NUREG/CR–6116
EGG–2716
Vol. 2

Systems Analysis Programs for Hands–on Integrated Reliability Evaluations (SAPHIRE) Version 5.0

Integrated Reliability and Risk Analysis System (IRRAS) Reference Manual

Prepared by
K. D. Russell, K. J. Kvarfordt, N. L. Skinner, S. T. Wood, D. M. Rasmuson

RECEIVED
AUG 08 1994
OSTI

EG&G Idaho, Inc.

Prepared for
U.S. Nuclear Regulatory Commission

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

NUREG/CR-6116
EGG-2716
Vol. 2

Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE) Version 5.0

Integrated Reliability and Risk Analysis System (IRRAS) Reference Manual

Manuscript Completed: December 1993
Date Published: July 1994

Prepared by
K. D. Russell, K. J. Kvarfordt, N. L. Skinner, S. T. Wood, D. M. Rasmuson*

Idaho National Engineering Laboratory
Managed by the U.S. Department of Energy

EG&G Idaho, Inc.
Idaho Falls, ID 83415

Prepared for
Division of Safety Issue Resolution
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
NRC FIN L1429
Under DOE Contract No. DE-AC07-76ID01570

MASTER

*Staff, U.S. Nuclear Regulatory Commission

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

AVAILABILITY NOTICE

Availability of Reference Materials Cited in NRC Publications

Most documents cited in NRC publications will be available from one of the following sources:

1. The NRC Public Document Room, 2120 L Street, NW., Lower Level, Washington, DC 20555-0001
2. The Superintendent of Documents, U.S. Government Printing Office, Mail Stop SSOP, Washington, DC 20402-9328
3. The National Technical Information Service, Springfield, VA 22161

Although the listing that follows represents the majority of documents cited in NRC publications, it is not intended to be exhaustive.

Referenced documents available for inspection and copying for a fee from the NRC Public Document Room include NRC correspondence and internal NRC memoranda; NRC bulletins, circulars, information notices, inspection and investigation notices; licensee event reports; vendor reports and correspondence; Commission papers; and applicant and licensee documents and correspondence.

The following documents in the NUREG series are available for purchase from the GPO Sales Program: formal NRC staff and contractor reports, NRC-sponsored conference proceedings, international agreement reports, grant publications, and NRC booklets and brochures. Also available are regulatory guides, NRC regulations in the *Code of Federal Regulations*, and *Nuclear Regulatory Commission Issuances*.

Documents available from the National Technical Information Service include NUREG-series reports and technical reports prepared by other Federal agencies and reports prepared by the Atomic Energy Commission, forerunner agency to the Nuclear Regulatory Commission.

Documents available from public and special technical libraries include all open literature items, such as books, journal articles, and transactions. *Federal Register* notices, Federal and State legislation, and congressional reports can usually be obtained from these libraries.

Documents such as theses, dissertations, foreign reports and translations, and non-NRC conference proceedings are available for purchase from the organization sponsoring the publication cited.

Single copies of NRC draft reports are available free, to the extent of supply, upon written request to the Office of Administration, Distribution and Mail Services Section, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

Copies of industry codes and standards used in a substantive manner in the NRC regulatory process are maintained at the NRC Library, 7920 Norfolk Avenue, Bethesda, Maryland, for use by the public. Codes and standards are usually copyrighted and may be purchased from the originating organization or, if they are American National Standards, from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

DISCLAIMER NOTICE

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, or any of their employees, makes any warranty, expressed or implied, or assumes any legal liability of responsibility for any third party's use, or the results of such use, of any information, apparatus, product or process disclosed in this report, or represents that its use by such third party would not infringe privately owned rights.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

ABSTRACT

The Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE) refers to a set of several microcomputer programs that were developed to create and analyze probabilistic risk assessments (PRAs), primarily for nuclear power plants. The Integrated Reliability and Risk Analysis System (IRRAS) is a state-of-the-art, microcomputer-based probabilistic risk assessment (PRA) model development and analysis tool to address key nuclear plant safety issues. IRRAS is an integrated software tool that gives the user the ability to create and analyze fault trees and accident sequences using a microcomputer. This program provides functions that range from graphical fault tree construction to cut set generation and quantification to report generation.

Version 1.0 of the IRRAS program was released in February of 1987. Since then, many user comments and enhancements have been incorporated into the program providing a much more powerful and user-friendly system. This version has been designated IRRAS 5.0 and is the subject of this Reference Manual. Version 5.0 of IRRAS provides the same capabilities as earlier versions and adds the ability to perform location transformations, seismic analysis, and provides enhancements to the user interface as well as improved algorithm performance. Additionally, version 5.0 contains new alphanumeric fault tree and event tree editors, and a powerful set of macro-based rule editors. These editors are used for event tree rules, recovery rules, and end state partitioning.

Fin No. L1429 - SAPHIRE Maintenance and User Support

Documents in NUREG/CR-6116 Report, Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE) Version 5.0

Volume 1 - Technical Reference Manual

Volume 2 - Integrated Reliability and Risk Analysis System (IRRAS) Reference Manual

Volume 3 - Integrated Reliability and Risk Analysis System (IRRAS) Tutorial Manual

Volume 4 - Systems Analysis and Risk Assessment (SARA) System Reference Manual

Volume 5 - Systems Analysis and Risk Assessment (SARA) System Tutorial Manual

Volume 6 - Graphical Evaluation Module (GEM) Reference Manual

Volume 7 - Fault Tree, Event Tree, and Piping & Instrumentation Diagram (FEP) Editors Reference Manual

Volume 8 - Models and Results Database (MAR-D) Reference Manual

Volume 9 - Validation and Verification (V&V) Manual

Volume 10 - Data Loading Manual

Previous Reports in the Series

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

CONTENTS

ABSTRACT iii

LIST OF FIGURES xv

LIST OF TABLES xxviii

EXECUTIVE SUMMARY xxix

FOREWORD xxxi

ACKNOWLEDGMENTS xxxiii

1. INTRODUCTION 1-1

2. GETTING TO KNOW IRRAS 5.0 2-1

2.1 IRRAS 5.0 Modules 2-1

2.2 IRRAS 5.0 Database Concepts 2-2

2.3 Using IRRAS for the First Time 2-4

2.4 Getting Around Inside IRRAS 5.0 2-6

2.5 Invoking IRRAS 2-8

2.6 Hot Keys 2-8

2.7 Menu Options Naming Conventions 2-8

2.8 Other Things You Should Know 2-10

3. SELECT FAMILY 3-1

3.1 Exit 3-2

3.2 Select 3-2

3.3 Family Copy 3-3

3.4 Copy 3-3

4. GENERATE EVENT DATA 4-1

4.1 Exit 4-1

4.2 Add 4-1

4.3 Modify 4-3

4.4 Delete 4-3

4.5 Probability 4-4

4.5.1 Exit 4-5
4.5.2 Probability 4-5
4.5.3 Reset Probability to Base 4-13

4.6 Class 4-14

4.7 Generate Changes 4-17

4.8 Report Changes 4-18

4.8.1 Exit 4-19
4.8.2 Unaffected Events (Base) 4-19
4.8.3 AFfected Events (Current) 4-19
4.8.4 All Events (Base, Current) 4-20

4.9 Base Case Update 4-21

5. BUILD FAULT TREES 5-1

5.1 Build Graphic Trees 5-2

5.1.1 EXIT 5-2
5.1.2 Move 5-2
5.1.3 SHOW 5-2
5.1.4 BILD 5-2
5.1.5 EDIT 5-8
5.1.6 TEXT 5-18
5.1.7 VIEW 5-22
5.1.8 FILE 5-24
5.1.9 NAME 5-27
5.1.10 Text 5-27
5.1.11 cntr/left/right 5-29
5.1.12 Text Size (0.50) 5-29
5.1.13 Fill 5-29
5.1.14 Line 5-29
5.1.15 type 5-30
5.1.16 Mult 5-30
5.1.17 Scroll Color Bar (↑ ↓) 5-30

5.2 Plot Trees 5-30

5.2.1 Plotter 5-31
5.2.2 Hpgl Files 5-31
5.2.3 Raster File 5-32
5.2.4 Low Resolution Raster 5-33

5.3 Load Graphic Trees 5-33

5.3.1 Exit 5-33
5.3.2 Load 5-34

5.4 Alpha to Graphics 5-34

5.4.1 Exit 5-34
5.4.2 Convert 5-35

5.5 Graphical Pager 5-35

5.5.1 Exit 5-35
5.5.2 Page 5-36

5.6 eXtract Fault Trees 5-37

5.6.1 Exit 5-38
5.6.2 eXtract Trees 5-38
5.6.3 Clear Extracted Trees 5-38
5.6.4 Display Extracted Trees 5-39

5.7 Define Plotter Pens 5-39

6. FAULT TREE ANALYSIS 6-1

6.1 Exit 6-1

6.2 Analyze Systems 6-2

6.2.1 Exit 6-3
6.2.2 Generate Cut Sets 6-4
6.2.3 Cut Set Update 6-7
6.2.4 Quantification 6-9
6.2.5 Prune Cut Sets 6-10
6.2.6 Uncertainty Analysis 6-10
6.2.7 Analysis Type 6-16
6.2.8 Min Max Quantification 6-17

6.3 Display Results 6-18

6.3.1 Exit 6-19
6.3.2 Cut Sets 6-19

6.3.3 Importance 6-24
6.3.4 Uncertainty 6-26
6.3.5 Analysis Type 6-26

6.4 Cut Set Editor 6-28

6.4.1 Exit 6-29
6.4.2 Help 6-30
6.4.3 <F5> - Find 6-33
6.4.4 <F6> - Previous 6-40
6.4.5 <F7> - Next 6-40
6.4.6 <F9> - Insert 6-40
6.4.7 <F10> - Delete 6-41
6.4.8 Change Analysis Type 6-41

6.5 Recover Cut Sets 6-41

6.6 Logic Editor 6-47

6.6.1 Exit 6-47
6.6.2 Logic Editor 6-47
6.6.3 Sub-System 6-57

6.7 Seismic Plotting 6-57

7. CREATE EVENT TREES 7-1

7.1 Exit 7-2

7.2 Create Event Trees 7-2

7.2.1 EXIT 7-2
7.2.2 Move (←→) 7-2
7.2.3 Show 7-2
7.2.4 EDIT 7-2
7.2.5 TOPS 7-6
7.2.6 ENDS 7-11
7.2.7 TEXT 7-16
7.2.8 VIEW 7-23
7.2.9 FILE 7-25
7.2.10 TRAN 7-27
7.2.11 Text 7-29
7.2.12 cntr/left/rght 7-29
7.2.13 Text Size 7-30
7.2.14 Line 7-30
7.2.15 ↑↓ (Color) 7-30

7.3 Link Event Trees 7-30

7.3.1 Exit 7-31
7.3.2 Generate Sequences 7-31
7.3.3 Rule Editor 7-34
7.3.4 Sequence Editor 7-37

7.4 Plot Trees 7-40

7.5 Graphics Load 7-40

7.5.1 Exit 7-40
7.5.2 Load 7-40

7.6 eXtract Event Trees 7-41

7.6.1 Exit 7-41
7.6.2 eXtract Trees 7-41
7.6.3 Clear Extracted Trees 7-42
7.6.4 Display Extracted Trees 7-42

7.7 Define Plotter Pens 7-42

8. ANALYZE SEQUENCES 8-1

8.1 Exit 8-2

8.2 Analyze Sequences 8-2

8.2.1 Exit 8-3
8.2.2 Generate Cut Sets 8-3
8.2.3 Cut Set Update 8-6
8.2.4 Quantification 8-6
8.2.5 Uncertainty Analysis 8-7
8.2.6 ENd State Uncertainty 8-7
8.2.7 Split Fraction 8-11
8.2.8 MinMax Quant. 8-11
8.2.9 Prune Cut Sets 8-12
8.2.10 Analysis Type 8-12

8.3 Display Results 8-12

8.4 Cut Set Editor 8-13

8.5 Recover Cut Sets 8-13

8.6 Partition Cut Sets 8-13

8.6.1 Exit 8-14
8.6.2 Sequence Rules 8-15

8.6.3 EVent Tree Rules 8-17
8.6.4 Family Rules 8-17
8.6.5 Apply Rules 8-17
8.6.6 Change Analysis Type 8-18

8.7 Link Event Trees 8-18

8.8 Event Tree Editor 8-18

8.8.1 Exit 8-18
8.8.2 Logic Editor 8-19
8.8.3 Switch to Subtrees 8-20

8.9 Seismic Plotting 8-20

9. ENDSTATE ANALYSIS 9-1

9.1 Exit 9-2

9.2 Analyze End States 9-2

9.2.1 Exit 9-2
9.2.2 Gather Cut Sets 9-3
9.2.3 Cut Set Update 9-4
9.2.4 Quantification 9-6
9.2.5 Uncertainty Analysis 9-6
9.2.6 Analysis Type 9-6

9.3 Display Results 9-6

9.3.1 Exit 9-6
9.3.2 Cut Sets 9-6
9.3.3 Importance 9-7
9.3.4 Uncertainty 9-7
9.3.5 Analysis Type 9-7

9.4 Cut Set Editor 9-7

10. MODIFY DATABASE 10-1

10.1 Exit 10-2

10.2 Family 10-2

10.2.1 Exit 10-3
10.2.2 Add 10-3
10.2.3 Modify 10-7
10.2.4 Delete 10-8

10.2.5 Text 10-8

10.3 EVent Trees 10-10

10.3.1 Exit 10-11
10.3.2 Add 10-11
10.3.3 Modify 10-20
10.3.4 Delete 10-20
10.3.5 Text 10-21
10.3.6 Sequences 10-22
10.3.7 Base Case Update 10-29
10.3.8 Clear Alternate Case 10-29

10.4 SYstems 10-29

10.4.1 Exit 10-29
10.4.2 Add 10-31
10.4.3 Modify 10-32
10.4.4 Delete 10-32
10.4.5 Text 10-34
10.4.6 Base Case Update 10-34
10.4.7 Clear Alternate Case 10-34

10.5 ENdstates 10-34

10.5.1 Exit 10-34
10.5.2 Add 10-34
10.5.3 Modify 10-36
10.5.4 Delete 10-36
10.5.5 Text 10-37
10.5.6 Base Case Update 10-37
10.5.7 Clear Alternate Case 10-38

10.6 Basic Events 10-38

10.6.1 Exit 10-38
10.6.2 Add 10-38
10.6.3 Modify 10-39
10.6.4 Delete 10-40
10.6.5 Transformations 10-42
10.6.6 Remove Unused Event 10-45

10.7 Attributes 10-46

10.7.1 Exit 10-48
10.7.2 Add 10-48
10.7.3 Modify 10-49

10.7.4 Delete 10-49

10.8 Analysis Types 10-49

10.8.1 Exit 10-49
10.8.2 Modify 10-50

10.9 Gates 10-51

10.9.1 Exit 10-51
10.9.2 Add 10-51
10.9.3 Modify 10-52
10.9.4 Delete 10-53
10.9.5 Remove Unused Gates 10-53

10.10 Histograms 10-55

10.10.1 Exit 10-55
10.10.2 Add Histograms 10-55
10.10.3 Modify Histograms 10-60
10.10.4 Delete Histograms 10-62

10.11 P&IDs 10-62

10.11.1 Exit 10-62
10.11.2 Add 10-63
10.11.3 Modify 10-64
10.11.4 Delete 10-64

11. REPORT ON DATABASE 11-1

11.1 Exit 11-2

11.2 Family 11-2

11.2.1 Exit 11-2
11.2.2 Summary 11-3
11.2.3 Text 11-3
11.2.4 StAtistics 11-4

11.3 Basic Event 11-4

11.3.1 Basic Event Overview 11-4
11.3.2 Basic Event Probability Report 11-6
11.3.3 Basic Event Uncertainty Report 11-7
11.3.4 Transformations 11-7
11.3.5 Basic Event Cross Reference Report 11-8

11.4 Attributes 11-11

11.4.1 System Attributes 11-11
11.4.2 Location Attributes 11-11
11.4.3 Failure Mode Attributes 11-12
11.4.4 Event Type Attributes 11-12
11.4.5 Train Attributes 11-12

11.5 SYstem 11-12

11.5.1 System Summary Report 11-13
11.5.2 System Logic Report 11-15
11.5.3 Cut Sets Report 11-16
11.5.4 System Importance 11-18
11.5.5 X-Reference 11-20

11.6 Event Tree 11-21

11.6.1 Logic/Rules 11-21
11.6.2 Initiating Event Report 11-23
11.6.3 Cross Reference 11-23

11.7 Sequence 11-24

11.7.1 Summary 11-24
11.7.2 Logic 11-27
11.7.3 Cut Sets 11-28
11.7.4 Importance 11-30

11.8 End States 11-31

11.8.1 End State Summary Report 11-32
11.8.2 Cut Set Report 11-34
11.8.3 Importance 11-36
11.8.4 X-Reference 11-36

11.9 Gates 11-38

11.10 Histograms 11-38

11.10.1 Summary 11-38
11.10.2 Detail 11-40

11.11 User Info 11-40

12. UTILITY OPTIONS 12-1

12.1 Exit 12-1

12.2 Define Constants 12-1

12.3 Load MAR-D Data Files 12-13

12.3.1 Load Verification 12-16
12.3.2 Family 12-18
12.3.3 Attributes 12-18
12.3.4 Basic Event 12-18
12.3.5 SYstem 12-18
12.3.6 EVent Tree 12-18
12.3.7 ENdstate 12-18
12.3.8 Sequence 12-18
12.3.9 Gate 12-19
12.3.10 Change Sets 12-19
12.3.11 Histograms 12-19

12.4 EXtract MAR-D Data Files 12-19

12.4.1 Family 12-19
12.4.2 Attributes 12-19
12.4.3 Basic Event 12-19
12.4.4 SYstem 12-20
12.4.5 EVent Tree 12-20
12.4.6 ENdstate 12-20
12.4.7 Sequence 12-20
12.4.8 Gate 12-20
12.4.9 Change Sets 12-20
12.4.10 Histograms 12-20

12.5 Archive Database 12-23

12.5.1 Archiving Options 12-25

12.6 Recover Data Base 12-26

APPENDIX A - HARDWARE REQUIREMENTS AND INSTALLATION PROCEDURES . . . A-1

APPENDIX B - DATA INTERCHANGE FORMATS B-1

LIST OF FIGURES

1. Constants screen for hardware information 2-5
2. Constants for cut set, transformation, uncertainty, and miscellaneous default settings 2-6
3. Constants screen for fault tree graphics information 2-7
4. Constants screen for event tree graphics information 2-7
5. Key Functions Help screen 2-8
6. IRRAS 5.0 main menu 2-9
7. Help screen for hot keys 2-9
8. Select family menu 3-1
9. Version conflict warning message 3-3
10. Enter source for file copy 3-4
11. Change sets menu 4-2
12. Add a change set 4-2
13. Change set screen after an add 4-3
14. Modify a change set 4-4
15. Delete a change set 4-4
16. Select an event for probability change 4-5
17. Events marked for modification 4-6
18. Changes to an event probability 4-7
19. Event change screen for marked events 4-7
20. Event probability and class changes flagged 4-8
21. Failure data calculation types (probability changes) 4-9
22. Uncertainty distribution types (probability change) 4-11
23. Process flag (probability change) 4-13

24. Class change for event data 4-14
25. Class and probability changes applied to select events 4-15
26. Uncertainty distribution types (class changes) 4-16
27. Failure data calculation types (class changes) 4-16
28. Set mission time for generate changes 4-17
29. Selecting the event report type 4-19
30. Selecting the sorting order for event reports 4-20
31. Unaffected events (base) report routing 4-20
32. Confirm the base case update request 4-21
33. Set mission time for base case update 4-22
34. Build fault trees menu 5-1
35. Editing commands for the BILD option 5-3
36. BILD pop-up menu options 5-4
37. Edit pop-up menu 5-9
38. Attributes pop-up menu 5-10
39. Font selection screen 5-14
40. TEXT main menu 5-19
41. FONT selection menu 5-20
42. VIEW main menu 5-23
43. FILE main menu 5-25
44. NAME menu options 5-28
45. HP plot files display screen 5-31
46. Locate a specific file prompt 5-32
47. Load graphics tree screen 5-33

48. Alpha to graphics screen 5-34
49. Set table/box toggle for conversion 5-35
50. Fault tree pager menu 5-36
51. Graphical pager pop-up menu 5-37
52. Extract fault trees screen 5-38
53. Warning screen for clearing extracted trees 5-39
54. Extracted trees display 5-40
55. Fault tree analysis main menu 6-2
56. System analysis main menu 6-3
57. Cut set generation cutoff values 6-4
58. Status screen for cut set update 6-6
59. Results of the cut set update 6-6
60. Cut set generation cutoff values 6-7
61. Status screen for cut set update 6-8
62. Results of the quantification process 6-9
63. Acceptance basis for pruning 6-11
64. Uncertainty calculation values 6-12
65. Current status of the Monte Carlo sampling 6-15
66. Monte Carlo uncertainty results 6-16
67. Analysis type selection window 6-17
68. Set the number of passes for quantification 6-18
69. Display system results screen 6-18
70. Cut sets display 6-19
71. System partitioning menu 6-20

72. Using Include to partition a system 6-21
73. Using EXclude to partition a system 6-21
74. Mark events to view 6-22
75. Results of marking events to view 6-23
76. Partition report type selection 6-23
77. Details of a cut sets basic events 6-24
78. Initial display of importance measures 6-25
79. Importance measures sorted by occurrences 6-26
80. Uncertainty data display 6-27
81. Quantile values display 6-27
82. System selection for cut set editor 6-28
83. Cut set editor main menu 6-29
84. Cut set editor exit screen 6-30
85. Help screen for cut set editor 6-31
86. Modify an existing cut set 6-32
87. Add a new event to the system 6-32
88. Find cut set 6-34
89. Event attributes mask 6-35
90. Find options 6-36
91. Event selection list 6-37
92. Prompt to continue with insert 6-37
93. Prompt to continue with deletion 6-38
94. Prompt to continue find and replace process 6-39
95. Prompt to continue with copy and replace process 6-39

96. Insert a cut set into a system 6-41
97. Prompt to delete an entire cut set 6-42
98. Initial screen to recover cut sets 6-44
99. List of cut sets with recovered events 6-44
100. Event list for recovered cut set 6-45
101. Enter probability values for recovery events 6-46
102. Enter probability cutoff value to apply rules 6-47
103. Logic editor menu 6-48
104. Logic editor display screen 6-48
105. Help list to select a gate 6-49
106. Help screen to select a gate type 6-50
107. Help screens to select gate or event 6-51
108. Modify gate information 6-51
109. Help screen to select a gate type 6-52
110. Modify an event 6-52
111. Find a specific gate, gate type, or event 6-53
112. Find suboptions menu 6-53
113. Event list for find operation 6-54
114. Event attributes mask 6-55
115. Gates attributes mask 6-56
116. Seismic plotting main menu 6-57
117. Basic event plotting 6-58
118. System fragility plotting 6-59
119. Event tree graphics system menu 7-1

120. Create event tree editing commands 7-3
121. Event tree EDIT pop-up menu 7-4
122. TOPS pop-up menu 7-7
123. Font type menu for event names and headers 7-9
124. DESC pop-up menu 7-10
125. Font selection for event descriptions 7-12
126. ENDS pop-up menu 7-13
127. Font selection for end state text 7-15
128. TEXT pop-up menu 7-17
129. FONT selection screen 7-18
130. EDIT pop up menu 7-20
131. Text font selection menu 7-22
132. VIEW pop-up menu 7-24
133. FILE pop-up menu 7-26
134. TRAN pop-up menu 7-28
135. Link event tree screen 7-31
136. Locate a specific system using <F5> 7-32
137. Generate sequences output screen 7-33
138. Macro based event tree rule editor 7-35
139. Rule editor help screen 7-36
140. Sequence editor menu 7-38
141. Global replacement using the sequence editor 7-39
142. ETG files display 7-40
143. Extract graphic event trees screen 7-41

144. Warning screen for extracting trees 7-42
145. Display extracted trees screen 7-43
146. Event tree analysis main menu 8-2
147. Sequence analysis main menu 8-3
148. Cut set generation cutoff values 8-4
149. Status screen for cut set update 8-6
150. Results of the cut set update 8-7
151. Uncertainty calculation values for multiple sequence processing 8-8
152. End state analysis screen 8-8
153. Uncertainty calculation values 8-9
154. Split fraction display screen 8-11
155. Indicate number of passes for sequence quantification 8-12
156. End states partition menu 8-15
157. Sequence partition screen 8-16
158. Specify sequences for partitioning 8-16
159. Enter a rule interactively 8-18
160. Event tree logic editor 8-19
161. Event tree editor 8-20
162. End state analysis main menu 9-1
163. End states for current family and available options 9-2
164. End state cut set generation cutoff values 9-3
165. Status screen for end state cut set update 9-5
166. Results of end state cut set generation 9-5
167. Display end state result menu 9-7

168. Modify data base main menu 10-1
169. Family editing menu 10-2
170. Editing screen for adding a family 10-3
171. Histogram selection screen 10-5
172. Add a new histogram 10-6
173. Modify event for corresponding bin 10-6
174. Editing screen for modifying a family 10-7
175. Editing screen for deleting a family 10-8
176. Warning screen for a family delete 10-9
177. Selection screen for event tree editing 10-10
178. Editing screen for adding an event tree 10-11
179. Selection screen for initiating events 10-12
180. Modify an initiating event 10-13
181. Add an initiating event to the current family 10-14
182. Editing screen for modifying an event tree 10-20
183. Warning screen for an event tree deletion 10-21
184. Editing screen for deleting an event tree 10-22
185. Sequence selection screen for editing 10-22
186. Editing screen for adding a sequence 10-23
187. End states selection screen 10-24
188. Modify end state 10-25
189. Add an end state 10-25
190. Editing screen for modifying a sequence 10-26
191. Editing screen for deleting a sequence 10-26

192. Warning screen for deletion of marked sequences 10-27
193. Base case update for sequences 10-28
194. Clear alternate case for selected sequence(s) 10-28
195. Base case update for all sequences in the event tree 10-29
196. Clear alternate case for event trees 10-30
197. Selection screen for system editing 10-30
198. Editing screen for adding a system 10-31
199. Editing screen for modifying a system 10-32
200. Editing screen for deleting a system 10-33
201. Warning message when deleting marked systems 10-33
202. Selection screen for end state editing 10-35
203. Editing screen for adding an end state 10-35
204. Editing screen for modifying an end state 10-36
205. Editing screen for deleting an end state 10-37
206. Warning message to delete marked end states 10-37
207. Selection screen for basic event editing 10-38
208. Editing screen for adding a basic event 10-39
209. Editing screen for modifying a basic event 10-40
210. Editing screen for deleting a basic event 10-41
211. Warning message to delete marked basic events 10-41
212. Initial transformation screen 10-42
213. Listing of all basic events 10-43
214. Enter transformation type and level 10-44
215. Remove unused events prompt 10-46

216. Attribute selection for editing 10-46
217. Selection screen for attribute editing 10-47
218. Editing screen for adding an attribute 10-47
219. Editing screen for modifying an attribute 10-48
220. Editing screen for deleting an attribute 10-48
221. Edit analysis types 10-50
222. Modify analysis type 10-50
223. Selection screen for gate editing 10-51
224. Editing screen for adding a gate 10-52
225. Editing screen for modifying a gate 10-52
226. Editing screen for deleting a gate 10-53
227. Warning message to delete marked gates 10-54
228. Remove unused gates warning message 10-54
229. Edit histograms menu 10-55
230. Select type of histogram to add 10-56
231. Adding a percentage histogram 10-57
232. Add the remaining percent to create a valid histogram 10-57
233. Add a range histogram 10-58
234. Adding an area histogram 10-59
235. Adding a hazard histogram 10-60
236. Modify a percentage histogram 10-61
237. Modify a range histogram 10-61
238. Delete a percentage histogram 10-62
239. Selection of graphics picture for editing 10-63

240. Add a P&ID graphic 10-63
241. Modify P&ID graphic 10-64
242. Delete P&ID graphic 10-65
243. Warning message for marked P&ID records 10-65
244. Report on data base main menu 11-1
245. Family summary option 11-2
246. Select family and report option menu 11-3
247. Output destination screen 11-4
248. Basic event selection screen 11-5
249. Basic event overview screen 11-5
250. Basic event probability screen 11-6
251. Basic event uncertainty report 11-7
252. Transformation screen 11-8
253. Basic event cross reference screen 11-9
254. Select referenced or used events 11-10
255. Select analysis type 11-11
256. Attributes report menu 11-12
257. System report selection screen 11-13
258. System summary report selection screen 11-13
259. System summary screen 11-14
260. Change analysis type 11-15
261. System logic report screen 11-16
262. Cut sets report screen 11-17
263. Cut set default report settings 11-18

264. System importance screen 11-19
265. Sort selection screen 11-19
266. System cross reference report selection screen 11-20
267. Event tree report selection screen 11-22
268. Logic/Rules selection screen 11-22
269. Event tree/subtree cross reference reports 11-23
270. Sequence report selection screen 11-25
271. Sequence summary report selection menu 11-25
272. Sequence summary screen 11-26
273. System combination screen 11-27
274. Sequence uncertainty screen 11-28
275. Sequence cut sets selection screen 11-29
276. Cut set report options 11-29
277. Sequence importance selection screen 11-30
278. Sort criteria selection screen 11-31
279. End state report selection screen 11-32
280. End state summary menu 11-32
281. End state summary 11-33
282. End state uncertainty menu 11-34
283. End state cut sets screen 11-35
284. End state cut sets default values 11-35
285. End state cross reference menu 11-36
286. End state reference option for cross reference 11-37
287. Gate report menu 11-38

288. List of available gates 11-39
289. Histogram reports 11-39
290. Utility options main menu 12-1
291. User information constants screen 12-2
292. Set default values and flags 12-5
293. Fault tree graphics information 12-8
294. Event tree graphics information 12-11
295. Load MAR-D main menu 12-13
296. Data types that can be loaded 12-14
297. Data type selection screen for loading 12-14
298. Actual data files that can be loaded 12-15
299. Actual data files that can be loaded 12-15
300. List of files with the selected extension 12-16
301. Extract main menu 12-21
302. Data types that can be extracted 12-21
303. Data type selection screen for extracting 12-22
304. Actual data files that can be extracted 12-22
305. Selection of the data file type to extract 12-23
306. Archive screen 12-24
307. Archiving options 12-25
308. Recover everything warning screen 12-26

LIST OF TABLES

1. Format for ASCII file containing intermediate samples 6-13
2. Sample of intermediate results 6-14
3. User Information field descriptions for constants option 12-3
4. Default values and flag settings 12-6
5. Fault tree graphics information field descriptions 12-9
6. Event tree graphics information field descriptions 12-12
7. MAR-D files load order dependencies 12-16

EXECUTIVE SUMMARY

The Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE) refers to a set of several microcomputer programs that were developed to create and analyze probabilistic risk assessments (PRAs), primarily for nuclear power plants. The Integrated Reliability and Risk Analysis System (IRRAS) is being developed at the Idaho National Engineering Laboratory (INEL) as the U.S. Nuclear Regulatory Commission's (NRC's) state-of-the-art microcomputer-based probabilistic risk assessment (PRA) model development and analysis tool to address key nuclear plant safety issues. IRRAS is an integrated PRA software tool that gives the user the ability to create and analyze fault trees and accident sequences using a microcomputer. This program provides functions that range from graphical fault tree and event tree construction to cut set generation and quantification to report generation.

The INEL's role in the IRRAS program is that of software developer and interface to the user community, including training and technology transfer. Version 1.0 of the IRRAS program was released in February of 1987 to prove the concept of performing this kind of analysis on microcomputers. That version contained many basic features needed for fault tree analysis and was well received by the PRA community. Since the release of Version 1.0, many user comments and enhancements have been incorporated into the program, providing a much more powerful and user-friendly system. This version has been designated IRRAS 5.0. Previous versions of IRRAS include versions 2.0, 2.5, and 4.0.

IRRAS has all the capabilities and functions required to create, modify, reduce, and analyze fault tree models used in the analysis of complex systems and processes. IRRAS uses advanced graphic and analytical techniques to achieve the greatest possible realization of the potential of the microcomputer. Version 5.0 of IRRAS provides all of the same capabilities as earlier versions and adds the ability to perform location transformations, seismic analysis, and provides enhancements to the user interface as well as improved algorithm performance. Additionally, version 5.0 contains new alphanumeric fault and event tree editors and macro-based rule editors used for event tree rules, recovery rules, and end-state partitioning.

FOREWORD

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

MAR-D is a program that is used primarily for PRA data loading. This program defines a common relational database structure that is used by the entire suite of programs. This structure allows all of the software to access and manipulate data created by other software in the system without performing a lengthy conversion. Therefore, data created by IRRAS is immediately available to SARA for sensitivity analysis. The MAR-D program also provides the facilities for loading and unloading of PRA data from the relational database structure used to store the data. A simple ASCII data format is used for interchange with other PRA software not included in NRC's suite of programs. This feature allows for compatibility with previously developed software systems and allows for maximum data interchange. Elements of this software are included with both IRRAS and SARA to allow these programs to load and unload data in the MAR-D format. Normally, the entire MAR-D software is used only by those performing a data loading function and is not required by the end user. Documentation for MAR-D Version 5.0 is available as NUREG/CR-6116, Volume 8. It should be noted that whenever the MAR-D database structure is changed, it necessitates changes in the remaining codes (i.e., IRRAS, SARA, and FEP). Therefore, the code version numbers are changed in unison. Each version set must be used together to maintain compatibility.

IRRAS is a program developed for the purpose of performing those functions necessary to create and analyze a complete PRA. This program includes functions to allow the user to create event trees and fault trees, to define accident sequences and basic event failure data, to solve system and accident sequence fault trees, to quantify cut sets, and to perform uncertainty analysis on the results. Also included in this program are features to allow the analyst to generate reports and displays that can be used to document the results of an analysis. Because this software is a very detailed technical tool, the user of this program should be familiar with PRA concepts and the methods used to perform these analyses. Although IRRAS has been designed to be user friendly and

makes the process of performing a PRA easier, the complexity of this type of analysis requires a user with a more detailed understanding of PRA concepts than is required by other tools in this suite. The IRRAS 5.0 reference manual and tutorial are available as NUREG/CR-6116, Volumes 2 and 3, respectively. In addition, a technical document that provides information on the principles and algorithms used in the construction and operation of IRRAS and SARA is available as NUREG/CR-6116, Volume 1.

SARA is a program that allows the user to review the results of a PRA and to perform limited sensitivity analyses on these results. It is limited primarily to the extent that changes in the plant model can be accommodated by using the cut set editor. If other than simple changes are being simulated, then IRRAS should be used so that new cut sets can be accurately generated. This tool is intended to be used by a less technically-oriented user and does not require the level of understanding of PRA concepts required by IRRAS. With this program a user can review the information generated by a PRA analyst and compare the results to those generated by making limited modifications to the data in the PRA. Also included in this program is the ability to graphically display the information stored in the MAR-D database. This information includes event trees, fault trees, P&IDs and uncertainty distributions. The user of this program can gain a better understanding of the results of a PRA without getting into the details of the construction and analysis work behind the PRA. The SARA reference manual and tutorial are available as NUREG/CR-6116, Volumes 4 and 5, respectively.

FEP is a program developed to provide a common access to the suite of graphical tools developed for performing risk assessment. These tools include the graphical fault tree, event tree, and P&ID editors. The fault tree and event tree editors are available through IRRAS; however, the P&ID editor is only accessible through FEP. The fault tree editor allows the user to construct and modify graphical fault trees. The event tree editor allows the analyst to construct and modify graphical event trees. The P&ID editor allows the user to construct and modify plant drawings. These drawings can then be used to document the modeling used in a PRA. These editors are an integral part of a PRA. With the FEP tool, the user need not be concerned with the complexity of the IRRAS program if the need is only to generate one of these graphical displays. The FEP Reference Manual is available as NUREG/CR-6116, Volume 7.

ACKNOWLEDGMENTS

The IRRAS project would not have enjoyed the success it has without the efforts of some other key contributors. These individuals provided a major contribution to the development and success of the IRRAS system.

- Howard D. Stewart for his support in designing the overall IRRAS concepts and for his software support in implementing these concepts.

- Dale M. Snider and Kurt L. Wagner for their contribution to the graphical concepts and software development in IRRAS 1.0.

- Scott D. Matthews and Cory Atwood for their support on the uncertainty analysis.

Appreciation is also expressed to all the various organizations and individuals who provided valuable comments and reviews of the preliminary versions of IRRAS.

SAPHIRE Version 5.0

Volume 2—Integrated Reliability and Risk Analysis System (IRRAS) Reference Manual

1. INTRODUCTION

The Integrated Reliability and Risk Analysis System (IRRAS) software development project was started because of a recognized need for microcomputer-based software to aid the probabilistic risk assessment (PRA) analyst. The initial scope of the project was to provide a software package that could show the feasibility of using the microcomputer as a workstation for performing PRA analyses. This package did not necessarily need to perform all of the functions required; however, it did need to provide certain essential functions such as fault tree construction, failure data input, cut set generation, and cut set quantification. The result of this software development project was IRRAS 1.0. That version of the software was released in February of 1987 and contained only the essential concepts mentioned above.

IRRAS 1.0 was an immediate success and clearly demonstrated not only the tremendous need but also the feasibility of performing this work on a microcomputer. As a result of this success, IRRAS 2.0 development was begun. This package was designed to be a comprehensive PRA analysis package and included all the functions necessary for a PRA analyst to perform his or her work. The areas that were not treated in version 1.0 were addressed, and a complete, integrated package was developed. Because IRRAS version 2.0 was a complete rewrite from version 1.0, a thorough test plan was necessary. The major features of IRRAS 2.0 along with an Alpha test were completed in early March of 1988. Following the Alpha test, approximately 15 sites were selected from among the sites currently using IRRAS 1.0. and were sent a Beta test version of IRRAS 2.0. In May of 1988, the Beta test was completed and work began on fixing any bugs found. In addition, any desired new features that could reasonably be incorporated into version 2.0 were included. IRRAS 2.0 was released in June 1990 and work began on the development of IRRAS 2.5.

IRRAS version 2.5 was an integrated PRA software tool that gave the user the ability to create and analyze fault trees and event trees using a personal computer (PC). This program provided functions for fault tree and event tree construction and analysis. The fault tree functions ranged from graphical fault tree construction to fault tree cut set generation and quantification. The event tree functions included graphical event tree construction, the linking of fault trees, defining accident sequences, generating accident sequence cut sets, and quantifying them.

IRRAS version 4.0 contained many significant enhancements over previous versions. This version provided much more powerful cut set generation algorithms. These algorithms are more than a thousand times faster than previous versions of IRRAS. Problems that took hours to solve can now be solved in seconds using IRRAS 4.0. Other enhancements provided in this version included the ability to use the system fault tree logic to solve accident sequences and the addition of flag sets to prune the sequence logic automatically. Many operations in IRRAS have also been streamlined and simplified to provide an even more powerful tool for the PRA analyst. This version has undergone a rigorous testing program to ensure reliability and usability. Overall, IRRAS 4.0 continued to provide more powerful tools for the PRA analyst.

The objective of the IRRAS development is to provide the U.S. Nuclear Regulatory Commission (NRC) with a PC-based tool that can be used by NRC staff to evaluate incidents in a timely manner. IRRAS 1.0 was released in February 1987. Since then, it has been distributed to over 400 users in the United States. These users include NRC staff, national laboratories, contractors, vendors, utilities, architectural engineering firms, consultants, universities, other government agencies, and their contractors. IRRAS is being used as an analysis tool in the resolution of generic issues, inspection activities, and other NRC programs.

At the center of the PRA is the fault tree model. This model, along with component reliability data, provides the basis for risk analysis in most PRA methods. Before the development of IRRAS, an analyst would generate models using an alphanumeric text editor. The information would be input in a format compatible with the analysis software, such as SETS, used to process the information. When changes to the model were needed, the analyst would go back to the text file and modify the card images to reflect the changes in the logic model. The analyst would then resubmit them to generate the new cut sets. This process is prone to errors and difficult for the analyst to visualize. IRRAS helps eliminate this problem.

IRRAS automates the model creation, manipulation, modification, and quantification processes. Designed for the IBM-PC and compatibles, IRRAS is readily accessible and portable. Taking advantage of new state-of-the-art algorithms, IRRAS is quite fast and powerful.

IRRAS simplifies the analysis process and automates the construction of input to the analysis software. The analyst can graphically construct and modify fault trees. IRRAS gives the users better visualization of the fault tree and simplifies the construction and maintenance. The program supports all of the basic constructs involved in fault tree construction, including NOT gates. Once the fault tree is constructed, the program automatically generates the alphanumeric input for the analysis software. The component reliability information is then easily input into the IRRAS database using specially designed menus and screens.

After constructing the system fault tree models, the analyst processes these models with an integrated fault tree analysis package. This package includes the capability to read a fault tree and failure rate data associated with the basic events. The program then generates the minimal cut sets of the fault tree and quantifies the fault tree top event probability using the minimal cut set upper bound. Importance measures for both cut sets and basic events are calculated. The results are documented in various reports generated by the program. The user may select truncation of cut sets by size and/or probability and specify the gate where reduction is to begin. The user may perform some cut set level analysis by using a cut set editor to modify the cut sets, save the new cut sets, and recalculate the minimal cut set upper bound and the new importance measures.

The analyst defines accident sequences in terms of the systems. IRRAS 4.0 can link fault trees according to the accident sequence logic to create core damage sequence cut sets. These accident sequence cut sets are then quantified to determine the accident sequence frequency. Importance measures are also calculated.

Many new features have been incorporated into Version 5.0. These new features include the capability to perform rule based recovery analysis and end state cut set partitioning. A completely new alphameric fault tree editor has been developed. This new editor allows the analyst to easily modify fault tree logic. A new cut set editor has also been developed. This editor is much more powerful than the previous editor and the user interface has been simplified. The MAR-D data interchange processor has been completely rewritten to provide much more flexibility in defining output options. An error message file has also been added to allow the analyst to determine the results of batch processing. A windows compatible version of the graphical fault tree editor has been developed and a 386 protected mode version is also now available. These two new versions allow the user to take advantage of the latest in microprocessor technology. The event tree rule editor has been changed to a powerful free format editor. This editor allows the analyst to much more easily define rules for event tree top substitutions. These rules include the ability to define rules for each transfer event tree in an analysis. Associated with the event tree changes is the ability to handle the large event tree, small fault tree methodology better. All these new features combine to make IRRAS 5.0 a powerful PRA analyses tool.

The sections that follow provide the user with the detailed information needed to become familiar with IRRAS 5.0. Sections 3 through 12 present a step-by-step approach to using the basic capabilities of IRRAS. Appendix A provides the specifics of hardware requirements and installation. Appendix B contains data interchange formats.

NOTE: It should be noted that this document assumes the reader is familiar with PRA methods and terminology. This manual does not instruct the reader in PRA methodology, but merely serves as a reference manual for the IRRAS user.

2. GETTING TO KNOW IRRAS 5.0

The purpose of this section is to give you, the user, an overview of what IRRAS 5.0 can do. We begin with brief discussions of the IRRAS 5.0 modules. (Each module roughly corresponds to a major function or feature.) Next, we explain a little about the IRRAS 5.0 database so you can begin to learn how IRRAS 5.0 operates. Then, we give some pointers on how to get around inside the program easily with some special keys. Finally, we provide some insight about how IRRAS 5.0 works, the usual order of operating IRRAS, and things you must do to prevent unpredictable results.

2.1 IRRAS 5.0 Modules

We have structured IRRAS 5.0 so that the various functions are contained in individual modules or program units. Each module is activated using a command from a menu on the screen. The main modules are SELECT Family, GENERATE Event Data, BUILD Fault Trees, FAULT Tree Analysis, CREATE Event Trees, ANALYZE Sequences, ENDSTATE Analysis, MODIFY Data Base, REPORT on Data Base, and UTILITY Options. Each module is described below.

The *SELECT Family* module is used to select the family data set you wish to work with and provides the capability of copying raw (MAR-D) data files or IRRAS database files into a specific family.

The *GENERATE Event Data* module is used to create a working copy of user event data for use in analysis. This data can then be modified using change sets or used to update the base case data.

The *BUILD Fault Trees* module is used to build and edit fault tree models and output them to several hard copy hardware devices. Fault trees can be drawn using the keyboard or a mouse. If you use the keyboard, you'll soon see the advantages of getting a mouse. We have used pop-up menu technology in this module to make tree drawing as simple as possible.

The *FAULT Tree Analysis* module is used to quantify the fault tree. Here you determine the minimal cut sets, calculate the probability of failure of the top event of the fault tree, calculate the importance measures of the basic events and the cut sets, and perform uncertainty analysis on the top event failure probability. Sensitivity analysis can be done by changing the failure probability of basic events and requantifying.

The *CREATE Event Trees* module is used to build, edit, and link event trees in a fashion similar to the way the fault trees are constructed in IRRAS 5.0. This greatly simplifies and automates the event tree construction and analysis process.

The *ANALYZE Sequences* module is a powerful sequence analyzer. This module generates the cut sets for an accident sequence by combining the cut sets or fault trees for the top events that make up the sequence. Comparisons are made between the cut set lists for successful and failed fault trees to eliminate impossible failure combinations (similar to the delete term option in SETS). Once the sequence cut sets have been generated, you can quantify the sequence, calculate importance measures, and perform uncertainty analysis. The results can be displayed on the screen, sent to a printer, or written to a file for later use.

The *ENDSTATE Analysis* module is used to gather and quantify end state cut sets, perform a cut set update, and perform an uncertainty analysis on these end state cut sets. The user can gather all the cut sets that map to the same end state together in a single place. Using the rule based end state partitioning editor, the user can define an end state for each cut set. This allows partitioning to occur on a cut set by cut set basis or at the sequence level.

The *MODIFY Data Base* module provides access to the IRRAS 5.0 relational database that is created, in part, from use of the other modules. All information is grouped into families. A family can be a facility, a group of systems, or any other logical group for which fault trees or sequences are desired. You define the families and assign descriptions in this module. Fault trees are assigned to families in the BUILD Fault Trees module. Sequences are created and assigned descriptions in the MODIFY Data Base module. Basic events are automatically extracted from the fault trees assigned to the family, but you must assign reliability data and descriptions in the MODIFY Data Base module. Additions, deletions, and modifications to the database can be made here. Section 2.2 provides more detailed information on the database.

The *REPORT on Data Base* module lets you see what is in the IRRAS 5.0 database. Reports are available on families, basic events, attributes, systems, event trees, sequences, end states, and user information.

The last module, *UTILITY Options*, performs program and computer-related tasks such as setting new machine constants after a hardware configuration change or interfacing with SETS or the PRA database. The Utility option consists of six functions: Define Constants, Load MAR-D Data Files, Extract MAR-D Data Files, Archive Data Base, and Recover Data Base. The first option, Define Constants, is used to indicate system hardware configuration, set uncertainty and cut set defaults, and set event tree and fault tree graphic's defaults. The second option, Load MAR-D data Files, allows you to load raw files into IRRAS. Extract MAR-D Data Files allows you to output the IRRAS database records into files that conform to MAR-D data format. The Archive Data Base option allows you to compress, backup, restore, or expand data files for a family. Finally, the Recover Data Base option allows you to rebuild the index files to each relation in the database.

2.2 IRRAS 5.0 Database Concepts

Before you can use IRRAS 5.0 effectively, you need a good understanding of the IRRAS 5.0 database structure and concepts. The database provides an effective way to manage the inputs and outputs of the various modules.

The IRRAS 5.0 database is divided into *families*. A family is the first thing that must be created when using IRRAS 5.0. As delivered, IRRAS 5.0 provides an initial family called DEMO. (Once you are comfortable with IRRAS 5.0, you may want to clear this family from the database.) A *family* is any logical grouping of fault trees and sequences with their associated basic events, cut sets, reliability data, and descriptions. Access to any portion of the database is obtained through the appropriate family.

A fault tree is automatically assigned to the current family selected when the BUILD Fault Trees module is exited. The basic events used by the fault tree are checked against the events already assigned to the family. Any new basic events are added to the family list. Thus, for a given family there is only

one list that contains all the basic events for all the fault trees in the family. This ensures that the reliability data used for a basic event in one tree are identical to those used for the same event in another tree in the family.

The family relation maintains data common to all fault trees in the family, including

- family name and description,
- basic event names and attributes,
- event-to-fault tree association,
- event-to-sequence association,
- fault tree change status information, and
- sequence change status information.

NOTE: Change status is a flag set by the system indicating one of the following:

'c'	=	flags the system or sequence as having cut sets that must be recalculated
'q'	=	flags the system or sequence as having cut sets that must be requantified
'u'	=	flags the system or sequence as needing uncertainty distributions recalculated.
'+'	=	flags the system or sequence as having cut sets

These are discussed in detail in Section 6.

The fault tree 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,
- importance measures, and
- uncertainty analysis results.

Similarly, the relation defined for an accident sequence includes:

- name and description,
- logic (combination of successful and failed systems),
- minimal cut sets,
- sequence probability,
- importance measures, and
- uncertainty analysis results.

The event tree relation includes:

- event tree name and description,
- event tree logic and graphic representation, and
- initiating event.

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

Unrelated to trees and/or families is the user/system data.

The relations are permanent relations used to maintain the IRRAS 5.0 database. For each relation, three files exist:

- *.DAT,
- *.IDX, and
- *.BLK.

The *.DAT file contains the actual data and information about which data constitutes a "key." The *.IDX file contains indices into the data for keyed fields. Finally, the *.BLK file contains variable length data (such as cut sets) that are accessible through pointers contained in the *.DAT file.

2.3 Using IRRAS for the First Time

The installation procedure for loading IRRAS 5.0 into your computer is found in Appendix A. The loading process creates three new directories, if they do not already exist. These are \SAF50, \SAF50\TOOLS, and \SAF50\HALO88. The \SAF50\TOOLS directory contains the program, the \SAF50\DEMO directory contains sample data, and the \SAF50\HALO88 directory contains the graphic's package. These directories take approximately 6000K of memory on the hard disk when first loaded.

Of course, storage requirements go up as you use the program and generate more data.

IRRAS 5.0 uses approximately 580K of internal memory when executed, therefore, memory-resident programs must be unloaded before using IRRAS 5.0 on a 640K machine.

The following procedure assumes your system is running DOS 3.3 or newer. If your DOS version is older than 3.3, you must upgrade DOS to use IRRAS 5.0.

To start IRRAS 5.0, simply change directories to \SAF50 (CD\SAF50), type IRRAS, and press <Enter>. (The < > designates pressing the indicated key.) This will execute IRRAS 5.0 with the keyboard as the graphics input device unless you have a mouse and have loaded your mouse driver. If so, then you may use either input device interchangeably.

On the very first entry into IRRAS 5.0 after installation, the first constant's screen will appear (see Figure 1). With this screen, you tell the program the configuration of your hardware and the default values desired for various functions within the program. In addition, you may supply archive information including the method used to archive and the paths where the compression, backup, and restore programs are located. This screen, once completed, will not appear on subsequent entries into IRRAS. If you desire to change a default or your hardware configuration has changed, this screen can be called up from the UTILITY Options menu (see Section 12).

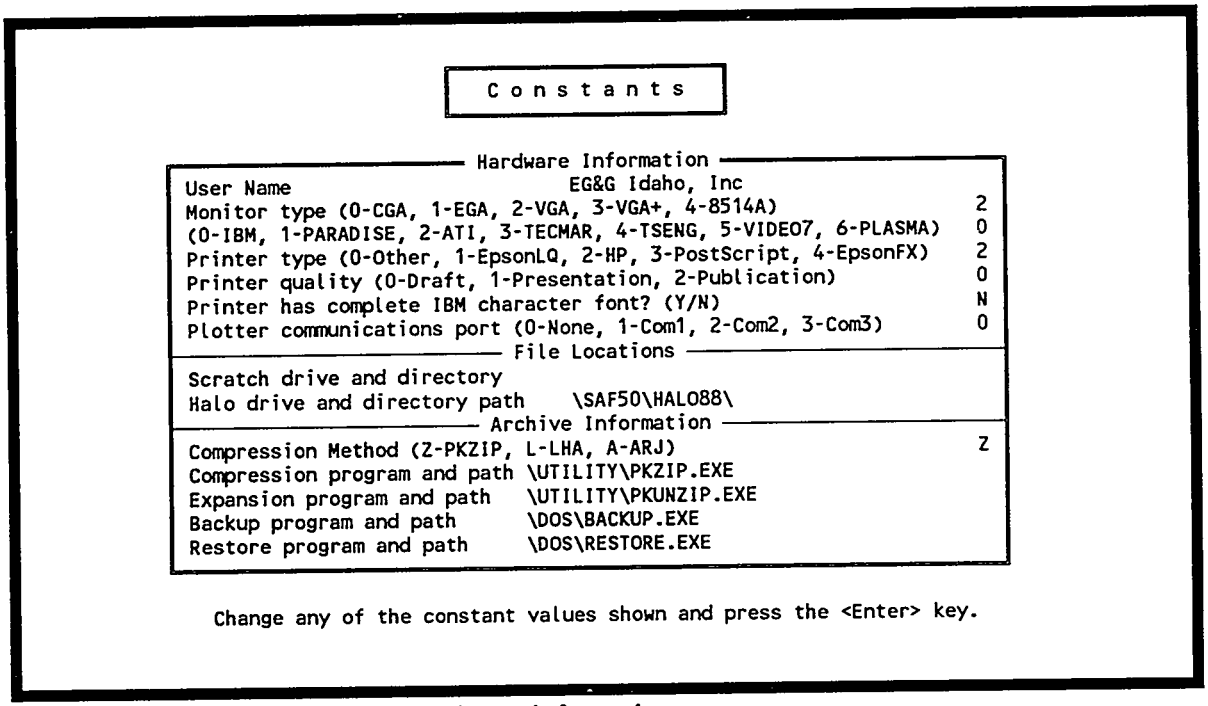


Figure 1. Constants screen for hardware information.

When this form is filled out properly, press <Enter> to place the information in the database. The second constants screen, shown in Figure 2, will appear. On this screen, you supply the default values for cut set generation, transformation, uncertainty analysis, and other miscellaneous settings. When complete, press <Enter>. Another defaults/constants screen will appear. This screen, shown

in Figure 3, establishes the defaults for the fault tree graphics. Once this is filled in properly, press <Enter>, and a fourth and final screen (Figure 4) will appear with defaults for the event tree editor. Fill this screen in as required and press <Enter>.

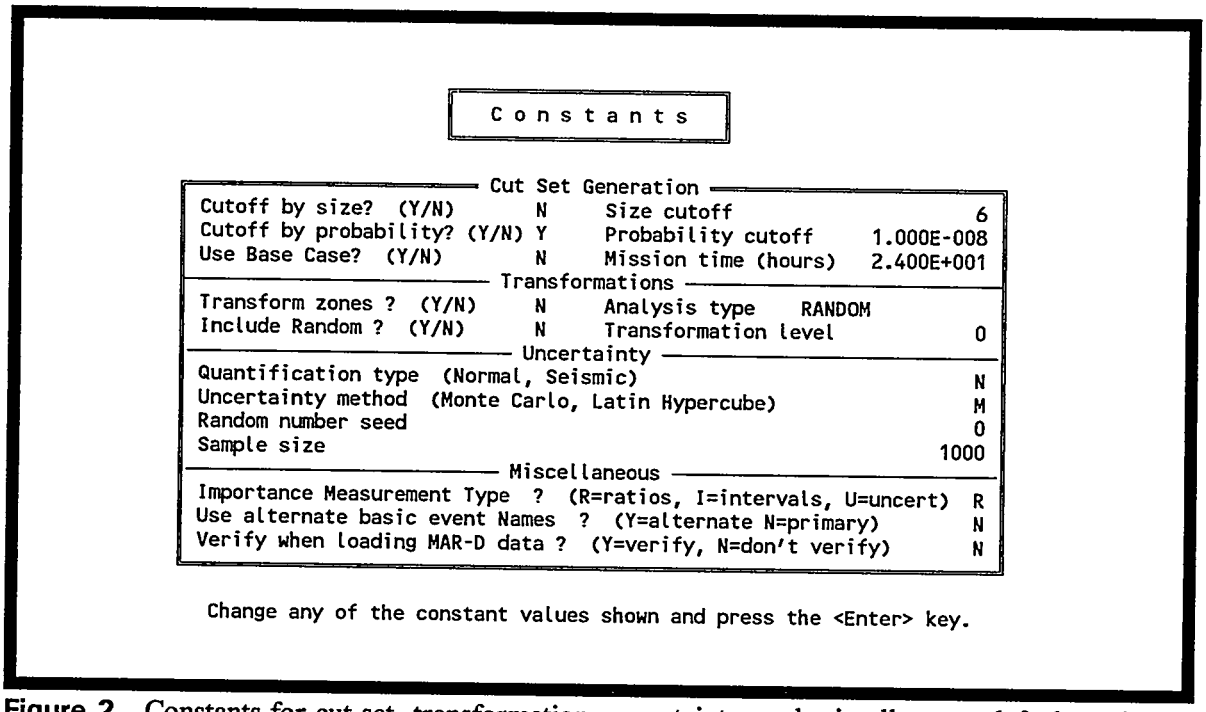


Figure 2. Constants for cut set, transformation, uncertainty, and miscellaneous default settings.

2.4 Getting Around Inside IRRAS 5.0

Option selection from any menu with a vertical list of options can be done in several ways. The up and down arrow keys can be used to move a highlight through the options. When the highlight is on the desired option, press <Enter> to select the option. The <Spacebar> will also move the highlight through the options. Another method of selecting an option is to type in the first or second letter of the option and press <Enter>. On menus that have horizontal lists of options, the highlighted letter of the option must be typed in the option field followed with <Enter>.

Certain portions of the program have help screens to aid the user. These help screens are accessed by pressing the <F1> key. The <Esc> key is used to cancel or abort a function.

Pressing <Alt> H will display the key function help screen. This screen is shown in Figure 5. This screen identifies the functions of some special keys for use on fill-in-the-blank type forms used in IRRAS 5.0.

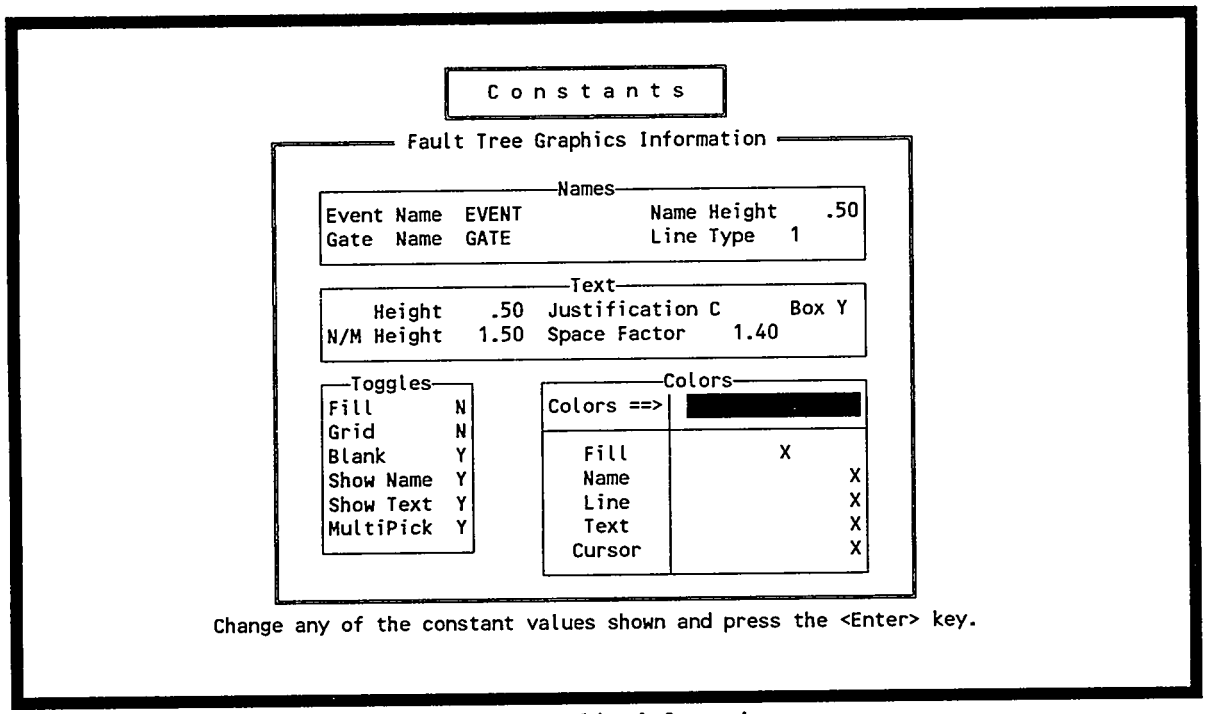


Figure 3. Constants screen for fault tree graphics information.

