buttons.
3. Choose the **Process** button. The *Seismic Events* dialog will be displayed. An "S" to the left of the event name indicates that the event is susceptible to seismic activity.
4. Highlight the desired basic event(s) or process all records.
5. Select the desired *Case* radio button.
6. Choose the **Continue** button.



Case

Current - Use current case values for all calculations. This is the default.
Base - Use base case values for all calculations.

Continue - Generate the report based on event selections. The *Report* dialog will be displayed and output destination for the report must be specified.

Exit - Close the *Seismic Events* dialog without generating a report.

10.7.10.2 Seismic Event - Definition

A seismic event has a calculation type of G (ground acceleration for screening G-levels) or H (hazard curve for screening G-levels), a distribution type of S (seismic log normal, Beta r, Beta u), and Susceptibility flag 4 set to "Y".

10.8 Fault Tree Reports

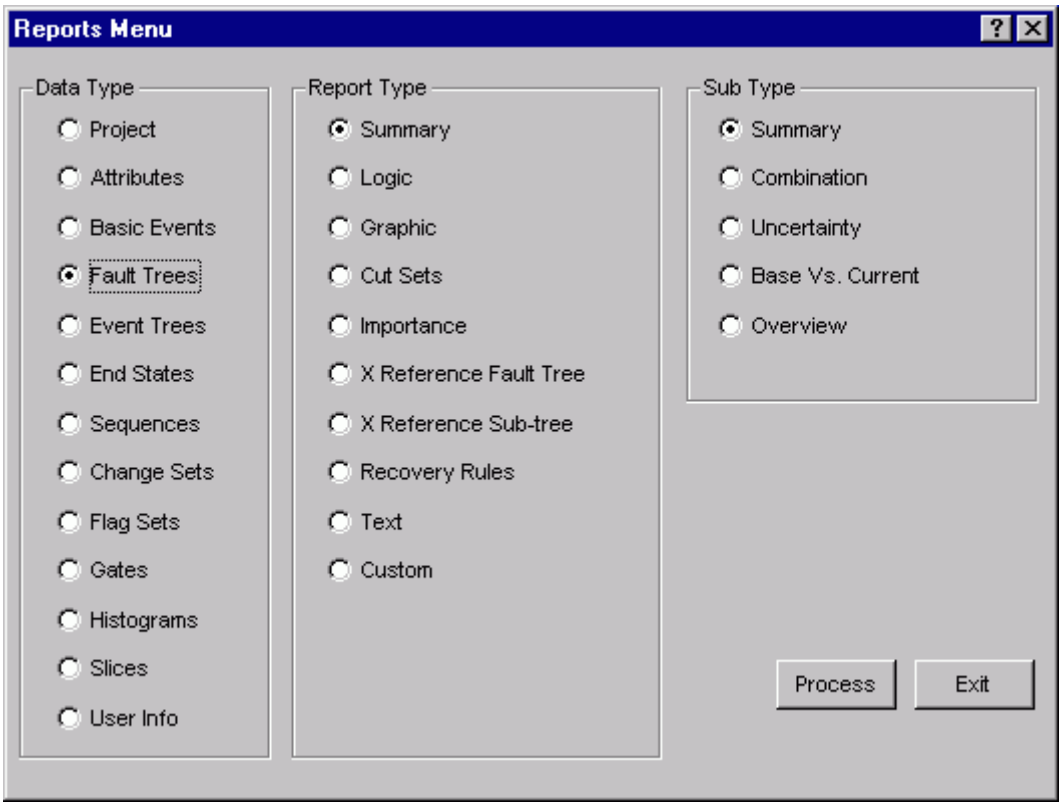
10.8.1 Fault Tree

PURPOSE

This option allows you to generate a variety of fault tree reports. These include summary, logic, cut sets, importance, and cross reference reports.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Fault Tree** *Data Type* and one of the *Report Type* radio buttons. Depending on the *Report Type* selected, you may be required to select an associated *Sub Type* as well.
3. Choose the **Process** button.
4. Highlight the desired fault tree(s) or process all records.
5. Choose the appropriate buttons to generate the report. The Report Viewer will display the report.



Report Type

Summary -	This option allows you to generate various fault tree summary reports.
Logic -	Generate a report showing the fault tree logic information associated with each selected fault tree.
Graphic -	Generate graphical logic reports either to a printer or word processing compatible files.
Cut Sets -	Generate a report displaying cut set information for each selected fault tree.
Importance -	Generate a report listing associated importance measures information for each selected fault tree.
X-Reference Fault Tree -	This option allows you to generate logic cross reference reports for fault trees.
X-Reference Sub-tree -	This option allows you to generate logic cross reference reports for sub-trees.
Recovery Rules -	This report outputs a listing of the recovery rule logic that applies to each selected fault tree. Choose the **Basic** or **Advanced** radio button to indicate the desired rule type.
Text -	Generate a report containing the descriptive text associated with the selected fault tree(s).
Custom -	Create or select a user-defined report relating to fault tree level information.

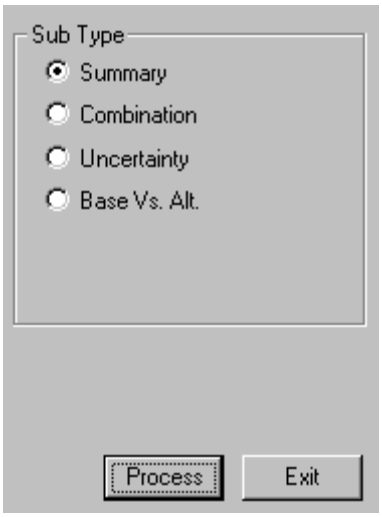
10.8.2 Fault Tree Summary Report

PURPOSE

This option allows you to generate fault tree summary reports that are based on current or base case values for a specified analysis type.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Fault Tree** *Data Type* and the **Summary** *Report Type* radio buttons.
3. Select the desired *Sub Type* radio button then choose the **Process** button.
4. Select the desired *Case* radio button.
5. Select the desired analysis type from the drop-down list.
6. Highlight the desired fault tree(s) or process all records.
7. Choose the **Continue** button to generate the report. The Report Viewer will display the report.



Case

Current - Use current case values for all calculations. This is the default.

Base - Use base case values for all calculations.

Summary - Generate the Fault Tree Brief Summary Report. This report contains the name, the associated minimum cut set upper bound, and the description of the selected fault trees.

Combination - Generate the Fault Tree Combination Report. This report contains the name, minimum cut set upper bound, mean, and number of cut sets in the selected fault trees.

Uncertainty - Generate the Fault Tree Uncertainty Value Report. This report contains the number, name, mean and median values, standard deviation, the 5th and 95th percentile, the minimum and maximum values, and the seed size of the selected fault trees.

BaseVs.Current-Generate the Fault Tree Base/Current Report. For each selected fault tree, this report contains the name, the minimal cut set upper bound for the base case and current case cut sets, the difference (base - current), and the number of base case and current case cut sets.

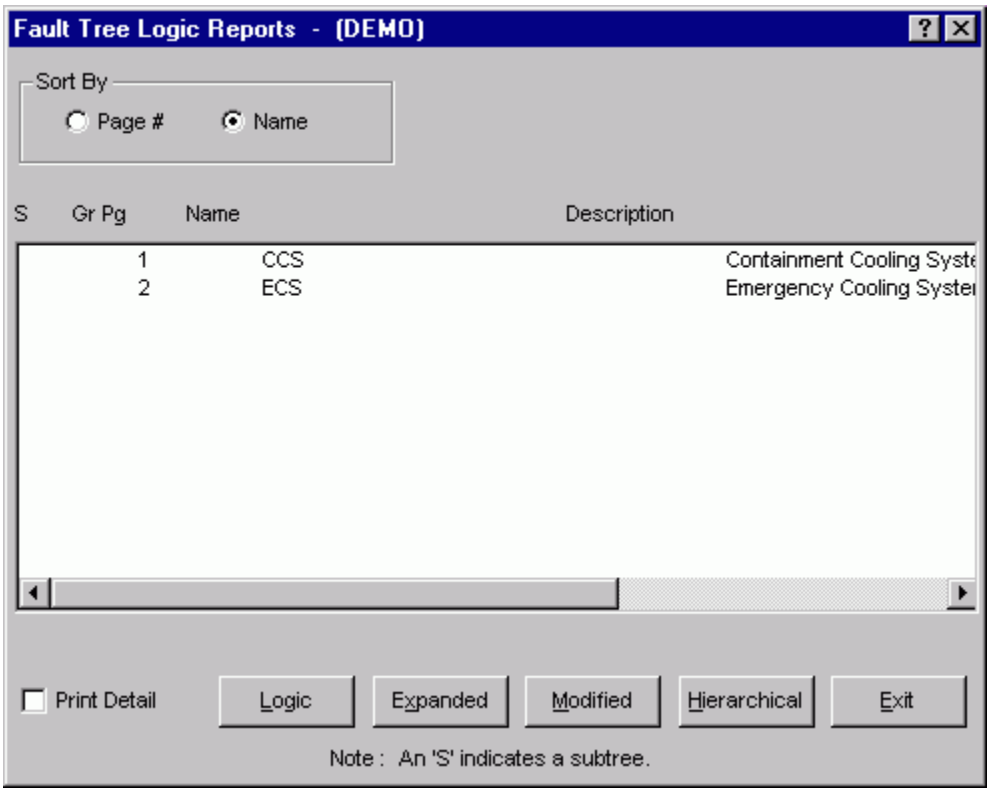
10.8.3 Fault Tree Logic Report

PURPOSE

This option generates fault tree logic reports.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Fault Tree** *Data Type* and the **Logic** *Report Type* radio buttons.
3. Choose the **Process** button. The *Fault Tree Logic Reports* dialog will be displayed, showing all of the **fault trees** in the currently selected project.
4. Highlight the desired **fault tree**(s) or process all records.
5. Choose the desired button to generate the report. The Report Viewer will display the report.



Sort By

Page # - The fault list (and selected report items) will appear according to the page numbers assigned to each fault tree (see Fault Tree Page Numbering utility for information on how to assign page numbering.)

Name - The fault list (and selected report items) will appear in alphabetic order.

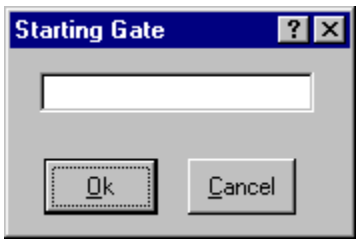
Print Detail - When checked, report will include event and gate descriptive information. This information is omitted from the reports when the option is unchecked.

Logic - Generate the Fault Tree Logic Report consisting of the logic as it is stored in the SAPHIRE database, including gate names, types, and inputs for the specified fault trees(s) or sub-tree(s). Transfer gates will not be expanded.

Expanded - Generate the Fault Tree Expanded Logic Report consisting of the gate names, types, and inputs for the specified fault tree(s), including the logic of the fault trees represented by any transfer gates. When you choose this button, you will be prompted to enter a starting gate for the report. You may specify a gate or leave the field blank to include all gates.

Modified - Generate the Fault Tree Modified Logic Report consisting of the logic after it is loaded and restructured to the point just prior to cut set generation. When you choose this button, you will be prompted to enter a starting gate for the report. You may specify a gate or leave the field blank to include all gates.

Hierarchical - Generate the Hierarchical Logic Report. This option presents the logic in a format similar to that displayed in the Logic Editor. Gate and Event information is indented according to their position in the logic. (The *Print Detail* option does not affect this report - event and gate descriptions are always included.)



Exit - Close the *Fault Tree Logic Reports* dialog without generating a report.

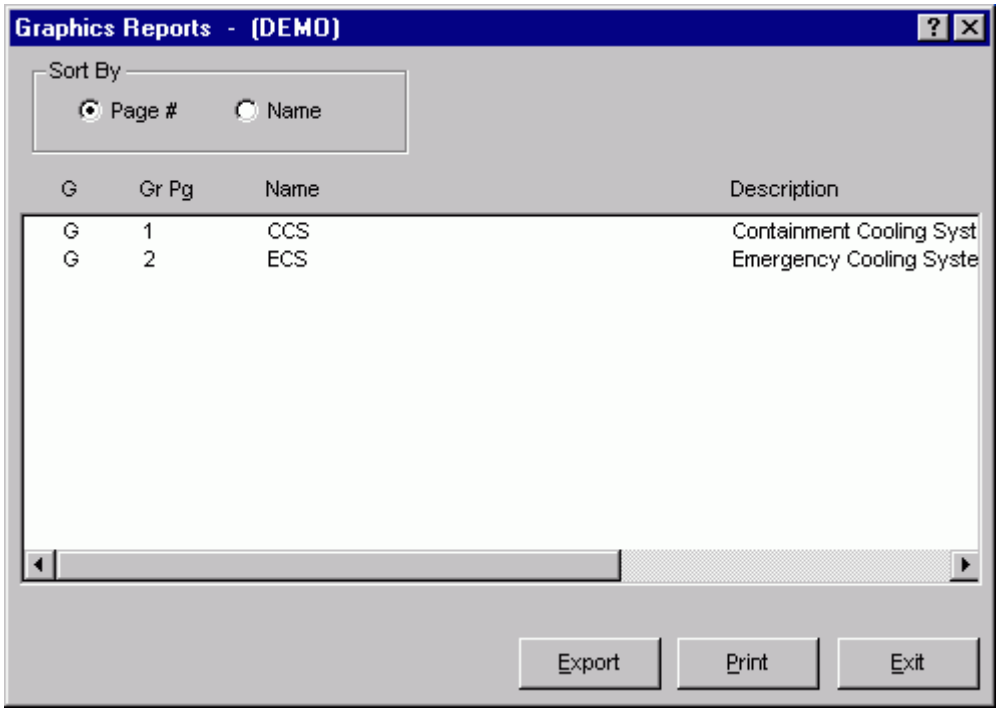
10.8.4 Fault Tree Graphics Report

PURPOSE

This option allows you to generate a printout the selected fault tree(s).

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Fault Tree** *Data Type* and the **Graphic** *Report Type* radio buttons.
3. Choose the **Process** button. The *Graphics Reports* dialog will be displayed, showing all of the fault trees in the currently selected project. A "G" next to the name indicates a graphic (.DLS) file is available.
4. Highlight the desired fault tree(s) or process all records.
5. Choose the **Print** button to generate the report.



Sort By

Page # - The fault list (and selected report items) will appear according to the page numbers assigned to each fault tree (see Fault Tree Page Numbering utility for information on how to assign page numbering.)

Name - The fault list (and selected report items) will appear in alphabetic order.

Export - Convert the graphic file(s) to either a file in Enhanced Metafile (EMF) or Windows Metafile (WMF) format.

Print - *Print* the graphic file(s) to the designated printer.

Exit - Close the *Graphics Reports* dialog without generating a report.

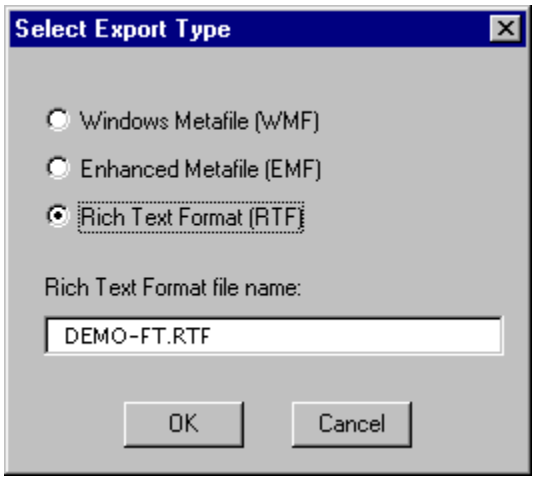
10.8.5 Graphics Export

PURPOSE

This option allows you to export the selected fault tree or event tree diagram(s) in WMF or EMF format.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Fault Tree/Event Tree** *Data Type* and the **Graphic** *Report Type* radio buttons.
3. Choose the **Process** button. The *Graphics Reports* dialog will be displayed, showing all of the fault trees/event trees in the currently selected project. A "G" next to the name indicates a graphic (.DLS/.ETG) file is available.
4. Highlight the desired fault tree(s)/event tree(s) or process all records.
5. Choose the **Export** button. The *Select Export Type* dialog will be displayed.



WMF – Export the diagram to Windows Metafile format.
EMF – Export the diagram to Enhanced Metafile format.
RTF – Export the diagram to Rich Text Format.
Cancel – Close the *Select Export Type* dialog without exporting the file(s).