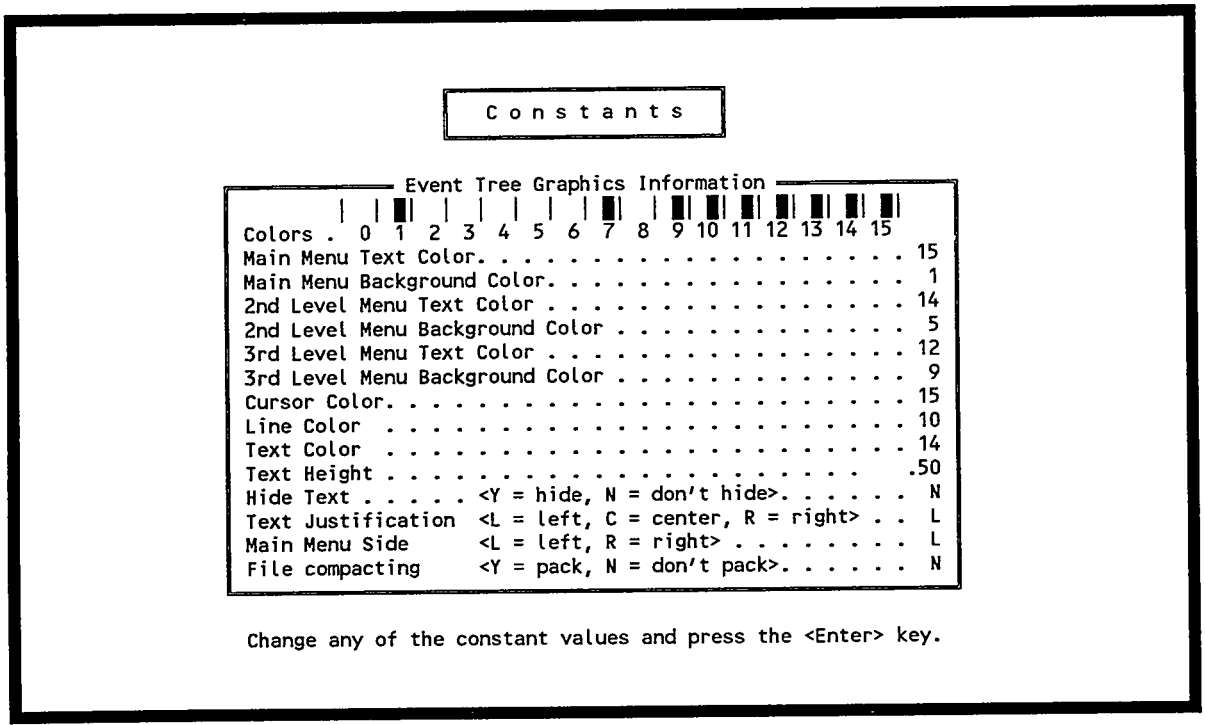


Figure 4. Constants screen for event tree graphics information.

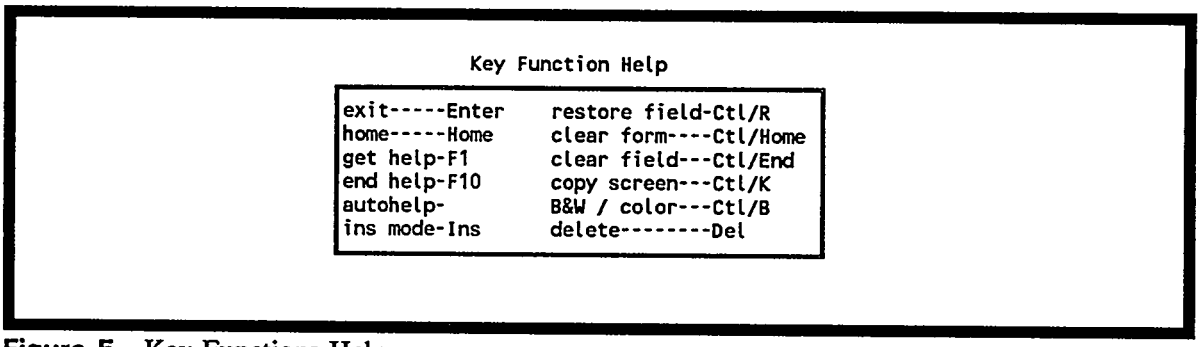


Figure 5. Key Functions Help screen.

The carriage return <CR> or <Enter> key sends a completed screen to the program for execution. The arrow keys and <Tab> key move the cursor around the fields on a screen. The <Home> key moves the cursor to the home field on the screen. The <Ins> key inserts characters in the text in a field. The <F10> key terminates a help screen. <Ctrl> R restores a field to its original setting. <Ctrl> <Home> clears all entries in all fields on the screen. <Ctrl> <End> clears the selected field. <Ctrl> B switches the display between black and white and color. <Ctrl> K copies the screen into a file on the disk named SCREEN.CPY. Multiple uses of <Ctrl> K will cause each screen to be appended to the bottom of the SCREEN.CPY file.

2.5 Invoking IRRAS

As mentioned earlier, to invoke IRRAS type **IRRAS** at the C:\SAF50 prompt. When you invoke this option, the main menu will be displayed (see Figure 6). Each menu option is discussed in the following sections (Sections 3 through 12).

2.6 Hot Keys

Hot keys allow you to directly transfer to any main menu option from any IRRAS module. To view the help screen for the hot key options, press <F1> from the main menu. Figure 7 will be displayed. This is a help screen only, and does not have to appear in order for the hot keys to be active. From most screens in IRRAS, you simply press the <Alt> key combination that corresponds to the desired main menu option. You will be immediately transferred into the corresponding module or to DOS.

2.7 Menu Options Naming Conventions

Throughout IRRAS, a consistent naming convention is used on all menus. On each menu (like the Create Event tree menus), some options appear in all upper-case letters, while for other options only the first letter is uppercase. When an option appears in all upper-case letters, an associated pop-up menu will be displayed listing the suboptions available when the option is invoked. If the option is not all uppercase, then no pop-up menu is associated and therefore no suboptions are available with the option.

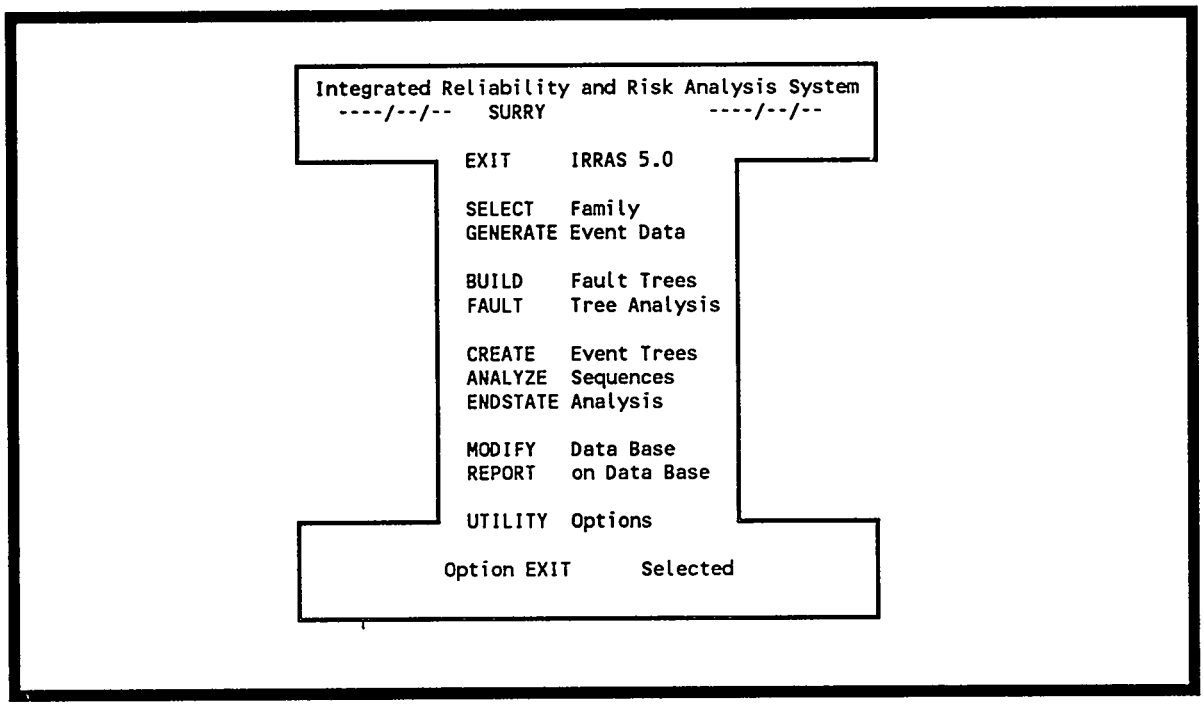


Figure 6. IRRAS 5.0 main menu.

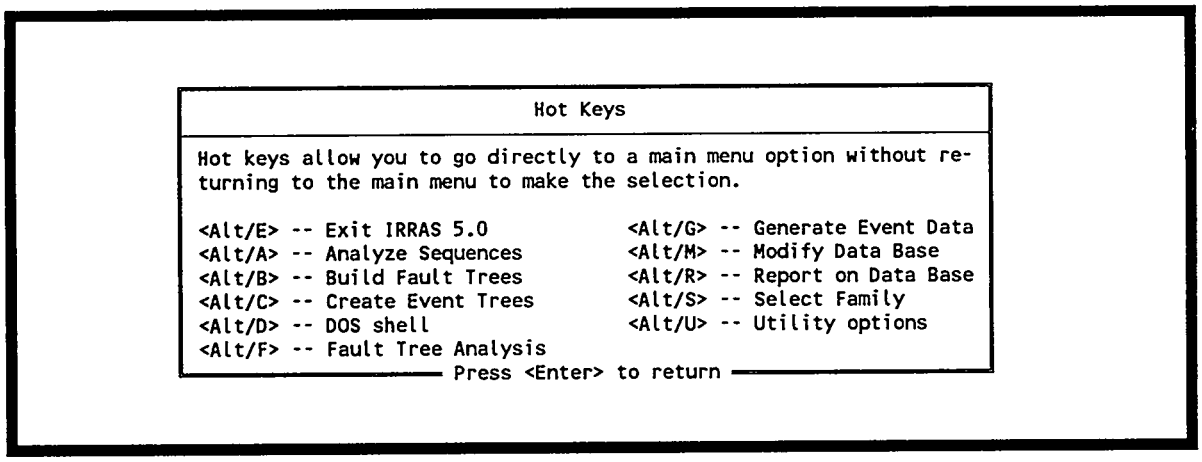


Figure 7. Help screen for hot keys.

2.8 Other Things You Should Know

IRRAS 5.0 uses a relational database to store and retrieve information. Certain information records are automatically added to the database depending on the functions performed by the user. IRRAS contains nine relations or tables of information. Each relation stores specific PRA information. The first relation is the "Family" relation. This relation contains general information about the PRA. Normally, a user will need to create a family relation for each PRA they are performing. All the information in a family is stored together in a subdirectory. The family relation also contains cross reference information for each basic event, system, sequence, and event tree in the family. The cross reference information is updated automatically each time one of these pieces of data is modified. When IRRAS is initially installed, only one family exists. This family is the "DEMO" family. The first thing the user will need to do is create a new family where the results of the PRA can be stored.

Once the "Family" is created, the user is ready to add information to the database. Typically the next step would be to use the Event Tree editor to generate the event trees for the Family. When the user creates event trees using this editor, IRRAS automatically adds certain information to the database. When the event tree is saved, an entry is created in the Graphics 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 an entry is also created in the Event Tree relation containing the name of the event tree, the initiating event for the event tree, and other descriptive data. The entry in the Event Tree relation is only created if the user has specified an initiating event. The reason for this is that if you have specified an initiating event, IRRAS assumes that you will be solving this event tree. If one is not specified, then IRRAS assumes that you will be only transferring to this event tree. Next, IRRAS creates an entry in the "System" relation for each top event defined in the event tree. By default, IRRAS assumes that each top event is represented by a system with the same name. At the time the system entry is created, IRRAS also creates a basic event with the same name as the system. This event is used when the system logic is not expanded during fault tree analysis or when the logic has not yet been developed.

The next step in the PRA analysis is to create the fault trees. If the graphical fault tree editor is used to create the fault trees, then IRRAS creates an entry in the Graphics relation for each fault tree created. An entry is not automatically created in the System relation for each fault tree. IRRAS only creates an entry in the System relation if it knows that the user will be solving this fault tree; otherwise, it assumes that it is only a subtree. If the user has not created any event trees with a top event having the same name as a fault tree, and the fault tree is to be solved, then the user must manually add the system name to the database, using the Modify Data Base option.

IRRAS requires that certain conventions be used for naming fault trees. If a fault tree is to be used as a top event in an event tree, or referenced in a sequence, then the name of the fault tree and the name of the top gate in the fault tree must be the same as the name of the top event in the event tree and system name in the System relation. A good procedure to follow is to name the top gate of a fault tree the same name as the fault tree.

IRRAS also adds all the basic event references in the fault tree to the Basic 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 defaulted. IRRAS also creates an entry in the Gate relation for each gate defined in the fault tree. The gate type and description is also stored in the database. Finally, IRRAS creates an entry in the Basic Event relation and the Graphics 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.

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 Data Base option or with the Generate Failure Data and Base Case update options. If the Modify Data Base option is used to change the default failure data, then the user must be sure to use the Generate Failure Data 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 IRRAS, the user should check to ensure that the proper data were generated.

The Sequence relation contains information about the sequences for an Event Tree. The user normally generates the sequence entries using the Link Event Tree option. When the user selects this option, IRRAS generates a sequence entry for each valid sequence in the event tree. Any sequences that may have been generated previously for an event tree are automatically removed from the database. Each sequence contains an end state name that is created in the Endstate 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 Endstate relation or the Event Tree for that sequence. When a sequence is solved, the cut sets generated are stored in the sequence relation.

The other relations in the IRRAS database are the Gate relation and the UserInfo relation. The Gate relation stores the name, type, and description of each gate contained in the fault trees for this 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 gates.

The Userinfo relation contains basic operating constants for IRRAS. The user may change these constants to reflect the desired defaults to be used. One piece of information stored in the Userinfo relation is a scratch drive and directory. IRRAS uses this information to locate scratch files during fault tree and sequence solutions. If the user has additional extended memory, a virtual disk drive may be created and the scratch path set to that drive. Doing this will improve the performance of IRRAS by a factor of from 2 to 5 times depending upon the problem being solved.

As the user adds information to the IRRAS database, a cross reference map is maintained for each basic event, system, 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, IRRAS checks these cross reference maps to ensure the piece of information being deleted is not used anywhere in the database. If it is used, IRRAS 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, system cut sets (base or current), event tree logic, sequence logic, or sequence cut sets (base or current). In the Modify Data Base module, IRRAS will display a "-" character in front of any event which it determines is not used by anything in the database. When deleting fault tree or event tree subtrees that are not used, the user will not find them in the System or Event Tree relation lists. Because they are subtrees, they are only found in the Graphics relation. To delete them, the user must use the Modify Data Base module and select the Graphics relation to be edited.

The information stored in the IRRAS database is buffered in and out of memory during processing. When the information is modified, IRRAS may not write the information out to the hard disk immediately. If the user does not exit IRRAS normally by using the "EXIT" option from the main menu, then the information that was changed may be lost. The user should always exit IRRAS before turning off or rebooting the computer. If a power failure or abnormal program abort occurs, the user should enter IRRAS, select the Utilities menu, and from that menu select the Rebuild 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 family 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.

3. SELECT FAMILY

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

The current directory is the current family unless you select another family. IRRAS retains the last family you selected when you exited the program so when you enter IRRAS again the last family selected is the current family. The Select Family screen (Figure 8) lists all families in the IRRAS database. In addition to listing the family name, directory and description, a status field is provided. The status field shows the current state of the database files for the family. For example, OnL indicates that all files are on-line and can be accessed without any further action on your part. In addition, the status field can contain any one of the following codes:

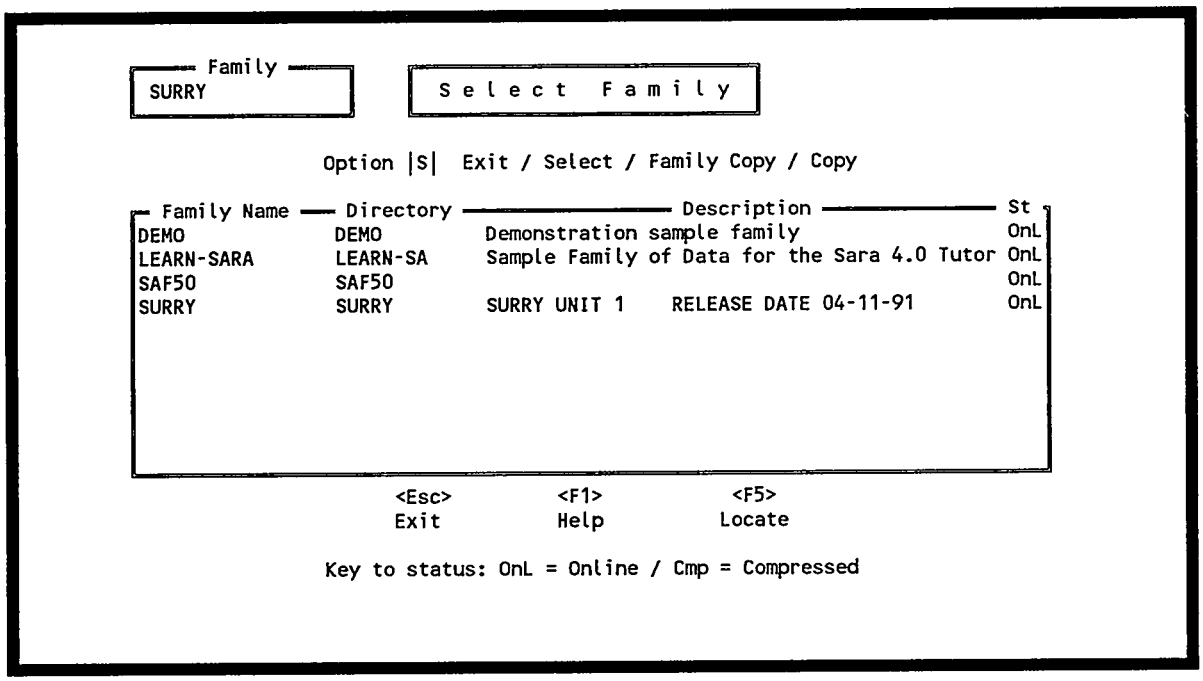


Figure 8. Select family menu.

Cmp - This indicates that the database files of the family are in a compressed state and are stored in an archive file. The compression packages PKZIP, LHA (LHARC), and ARJ are all supported. You must decompress these files before they can be accessed. The decompression process is done using the Archive Database option in the Utility Module (see Section 12.5).

The select family function provides four options: Exit, Select, Family Copy, and Copy. In addition, three function keys are available:

<Esc>	The <Esc> key exits the Select Family module and returns you to the IRRAS main menu.
<F1>	The <F1> key displays on-line help messages.
<F5>	The <F5> key allows you to locate a specified family. When you press <F5> a blank line will appear on the screen. Enter all or part of the family name you wish to locate and press <Enter>. This feature will place the highlight on the located name. If the requested name is not found, then the next name in alphabetical order will be highlighted. This feature is especially useful when there are several screens of families to display.

3.1 Exit

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

3.2 Select

This option is used to select the family data files that will be accessed during subsequent IRRAS functions. To invoke the option, type <S> in the option field, highlight a family, and press <Enter>. If a family is not highlighted, the message **Position the cursor over the family to select** will be displayed. When a family is highlighted and selected, you will be returned to the IRRAS main menu where the selected family name will appear at the top of the menu. For later functions, the selected family name will appear in the box in the upper left corner of the screen. If for any reason the family cannot be selected, the message **Unable to select desired family** appears, the previously selected family will be retained, and you will be given another chance to select a family. If the highlighted family's data version does not match the current software version, the version update screen appears (Figure 9), and you will be asked if you want to rebuild the data. To select the family, the data must be rebuilt, so enter a <Y> to rebuild, and then select the desired family. If you type <N>, that family's data will not be rebuilt, that family will not be selected, the former selected family will be retained, and the message **Unable to select desired family** appears.

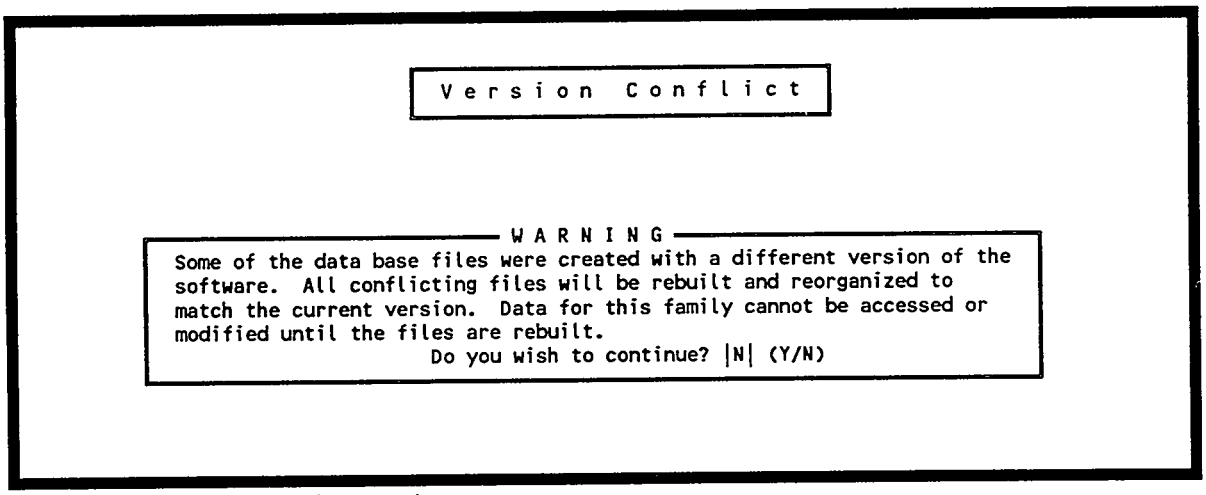


Figure 9. Version conflict warning message.

3.3 Family Copy

This option provides the means of copying database files between families. The family you are copying to should be empty. (**NOTE:** To create a new family, invoke the Modify Database module). The Family Copy option will overwrite all existing files. To invoke this option, type <F> in the option field, highlight a family, and press <Enter>. If no family has been highlighted, the message **Position the cursor over the family to copy from** appears at the bottom of the screen. If this message appears, highlight a family and press <Enter>. The message **Position the cursor over the family to copy to** will then appear. Again, highlight a family and press <Enter>. All family database files will be copied from the first family highlighted to the second family highlighted. When the files are copied, the message **Family successfully copied** appears.

3.4 Copy

This option provides the means of copying any file (raw data and/or a MAR-D file) into any family. To invoke this option, type <C> in the option field, highlight the family to copy to, and press <Enter>. If no family is highlighted, the message **Position the cursor over the family to copy to** is displayed at the bottom of the screen. If this message appears, highlight a family and press <Enter>. A new screen, File Copy (shown in Figure 10), requesting the path and file name of the source data being copied into the selected family is displayed. Specify the entire path of the data to be copied and press <Enter> (e.g., A:*.* or D:\RAWDATA\DEMO*.*). A confirmation message **File(s) successfully copied** is displayed when the files have been copied.

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

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

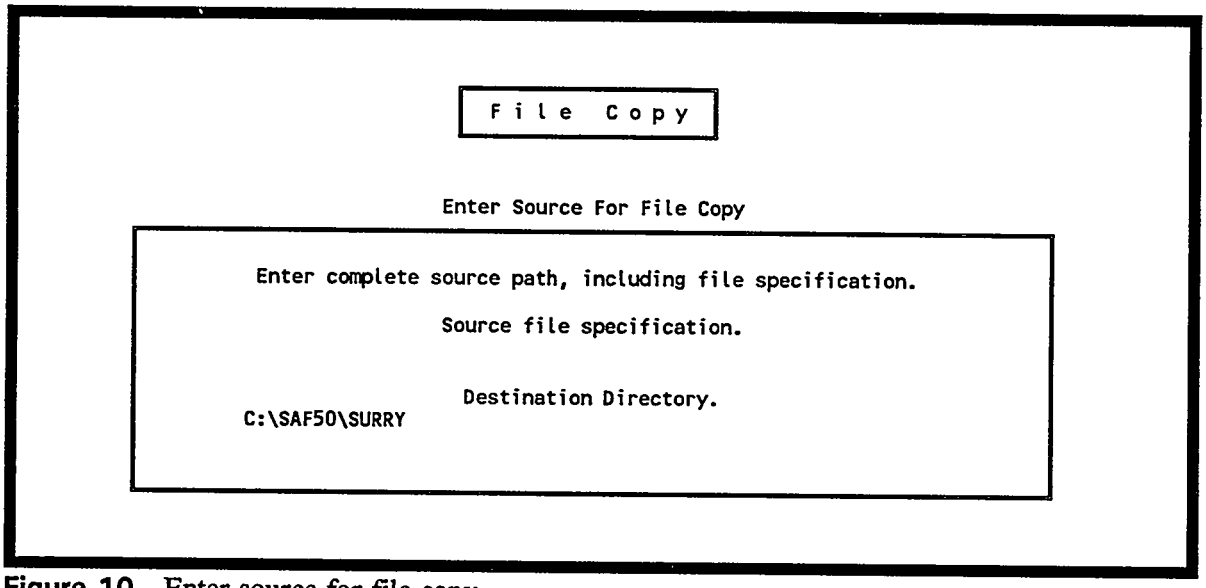


Figure 10. Enter source for file copy.

4. GENERATE EVENT DATA

The Generate Event Data module is used to create a working copy of user event data for use in analysis. This data can then be modified using change sets or used to update the base case data. This option allows you to add, modify, and delete change sets. Change sets contain information about the probability/class changes that are to be applied to basic events during system or sequence analysis. Within a change set you may modify selected event probabilities, and reset those event probabilities to the base case values. In addition, you may perform a base case update that takes all current basic event data and makes it the new base case data. The original base case data are overwritten in this process.

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

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

Highlight Generate Event Data on the main menu or type a <G> to select this option and press <Enter>. The Change Sets screen shown in Figure 11 will be displayed. A change set is a set of sensitivity data modifications to be applied to the basic events. Change sets modify the current case basic event data. A change set consists of probability and/or class changes for a group of basic events. As shown in Figure 11, nine options are available. Each of these options is discussed in the following paragraphs.

4.1 Exit

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

4.2 Add

The Add function is used to add a change set name and description to the database. You supply a name (16 characters maximum) and a description (60 characters maximum). The current date is supplied by the system; however, you may change it by typing over the default date.

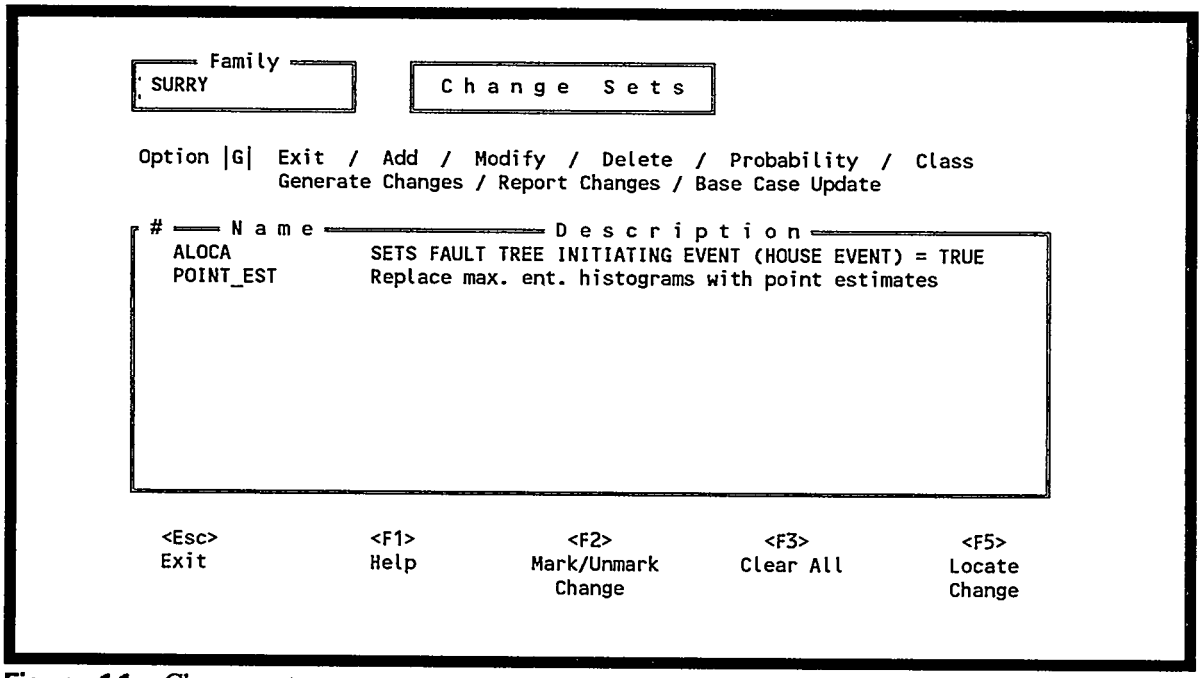


Figure 11. Change sets menu.

To invoke the add function, type an <A> in the option field and press <Enter>. The Add Change Set screen shown in Figure 12 will be displayed. This screen is displayed with the <A> (Add) option as the default entry in the option field. After entering the change set name (required) and description (optional) and pressing <Enter>, the message **New change record added** is displayed at the bottom of the screen. You are returned to the previous screen, where the newly added change set will be included (see Figure 13). If the name you entered already exists, the message **Duplicate change record name - not added** is displayed at the bottom of the screen.

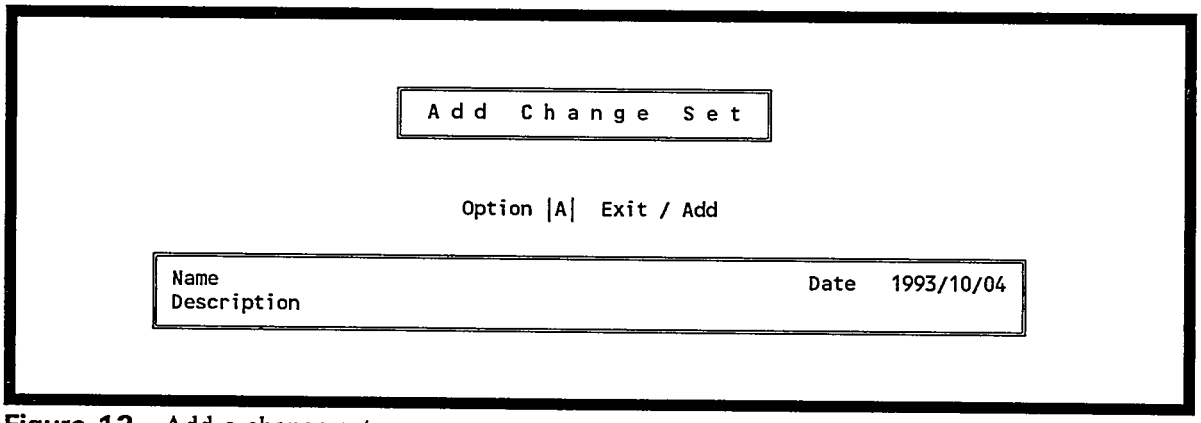


Figure 12. Add a change set.

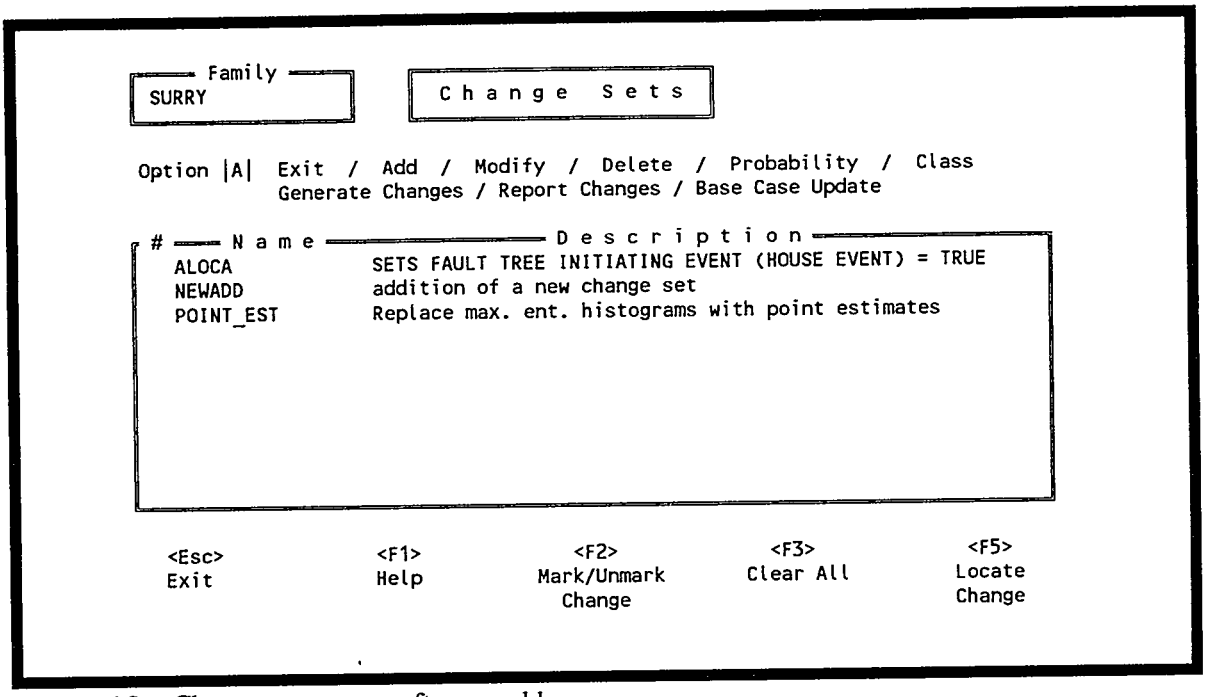


Figure 13. Change set screen after an add.

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

4.3 Modify

This option allows you to modify the name, description, and/or date for an existing change set. To invoke this function, type an <M> in the option field, highlight the change set you want to modify, and press <Enter>. The Modify Change Set screen (shown in Figure 14) appears. If you did not highlight the change set to modify before pressing <Enter>, the message **Record must be highlighted first** appears.

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

4.4 Delete

This function is used to remove a change set from the database. To invoke this function, type a <D> in the option field, highlight the change set you want to delete, and press <Enter>. The Delete Change Set screen (see Figure 15) is displayed, with an "E" (Exit) in the option field. To delete the change set, type a <D> and press <Enter>. You will be returned to the Change Sets screen, and the message **Change record deleted** is displayed.

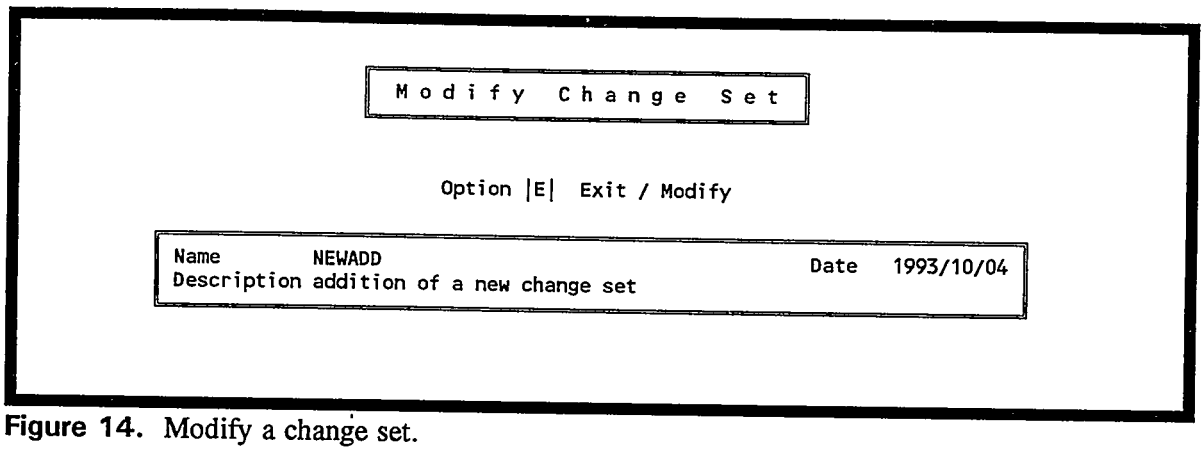


Figure 14. Modify a change set.

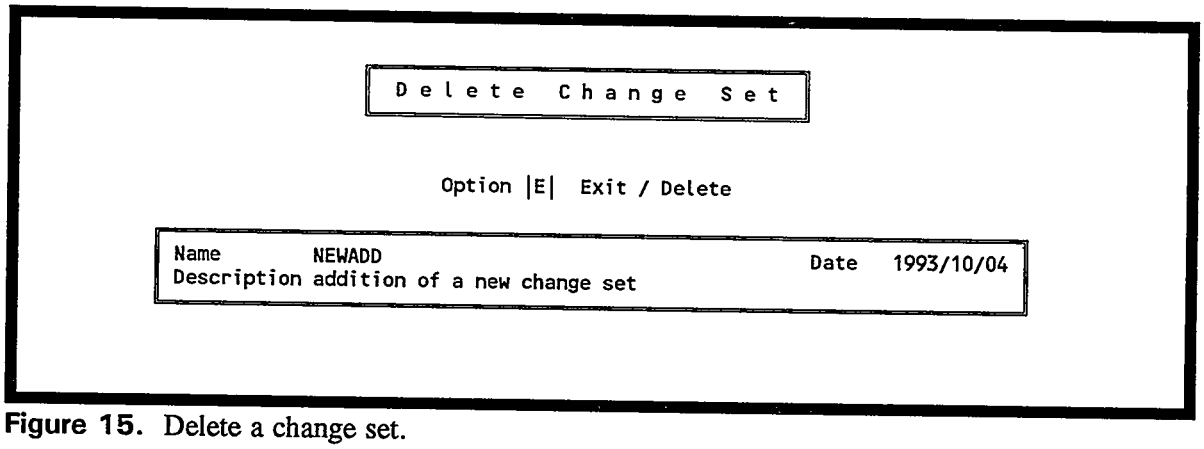


Figure 15. Delete a change set.

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

4.5 Probability

This function allows you the flexibility to experiment with setting different basic event failure and uncertainty data. These data values may be set for a single event or for a specified group of events. The function also provides a reset option to set data values back to the base case values. To invoke the Probability function, type a <P> in the option field, highlight a change set, and press <Enter>. If you press <Enter> without highlighting a change set, the message **A line must be highlighted** will be displayed. If you receive this message, highlight an event and press <Enter>. The Select Event screen (see Figure 16) appears with <P> (Probability) as the default option. This screen lists the event name and description of each event in the change set. In addition, the screen shows the event usage and change set 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), system logic (L), or system cut sets (Y). The change set flag indicates if the event

has been marked for a probability change (P), a class change (C) or both (c). The change set name is shown in the upper right corner in the Change Set box. Three options are available: Exit, Probability, and Reset probability to base.

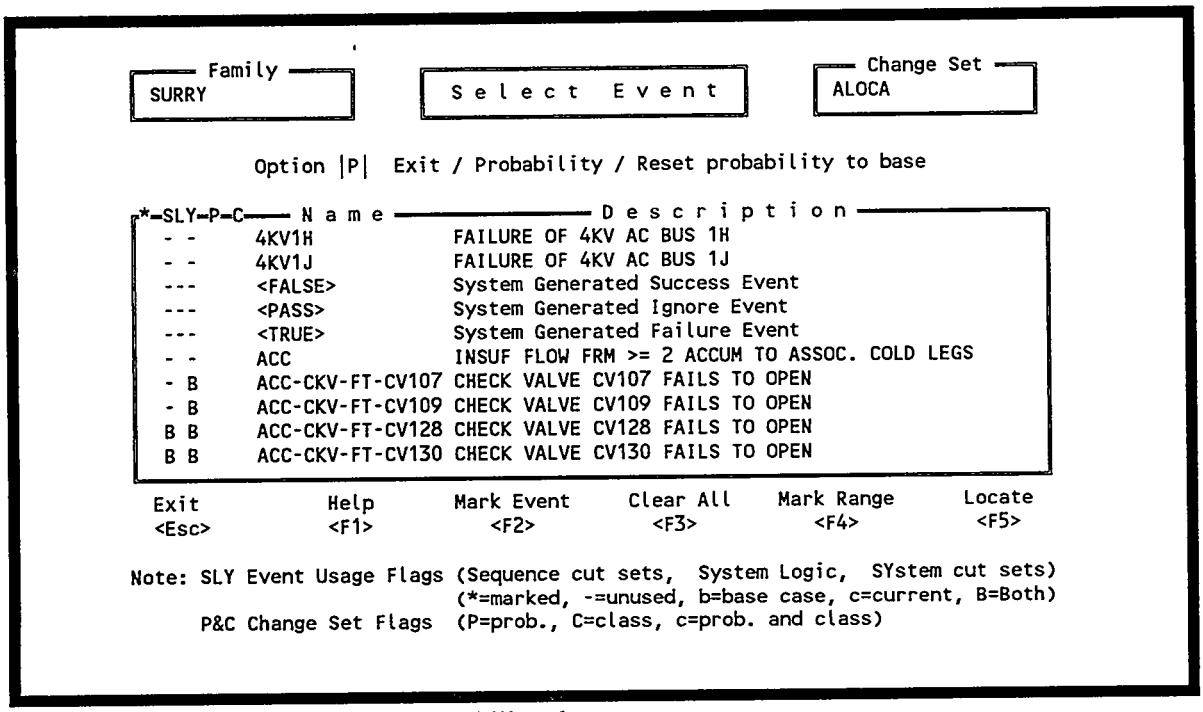


Figure 16. Select an event for probability change.

4.5.1 Exit

This option terminates the probability function and returns you to the Change Sets screen (Figure 11). To invoke this option, type an <E> in the option field and press <Enter>, or press the <Esc> key.

4.5.2 Probability

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

To invoke this function, type a <P> in the option field, highlight an event or mark a group of events (using the <F2> and/or <F4> function keys) and press <Enter> (see Figure 17). If only a single event has been selected, then the Event Probability Changes screen (for a single event) will be displayed (Figure 18). The display is divided into five data areas: Event Attributes, Failure Data, Uncertainty Data, Miscellaneous (i.e., Process Flag), and Seismic Fragility. The Event Attributes data display is for information only; no changes may be made to the data fields in this display. The Failure

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

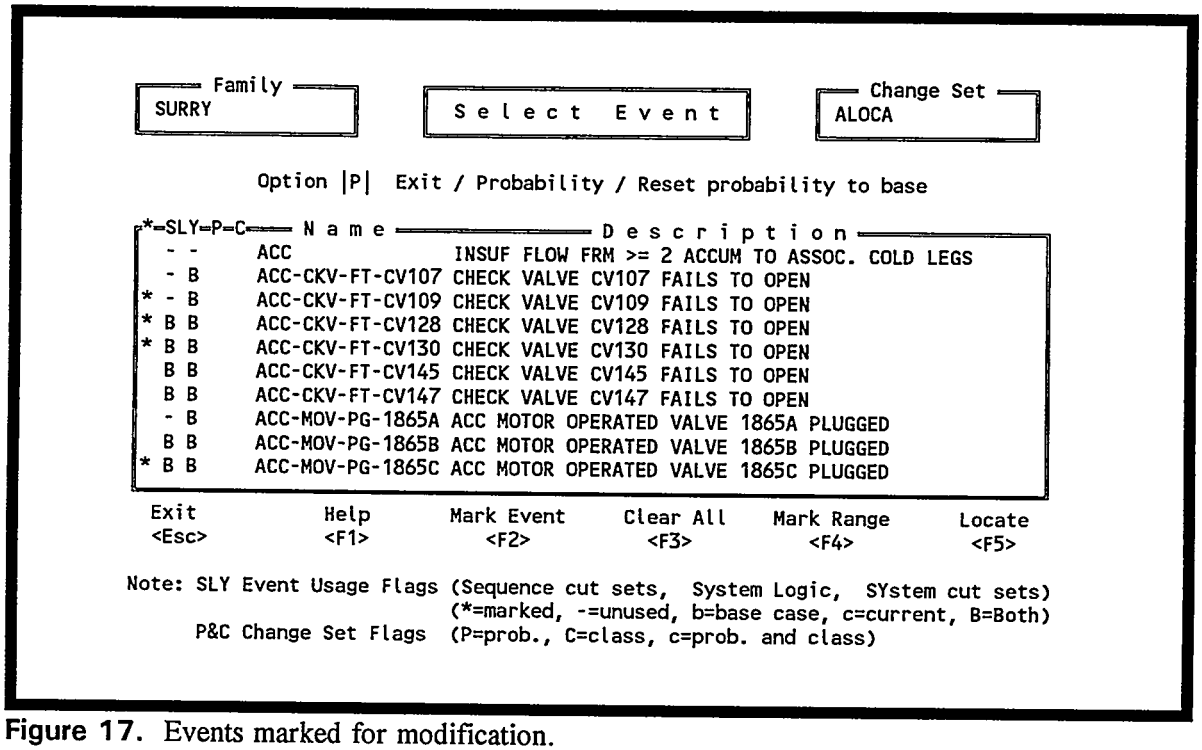


Figure 17. Events marked for modification.

If a group of events were marked (see Figure 17) using the <F2> and <F4> function keys, and the cursor was in the option field, then upon pressing <Enter> the Events Probability Changes screen (for a group of events) will be displayed (see Figure 19). This display is divided into four areas: Failure Data, Uncertainty Data, Miscellaneous (i.e., Process Flag), and Seismic Fragility. As before, both the base case and current data values are shown. You may only change the current values. The changes entered on this screen will be applied to all marked events.

The probability changes made are reflected on the Select Event display by showing a "P" to the left of the affected events. Probability changes have a higher priority than class changes. When both are applied to an event, the probability change will be used during fault tree/sequence analysis. This is indicated by flagging the affected events with a "P" and "c" as shown in Figure 20.

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

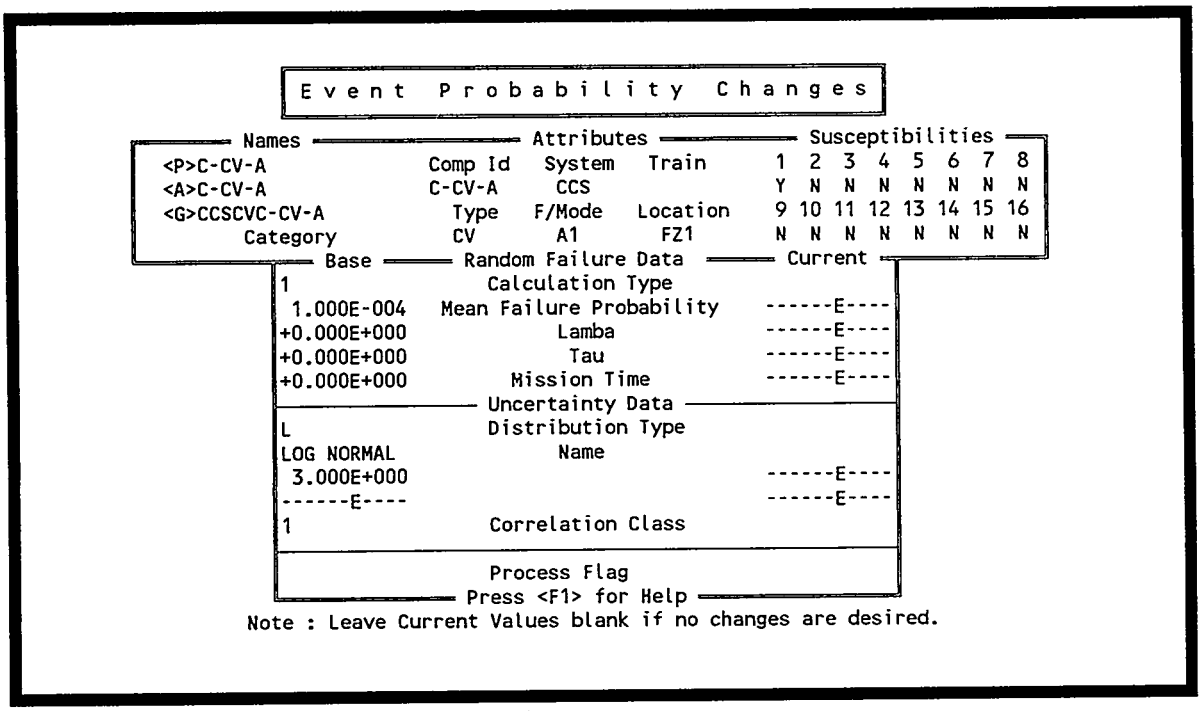


Figure 18. Changes to an event probability.

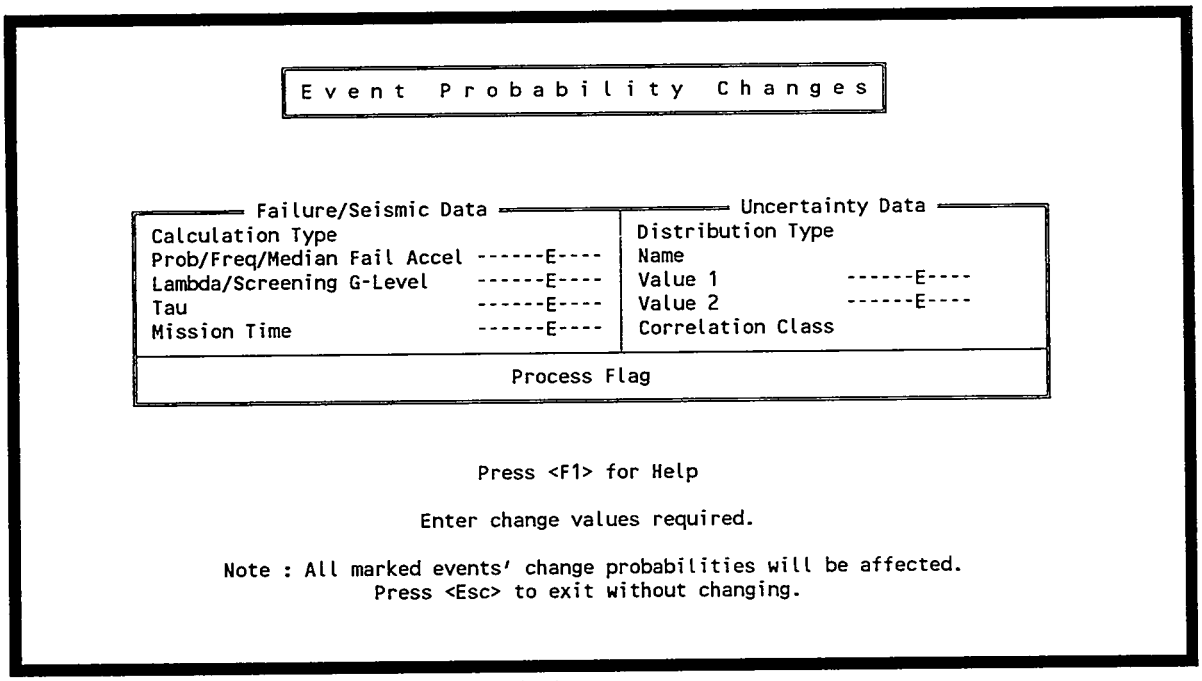


Figure 19. Event change screen for marked events.

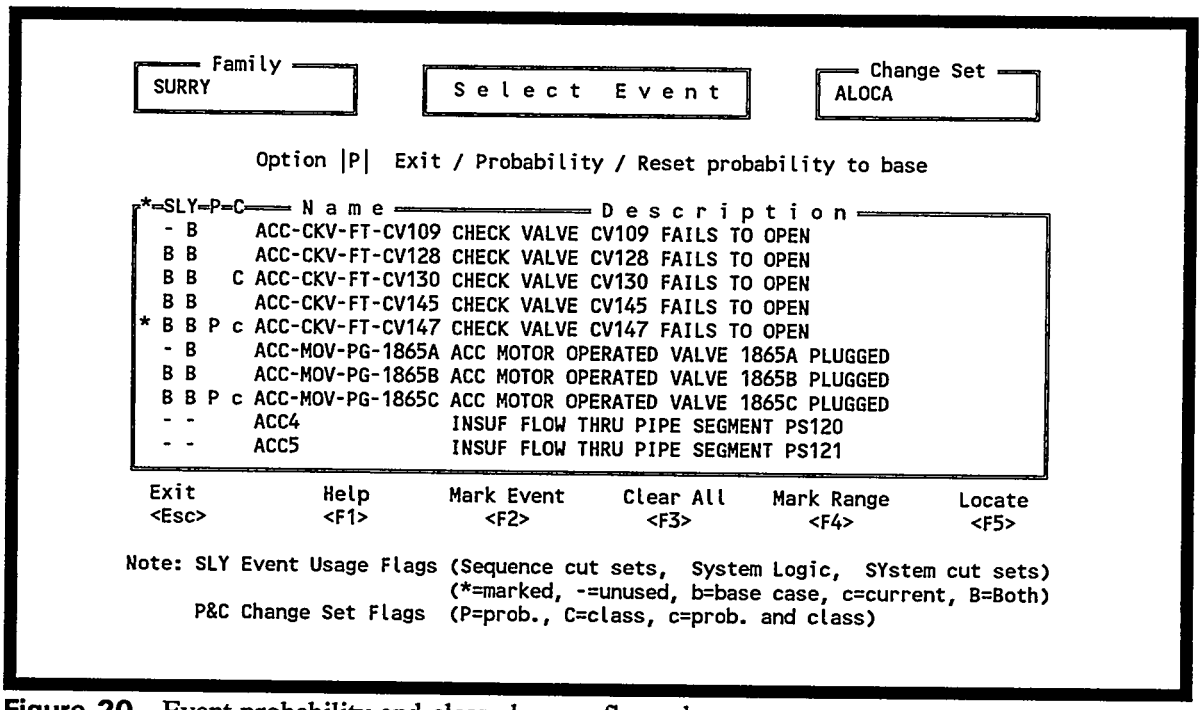


Figure 20. Event probability and class changes flagged.

In the Failure Data box the calculation type is a numerical reference to the calculation method to be used. There are 17 calculation types numbered 1 through 9, T, F, I, S, G, L, M, and H. When the cursor is positioned in the Calculation Type field, press <F1> for an explanation of these calculations. The help screen is shown in Figure 21.

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

P = failure probability of the basic event,
p = failure probability,
bp = base case failure probability,
L = failure rate per hour, input as lambda,
t_m = mission time expressed in hours, input as a default,
T = average time to repair expressed in hours, input as tau,
Π = standard normal cumulative distribution function,
a = median killer acceleration (the approximate ground acceleration sufficient to cause the component to fail),
Bu = confidence level that "a" is really the median killer acceleration,
Br = the amount the killer acceleration "a" can vary
ln = natural log
g = ground acceleration for screening.

An equation for each calculation type follows:

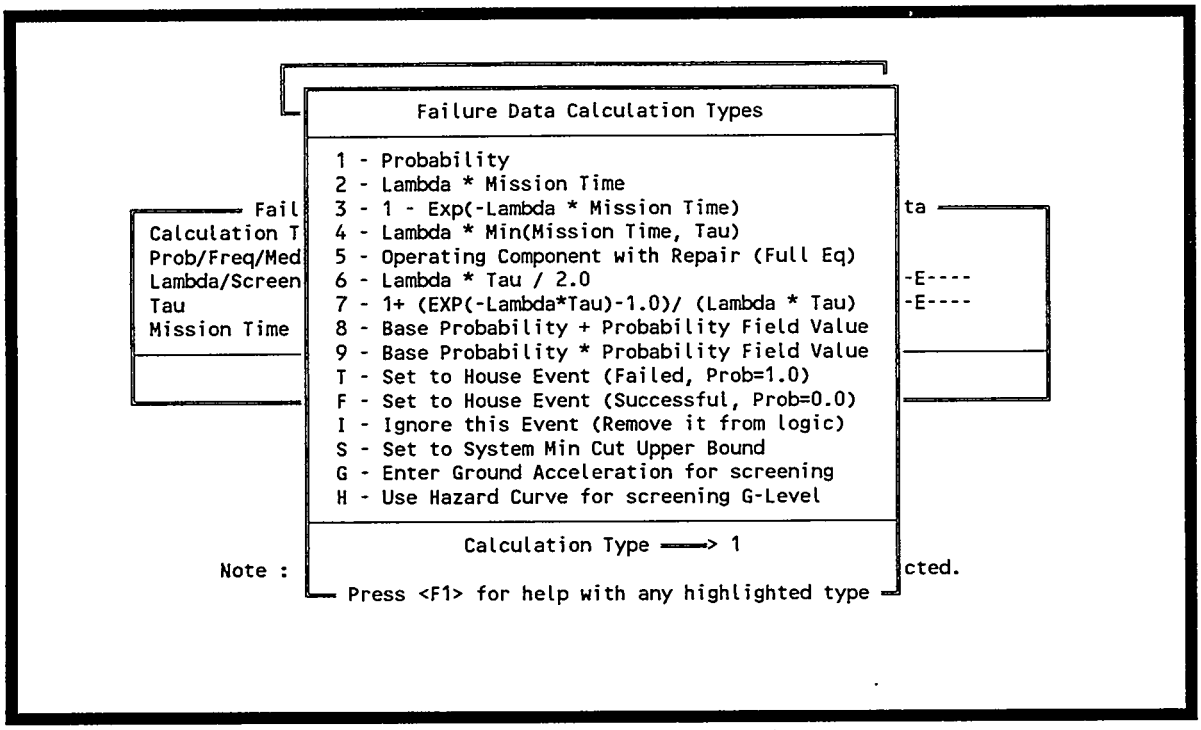


Figure 21. Failure data calculation types (probability changes).

Calculation Type 1 $P = p$.
This calculation type uses the stated probability.

Calculation Type 2 $P = L * t_m$.
This calculation type is the rare event approximation for probability of failure of a nonrepairable component in a non-demand failure mode.

Calculation Type 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.

Calculation Type 4 $P = L * \text{Min}(t_m, T)$.
This calculation type is the rare event approximation to the failure probability for an operating component with consideration given to the ability to repair the component.

Calculation Type 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.

Calculation Type 6 $P = L * (T/2)$.
This calculation type is the rare event approximation to the failure probability for a standby component in a non-demand failure mode with consideration given to periodic testing.

Calculation Type 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.

Calculation Type 8 P = bp + p.
This calculation is one of the ways to establish a current case basic event probability using the base case calculation. The current case basic event probability is calculated by adding a probability value to the base case probability. The probability change value is input with the "Probability" field. To make the current case probability lower than the base case, input a negative change value (e.g., -1.2E-002).

Calculation Type 9 P = bp * p.
This calculation type is one of the ways to establish a current case basic event probability using the base case calculation. The current case basic event probability is calculated by applying a multiplier to the base case probability. The multiplier is input with the "Probability" field. To make the current failure probability larger than the base case, use a multiplier greater than 1.0. To make the current case failure probability less than the base case, use a multiplier less than 1.0.

Calculation Type 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.

Calculation Type 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.

Calculation Type 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.

Calculation Type S P = 0.0 (find a system with the same name and use its current mincut upperbound as the probability)
This calculation type indicates that the basic event is to replace its matching system. If no matching system exists, the probability will be set to 0.0.

Calculation Type 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.

Calculation Type 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 family hazard curve.

For the Uncertainty Data box, there are nine predefined distribution types available. The predefined distribution types are normal, lognormal, beta, 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. Figure 22 shows the help form associated with the distribution type field on the Event Probability Changes screen. From this help screen, help forms associated with each of the nine predefined distribution types are available. To view these distribution help forms, press the <F1> key while the cursor is positioned on the desired distribution type.

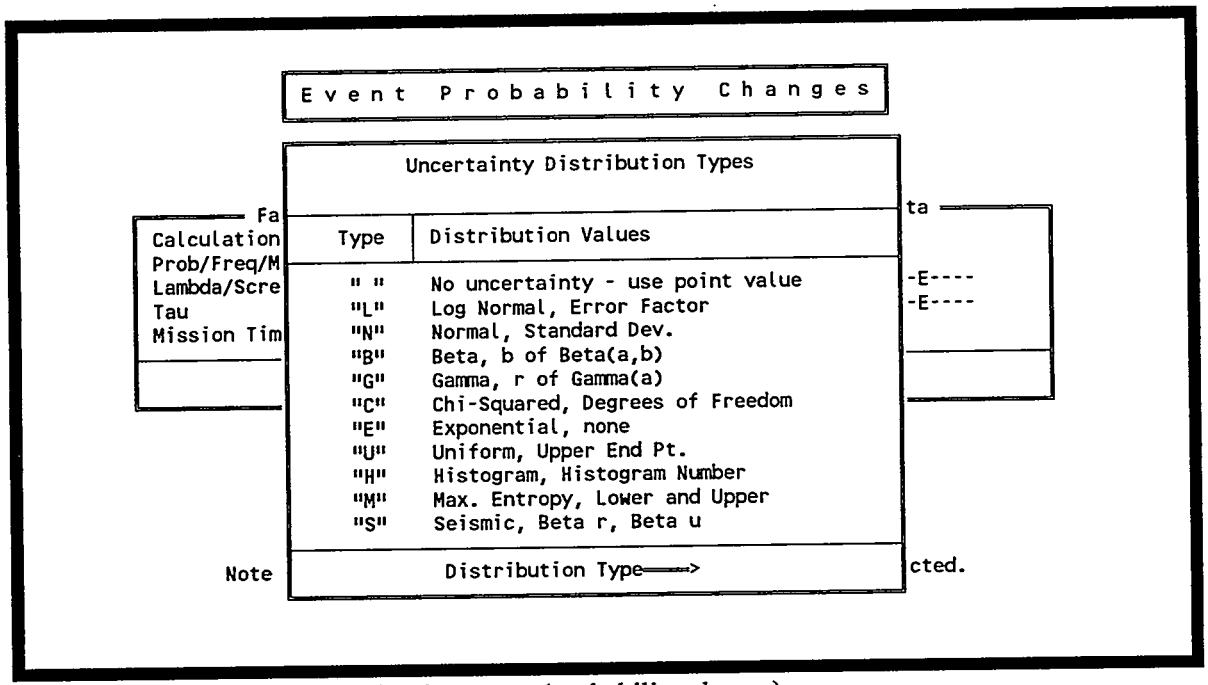


Figure 22. Uncertainty distribution types (probability change).