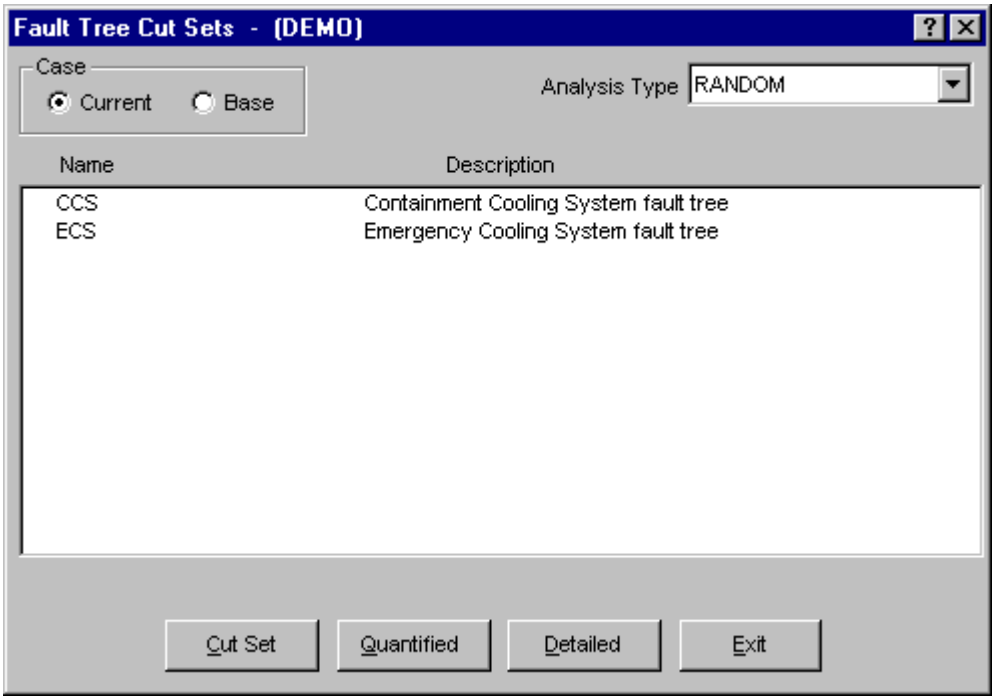
10.8.6 Cut Sets Report

PURPOSE

This option allows you to generate cut set reports based the selected analysis type and on current or base case values.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Fault Tree** *Data Type* and the **Cut Sets** *Report Type* radio buttons.
3. Choose the **Process** button. The *Fault Tree Cut Sets* dialog will be displayed, listing all of the fault trees residing in the current project.
4. Select the desired *Case* radio button.
5. Select the desired analysis type from the drop-down list.
6. Highlight the desired fault tree(s) or process all records
7. Choose the desired button to generate the report. The Report Viewer will display the report.



Case

Current - Use current case values for all calculations. This is the default.

Base - Use base case values for all calculations.

Cut Set - Generate the Fault Tree Cut Sets Report which consists of the cut set number, size, and the basic event names that are included in the corresponding cut sets (current or base) for the selected fault tree(s). When you choose this button, the *Cut Set Report Options* dialog will be displayed.

Quantified - Generate the Fault Tree Cut Set (Quantification) Report for quantified cut sets only. The report consists of the cut set number, percent of total, percent of the cut set, probability/frequency and the basic event names that are included in the associated cut sets (current or base) for the selected fault tree(s). When you choose this button, the *Cut Set Report Options* dialog will be displayed.

Detailed - Generate the Fault Tree Cut Set (Detailed) Report which consists of the cut set number, percent of the cut set, probability/frequency, and the basic event names and descriptions included in associated cut sets (current or base) for the selected fault tree(s). When you choose this button, the *Cut Set Report Options* dialog will be displayed.

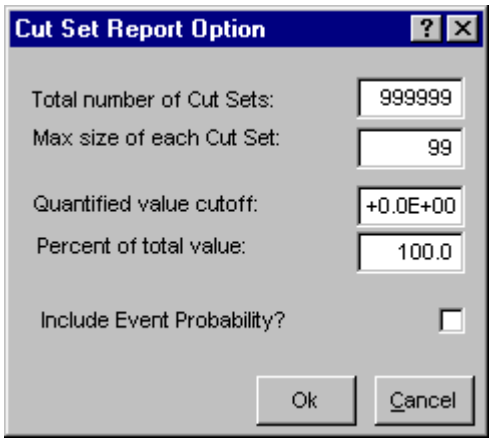
Exit - Close the *Fault Tree Cut Sets* dialog without generating a report.

10.8.7 Cut Set Report Options

PURPOSE

This option allows you to specify several cut set cutoff values that will be used to determine if a cut set is to be included in the report.

You can modify any of the default values provided by typing over the existing data.



Total number of Cut Sets - The number of cut sets included in the report will not exceed this number. Cut sets are considered beginning with the cut that contributes the highest percent frequency.

Max size of each Cut Set - Include only those cut sets that contain no more than the number of events entered here.

Quantified value cutoff - Include only those cut sets whose frequency is greater than or equal to the value entered here. Applies only to the *Quantified* and *Detailed* cut set reports.

Percent of total value - Include only those cut sets whose sum of the percent contribution is less than this value, beginning with the cut set that contributes the greatest percent. By entering 100.0 (the default) here, all cut sets will be included.

Include Event Probability? - Preface the report with a list of each of the basic events referenced in the cut sets along with the basic event probabilities.

Ok - Generate the report based on the specified cutoff values. The Report Viewer will display the report.

Cancel - Close the *Cut Set Report Option* dialog without generating a report.

10.8.8 Fault Tree Importance Report

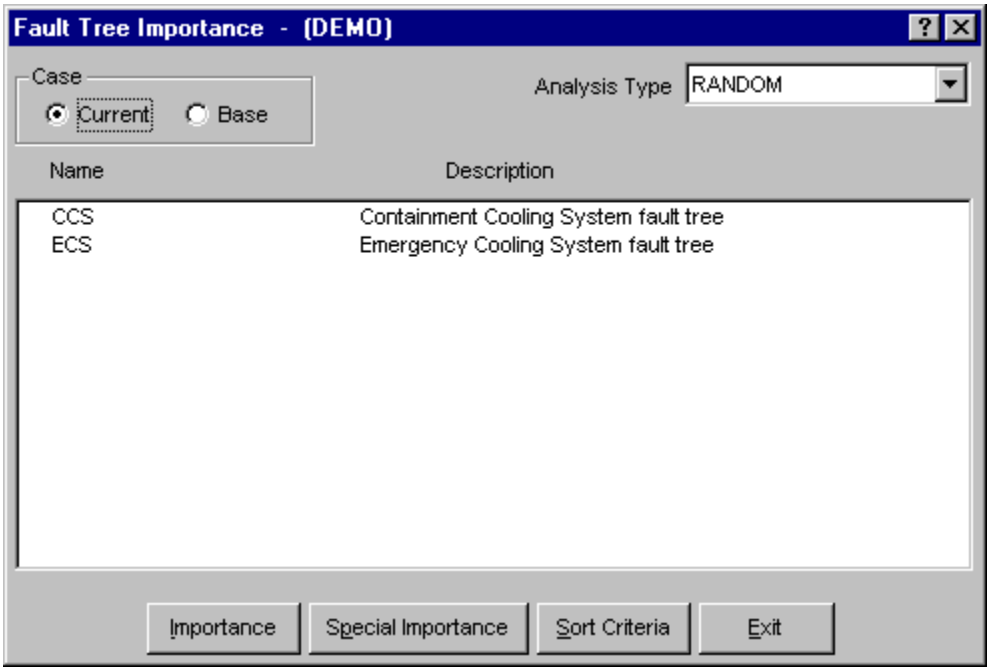
PURPOSE

This option allows you to generate importance reports based the selected analysis type and on current or base case values.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.

2. Select the **Fault Tree** *Data Type* and **Importance** *Report Type* radio buttons.
3. Choose the **Process** button. The *Fault Tree Importance* dialog will be displayed, listing all of the fault trees residing in the current project.
4. Select the desired *Case* radio button.
5. Select the desired analysis type from the drop-down list.
6. Highlight the desired fault tree(s) or process all records.
7. Choose the desired button to generate the report. The Report Viewer will display the report.



Case

Current - Use current case values for all calculations. This is the default.
Base - Use base case values for all calculations.

Importance - Generate the Fault Tree Importance Measures report consisting of event names, number of times the event occurs, probability of failure, uncertainty importance value, risk reduction difference, and risk increase difference for the selected fault tree(s).

Special Importance - Generate the Fault Tree Importance Measures report consisting of event names, probability of failure, Fussell-Vesely value, risk reduction ratio, risk increase ratio, Birnbaum importance value, and event descriptions for the selected fault tree(s).

Sort Criteria - Select the sort order in which to display the Fault Tree Importance Measures Report. When you choose this button, the *Select Sort Criteria* dialog will be displayed.

Exit - Close the *Fault Tree Importance* dialog without generating a report.

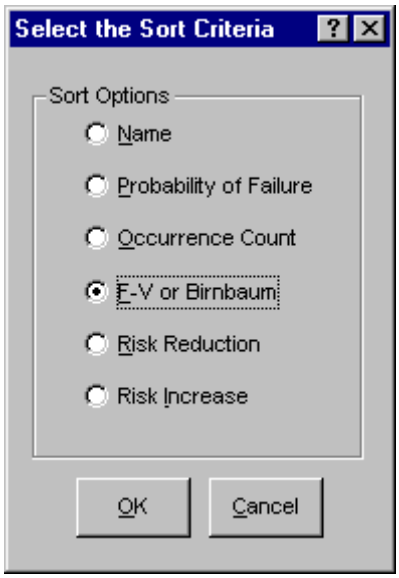
10.8.9 Select Sort Criteria

PURPOSE

This option allows you to select the sort order in which to display the Fault Tree/Sequence/End State Importance Measures Report.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Fault Tree/Sequence** *Data Type* and **Importance** *Report Type* radio buttons.
3. Choose the **Process** button. The *Fault Tree/Sequence Importance* dialog will be displayed, listing all of the fault trees residing in the current project.
4. Select the desired *Case* radio button.
5. Select the desired analysis type from the drop-down list.
6. Highlight the desired fault tree(s) or process all records.
7. Choose the **Sort Criteria** button to select the sort order and choose OK.
8. Choose the desired report button from the *Fault Tree/Sequence Importance* dialog. The Report Viewer will display the report in the specified order.



Name -	Sort by event name
Probability of Failure -	Sort by the probability failures
Occurrence Count -	Sort by the number of occurrences (most to fewest)
F-V or Birnbaum -	Sort in Fussell-Vesely or Birnbaum order
Risk Reduction -	Sort in risk reduction ratio or difference order
Risk Increase -	Sort in risk increase ratio or difference order.

OK - Closes the *Select the Sort Criteria* dialog and saves the sort option.
Cancel - Closes the *Select the Sort Criteria* dialog without saving the sort option.

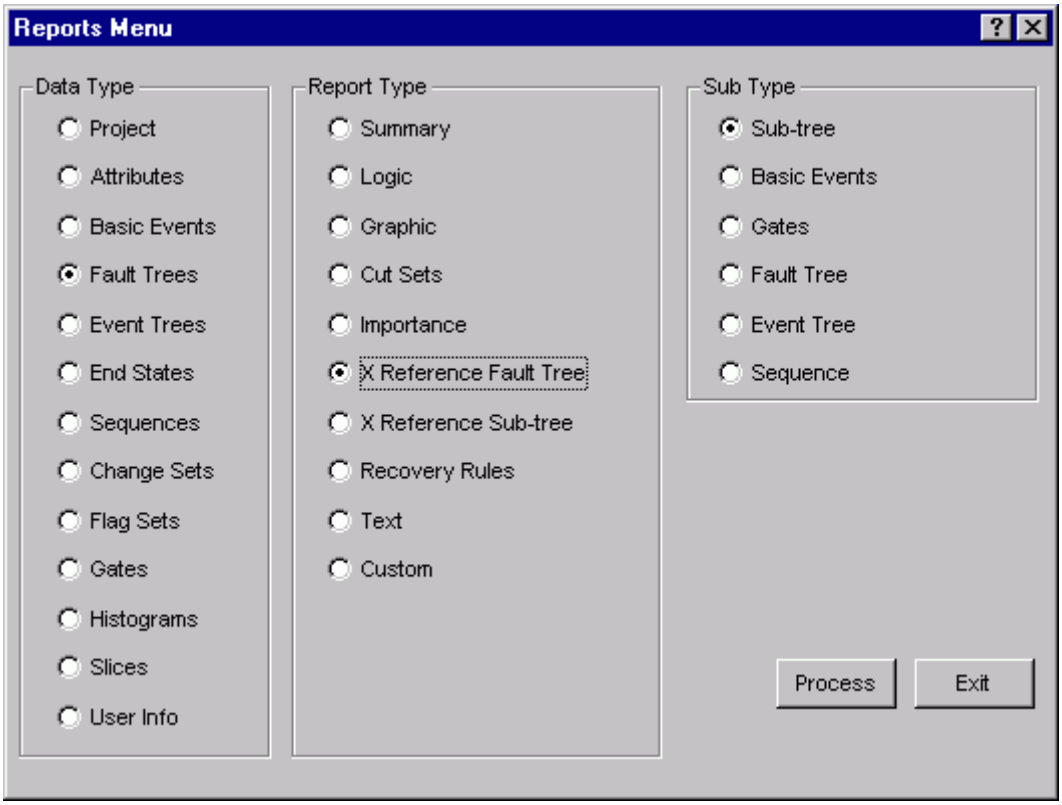
10.8.10 X-Reference Fault Tree

PURPOSE

This option allows you to generate logic cross reference reports for fault trees.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Fault Tree** *Data Type* and the **X Reference Fault Tree** *Report Type* radio buttons.
3. Select the desired *Sub Type* radio button.
4. Choose the **Process** button. From the subsequent *Reports* dialog, highlight the desired fault tree(s) or process all records. Notice that no sub-trees are included in this list.
5. Choose the **Continue** button to generate the report. The Report Viewer will display the report.



Sub-tree - Generate the Fault Tree Hierarchy Report. Each selected fault tree will be placed on a separate page with the selected fault tree name and a list of all sub-trees it uses.
Basic Events - Generate the Fault Tree/Basic Event Reference Report consisting of the selected fault tree(s) and a corresponding list of all basic events used by that fault tree.

Gates - Generates the Fault Tree/Gate Reference Report consisting of the selected fault tree(s) and a corresponding list of gates used by that fault tree.

Fault Tree - Generate the Sub-tree Cross Reference Report consisting of the selected fault tree(s) listed as the Sub-tree Name with the corresponding trees using that sub-tree.

Event Tree - Generate the Fault Tree/Event Tree Reference Report consisting of the selected fault tree(s) and the corresponding event tree logic or rules using that fault tree.

Sequence - Generate the Fault Tree/Sequence Reference Report consisting of the selected fault tree(s) and the corresponding event trees and sequences using that fault tree.

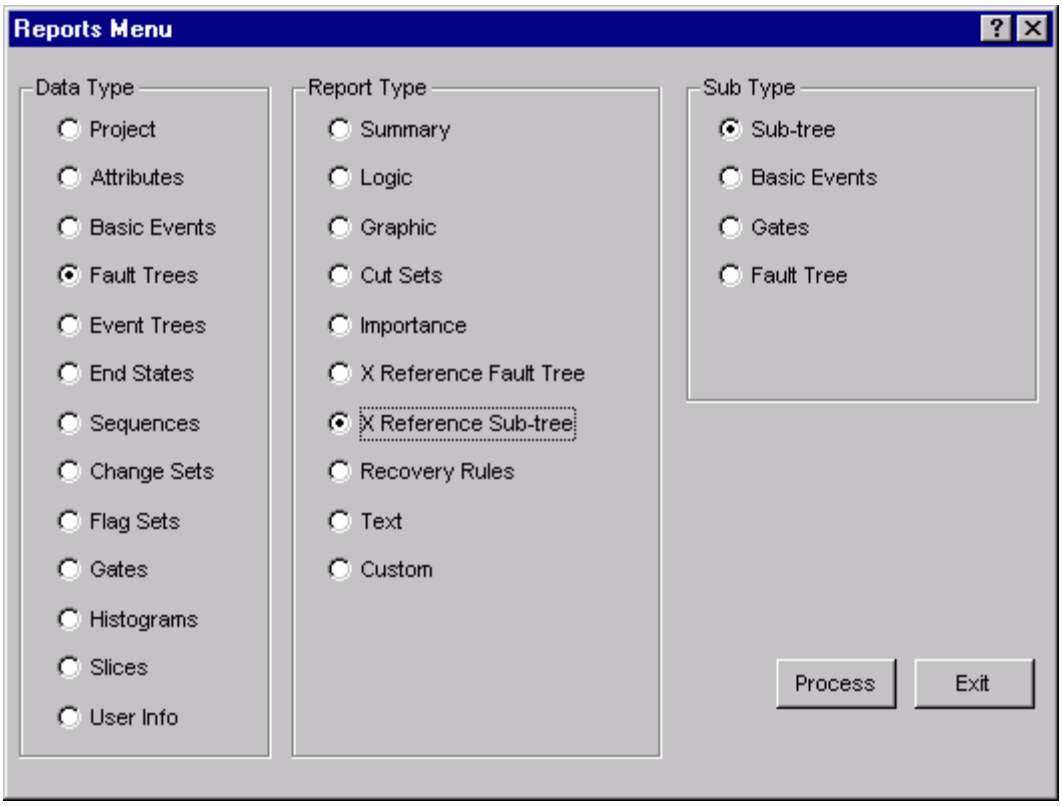
10.8.11 X-Reference Sub-tree

PURPOSE

This option allows you to generate logic cross reference reports for sub-trees.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Fault Tree** *Data Type* and the **X Reference Sub-tree** *Report Type* radio buttons.
3. Select the desired *Sub Type* radio button.
4. Choose the **Process** button.
5. From the subsequent *Reports* dialog, highlight the desired sub-tree(s) or process all records. Notice that both fault trees and sub-trees are included in this list
6. Choose the **Continue** button to generate the report. The Report Viewer will display the report.



Sub-tree - Generate the Fault Tree Hierarchy Report. Each selected fault tree or sub-tree will be placed on a separate page with the selected fault tree name and of a list of all sub-trees it uses.

Basic Events - Generate the Fault Tree/Basic Event Reference Report consisting of the selected fault tree(s) and/or sub-tree(s) and a corresponding list of all basic events used by that fault tree.

Gates - Generates the Fault Tree/Gate Reference Report consisting of the selected fault tree(s) and/or sub-tree(s) and a corresponding list of gates used by that fault tree.

Fault Tree - This option generates the Sub-tree Cross Reference Report consisting of a sub-tree and a list of all fault trees/sub-trees that reference or use it.

10.9 Event Tree Reports

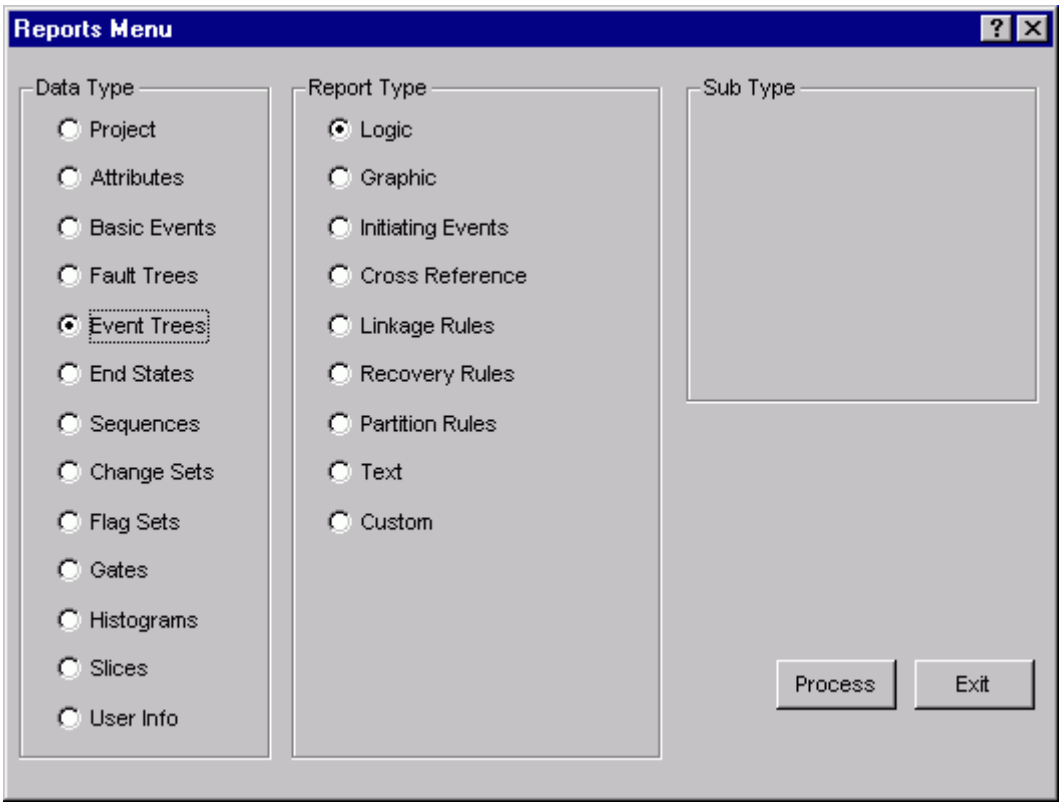
10.9.1 Event Tree

PURPOSE

This option generates a variety of event tree reports. The following reports may be generated: Logic/Rules, Graphics, Initiating Events, and Cross Reference.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Event Tree** *Data Type* and one of the *Report Type* radio buttons.
3. Choose the **Process** button.
4. Highlight the desired event tree(s) or process all records.
5. Choose the appropriate buttons to generate the report. The Report Viewer will display the report.



Report Type

Logic - Generate a report showing the sequence logic information associated with each selected event tree.

Graphic - Generate graphical logic reports either to a printer or word processing compatible files.

Initiating Events - Generate a report summarizing the initiating event and description and top/subtree status of the selected event tree(s).

Linkage Rules - This report outputs a listing of the linkage rule logic defined for each event tree. Choose the **Basic** or **Advanced** radio button to indicate the desired rule type.

Recovery Rules - This report outputs a listing of the recovery rule logic that applies to all sequence cut sets within each selected event tree. Choose the **Basic** or **Advanced** radio button to indicate the desired rule type.

Partition Rules - This report outputs a listing of the partition rule logic that applies to all sequence cut sets within each selected event tree. Choose the **Basic** or **Advanced** radio button to indicate the desired rule type.

Text - Generate a report containing the descriptive text associated with the selected event tree(s).

Custom - Create or select a user-defined report relating to event tree level information.

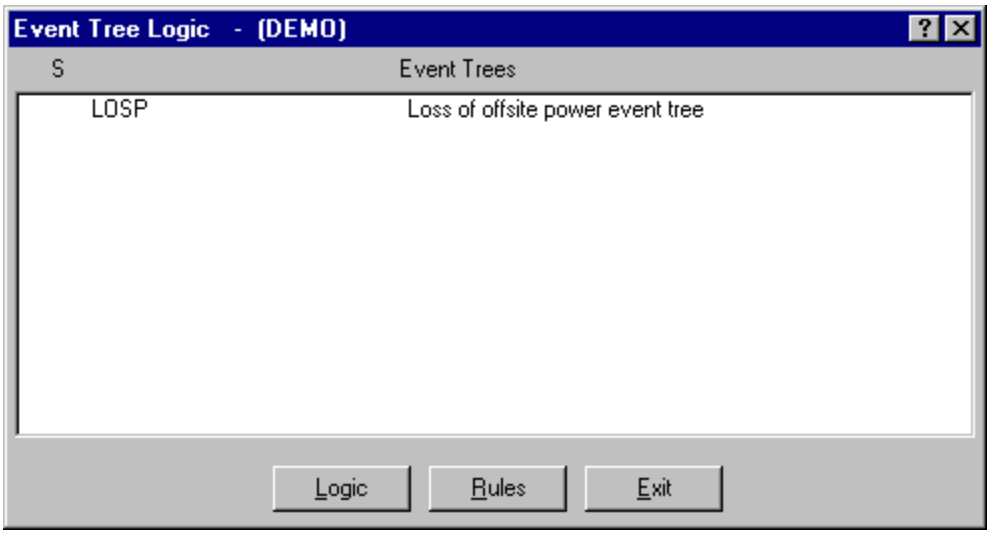
10.9.2 Event Tree Logic

PURPOSE

This option allows you to generate the Event Tree Logic Report and the Event Tree Rules report.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Event Tree** *Data Type* and the **Logic** *Report Type* radio buttons.
3. Choose the **Process** button. The *Event Tree Logic* dialog will be displayed, listing all of the event trees contained in the current project. An "S" to the left of the event tree name indicates a sub-tree.
4. Highlight the desired event tree(s) or process all records.
5. Choose the desired button to generate the report. The Report Viewer will display the report.



Logic - Produce the Event Tree Logic Report. This report lists all sequence names and the associated logic (pass/fail) associated with each selected event tree.

Rules - Produce the Event Tree Linkage Rules Report. This report lists all linkage rules (exceptions) associated with each selected event tree.

Exit - Close the *Event Tree Logic* dialog without generating a report.

After report options have been selected and the button chosen, the *Report* dialog will be displayed at which point the output destination for the report must be specified.

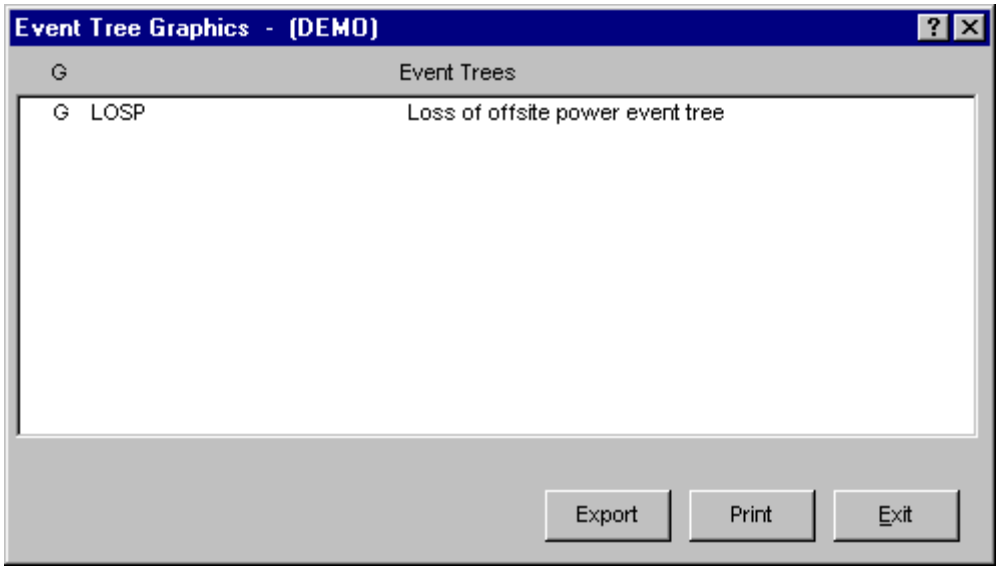
10.9.3 Event Tree Graphics

PURPOSE

This option allows you to generate a printout the selected event tree(s).

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Event Tree** *Data Type* and the **Graphic** *Report Type* radio buttons.
3. Choose the **Process** button. The *Event Tree Graphics* dialog will be displayed, showing all of the event trees in the currently selected project. A "G" next to the name indicates a graphic (.ETG) file is available.
4. Highlight the desired event tree(s) or process all records.
5. Choose the **Print** button to generate the report.



Export - Convert the graphic file(s) to either a file in Enhanced Metafile (EMF) or Windows Metafile (WMF) format.
Print - *Print* the graphic file(s) to the designated printer.
Exit - Close the *Graphics Reports* dialog without generating a report.

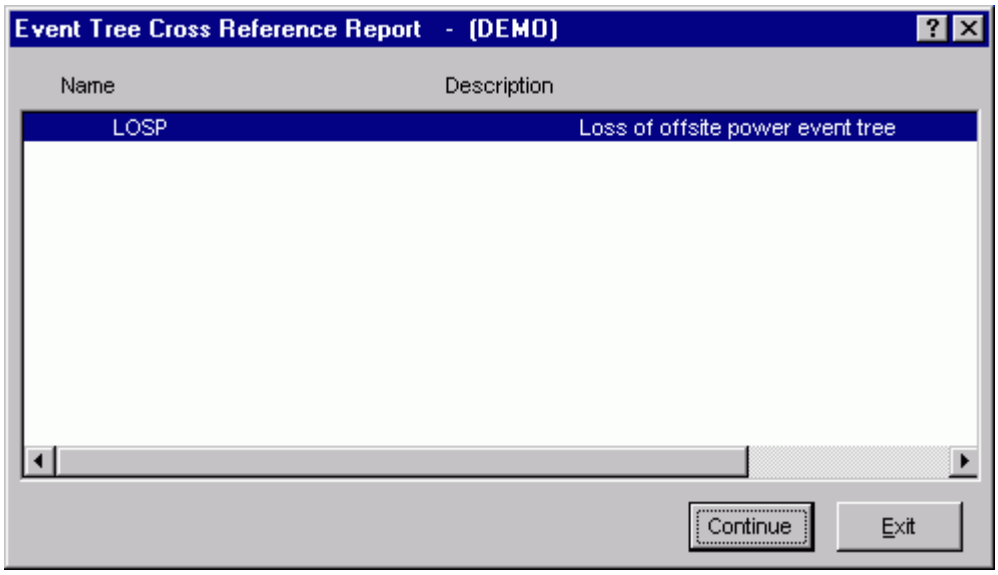
10.9.4 Initiating Events Report

PURPOSE

This option allows you to generate the Event Tree Initiating Events Report. This report contains the event tree name and the corresponding event tree description and initiating event for all event trees in the current project.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Event Tree** *Data Type* and the **Initiating Events** *Report Type* radio buttons.
3. Choose the **Process** button.
4. Highlight the desired event tree(s) or process all records.
5. The Report Viewer will display the report.



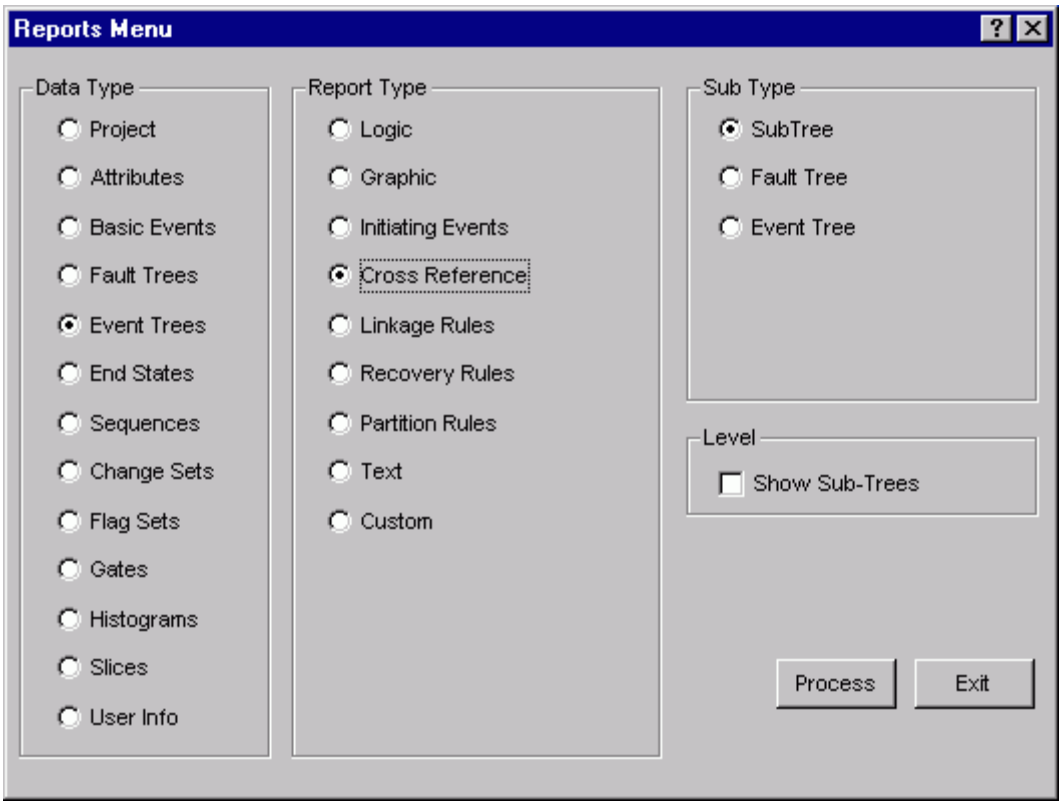
10.9.5 Cross Reference

PURPOSE

This option provides the means for generating a cross reference report for event trees or sub-trees.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Event Tree** *Data Type* and the **Cross Reference** *Report Type* radio buttons.
3. Select the desired Sub Type radio button and the Show Sub-Trees check box, if desired.
4. Choose the **Process** button.
5. From the subsequent dialog, highlight the desired event tree(s) or process all records.
6. Choose the **Continue** button to generate the report. The Report Viewer will display the report.