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

The Miscellaneous area contains the Process Flag, which is a one-character field that specifies if certain processes should take special note of the selected event. One of the following upper-case values can be input:

For a general event:

'S' - sensitivity analysis. If an event is marked for sensitivity analysis, IRRAS will map a core damage frequency plot. A sensitivity analysis allows you to see how sensitive the core damage frequency is in relation to an event.

'Z' - 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 IRRAS encounters a zone flagged event, it performs a transformation. A transformation is an event or set of events that replace a zone flagged event.

For a sequence top event:

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

'W' - use system logic (if top event fails), use complement of the developed event (if top event succeeds). That is, if the event fails IRRAS will expand the fault tree and solve; if the event succeeds, IRRAS will use the complement of the developed event for the system.

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

'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.

For sequence and system logic body:

'X' - always use developed event. That is, never expand the fault tree and solve; always use the event.

Propagate event failure:

'K' - this is a key event and fails all locks in same group

'L' - this is a lock event and is failed only by its key event.

The help screen for the Process Flag field is shown in Figure 23.

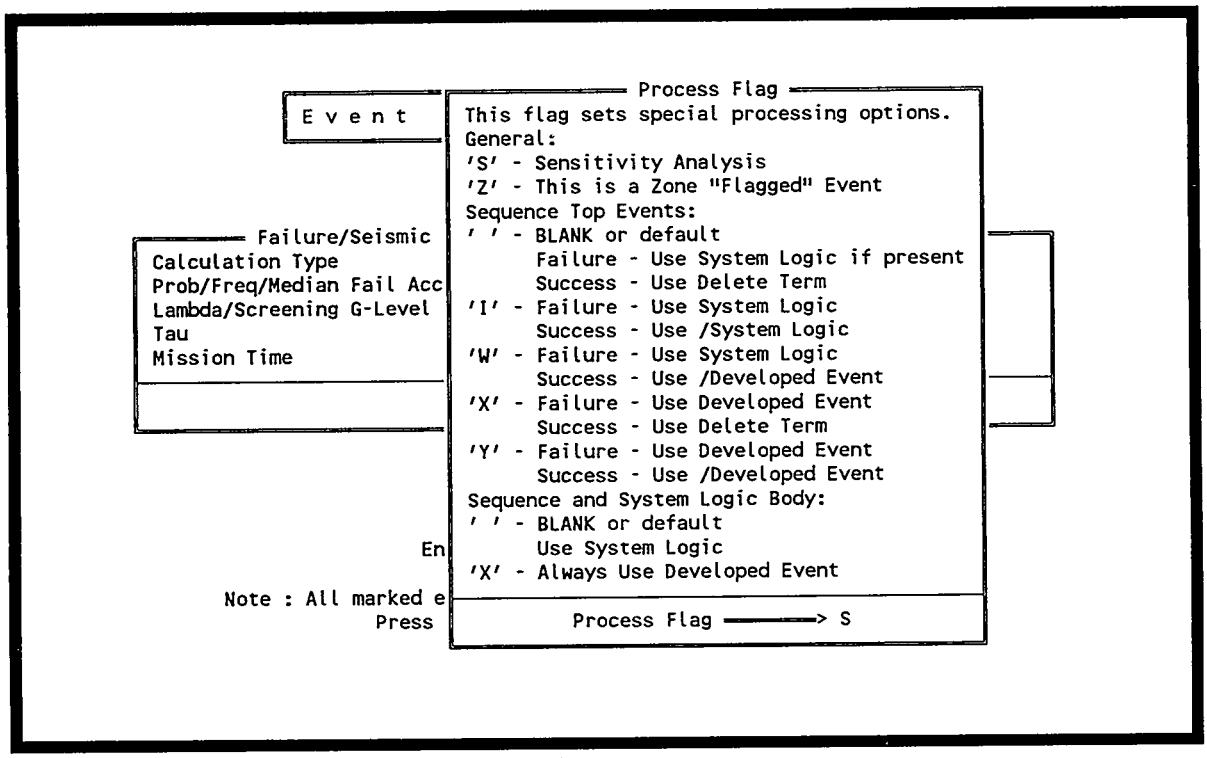


Figure 23. Process flag (probability change).

When the Process Flag field is blank, the transfer associated with this event is expanded for failure references. For success references, the transfer is also expanded; however, the cut sets generated are removed from the failure cut sets using cut set matching.

4.5.3 Reset Probability to Base

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

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

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

To reset all event probabilities to the base case values, clear all existing marks with the <F3> key, type an <R> in the option field and press <Enter>. The message **"Reset ALL probability**

changes? (Y/N)" is displayed at the bottom of the screen. Press <Y> to perform the reset operation, or <N> to terminate the reset operation.

4.6 Class

This option allows you to change event data parameters for a specified grouping of events. To invoke this option, enter a <C> in the option field, highlight the desired change set, and press <Enter>. If you do not highlight a change set before pressing <Enter>, the message **An event change must be highlighted** will be displayed at the bottom of the screen. The screen display for this option is shown in Figure 24. All data fields in the five data areas are data entry fields. The event class is defined by entering data in the Event Attributes data fields. The more of these fields that are filled in the finer the class definition becomes.

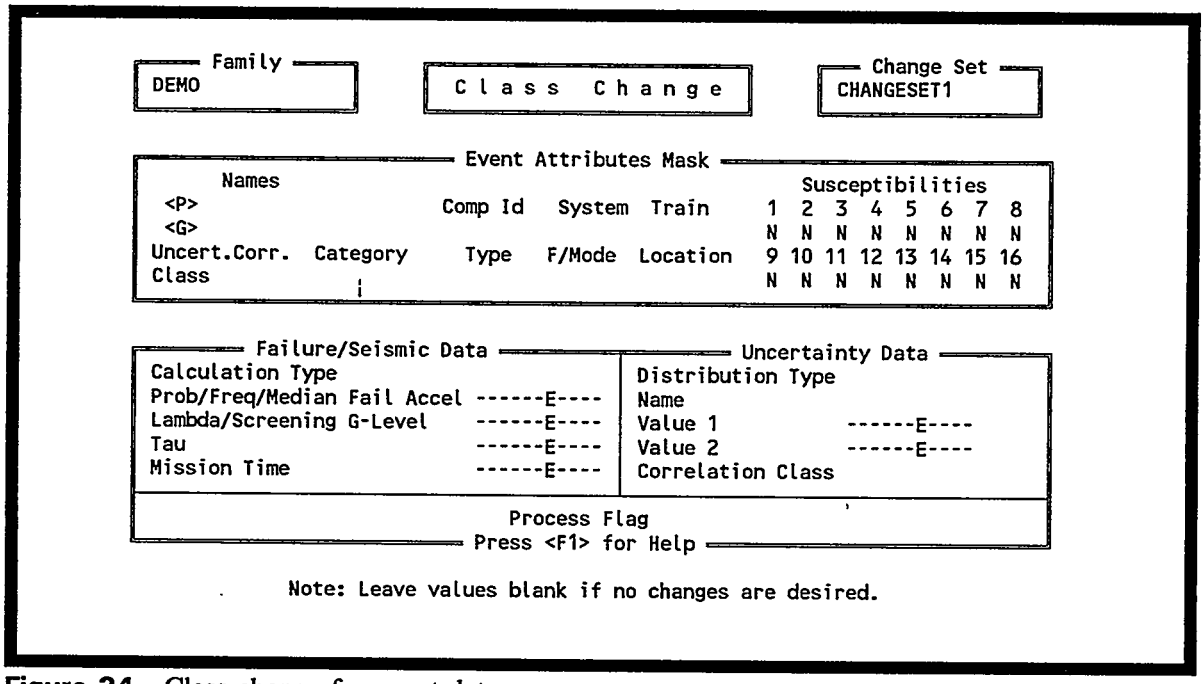


Figure 24. Class change for event data.

The class changes that you request are reflected on the Select Event display by showing a "C" to the left of the affected events (Figure 25). Probability changes have a higher priority than class changes. When both are applied to an event, the probability change will be used during event tree analysis. This is indicated by flagging the affected events with a "P" and "c" as shown in Figure 25.

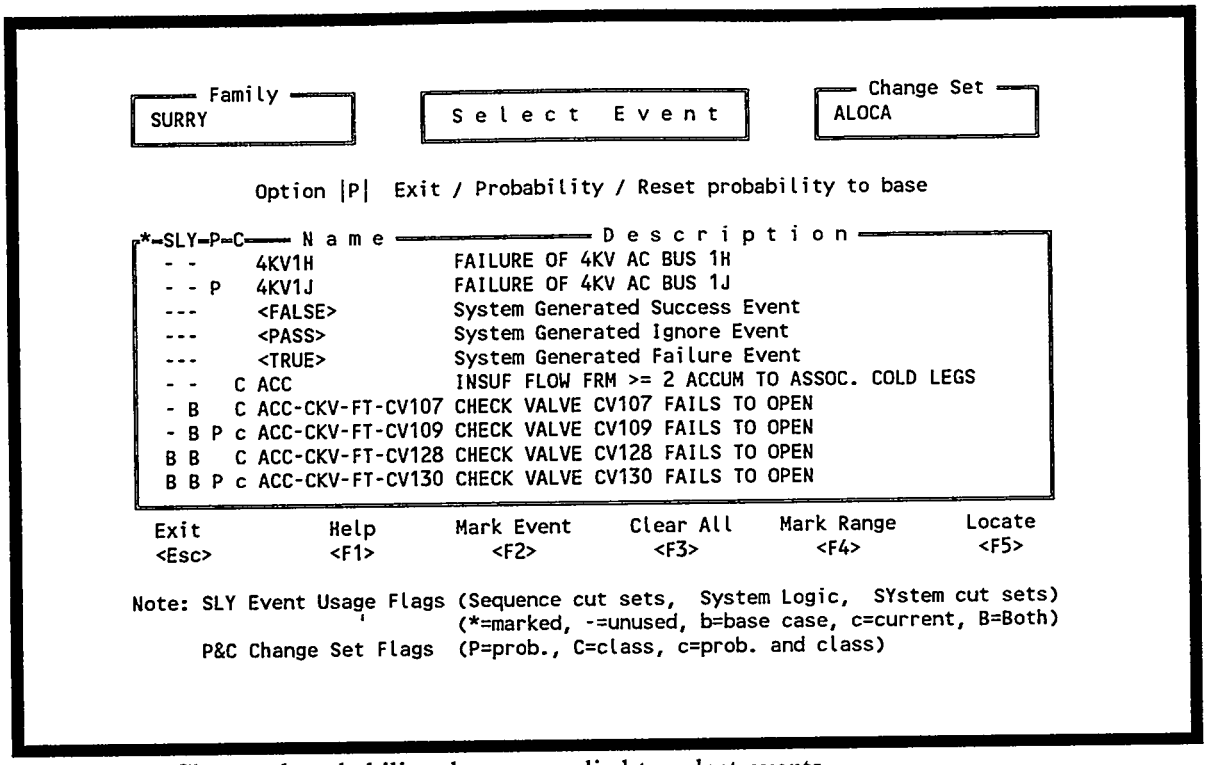


Figure 25. Class and probability changes applied to select events.

On the Class Change display, help screens are supplied for all data entry fields. Pressing <F1> when the cursor is in any data entry field will cause a help screen to be displayed. Figure 26 and Figure 27 show the help screens for Distribution Type and Calculation Type, respectively and the help forms for process flag and seismic fragility are shown in Figure 23 and ?. Most of the help forms in this situation contain a data entry field at the bottom of the display. This field may be used to enter the desired data value, which will then be transferred into the proper data field upon exiting the help screen. Highlighting an item in the help form list will set the correct value in the data entry field.

The susceptibility flags indicate whether or not the event is susceptible to a specific kind of failure. There are 16 susceptibilities as defined below:

*1 - Random
2 - Fire
3 - Flood
4 - Seismic
5 - Reserved 1
6 - Reserved 2
7 - Reserved 3
8 - Reserved 4
9 through 16 - user defined.

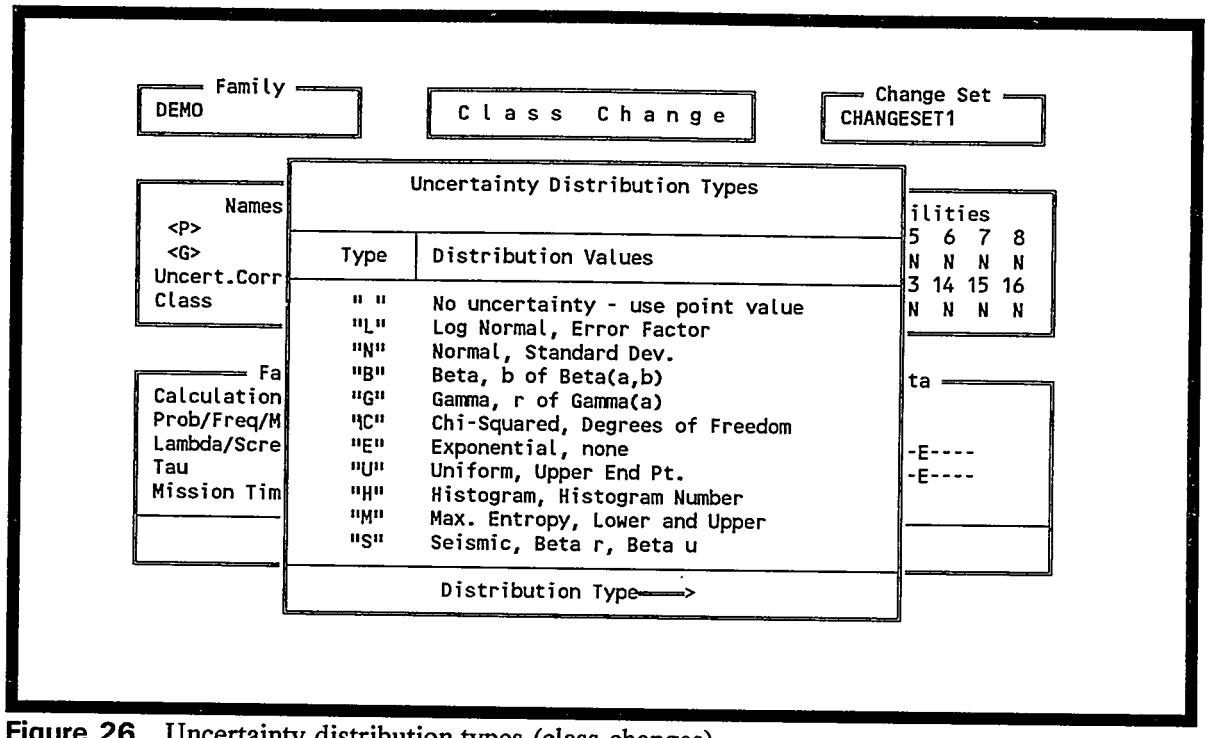


Figure 26. Uncertainty distribution types (class changes).

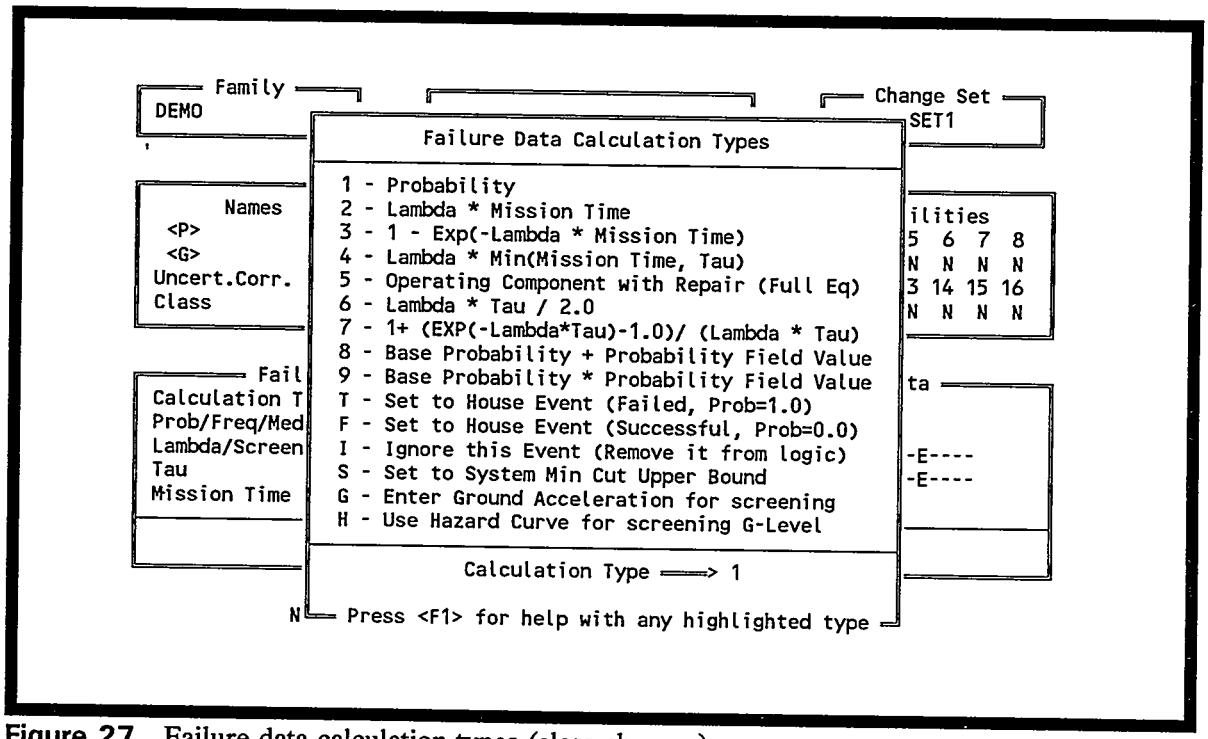


Figure 27. Failure data calculation types (class changes).

All other susceptibility flags must be set to "Y" to be considered susceptible to a specific type of failure.

All events are susceptible to random failure regardless of the random flag's value (Flag 1).

4.7 Generate Changes

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

To activate this function, type <G> (Generate Changes) in the option field, use the function key <F2> to mark the change sets to be used during the generation process, and then press <Enter>. Upon pressing <Enter>, the default mission time and propagate event failure flag are displayed at the bottom of the screen (Figure 28). If you do not wish to change the mission time, press <Enter>. **New event data has been generated with changes** is displayed when the changes are successfully generated. If no changes were made, the message **New event data has been generated (no changes)** is displayed at the bottom of the Change Sets screen.

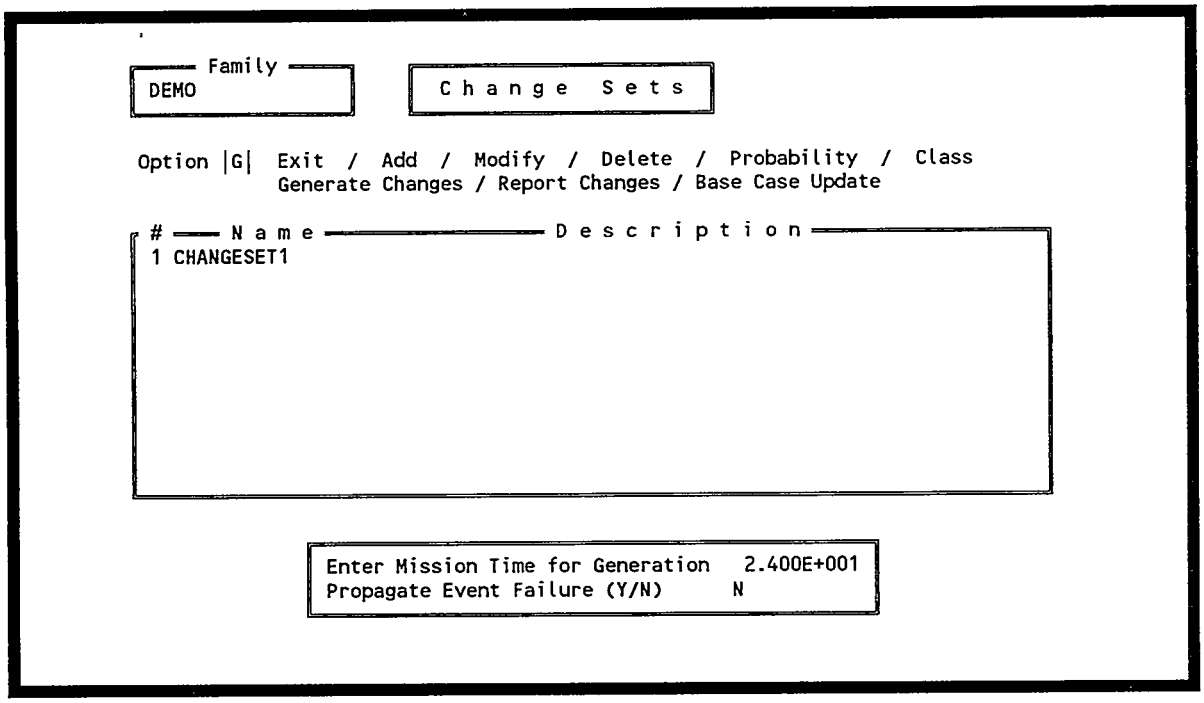


Figure 28. Set mission time for generate changes.

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

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

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

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

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

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

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

The current case data for event C would be set to the temporary values associated with the class change in CS 1.

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

4.8 Report Changes

This option allows you to create reports that reflect the event modifications that currently exist within the database. There are three report types: Unaffected Events, Affected Events, and All Events (see Figure 29). Each of the report types may be sorted by event name, ascending probability, or change sets. In addition, a report may be routed to the console, an attached printer, or a disk file. When a report is routed to the printer or a disk file, the data will be echoed on the console.

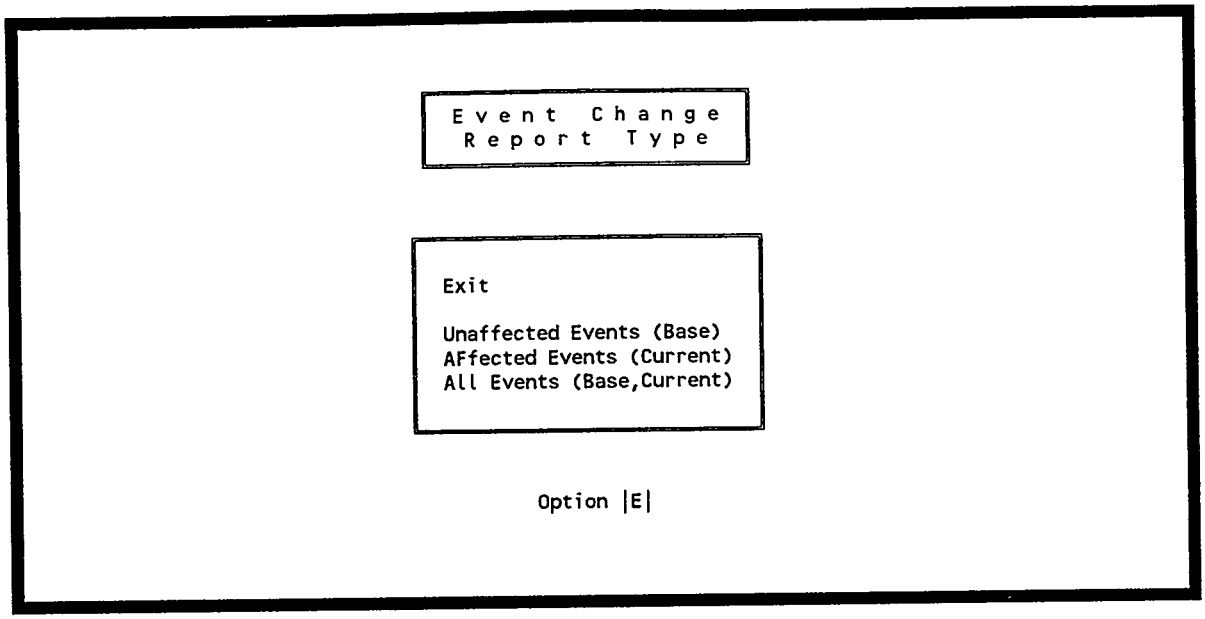


Figure 29. Selecting the event report type.

4.8.1 Exit

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

4.8.2 Unaffected Events (Base)

This option allows you to generate a report of the events that are not affected by any of the change sets that currently exist in the database. To invoke this option, type <U> in the option field and press <Enter>. The sort selection menu will be displayed, allowing you to sort the data by event name, ascending probability, or change set (see Figure 30).

After the sorting method has been selected, you are asked to specify the routing of the report (Figure 31).

4.8.3 AFfected Events (Current)

This option allows you to generate a report of the events that are affected by the change sets that currently exist in the database. To invoke the option, type <F> in the option field and press <Enter>. The sort selection menu will be presented allowing you to sort the data by event name, ascending probability, or change set (Figure 30).

After the sorting method has been selected, you are asked to specify the routing of the report (see Figure 31).

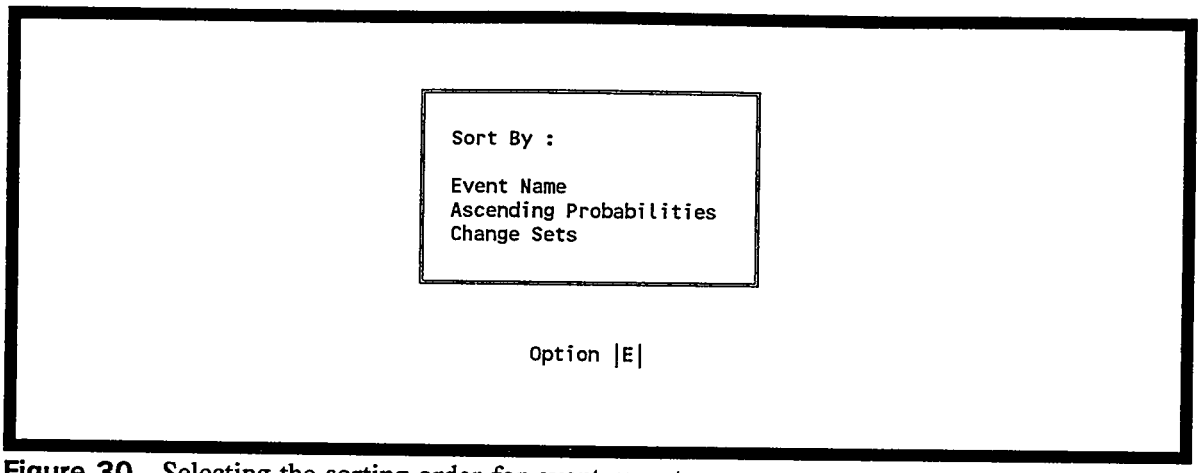


Figure 30. Selecting the sorting order for event reports.

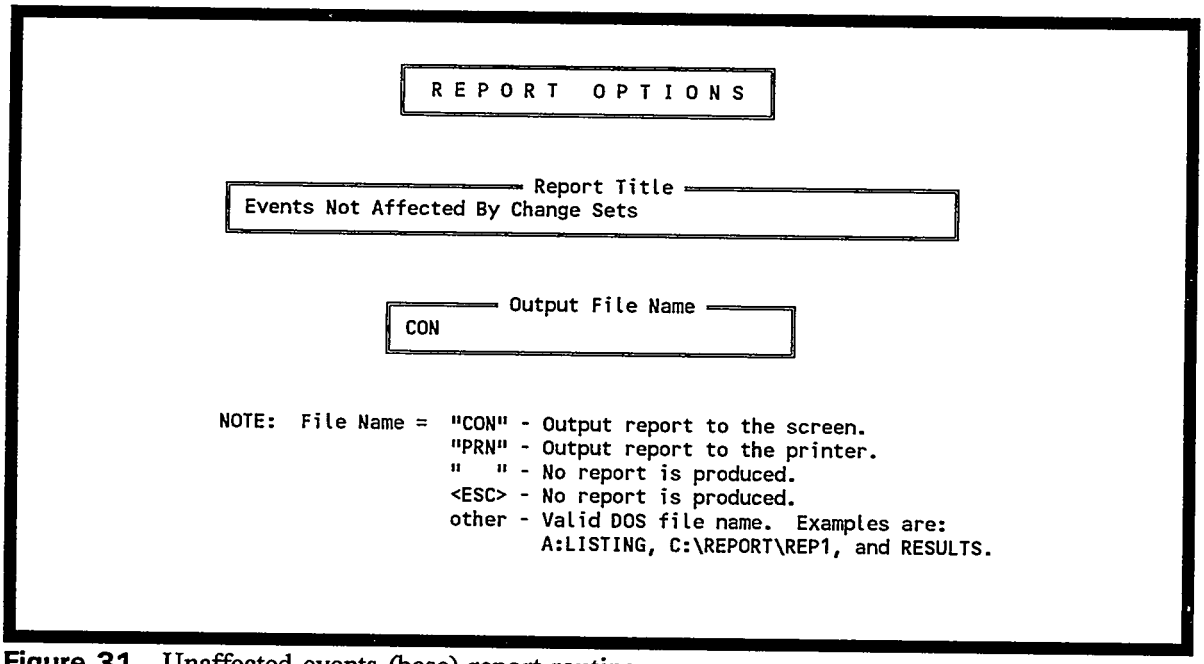


Figure 31. Unaffected events (base) report routing.

4.8.4 All Events (Base, Current)

This option allows you to generate a report of all of the events in the database. The report will indicate the events affected by a change set. To invoke the option, type <A> in the option field and press <Enter>. The sort selection menu will be presented allowing you to sort the data by event name, ascending probability, or change set (Figure 30).

After the sorting method has been selected, you are asked to specify the routing of the report (see Figure 31).

4.9 Base Case Update

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

To invoke this option, type <B> (Base Case Update) in the option field, mark the desired change set(s) and press <Enter>. A confirmation screen (Figure 32) will appear to ensure you wish to update the base case values with the temporary data values from the marked change set(s). To terminate the process type an <N> in the option field and press <Enter>. To initiate the update process, type a <Y> in the option field and press <Enter>. Upon pressing <Enter>, the default mission time and seismic level are displayed at the bottom of the screen (Figure 33). If you do not wish to change the mission time press <Enter>.

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

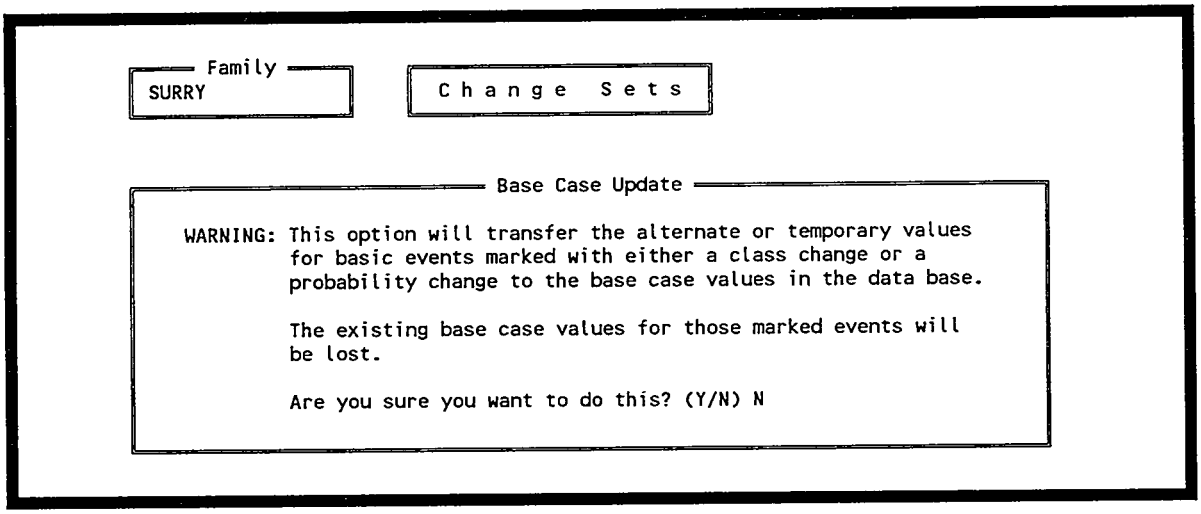


Figure 32. Confirm the base case update request.

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

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

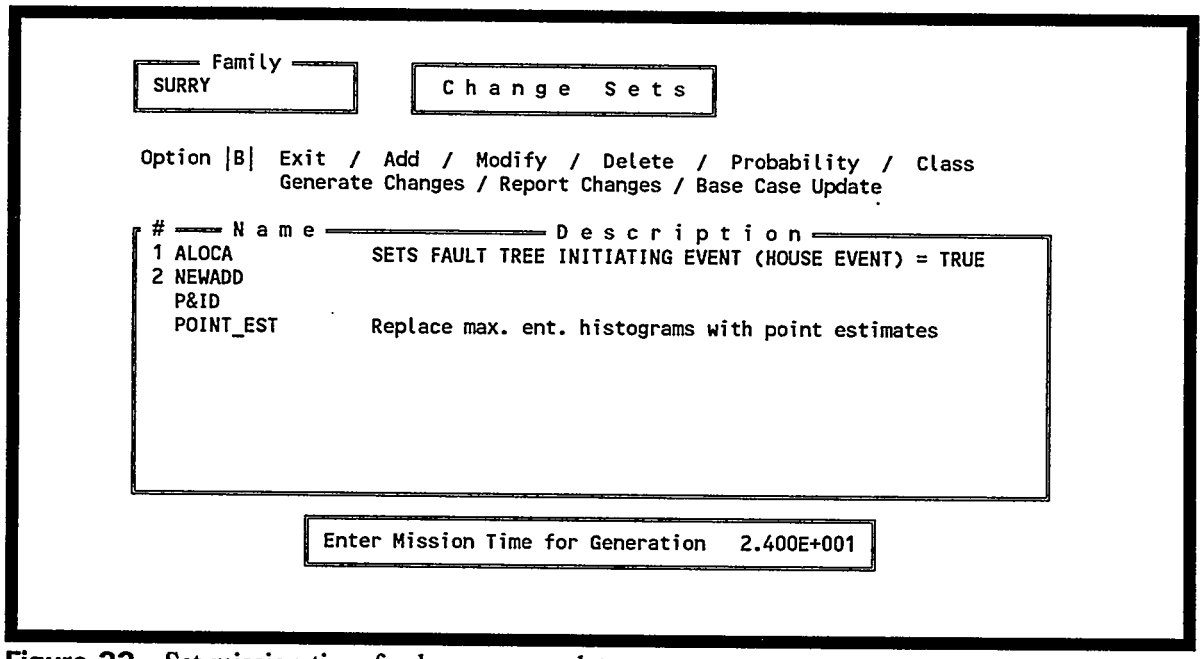


Figure 33. Set mission time for base case update.

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

5. BUILD FAULT TREES

This option allows you to build and edit fault tree models graphically and output them to several hard copy hardware devices. The defaults for the hardware devices are set in the Hardware Information screen (Figure 1). When this option is selected, Figure 34 is displayed.

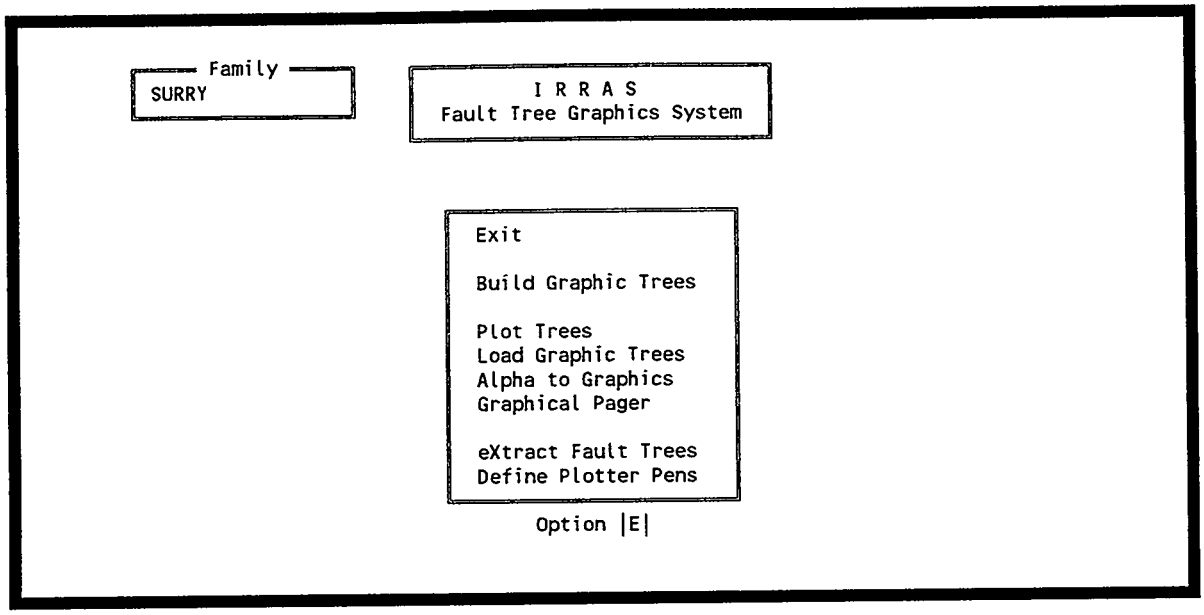


Figure 34. Build fault trees menu.

As shown, the following options are available:

Exit	-	This option returns you to the IRRAS Main Menu.
Build Graphic Trees	-	This option allows you to construct the actual fault tree diagram.
Plot Trees	-	This option allows you to plot an HP graphic's file.
Load Graphic Trees	-	This option allows you to load a .DLS (graphics) file.
Alpha to Graphics	-	This option allows you to convert the alphanumeric logic for a system or subsystem to a graphical format.
Graphical Pager	-	This option allows you to breakup a diagram into multiple pages.
eXtract Fault Trees	-	This option allows you to extract fault trees, clear extracted fault trees, and display extracted fault trees.

Define Plotter Pens	This option allows you to assign colors to your plotter pens.

Each of these options is discussed in the following paragraphs.

5.1 Build Graphic Trees

This option allows you to construct the actual fault tree diagram. You may start building from scratch or from an existing file to generate or modify logic. When this option is selected, Figure 35 will be displayed. The editing commands are shown in the left column, while the remaining part of the screen is the drawing surface. The editing commands shown in upper-case letters have additional pop-up menus associated with them (except the SHOW command). The cursor is used to position pop-up menus, draw lines, place drawing symbols, and select menu options.

To invoke any of the editing commands (using a mouse), position the cursor over the desired editing command on the active menu. The active menu is the last menu you pulled up or moved. When the editing command box is highlighted (a white line outlines the box), press the left mouse button. The command is now invoked. Each editing command is described in the following paragraphs.

5.1.1 EXIT

This option terminates the editing session and returns you to the previous screen. To invoke this option, position the cursor over the EXIT box and press the left mouse button or <Enter>.

5.1.2 Move

The move command, which is represented by ←→, allows you to position the editing command menu anywhere on the screen. When you invoke this command, a white line surrounds the entire editing menu. Drag the cursor to position the outline at the new location and press the left mouse button or <Enter>. The menu will be displayed at the new location.

5.1.3 SHOW

This command clears the screen and redisplays the currently defined diagram.

5.1.4 BILD

This command allows you to generate drawing symbols. When you invoke this command, an additional pop-up menu is displayed (Figure 36). This submenu contains all the constructs needed to create fault tree models. These constructs are

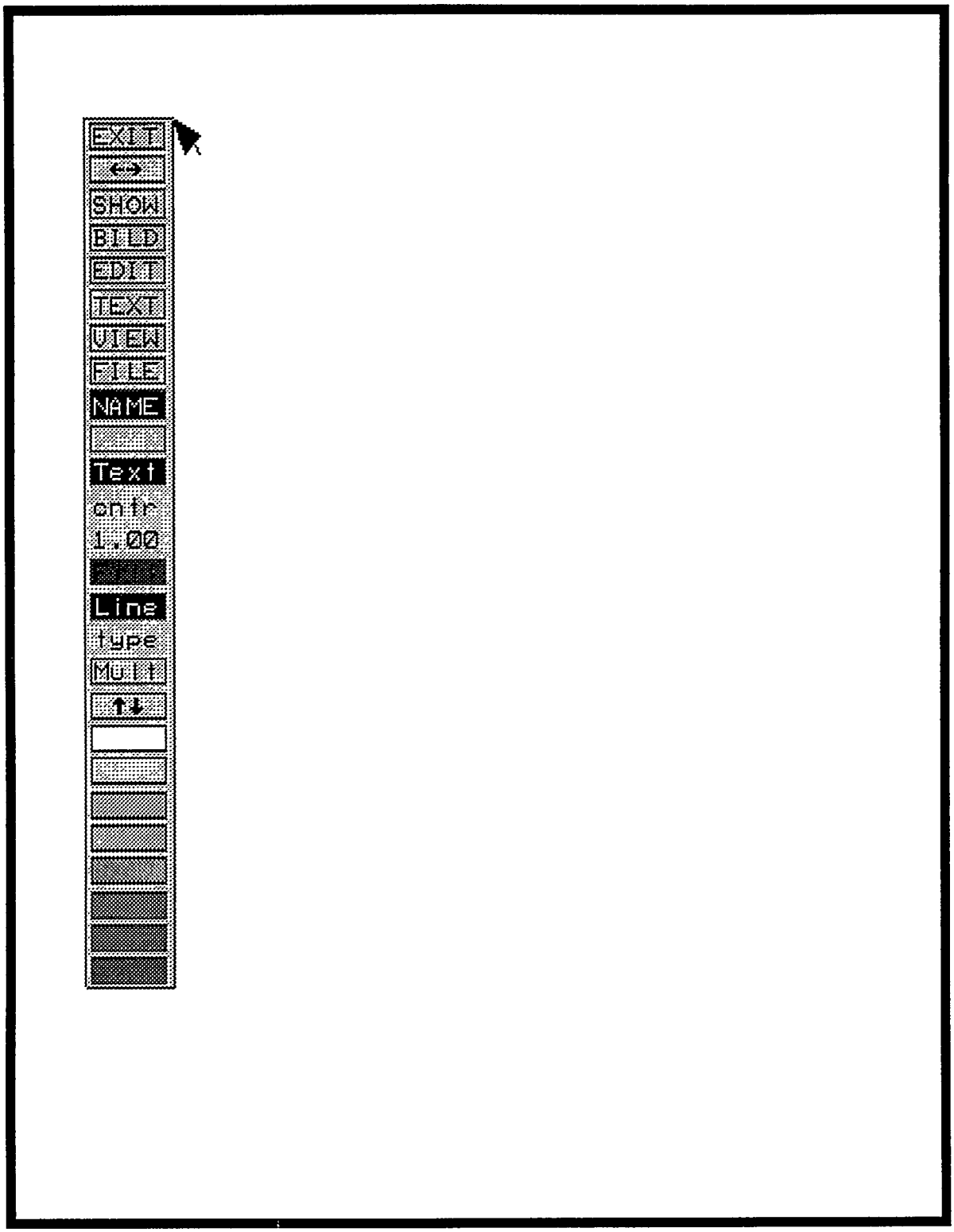


Figure 35.. Editing commands for the BILD option.

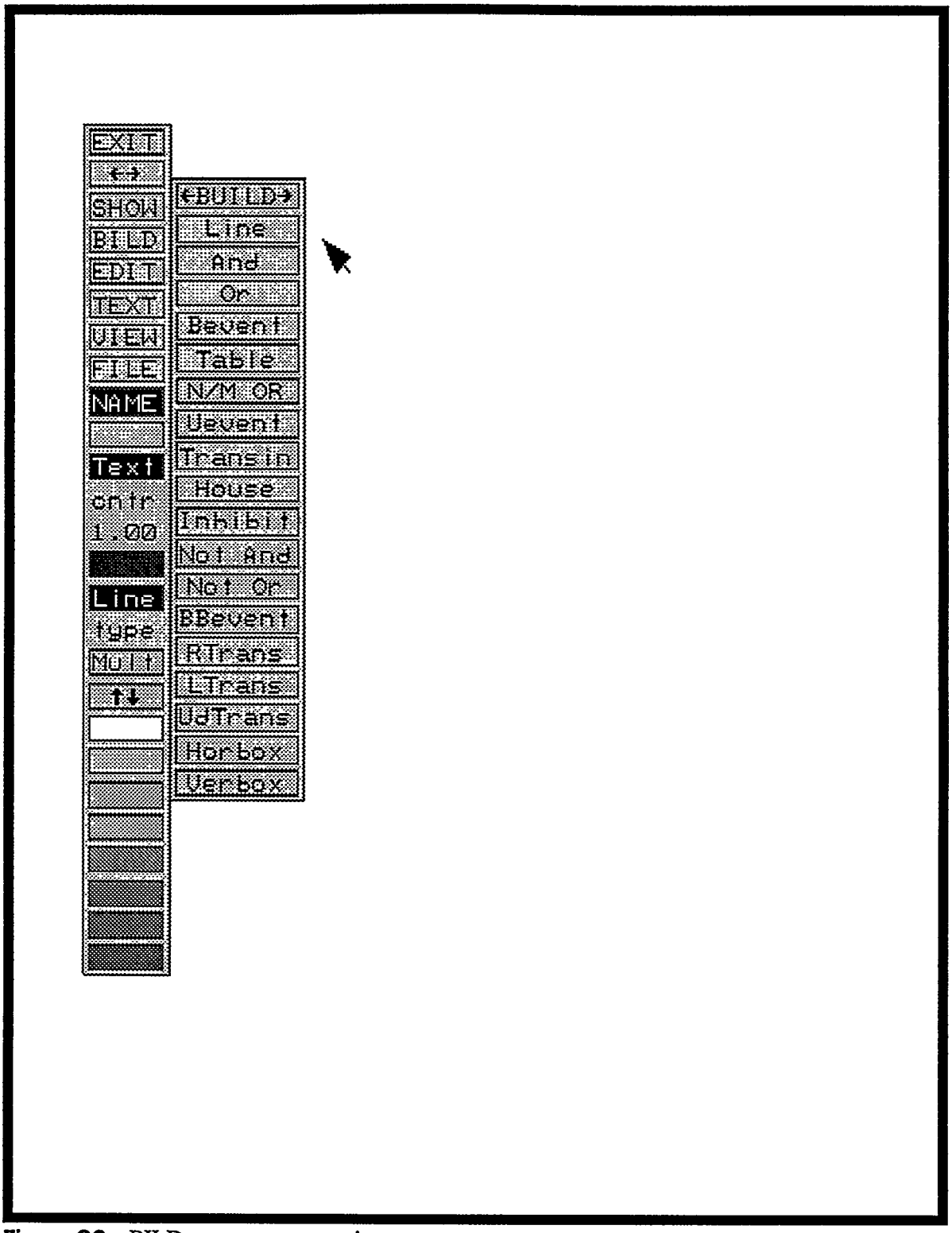


Figure 36. BILD pop-up menu options.

←BUILD→

This option allows you to move the BUILD pop-up menu to a new location on the screen. When you invoke this command, a white outline box appears. Drag the cursor to position the outline to the desired location and press the left mouse button or <Enter>. The BUILD pop-up menu will be redisplayed at the new location.

Line

This construct allows you to draw lines. When you invoke this option, you will be prompted with **Enter points for line**. The cursor will change from an arrow to a cross hair. Position the cross hair at the point where you want the line to begin, press the left mouse button or <Enter>. The cross hair will now change to a small dot. Drag the cursor in the direction you want the line to follow. When satisfied with the length and direction of the line, press the left mouse button or <Enter>. If the multipick option is turned on (see Section 5.1.16), the prompt **Enter points for next line** will appear. You may draw another line or press the right mouse button to terminate line mode. When you terminate line mode, the cross hair will return. Press the right mouse button to return to the normal cursor mode (arrow).

And

This construct generates the "And" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another And symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate And symbol generation.

Or

This construct generates the "Or" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another Or symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate Or symbol generation.

Bevent

This construct generates the "Bevent" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another Bevent symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate Bevent symbol generation.

Table

This construct generates the "Table" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see

Section 5.1.16), another Table symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate Table symbol generation.

N/M OR

This construct generates the "N/M OR" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. The prompt **Enter N (out of) M values** will appear at the bottom of the screen. Enter the required values (e.g., 2 5) and press <Enter>. If the multipick option is turned on (see Section 5.1.16), another N/M OR symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate N/M OR symbol generation.

Uevent

This construct generates the "Uevent" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another Uevent symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate Uevent symbol generation.

Transin

This construct generates the "Transin" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another Transin symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate Transin symbol generation.

House

This construct generates the "House" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another House symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate House symbol generation.

Inhibit

This construct generates the "Inhibit" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another Inhibit symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate Inhibit symbol generation.

Not And	This construct generates the "Not And" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another Not And symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate Not And symbol generation.
Not Or	This construct generates the "Not Or" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another Not Or symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate Not Or symbol generation.
BBevent	This construct generates the "BBevent" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another BBevent symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate BBevent symbol generation.
RTrans	This construct generates the "RTrans" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another RTrans symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate RTrans symbol generation.
LTrans	This construct generates the "LTrans" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another LTrans symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate LTrans symbol generation.
UdTrans	This construct generates the "UdTrans" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another UdTrans symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate UdTrans symbol generation.

Horbox — This construct generates the "Horbox" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another Horbox symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate Horbox symbol generation.

Verbox — This construct generates the "Verbox" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section 5.1.16), another Verbox symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate Verbox symbol generation.

5.1.5 EDIT

This option allows you to modify fault tree diagrams. Besides modifying the actual diagram, you may use this option to load existing diagrams and modify various attributes of the drawing. When you invoke the EDIT option, a pop-up menu (Figure 37) will be displayed. The first box, ←EDIT→, is used to position the pop-up menu to a new location on the screen. The remaining editing options are described in the following paragraphs.

5.1.5.1 ATTRIBUTES. This option allows you to specify the actual attributes of the symbols and text used in the fault tree diagram. Attributes include text size, line type, fill, font size, etc. Changing the attributes does not affect the global (default) values. Only the specific objects selected while in the given mode (e.g., Fill Col, Line Col, etc.) will be affected. When you invoke this option an additional pop-up menu is displayed as shown in Figure 38. The following attributes may be modified:

Fill Col — This attribute allows you to change the color for the drawing symbols. When you pick this option, the message **Pick a new color from the color bar** will be displayed at the bottom of the screen. To select a color, position the cursor over the desired color and press the left mouse button. (**NOTE:** The ↑↓ (color) option is active at this time. This option will display the additional color selections available.) Next, you will be prompted to **Pick shapes to be modified**. The cursor will change to a cross hair. Box the shapes to be changed by marking opposite corners. To box the symbols, position the cursor on the symbols to change and press the left mouse button. The cross hair is replaced with a small white dot. Drag the cursor over the shapes to be changed. An outline box appears. When the box surrounds the desired shapes completely, press the left mouse button. The box will disappear and the selected symbols will change to the new color. If no shapes

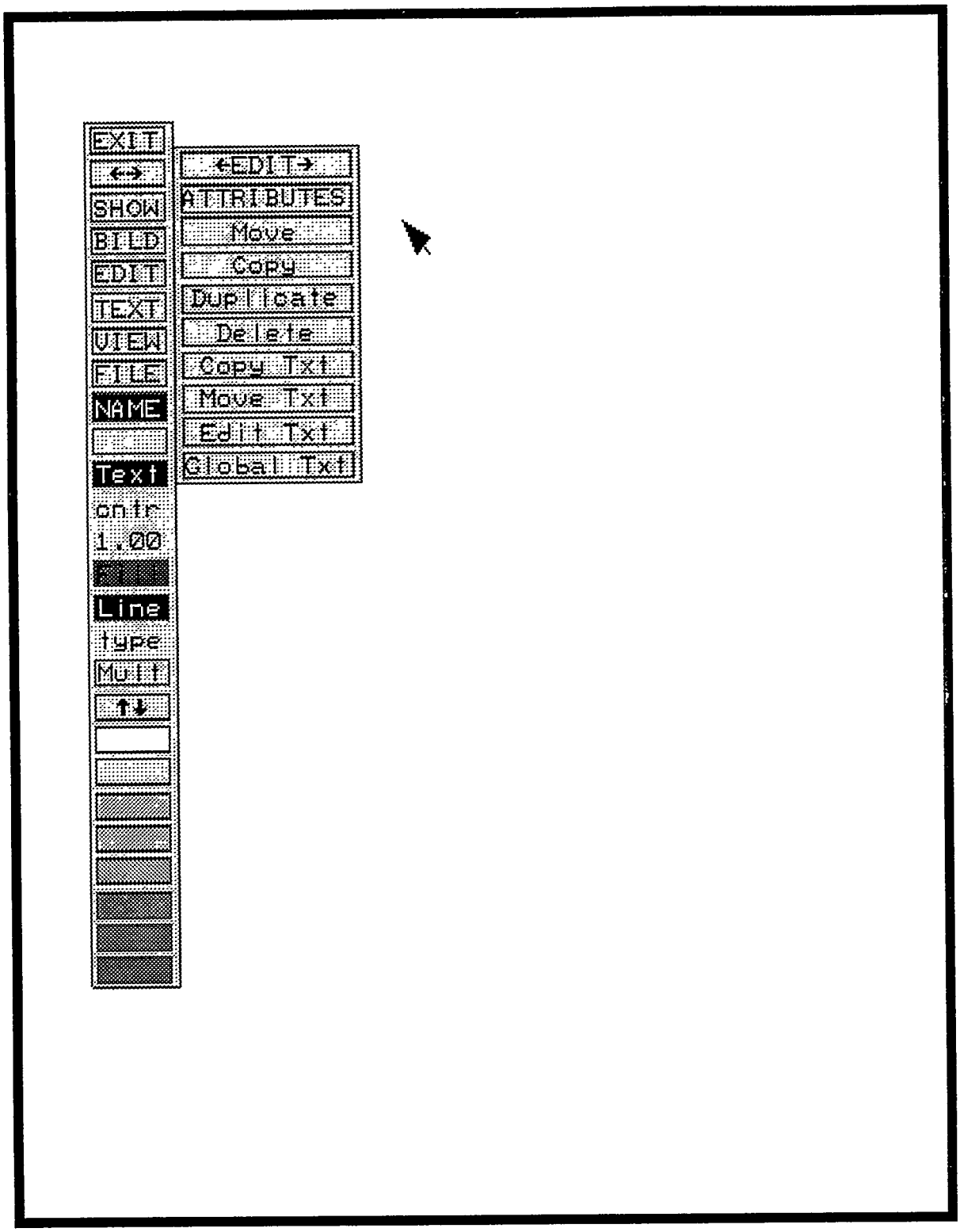


Figure 37. Edit pop-up menu.

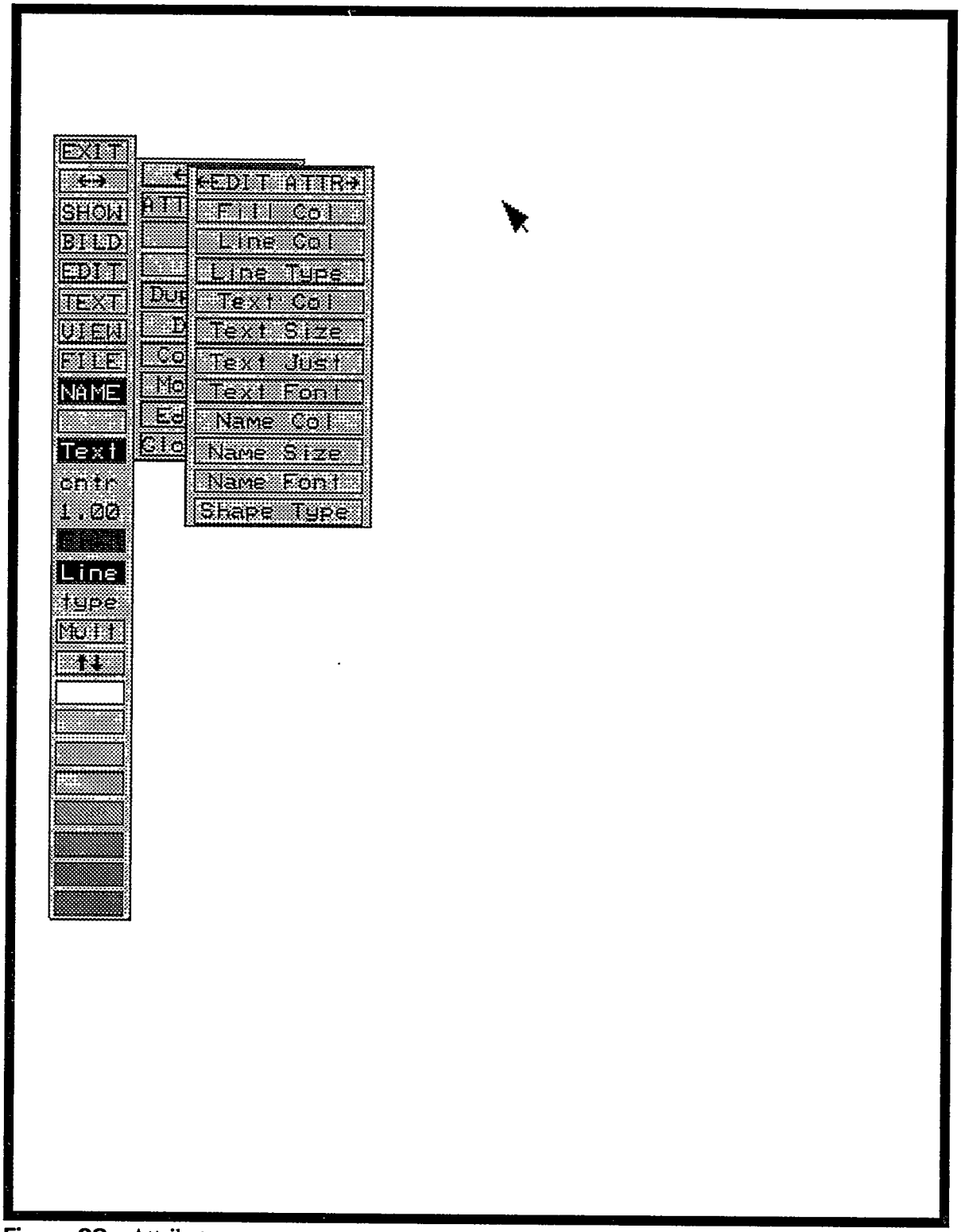


Figure 38. Attributes pop-up menu.

change color, then the selected box was not large enough to include any shapes. If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Pick next shapes to be modified**. At this point, you may select more shapes or press the right mouse button to terminate this process.

Line Col

This attribute allows you to change the color of the lines in the current diagram. Again, you will be prompted to **Pick a new color from the color bar**. To select a color, position the cursor over the desired color box and press the left mouse button. (**NOTE:** The ↑ ↓ (color) option is active at this time. This option will display the additional color selections available.) Next, you will be prompted to **Pick the line(s) to be modified**. The cursor will change from an arrow to a cross hair. Box the lines to be changed by marking opposite corners. To box the lines, position the cursor on the lines whose color you wish to change and press the left mouse button. The cross hair is replaced by a small white dot. Drag the cursor through the lines to be modified. A box appears surrounding the chosen lines. When the box completely surrounds the chosen lines, press the left mouse button. The box will disappear and the selected line(s) will change to the new color. If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Pick next line(s) to be modified**. At this point, you may choose additional lines to change, or press the right mouse button to terminate the process.

Line Type

This attribute allows you to select the line type. When you select this option, a small window appears displaying the three available line types (solid, broken, or dotted line). You will be prompted to **Pick line type**. The cursor will change to a cross hair. Position the cross hair over the desired line type, and press the left mouse button. Next, you will be prompted to **Pick line(s) to be modified**. Box the lines to be changed by marking the opposite corners of the region. Choose the lines to be modified by positioning the cursor over the lines to be modified and pressing the left mouse button. Again, the cursor changes to a small dot. Drag the cursor over the lines to be modified. An outline box will appear. When the box completely surrounds the lines to be modified, press the left mouse button. The box will disappear and the selected lines will change to the new line type. If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Pick next line(s) to be modified**. At this point, you may select more lines or press the right mouse button to terminate the process. Upon termination, the normal cursor will return.

Text Col

This attribute option allows you to change the color of the text in your fault tree diagram. When you invoke this option, you will be prompted to **Pick a new color from the color bar**. Position the cursor over the desired color and press the left mouse button. (**NOTE:** The ↑ ↓ (color)

option is active at this time. This option will display the additional color selections available.) Next, you will be prompted to **Pick text to be modified**. The cursor will change from an arrow to a cross hair. Box the text to be changed by marking the opposite corners of the text area. To box the area, position the cursor over the text to be changed and press the left mouse button. A small dot will appear. Drag the cursor over the text until the outline box surrounds all the desired text. Press the left mouse button. All selected text will change to the new color. If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Pick next text to be modified**. At this point, you can select more text or press the right mouse button to terminate the process. The color change will only affect the selected text.

Text Size

This attribute option allows you to specify the height of the text in your diagram. When you invoke this option, you will be prompted to **Enter text size**. Text sizes are indicated by a number between 0.01 and 66.00, with 66 being the full 66 lines from the top to the bottom of the screen. This roughly corresponds to the 66 lines on a full sheet of regular paper. For writing text in gate blocks, a text size of about 0.5 is appropriate. The size looks too small on the screen, but it is a good size for sending to a LaserJet printer. Larger text sizes will be necessary for printers with lower resolution. Next, you will be prompted to **Pick text to be modified**. Position the cursor on the text to be resized and press the left mouse button. A small dot will appear. Drag the cursor over the text to be resized. When the outline box completely surrounds the text to be modified, press the left mouse button. The box will disappear and the selected text will be displayed in the new text size. If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Pick next text to be modified**. At this point, you can select more text, or press the right mouse button to terminate the process. This new text size will only affect the selected text.