Level

Show Sub-trees - Include the event trees marked as sub-trees in the list of event trees.

SubType

Sub-tree - Generate the Sub Event Tree Hierarchy Report. Each selected event tree or sub-tree will be placed on a separate page with the selected event tree name and of a hierarchical list of all sub-trees it uses.

Fault Tree - Generate the Event Tree / Fault Tree Reference Report consisting of the selected event tree(s) and/or sub-tree(s) name with the corresponding list of fault trees that it uses.

Event Tree - Generate the Sub-tree Cross Reference Report consisting of the selected event tree(s) and/or sub-tree(s) name and the corresponding trees that use it.

10.10 End State Reports

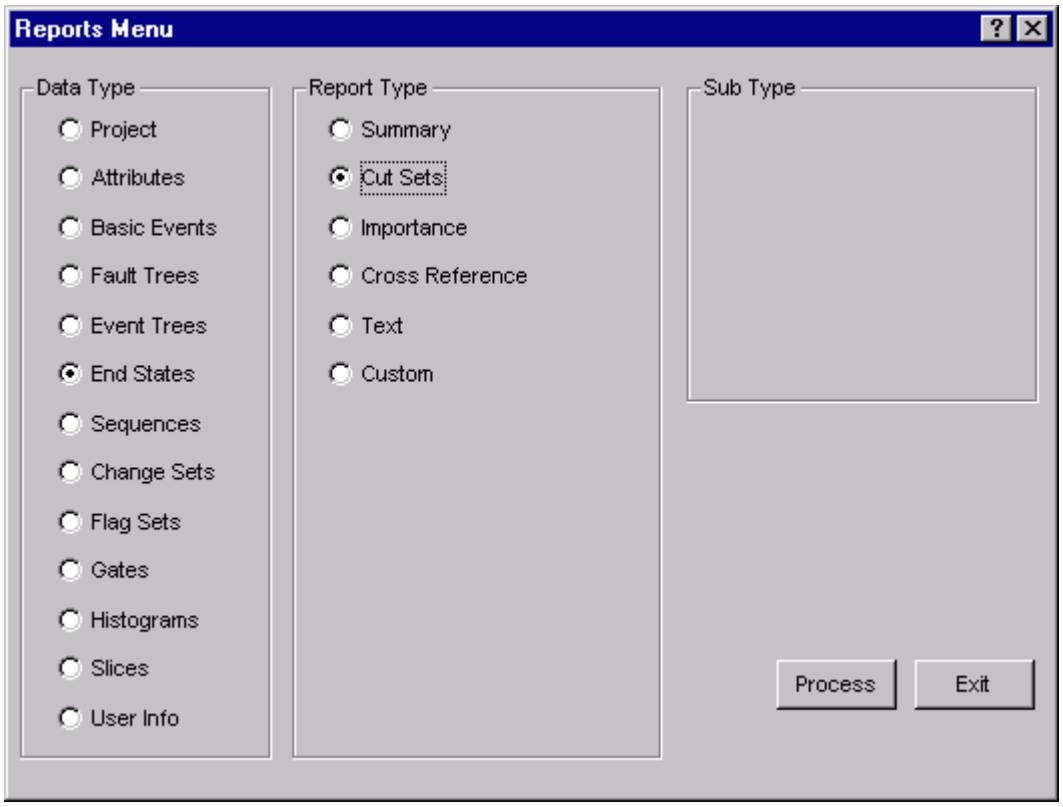
10.10.1 End State

PURPOSE

This option provides the means to generate end state reports. These include summary, combination, uncertainty, and base vs. current case reports.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **End State** *Data Type* and one of the *Report Type* radio buttons.
3. Choose the **Process** button.
4. From the subsequent dialog, highlight the desired end state(s) or process all records.
5. Choose the appropriate buttons to generate the report. The Report Viewer will display the report.



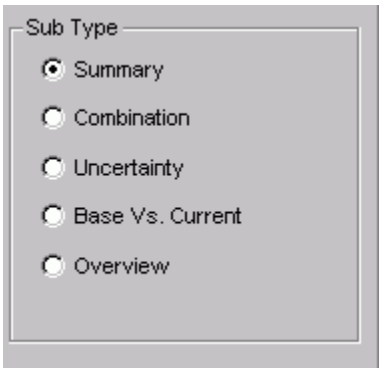
10.10.2 End State Summary Report

PURPOSE

This option allows you to generate an end state summary report based on current or base case values for a specified analysis type.

STEPS

1. From the SAPHIRE menu select **Report** The *Reports Menu* dialog will be displayed.
2. Select the **End State** *Data Type* and the **Summary** *Report Type* radio buttons.
3. Choose the desired *Sub Type* radio button then
4. Choose the **Process** button.
5. From the subsequent dialog, select the desired *Case* radio button and the desired analysis type from the drop-down list.
6. Highlight the desired end state(s) or process all records
7. Choose the **Continue** button to generate the report. The Report Viewer will display the report.



Case

Current - Use current case values for all calculations. This is the default.
Base - Use base case values for all calculations.

Summary - Generate the End State Brief Summary Report. This report contains the name, the associated minimum cut set upper bound, and the description of the selected fault trees.

Combination - Generate the End State Combination Report. This report contains the name, minimum cut set upper bound, mean, and number of cut sets in the selected fault trees.

Uncertainty - Generate the End State Uncertainty Value Report. This report contains the number, name, mean and median values, standard deviation, the 5th and 95th percentile, the minimum and maximum values, and the seed size of the selected end states

Base Vs. Current - Generate the End State Base/Current Report. For each selected fault tree, this report contains the name, the minimal cut set upper bound for the base case and current case cut sets, the difference (base - current), and the number of base case and current case cut sets.

Overview - This option is not yet implemented.

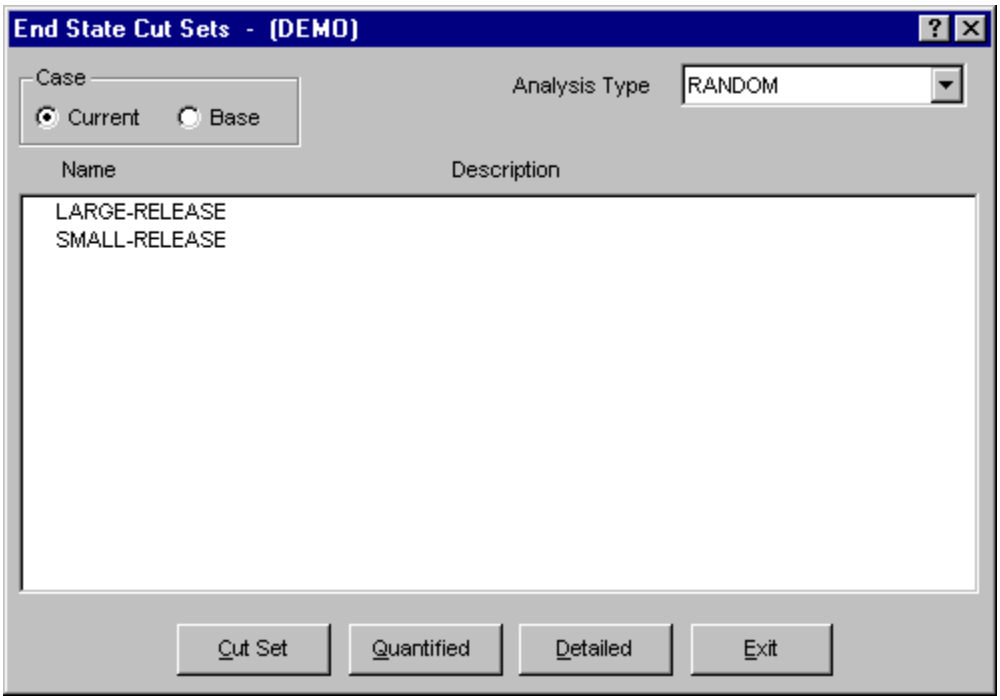
10.10.3 End State Cut Sets Report

PURPOSE

This option allows you to generate cut set reports based on current and base case values for a specified analysis type.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **End State** *Data Type* and the Cut Sets *Report Type* radio buttons.
3. Choose the **Process** button. The *End State Cut Sets* dialog will be displayed, listing all of the end states residing in the current project.
4. Select the desired *Case* radio button.
5. Select the desired analysis type from the drop-down list.
6. Highlight the desired end state(s) or process all records
7. Choose the desired button to generate the report. The Report Viewer will display the report.



Case

Current - Use current case values for all calculations. This is the default.
Base - Use base case values for all calculations.

Cut Set - Generate the End State Cut Sets Report which consists of the cut set number, size, and the basic event names that are included in the corresponding cut sets (current or base) for the selected end state(s). When you choose this button, the *Cut Set Report Options* dialog will be displayed.

Quantified - Generate the End State Cut Sets (Quantification) Report for quantified cut sets only. The report consists of the cut set number, percent of total, percent of the cut set, probability/frequency and the basic event names that are included in the associated cut sets (current or base) for the selected end state(s). When you choose this button, the *Cut Set Report Options* dialog will be displayed.

Detailed - Generate the End State Cut Sets (Detailed) Report which consists of the cut set number, percent of the cut set, probability/frequency, and the basic event names and descriptions included in associated cut sets (current or base) for the selected end state(s). When you choose this button, the *Cut Set Report Options* dialog will be displayed.

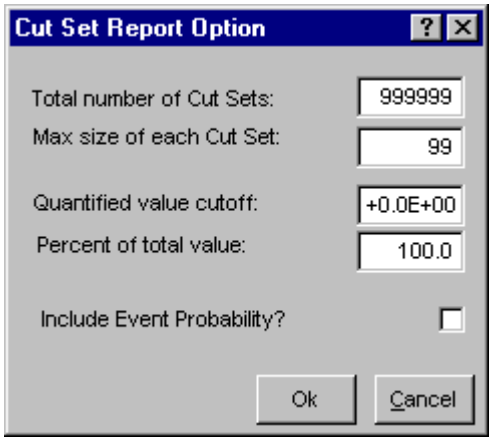
Exit - Close the *End State Cut Sets* dialog without generating a report.

10.10.4 Cut Set Report Options

PURPOSE

This option allows you to specify several cut set cutoff values that will be used to determine if a cut set is to be included in the report.

You can modify any of the default values provided by typing over the existing data.



Total number of Cut Sets -	The number of cut sets included in the report will not exceed this number. Cut sets are considered beginning with the cut that contributes the highest percent frequency.
Max size of each Cut Set -	Include only those cut sets that contain no more than the number of events entered here.
Quantified value cutoff -	Include only those cut sets whose frequency is greater than or equal to the value entered here. Applies only to the *Quantified* and *Detailed* cut set reports.
Percent of total value -	Include only those cut sets whose sum of the percent contribution is less than this value, beginning with the cut set that contributes the greatest percent. By entering 100.0 (the default) here, all cut sets will be included.
Include Event Probability? -	Preface the report with a list of each of the basic events referenced in the cut sets along with the basic event probabilities.
Ok -	Generate the report based on the specified cutoff values. The Report Viewer will display the report.
Cancel -	Close the *Cut Set Report Option* dialog without generating a report.

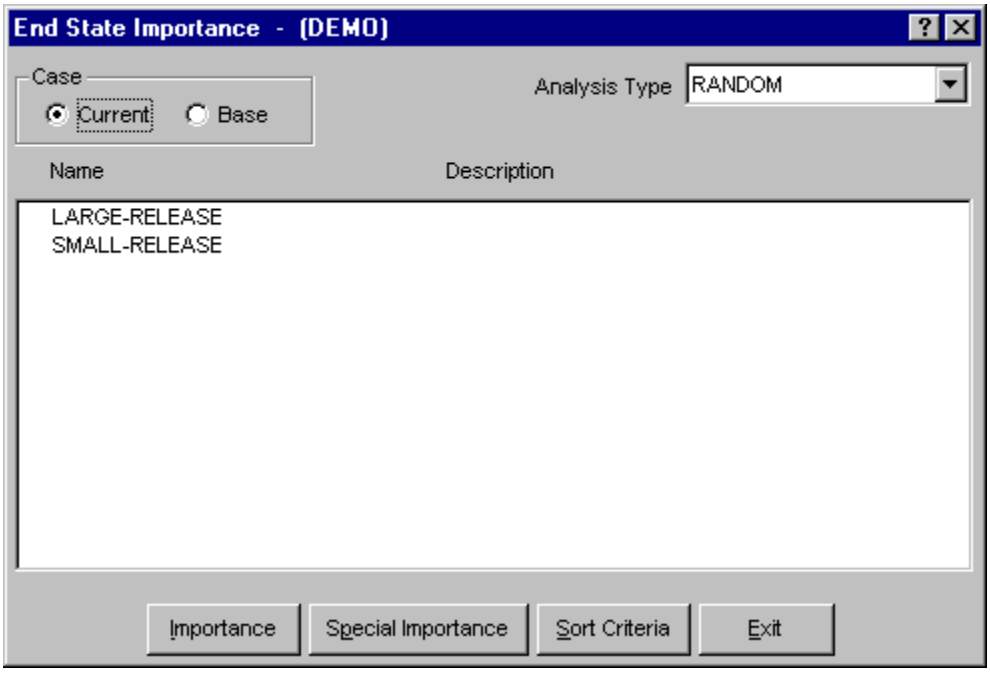
10.10.5 End State Importance Reports

PURPOSE

This option allows you to generate end state importance reports based the selected analysis type and on current or base case values.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **End State** *Data Type* and the **Importance** *Report Type* radio buttons.
3. Choose the **Process** button. The *End State Importance* dialog will be displayed, listing all of the end states residing in the current project.
4. Select the desired *Case* radio button.
5. Select the desired analysis type from the drop-down list.
6. Highlight the desired end state(s) or process all records.
7. Choose the desired button to generate the report. The Report Viewer will display the report.



Case

Current - Use current case values for all calculations. This is the default.

Base - Use base case values for all calculations.

Importance - Generate the End State Importance Measures report consisting of event names, number of times the event occurs, probability of failure, uncertainty importance value, risk reduction difference, and risk increase difference for the selected end state(s).

Special Importance - Generate the End State Importance Measures report consisting of event names, probability of failure, Fussell-Vesely value, risk reduction ratio, risk increase ratio, Birnbaum importance value, and event descriptions for the selected end state(s).

Sort Criteria - Select the sort order in which to display the End State Importance Measures Report. When you choose this button, the *Select Sort Criteria* dialog will be displayed.

Exit - Close the *End State Importance* dialog without generating a report.

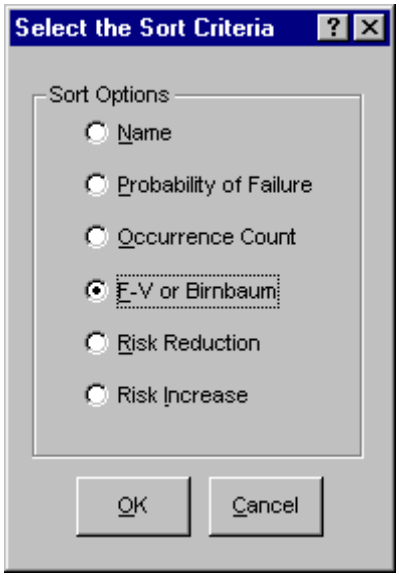
10.10.6 Select Sort Criteria

PURPOSE

This option allows you to select the sort order in which to display the Fault Tree/Sequence/End State Importance Measures Report.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Fault Tree/Sequence** *Data Type* and **Importance** *Report Type* radio buttons.
3. Choose the **Process** button. The *Fault Tree/Sequence Importance* dialog will be displayed, listing all of the fault trees residing in the current project.
4. Select the desired *Case* radio button.
5. Select the desired analysis type from the drop-down list.
6. Highlight the desired fault tree(s) or process all records.
7. Choose the **Sort Criteria** button to select the sort order and choose OK.
8. Choose the desired report button from the *Fault Tree/Sequence Importance* dialog. The Report Viewer will display the report in the specified order.



Name - Sort by event name
Probability of Failure - Sort by the probability failures
Occurrence Count - Sort by the number of occurrences (most to fewest)
F-V or Birnbaum - Sort in Fussell-Vesely or Birnbaum order
Risk Reduction - Sort in risk reduction ratio or difference order
Risk Increase - Sort in risk increase ratio or difference order.
OK - Closes the *Select the Sort Criteria* dialog and saves the sort option.
Cancel - Closes the *Select the Sort Criteria* dialog without saving the sort option.

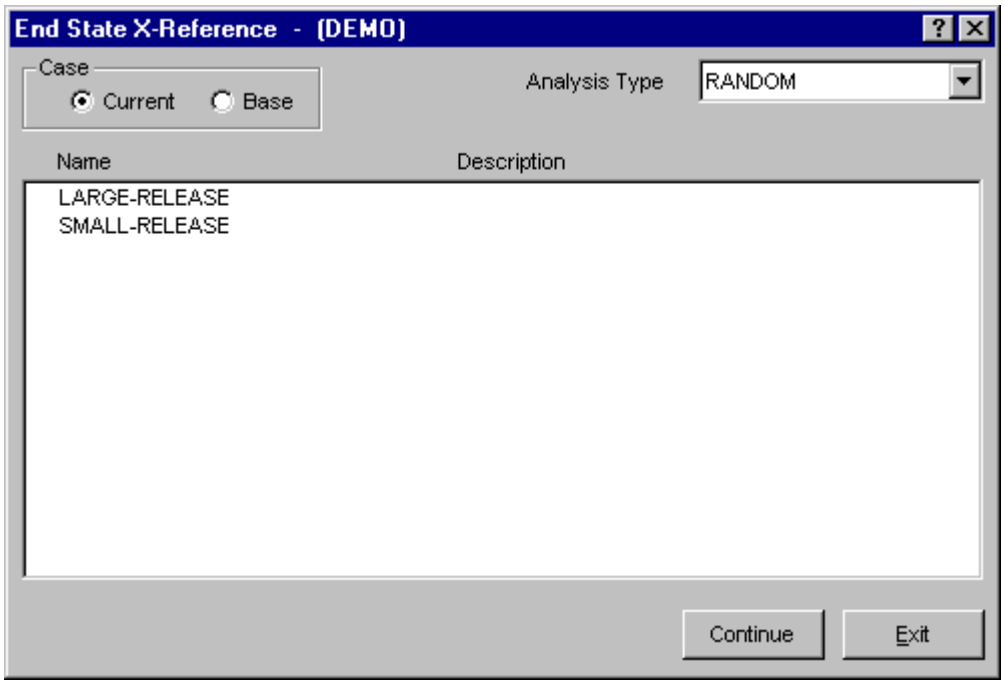
10.10.7 End State Cross Reference Report

PURPOSE

This option allows you to generate a cross reference report consisting of the end state number, end state name, and a list of event trees and sequences for each selected end state.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **End State** *Data Type* and the **Cross Reference** *Report Type* radio buttons.
3. Choose the **Process** button. The *End State X-Reference* dialog will be displayed, listing all of the end states residing in the current project.
4. Select the desired *Case* radio button.
5. Select the desired analysis type from the drop-down list.
6. Highlight the desired end state(s) or process all records.
7. Choose the **Continue** button to generate the report. The Report Viewer will display the report.



Case

Current - Use current case values for all calculations. This is the default.
Base - Use base case values for all calculations.

Continue - Generate the End State - Sequence Cut Set Reference Report. After choosing this button, the *Report Viewer* will display the report

Exit - Close the *End State X-Reference* dialog without generating a report.

10.11 Sequence Reports

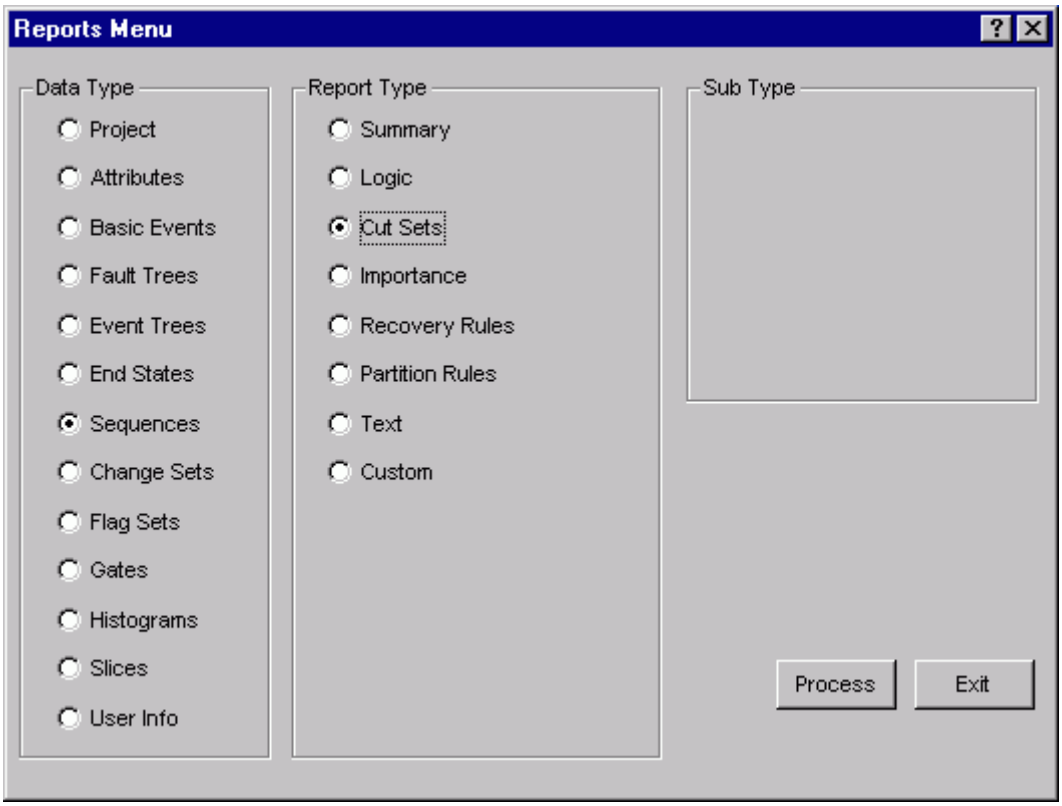
10.11.1 Sequence

PURPOSE

This option provides the means to generate a variety of sequence reports. These include summary, logic, cut sets, and importance reports.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Sequence** *Data Type* and one of the *Report Type* radio buttons.
3. Choose the **Process** button.
4. From the subsequent dialog, highlight the desired sequence(s)
5. Choose the appropriate buttons to generate the report. The Report Viewer will display the report.



Report Type

Summary - This option allows you to generate various fault tree summary reports.

Logic - Generate a report showing the sequence logic information associated with each selected event tree.

Cut Sets - Generate a report displaying cut set information for each selected sequence.

Importance - Generate a report listing associated importance measures information for each selected sequence.

Recovery Rules - This report outputs a listing of the recovery rule logic that applies to each selected sequence. Choose the **Basic** or **Advanced** radio button to indicate the desired rule type.

Partition Rules - This report outputs a listing of the partition rule logic that applies to each selected sequence. Choose the **Basic** or **Advanced** radio button to indicate the desired rule type.

Text - Generate a report containing the descriptive text associated with the selected sequence(s).

Custom - Create or select a user-defined report relating to sequence level information.

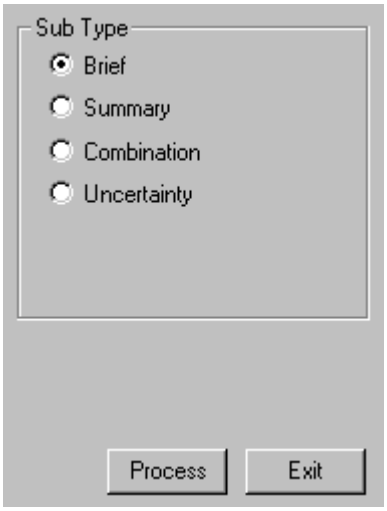
10.11.2 Sequence Summary Reports

PURPOSE

This option allows you to generate sequence summary reports that are based on current or base case values for a specified analysis type.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Sequence** *Data Type* and the **Summary** *Report Type* radio buttons.
3. Select the desired *Sub Type* radio button
4. Choose the **Process** button.
5. From the subsequent dialog, select the desired *Case* radio button and the desired analysis type from the drop-down list.
6. Highlight the desired sequence(s) or process all records.
7. Choose the **Continue** button to generate the report. The Report Viewer will display the report.



Case

Current - Use current case values for all calculations. This is the default.
Base - Use base case values for all calculations.

Brief Summary - Generate the Sequence Brief Summary Report. This report contains the event tree name, sequence name, end state name, and the minimum cut set upper bound for the selected sequence(s). The minimum cut set upper bound values for the selected sequences are totaled at the end or the report.

Summary - Generate the Sequence Summary Report. This report contains the event tree name, sequence name, the associated minimum cut set upper bound, and the description of the selected sequence(s). The minimum cut set upper bound values for the selected sequences are totaled at the end or the report.

Combination - Generate the Sequence Combination Report. This report contains the event tree name, sequence name, minimum cut set upper bound, mean, and number of cut sets in the selected sequence(s). Totals for the minimum cut set upper bound, mean and number of cut sets are provided at the end of the report.

Uncertainty - Generate the Sequence Uncertainty Values Report. This report contains the number, event tree name, sequence name, mean and median values, standard deviation, the 5th and 95th percentile, the minimum and maximum values, and the seed size of the selected sequence(s).

10.11.3 Sequence Logic Report

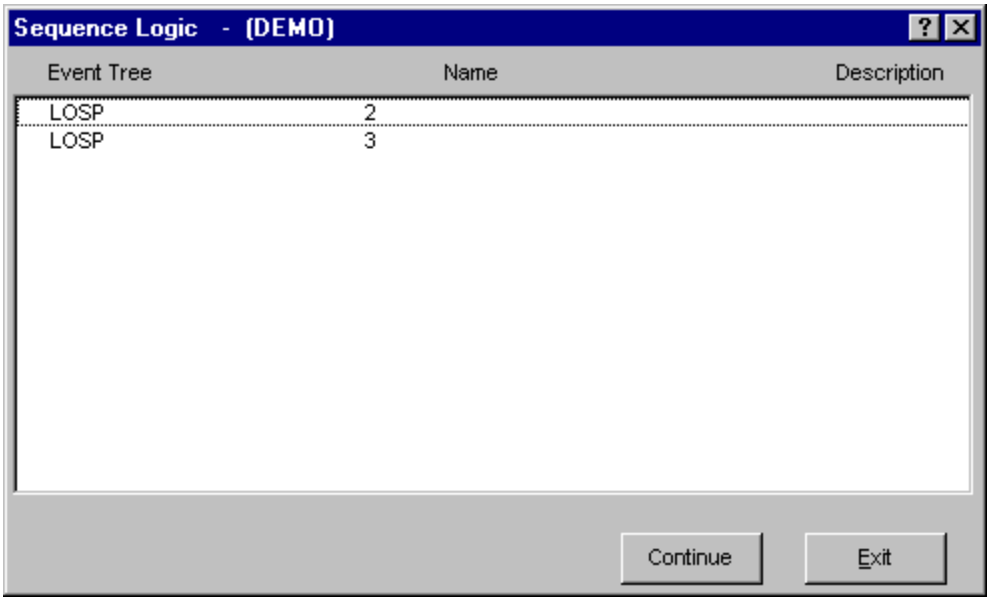
PURPOSE

This option allows you to generate the Sequence Logic Report. This report contains the sequence number, event tree name, sequence name, initiating event name, flag set name, and the logic paths (pass/fail) for the selected sequence(s).

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.

2. Select the **Sequence** *Data Type* and the **Logic** *Report Type* radio buttons.
3. Choose the **Process** button. The *Sequence Logic* dialog will be displayed, listing all of the sequences in the currently selected project.
4. Highlight the desired sequence(s) or process all records.
5. Choose the **Continue** button to generate the report. The Report Viewer will display the report.



Continue - Generate the report. After this button has been selected, the Report Viewer will display the report.

Exit - Close the *Sequence Logic* dialog without generating a report.

10.11.4 Sequence Cut Sets Reports

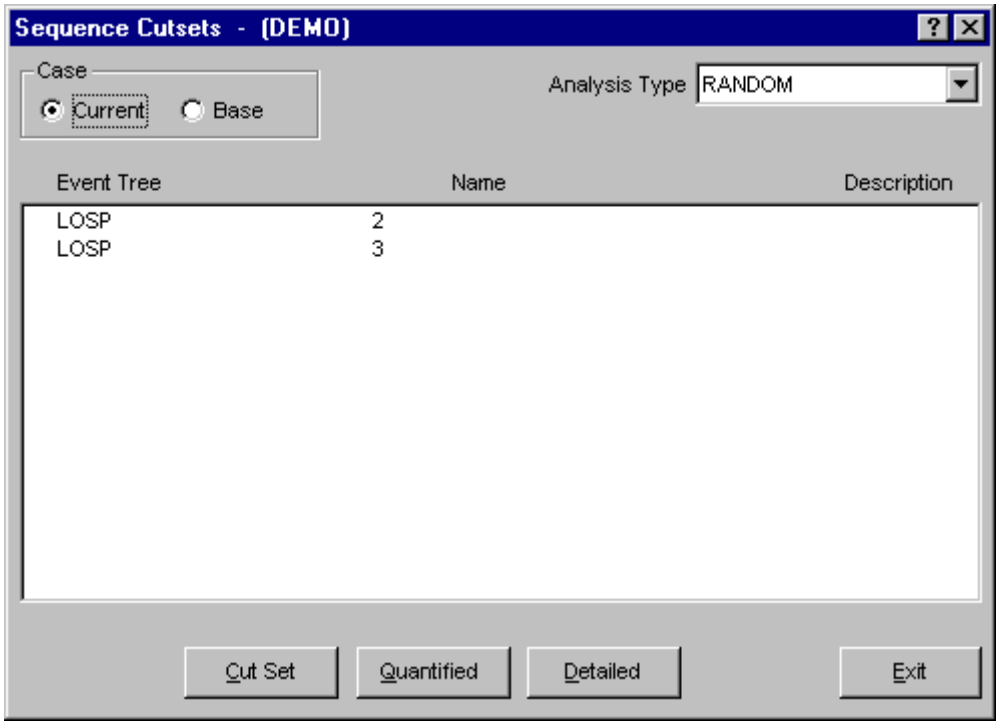
PURPOSE

This option allows you to generate three types of sequence cut set reports based the selected analysis type and on current or base case values.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Sequence** *Data Type* and the **Cut Sets** *Report Type* radio buttons.
3. Choose the **Process** button. The *Sequence Cut Sets* dialog will be displayed, listing all of the sequences residing in the current project.

4. Select the desired *Case* radio button.
5. Select the desired analysis type from the drop-down list.
6. Highlight the desired sequence(s) or process all records.
7. Choose the desired button to generate the report. The Report Viewer will display the report.



Case

Current - Use current case values for all calculations. This is the default.
Base - Use base case values for all calculations.

Cut Set - Generate the Sequence Cut Sets Report which consists of the cut set number, size, and the basic event names that are included in the corresponding cut sets (current or base) for the selected sequence(s). When you choose this button, the *Cut Set Report Options* dialog will be displayed followed by the *Report* dialog.

Quantified - Generate the Sequence Cut Sets (Quantification) Report for quantified cut sets only. The report consists of the cut set number, percent of total, percent of the cut set, probability/frequency and the basic event names that are included in the associated cut sets (current or base) for the selected sequence(s). When you choose this button, the *Cut Set Report Options* dialog will be displayed followed by the *Report* dialog.