Text Just

This attribute allows you to justify selected portions of the text in your diagram. When you invoke this option, you will be prompted to **Pick text to be modified**. Position the cross hair over the text to be justified and press the left mouse button. A small dot will appear. Drag the cursor over the text to be justified. When the outline box completely surrounds the desired text, press the left mouse button. The outline box will disappear and the selected text will be justified (see Section 5.1.11 for a complete discussion on setting the justification). If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Pick next text to be modified**. At this point, you may select additional text to be justified or press the right mouse button to terminate the process. Only the selected text will be justified. The remaining text will be unchanged.

Text Font

This attribute option allows you to select the font type for selected text. When you select this option an additional pop-up menu will be displayed (Figure 39). Select the desired font type by positioning the cursor over the font and pressing the left mouse button. You must select a font (or cancel) in order to continue. Next, you will be prompted to **Pick text to be modified**. Position the cursor over the text to be changed and press the left mouse button. A small dot will appear. Drag the cursor over the text to be modified. When the box completely surrounds the text to be modified, press the left mouse button. The selected text will be displayed in the new font size. If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Pick next text to be modified**. At this point, you may select more text, or press the right mouse button to terminate the process. Only the selected text will carry the new font type. The remaining text (unselected) will remain unchanged.

Name Col

This attribute option allows you to change the color of the default or given name of the symbol/shape. When you select this option, you will be prompted to **Pick a new color from the color bar**. Position the cursor over the desired color and press the left mouse button. (**NOTE:** The ↑ ↓ (color) option is active at this time. This option will display the additional color selections available.) Next, you will be asked to **Pick shapes to be modified**. Position the cross hair over the shapes to be changed and press the left mouse button. A small dot will appear. Drag the cursor over the shapes to be modified. You must be sure to place the box completely around the shape and not just the name. When the box surrounds the desired shapes, press the left mouse button. The selected symbol name(s) will change to the new color. If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Pick next shapes to be modified**. At this point, you may select additional shapes or press the right mouse button to terminate the process.

Name Size

This attribute option allows you to specify the height of the shape name in your diagram. When you invoke this option, you will be prompted to **Enter text size**. Text sizes are indicated by a number between 0.01 and 66.00, with 66 being the full 66 lines from the top to the bottom of the screen. This roughly corresponds to the 66 lines on a full sheet of regular paper. For writing text in gate blocks, a text size of about 0.5 is appropriate. The size looks too small on the screen, but it is a good size for sending to a LaserJet printer. Larger text sizes will be necessary for printers with lower resolution. Next, you will be prompted to **Pick shapes to be modified**. Position the cursor on the shape to be modified and press the left mouse button. A small dot will appear. Drag the cursor over the text to be changed. When the box surrounds the shapes to be modified, press the left mouse button. If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Pick next shapes to be modified**. At this point, you can select more

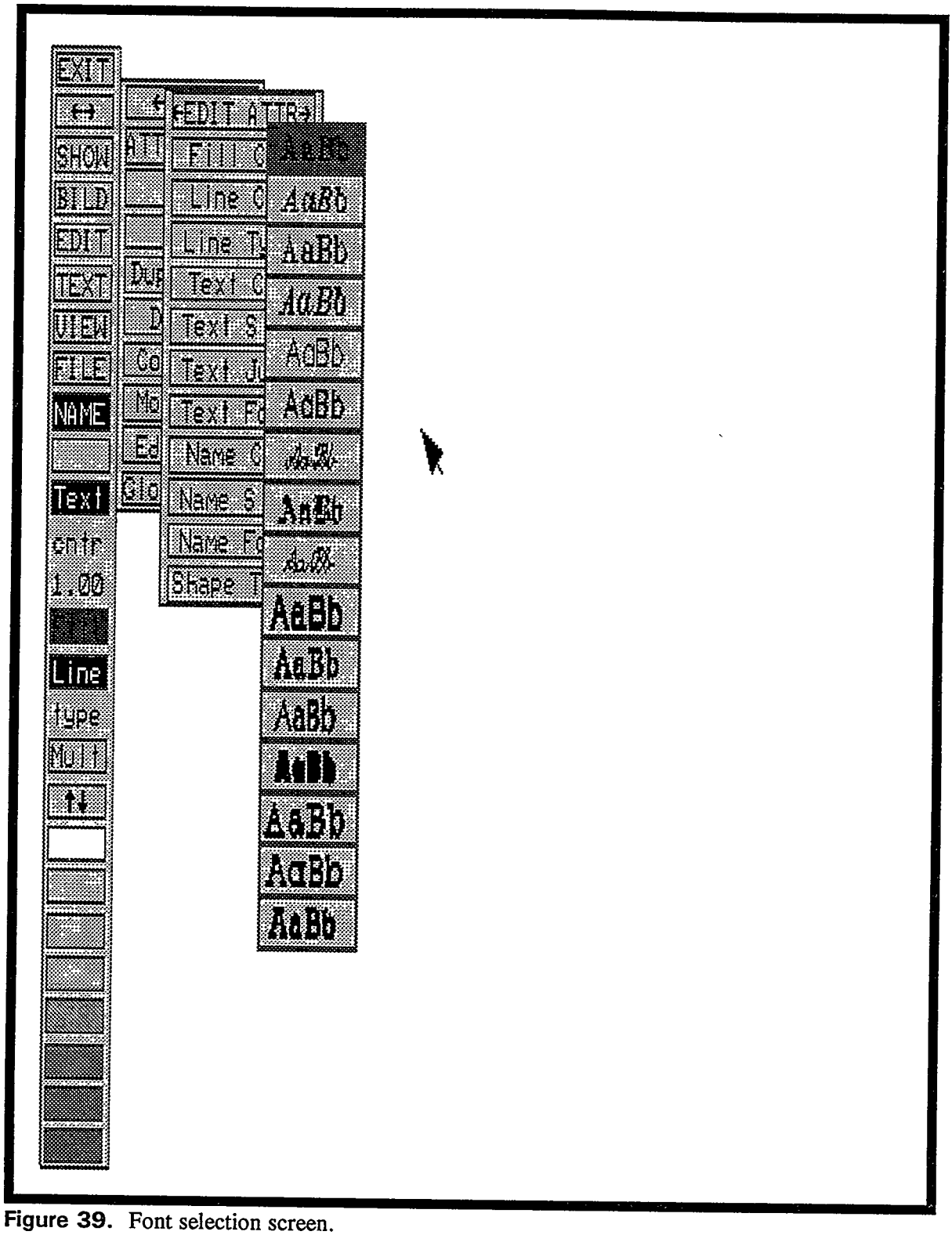


Figure 39. Font selection screen.

shapes, or press the right mouse button to terminate the process. This new text size will only affect the selected shapes.

Name Font

This attribute option allows you to select the font type the shape name will have in your diagram. When you select this option an additional pop-up menu will be displayed (Figure 39). Select the desired font type by positioning the cursor over the font and pressing the left mouse button. Next, you will be prompted to **Pick shapes to be modified**. Position the cursor over the shapes to be changed and press the left mouse button. A small dot will appear. Drag the cursor over the text to be modified. When the box surrounds the shapes to be modified, press the left mouse button. If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Pick next shapes to be modified**. At this point, you may select more shapes, or press the right mouse button to terminate the process. Only the selected shapes will carry the new font type. The remaining shapes (unselected) will be unchanged.

Shape Type

This attribute allows you to change an existing symbol in the current diagram to another symbol. When you select this option an additional pop-up menu will be displayed showing a menu similar to the build pop-up menu shown in Figure 36. You will be prompted to **Select the new shape type, or <cancel> to quit**. On this menu, you must select the desired shape. This is the symbol with which you are replacing the existing symbol. Highlight the desired symbol and press the left mouse button on the <Enter> key. You will be prompted with **Select shapes to be changed to new type**. Position the cursor over the shape to be changed to the new shape and press the left mouse button or the <Enter> key. A small dot appears. Drag the cursor over the shape(s) to be changed. When the box completely surrounds the desired shape(s), press the left mouse button. The box will disappear and the symbols will be changed to the new symbols. If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Select next shape(s) to be changed or <cancel> to reselect type**. At this point, you may select more shapes to change, or press the right mouse button to select a new replacement symbol.

5.1.5.2 Move. This editing option allows you to move part of the diagram to a new location. When you invoke this option, you will be prompted to **Box region to be moved - press CANCEL to quit.** Position the cross hair over the region to be moved and press the left mouse button. A small dot will appear. Drag the cursor over the region until the box completely surrounds the region to be moved, and press the left mouse button. Next, you will be prompted to **Pick reference point - press CANCEL to reselect.** The reference point is used to give you some indication of the position of the object being moved relative to the box. Position the cross hair at the location where you want the selected region to be moved. Next, you will be prompted to **Position Box at new location - press CANCEL to reselect.** Use the cursor to move the box to the exact position where you want the box to appear. When you are satisfied with the new position press the right mouse button. The selected region will be moved to this

new location. If the multipick option is turned on (see Section 5.1.16), you will be returned to the **Position box at new location ...** prompt. At this point, you may select a new location to move the selected symbols or press the right mouse button to return to the "box region" prompt. At this point, you may select another region to move or press the right mouse button to terminate the process.

5.1.5.3 Copy. This editing option allows you to copy a portion of the diagram and move it to a new location. This option does not create an exact copy, but rather copies the structure of the objects. When you invoke this option, you will be prompted to **Box region to be copied - press CANCEL to quit.** To box the region to be copied, mark the opposite corners of the region. Position the cross hair on the region to be copied and press the left mouse button. A small dot will appear. Drag the cursor over the region to be copied until the box completely surrounds the region. Press the left mouse button. You will be prompted to **Pick reference point - press CANCEL to reselect.** Position the cursor at the location you want the region to be copied to and press the left mouse button. The selected region will be copied and displayed at the chosen location. If the multipick option is turned on (see Section 5.1.16), you will be returned to the **Position Box at new location -press CANCEL to reselect** prompt. At this point, you can copy the selected region to another location on the diagram, or press the right mouse button to terminate the process. If the process is terminated, you will be returned to the "box region" prompt. You may select another region to copy or press the right mouse button to terminate the process.

5.1.5.4 Duplicate. This editing option allows you to duplicate a portion of the fault tree diagram. This option makes an **exact** copy. Duplicate replicates the structure, logic, and even the names used. When you invoke this option, you will be prompted to **Box region to be duplicated -press CANCEL to quit.** To box the region to be duplicated, mark the opposite corners of the region. Position the cross hair at the area to be duplicated and press the left mouse button. A small dot appears. Drag the cursor over the area to be duplicated until the outline box completely surrounds the desired area. When complete, press the left mouse button. The box will disappear and you will be prompted to **Pick reference point - press CANCEL to reselect.** Position the cursor at the desired point and press the left mouse button. An outline box the size of the selected area will appear. You will be prompted to **Position Box at new location - press CANCEL to reselect.** Position the cursor at the desired location and press the left mouse button. The selected area will be duplicated (an exact copy) and displayed at the new location. If the multipick option is turned on (see Section 5.1.16), another outline box will appear and you will be prompted to **Position Box at new location - press CANCEL to reselect.** At this point, you can duplicate the region again, or press the right mouse button to terminate the process. You will be returned to the **Box region to be duplicated** prompt. You may select another region to be duplicated or press the right mouse button to cancel the process.

5.1.5.5 Delete. This editing option allows you to delete any portion of the displayed fault tree diagram. When you invoke this option, you will be prompted to **Pick region to be deleted.** Position the cursor at the place you want to delete and press the left mouse button. A small dot will appear. Drag the cursor over the area to be deleted until the outline box completely surrounds the area. Press the left mouse button. Next, you will be prompted **Delete region? Left = delete, Right = cancel.** If the boxed area is the area you want to delete, press the left mouse button. If it is not the desired region, press the right mouse button. If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Pick next region to be deleted.** At this point, you may select another region to delete, or press the right mouse button to terminate the process.

5.1.5.6 Copy Txt. This option allows you to copy text from one area of the diagram to another. When you invoke this option, you will be prompted to **Pick text to be copied - press CANCEL to quit.** Position the cross hair on the text to be copied. A small dot will appear. Drag the cursor over the text until the outline box completely surrounds the entire text. Press the left mouse button. Next, you will be prompted to **Pick reference point - press CANCEL to reselect.** The reference point is used to give you some indication of the position of the object being moved relative to the box. Position the cursor at the desired point and press the left mouse button. You will be prompted to **Position Box at new location - press CANCEL to reselect.** The selected text will now be displayed at the new location. (The text still remains at its original location). If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Position Box at new location**. At this point, you may copy the text to yet another location or press the right mouse button to terminate the process. You will be returned to the **Pick text to be copied - press CANCEL to quit** prompt. You may select another piece of text to copy or press the right mouse button to terminate the copy process.

5.1.5.7 Move Txt. This editing option allows you to move text from one area of the diagram to another. When you invoke this option, you will be prompted to **Pick text to be moved - press CANCEL to quit.** To mark the text to be moved, box the opposite corners of the text region. Position the cross hair at the start of the text to be moved, and press the left mouse button. A small dot will appear. Drag the cursor over the text to be moved until the outline box completely surrounds the desired text. Press the left mouse button. Next, you will be prompted to **Pick reference point - press CANCEL to reselect**. The reference point is used to give you some indication of the position of the object being moved relative to the box. Position the cursor at the desired location and press the left mouse button. You will be prompted to **Position Box at new location - press CANCEL to reselect.** Move the cursor until the box is positioned at the point where you want to move the text. Press the left mouse button again. The text will be moved to the new location. If the multipick option is turned on (see Section 5.1.16), the box will appear again and you will be prompted to **Position Box at new location - press CANCEL to reselect.** At this point, you can move the same text to yet another location or press the right mouse button to terminate the process. If you choose to terminate, you will be returned to the **Pick text to be moved** prompt. You may choose more text to move or press the right mouse button to cancel the move text option. **NOTE:** When you move text, the selected text will be removed from its original position.

5.1.5.8 Edit Txt. This editing option allows you to edit text. When you invoke this option, you will be prompted to **Box text to be edited**. To box the text to be edited, mark the opposite corners of the text region. Position the cursor at the text to be modified and press the left mouse button. A small dot will appear. Drag the cursor over the text to be modified until the outline box surrounds all the desired text. Press the left mouse button. A large window will appear displaying the selected text in a readable format. The text is displayed one line at a time. To edit the text, simply type over the existing text. You may use the <Ins> and <Del> keys to add and delete characters as necessary. In addition, you may use the backspace and end keys. Backspace moves all characters from the right of the cursor to the left one space. The End key positions the cursor at the end of the current line. When complete, press <ESC> and the next line of text will appear. When complete, you will be prompted to **Box text to be edited** (if the multipick option is turned on - see Section 5.1.16. At this point, you can select additional text to modify or press the right mouse button to terminate the process.

5.1.5.9 Global Txt. This editing option allows you to replace a specified word or group of words with a new word(s) at each and every occurrence in the fault tree diagram. When you invoke this

option, you will be prompted to **Enter search string:**. Enter the word or phrase to be replaced (up to 42 characters are allowed for one search) and press <Enter>. Next, you will be prompted to **Enter replacement string:**. Enter the replacement word or phrase (again, up to 42 characters are allowed) and press <Enter>. Every occurrence will be replaced. When complete, the normal cursor (arrow) will return. **NOTE:** All occurrences of the strings will be replaced. For example, if you have a string in a text area you wish to change and that string also happens to be part of a NAME, both instances will be replaced with the new string.

5.1.6 TEXT

The TEXT command allows you to create titles, labels, descriptions, and names for your fault tree diagram. When you invoke this option, Figure 40 will be displayed. Each of the text submenu options is described in the following paragraphs.

The first option shown, ←TEXT→, is used to move the options menu to a new location. Position the cursor on the ←TEXT→ box and press the left mouse button. An outline box will appear. Position the box to the desired location and press the left mouse button. To remove the text suboptions menu, position the cursor anywhere in the text suboptions column and press the right mouse button. The remaining TEXT suboptions are discussed in the following paragraphs.

5.1.6.1 Write Text. This text suboption allows you to add text anywhere on the fault tree diagram. When you invoke this option, you will be prompted to **Pick location for text**. Position the cursor where you want to write text and press the left mouse button. A window will appear. This window can hold up to 10 lines of text. Type in the new text as you want it to appear on the diagram. When finished, press <Esc>. When you return to the diagram, the newly added text will be included. If the multipick option is turned on (see Section 5.1.16), you will be prompted to **Pick next location for text.** At this point, you can choose another location to add text, or press the right mouse button to terminate the process.

5.1.6.2 Edit Text. This text suboption allows you to edit any of the text appearing on the diagram. When you invoke this option, you will be prompted to **Box text to be edited.** Position the cross hair at the beginning of the text you wish to modify and press the left mouse button. A small dot will appear. Drag your cursor over the text until the outline surrounds the text you wish to modify. When the text is surrounded, press the left mouse button. A window will appear displaying the first line of the selected text. To modify the text, simply type over the existing text. Use the <Ins> and <Del> keys to add and delete characters as necessary. In addition, you may use the Backspace and End keys. The Backspace key moves all characters from the right of the cursor to the left one space. The End key positions the cursor at the end of the current line. When complete, press <Esc>. If the multipick option is turned on (see Section 5.1.16), you will be returned to the **Box text to be edited** prompt. At this point, you may box more text to edit or press the right mouse button to terminate the process.

5.1.6.3 FONT. This text suboption allows you to change the FONT of the text. When you invoke this option, Figure 41 will be displayed. To select a font, position the cursor on the desired font and press the left mouse button. The font is now selected. New text will now appear in the new font style. This option updates the global font default. **NOTE:** The currently selected font is shown in a different color.

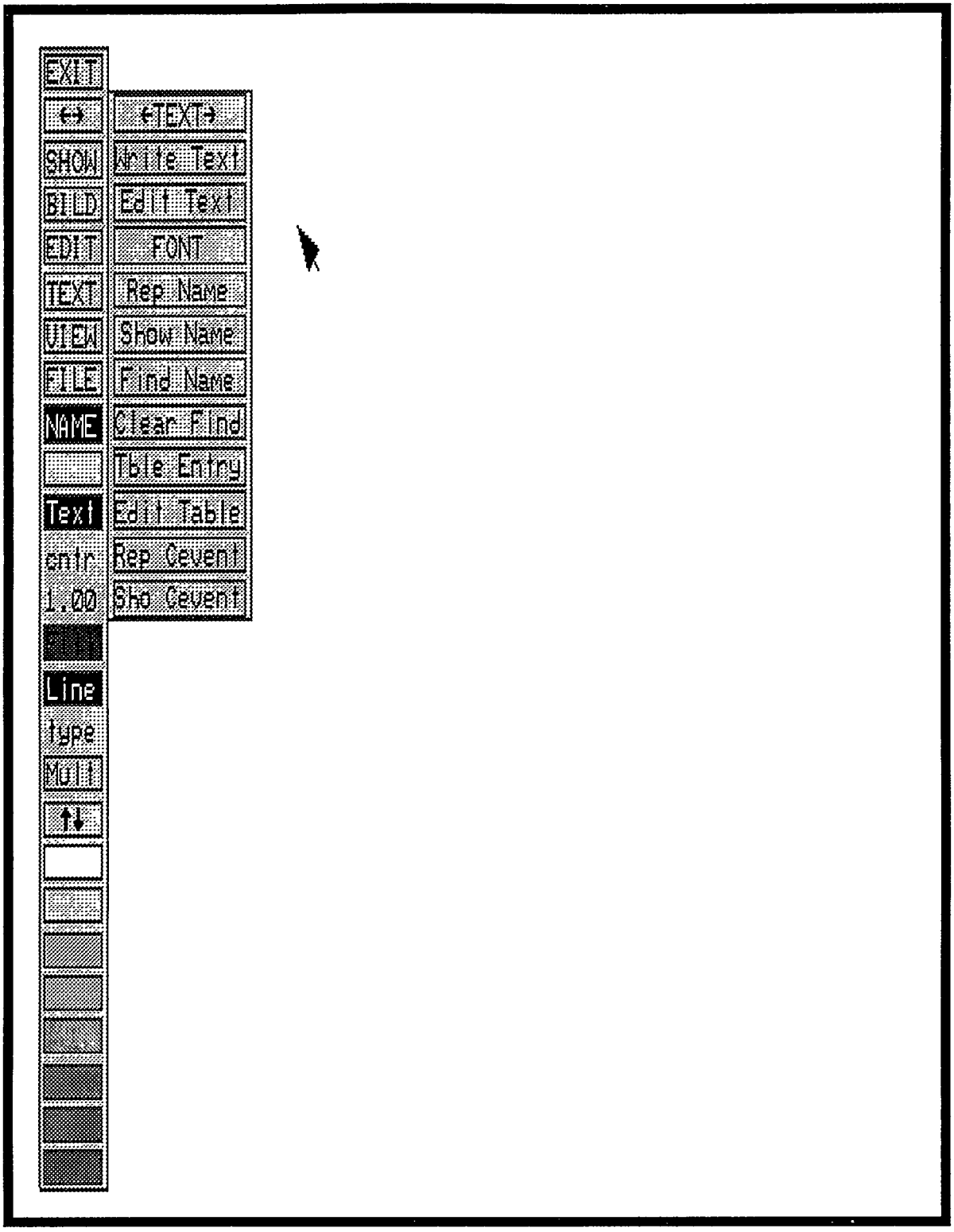


Figure 40. TEXT main menu.

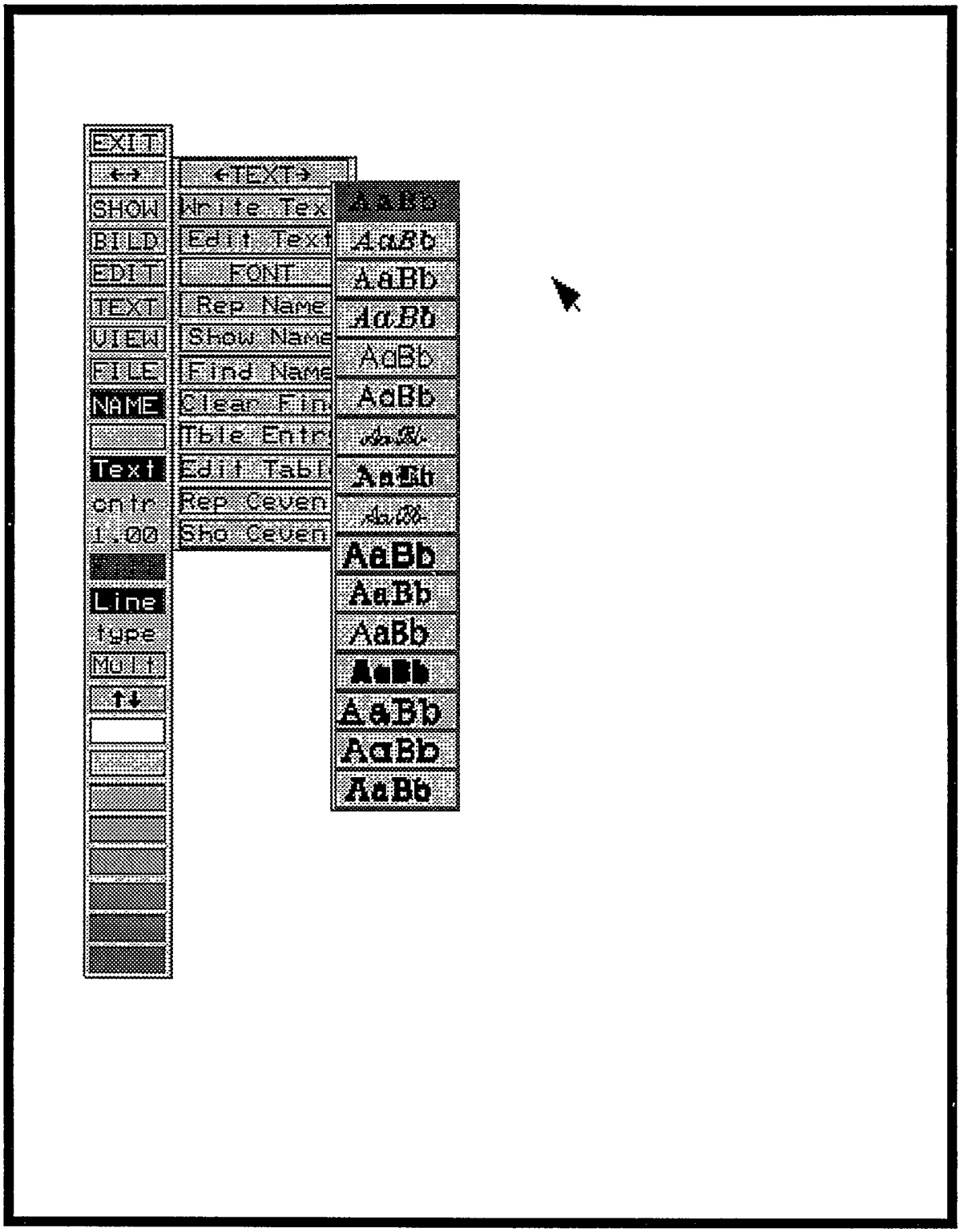


Figure 41. FONT selection menu.

5.1.6.4 Rep Name. This text suboption allows you to name or replace a name. When you invoke this option you will be prompted to **Pick shape to be named.** Position the cursor on the shape to be named and press the left mouse button. The prompt **Enter new name or CR for =>** will be displayed. Enter a new label and press <Enter>. The shape(s) will be renamed. If the multipick option is turned on (see Section 5.1.16), you will be returned to the **Pick next shape to be named** prompt. At this point, you may choose another shape to label or press the right mouse button to terminate the process.

5.1.6.5 Show Name. This text suboption allows you to display (in readable characters) a shape name. When you invoke this option, you will be prompted to **Pick the shape.** Position the cross hair on the desired shape and press the left mouse button. The name for the selected shape will be displayed at the bottom of the screen. If the multipick option is turned on (see Section 5.1.16), the cross hair returns and you may select another shape or press the right mouse button to terminate the process.

5.1.6.6 Find Name. This text suboption allows you to locate a specific shape name on your diagram. When you invoke this option, you will be prompted with **Enter name >.** Enter the shape name you wish to locate and press <Enter>. A broken dotted line will outline the shape containing the specified label. This outline will appear until you invoke the Clear Find option.

5.1.6.7 Clear Find. To invoke this option, position the cursor over the Clear Find menu option, and press the left mouse button. All highlight outlines will be cleared from the screen.

5.1.6.8 Tble Entry. This option allows you to add entries to an existing table. When you invoke this option, you will be prompted to **Pick Table.** Position the cross hair over the table to be modified and press the left mouse button. You will be prompted to **Enter name (terminate with CR) >.** Enter the new table entry and press <Enter>. If the multipick option is turned on, you will be prompted with **Next name (terminate with CR) >.** At this point, you may enter another table entry or press the <Enter> key to terminate the process. Upon pressing <Enter> you will be returned to the **Pick Next Table** prompt. At this point, you may mark another table symbol for entry or press the right mouse button to terminate the process.

5.1.6.9 Edit Table. This option allows you to edit individual table entries. When you invoke this option, you will be prompted to **Pick gate, event, or tab.** Position the cross hair on the desired gate, event, or table and press the left mouse button. A window will appear displaying the names. You are prompted to **Pick the name to modify,-use "@" in 1st col to delete.** Position the cursor over the name to modify and press the left mouse button. You will be prompted to enter a new name. Enter the name and press <Enter>. To cancel or terminate this process, press the right mouse button.

5.1.6.10 Rep Cevent. This option allows you to rename or change the name (label) given to the event part of an inhibit gate. When you select this option you will be prompted to **Pick INHIBIT gate.**

5.1.6.11 Sho Cevent. This option allows you to view the Cevent name associated with the inhibit gate. When you invoke this option, you will be prompted to **Pick the INHIBIT gate.**

5.1.7 VIEW

This option allows you to change the position and size of the displayed diagram. You may move the drawing up, down, right, left, zoom in, zoom out, or restore the drawing to its original size and/or position. You may also use a toggling method to display/not display names and text, and display a grid. When you select this option, Figure 42 will be displayed.

The first box, ←VIEW→, is used to move the VIEW menu to a new location on the screen. To invoke this option, position the cursor on the ←VIEW→ box and press the left mouse button. An outline box will appear. Move the outline to the desired location on the screen and press the left mouse button. In addition, you can remove the VIEW option box by positioning the cursor on any command in the VIEW menu and pressing the right mouse button or pressing the <Esc> key. The VIEW submenu consists of the following options:

- Page ↑: Invoking this option allows you to shift the figure up one page (previous page). To invoke this option, position the cursor in the Page ↑ box and press the left mouse button or <Enter>. The diagram's previous page will be displayed and the message **View changed** will appear at the bottom of the screen. This message will remain on the screen until the view option is terminated.

- Page ↓: Invoking this option allows you to shift the figure down one page (next page). To invoke this option, position the cursor in the Page ↓ box and press the left mouse button or <Enter>. The diagram's next page will be displayed and the message **View changed** will appear at the bottom of the screen. This message will remain on the screen until the view option is terminated.

- Page ←: Invoking this option allows you to shift the figure to the left one page (one screen). To invoke this option, position the cursor in the Page ← box and press the left mouse button or <Enter>. The diagram will shift to the left one screen at a time and the message **View changed** will appear at the bottom of the screen. This message will remain on the screen until the view option is terminated.

- Page → : Invoking this option allows you to shift the figure to the right one page (one screen). To invoke this option, position the cursor in the Page → box and press the left mouse button or <Enter>. The diagram will shift to the right one screen at a time and the message **View changed** will appear at the bottom of the screen. This message will remain on the screen until the view option is terminated.

- Scroll: Invoking this option allows you to move the diagram to another location on the screen. To invoke this option, position the cursor in the Scroll box and press the left mouse button. A white outline box appears, with a cross hair placed in the center of the outline. Position the cursor at the desired location and press the left mouse button. The cross hair serves as a reference point for placing the drawing. The reference point (+) is used to give you some indication of the position of the object being moved relative to the screen.

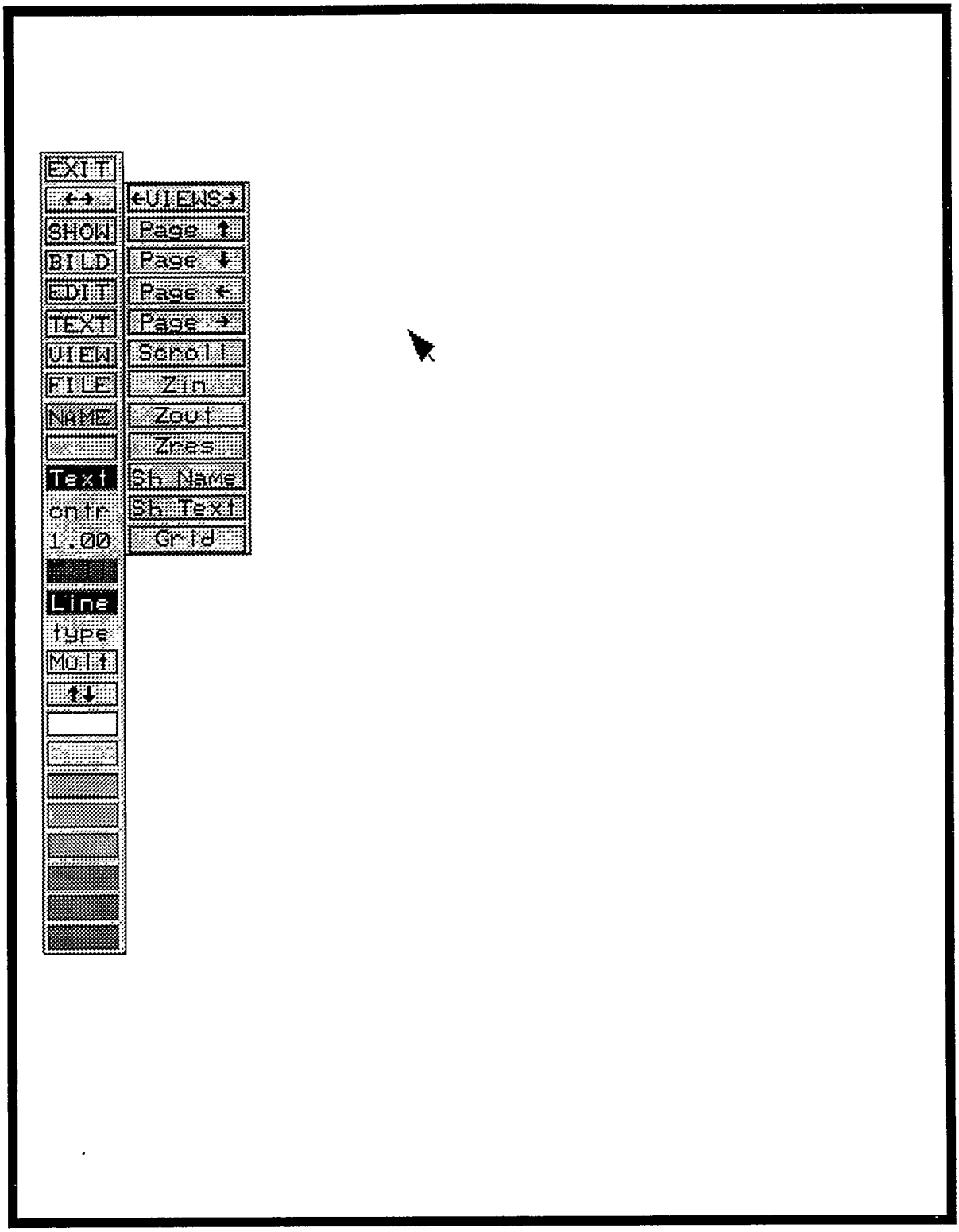


Figure 42. VIEW main menu.

- Zoom in: Invoking this option allows you to fill the screen with a small portion of the original display (magnifies the selected portion of the screen). To invoke this option, position the cursor in the Zin (zoom in) box and press the left mouse button or <Enter>. The message **Pick two corners of box** will be displayed. Move the cursor to the start of the portion of the diagram to be enlarged and press the left mouse button. A small dot appears. Drag the cursor across the desired area until it is completely surrounded by the outline box. Press the left mouse button. The portion of the original display enclosed by the box will now fill the entire screen. The display can be restored to its original size by invoking the Zres (zoom restore) option.

- Zoom out: Invoking this option allows you to shrink the displayed diagram by approximately 50%. To invoke this option, position the cursor in the Zout (zoom out) box and press the left mouse button or <Enter>. The entire display will be reduced. To restore the display to its original size, invoke the Zres option.

- Zoom Restore: This option restores any display created by Zin (zoom in), page up, page down, page left, page right, or Zout (zoom out) to the original display size or to the last saved file. To invoke this option, position the cursor in the Zres box and press the left mouse button or <Enter>.

- Sh Name: This option allows you to toggle the setting to display or not display names. Sh Name displays all the names in your diagram. No Name does not display any of the names in your diagram.

- Sh Text: This option allows you to toggle the text setting from Sh Text to No Text. Sh Text displays all defined text. No Text does not display the text.

- Grid: This option displays a grid behind your diagram to allow you to line up symbols and text. This is a toggle switch. To turn the grid on position the cursor in the GRID option box and press the left mouse button or <Enter>. To turn the grid off, repeat the same steps.

5.1.8 FILE

This option allows you to perform various file maintenance utilities including loading, saving, merging files, and printing hard copies of your diagrams. When you invoke this option, Figure 43 will be displayed. Each FILE option is discussed in the following paragraphs.

The first box, ←FILE→, is used to move the FILE menu to a new location on the screen. To invoke this option, position the cursor on the ←FILE→ box and press the left mouse button. An outline box will appear. Move the outline to the new location on the screen and press the left mouse button. The menu will be placed at the new location. In addition, you can remove the FILE menu box by positioning the cursor on any command in the FILE menu and pressing the right mouse button or pressing the <Esc> key.

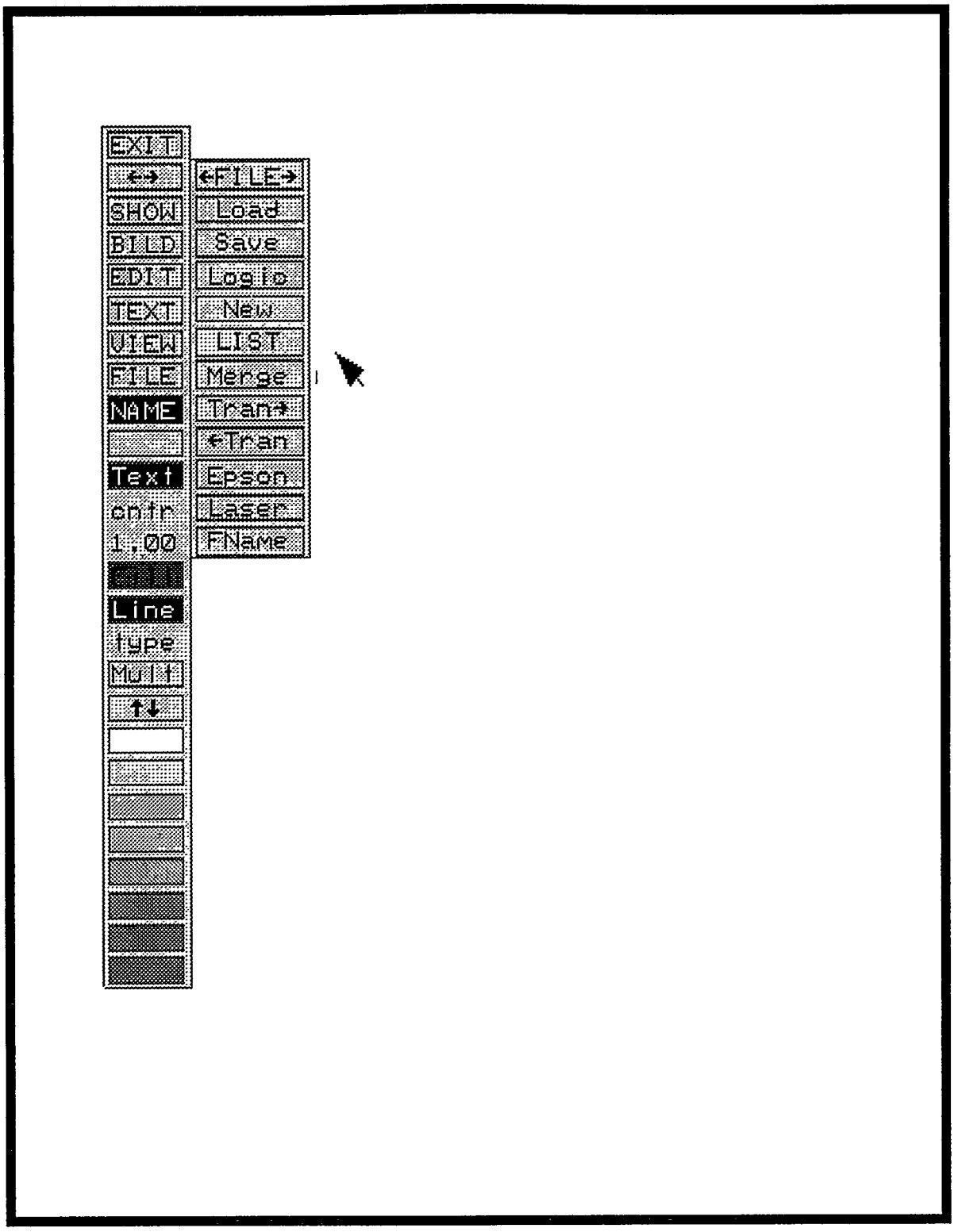


Figure 43. FILE main menu.

5.1.8.1 Load. This FILE suboption allows you to load any Fault Tree File (graphics) with the extension ".DLS" onto the screen. When you invoke this option, you will be prompted to **Enter file name >**. Enter the name of the file you wish to load and press <Enter>. The diagram will appear on the screen. If you do not remember your file name, use the LIST suboption to display all existing files in the current directory.

5.1.8.2 Save. This FILE suboption allows you to save all changes made to the diagram. When you invoke this option you will be prompted to **Enter file name or CR for File ...>**. The default file name will consist of the currently displayed diagram and an extension of .DLS. Enter a new file name if desired, or press <Enter> to save the diagram under the default name. If the default file name already exists (i.e., you have saved your diagram previously), the message **File already exists. Do you wish to replace? Y/N>** will be displayed. If you wish to write the changes over the existing file, type a Y and press <Enter>; otherwise, enter an N.

5.1.8.3 Logic. This FILE suboption allows you to save the logic of the diagram. When you invoke this option, you are prompted to **Enter file name or CR for file XXX >**, where XXX is the file name of the currently displayed diagram. Enter the new file name and press <Enter>. When complete, the message **Logic saved** will be displayed at the bottom of the screen.

5.1.8.4 New. This FILE suboption allows you to essentially cancel your current editing session. All changes made since the last save will not be applied. When you invoke this option, the screen will be cleared and you will be returned to Figure 35.

5.1.8.5 LIST. This FILE suboption displays the list of files currently residing in the default directory. When you invoke this option, a pop-up menu will be displayed showing all the files contained in the current directory. You will be prompted to **Pick the file to load**. Position the cursor over the file to load and press the left mouse button or <Enter>. The file will be loaded and displayed on the screen.

5.1.8.6 Merge. This FILE suboption allows you to merge the contents of two files into a single file. When you invoke this option, a pop-up menu will be displayed showing all the files contained in the current directory. You will be prompted to **Pick the file to load**. Position the cursor over the file to merge into the currently displayed diagram and press the left mouse button or <Enter>. Next, you will be prompted to **Pick location for the top center of merged file**. Position the cross hair at the desired location and press the left mouse button or <Enter>. The screen will be cleared and then reshown with the merged files displayed.

5.1.8.7 Tran→. This FILE suboption allows you to view the drawing defined in the file given in the transfer name.

5.1.8.8 ←Tran. This FILE suboption allows you to view the drawing that define(s) the transfer logic. Transfers allow you to create fault trees consisting of many pages.

5.1.8.9 Epson. This option formats the diagram for an Epson printer and sends it to the local Epson printer.

5.1.8.10 Laser. This option formats the diagrams for a laser printer and sends it to the local laser printer to be printed.

5.1.8.11 FName. This option displays the current file name of the diagram being displayed. When you invoke this option, the file name will be displayed at the bottom of the screen.

5.1.9 NAME

This option allows you to change the defaults for the name symbols. When you invoke this option, Figure 44 will be displayed. Each option is described below.

- Name Col: This option allows you to change the color of the name. When you invoke this option, you will be prompted to **Pick a new color from the color bar**. Position the cursor on the desired color and press the left mouse button. (**NOTE:** The ↑ ↓ (color) option is active at this time. This option will display the additional color selections available.) The NAME box will change to the new default color.

- Name Size: This option allows you to change the text size of the name. When you invoke this option, you will be prompted to **Enter text size >**. As mentioned earlier, text sizes are indicated by a number between 0.01 and 66.00, with 66 being the full 66 lines from the top to the bottom of the screen. This roughly corresponds to the 66 lines on a full sheet of regular paper. Enter the desired text size and press <Enter>.

- Dflt Gate: This option allows you to assign a default name to the gate. When you invoke this option you will be prompted to **Enter gate default name >**. Enter the name (up to 11 characters are allowed) and press <Enter>.

- Dflt Event: This option allows you to assign a default name for an event. When you invoke this option you will be prompted to **Enter event default name >**. Enter the desired name (up to 11 characters are allowed) and press <Enter>.

5.1.10 Text

This option allows you to set a default color for the text in your diagram. To invoke this option position the cursor over the Text box and press the left mouse button. You will be prompted to **Pick a new color from the color bar**. Position the cursor on the desired color box and press the left mouse button. (**NOTE:** The ↑ ↓ (color) option is active at this time. This option will display the additional color selections available.) All text will now be displayed in this color. If the diagram already exists, only the new text will be displayed in the new color. You must return to the ATTRIBUTES option to change the existing text color (if desired).

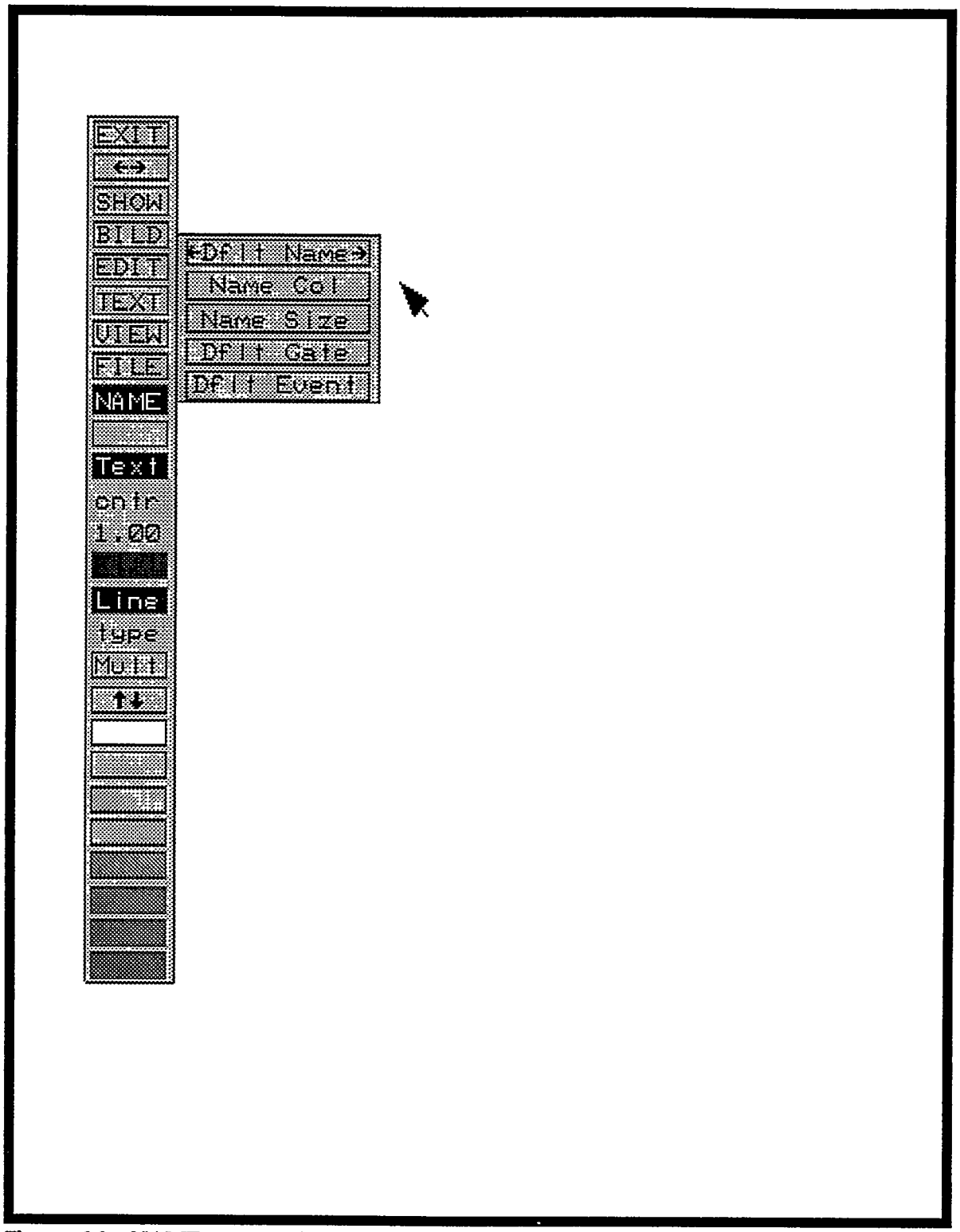


Figure 44. NAME menu options.

5.1.11 cntr/left/right

This option allows you to set the justification for your diagrams. Justification is where the text will be placed offset from the placement point. This works as a toggle switch. To change justification, position the cursor over the cntr (default) box and press the left mouse button or the <Enter> key. You will see the box change from cntr to rght (right). Press the left mouse button or <Enter> key again, and the box will change from rght to left.

Left justification means the text will be anchored at the left bottom corner, or the text will flow to the right of where it was placed. Center justification means the text will be centered about the placement point. Right justification means the text will be placed to the left of the placement point. Set the toggle for the desired justification.

5.1.12 Text Size (0.50)

This option allows you to set a default text size for your diagrams. The default value is .5. Text size ranges from .001 to 9.0. For the purpose of writing text in gate blocks, a text size of about 0.5 is appropriate. The size looks too small on the screen, but it is a good size for sending to a laser printer. **REMEMBER,** here you are setting the default text size. You may always change the text size for special text by invoking the ATTRIBUTES option, under the EDIT command.

5.1.13 Fill

This option allows you to select a color for the drawing symbols. When you invoke this option you will be prompted to **Pick a new color from the color bar**. Position the cursor over the desired color and press the left mouse button. (**NOTE:** The ↑ ↓ (color) option is active at this time. This option will display the additional colors available.) The Fill box will change to the newly selected color. All drawing symbols created in your new diagram will be displayed in this selected color. If you modify an existing drawing, the symbol colors won't change. To change the color of existing symbols you must invoke the ATTRIBUTES suboption from the EDIT option.

5.1.14 Line

This option allows you to select a color for the lines that connect the text and symbols in the diagram. When you invoke this option you will be prompted to **Pick a new color from the color bar**. Position the cursor over the desired color and press the left mouse button. (**NOTE:** The ↑ ↓ (color) option is active at this time. This option will display the additional color selections available.) The Line box will change to the selected color. All lines generated in your new diagram will be this selected color. Again, if you are modifying an existing drawing the lines won't change to this color. To change existing lines to the new color you must invoke the ATTRIBUTES suboption for the EDIT option.

5.1.15 type

This option allows you to set a default line type for your diagrams. When you invoke this option, a small window appears displaying the three line types (solid, broken, and dotted). To select a line type, position the cross hair over the desired line type and press the left mouse button. All lines drawn in your new diagram will be of this type. If you have an existing drawing that you are modifying, remember - the existing lines do not change. To change existing lines you must access the ATTRIBUTES suboption under the EDIT option.

5.1.16 Mult

This option allows you to toggle between multiple pick and single pick. The multipick option allows you to continue with a given process until terminated. For example, when creating an "AND" gate, the symbol will reappear after each placement until you cancel the process by pressing the right mouse button. If single pick (sngl) is turned on, the user must return to the menu and select "AND" again after each placement.

5.1.17 Scroll Color Bar (↑ ↓)

This option allows you to scroll the color bar to display the additional color selections available. Position the cursor on the color bar scroll box (up and down arrow) and press the left mouse button or <Enter> key. The next series of available colors will be displayed.

5.2 Plot Trees

This option allows you to plot graphics. When you invoke this option, Figure 45 will be displayed. All available plot files are displayed. The following options are available:

Exit	-	Returns you to Figure 34.
Plotter	-	Sends the specified file to the plotter.
Hpgl File	-	Generates an HPGL formatted file.
Raster File	-	Rasterizes a selected fault tree diagram for printing (highest quality - 300 dpi).
Low Resolution Raster	-	Rasterizes a selected fault tree for printing (lower quality - 150 dpi).

In addition, the following function keys are available for the remaining options presented in this section:

<Esc>	-	Returns you to the previous screen.

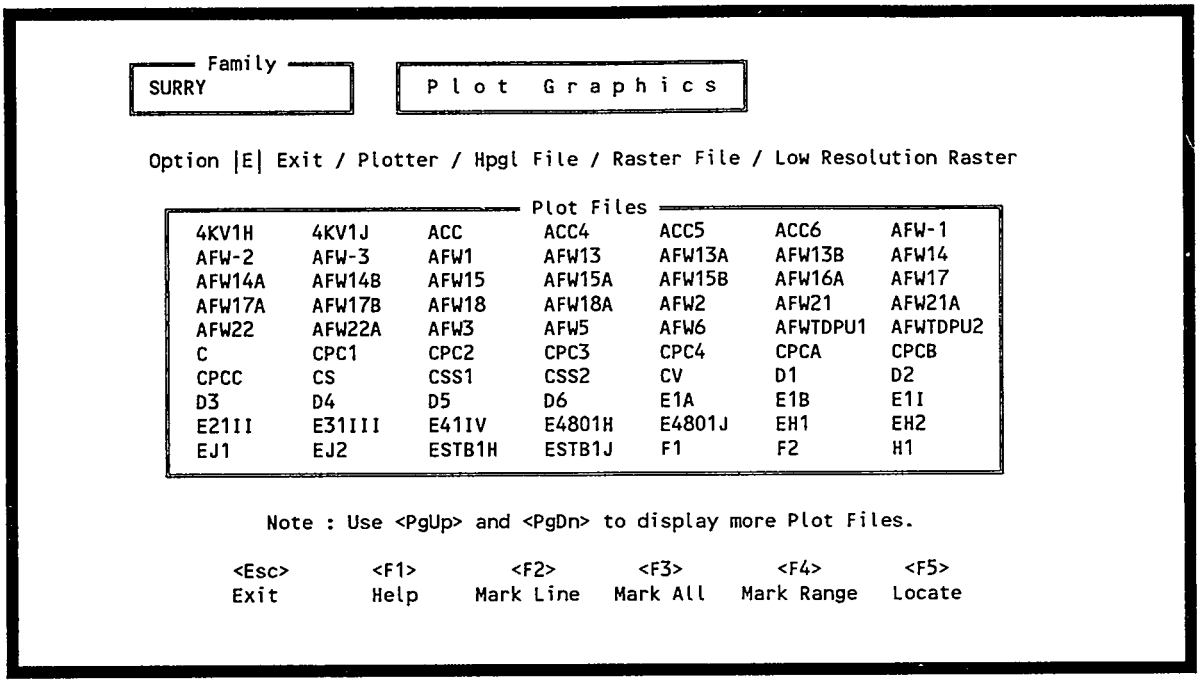


Figure 45. HP plot files display screen.

<F1>	-	Displays on-line help messages.
<F2>	-	Marks a file for further processing. When you mark a file, an asterisk will appear in front of the file name.
<F3>	-	Marks all the displayed files for further processing.
<F4>	-	Allows you to mark a range of files for further processing.
<F5>	-	Allows you to locate a specific file for further processing. When you invoke this function, Figure 46 will be displayed. Enter the file name to locate and press <Enter>. The specified file will be highlighted. If the file name does not exist, then the next name in alphabetical order will be highlighted.

5.2.1 Plotter

This option takes the .DLS files generated in the HP Plotter option in the graphics editor (Build) and sends it to the HP Pen Plotter (7475). If a plotter is not defined, you will receive the message **Plotter not attached.**

5.2.2 Hpgl Files

This option creates .HPG files. An .HPG file may be printed using the batch program PLOTHPG. Once the *.HPG file is created, exit IRRAS and return to the SAF50\XXXXXX subdirectory. At this point, you must type the following command:

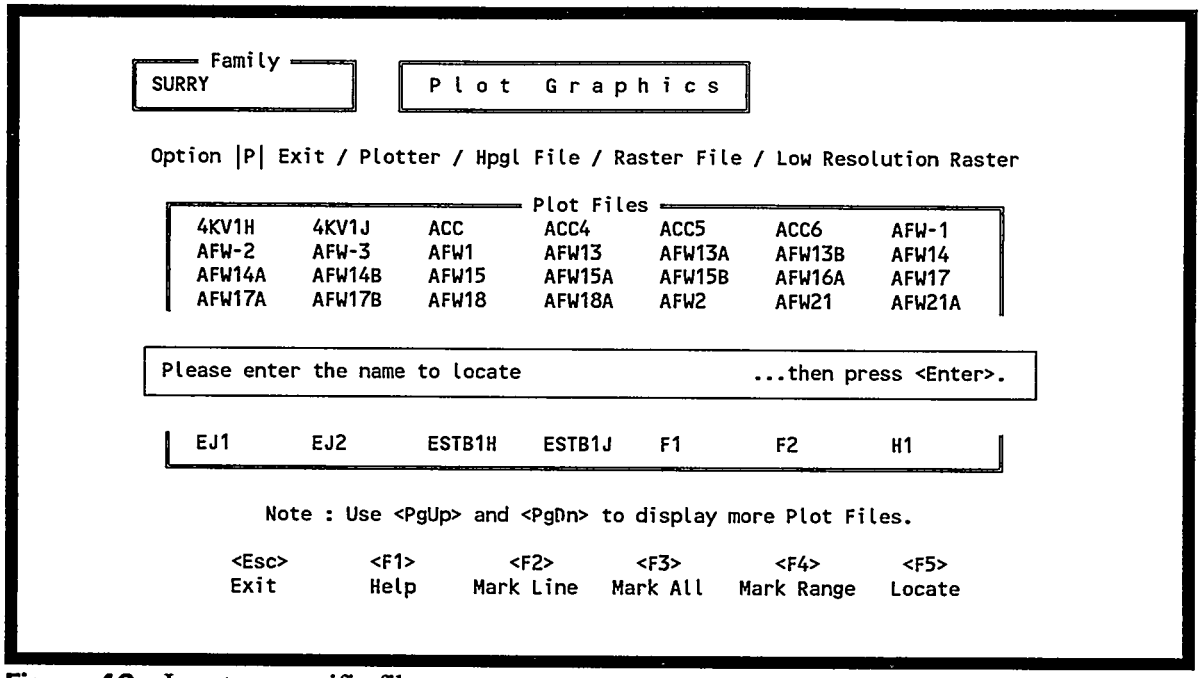


Figure 46. Locate a specific file prompt.

..\PLOTHPG *.HPG

where

*	=	wild card specification used to spool all .HPG files contained in the specified directory. If you do not wish to print all *.HPG files, you may specify an individual file.

NOTE: PLOTHPG will only work on an HP LaserJet III or IIIP.

5.2.3 Raster File

This option allows you to rasterize fault tree diagrams for printing. Obtaining a "laser printed" output of a fault tree diagram is done in two steps. First, you must select the drawings to rasterize. Once the drawings have been rasterized, you must exit the program and return to the SAF50\XXXXXX subdirectory. At this point, you use the PLOTRAS batch program to send the files to the laser printer. The command to invoke this batch program is:

..\PLOTRAS *.RAS.

(See 5.2.2 for where list definition).

NOTE: PLOTRAS will work on any laser printer.

This option rasterizes the selected fault tree to 300 dots per inch (dpi). This option provides you with the highest quality of output available. To invoke this option, enter an <R> in the option field, highlight or mark the file(s) to rasterize, and press <Enter>. A percent complete message will be displayed so you can track the progress of the rasterizing. When complete, a message will be displayed notifying you that the raster image has been created.

5.2.4 Low Resolution Raster

This option rasterizes the selected fault tree to 150 dpi. To invoke this option, enter an <L> in the option field, highlight the file(s) to be rasterized, and press <Enter>. A message will be displayed telling you that the rasterizing is being performed. A percent complete will also be displayed so you can track the progress of the rasterizing. When complete, a message will be displayed notifying you that the raster image has been created.

5.3 Load Graphic Trees

This option allows you to load graphic files. When you invoke this option, Figure 47 will be displayed. As shown, two options are available: Exit and Load.

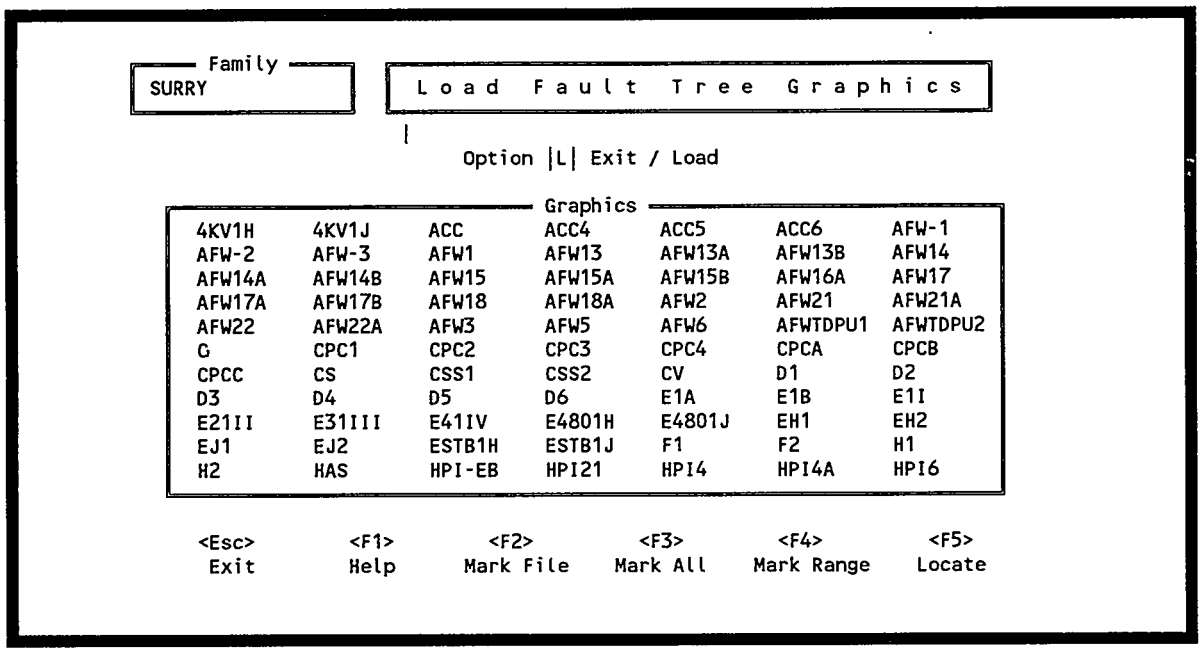


Figure 47. Load graphics tree screen.

5.3.1 Exit

This option returns you to the previous screen (Figure 34). To invoke this option, enter an <E> in the option field and press <Enter>, or press the <Esc> key.

5.3.2 Load

This option allows you to load graphics into the system. A conversion of the selected file will be performed. To invoke this option, enter an <L> in the option field, highlight the file or mark the files to be loaded using the function keys, and press <Enter>. A message will be displayed telling you that the selected file(s) is being converted.