Detailed - Generate the Sequence Cut Sets (Detailed) Report which consists of the cut set number, percent of the cut set, probability/frequency, and the basic event names and descriptions included in associated cut sets (current or base) for the selected

sequence(s). When you choose this button, the *Cut Set Report Options* dialog will be displayed followed by the *Report* dialog.

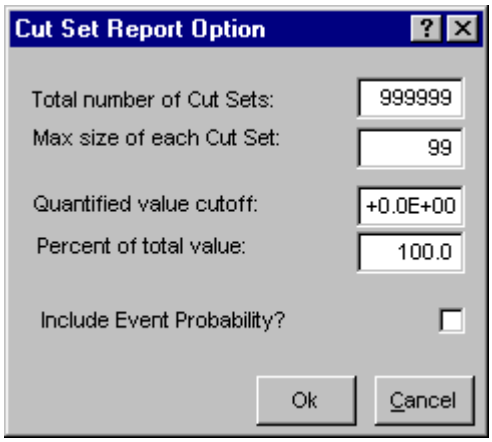
Exit - Close the *Sequence Cut Sets* dialog without generating a report.

10.11.5 Cut Set Report Options

PURPOSE

This option allows you to specify several cut set cutoff values that will be used to determine if a cut set is to be included in the report.

You can modify any of the default values provided by typing over the existing data.



Total number of Cut Sets - The number of cut sets included in the report will not exceed this number. Cut sets are considered beginning with the cut that contributes the highest percent frequency.

Max size of each Cut Set - Include only those cut sets that contain no more than the number of events entered here.

Quantified value cutoff - Include only those cut sets whose frequency is greater than or equal to the value entered here. Applies only to the *Quantified* and *Detailed* cut set reports.

Percent of total value - Include only those cut sets whose sum of the percent contribution is less than this value, beginning with the cut set that contributes the greatest percent. By entering 100.0 (the default) here, all cut sets will be included.

Include Event Probability? - Preface the report with a list of each of the basic events referenced in the cut sets along with the basic event probabilities.

Ok - Generate the report based on the specified cutoff values. The Report Viewer will display the report.

Cancel - Close the *Cut Set Report Option* dialog without generating a report.

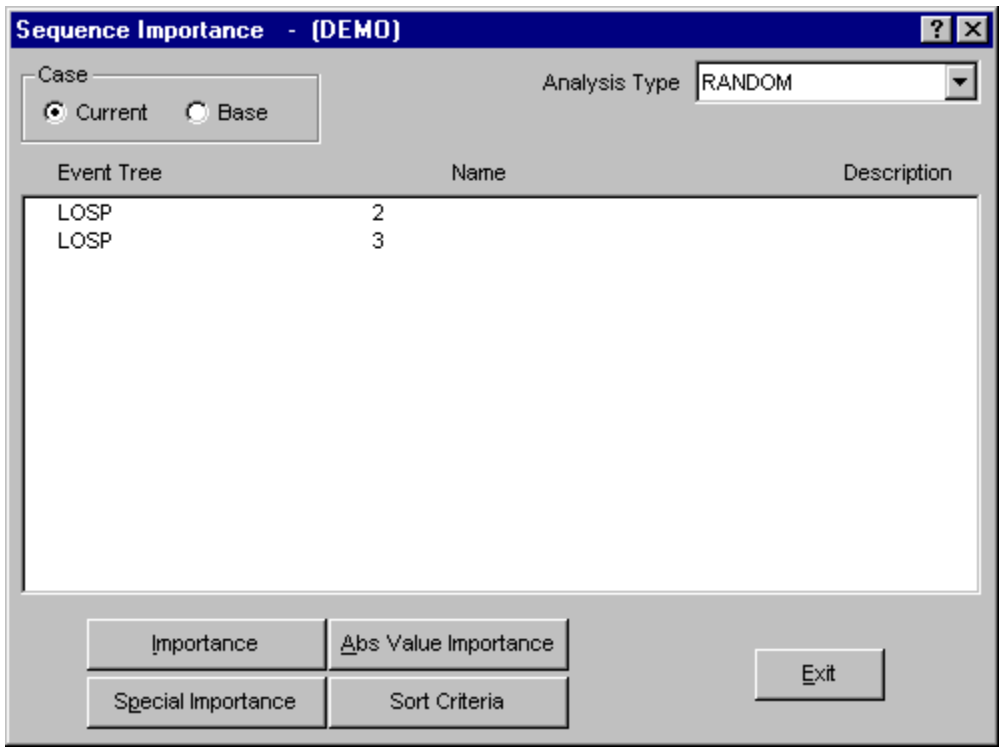
10.11.6 Sequence Importance Reports

PURPOSE

This option allows you to generate importance reports based on the selected analysis type and on current or base case values. The header for each page contains the currently selected project name, analysis type, case (base or current), the sequence name, event tree name, and initiating event name. Also included, in parenthesis, is the selected sort order.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Sequence** *Data Type* and the **Importance** *Report Type* radio buttons.
3. Choose the **Process** button. The *Sequence Importance* dialog will be displayed, listing all of the sequences residing in the current project.
4. Select the desired *Case* radio button.
5. Select the desired analysis type from the drop-down list.
6. Highlight the desired sequence(s) or process all records.
7. Choose the desired button to generate the report. The Report Viewer will display the report.



Case

Current - Use current case values for all calculations. This is the default.
Base - Use base case values for all calculations.

Importance - Generate the Sequence Importance Measures report consisting of event names, number of times the event occurs, probability of failure, uncertainty importance value, risk reduction difference, and risk increase difference for the selected sequence(s).

Special Importance - Generate the Sequence Importance Measures report consisting of event names, probability of failure, Fussell-Vesely value, risk reduction ratio, risk increase ratio, Birnbaum importance value, and event descriptions for the selected sequence(s).

Abs. Value Importance - Generate the Sequence Absolute Value Importance report consisting of event names, number of times the event occurs, probability of failure, uncertainty importance value, risk reduction difference, and risk increase difference for the selected sequence(s).

Sort Criteria - Select the sort order in which to display the Sequence Importance Measures Report. When you choose this button, the *Select Sort Criteria* dialog will be displayed.

Exit - Close the *Sequence Importance* dialog without generating a report.

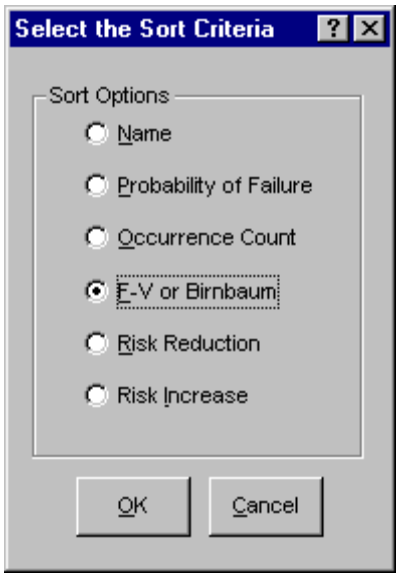
10.11.7 Select Sort Criteria

PURPOSE

This option allows you to select the sort order in which to display the Fault Tree/Sequence/End State Importance Measures Report.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Fault Tree/Sequence** *Data Type* and **Importance** *Report Type* radio buttons.
3. Choose the **Process** button. The *Fault Tree/Sequence Importance* dialog will be displayed, listing all of the fault trees residing in the current project.
4. Select the desired *Case* radio button.
5. Select the desired analysis type from the drop-down list.
6. Highlight the desired fault tree(s) or process all records.
7. Choose the **Sort Criteria** button to select the sort order and choose OK.
8. Choose the desired report button from the *Fault Tree/Sequence Importance* dialog. The Report Viewer will display the report in the specified order.



Name -	Sort by event name
Probability of Failure -	Sort by the probability failures
Occurrence Count -	Sort by the number of occurrences (most to fewest)
F-V or Birnbaum -	Sort in Fussell-Vesely or Birnbaum order
Risk Reduction -	Sort in risk reduction ratio or difference order
Risk Increase -	Sort in risk increase ratio or difference order.
OK -	Closes the *Select the Sort Criteria* dialog and saves the sort option.
Cancel -	Closes the *Select the Sort Criteria* dialog without saving the sort option.

10.12 Change Set Reports

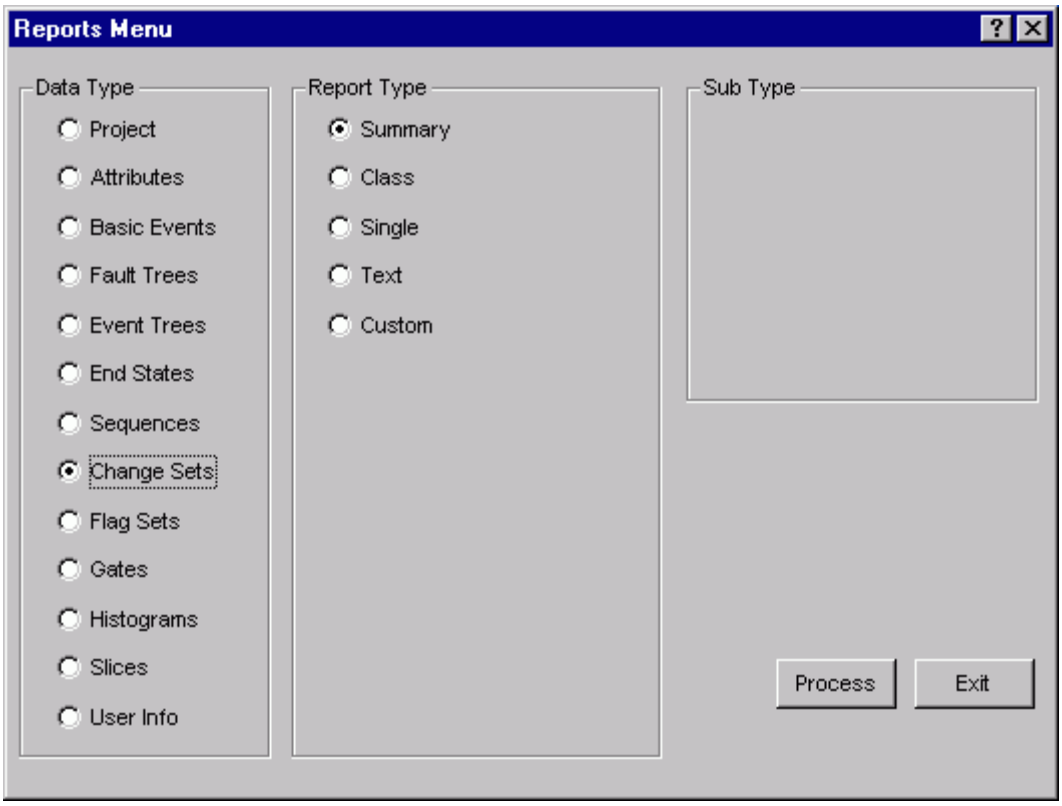
10.12.1 Change Sets

PURPOSE

This option provides the means to generate change set reports. These include separate reports for summary, single, and class change information.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Ch*ange Sets*** *Type* and one of the *Report Type* radio buttons.
3. Choose the **Process** button.
4. From the subsequent dialog, highlight the desired change set(s)
5. Choose the appropriate buttons to generate the report. The Report Viewer will display the report.



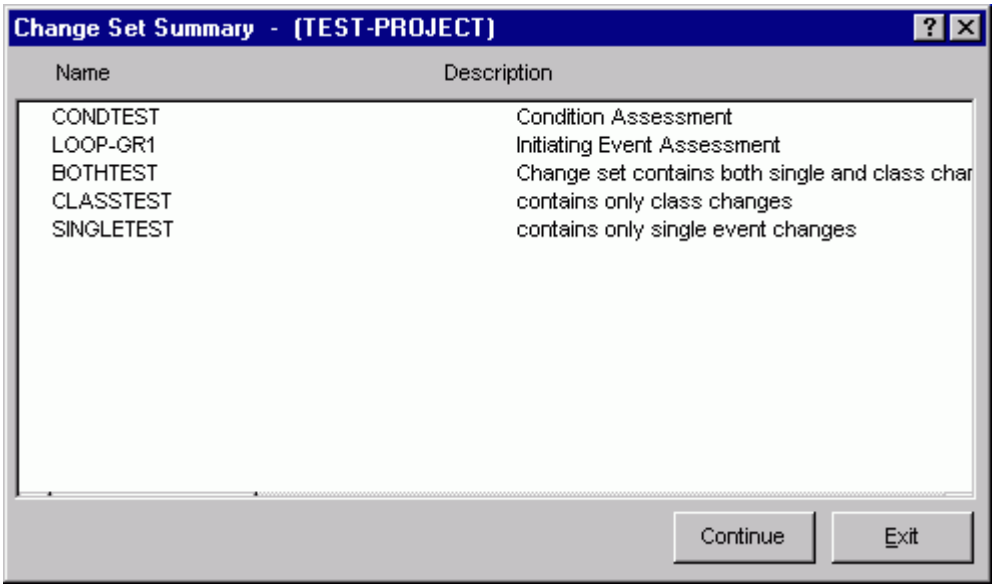
10.12.2 Change Set/Flag Set Summary Reports

PURPOSE

This option allows you to generate change set/flag set summary reports listing the name, description, and, for change sets, the current mark status.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Change Set** *Data Type* and the **Summary** *Report Type* radio buttons.
3. Choose the **Process** button.
4. Highlight the desired change sets/flag sets or process all records.
5. Choose the **Continue** button to generate the report. The Report Viewer will display the report.



Continue - Generate the summary event report. The Report Viewer will display the report.
Exit - Close the summary dialog without generating a report.

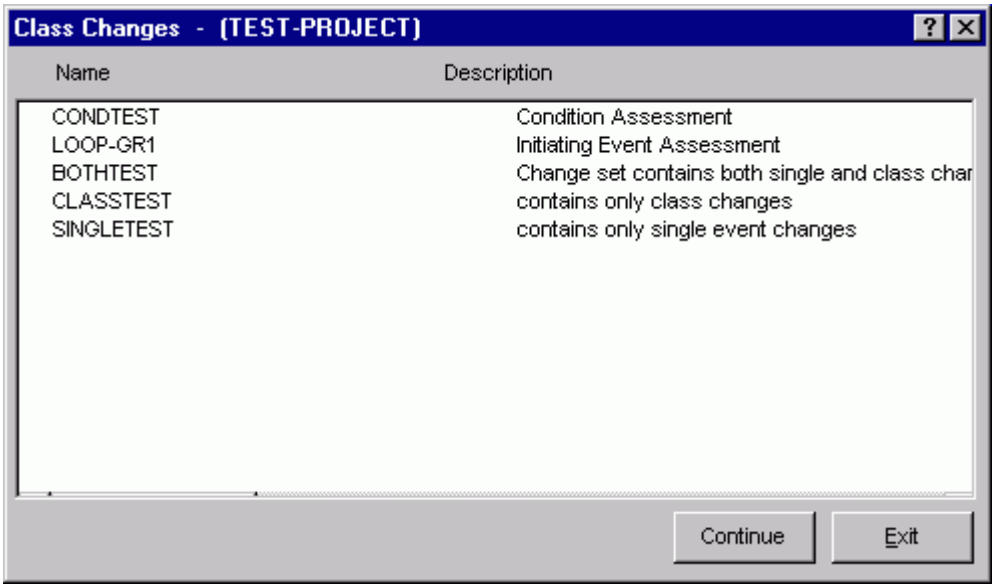
10.12.3 Change Set Class Reports

PURPOSE

This option allows you to generate a detailed change set report. The report will list the mark status and name of each selected change set, as well as a list of all events in the project that would be affected by the class change. (Single changes will not be included in this report.) For each included event the affected field change information is displayed. (Unaffected field information will be blank.)

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Change Set** *Data Type* and the **Class** *Report Type* radio buttons.
3. Choose the **Process** button.
4. Highlight the desired change sets or process all records.
5. Choose the **Continue** button to generate the report. The Report Viewer will display the report.



Continue - Generate the class change report. The Report Viewer will display the report.
Exit - Close the dialog without generating a report.

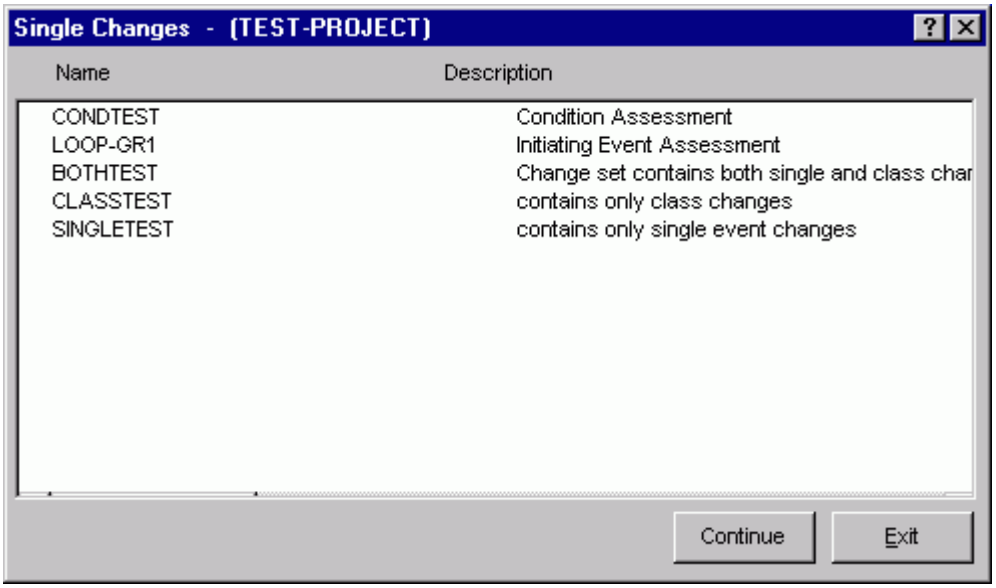
10.12.4 Single Changes Report

PURPOSE

This option allows you to generate a detailed change set report. The report will list the mark status and name of each selected change set, as well as a list of all events explicitly included in the change set via the Single Change option. (Class changes will not be included in this report.) For each included event the affected field change information is displayed. (Unaffected field information will be blank.)

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Change Set** *Data Type* and the **Class** *Report Type* radio buttons.
3. Choose the **Process** button.
4. Highlight the desired change sets or process all records.
5. Choose the **Continue** button to generate the report. The Report Viewer will display the report.



Continue - Generate the class change report. The Report Viewer will display the report.
Exit - Close the dialog without generating a report.

10.13 Flag Set Reports

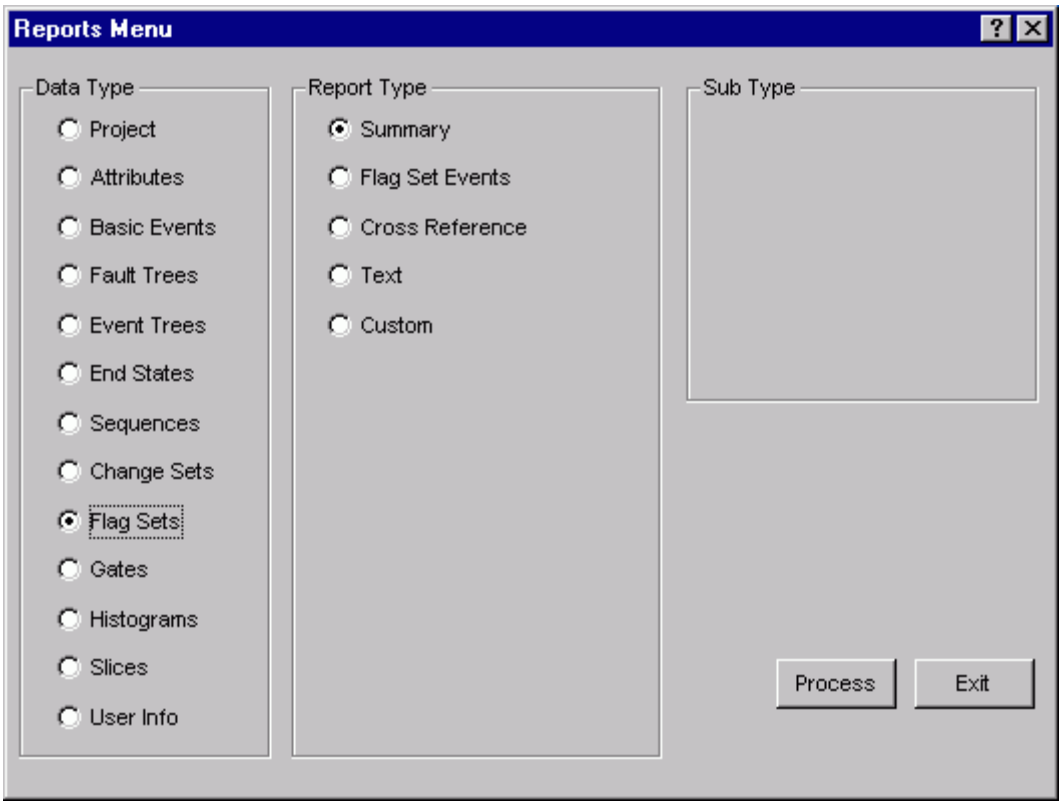
10.13.1 Flag Sets

PURPOSE

This option provides the means to generate flag set reports. These include separate reports for summary, detail (flag set events), and cross references.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the ***Flag Sets*** *Type* and one of the *Report Type* radio buttons.
3. Choose the **Process** button.
4. From the subsequent dialog, highlight the desired change set(s)
5. Choose the appropriate buttons to generate the report. The Report Viewer will display the report.



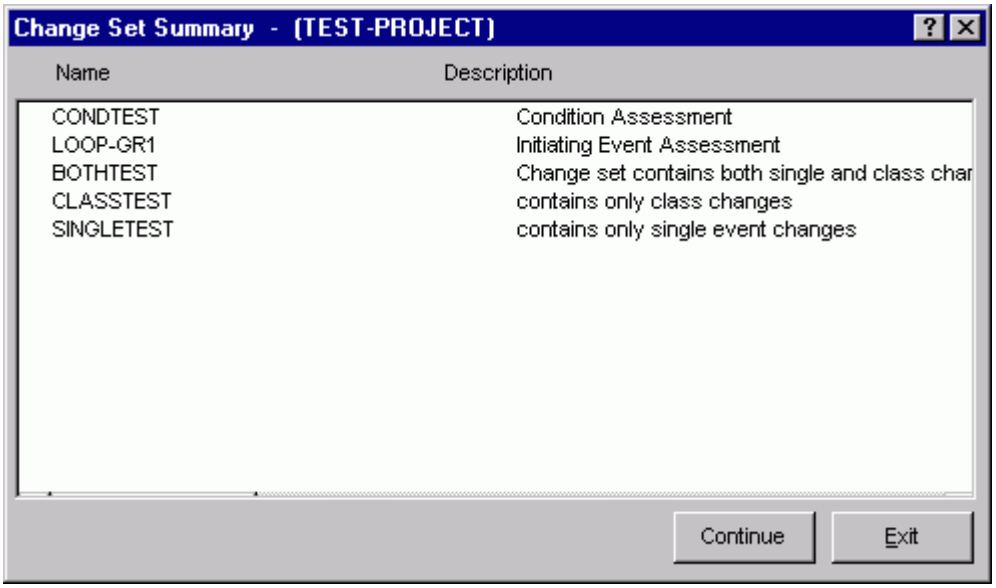
10.13.2 Change Set/Flag Set Summary Reports

PURPOSE

This option allows you to generate change set/flag set summary reports listing the name, description, and, for change sets, the current mark status.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Change Set** *Data Type* and the **Summary** *Report Type* radio buttons.
3. Choose the **Process** button.
4. Highlight the desired change sets/flag sets or process all records.
5. Choose the **Continue** button to generate the report. The Report Viewer will display the report.



Continue - Generate the summary event report. The Report Viewer will display the report.
Exit - Close the summary dialog without generating a report.

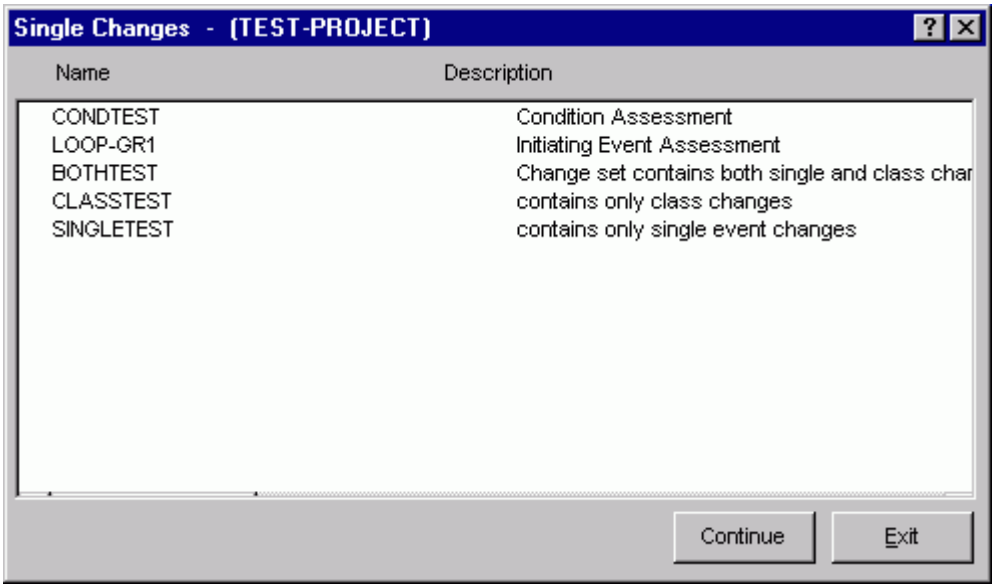
10.13.3 Single Changes Report

PURPOSE

This option allows you to generate a detailed flag set report. The report will list the name of each selected flag set, as well as a list of all events included in the flag set. For each included event the affected field change information is displayed. (Unaffected field information will be blank.)

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Flag Set** *Data Type* and the **Flag Set Events** *Report Type* radio buttons.
3. Choose the **Process** button.
4. Highlight the desired change sets or process all records.
5. Choose the **Continue** button to generate the report. The Report Viewer will display the report.



Continue - Generate the class change report. The Report Viewer will display the report.
Exit - Close the dialog without generating a report.

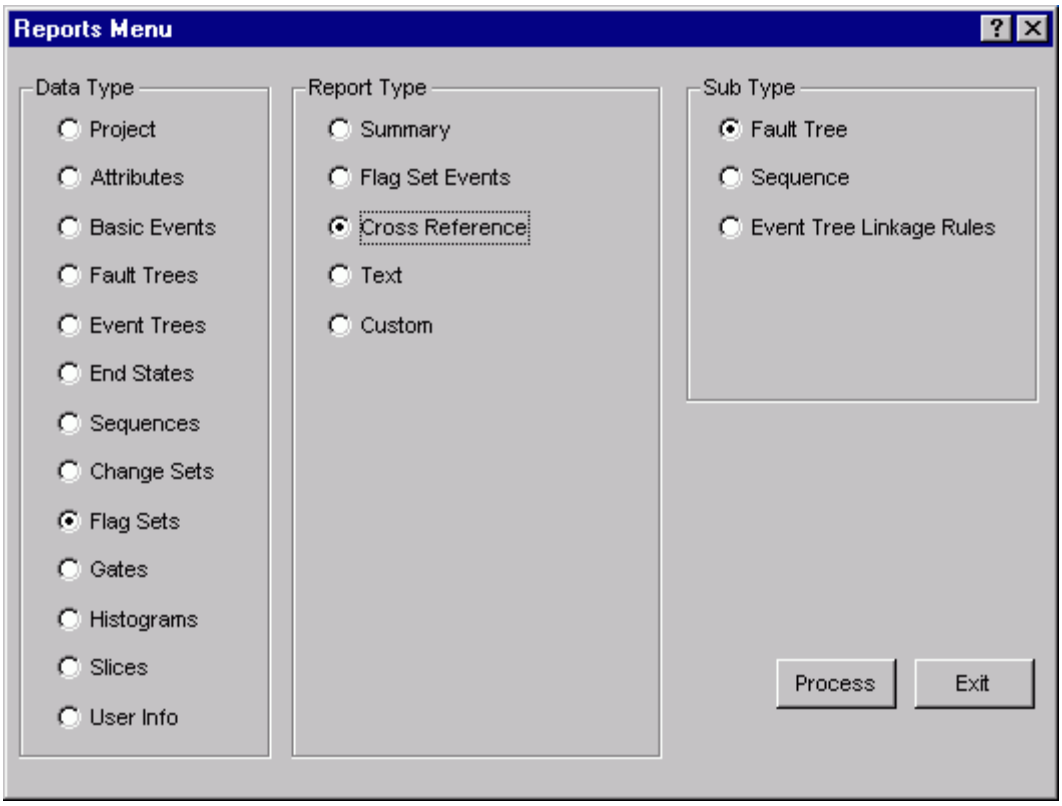
10.13.4 Flag Set Cross Reference Report

PURPOSE

This option allows you to generate the Flag Set Cross Reference Report. Reports

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Flag Set** *Data Type* and **Cross Reference** *Report Type* radio buttons.
3. Choose the **Process** button. The *Flag Set Cross Reference* dialog will be displayed, listing all of the flag sets in the currently selected project .
4. Highlight the desired flag set(s) or process all records.
5. Choose the **Continue** button. The Report Viewer will display the report.



Fault Tree - Produce a flag set to fault tree cross-reference report. The report will include the flag set names and all fault trees that reference them.

Sequence - Produce a flag set to sequence cross-reference report. The report will include the flag set names and all event tree/sequences that reference them.

Event Tree Linkage Rules - Produce a flag set to event tree link rules cross-reference report. The report will include the flag set names and all event trees having either basic or advanced rules that reference them.

Exit - Close the dialog without generating a report.

10.14 Gate Report

10.14.1 Gates

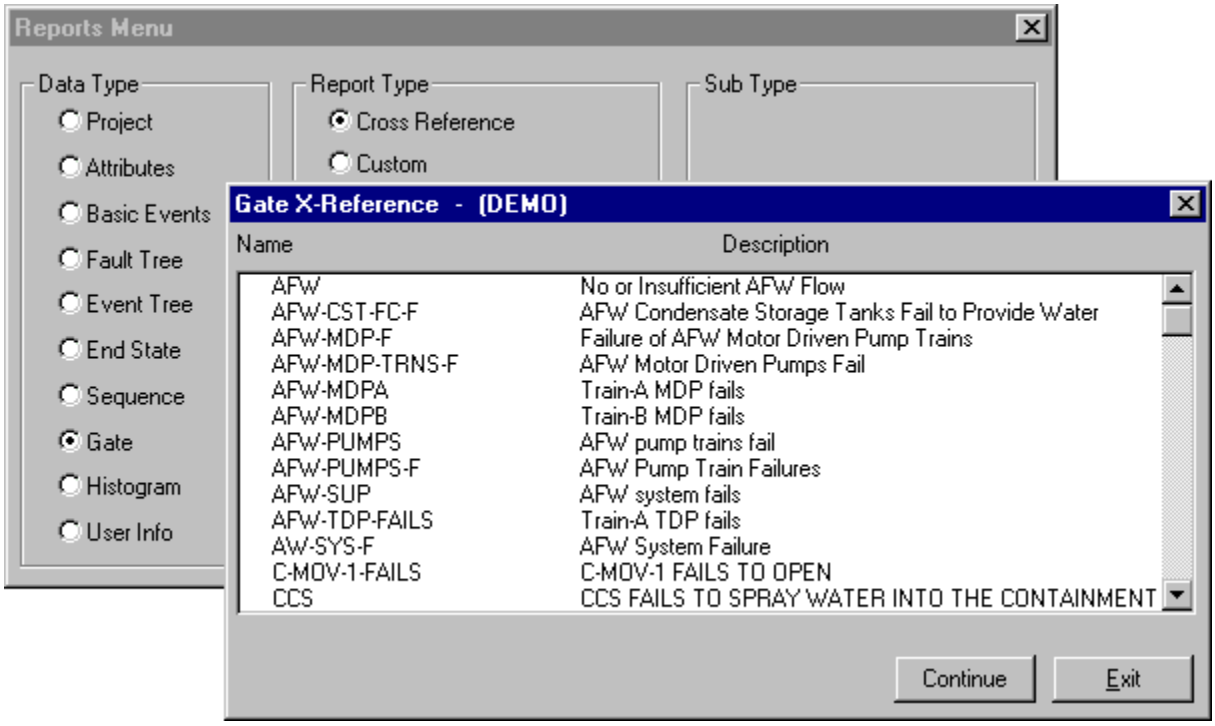
PURPOSE

This option provides the means to generate the Gate-Fault Tree Logic Reference Report. This report lists the selected gate's name and the fault tree(s) that reference the gate.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.