5.4 Alpha to Graphics

This option allows you to convert the alphanumeric logic for a system or subsystem to a graphical format. Use this option when you define the fault tree logic with an ASCII file or use the logic editor to change the logic for a fault tree. The graphics and logic information for a fault tree are two separate entities, therefore, a conversion must be made if any changes are made to the alphanumeric logic. However, if changes are made to the graphics representation, the changes are automatically reflected in the alphanumeric logic. When you invoke this option, Figure 48 will be displayed. As shown, two options are available: Exit and Convert.

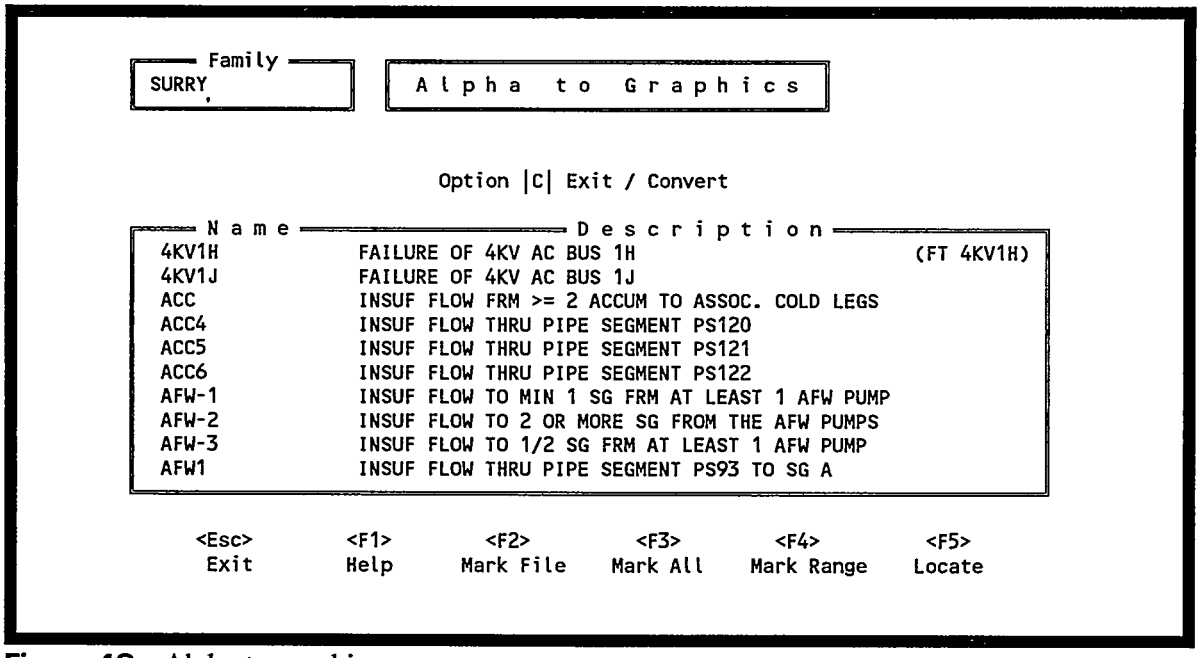


Figure 48. Alpha to graphics screen.

5.4.1 Exit

This option returns you to the previous screen (Figure 34). To invoke this option, enter an <E> in the option field and press <Enter>, or press the <Esc> key.

5.4.2 Convert

This option allows you to convert an alpha file(s) to a graphical format. To invoke this option, enter a <C> in the option field, highlight the file (using the arrow key) or mark the files (using the function keys) you wish to convert. A small window will appear at the top of the screen (as shown in Figure 49). Two prompts are displayed asking you whether you want to use tables and/or boxed events in the newly created graphic file. Enter a Y or N. Press <Enter> when complete. A message will appear notifying you that the graphics image has been created.

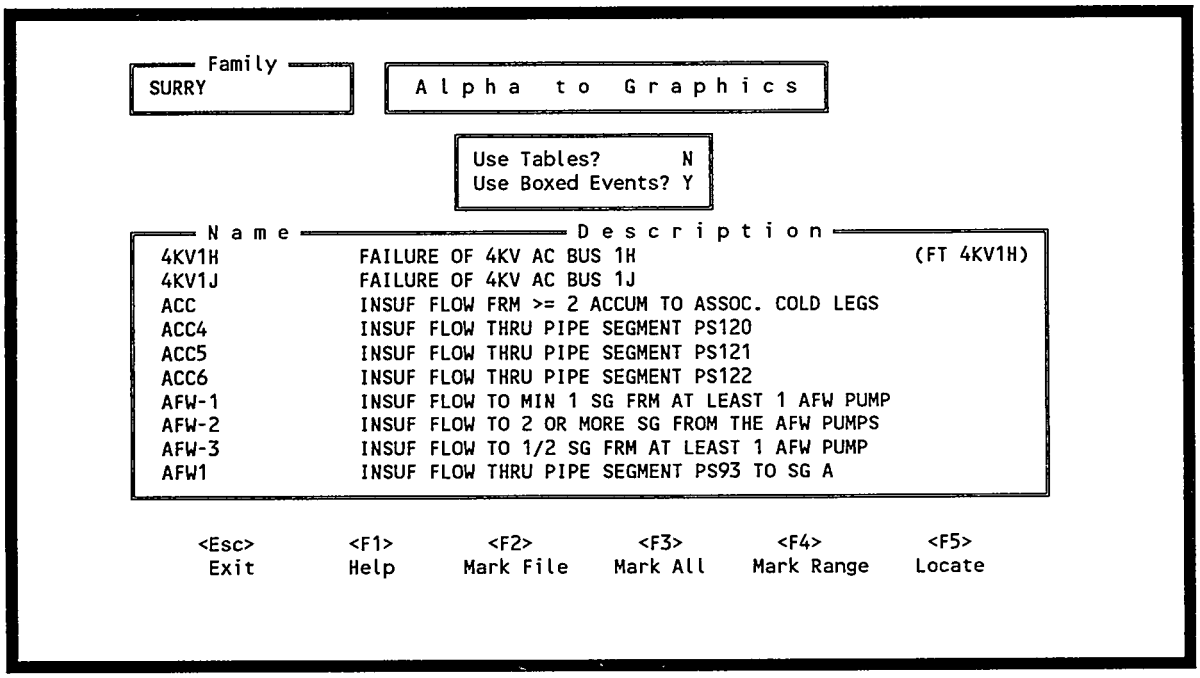


Figure 49. Set table/box toggle for conversion.

5.5 Graphical Pager

This option allows you to break up larger drawings into many pages or smaller drawings. When you invoke this option, Figure 50 is displayed. Each menu option is discussed in the following paragraphs.

5.5.1 Exit

This option returns you to the previous screen (Figure 34). To invoke this option, enter an <E> in the option field and press <Enter> or press the <Esc> key.

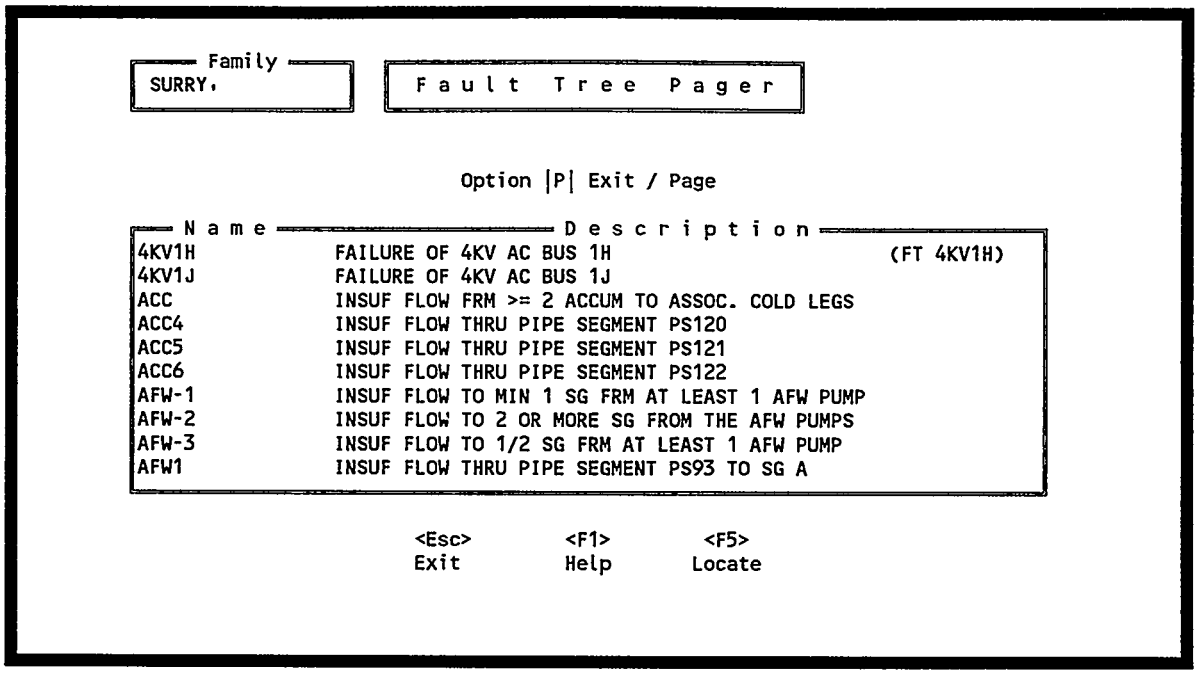


Figure 50. Fault tree pager menu.

5.5.2 Page

This option invokes the paging options. To invoke this option, enter a <P> in the option field, highlight the file to page, and press <Enter>. Figure 51 will be displayed. As shown, seven options are available. Each option is discussed in the following paragraphs.

5.5.2.1 ←PAGE→. This option allows you to move the menu to another location on the screen. To invoke this option, position the cursor on the ←PAGE→ box and press the left mouse button. An outline box will appear. Move the box to the desired location and press the left mouse button again. The pop-up menu will be displayed at the new location.

5.5.2.2 Exit. This option returns you to the previous screen (Figure 50). To invoke this option, enter an <E> in the option field and press <Enter>, or press the <Esc> key.

5.5.2.3 Find. This option allows you to locate a specific event or label on the diagram. When you invoke this option, you will be prompted to **Enter name >**. Enter the name you wish to locate and press <Enter>. The symbol containing the entered name will be highlighted with a broken dotted line. The dotted line will remain until you invoke another option.

5.5.2.4 Show. This option allows you to display the labels in a readable format. When you invoke this option, you will be prompted to **Pick a shape.** Position the cross hair on the desired shape and press the left mouse button. The event or label will be displayed at the bottom of the screen. At this point, you may position the cross hair on another symbol or shape or press the right mouse button to terminate the process.

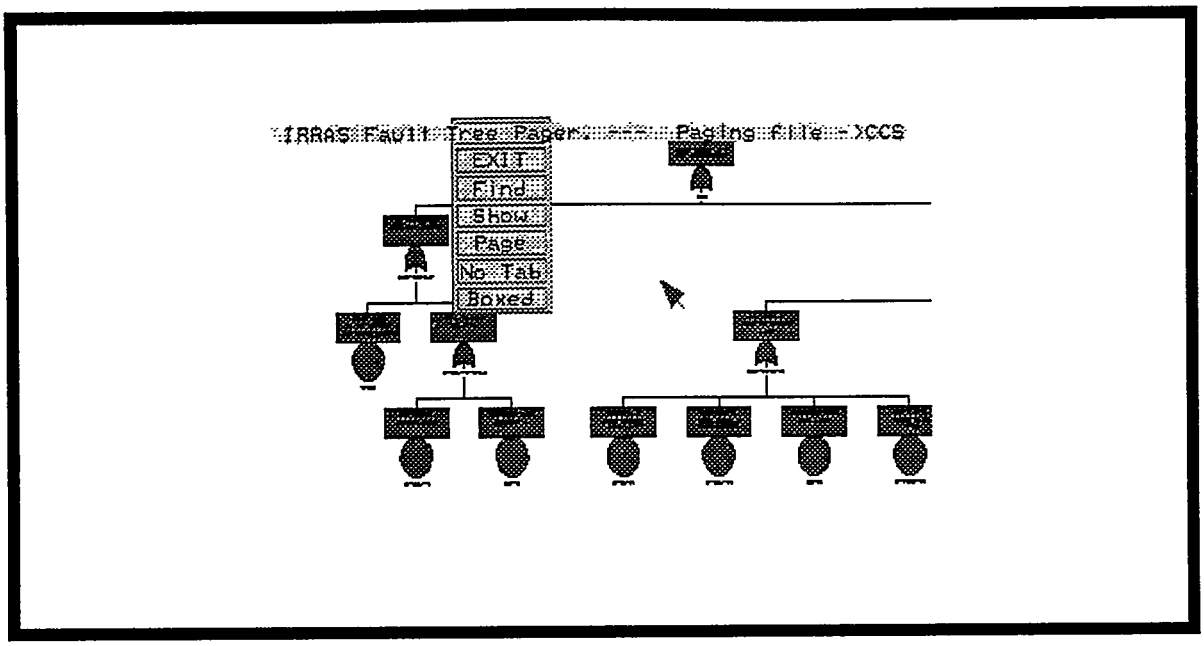


Figure 51. Graphical pager pop-up menu.

5.5.2.5 Page. This option allows you to insert or transfer a page break in your diagram. When you invoke this option you will be prompted to **Select a Gate for the desired page break**. Position the cross hair at the appropriate gate and press the left mouse button. The page break will be created. At this point, you may create another page or press the right mouse button to terminate the process.

5.5.2.6 Table/No Tab. This option toggles generation of "tables" rather than "basic events." To toggle, position the cursor on the Table box and press the left mouse button. The menu will be redisplayed and the Table box will now read No Tab (basic events).

5.5.2.7 Boxed/No Box. This option toggles generation of "boxed basic events" rather than "basic events." To toggle, position the cursor on the Boxed option and press the left mouse button. The menu will be redisplayed and the Boxed option will now read No Box (basic events).

5.6 eXtract Fault Trees

This option allows you to extract fault trees from the database. When you create a fault tree diagram and save it, the .DLS file is saved in the database as well as in a temporary .DLS file. When you delete the temporary .DLS file, the file still exists in the database. This option allows you to extract the .DLS file from the database. When you invoke this option, Figure 52 will be displayed. On this screen all the fault trees residing in the current directory are displayed. Four options are available: Exit, eXtract Trees, Clear Extracted Trees, and Display Extracted Trees.

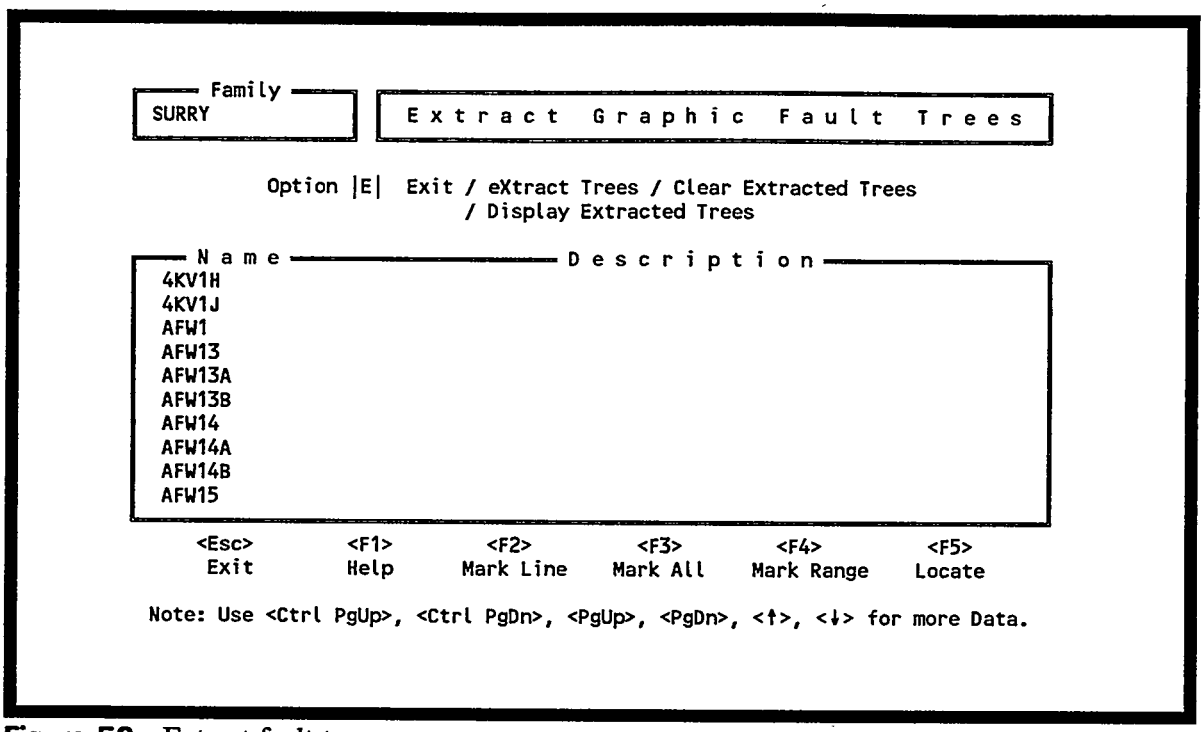


Figure 52. Extract fault trees screen.

5.6.1 Exit

This option returns you to the previous screen (Figure 34). To invoke this option, enter an <E> in the option field and press <Enter>, or press the <Esc> key.

5.6.2 eXtract Trees

This option allows you to remove specific trees from the database. To invoke this option, enter an <X> in the option field, highlight the tree to be extracted or mark the trees to be extracted (using the function keys) and press <Enter>. A message will be displayed notifying you that the tree(s) was successfully extracted.

5.6.3 Clear Extracted Trees

This option allows you to clear all extracted trees from a file. To invoke this option, enter a <C> in the option field, highlight the file to be cleared or mark the files using the function keys, and press <Enter>. A warning screen will appear (Figure 53) telling you that all existing *.DLS files will be deleted. Enter a <Y> to delete or an <N> to terminate the process. Remember, this deletion only deletes the extracted picture file. The picture file will still reside in the database.

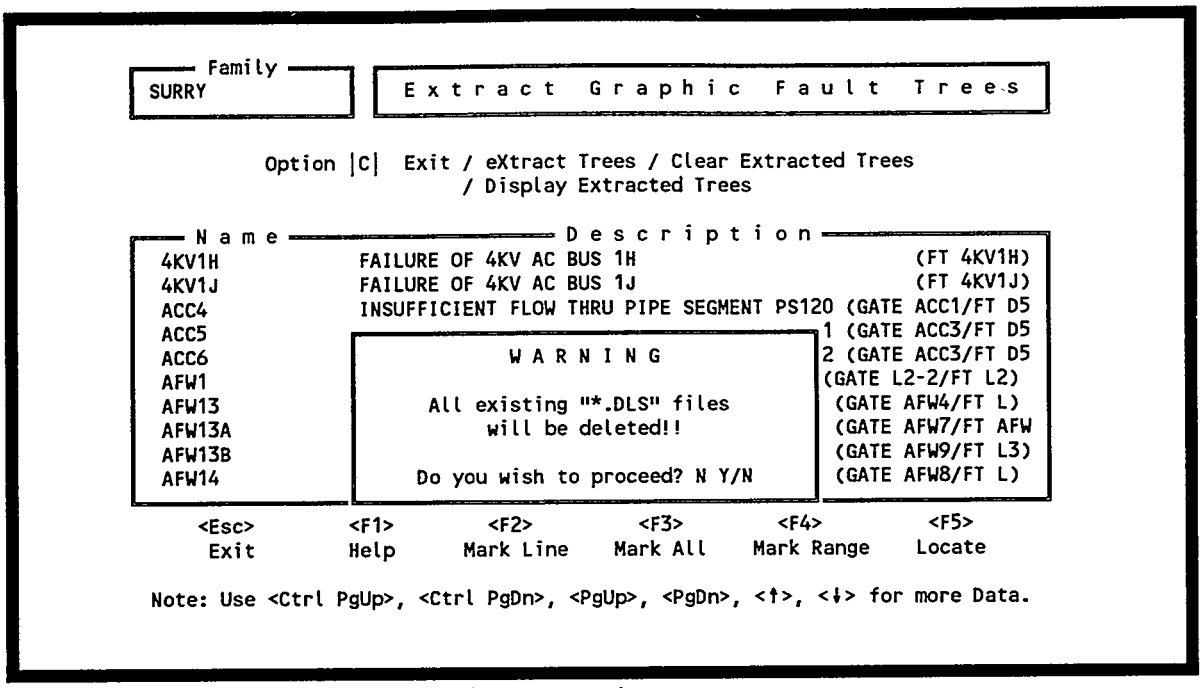


Figure 53. Warning screen for clearing extracted trees.

5.6.4 Display Extracted Trees

This option allows you to display all the extracted trees to date. To invoke this option, enter a <D> in the option field and press <Enter>. A screen similar to the one shown in Figure 54 will be displayed. Press <Enter> to return to the previous screen.

5.7 Define Plotter Pens

This option allows you to assign colors to the plotter pens. When you invoke this option, a screen will be displayed showing 16 colors. Select the color to be mapped by positioning the cross hair over the desired color and pressing the left mouse button. You will then be prompted to **Enter number of pen >**. Enter the number of the pen that will contain the selected color. Continue this process until all pens have been defined. To terminate the process, position the cursor on the STOP symbol and press the left mouse button.

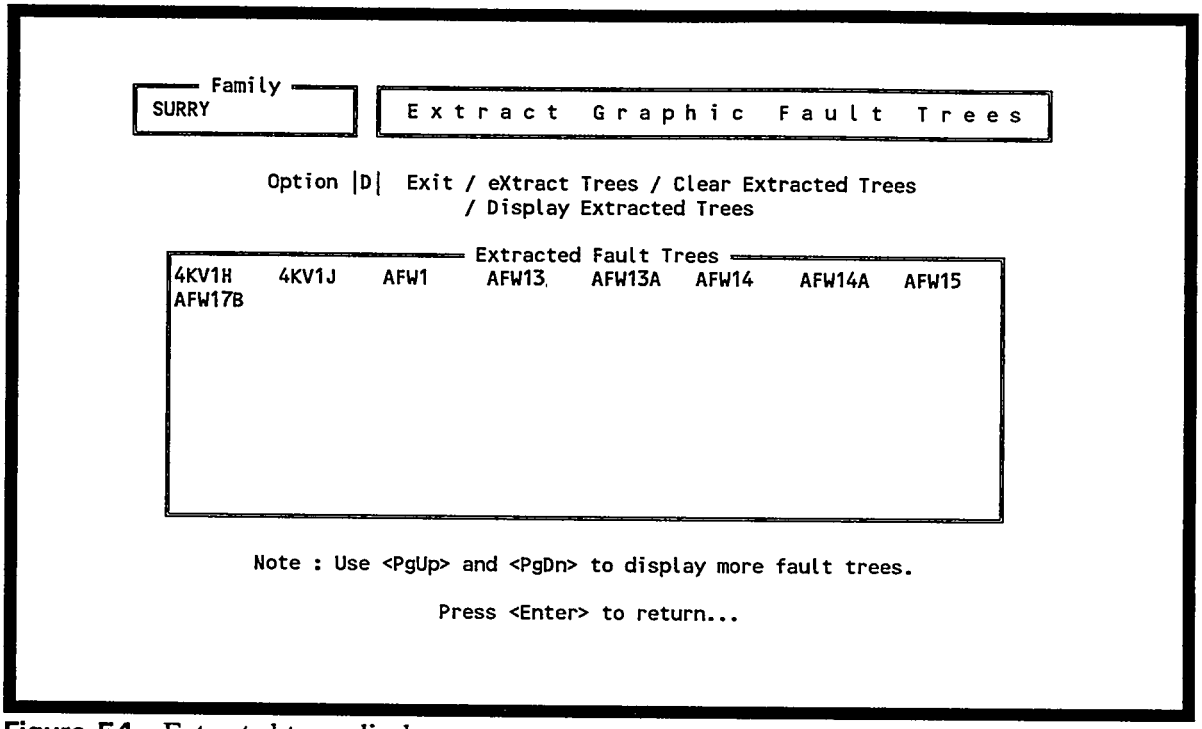


Figure 54. Extracted trees display.

6. FAULT TREE ANALYSIS

The Fault Tree Analysis module consists of six main functions.

1. Analyze Systems includes updating the cut sets, quantifying the cut sets, and running uncertainty analyses.

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

3. The Cut Set Editor provides the means to modify the fault tree cut sets.

4. Recover Cut Sets allows the analyst to add recovery to cut sets based on system rules.

5. Logic Editor provides a means for editing the fault tree logic in an alphanumeric format.

6. Seismic Plotting provides a means for plotting seismic curves. A seismic curve shows discrete points as a distribution and reflects the differences of opinion among experts for the frequency of earthquakes at a given site.

Keys that you will frequently use are

<Esc>	Escape cancels your last choice and returns you to the previous screen.
<F1>	Help briefly explains the function of a field and may show you examples of data entered.
<F2>	Mark/Unmark tags items for use in the selected option.
<F3>	Mark all of the events (*) for further processing. If all items are marked, this option will unmark all of the items.
<F4>	Mark/Unmark range of items tags large numbers of items for processing.
<F5>	Locate an item displays a blank field in the center of the screen, and a message **Please enter the name to locate** will appear. The user should enter all or part of the name to be located and then press <Enter>. This feature will place the highlight on the located name. If the required name is not found, then the next name in alphabetical order will be highlighted.

To invoke this option, highlight FAULT Tree Analysis and press <Enter>. The fault tree analysis main menu is shown in Figure 55. The options available from the fault tree analysis main menu are: Exit, Analyze Systems, Display Results, Cut Set Editor, Recover Cut Sets, Logic Editor, and Seismic Plotting. These options and their functions are discussed in the following paragraphs.

6.1 Exit

The Fault Tree Analysis screen appears with Exit <E> as the default choice in the command line (see Figure 55). Press <Enter> to return to the IRRAS main menu.

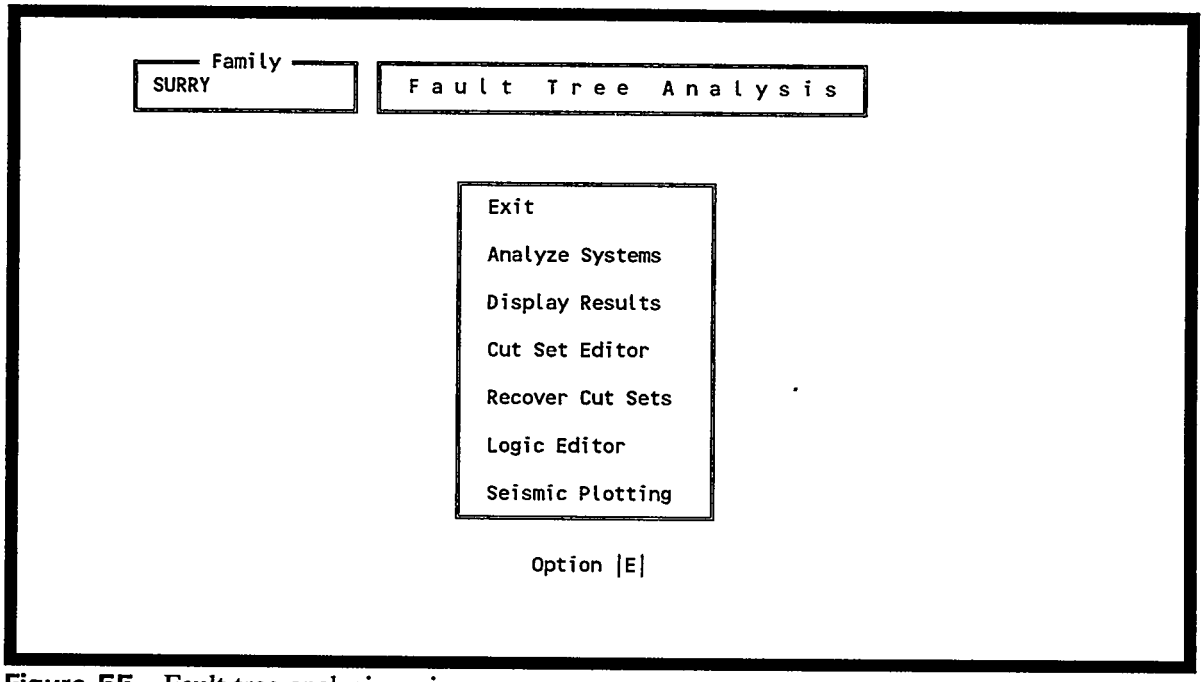


Figure 55. Fault tree analysis main menu.

6.2 Analyze Systems

This option provides the means to recalculate system values after events and/or cut sets have been modified. To invoke this option, highlight Analyze Systems or type <A> in the option field, and press <Enter>. A screen similar to the one shown in Figure 56 will appear. This screen lists the systems defined for the current family. The letters c, q, u, and + (in any combination) may precede a system name and are defined as follows:

c - flags the system as having cut sets that must be regenerated
q - flags the system as having cut sets that must be requantified
u - flags the system as needing uncertainty distributions recalculated
+ - flags systems with existing cut sets.

Once the corresponding function has been executed the corresponding letter is removed from the display. The options available from the Analyze Systems screen are Exit, Generate Cut Sets, Cut Set Update, Quantification, Prune Cut Sets, Uncertainty, Analysis Type, and Min Max Quantification.

IRRAS writes the summary information generated during analysis to a file that the user can read to determine the results of a batch operation involving several systems or sequences. This file is called "SCREEN.CPY." When either Analyze Systems or Analyze Sequences is executed, IRRAS deletes a file in the current family subdirectory called "SCREEN.OLD." The file "SCREEN.CPY" is then renamed to "SCREEN.OLD." The summary screens for any operations performed during this session (using the Analyze option) are then written to the file "SCREEN.CPY." The user may exit IRRAS, change to the specified subdirectory, and print, edit, or review this file.

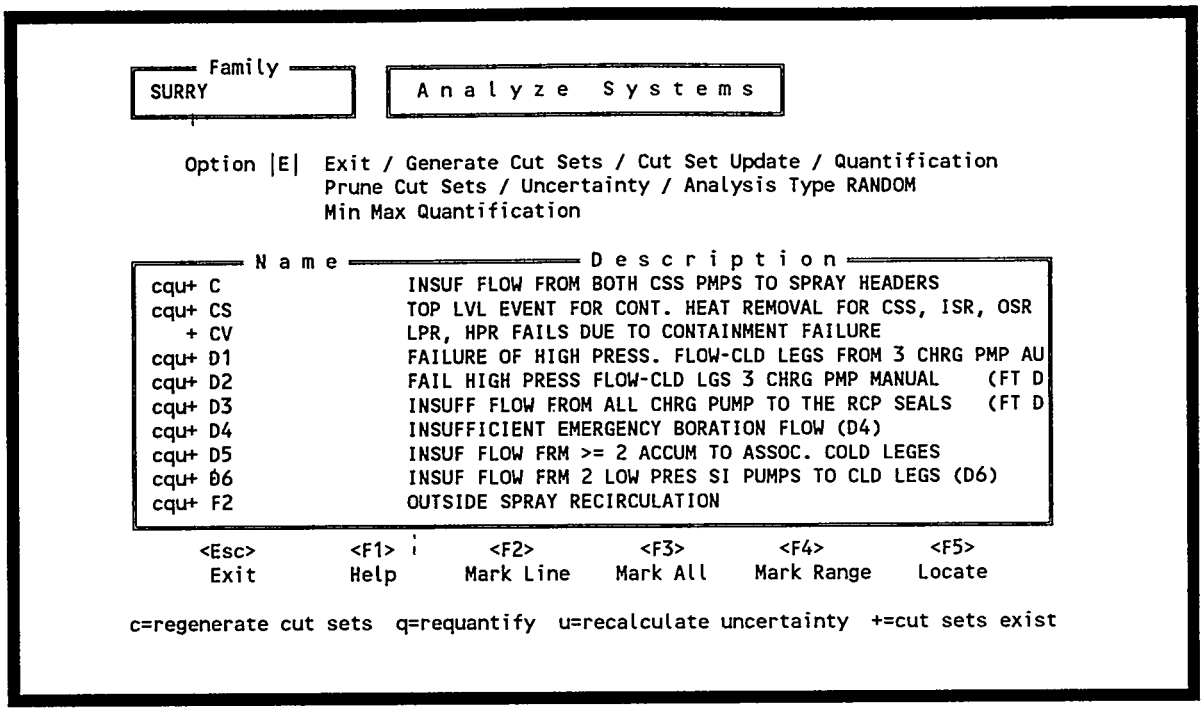


Figure 56. System analysis main menu.

IRRAS 5.0 allows the user to store multiple analysis types in the same family. For instance, the user can do a normal random analysis and then using the same database, do 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 IRRAS, there are eight reserved analysis types and eight user definable types. The first four reserved types are "Random," "Fire," "Flood," and "Seismic." The remaining four 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."

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.

6.2.1 Exit

To return to the Fault Tree Analysis menu, type an <E> (Exit) in option field and press <Enter>, or press the <Esc> key.

6.2.2 Generate Cut Sets

This option allows you to generate the cut sets for a selected system based on cut set generation cutoff values. You are given the opportunity to specify several cut set generation cutoff values that will be used to determine if a cut set is to be retained or discarded from the selected system.

You are given the ability to generate cut sets for a selected system, a group of systems, or all systems within the current family. To invoke the Generate Cut Sets option for a single selected system, type <G> (Generate Cut Sets) in the option field, highlight the desired system, and press <Enter>. To invoke this process for a group of systems, mark the desired systems using the function keys <F2>, <F3>, and <F4>, type a <G> in the option field, and press <Enter>. To invoke this option for all systems in the current family, clear all marked entries with the <F3> key, type <G> in the option field and press <Enter>. A message **Process all records? (Y/N)** will appear at the bottom of the screen. Type a <Y> to continue the Generate Cut Sets for all records that need processing or type an <N> to terminate the update for all systems.

Whether you are generating cut sets for a single system, a group of systems, or for all systems the Cut Set Generation Cutoff Values screen shown in Figure 57 will be displayed. You may change any of the data fields on this screen. Each field is described below. The default values that appear on this screen may be reset to new values by selecting the Utility Options from the IRRAS main menu and then invoking the Define Constants option.

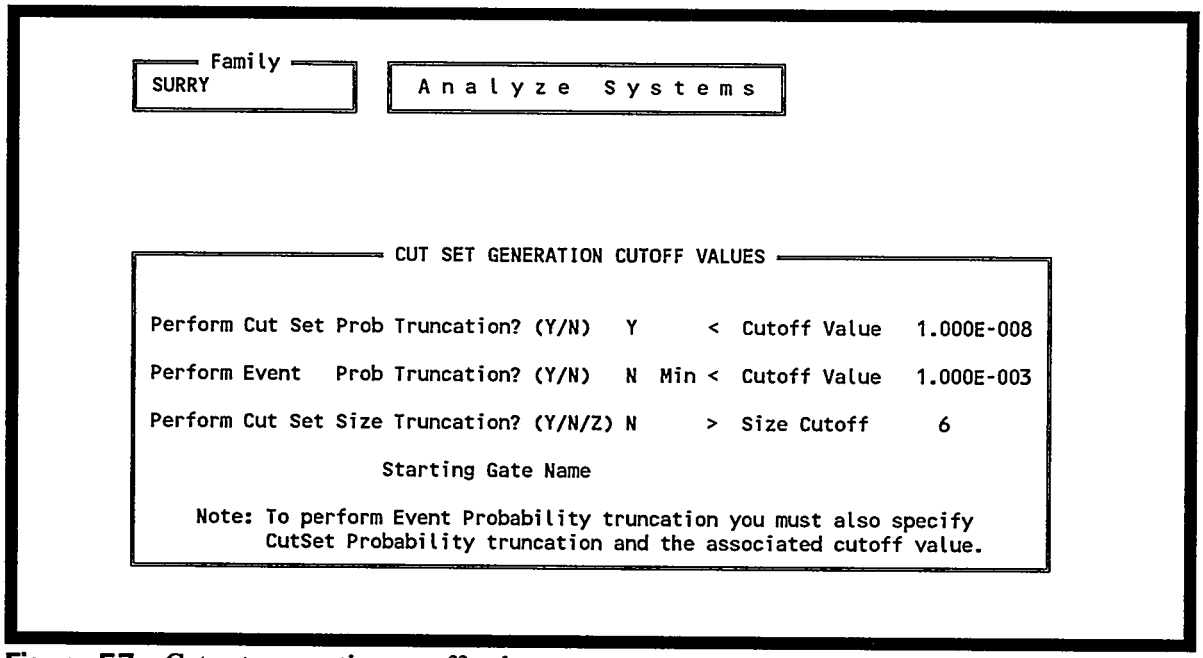


Figure 57. Cut set generation cutoff values.

Perform Cut Set Prob Truncation? - If you enter a <Y>, then 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.

All other cut sets will be removed.

If you enter an <N>, then the probability for the cut set will be irrelevant for determining if the cut set should be retained or discarded.

Perform Event Prob Truncation? - If you enter a <Y>, then you must also enter <Y> for "Perform Cut Set Prob Truncation." 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.

Perform Cut Set Size Truncation? - If you enter a <Y>, then only the cut sets whose number of events is less than or equal to the value specified in the Size Cutoff field will be kept in the cut sets for that system. All other cut sets will be removed.

If you enter an <N>, then the number of events in a cut set will be irrelevant for determining if the cut set should be retained or discarded.

If you enter a <Z>, then only zone flagged events will be checked (see Section 4.5.2).

Starting Gate Name - If you specify a gate in this field, then this gate will be the gate assumed to be the top gate of the tree. If you do not specify a name, the top gate will be determined by finding the gate that is not referenced by any other gate. This is usually the same as the system or subsystem name.

During processing the screen shown in Figure 58 is displayed and updated as the calculations proceed. Upon completion of the cut set generation, the results are displayed as shown in Figure 59.

There is no limit on the number of cut sets that can be stored for a given system. The screen showing the summary information for all generated cut sets is displayed. When complete, you are returned to Figure 58 where the "c" in front of the processed cut sets will be removed. (NOTE: If you entered a Y at the Perform Event Prob Truncation prompt, IRRAS will also perform the quantification. Therefore, the "q" will also be removed.)

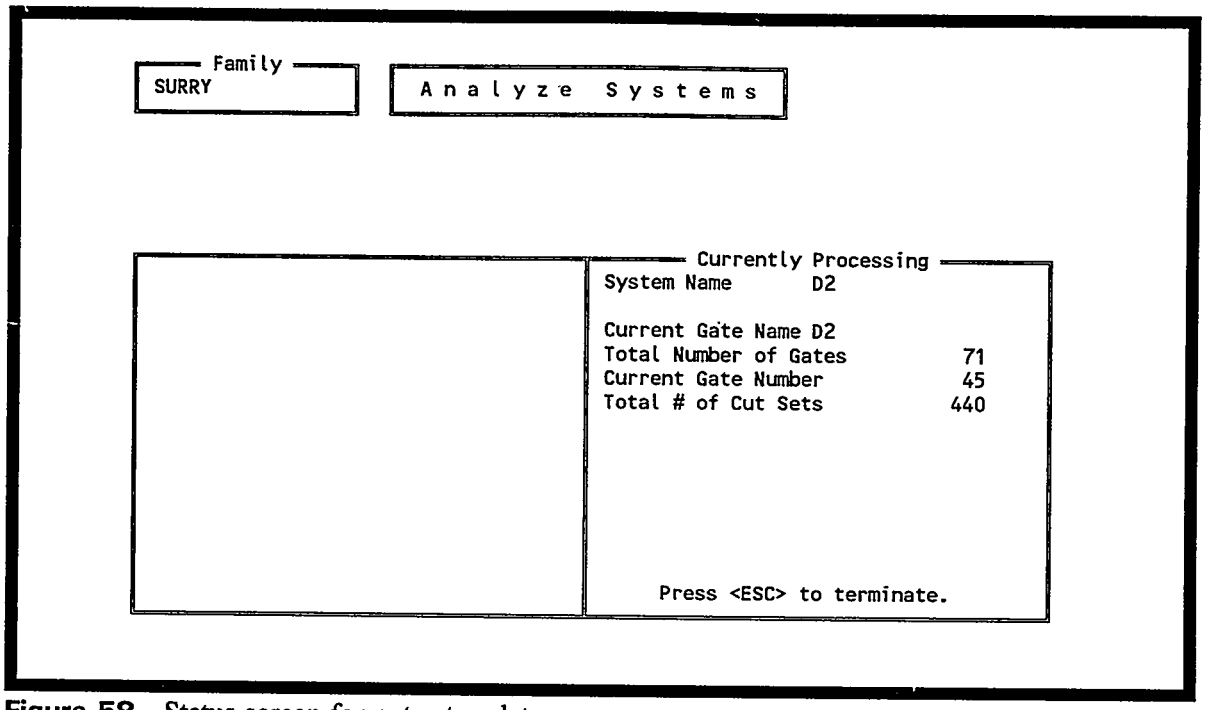


Figure 58. Status screen for cut set update.

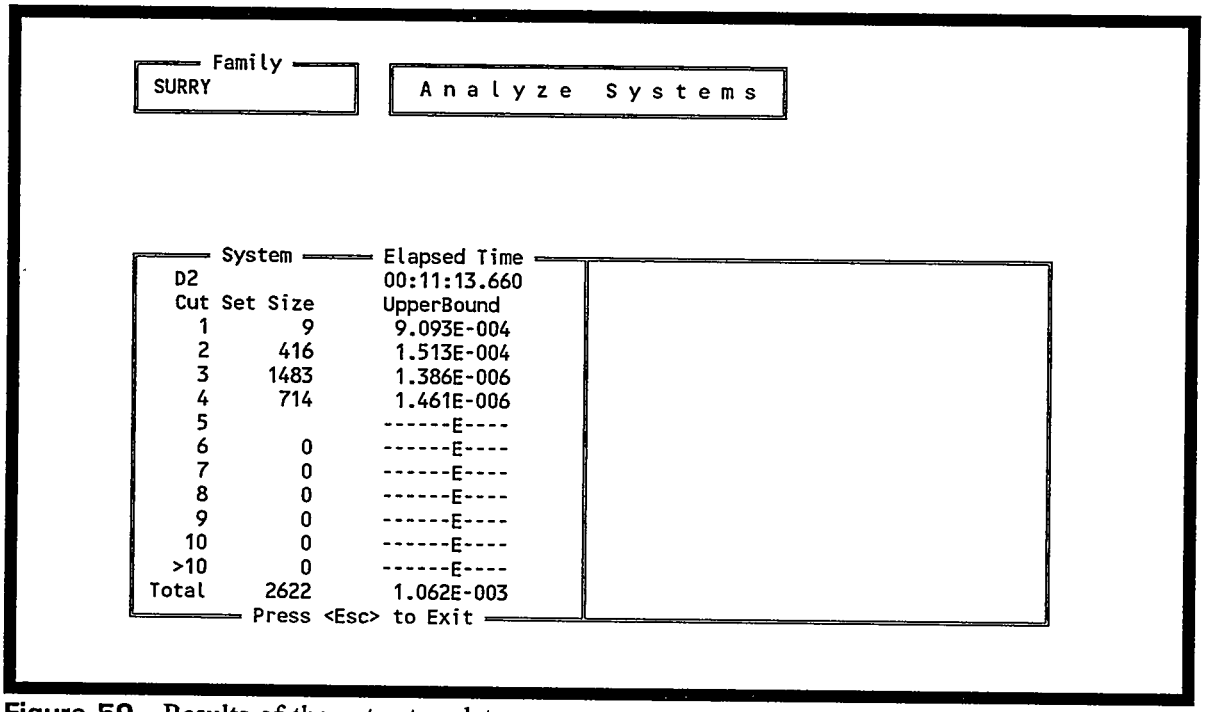


Figure 59. Results of the cut set update.

6.2.3 Cut Set Update

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

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

Whether you are updating alternate cut sets for a single system, a group of systems, or for all systems the Cut Set Generation Cutoff Values screen shown in Figure 60 will be displayed. You may change any of the data fields on this screen. The default values that appear on this screen may be reset to new values by selecting Utility Options on the IRRAS main menu and then invoking the Define Constants option.

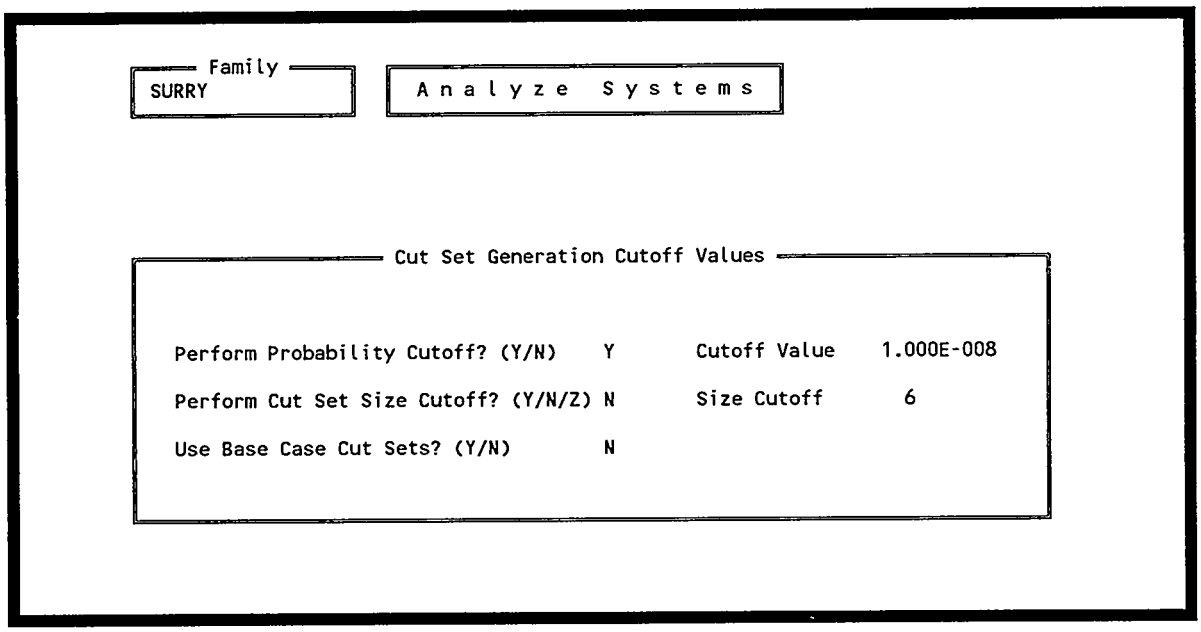


Figure 60. Cut set generation cutoff values.

If you type a <Y> in the Perform Probability Cutoff field, then only the cut sets whose product for all of its event probabilities is greater than or equal to the value in the Cutoff Value field will be kept.

All other cut sets will be removed from alternate case cut sets for that system. If you type an <N> in this field, then the probability for the cut set will not be relevant for determining if the cut set should be retained or discarded.

If you type a <Y> in the Perform Cut Set Size Cutoff field, then only the cut sets whose number of events is less than or equal to the value in the Size Cutoff field will be kept in the alternate case cut sets for that system. All other cut sets will be removed. If you type an <N> in this field, then the number of events in a cut set will be irrelevant for determining if the cut set should be retained or discarded. If you type a <Z>, then only zone flagged events will be checked (see Section 4.5.2).

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

During processing the screen shown in Figure 61 is displayed and updated as the calculations proceed. Upon completion of the cut set update, the results are displayed as shown in Figure 59. When finished viewing the results, press <Enter> to return to Figure 56.

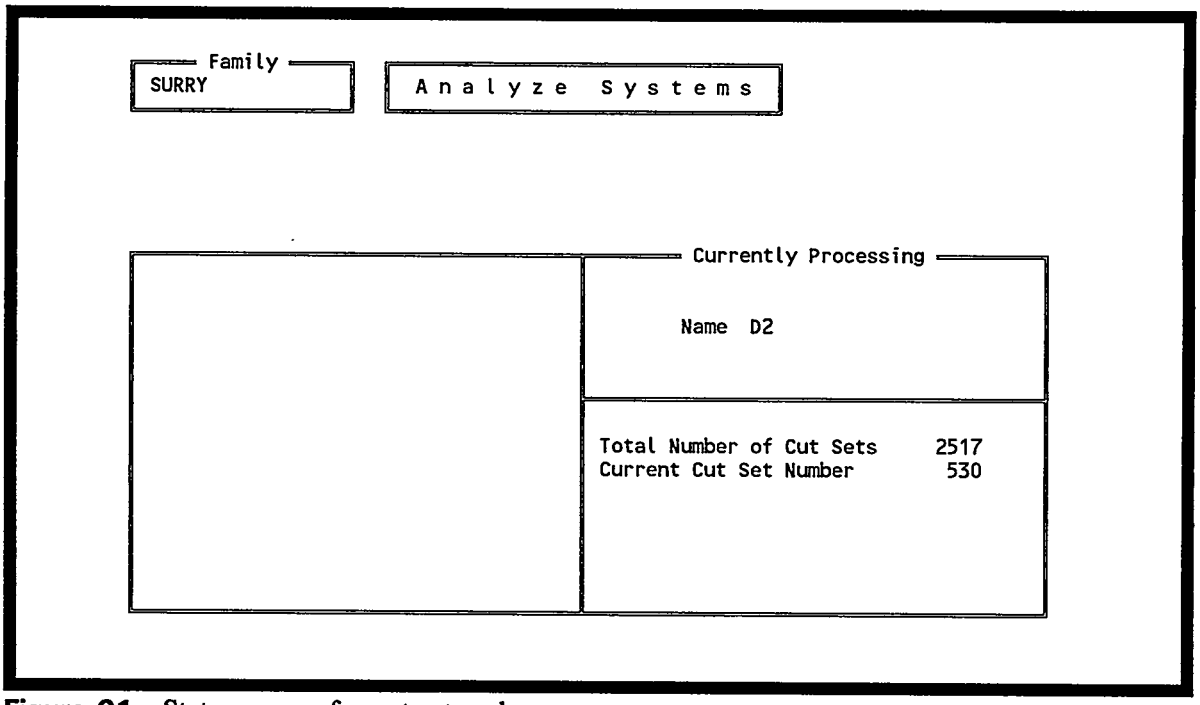


Figure 61. Status screen for cut set update.

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

6.2.4 Quantification

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

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

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

Upon completion of the quantification process, the results are displayed as shown in Figure 62. The requantify flag 'q' will then be removed from every system on the Analyze Systems screen for which the quantification process has been performed.

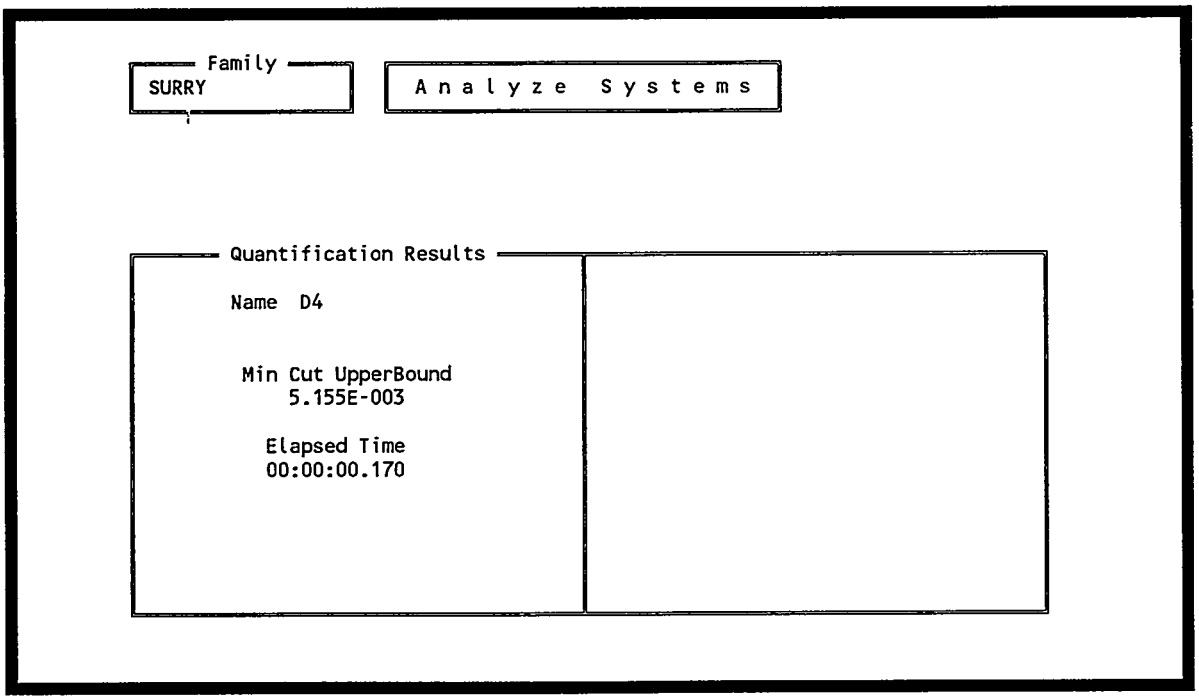


Figure 62. Results of the quantification process.

6.2.5 Prune Cut Sets

This option allows you to eliminate cut sets from a selected system that contains events that conflict in some way with one another. This may be useful in location analysis or in eliminating technical specification violations. To use this option, you must first define and generate cut sets for a "pruning" fault tree. The cut sets of this tree define the basis for accepting or rejecting each cut set for the selected system. Events in the pruning logic indicate incompatibility with all other events in the logic except those that are ANDed together. For example, the fault tree

AND A B
OR C

will remove all cut sets from the pruned system where A and C, or B and C appear together, but keep any cut sets containing A and B.

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

Whether you are pruning cut sets for a selected system, a group of systems, or all of the systems within the current family the window shown in Figure 63 will appear. In this window, you must enter the name of the system whose cut sets form the acceptance basis for the pruning process. Enter the system name and press <Enter>. When the pruning process is complete, the results are displayed on a screen similar to the one shown in Figure 59.

6.2.6 Uncertainty Analysis

This option allows you to run an uncertainty analysis on a system using one of the two sampling techniques provided. The two sampling techniques are the Monte Carlo simulation technique and the Latin Hypercube simulation technique. In addition, you may perform a seismic or normal uncertainty. In a normal uncertainty analysis, IRRAS 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, IRRAS performs the analysis at each G-level in the site hazard curve for the current family. The seismic events are sampled at each new G-level and a quantification performed.

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

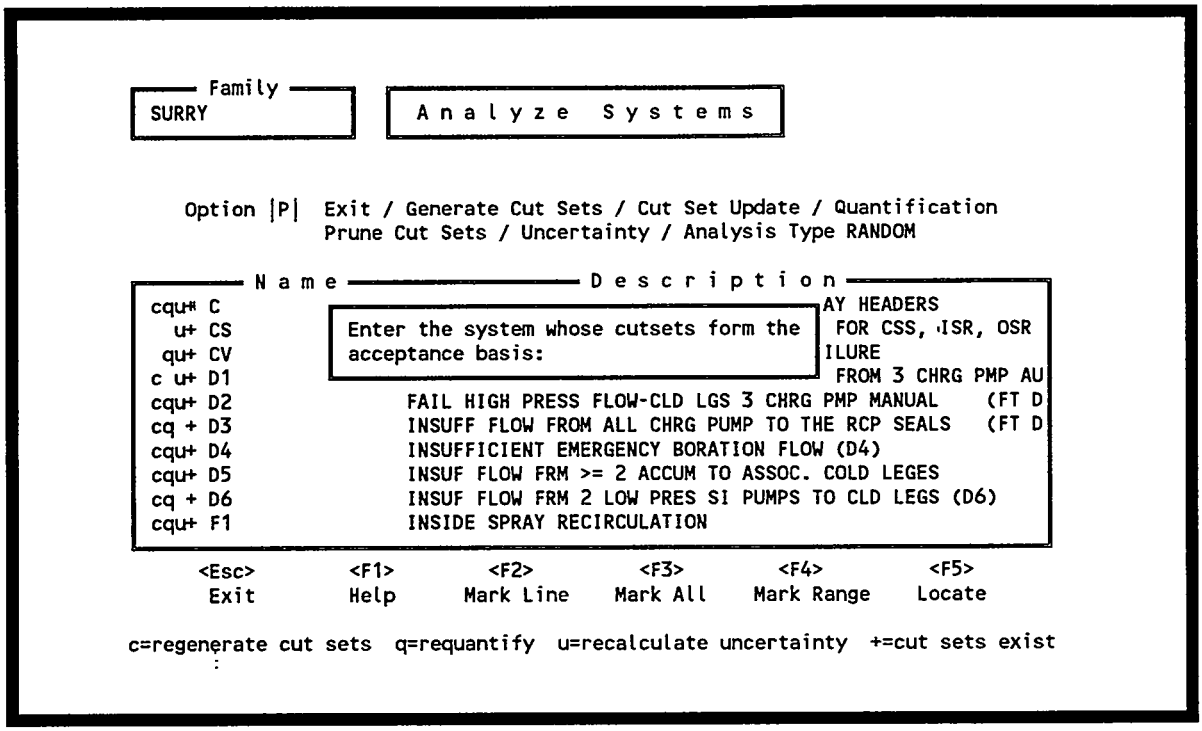


Figure 63. Acceptance basis for pruning.

<Y> to continue the uncertainty analysis for all of the systems, or type an <N> to discontinue the analysis.

Whether you are running the uncertainty analysis for a single system, a group of systems, or for all systems in the current family the Uncertainty Calculation Values screen shown in Figure 64 is displayed. On this screen, you must supply the following information:

Latin Hypercube/Monte Carlo - To use the Monte Carlo sampling technique to obtain an uncertainty, enter an <M>. However, if you wish to use the Latin Hypercube sampling technique, type an <L> into the field.

Number of Samples to use in simulation - A default value is provided for the number of samples. You may use this value or enter another value. You may change the default values for both the number of samples and the random seed in the Utility Options, Define Constants suboption.

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.

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.

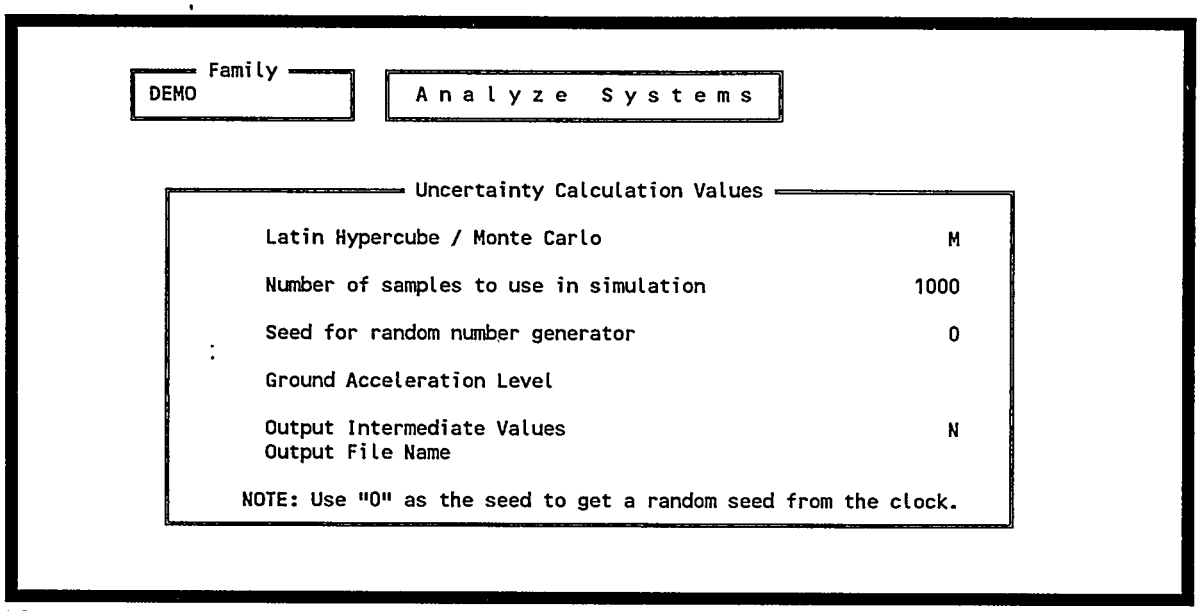


Figure 64. Uncertainty calculation values.

Output Intermediate Values - In this field, the user can indicate whether or not the output of the results and intermediate samples should be written to an ASCII file. The format used for this ASCII file, as well as a sample of the output, are shown in Tables 1 and 2, respectively.

Output File Name - In this field, the user specifies the name of the ASCII file where the intermediate values will be stored.

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

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

Table 1. Format for ASCII file containing intermediate samples.

```
$ Anything after a "$" is a comment.
 $ In this description, there are n variables and the LHS sample size is m.
 $
 $         The first block contains point estimates for each variable.  The point estimate
 $         could be a mean, median, or other value.
 $
           Variable 1              [Point Estimate for Variable 1]
           Variable 2              [Point Estimate for Variable 2]
              .
              .
              .
           Variable n              [Point Estimate for Variable n]
 $
 @UNCERTAINTY
      @OBSERVATIONS                [m]
      @VARIABLES                   [n]
 $
 $ Note a colon follows each variable name
 $
                  Variable 1:
                  Variable 2:
                     .
                     .
                     .
                  Variable n:
 @SAMPLEDATA
 $
 $ This portion of the file is the same as the "old" LHS output format
 $
 [Observation Number, 1] [Number of Variables, n]            Value for variable 1 for obser. 1]
 [Value for variable 2, for observation 1]...    [Value for variable n for obervation 1]
                        .
                        .
                        .
 [Observation Number, m] [Number of Variables, n]            Value for variable 1 for obser. m]
 [Value for variable 2, for observation m]...    [Value for variable n for obervation m]
```

Table 2. Sample of intermediate results.

```
$ In this example there are 7 variables and a LHS sample size of 4 was used.  The point
$ estimates are based on the mean of the distribution
$
          PDSG1 3.09E-04
          PDSG2 2.37E-06
          SF1   0.495
          SF2   0.505
          SF3   0.1475
          SF4   0.2625
          SF5   0.59
$
@UNCERTAINTY
     @OBSERVATIONS                4
     @VARIABLES                   7

          PDS1:
          PDS2:
          SF1:
          SF2:
          SF3:
          SF4:
          SF5:

@SAMPLEDATA
     1    7    3.06E-5        4.02E-6        0.45   0.55   0.10   0.30   0.60
     2    7    4.12E-4        4.66E-6        0.65   0.35   0.15   0.25   0.60
     3    7    5.55E-6        4.56E-7        0.34   0.66   0.13   0.17   0.70
     4    7    7.89E-4        3.56E-7        0.54   0.46   0.21   0.33   0.46
```

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

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

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

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

During processing the current status screen will be displayed and updated as the samples are generated. Figure 65 illustrates the current status screen for the Monte Carlo sampling technique. When

the requested number of samples has been generated or the user has terminated the process of generating the samples by pressing the <Esc> key, statistical information will be calculated using the generated samples. A sample mean, median, and standard deviation will be calculated for the selected system. Coefficients of skewness and kurtosis, and quantile values will also be calculated for the system. This data will be saved in the database for the selected system.

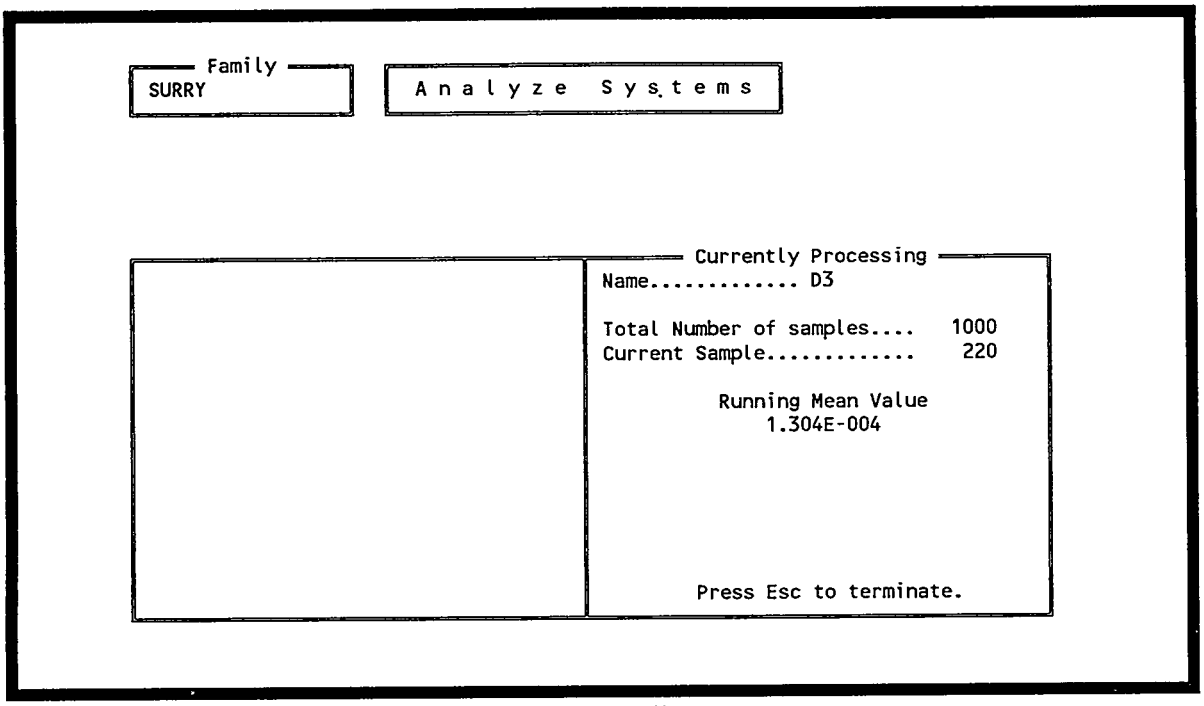


Figure 65. Current status of the Monte Carlo sampling.

If the user has selected to perform a seismic analysis, then a G-level was also selected. This option allows the user to specify how IRRAS performs the analysis. If the user selects to do "ALL COMBINED", then IRRAS performs an uncertainty analysis on all G-levels defined in the site hazard curve for this family. The combined results are then stored in the database. If the user selects "ALL SEPARATE", then IRRAS performs an uncertainty analysis on all G-levels, but does the analysis and stores the results separately for each G-level. If the user selects a specific G-level, then IRRAS only performs then analysis for that specified G-level.

Upon completion of these calculations, the following values will be displayed on the Uncertainty Results screen for viewing: the system name, random seed used, the number of samples generated in this process, the total number of events and cut sets in the system being processed, the point estimate, the mean, the median, the 5th and 95th percentile values, the minimum and maximum generated sample values, the standard deviation, the skewness and kurtosis, and the time involved to perform the analysis. Figure 66 illustrates the Uncertainty Results screens for the Monte Carlo sampling techniques, respectively.

If only one system was selected (highlighted) for the uncertainty analysis process, then you will need to press <Enter> to return to the Analyze Systems screen from the Uncertainty Results screen.

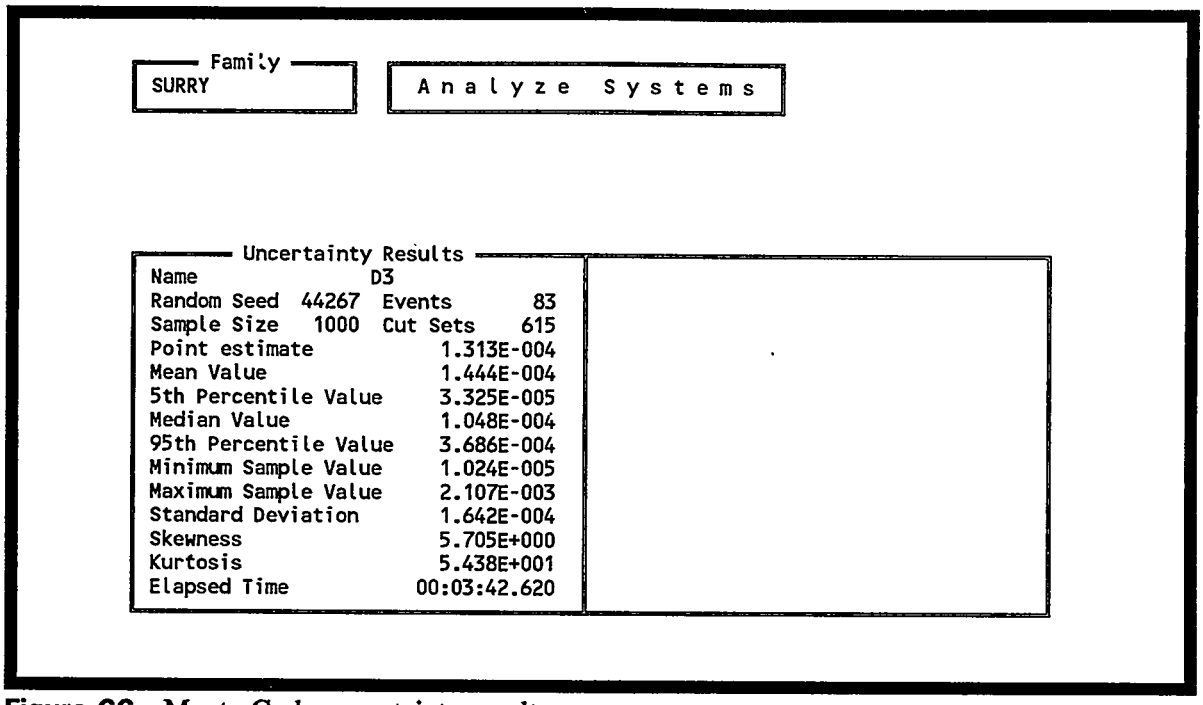


Figure 66. Monte Carlo uncertainty results.

However, if more than one system is being processed, the Uncertainty Results screen will be displayed for each system, and when all of the selected systems have been processed, you will automatically be returned to the Analyze Systems screen. The uncertainty flag "u" will be removed from every system on the Analyze System screen for which the uncertainty analysis has been performed.

6.2.7 Analysis Type

In earlier versions, IRRAS performed random analysis only. In version 5.0, IRRAS offers four additional predefined analysis types and eight user-defined analysis types.

> **NOTE: You must select the analysis type before performing any calculations or analysis. RANDOM is the default type; however, this can be changed by invoking the Define Constants option in the Utility module (see Section 12.2).**

This option allows you to indicate the type of analysis you wish to perform on the selected system. To invoke this option, type an <A> in the option field and press <Enter>. A screen similar to the one shown in Figure 67 will appear. Scroll through the list until the desired type is highlighted. Press <Enter>. You will be returned to the previous screen where the selected type will be displayed in the field provided next to the Analysis Type option. The following analysis types are available:

RANDOM - Random Failure. No external events are considered.

FIRE - Fire Analysis. External events relating to fire are considered.

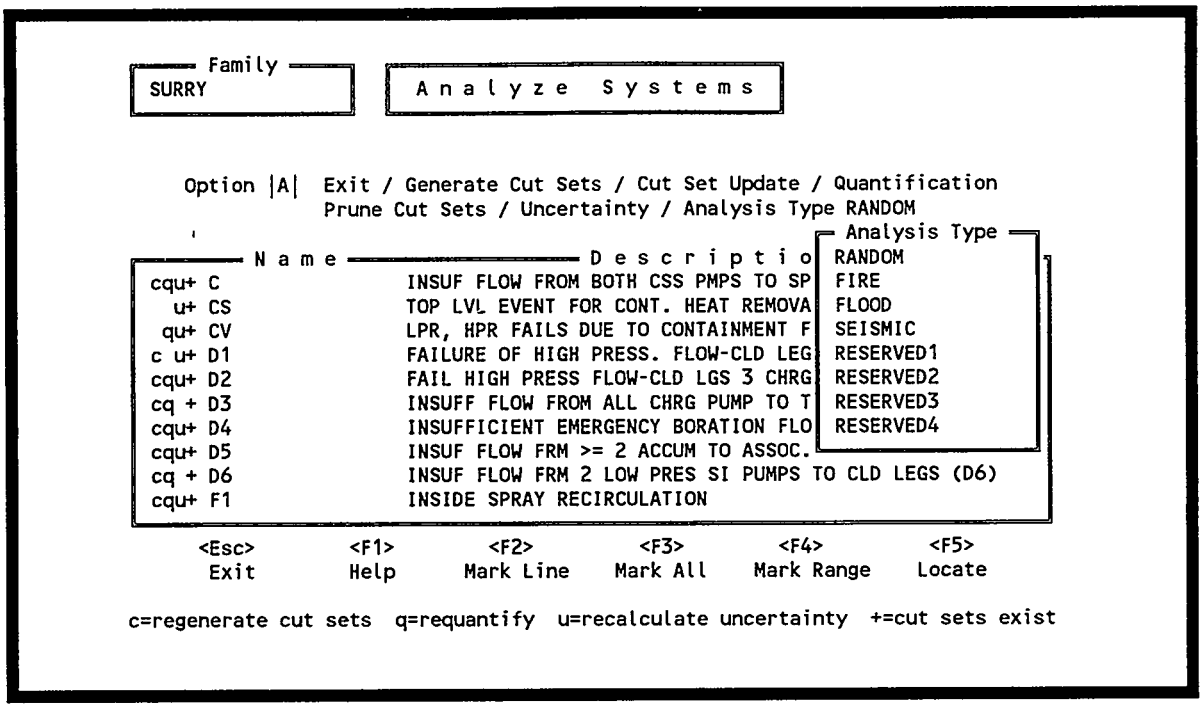


Figure 67. Analysis type selection window.

FLOOD - Flood Analysis. External events relating to flood are considered.

SEISMIC - Earthquakes or Other Ground Disturbances. External events relating to earthquakes or other ground disturbances are considered.

RESERVED (1-4) - Reserved for future external events.

USER (1-8) - User-defined Types. Reserved for special cases of external/internal events.

6.2.8 Min Max Quantification

The Min-Max quantification option performs the exact quantification algorithm for probabilities. 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 invoke this option, Figure 68 will appear. On this screen, type a number from 1 to 10 to indicate the number of passes you want IRRAS to make. The higher the number, the more the calculation speed decreases and the accuracy increases.

Upon entering the number of passes, press <Enter> to continue. IRRAS will perform the specified number of passes and when complete will show the results on the quantification results screen (see Figure 62).

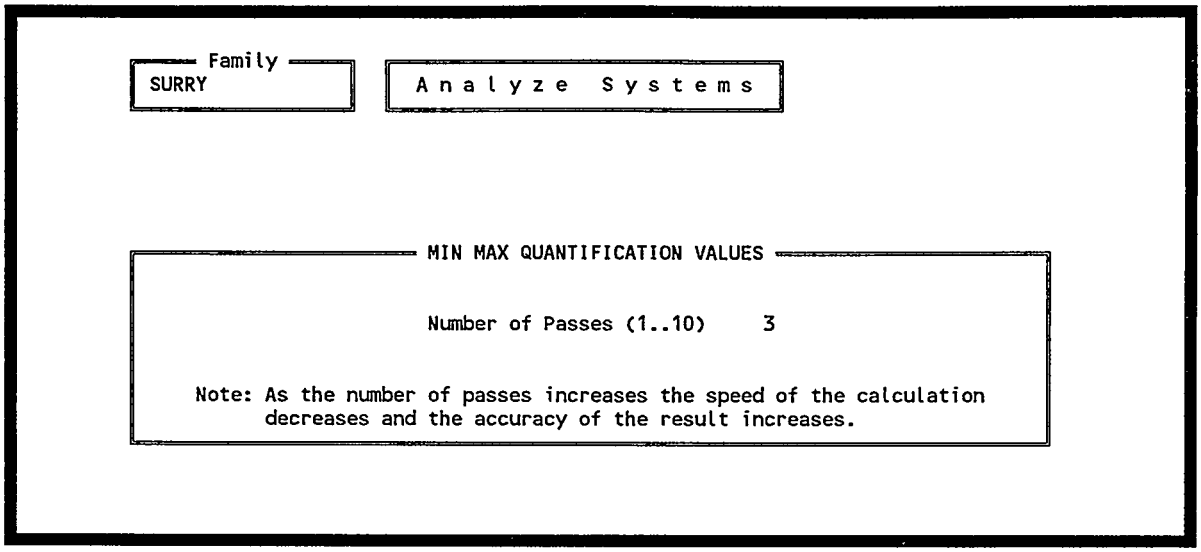


Figure 68. Set the number of passes for quantification.

6.3 Display Results

To display the results of your system analysis, highlight Display Results or type <D> on the Fault Tree Analysis screen and press <Enter>. The Display System Results screen will be displayed showing a list of the systems contained in the database (Figure 69). The following options are available: Exit, Cut Sets, Importance, Uncertainty, and Analysis Type.

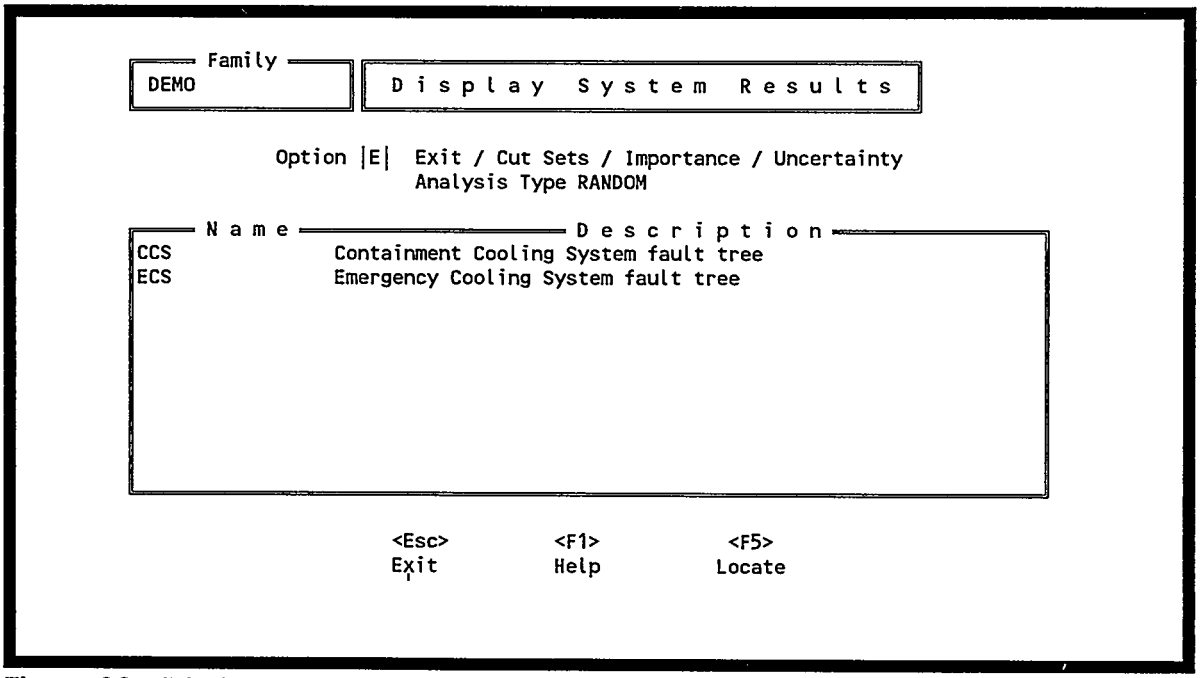


Figure 69. Display system results screen.

6.3.1 Exit

This option terminates the process and returns to the Fault Tree Analysis screen (Figure 55). To invoke the option, type <E> in the option field and press <Enter>, or press the <Esc> key.

6.3.2 Cut Sets

To invoke this option, enter a <C> in the option field, highlight the desired system, and press <Enter>. This option displays the system's cut sets (Figure 70), their percent of contribution to the system, the frequency, and the event names that make up the cut sets. The system minimum upper bound, the number of cut sets that make up the system, the current partition upper bound, the percentage that the partition contributes to the system, and the number of cut sets in the partition are displayed at the bottom of the screen. In addition, five suboptions are available. Each option is discussed in the following paragraphs.

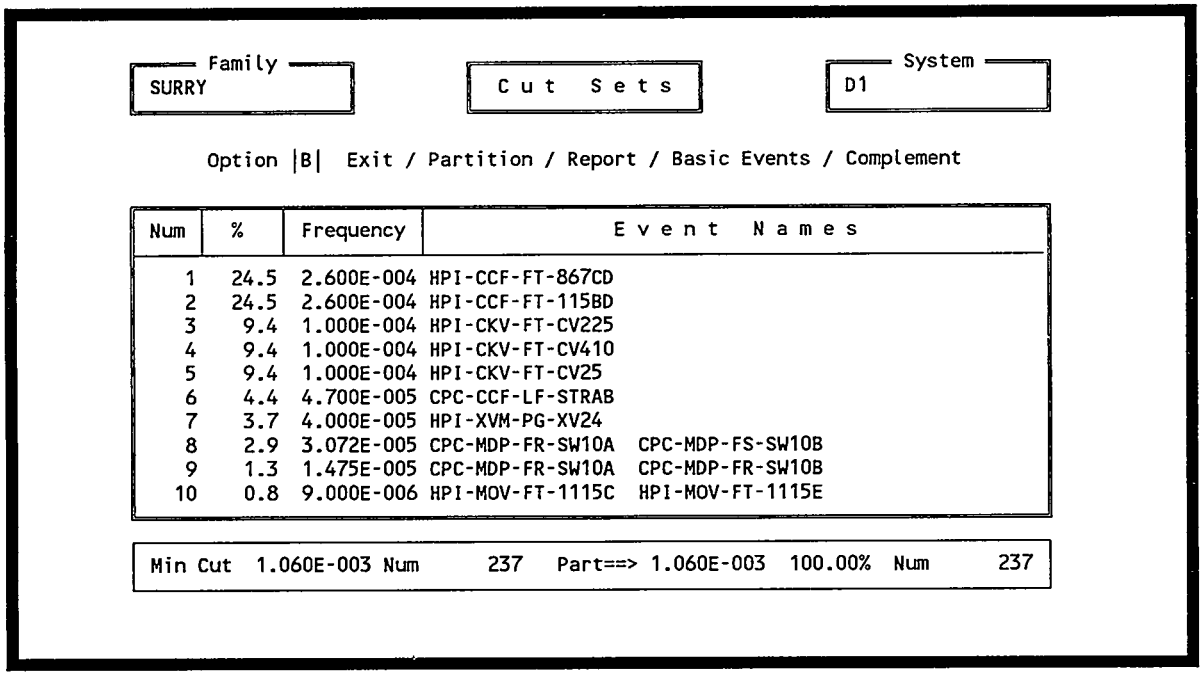


Figure 70. Cut sets display.

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

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

To invoke this option, type a <P>. This will bring up the screen shown in Figure 71.

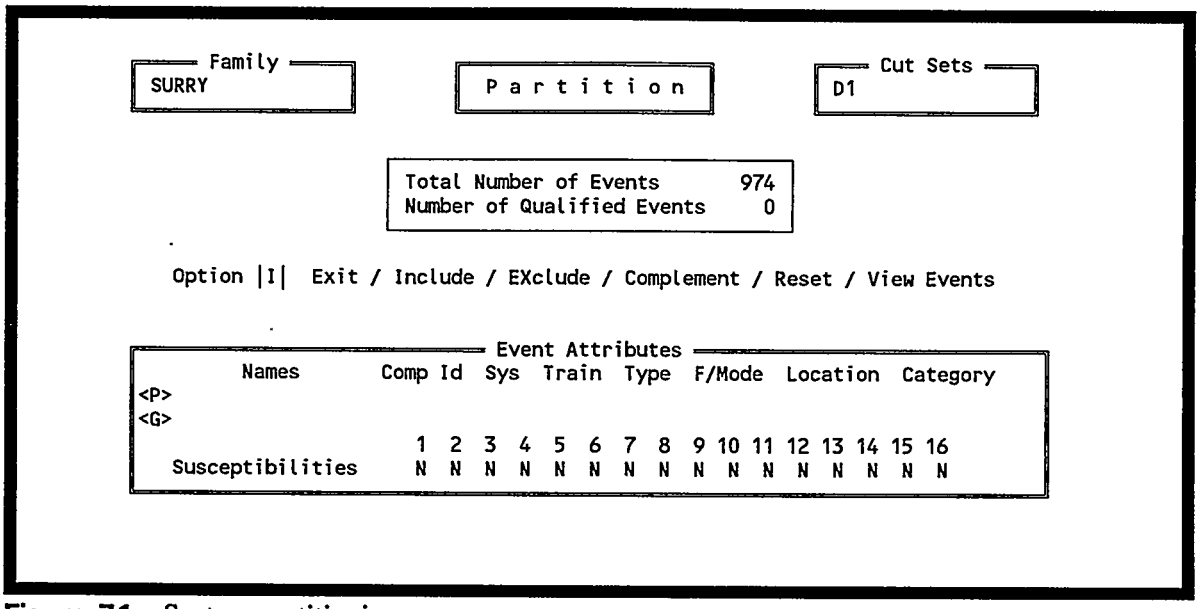


Figure 71. System partitioning menu.

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

Include: To establish a partition via this option, type <I> in the option field, then fill in the entry fields that are to be used to qualify the events that may be used in the new partition and press <Enter>. The application proceeds to qualify the events and when complete will update the Number of Qualified Events field that appears at the top of the screen. In this case, qualified events are those events that contain the included attributes. Returning to the Cut Sets screen via the Exit option, you will see that the system cut set list contains only those cut sets that are made up of qualified events. Figure 72 was the result of specifying the event name "HPI*" for the "Include" option. If the system cut sets do not contain any of the qualified events, then the message **No cut sets qualify** is displayed at the bottom of the screen.

EXclude: To establish a partition via this option, type <X> in the option field, then fill in the entry fields on the screen that are to be used to remove events from the list of qualified events. The application proceeds to remove the events. When complete, the Number of Qualified Events field that appears at the top of the screen will be updated accordingly. Returning to the Cut Sets screen via the Exit option you will see that the system cut set list contains only those cut sets that are made up of qualified events. Figure 73 was the result of specifying the event name "HPI-CKV-FT-CV410" for the "EXclude" option. If the system cut sets do not contain any of the qualified events, then the message **No cut sets qualify** is displayed at the bottom of the screen.

Complement: To establish a partition via this option, type <C> in the option field, and press <Enter>. This causes all currently qualified events to be disqualified, and all

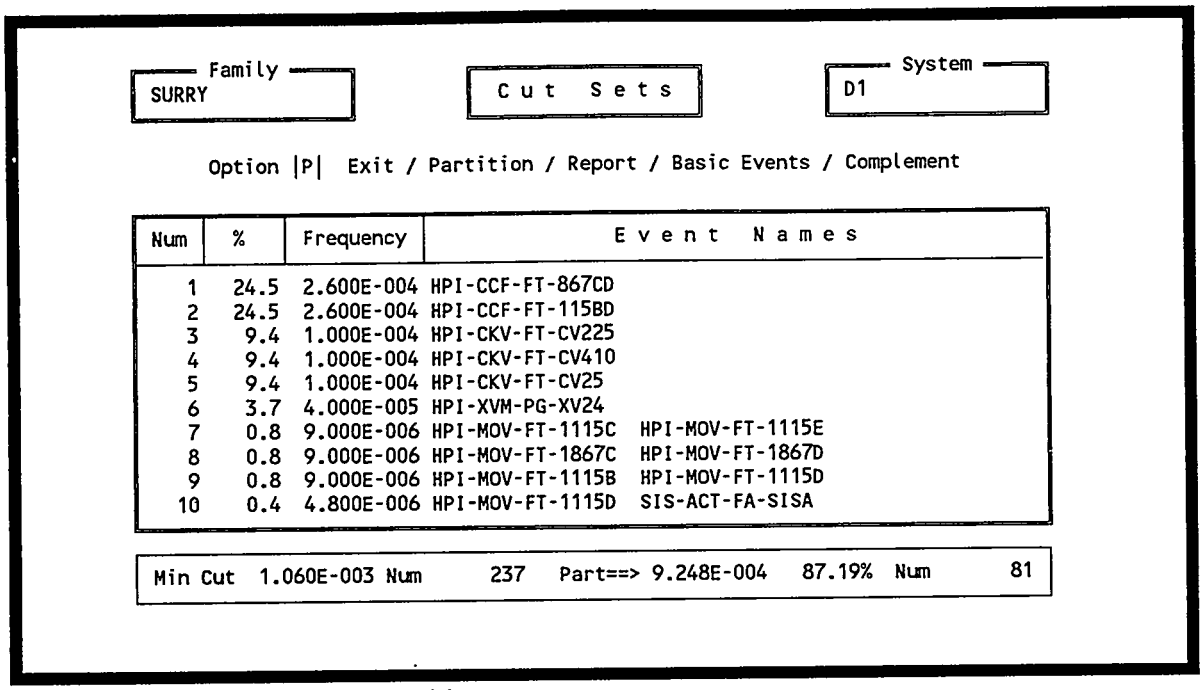


Figure 72. Using Include to partition a system.

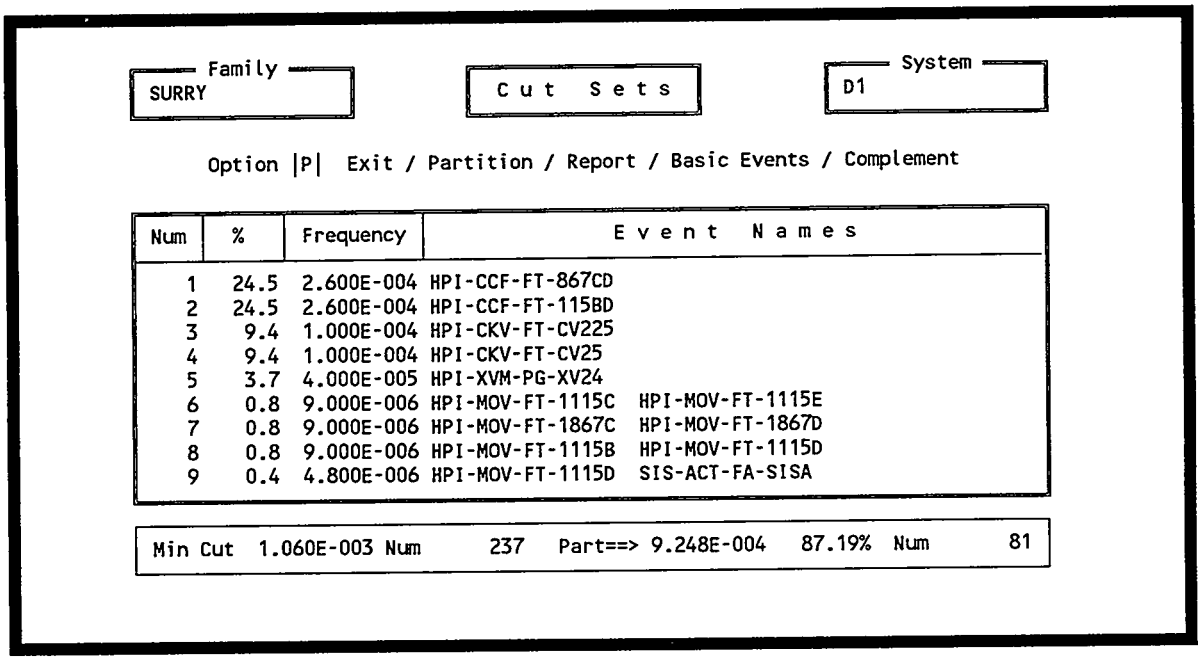


Figure 73. Using EXclude to partition a system.

unqualified events to become the set of qualified events. The Number of Qualified Events field at the top of the screen will change accordingly. Returning to the Cut Sets screen via the Exit option you will see that the system cut set list contains only those cut sets that are made up of qualified events. If the system cut sets do not contain any of the qualified events then the message **No Cut Sets Qualify** is displayed at the bottom of the screen.

Reset: This option sets all events in the database to qualified. This, of course, removes all partitioning from the current system cut sets. To activate this option, type <R> in the option field and press <Enter>. (Assume the partition shown in Figure 72). The original cut set list is the result, as shown in Figure 70.

View Events: This option displays the list of family events and allows you to mark those events that are to be considered qualified events (Figure 74). To activate this option, type <V> in the option field and press <Enter>. Using <F2>, <F3>, or <F4> keys, mark the events that are considered qualified and press <Enter>. You will be returned to the Partition screen where the number of qualified events will be updated accordingly (Figure 75). If the system cut sets do not contain any of the qualified events, then the message **No cut sets qualify** is displayed at the bottom of the screen.

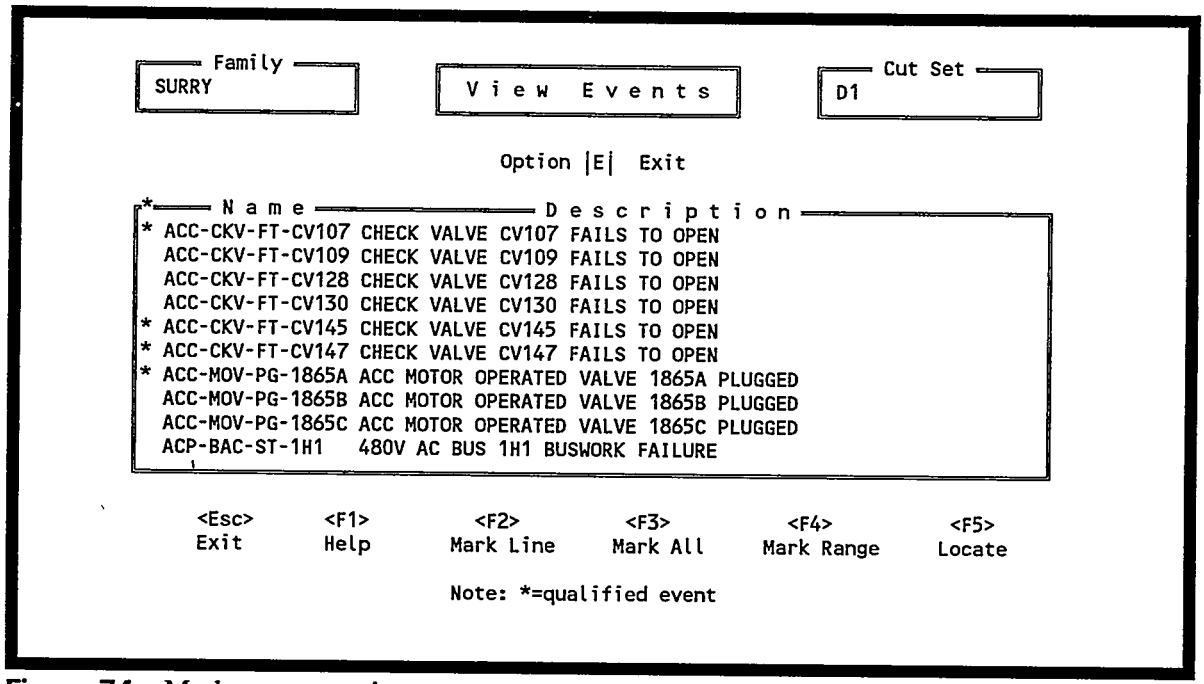


Figure 74. Mark events to view.

6.3.2.3 Report. The Report option allows you to generate a report of the data that is displayed on the screen. The report may be displayed on the console, sent to an attached printer, or saved to a file for later processing (Figure 76). To invoke this option, type <R> in the option field, and press <Enter>. Upon pressing <Enter>, Figure 76 is displayed. This screen shows a default title and file name. You may change these defaults to meet your needs.

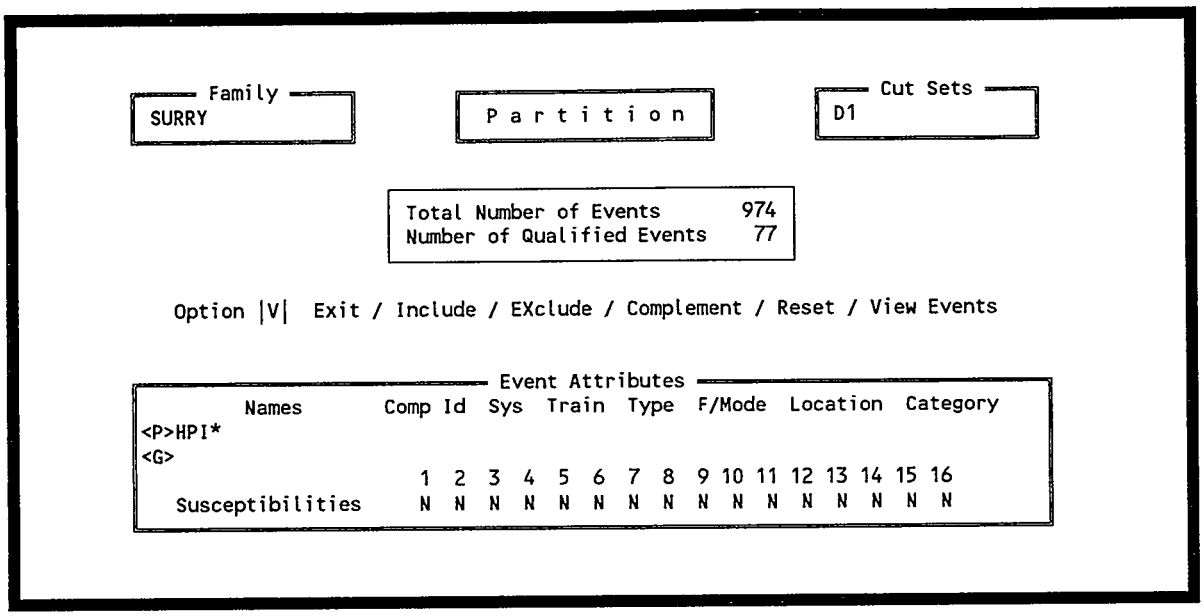


Figure 75. Results of marking events to view.

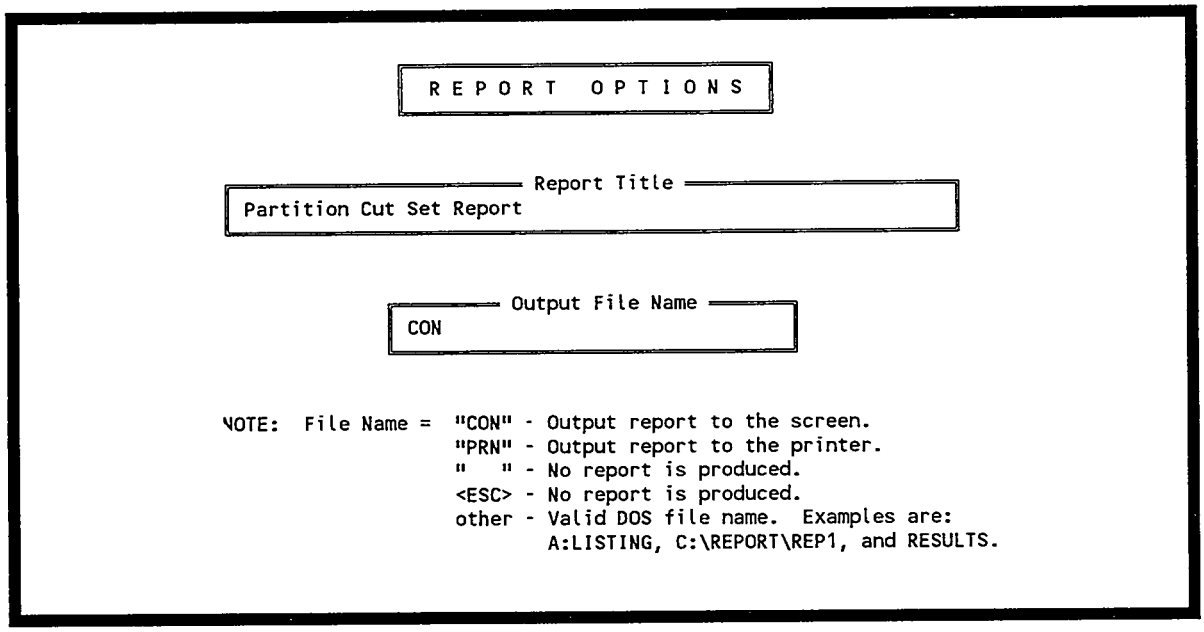


Figure 76. Partition report type selection.

6.3.2.4 Basic Events. The Basic Event option provides the following detailed information about the basic events that make up a cut set: event name, probability, component ID, system, component type, failure mode, and location (Figure 77). To invoke this option, type <B> in the option field, highlight a cut set, and press <Enter>.

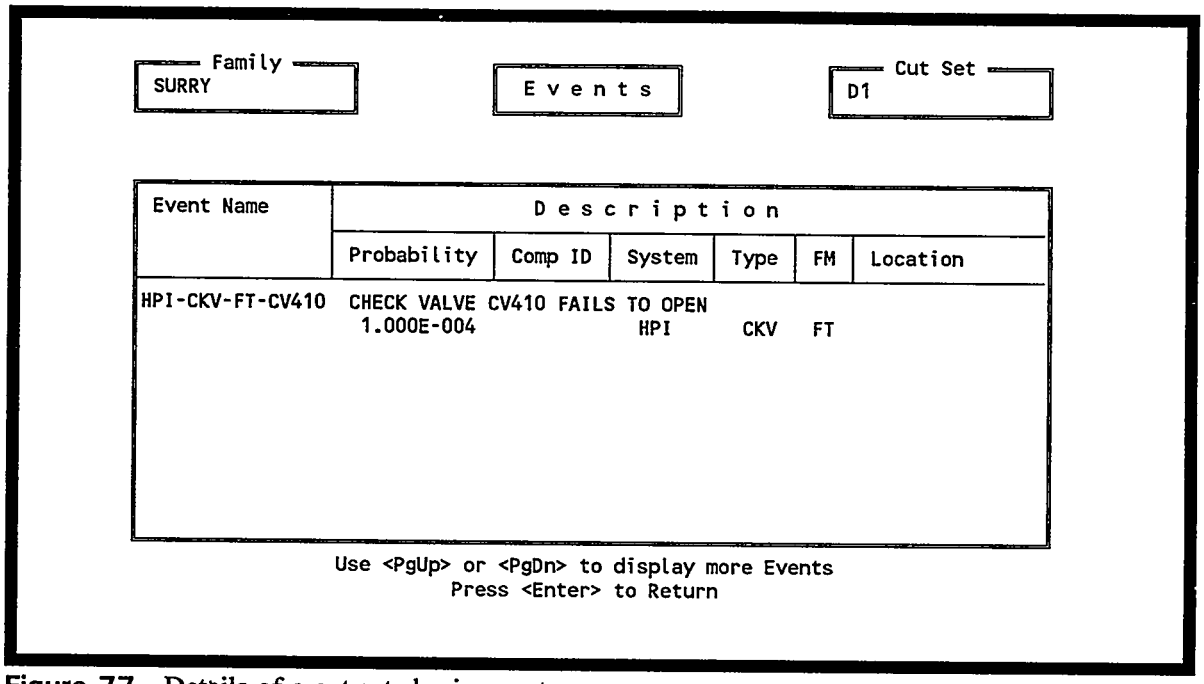


Figure 77. Details of a cut sets basic events.

6.3.2.5 Complement. The Complement option operates on the current system partition. Its function is to set all currently qualified cut sets to unqualified. This allows you to split a system into two partitions and then switch between the two partitions to view the results. To invoke this option, type <C> in the option field, and press <Enter>. (Assume the partition shown in Figure 72). The resulting display is shown in Figure 73.

6.3.3 Importance

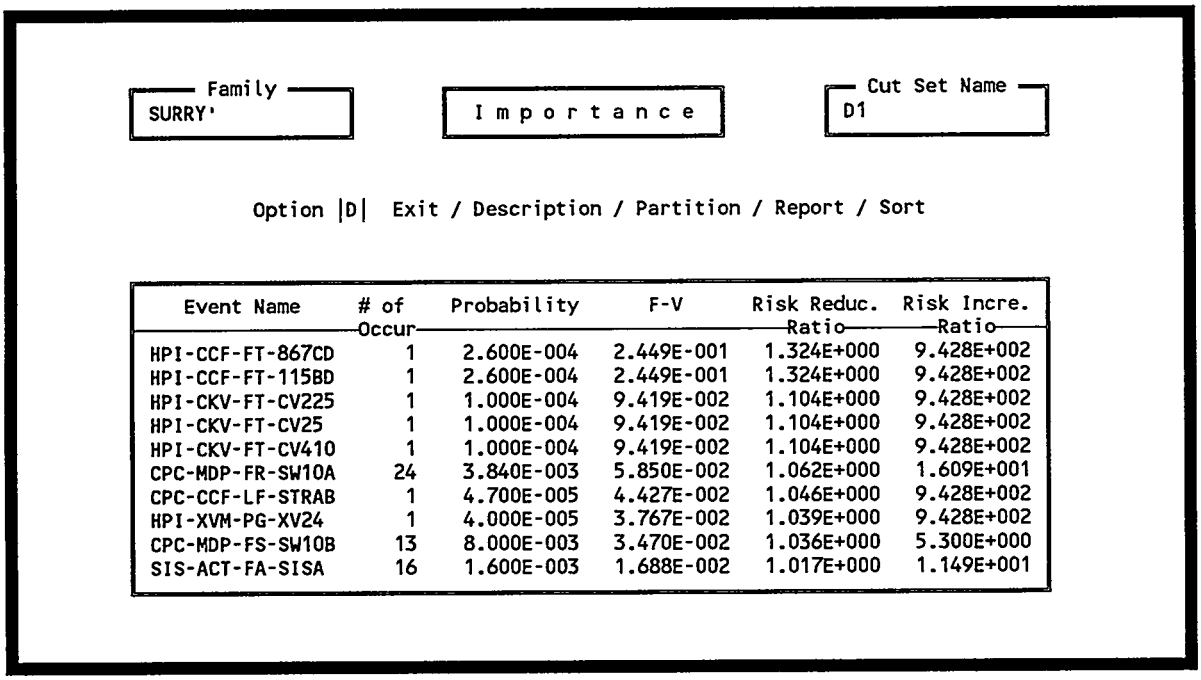
This option calculates and displays the following three importance measures for each event in the system:

- Fussell-Vesely importance - an indication of the percentage of the minimal cut set upper bound contributed by the cut sets containing the basic event.
- Risk Reduction Ratio - an indication of how much the minimal cut set upper bound would decrease if the basic event never occurred (typically if the corresponding component never failed).
- Risk Increase Ratio - an indication of how much the minimal cut set upper bound would

increase if the basic event always occurred (typically if the corresponding component always failed).

If the Intervals flag is set in the Constants Menu, the Birnbaum measure (the partial derivative), the Risk Reduction Interval, and the Risk Increase Interval will be displayed. If the analysis type is seismic, the system will prompt you to select a ground acceleration level defined in the family hazard curve.

To invoke this option, type <I> in the option field, highlight a system (or you may process all records by not specifying a system), and press <Enter>. By default, when the importance data are first displayed it is sorted, high to low, by Fussell-Vesely importance value (Figure 78).



Event Name	# of Occur	Probability	F-V	Risk Reduc. Ratio	Risk Incre. Ratio
HPI-CCF-FT-867CD	1	2.600E-004	2.449E-001	1.324E+000	9.428E+002
HPI-CCF-FT-115BD	1	2.600E-004	2.449E-001	1.324E+000	9.428E+002
HPI-CKV-FT-CV225	1	1.000E-004	9.419E-002	1.104E+000	9.428E+002
HPI-CKV-FT-CV25	1	1.000E-004	9.419E-002	1.104E+000	9.428E+002
HPI-CKV-FT-CV410	1	1.000E-004	9.419E-002	1.104E+000	9.428E+002
CPC-MDP-FR-SW10A	24	3.840E-003	5.850E-002	1.062E+000	1.609E+001
CPC-CCF-LF-STRAB	1	4.700E-005	4.427E-002	1.046E+000	9.428E+002
HPI-XVM-PG-XV24	1	4.000E-005	3.767E-002	1.039E+000	9.428E+002
CPC-MDP-FS-SW10B	13	8.000E-003	3.470E-002	1.036E+000	5.300E+000
SIS-ACT-FA-SISA	16	1.600E-003	1.688E-002	1.017E+000	1.149E+001

Figure 78. Initial display of importance measures.

6.3.3.1 Exit. Returns you to the previous screen.

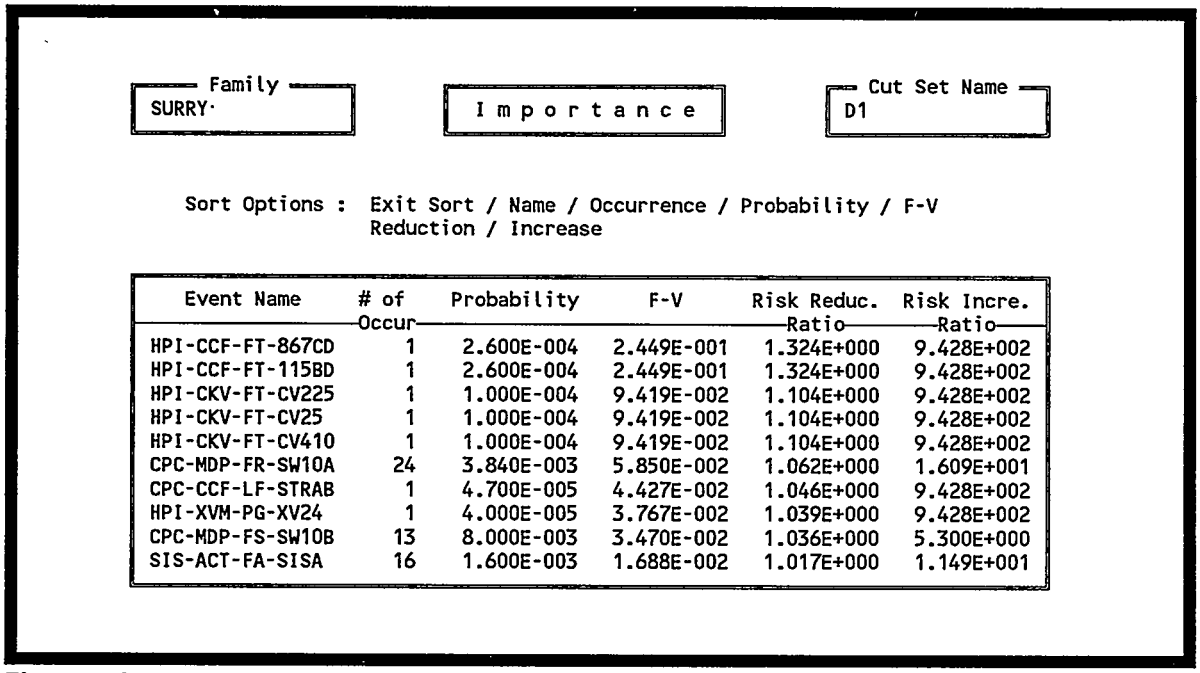
6.3.3.2 Description. Displays the full description for the highlighted event on the bottom of the screen. To invoke this option, enter a <D>, highlight the desired event, and press <Enter>. If no event is highlighted, the message **An event must be selected first...** is displayed.

6.3.3.3 Partition. This option invokes the same process as described in Section 6.3.2.2, except the effect is to limit which events are displayed/reported.

6.3.3.4 Report. This option invokes the same process as described in Section 6.3.2.3.

6.3.3.5 Sort. When you invoke this option, Figure 79 will be displayed. As shown, the data

can be sorted by the following: Name, Occurrence, Probability, F-V, Reduction, and Increase.



Event Name	# of Occur	Probability	F-V	Risk Reduc. Ratio	Risk Incre. Ratio
HPI-CCF-FT-867CD	1	2.600E-004	2.449E-001	1.324E+000	9.428E+002
HPI-CCF-FT-115BD	1	2.600E-004	2.449E-001	1.324E+000	9.428E+002
HPI-CKV-FT-CV225	1	1.000E-004	9.419E-002	1.104E+000	9.428E+002
HPI-CKV-FT-CV25	1	1.000E-004	9.419E-002	1.104E+000	9.428E+002
HPI-CKV-FT-CV410	1	1.000E-004	9.419E-002	1.104E+000	9.428E+002
CPC-MDP-FR-SW10A	24	3.840E-003	5.850E-002	1.062E+000	1.609E+001
CPC-CCF-LF-STRAB	1	4.700E-005	4.427E-002	1.046E+000	9.428E+002
HPI-XVM-PG-XV24	1	4.000E-005	3.767E-002	1.039E+000	9.428E+002
CPC-MDP-FS-SW10B	13	8.000E-003	3.470E-002	1.036E+000	5.300E+000
SIS-ACT-FA-SISA	16	1.600E-003	1.688E-002	1.017E+000	1.149E+001

Figure 79. Importance measures sorted by occurrences.

6.3.4 Uncertainty

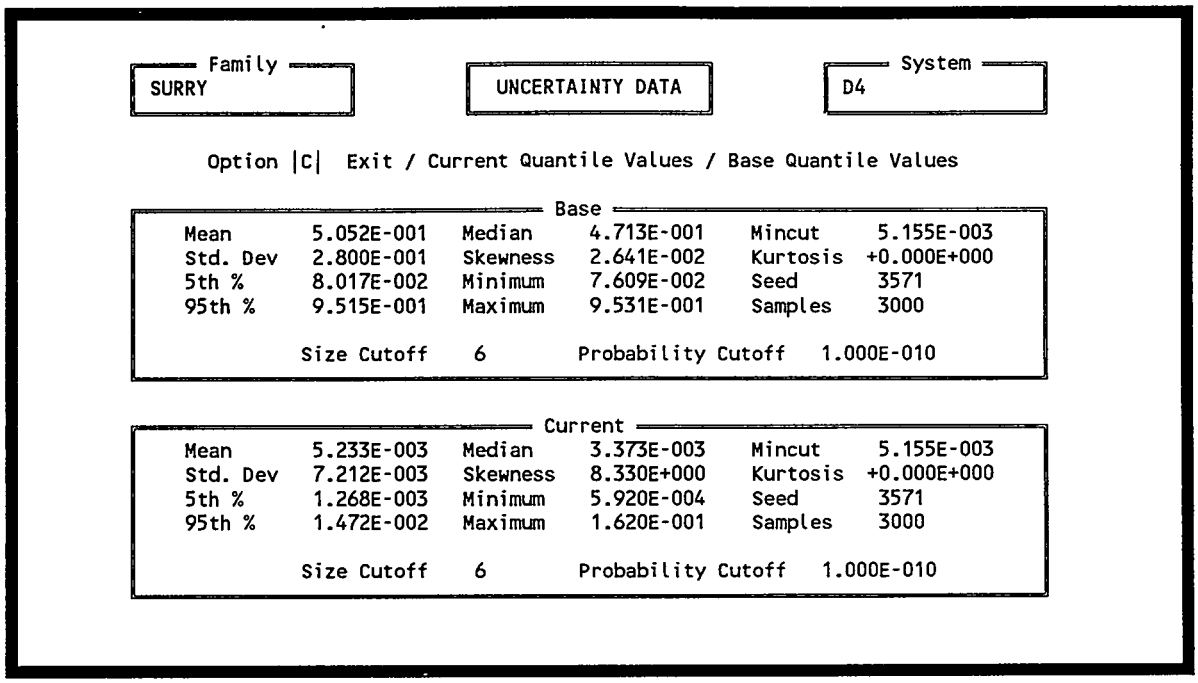
The Uncertainty option displays the distribution and confidence limits of a system for both base and current data values. These values were calculated using either the Latin Hypercube or the Monte Carlo simulation technique. To invoke this option, type <U> (Uncertainty) in the option field of the Display System Results screen, highlight the desired system, and press <Enter>. Figure 80 shows the base and current case uncertainty data for a highlighted system.

If the analysis type is seismic, the system will prompt you to select a ground acceleration level defined in the family hazard curve.

From this screen you may either return to the System Display screen or view the quantile values associated with the current case data or the base case data. To return to the System Display screen, type an <E> (Exit) in the option field and press <Enter>, or press the <Esc> key. To view the quantile values for the current case, type a <C> in the option field and press <Enter>. A screen showing the quantile values will appear (Figure 81). To return to the previous screen, press <Enter>. If you wish to view base case quantile values, type a <B> in the option field and press <Enter>.

6.3.5 Analysis Type

This option operates the same as described in Section 6.2.7. Refer to that section for details.



Family: SURRY

UNCERTAINTY DATA

System: D4

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

Base

Mean	5.052E-001	Median	4.713E-001	Mincut	5.155E-003
Std. Dev	2.800E-001	Skewness	2.641E-002	Kurtosis	+0.000E+000
5th %	8.017E-002	Minimum	7.609E-002	Seed	3571
95th %	9.515E-001	Maximum	9.531E-001	Samples	3000

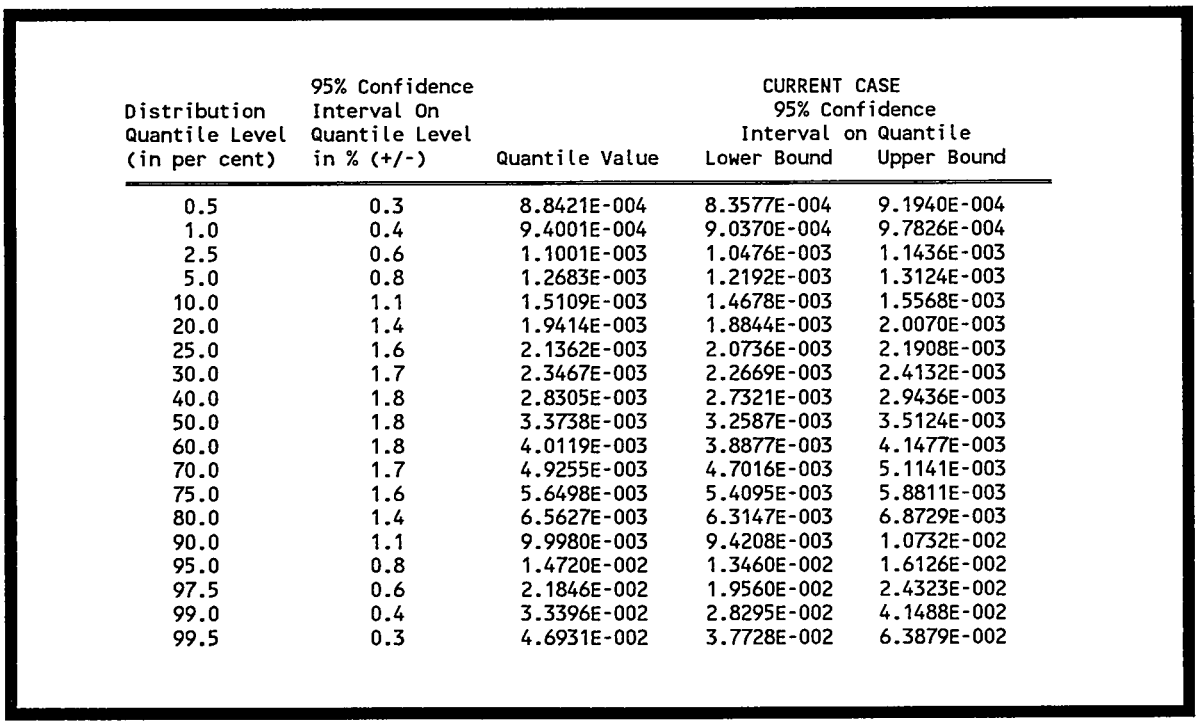
Size Cutoff 6 Probability Cutoff 1.000E-010

Current

Mean	5.233E-003	Median	3.373E-003	Mincut	5.155E-003
Std. Dev	7.212E-003	Skewness	8.330E+000	Kurtosis	+0.000E+000
5th %	1.268E-003	Minimum	5.920E-004	Seed	3571
95th %	1.472E-002	Maximum	1.620E-001	Samples	3000

Size Cutoff 6 Probability Cutoff 1.000E-010

Figure 80. Uncertainty data display.



Distribution Quantile Level (in per cent)	95% Confidence Interval On Quantile Level in % (+/-)	CURRENT CASE Quantile Value	95% Confidence Interval on Quantile Lower Bound	Upper Bound
0.5	0.3	8.8421E-004	8.3577E-004	9.1940E-004
1.0	0.4	9.4001E-004	9.0370E-004	9.7826E-004
2.5	0.6	1.1001E-003	1.0476E-003	1.1436E-003
5.0	0.8	1.2683E-003	1.2192E-003	1.3124E-003
10.0	1.1	1.5109E-003	1.4678E-003	1.5568E-003
20.0	1.4	1.9414E-003	1.8844E-003	2.0070E-003
25.0	1.6	2.1362E-003	2.0736E-003	2.1908E-003
30.0	1.7	2.3467E-003	2.2669E-003	2.4132E-003
40.0	1.8	2.8305E-003	2.7321E-003	2.9436E-003
50.0	1.8	3.3738E-003	3.2587E-003	3.5124E-003
60.0	1.8	4.0119E-003	3.8877E-003	4.1477E-003
70.0	1.7	4.9255E-003	4.7016E-003	5.1141E-003
75.0	1.6	5.6498E-003	5.4095E-003	5.8811E-003
80.0	1.4	6.5627E-003	6.3147E-003	6.8729E-003
90.0	1.1	9.9980E-003	9.4208E-003	1.0732E-002
95.0	0.8	1.4720E-002	1.3460E-002	1.6126E-002
97.5	0.6	2.1846E-002	1.9560E-002	2.4323E-002
99.0	0.4	3.3396E-002	2.8295E-002	4.1488E-002
99.5	0.3	4.6931E-002	3.7728E-002	6.3879E-002

Figure 81. Quantile values display.

6.4 Cut Set Editor

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

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

To invoke this option, highlight Cut Set Editor or type <C> in the option field and press <Enter>. Figure 82 shows the Cut Set Editor screen listing the system names and descriptions. Whether the system has associated base case cut sets and/or alternate cut sets is indicated by the letter B and A preceding the system name. To edit the base case cut set, select <B>, highlight a system showing a letter B, and press <Enter>. Likewise, to edit an alternate cut set select <A>, highlight a system showing a letter A, and press <Enter>. If a system name is not flagged with a B or A it may still be edited.

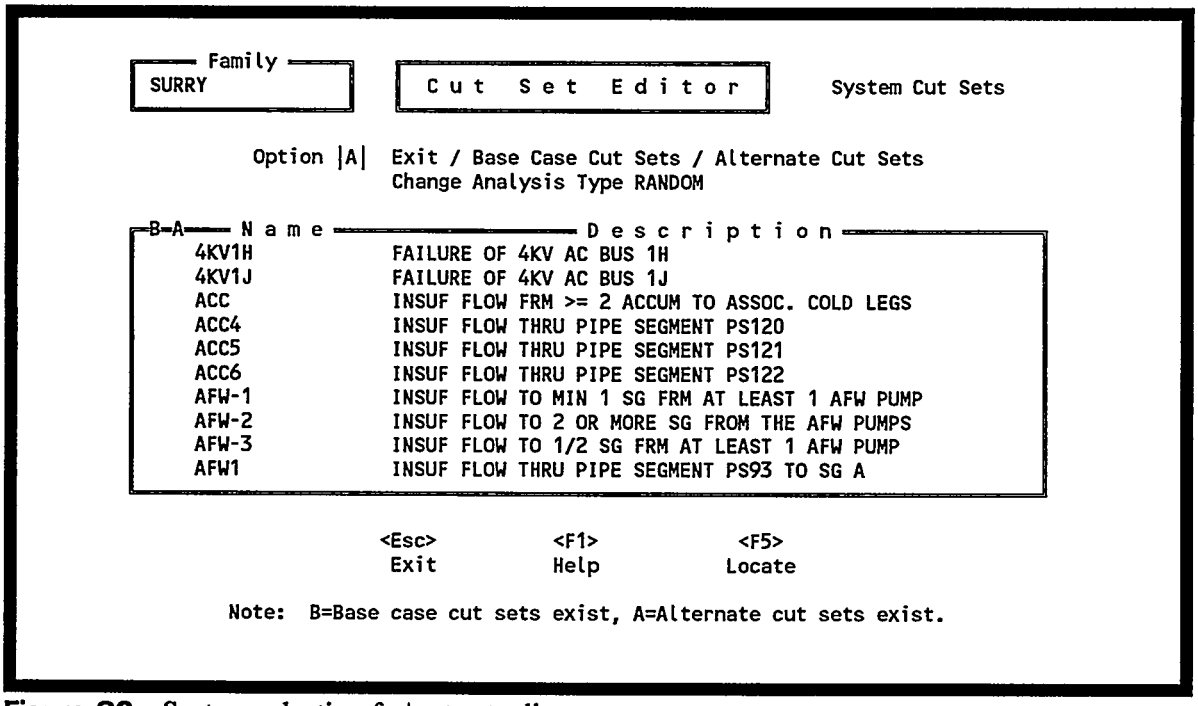


Figure 82. System selection for cut set editor.