2. Select the **Gate** *Data Type* and **Cross Reference** *Report Type* radio buttons.
3. Choose **Process** button. The *Gate X-Reference* dialog will be displayed listing all of the gates for the currently selected project.
4. Highlight the desired gate(s) or process all records.
5. Choose the desired button.



Continue - Generate the report. When this button is selected, the *Report Viewer* will display the report.

Exit - Close the *Gate X-Reference* dialog without generating a report.

10.15 Histogram Reports

10.15.1 Histogram

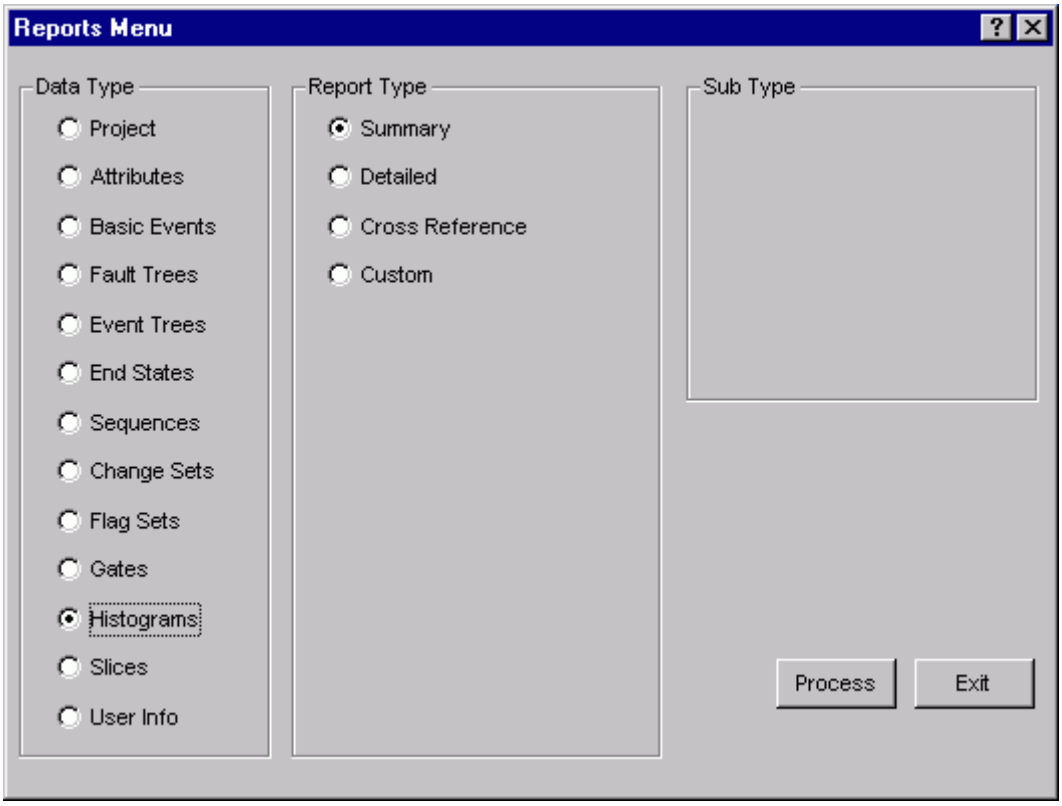
PURPOSE

This option provides the means to generate histogram reports. Two histogram reports are available: Summary and Detail.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Histogram** *Data Type* and one of the *Report Type* radio buttons.

3. Choose the **Process** button.



10.15.2 Histogram Summary Report

PURPOSE

This option allows you to generate the Histogram Summary Report. This report contains the histogram type and subtype, its name and description for each histogram defined in the current project.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Histogram** *Data Type* and the **Summary** *Report Type* radio buttons.
3. Choose the **Process** button. The Report Viewer will display the report.

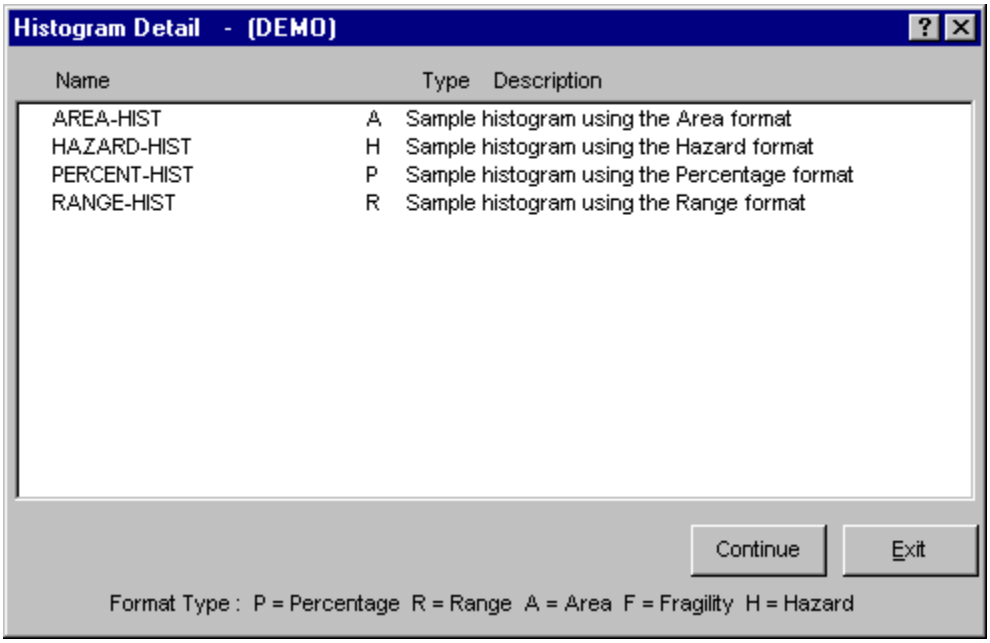
10.15.3 Histogram Detail Report

PURPOSE

This option allows you to generate the Histogram Detail Report. This report consists of the histogram name, format and where applicable, the starting value, ending probability and area or height values, or acceleration and frequency values.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Histogram** *Data Type* and **Detail** *Report Type* radio buttons.
3. Choose the **Process** button. The *Histogram Detail* dialog will be displayed, listing all of the histograms in the currently selected project along with the histogram type and description.
4. Highlight the desired histogram(s) or process all records.
5. Choose the **Continue** button. The Report Viewer will display the report.



Continue - Generate the report. When this button is selected, the Report Viewer will display the report.

Exit - Close the *Histogram Detail* dialog without generating a report.

10.15.4 Histogram Cross Reference Report

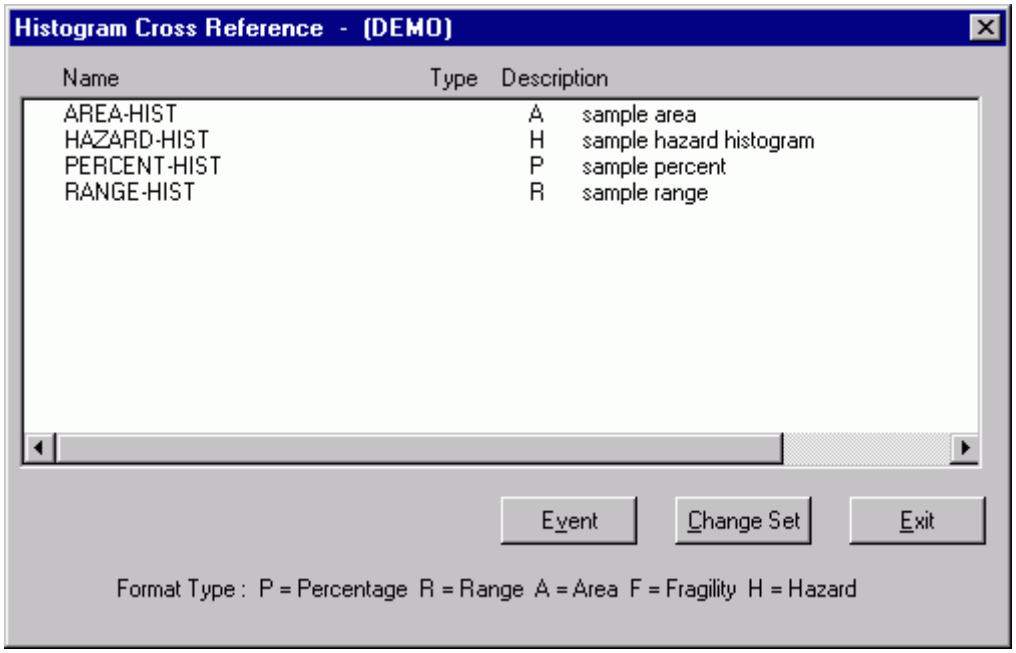
PURPOSE

This option allows you to generate the Histogram Cross Reference Report. This report consists of the histogram name, format and where applicable, the starting value, ending probability and area or height values, or acceleration and frequency values.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Histogram** *Data Type* and **Cross Reference** *Report Type* radio buttons.
3. Choose the **Process** button. The *Histogram Cross Reference* dialog will be displayed, listing all of the histograms in the currently selected project along with the histogram type and description.
4. Highlight the desired histogram(s) or process all records.

5. Choose the desired report button. The Report Viewer will display the report.



Event - Produce a histogram to event cut set cross-reference report. The report will include the histogram names and all events that reference them.

Change Set - Produce a histogram to change set cut set cross-reference report. The report will include the histogram names and all change sets that reference them.

Exit - Close the dialog without generating a report.

10.16 Slices Report

10.16.1 Slices

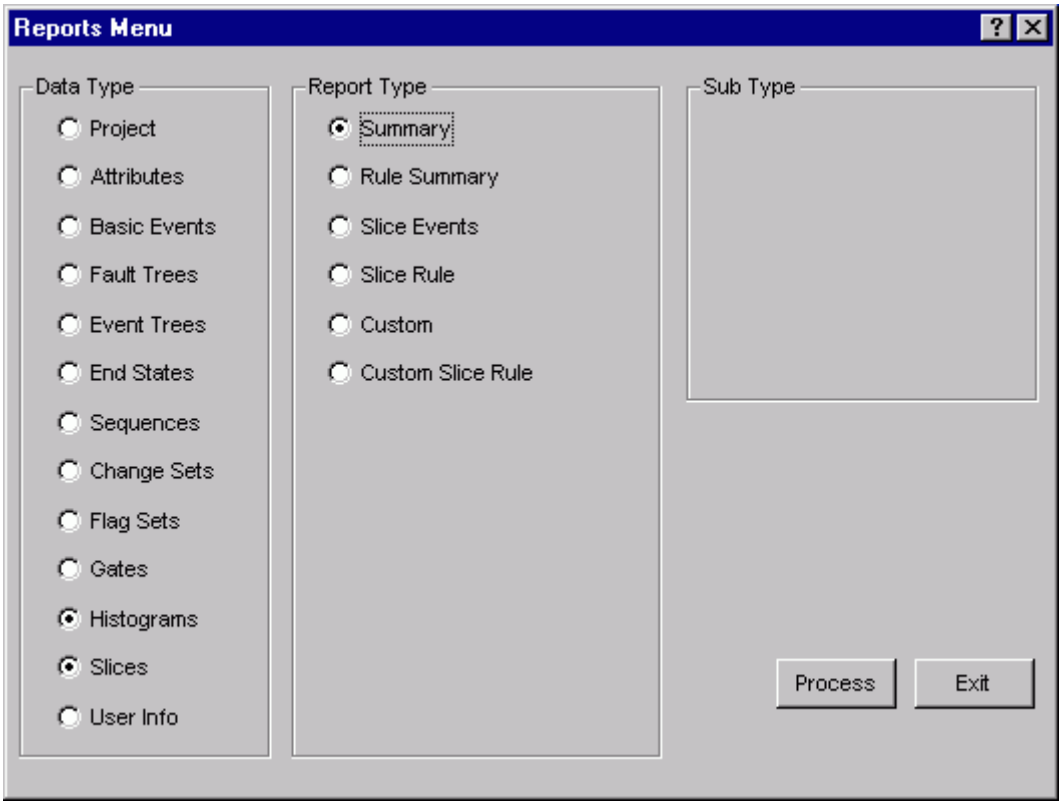
PURPOSE

This option provides the means to generate slice reports. There are two kinds of slices that can be stored in SAPHIRE, slice lists (referred to as simply a "slice"), and slice rules. The two are reported separately. To view slice list information, choose the Summary, Slice Events, or Custom option. To view slice rule information, choose Rule Summary, Slice Rule, Custom Slice Rule.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **Slice** *Data Type* and one of the *Report Type* radio buttons.
3. Choose the **Process** button.
4. Highlight the desired slice(s) or process all records.

5. Choose the appropriate buttons to generate the report. The Report Viewer will display the report.



Report Type

Summary - Generate a summary report listing the selected slice(s) name and associated description.

Rule Summary - Generate a report containing the selected slice rule(s) name and associated description.

Slice Events - Generate a report containing the list of events included in the slice rule.

Slice Rule - Generate a report containing the rule logic for each selected slice rule.

Custom - Create or select a user-defined report relating to slice(s).

Custom Rules - Create or select a user-defined report relating to slice rule(s).

Process - Display the selected report in the Report Viewer.

Exit - This option closes the *Reports Menu* dialog.

10.17 User Information Report

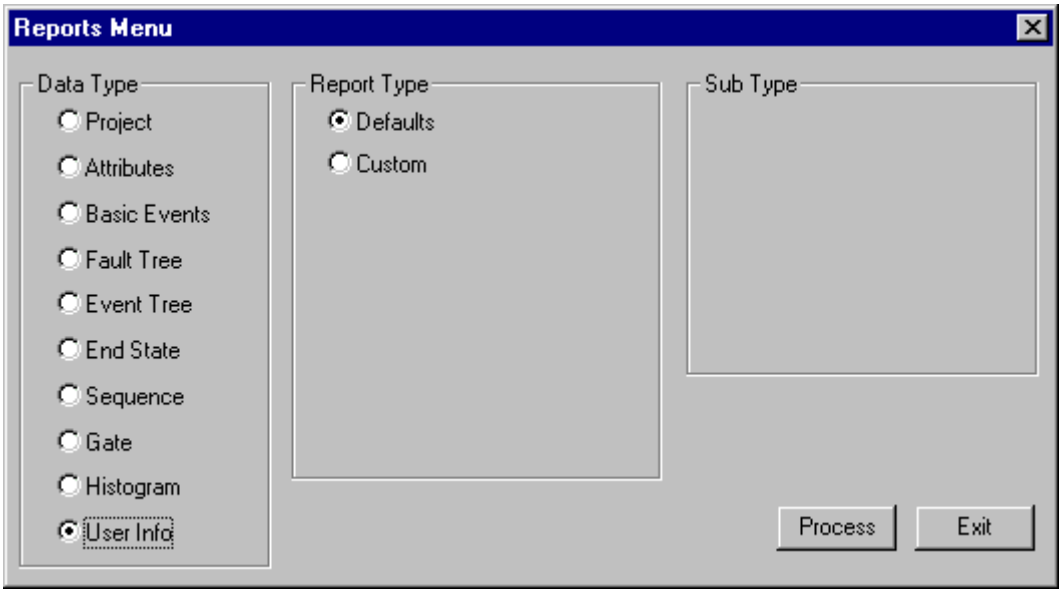
10.17.1 User Information

PURPOSE

This option provides the means to generate the User Defined Constants Report. This report lists the user's name, hardware configuration, default file locations, archive information, default values for cut set generation and uncertainty calculations, and default flag settings.

STEPS

1. From the SAPHIRE menu select **Report**. The *Reports Menu* dialog will be displayed.
2. Select the **User Info** *Data Type* and **Defaults** *Report Type* radio buttons.
3. Choose the **Process** button. The Report Viewer will display the report.



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10. SUPPLEMENTARY NOTES
D. O'Neal, NRC Project Manager

11. ABSTRACT (200 words or less)
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 (PC) running the Microsoft Windows operating system. SAPHIRE is primarily funded by the U.S. Nuclear Regulatory Commission (NRC) and developed by the Idaho National Laboratory (INL). 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. Finally, a series of appendices are provided that detail information about some of the more complex operations of the software.

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