In any case, a screen similar to the one shown in Figure 83 is displayed. This screen shows seven editing options that are activated by a single key stroke. The seven options include: Exit, Help, Find, Previous, Next, Insert, and Delete. The Insert and Delete functions will perform their function on either the entire cut set or on a single event in a cut set depending upon where the cursor is positioned

at the time the key to activate the function is pressed. If the cursor is in the first column of the screen (i.e., Cut Set No), then the function will be performed on the entire cut set. However, if the cursor is in one of the other four columns, then the function will be performed on the event where the cursor is positioned.

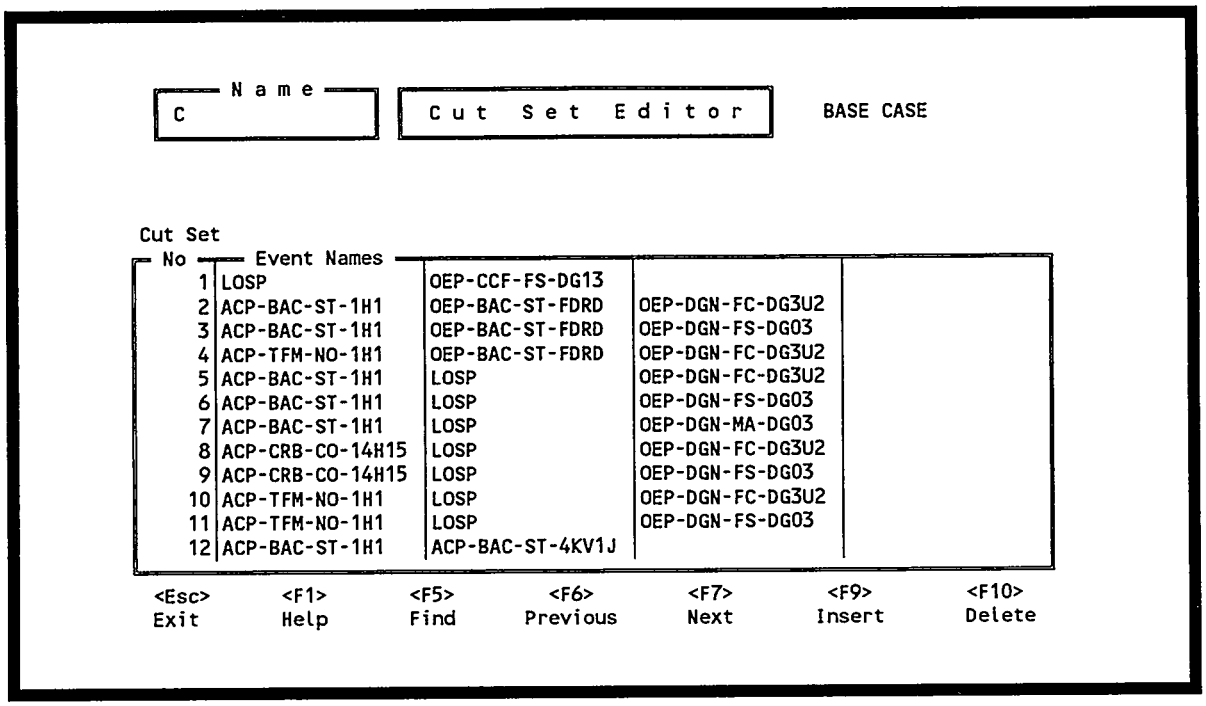


Figure 83. Cut set editor main menu.

To move the cursor about the editing window, use the keyboard cursor pad. The arrow keys move one field in each respective direction. The <PgUp> key moves the window up one page (12 lines). The <PgDn> key moves the window down one page. <Ctrl-PgUp> and <Ctrl-PgDn> moves to the top and bottom of the file.

6.4.1 Exit

This option returns you to the Cut Set Editor screen (Figure 82). After pressing <Esc> you are asked if the changes are to be saved or discarded (Figure 84). If the changes are saved, the sequence and plant frequencies must be recalculated to reflect the new cut set configurations.

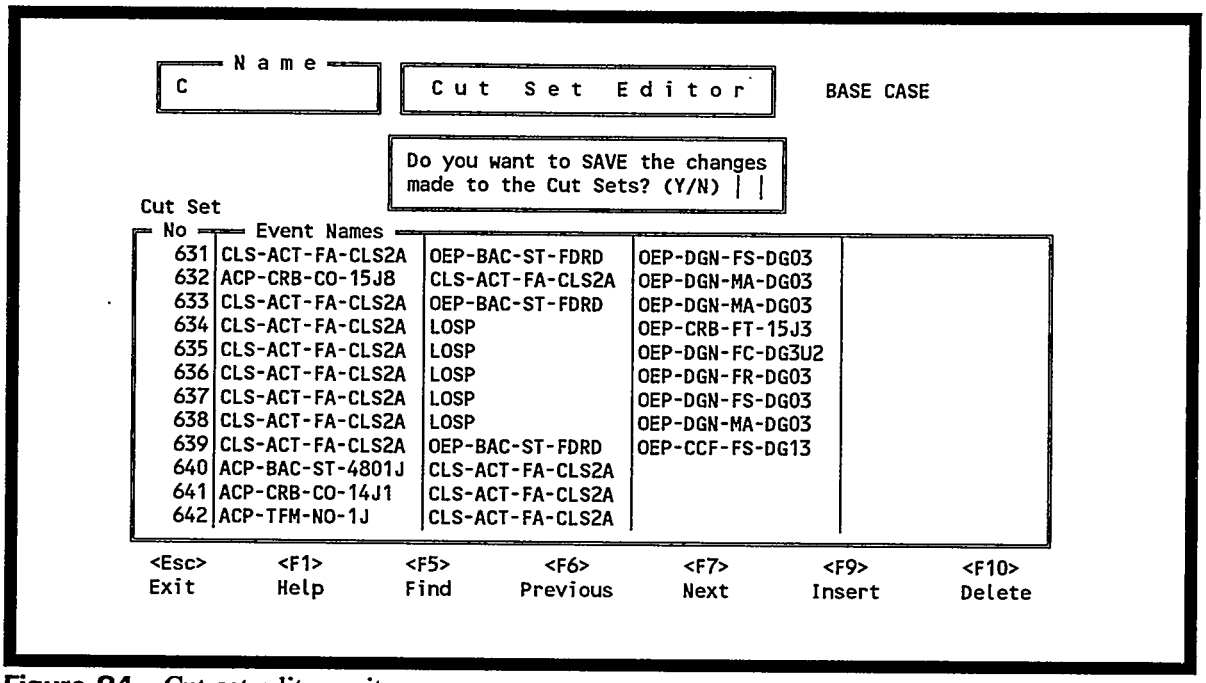


Figure 84. Cut set editor exit screen.

6.4.2 Help

To invoke the help function, the cursor must be positioned in an event name column. When you press <F1>, a screen similar to the one shown in Figure 85 will be displayed.

This screen lists all the events contained in the database. Those events that are unused (indicated by a "-") are not used by the selected cut set. To help you locate a specific event, IRRAS offers a speed search function. To locate an event, simply start typing the first few characters of the event name. As you type each character, the event that most closely matches the typed character(s) is highlighted in the list. If this is the desired event, press <Enter> to return to the previous screen (Figure 83), where the located event will be highlighted.

From the help screen, the following options are available:

<Enter> - The <Enter> key returns to the previous screen (Figure 83), where the selected event will be highlighted.

<Esc> - The <Esc> key exits the help screen and returns to the previous screen.

<F8> - The <F8> key allows you to modify a selected event. You may modify any of the events in the list. Once the event to be modified is located and highlighted, press <F8> to modify the event. A screen similar to the one shown in Figure 86 will be displayed. You can

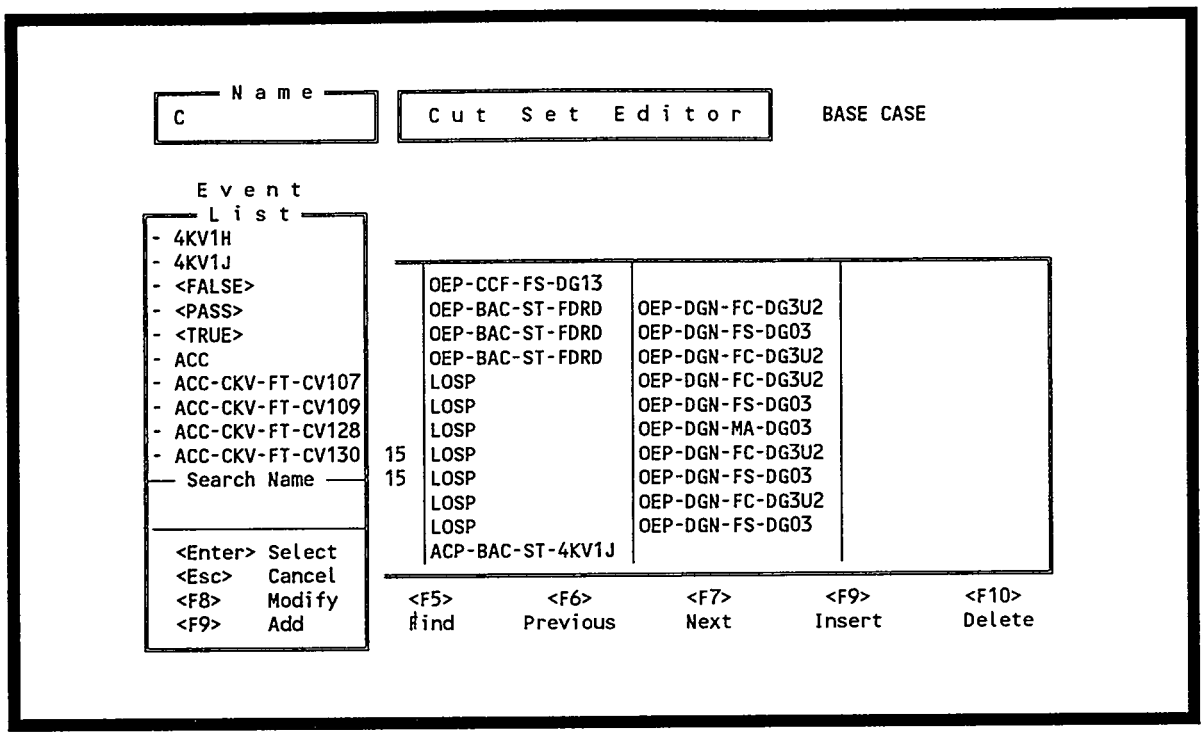


Figure 85. Help screen for cut set editor.

modify any of the data displayed by simply typing over the existing data. (For a description of each field, refer to the <F9> Add option that follows.) Help forms are available for some of the fields. To invoke the help, press <F1>. When you have finished your modifications, press <Enter>. (**NOTE:** The Modify <M> option is selected when you enter this screen.)

<F9> - The <F9> key allows you to add a new event to the system. When you invoke this option, a screen similar to the one shown in Figure 87 will be displayed.

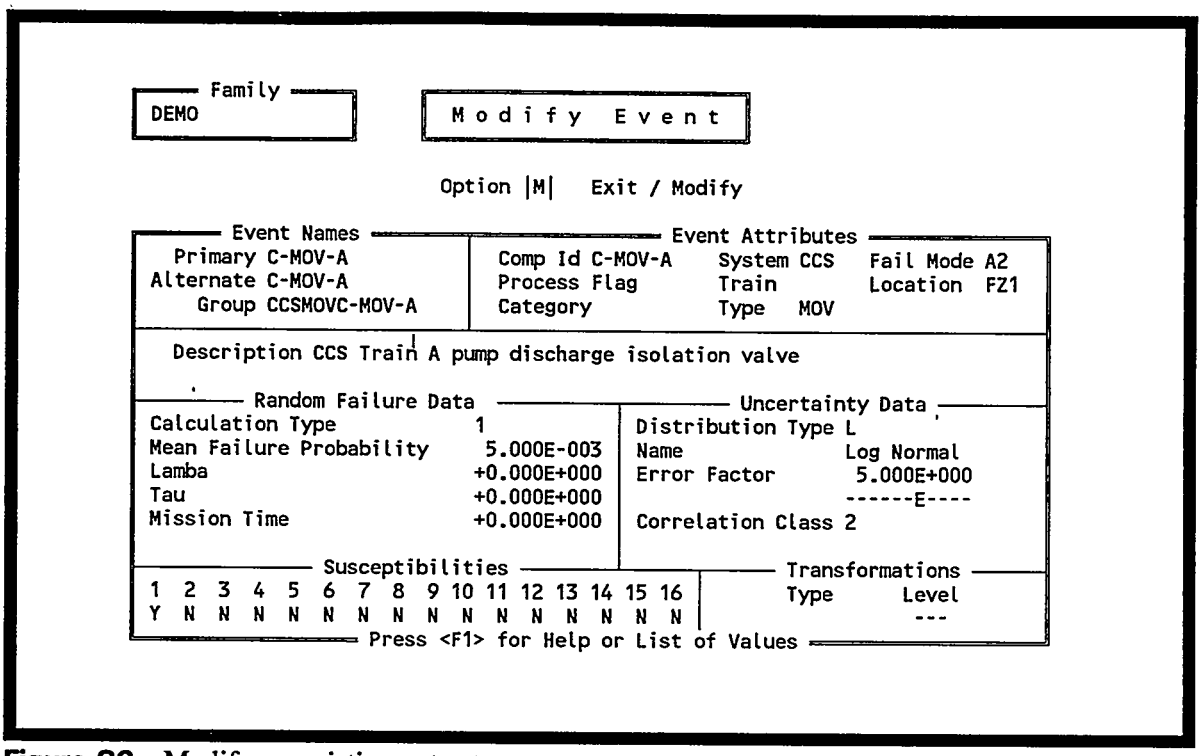


Figure 86. Modify an existing cut set.

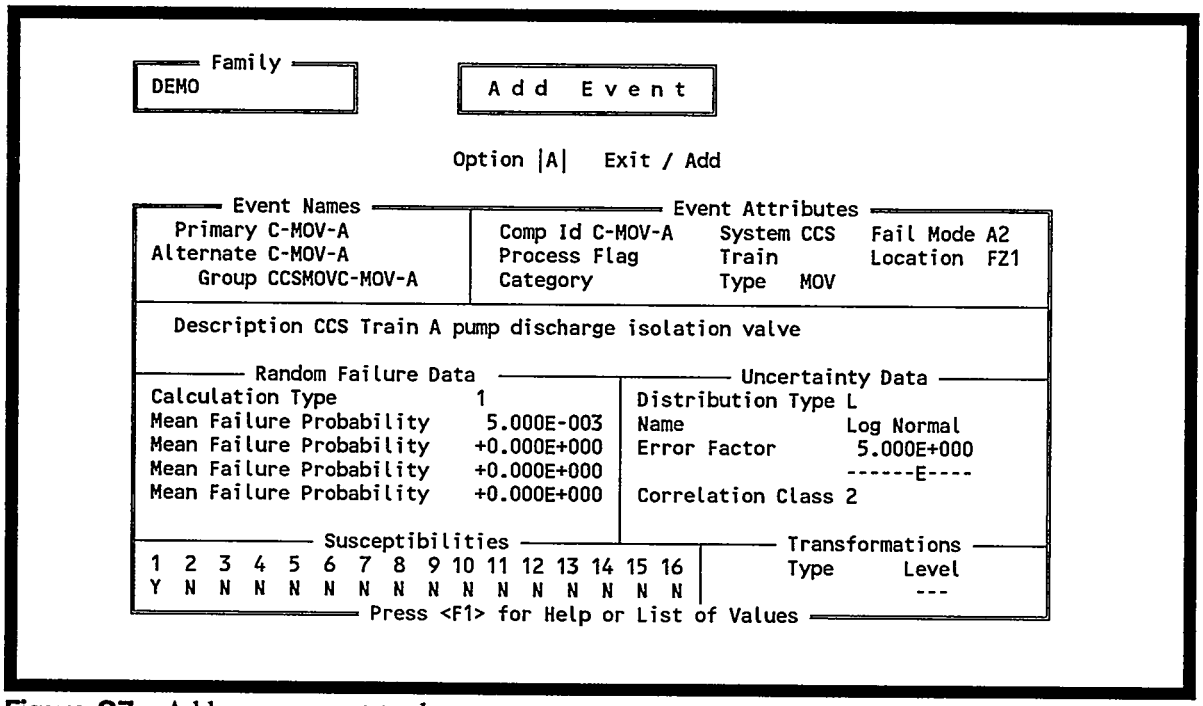


Figure 87. Add a new event to the system.

On this screen, you can enter the following data:

Event Data - Enter the primary names, process flag, category and component ID.

Failure Data - Refer to Section 4.5.

Attributes - Include systems, trains, types, failure modes, and locations.

Uncertainty Data - Refer to Section 4.5.

Transformations - An event or group of events that replace a zone flagged event or are added to the fault tree logic.

Susceptibilities - A susceptibility indicates whether the event is affected by a certain type of failure (e.g., fire, flood, etc.). It relates to the 16 analysis types.

There are help screens for many of the fields. Press <F1> to display help messages. When finished with this screen, press <Enter> to add the event to the system. (**NOTE:** Add <A> is the default option for this screen.)

6.4.3 <F5> - Find

This option allows you to find specific events and mark them for further action. The Find option speeds up many of the subsequent functions performed by IRRAS by finding and marking events, thereby reducing the search time required. When you invoke this option, a screen similar to the one shown in Figure 88 will be displayed.

This screen lists all the events contained in the database. A "-" in front of an event indicates that the event is not used by the selected cut set. On this screen, mark events for further processing. You may mark a single event, a group of events, or all events. Once the events are marked, they can be inserted into other cut sets, copied, replaced or deleted.

There are several ways to mark events. To mark a single event, two methods are available. First, you may scroll through the list of events using the arrow keys and <PgUp> and <PgDn> keys until the desired event is highlighted. Or, you can invoke the speed search function. To invoke the speed search function, simply start typing the first few characters of the event name you are trying to find. As you type each character, the event that most closely matches the typed characters will be highlighted.

You may also mark events using the following keys:

<F2> - The <F2> key allows you to mark events one at a time or mark an event as a complement event. This is a toggle that switches from a marked event, to a complemented event, to an unmarked event by pressing the <F2> key repeatedly. To use this option, simply scroll

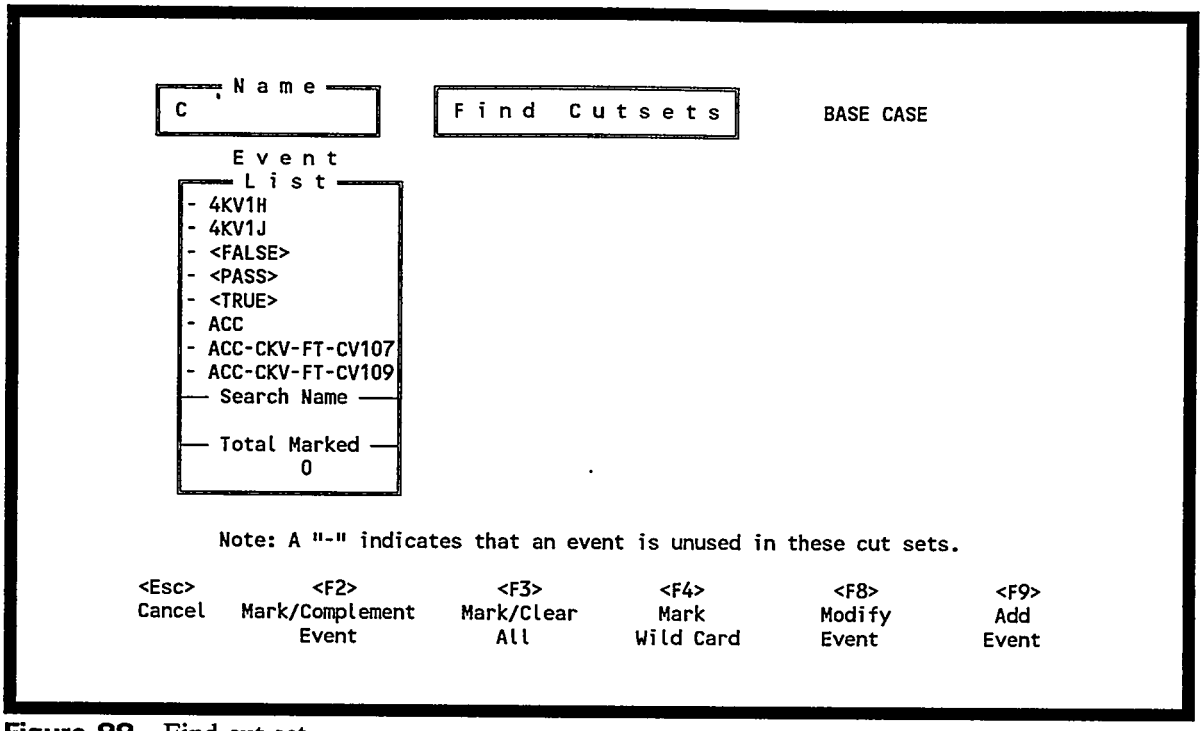


Figure 88. Find cut set.

through the list of events or invoke the speed search function. When the desired event is highlighted, press <F2> once to mark the event. To change this same event to a complemented event, press <F2>. To unmark the event, press <F2> again. When the desired events are marked, press <Enter> to advance to the Find Suboptions to perform the next function (see Section 6.4.3.1).

NOTE: You cannot mark an unused event.

<F3> - The <F3> key allows you to mark or unmark all of the events used in a cut set. The <F3> key is a toggle. If you press <F3> all used events will be marked. If you decide you did not want to mark all the events, press <F3> again. The message "Individual entries marked - Clear All? (Y/N)" will appear at the bottom of the screen. Enter a Y to unmark the events or enter an N to leave the events marked. If you mark all events, you may then use the <F2> key to unmark events one at a time.

<F4> - The <F4> allows you to mark several events at one time using wildcard specifications. When you press <F4>, the screen shown in Figure 89 will be displayed. Enter any valid DOS wildcard specification and press <Enter>. Upon pressing <Enter> you will be returned to the event list where the Total Marked field will be updated to reflect the number of event meeting your wildcard specification.

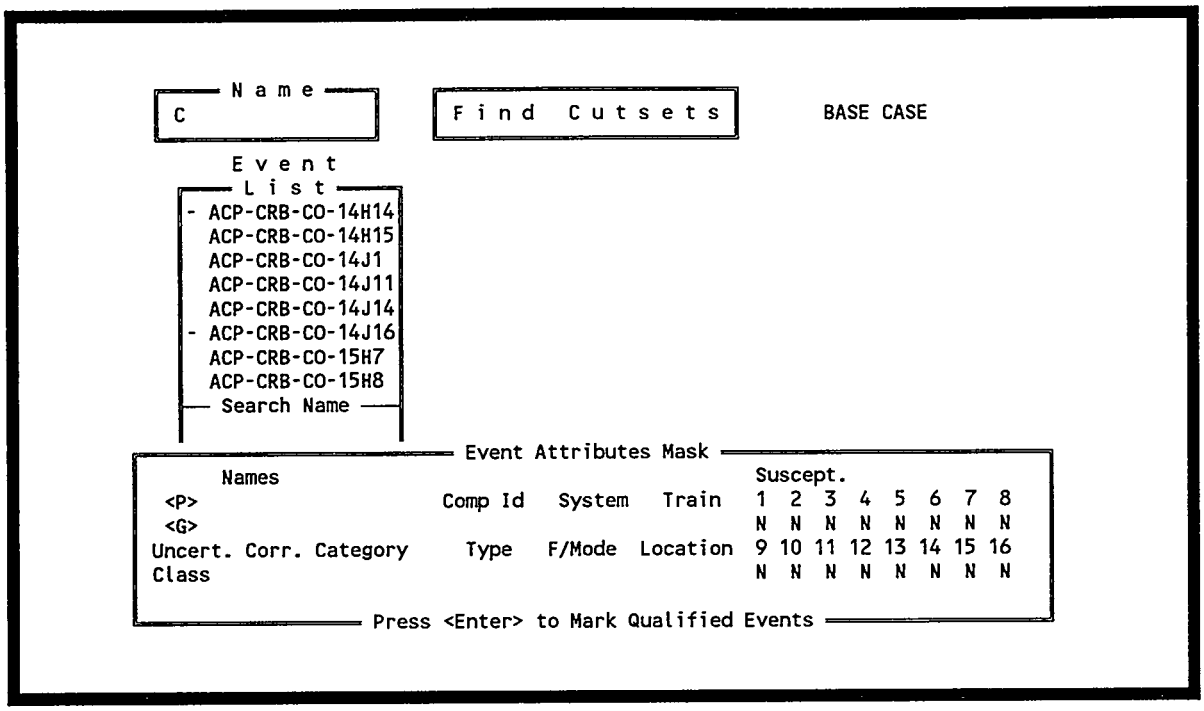


Figure 89. Event attributes mask.

Regardless of the marking method used, IRRAS keeps a total of the marked events at the bottom of the event list. As mentioned earlier, this marking process speeds up the search process for subsequent functions. These subsequent functions are discussed in paragraph 6.4.3.1.

In addition to marking and selecting events, from Figure 88 you may also modify or add a new event from the Find Event List screen by invoking the following:

<F8> - The <F8> key allows you to modify an event. This is the same function as described in Section 6.4.2. Refer to that section for operating instructions.

<F9> - The <F9> key allows you to add an event. This is the same function as described in Section 6.4.2. Refer to that section for operating instructions.

6.4.3.1 Find Suboptions. After you have selected the event by highlighting it and pressing <Enter>, the window shown in Figure 90 will be displayed. From this screen, the following options are available:

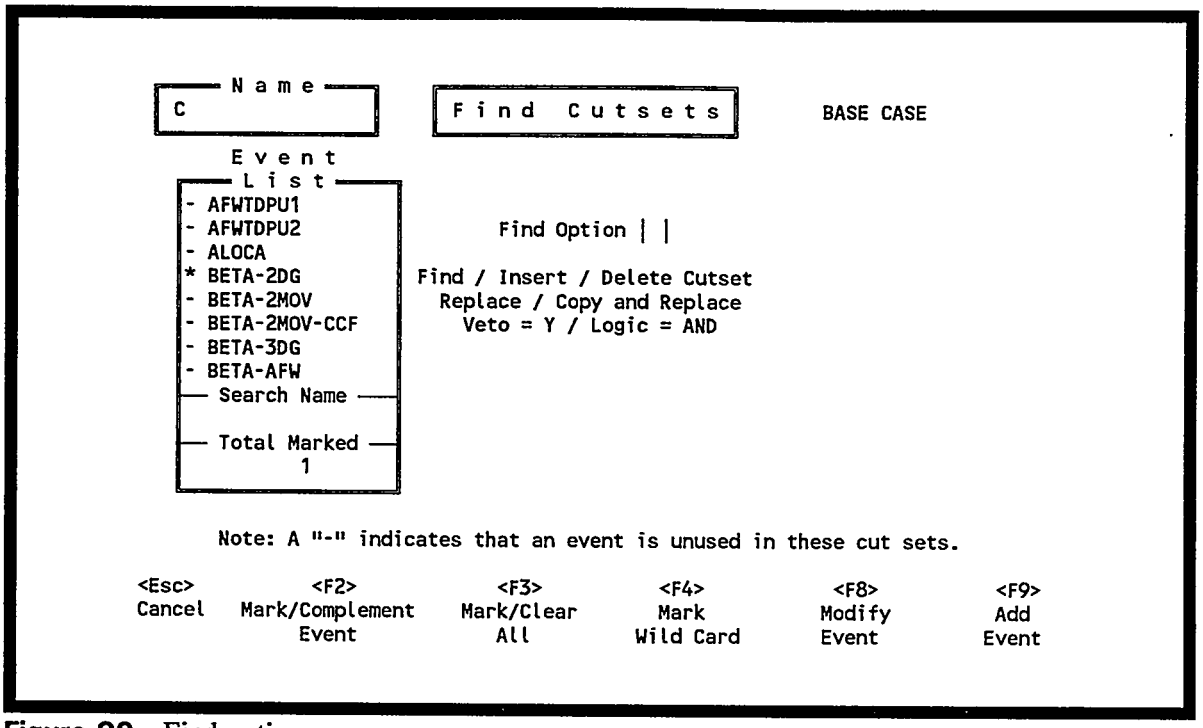


Figure 90. Find options.

<F>ind - This option will find the highlighted cut set in the event list shown in Figure 83. If the cut set is found, the message "Cut set found" will be displayed at the bottom of the screen.

<I>nsert - This option allows you to locate an event and insert it next to another marked event. To invoke this option, type an <I>. The event list shown in Figure 91 will be displayed. Again, this screen lists all the events currently contained in the database. On this screen, you must mark the event or events you wish to insert next to the previously marked events. The same marking methods are available here as were discussed in Section 6.4.3. On this second event list, you may mark unused events to be inserted. When the events are marked, press <Enter>. Upon pressing <Enter>, the screen shown in Figure 92 will be displayed. This screen shows the cut set number and the corresponding events (the event you marked in the first list and any other events attached to the cut set). If this is the cut set and event where you wish to insert the event (selected from the second list) press <Y>; otherwise enter an N. If the event selected from the first list occurs in more than one cut set, each cut set will be displayed on this screen. You are given the opportunity to respond Y or N at each occurrence. Once all cut sets have been addressed, you will return to the previous screen, where the cut set display will be updated with the inserted events.

<D>elete - This option allows you to delete events that were marked in the previous step. To invoke this option, press <D>. Figure 93 will be displayed. This screen contains the cut set number and the first occurrence of the selected event. If this is the event you wish to delete, press <Y>; otherwise, press <N>. If you respond <Y>, this occurrence of the event will be deleted. As with the Insert option, this screen scrolls through each occurrence of the selected event(s), providing you with the opportunity to delete or not delete each and every occurrence.

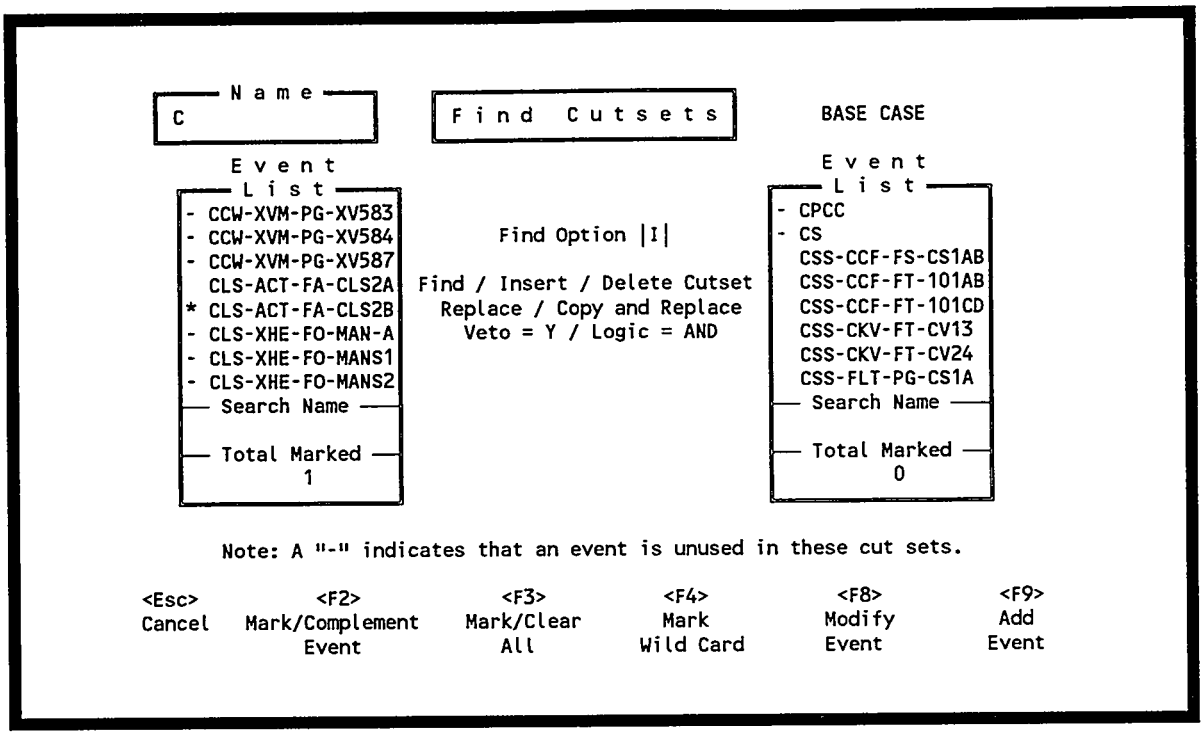


Figure 91. Event selection list.

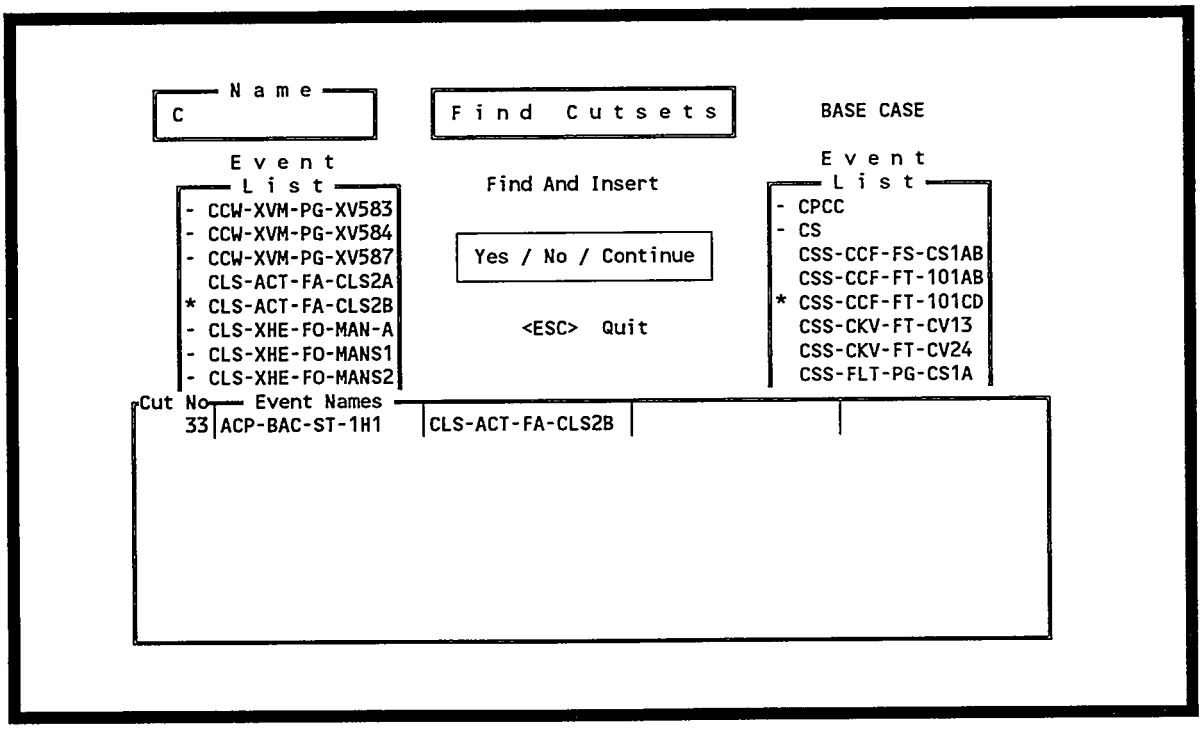


Figure 92. Prompt to continue with insert.

When complete you will be returned to the previous screen where the cut set list will be updated accordingly.

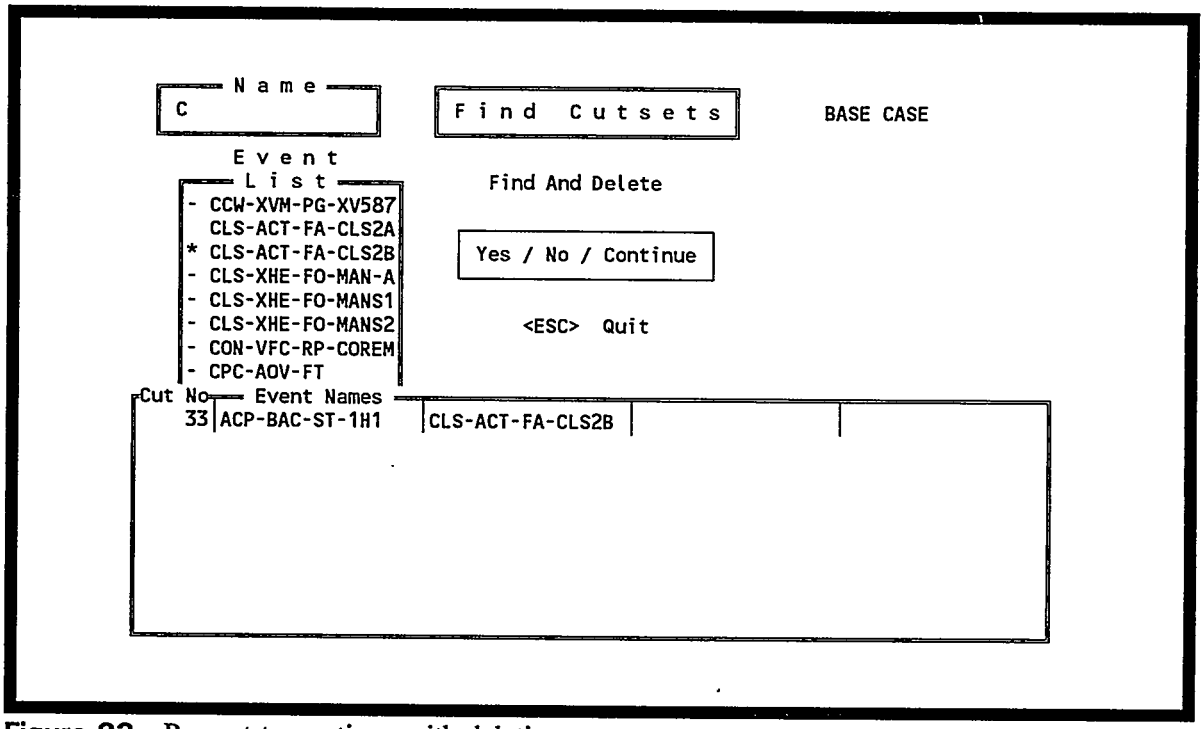


Figure 93. Prompt to continue with deletion.

<R>eplace - This option allows you to replace each occurrence of an event selected in the previous step with another event. To invoke this, type an R. The event list shown in Figure 91 will appear. Select the event(s) to replace the previously marked events. The same marking methods are available here as were discussed in Section 6.4.3. Once the events have been marked, press <Enter>. Figure 94 will be displayed. This screen contains the cut set number and the first occurrence of the selected event. If this is the event you wish to replace, press <Y>; otherwise, enter an <N>. If you respond <Y>, this occurrence of the event will be replaced with the selected event. As with the Insert option, this screen scrolls through each occurrence of the selected event(s), providing you with the opportunity to replace or not replace each and every occurrence. When complete, you will be returned to the previous screen where the cut set list will be updated accordingly.

<C>opy and Replace - This option works like the Replace option described above, except with this option a new cut set is created. The new cut set will contain the original events plus any replacements indicated. Once the event(s) has been selected, press <Enter>. Figure 95 will be displayed. This screen contains the cut set number and the first occurrence of the selected event. If this is the event you wish to replace, press <Y>. This occurrence of the event will be replaced with the selected event. As with the Insert option, this screen scrolls through each occurrence of the selected event(s), providing you with the opportunity to replace or not replace each and every occurrence. When complete, you will be returned to the previous screen where the cut set list will be updated accordingly.

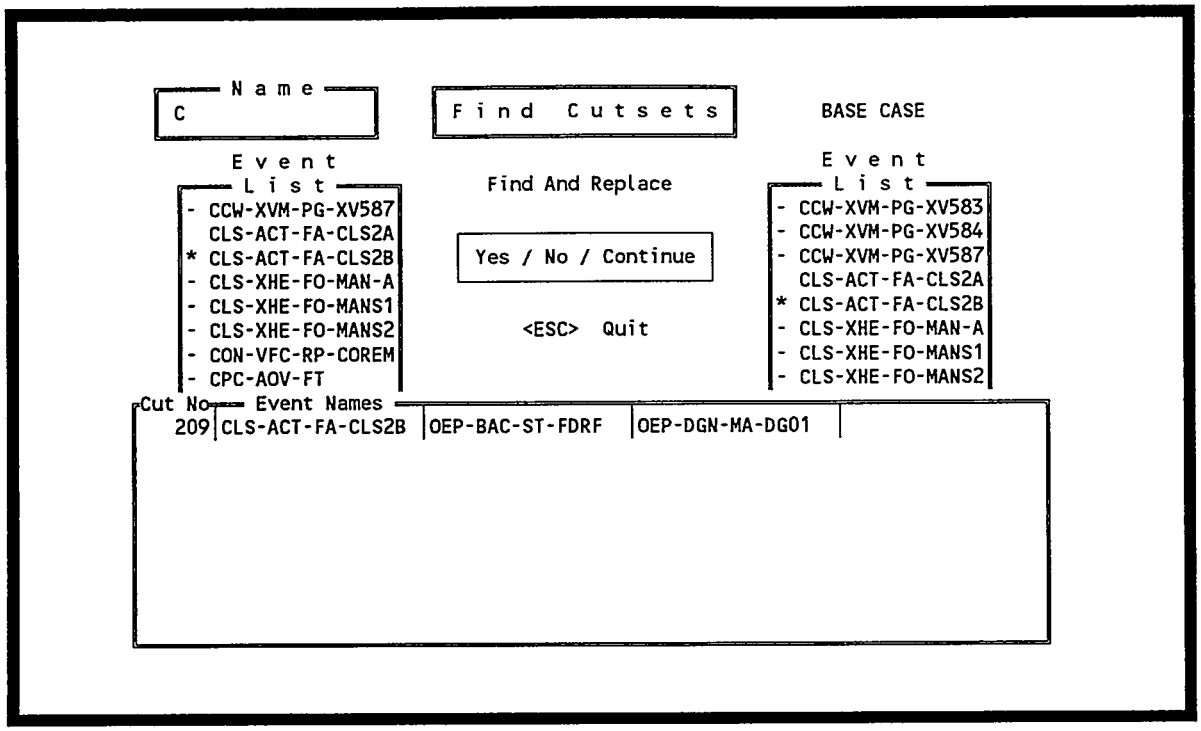


Figure 94. Prompt to continue find and replace process.

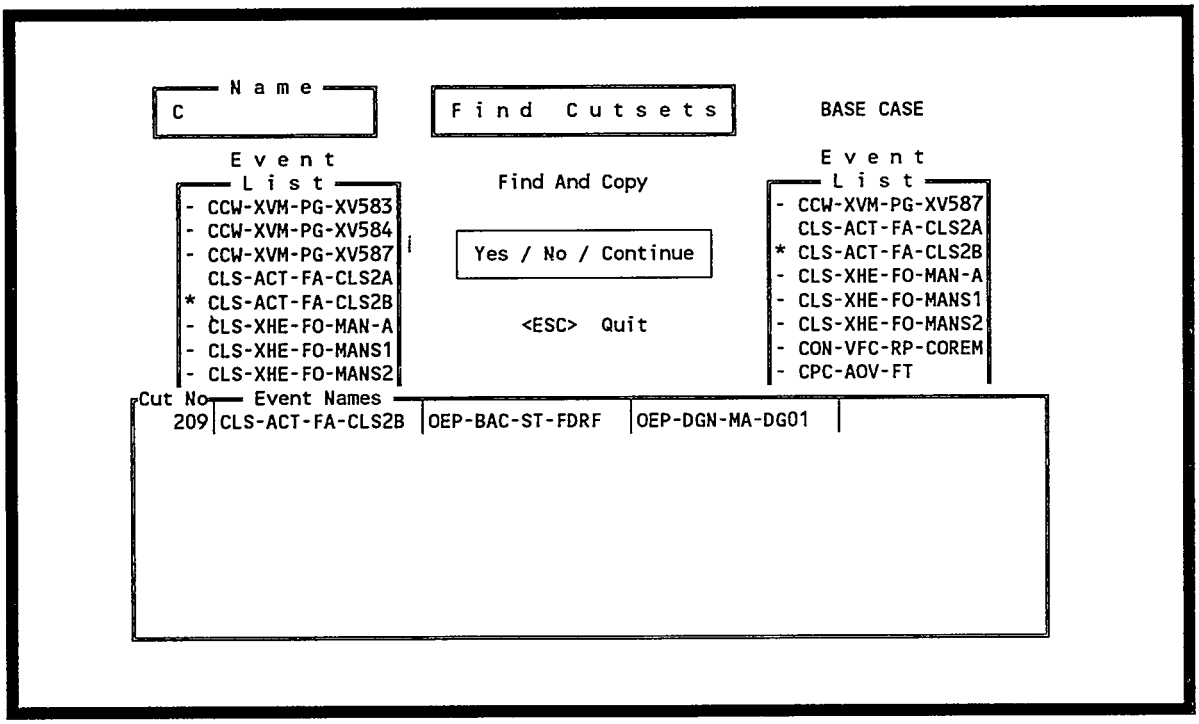


Figure 95. Prompt to continue with copy and replace process.

<V>eto - This option allows you to set the veto option. This option uses a toggle device. When you press <V> and <Enter> the prompt changes from <Y>es to <N>. The <Y> setting tells each operation (delete, replace, etc.) to ask again if you wish to continue with the process. By default this is turned on. A <N>o setting will not ask you for a confirmation. The operation will be performed immediately.

<L>ogic - This option allows you to set the logic to AND or OR. This is a toggle. When you press <L> and <Enter>, the logic changes from AND to OR. Depending upon the search option you wish to perform, you may need to change the logic accordingly.

6.4.4 <F6> - Previous

This option is used in conjunction with the Find option discussed in Section 6.4.3. The previous command allows you to go back to the previous occurrence of the event name that was located in the Find option.

6.4.5 <F7> - Next

This option is used in conjunction with the Find option discussed in Section 6.4.3. The next command allows you to go to the next occurrence of the event name that was located in the Find option.

6.4.6 <F9> - Insert

This option allows you to insert a cut set into a system or an event into a cut set. To insert a new cut set, move the cursor into the cut set number column and press <F9>. The cursor will move to the end of the cut set list, where the next cut set number is assigned (see Figure 96). The event names that make up the new cut set may be entered using the <Tab> key to move between fields. Press <Enter> to end the addition process.

Upon pressing <Enter>, the save window shown in Figure 84 will appear. Enter a Y and press <Enter> to save the changes, or enter an N and press <Enter> to exit without saving the changes. Upon entering a Y and pressing <Enter>, the inserted cut set will be saved and you will return to the Cut Set Editor main menu (Figure 82).

To insert an event into a cut set, position the cursor at the location where you want to insert the event. Remember, use the <Tab> key to move from field to field or use the cursor positioning keys described in Paragraph 6.4 to position the cursor at the desired location. When positioned at the desired location, press <Enter>. Type in the event name and press <Enter> to complete the addition process.

NOTE: When you insert an event where the line is full (that is, all four event columns are full), a blank line will be provided. If you press <F9>, while positioned on an existing event name, the event name will be replaced by whatever you type over it. If the line is not full, position the cursor in an empty column and press <F9>.

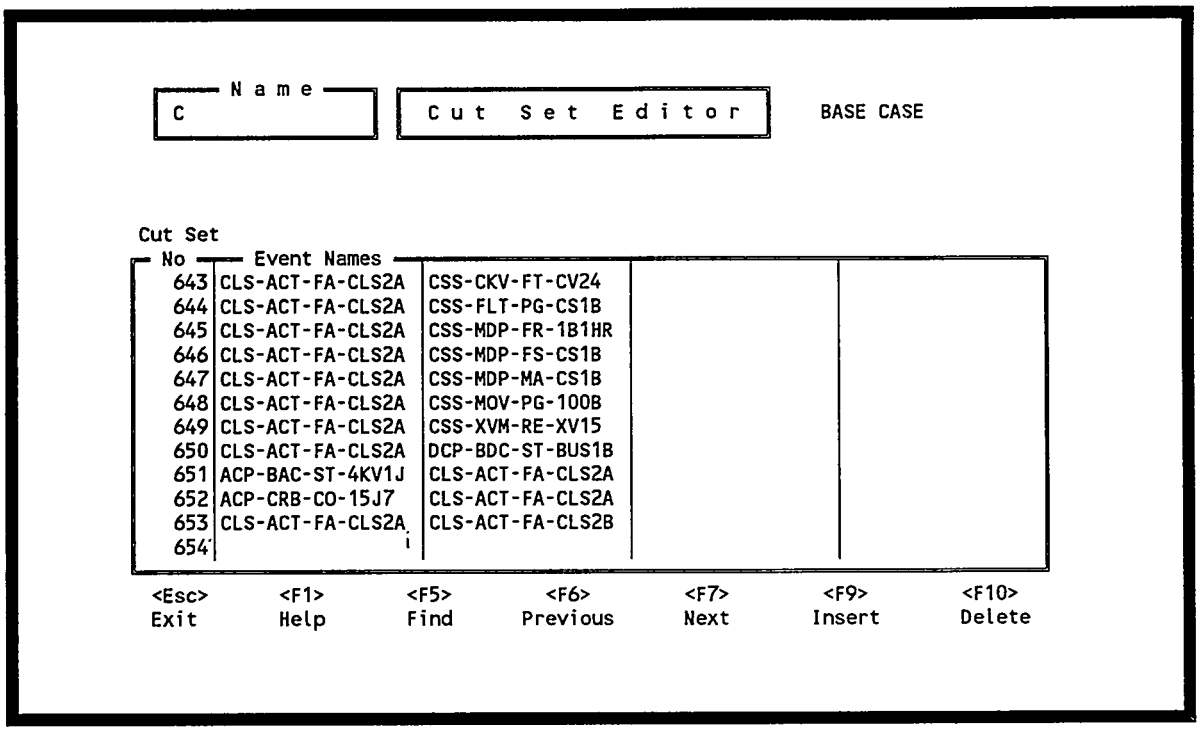


Figure 96. Insert a cut set into a system.

6.4.7 <F10> - Delete

This option allows you to delete a cut set from the system or an individual event from a cut set. To delete an entire cut set, locate the desired cut set using one of the methods described above and press <F10>. If the Veto option is set to <Y> (see Paragraph 6.4.3), the window shown in Figure 97 will be displayed. Enter a Y and press <Enter> to delete the cut set; otherwise, enter an N and press <Enter> to exit without deleting.

To delete an event from a cut set, place the cursor on the event name and press <F10>, The event at that location only is deleted from the cut set (not every instance of the event is deleted).

6.4.8 Change Analysis Type

This function is the same as discussed in Section 6.2.7. Refer to that section for details.

6.5 Recover Cut Sets

The recovery option allows the user to modify cut sets by adding recovery actions to them. The user defines recovery rules to be applied to each cut set. These rules define the action to be taken. The rules are defined using the same editor that is used for event tree rules definition. This editor is a macro-based editor. This means that the user can define macros or variables that can be used in tests. The macro defined by the following syntax,

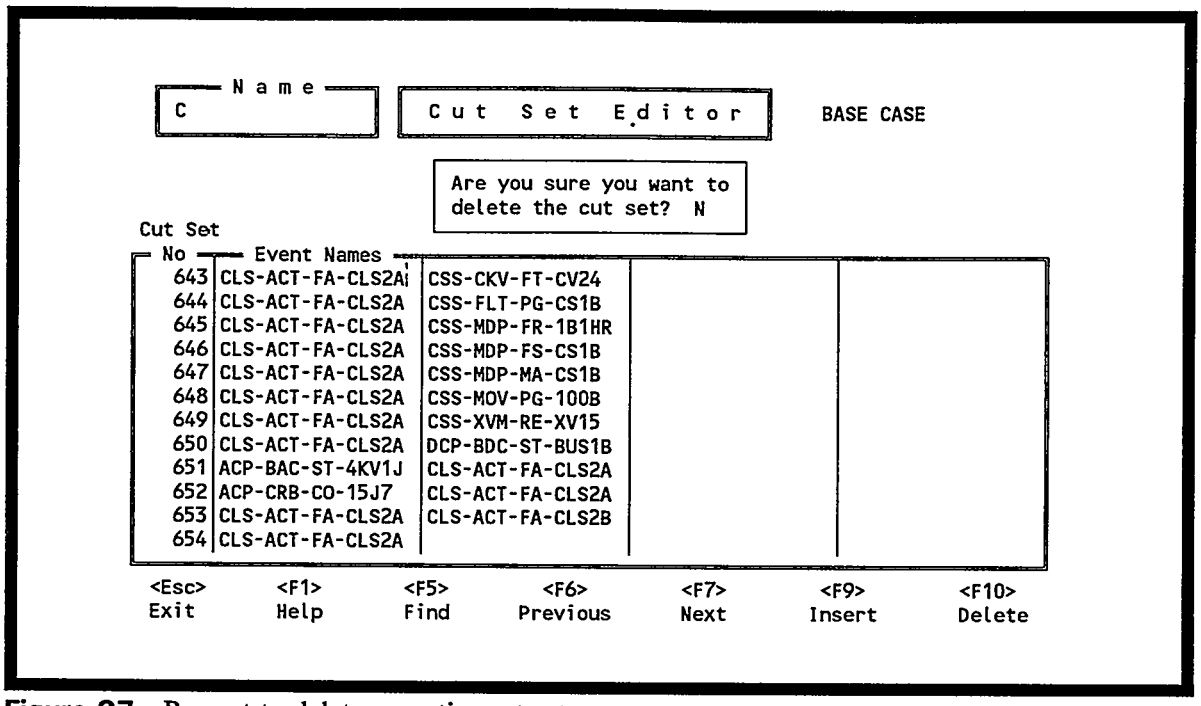


Figure 97. Prompt to delete an entire cut set.

NO-FLOW = (EVENT1 + EVENT2) * (EVENT3 + /EVENT4);

indicates that "NO-FLOW" is to be true if the following conditions are true. (1) EVENT1 or EVENT2 appear in the cut set and EVENT3 appears or EVENT4 appears as a complemented event. The "+" sign is used to indicate "or" logic, the "*" sign is used to represent "and" logic, and the "/" sign is used to represent the complement or "not" logic. The user can also use the "~" character to indicate that the item following the character is not in the current cut set. Once a macro is defined, it can be used in an "if" test. The following rule is an example of an "if" test using a macro.

```
if NO-FLOW then
  recovery = EVENT5;
endif
```

The information between the "if" and the "endif" clause defines the recovery events to be added to the cut set. The user can specify as many recovery actions between these clauses as they desire. There are some additional clauses that can be used in the recovery rules. The following rules demonstrate these additional clauses.

```
if ALWAYS then
  recovery = EVENT5;
endif

if NO-FLOW then
  recovery = EVENT6;
```

```
elsif ~EVENT7 then
  recovery |= EVENT7;
else
  recovery = EVENT8;
endif
```

This rule will always add EVENT5 to the cut set and additionally one of the three events EVENT6, EVENT7, or EVENT8. The "elsif" clause allows the user to specify an alternate test for the rule. The first condition that is met is used and the others are ignored. The "else" clause allows the user to specify a condition that is to be used if none of the previous conditions are met. If the user wants a condition to always be used then they can use the predefined macro "ALWAYS". The substitutions following this condition are always made. Blank lines are encouraged in the editor to improve readability and comments can be entered following the "|" character. All information on a line following the comment character is ignored.

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 that 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. For instance, if the name "EVENT5" was really the name of a system then the user could change its default type with the following syntax; "system(EVENT5)". The editor will then treat this name as a system. Cast operators are provided for macros, recovery actions, events, and initiating events. There is no limit to the number of rules the user may input to the editor. Each rule is processed in sequential order. The editor allows the user to list the names for a given type by using the <Ctrl> key in combination with a letter defining the data type to list. The <Alt> key in combination with the same key allows the user to check if a name of the specified type exists in the database and optionally add it and cast the name to that type.

To exit the editor and save the defined rules, press the <Esc> key. To exit without saving, press the <Alt/Q> keys simultaneously.

When this option is invoked, a screen similar to the one shown in Figure 98 will be displayed.

From this screen, the following options are available:

Exit - The E or Exit option terminates the recover option and returns you to the Fault Tree Analysis menu.

System Rules - This option allows you to view the quantified cut sets for a system. Using this option, you can interactively define and apply recovery rules before saving the recovered cut sets. To invoke this option, highlight the desired system, type an "S" in the option field and press <Enter>. If no cut sets exists for this system, an appropriate message is displayed. If cut sets do exists, they will be displayed on a screen similar to the one shown in Figure 99. From this screen, you can modify or apply or edit rules for recovery. The following two options are available: Modify Rules or Apply Rules.

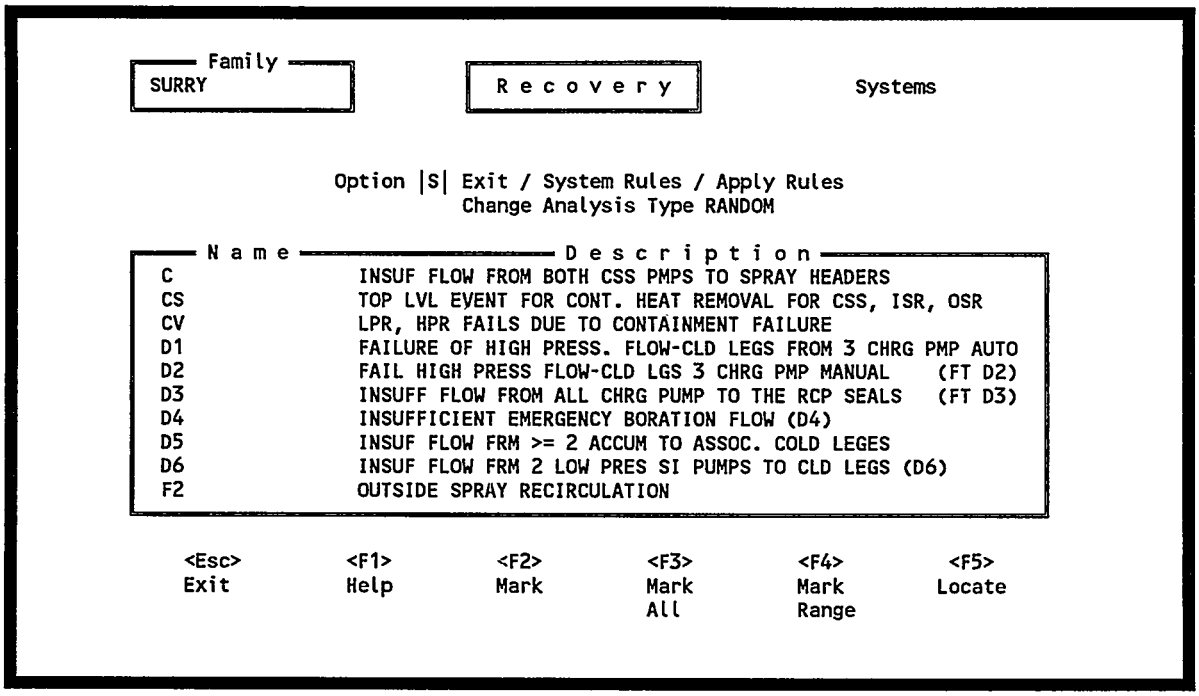


Figure 98. Initial screen to recover cut sets.

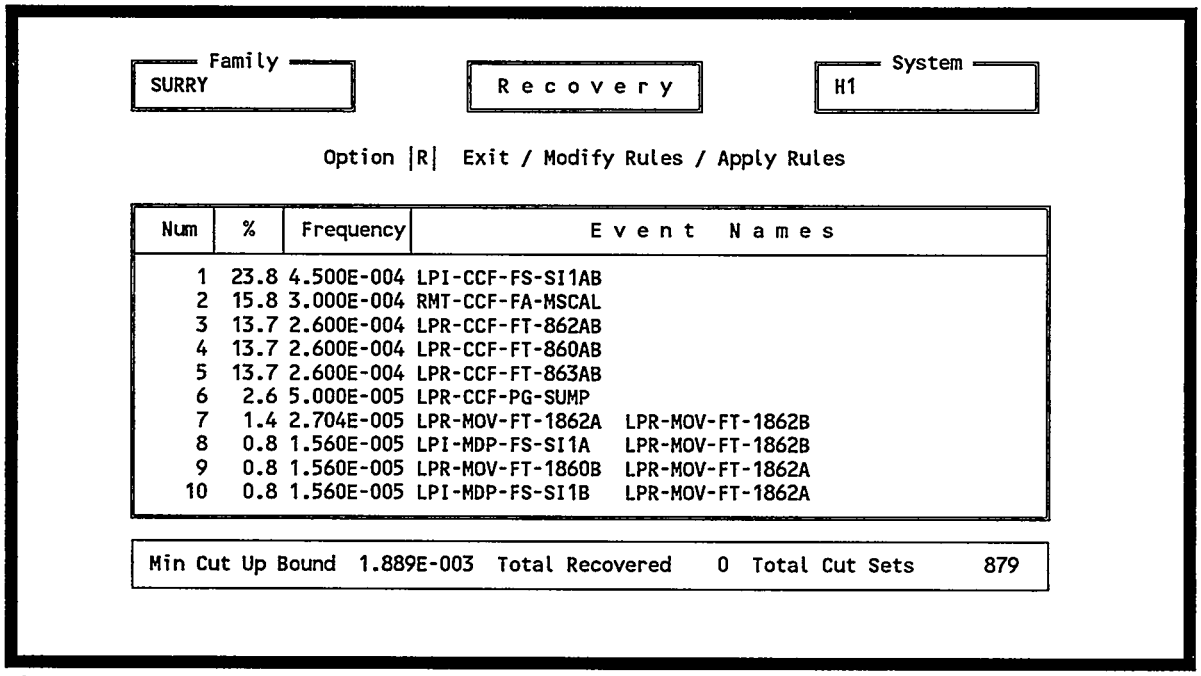


Figure 99. List of cut sets with recovered events.

Modify Rules - This option allows you to modify the cut sets before the recovery event(s) are inserted into the cut set. To invoke this option, type an <M> in the option field, and highlight the cut set you wish to recover. A screen similar to the one shown in Figure 100 will be displayed. From this screen, the following options are available:

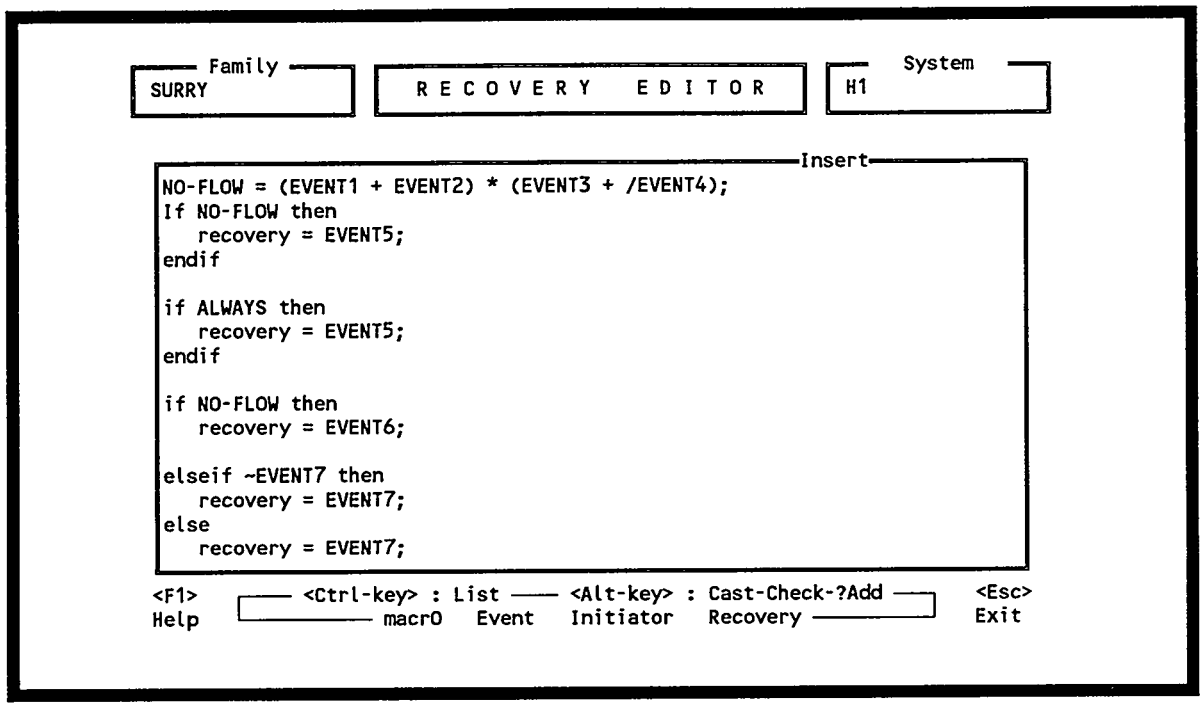


Figure 100. Event list for recovered cut set.

<F1> - Displays the list of function keys available to you to perform various editing functions.

<Ctrl/O> - Displays a window showing a list of macros that have been previously defined. You may select a macro from the list to include as a recovery rule.

<Ctrl/E> - Displays the event list containing all events defined for the cut set. From this window, you may select the event to be used in the recovery rule.

<Ctrl/I> - Displays the initiator list containing all initiators defined for the family. From this window, you may select the initiator to be used in the recovery rule.

<Ctrl/R> - Displays the list previously-defined recovery rules. From this window, you can select the recovery rule to be used.

From the event, initiator, and recovery lists you can add a new item to the list using the <F8> key or modify an existing item using the <F9> key.

NOTE: The <Alt> key in combination with the same key shown above allows you to check if a name specified type exists in the database and optionally add it and cast the names to that type.

Apply Rules - When you invoke this option, Figure 101 will appear. From this screen, you can interactively define and apply recovery rules before saving the recovered cut set. If rules have already been defined, they will be displayed on the screen. From this screen, the following options are available:

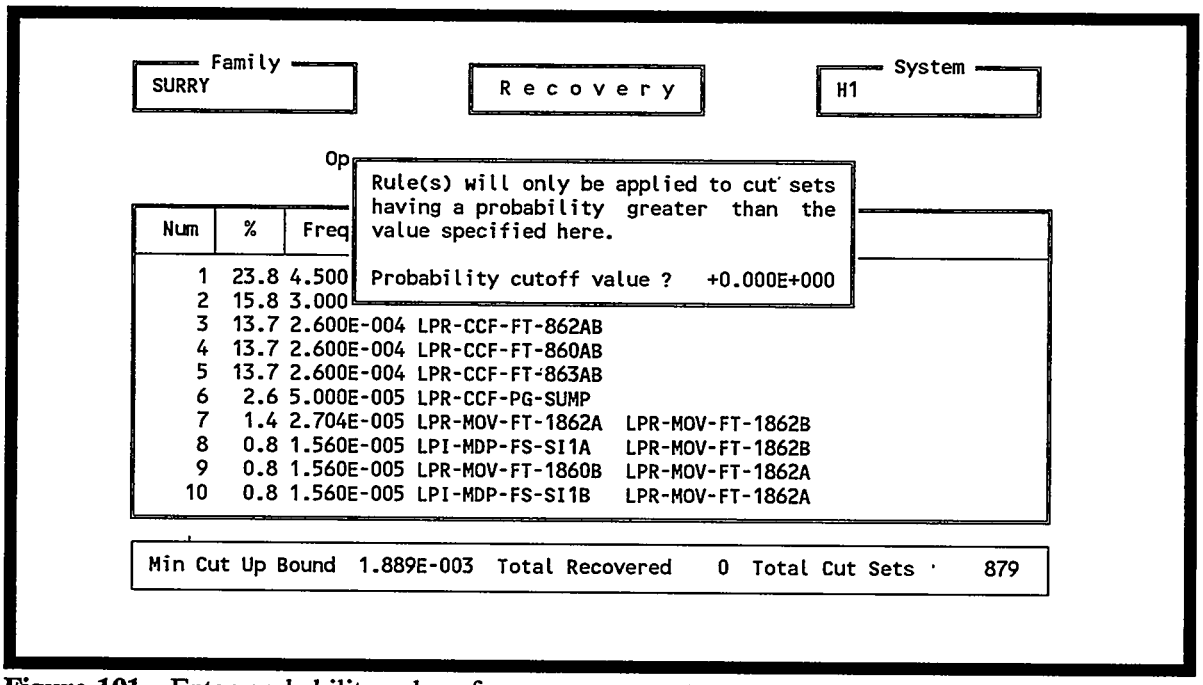


Figure 101. Enter probability values for recovery events.

Apply Rules - This option applies all rules currently defined to the highlighted or marked systems. When you invoke this option, Figure 102 will be displayed.

This option provides a shortcut for applying rules to the cut sets. When you have several hundred cut sets. It will take some time to apply rules. By setting a probability cutoff value, only those events with a high probability will have rules applied.

Change Analysis - Refer to Section 6.2.7 for operating instructions.

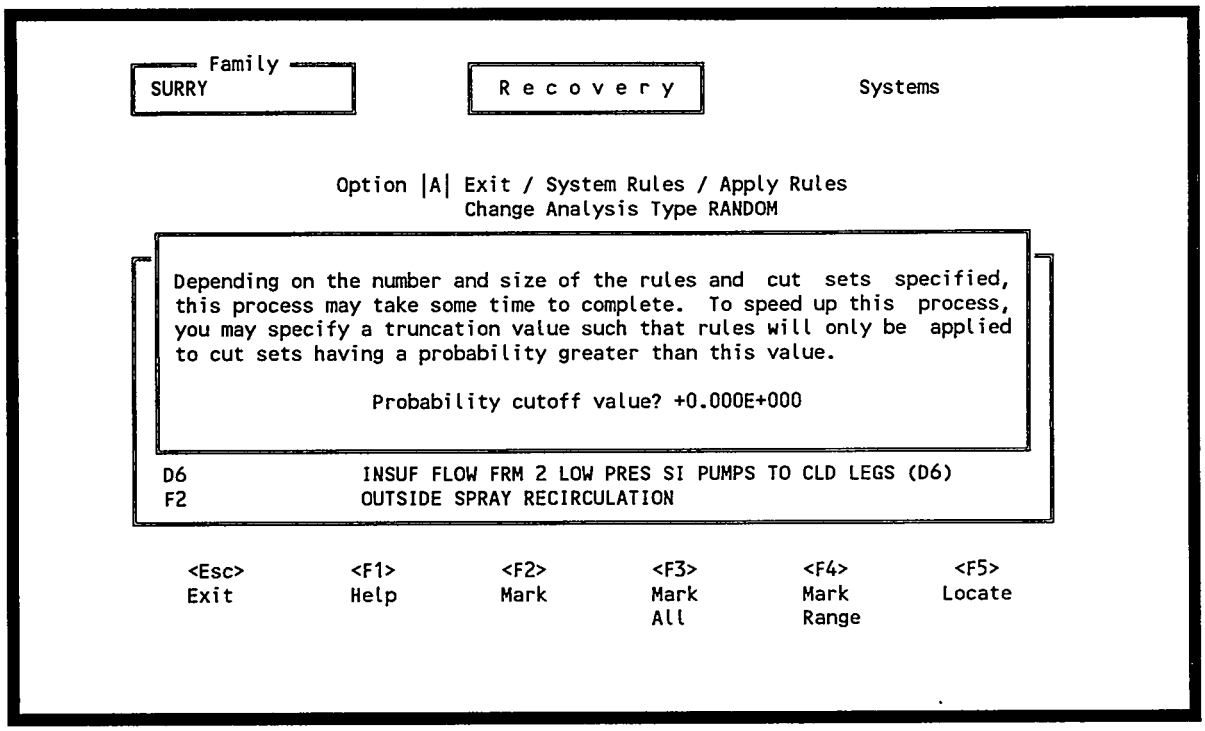


Figure 102. Enter probability cutoff value to apply rules.

6.6 Logic Editor

This option allows you to modify the logic of a system or subsystem. When you invoke this option, Figure 103 will be displayed. You may toggle the display to list systems or subsystems (see Section 6.6.3). Three options are available: Exit, Logic Editor, and Sub-systems.

6.6.1 Exit

This option terminates the process and returns you to the Fault Tree Analysis screen (Figure 55). To invoke this option, enter an <E> in the option field and press <Enter>, or press the <Esc> key.

6.6.2 Logic Editor

To invoke this option, enter an <L> in the option field, highlight the desired system, and press <Enter>. If you do not highlight a system, the message **A record must be highlighted first** will be displayed. After highlighting a system and pressing <Enter>, Figure 104 will be displayed. All gates, types, and inputs contained in the selected system or subsystem will be displayed. Several options are available from this screen. Each option will be discussed in the following paragraphs.

6.6.2.1 <Esc> - Exit. This option terminates the process and returns you to the System Logic Editor screen. To invoke this option, and press <Esc>.

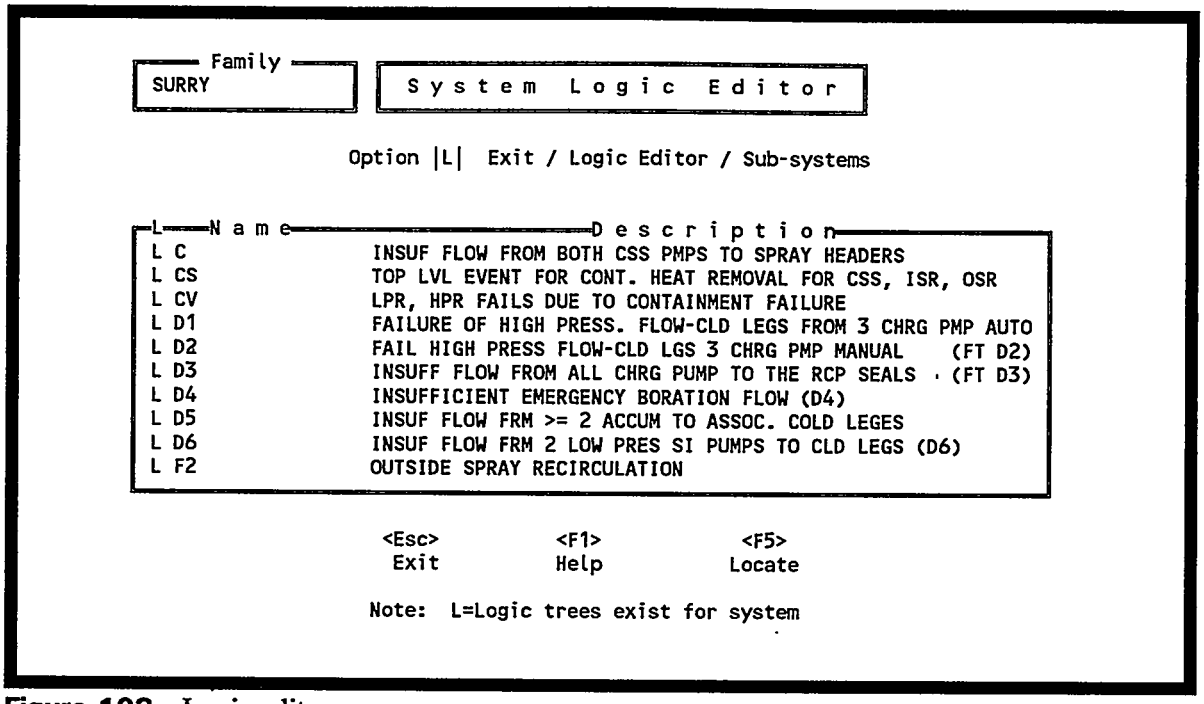


Figure 103. Logic editor menu.

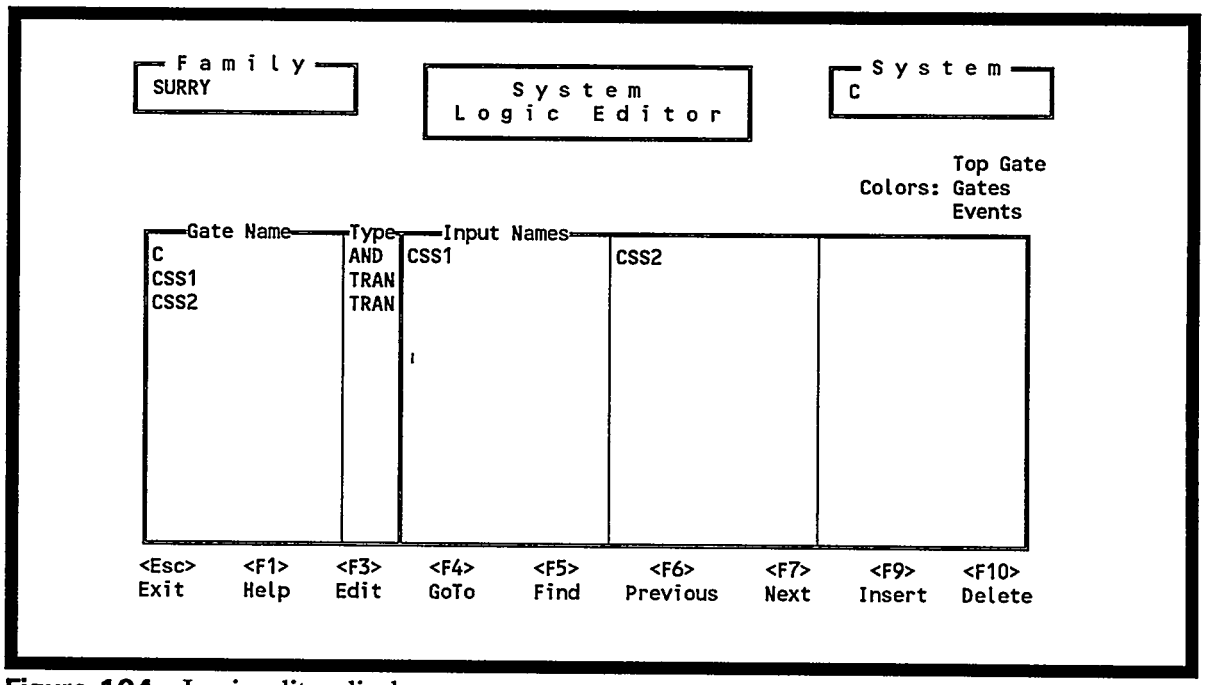


Figure 104. Logic editor display screen.

6.6.2.2 <F1> - Help. Depending upon where the cursor is positioned when the <F1> key is pressed, a scrolling help form will list all the gates, types, or inputs available in the database.

If you press <F1> while positioned in the Gate Name column, the help form shown in Figure 105 will be displayed. This screen lists all the gates defined in the database. A dash (-) in front of the gate name indicates that the gate is not currently in the system; if left blank, the gate is in the system. From this screen, you can replace an existing gate or add a new gate to the system. For example, if an existing gate is highlighted when <F1> is pressed, the gate you select from the help form will replace the highlighted gate. On the other hand, if you pressed <F9> before invoking the help screen, the gate you select from the help form will be added to the list (see Section 6.6.2.8).

Whether adding or replacing a gate, when <F1> is pressed the help screen shown in Figure 105 will appear. To select a gate from this list, two methods are available. First, you can use the arrow or <PgUp> and <PgDn> keys to scroll through the list until the desired gate is highlighted. Once the desired gate is highlighted, press <Enter>.

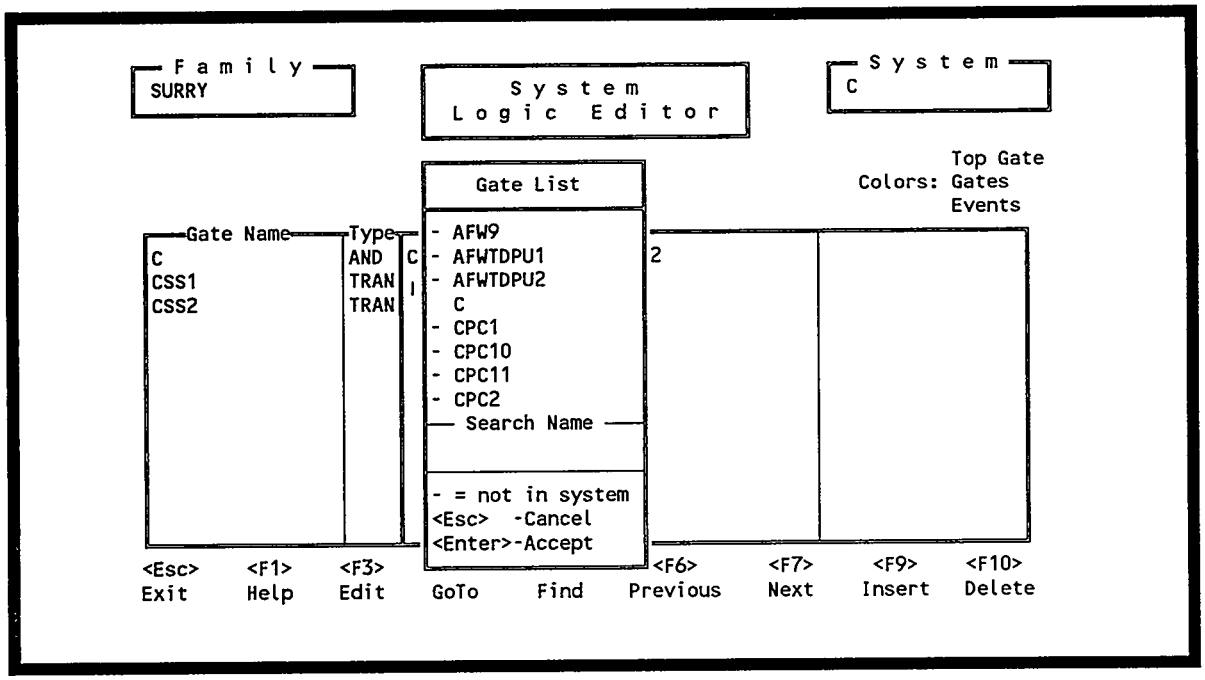


Figure 105. Help list to select a gate.

The help and selection screen for the Type column operates in a similar fashion as described above. To replace a gate type, highlight the type to be replaced or inserted and press <F1>. The help screen for the Type column is shown in Figure 106. Select the desired type and press <Enter>.

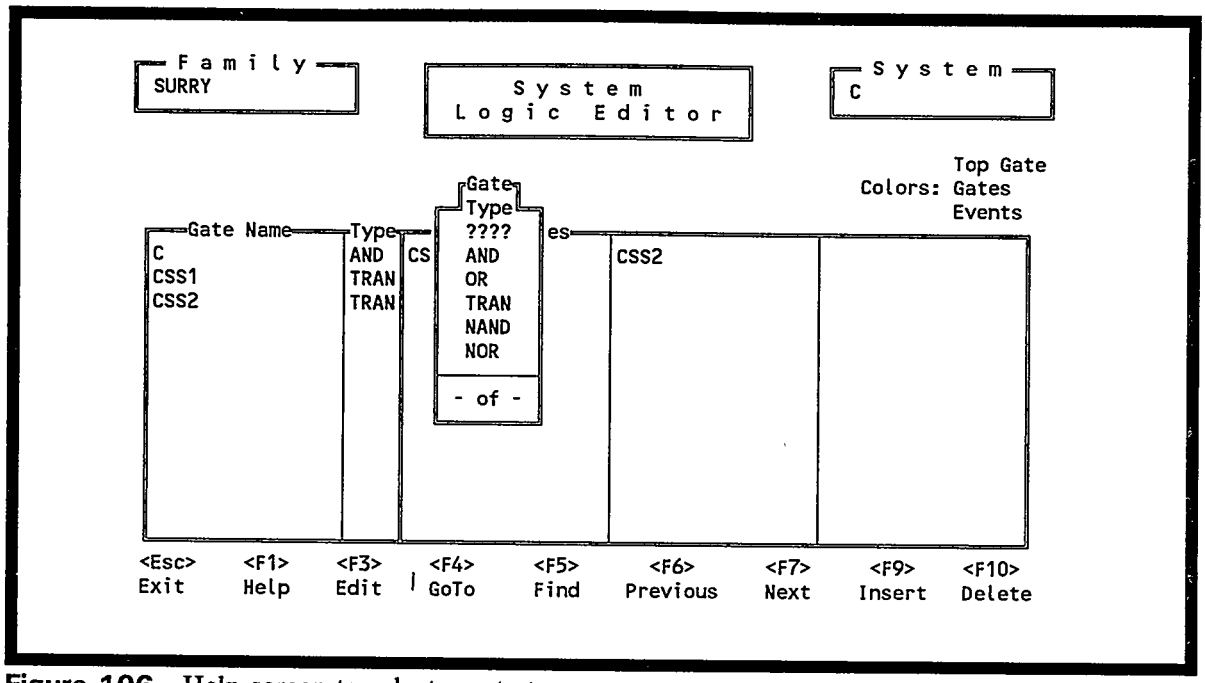


Figure 106. Help screen to select a gate type.

Two types of inputs can be entered in the Input Name column: gates and events. Therefore, two different help and selections screens are available. When the cursor is positioned in the Input Name column, press <F1>. The help screen shown in Figure 107 will appear. This screen lists all the gates in the database (the event side of the help screen will be blacked-out). The locate and select functions work the same on this screen as described above for gates. However, if you wish to enter an event, press the <Tab> key once. The screen shown in Figure 107 (the gate side of the help screen will be blacked-out) will appear. Once again, the same locate and search functions are available here as were described earlier.

6.6.2.3 <F3> - Edit. This option allows you to modify any of the data displayed on the screen. To invoke this option, highlight the gate, type, or input name you wish to modify and press <F3>. If you highlight a gate name and press <F3>, a screen similar to the one shown in Figure 108 will be displayed. On this screen, you may modify the gate name, description, or type by simply typing over existing data. When complete, press <Enter> to save the changes (M - Modify is the default option) or press <Esc> to exit without saving any of the changes.

If you highlight a type and press <F3>, Figure 109 will appear. Use the arrow keys to highlight the desired type and press <Enter> (press <Esc> to exit without changing the type). Upon pressing <Enter>, the selected type will overwrite the highlighted type.

If you highlight an event and press <F3>, Figure 110 will appear. On this screen you can modify the failure data, uncertainty data, seismic fragility, attributes, transformations, and susceptibilities. This screen is discussed in the Modify Data Base option in Section 10.3. Refer to that section for details.

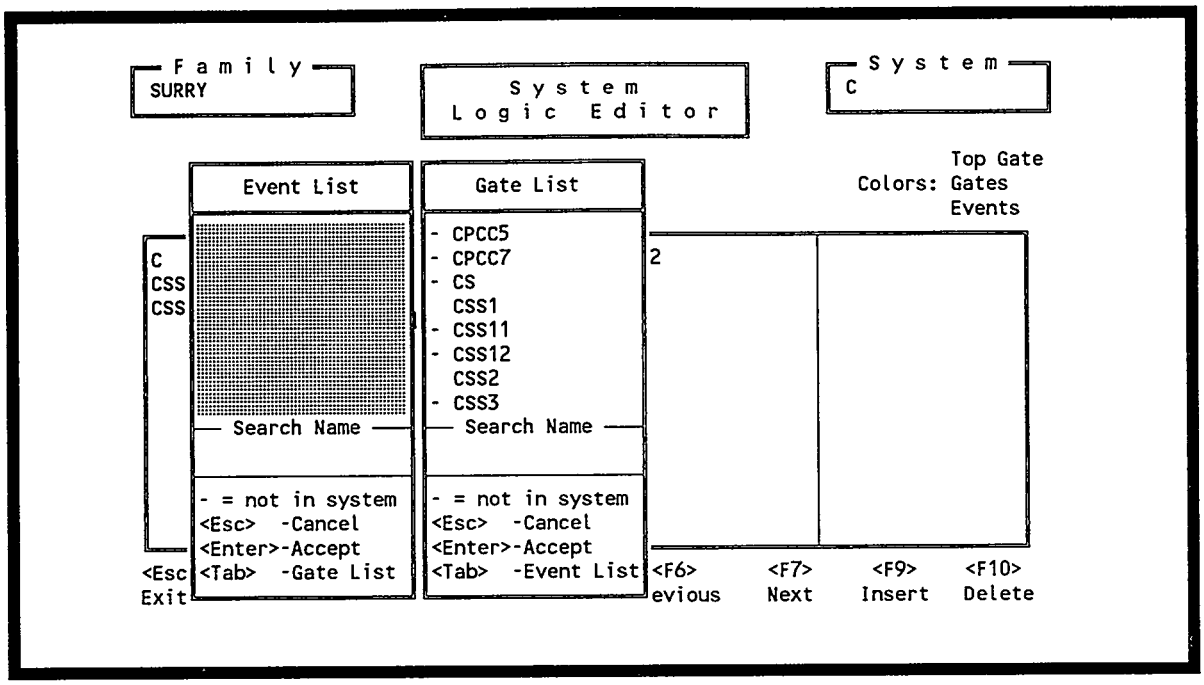


Figure 107. Help screens to select gate or event.

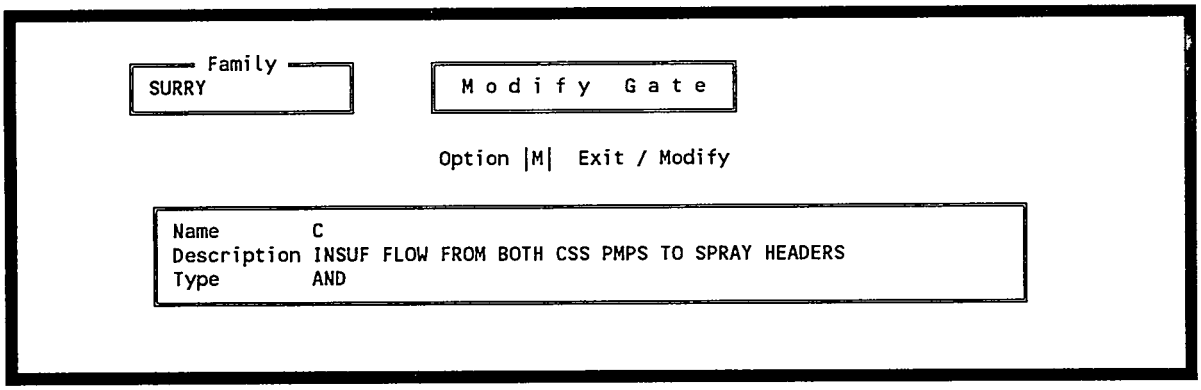


Figure 108. Modify gate information.

6.6.2.4 <F4> - GoTo. This option can be used only on transfer gates. This option transfers you to the system specified by the transfer gate. To invoke this option highlight a transfer gate and press <F4>.

6.6.2.5 <F5> - Find. This option is used to locate a specific event, gate, or type. To invoke this option, press <F5>. The screen shown in Figure 111 will be displayed. This screen lists all the events currently stored in the database. To locate a specific event, use the arrow keys or the <PgUp> and <PgDn> keys to highlight the desired event. Or, you may invoke the speed search function. To invoke the speed search function, type the first character or the first few characters of the event name. As each letter is typed, the event name that most closely matches the typed characters will be highlighted. In either case, once the desired event is highlighted, press <Enter>. Figure 112 will be displayed. From this screen, you can perform the following:

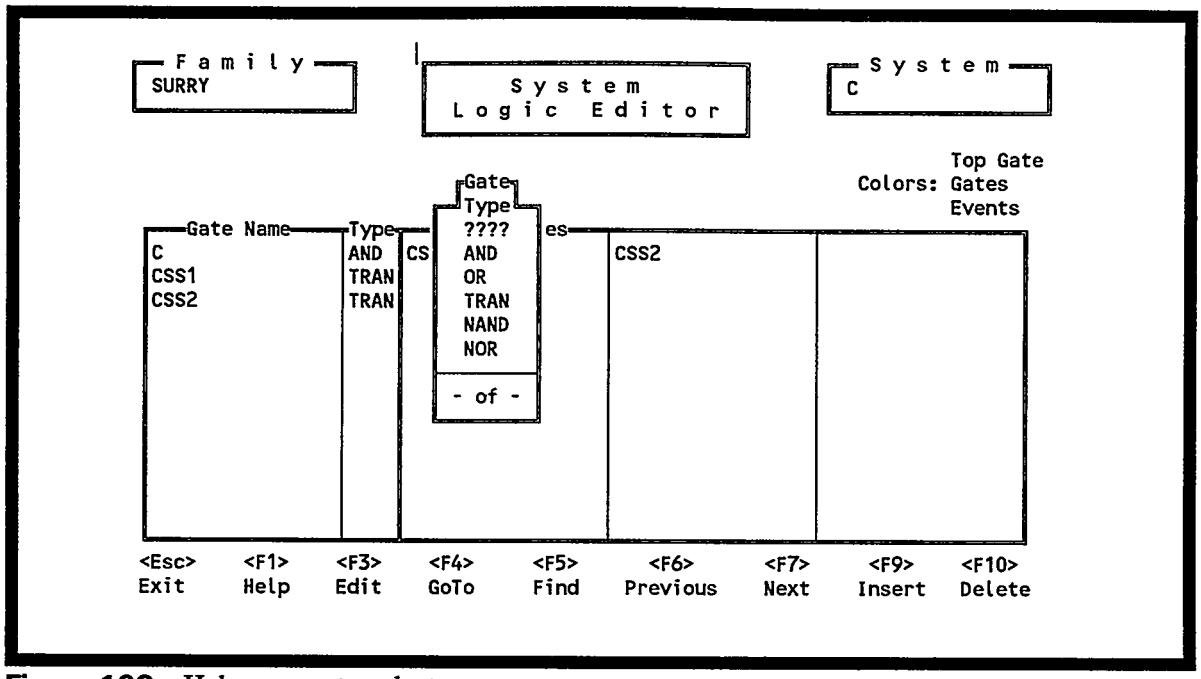


Figure 109. Help screen to select a gate type.

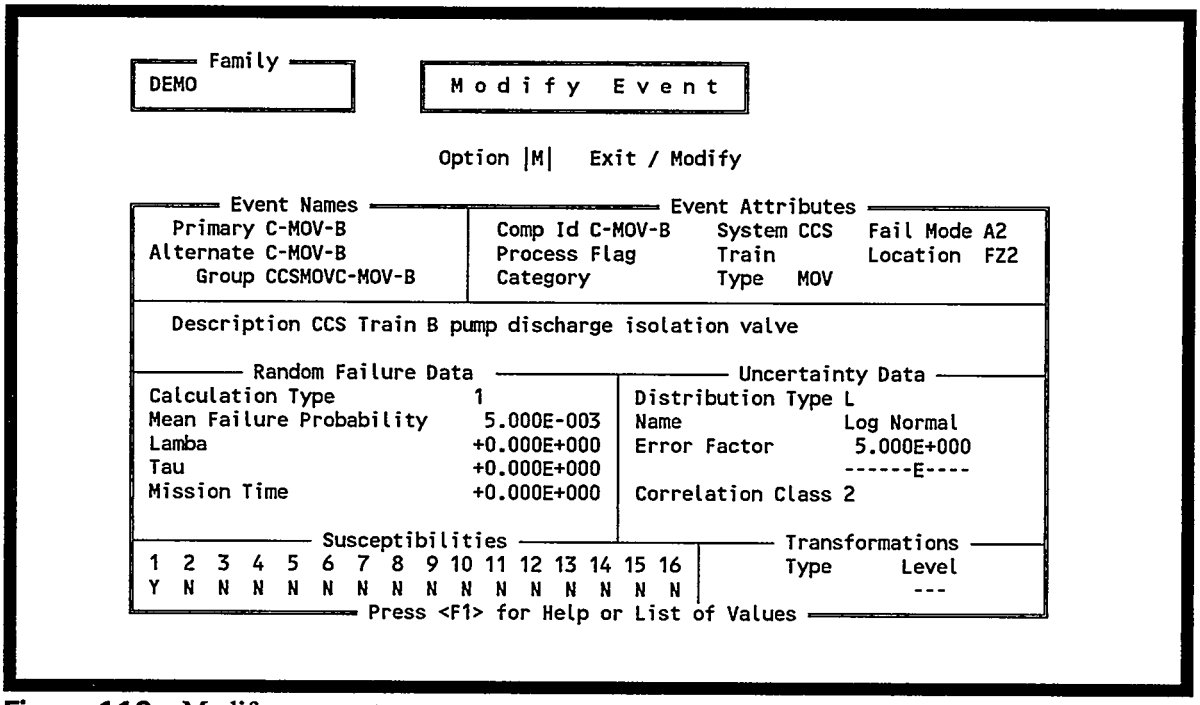


Figure 110. Modify an event.

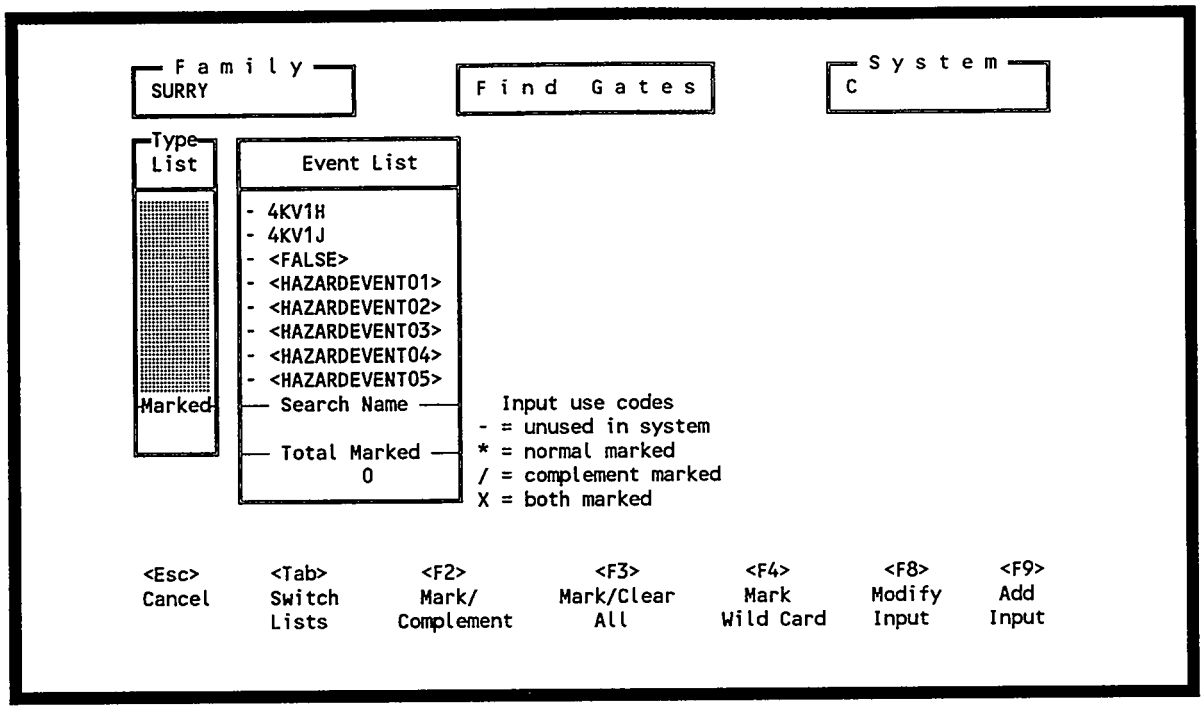


Figure 111. Find a specific gate, gate type, or event.

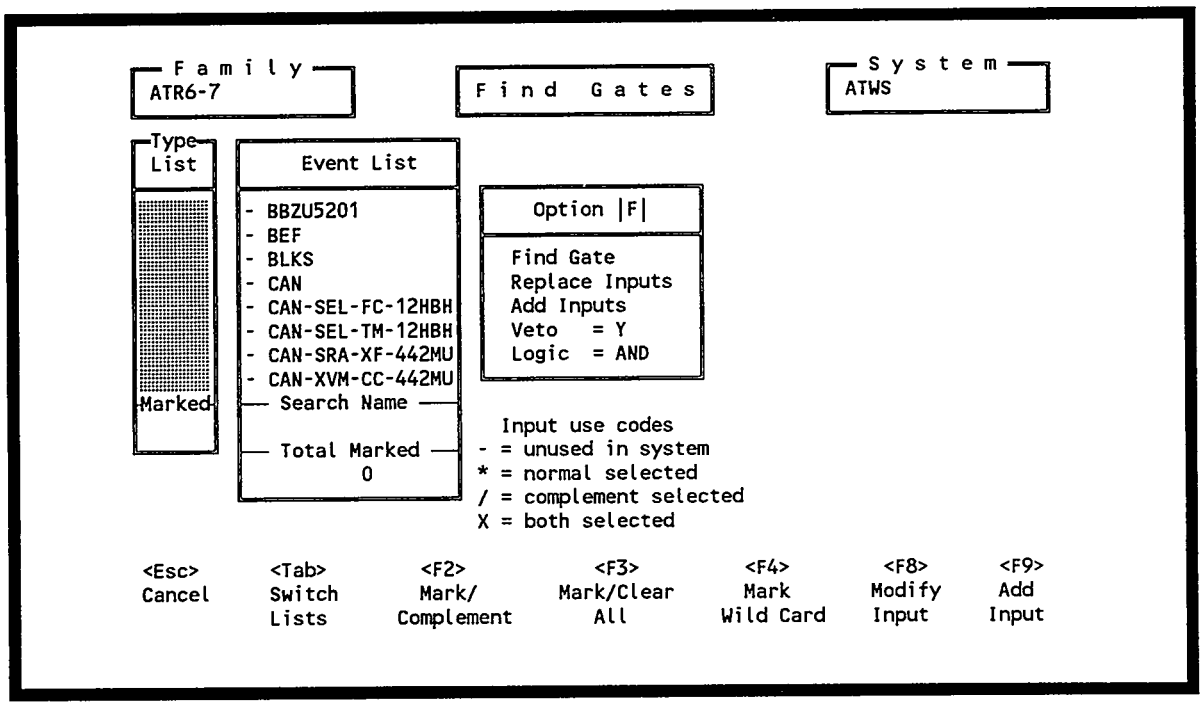


Figure 112. Find suboptions menu.

Find Gate - This option will locate the specified event or gate located in the previous step.

Replace - This option allows you to replace the event specified in the previous step (i.e., the "find" name) with an event from a selection list. When you invoke this option, a selection list will appear (see Figure 111) from which to chose the event used in the replacement.

Add Inputs - This option allows you to add a new gate or event into the selected system or subsystem. When you invoke this option, the event selection list will appear (see Figure 113). Locate the event to add using the arrow keys or the speed search function as described earlier. Once the desired event is highlighted, press <Enter>. The event will be added.

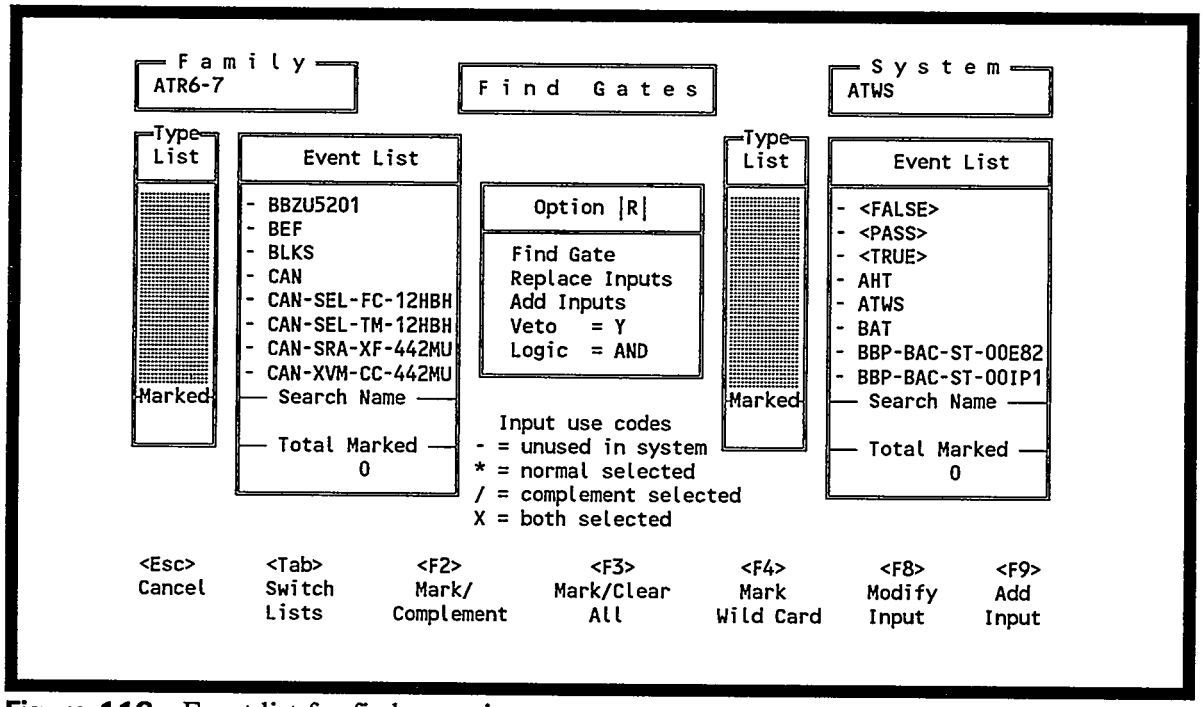


Figure 113. Event list for find operation.

Veto - This is a toggle. Veto tells each operation to ask again of you wish to modify the data. By default, this is set to Y. To change the default, press <Enter>.

Logic - This is a toggle. By default, this is set to AND. If Logic is AND then the search must include all the items in the search criteria. If the logic is set to OR then any item in the search criteria will satisfy the condition. To change the default, press <Enter>.

NOTE: These same options are available to modify gates and types. Press <Tab>, described below, to change the event list, to a type list or to a gate list.

From Figure 111, the following functions can be performed:

<Esc> - Terminates this option and returns you to the previous screen.

<Tab> - This option switches the selection lists from events, to gates and to gate types.

<F2> - This option allows you to mark a used event:

* - selected
/ - as a complement
X = as selected and as a complement.

<F2> is a toggle. Press <F2> until the desired setting is reached.

<F3> - This option allows to clear all marked items or mark all items, depending on the current status of the list.

<F4> - This option allows you to mark items using wildcard specifications. When you invoke this option, Figure 114 will be displayed (if the event list is invoked) or Figure 115 (if the gate list is invoked).

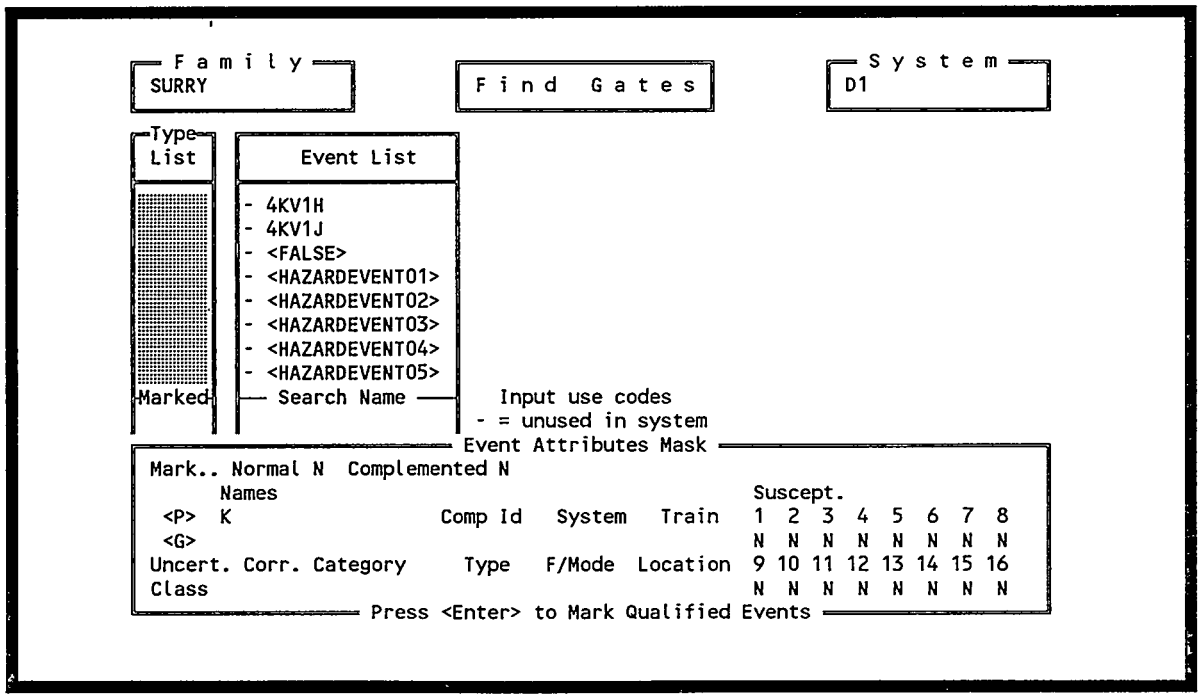


Figure 114. Event attributes mask.

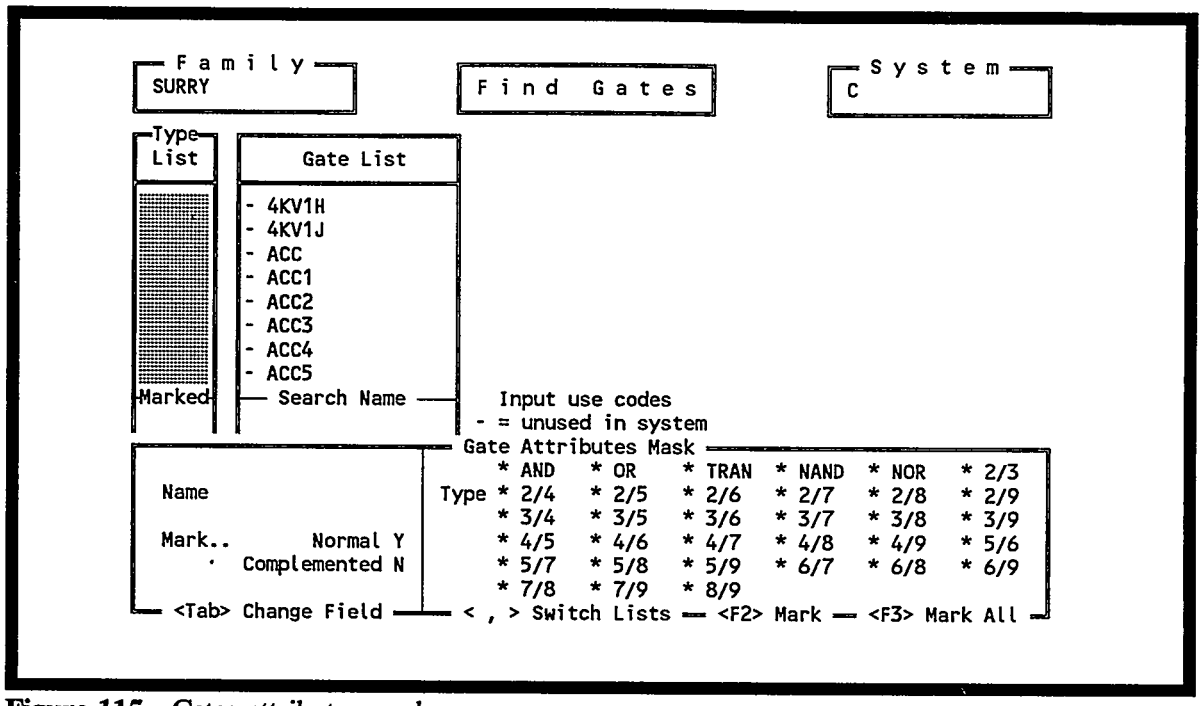


Figure 115. Gates attributes mask.

<F8> - This option allows the user to modify the currently selected gate or event.

<F9> - This option allows the user to add either a gate or an event.

6.6.2.6 <F6> - Previous. The <F6> key will highlight the previous record that was located via the Find option. A successful Find operation must be performed before using this option.

6.6.2.7 <F7> - Next. The <F7> key will highlight the next record that was located via the Find option. A successful Find operation must be performed before using this option.

6.6.2.8 <F9> - Insert. This option allows you to insert a gate or event name. If the cursor is positioned in the gate name column when <F9> is pressed, a blank line appears at the beginning of the gate name column. At this point, you may enter the gate name or you may press <F1> to bring up a selection list. In either case, once an event in entered or selected, press <Enter>. The gate will be added to the list.

6.6.2.9 <F10> - Delete. This option allows you to delete any gate or event displayed on the screen. To invoke this option, highlight the gate or event you wish to delete and press <F10>. When deleting a gate, a confirmation screen will appear asking of you really want to delete this gate. Enter a Y and press <Enter> to continue with the deletion or enter an N and press <Enter> to terminate without deleting the gate. When deleting an event, no confirmation window is displayed. The event is deleted immediately upon pressing <F10>.

6.6.3 Sub-System

Toggles the System Logic editor display to list systems or subsystems on the screen. To invoke this option, enter an <S> in the option field, and press <Enter>. To toggle back to the previous display, simply enter an <S> in the option field and press <Enter>.

6.7 Seismic Plotting

This option allows you to plot seismic curves for a family. A seismic curve shows discrete points as a distribution and reflects the differences of opinion among experts for the frequency of earthquakes at a given site. When you invoke this option Figure 116 will appear. As shown, this screen provides the following options:

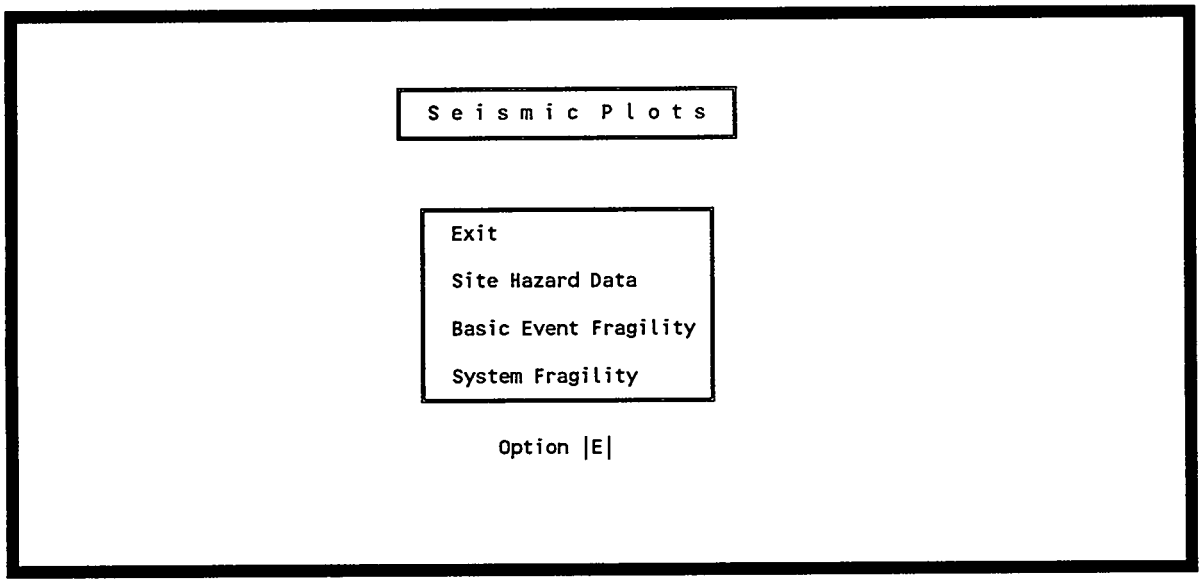


Figure 116. Seismic plotting main menu.

Exit - This option returns you to the Fault Tree Analysis menu.

Site Hazard Data - If the three site curves (low, medium, high) have been defined, each of them will be plotted showing the annual frequency of exceedance along with the 'Y' axis and the peak ground acceleration along the 'X' axis. A plot can be outputted to the screen, a printer, or a file.

Basic Event Fragility - Each basic event may have a fragility curve which represents its failure rate based upon a ground acceleration instead of calculating it with the formula. If fragility curve is used, it will be plotted. If the formula is used, a curve will be generated from the formula, and plotted. Plots may be created using both as well. Only basic events of failure type 'G' can be plotted. A plot can be outputted to the screen, a printer, or a file.

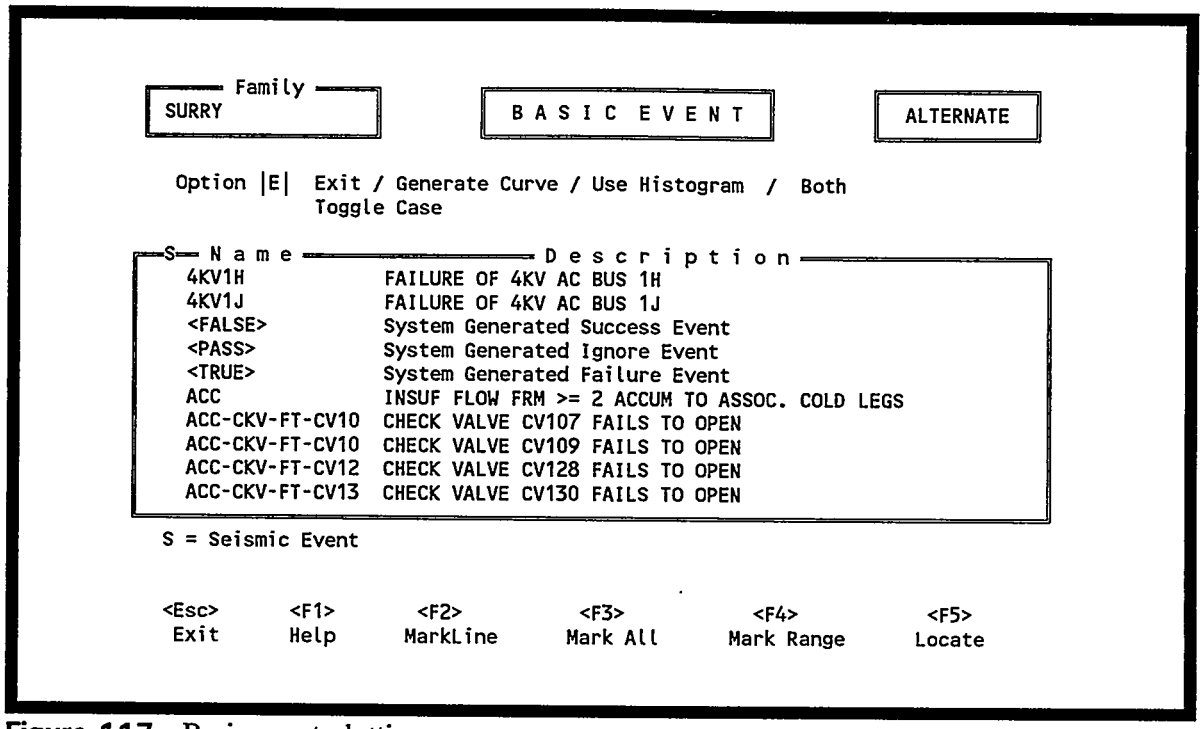


Figure 117. Basic event plotting.

System Fragility - The system fragility plot generates a curve of the G-levels in the Site Hazard curves versus the minimum cut upperbound for the corresponding G-levels for the system. when you invoke this option, Figure 118 appears. From this screen, the following options are available:

Plot Curve - This option plots a fragility curve for the selected seismic events. Each basic event must have a mincut for each seismic level. Highlight the desired event and press <P>.

Toggle - Toggles for alternate to base case events.

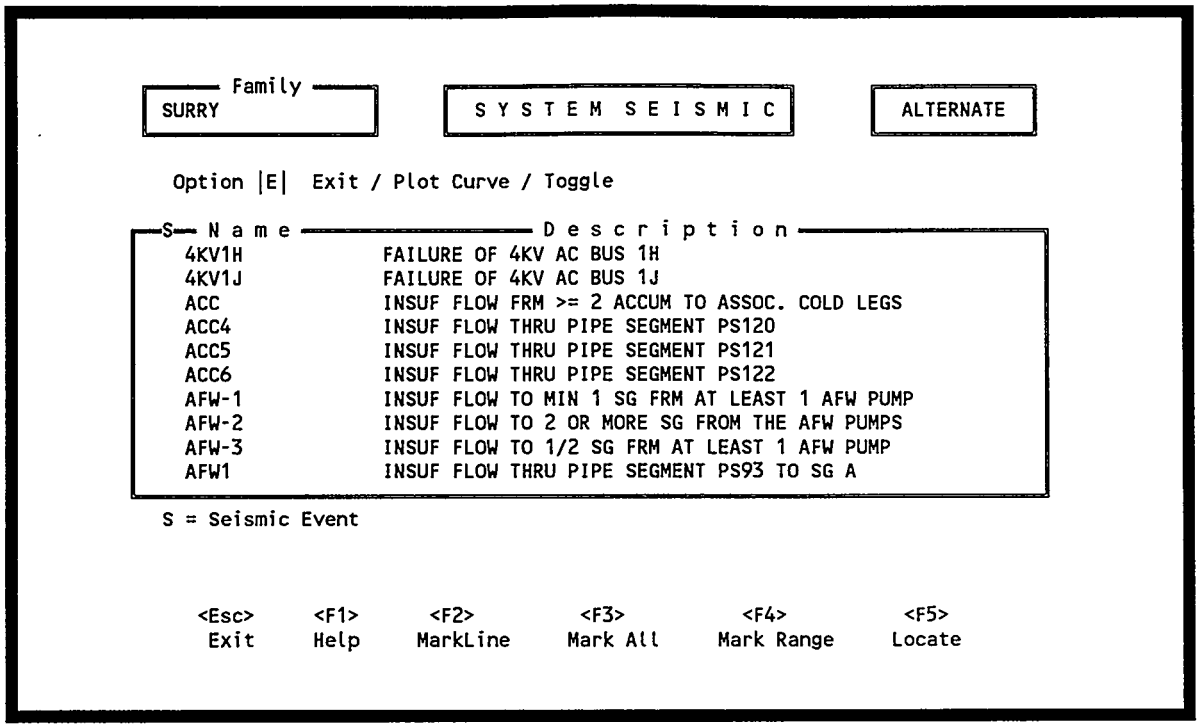


Figure 118. System fragility plotting.

7. CREATE EVENT TREES

This option allows you to build and edit event trees graphically and output them to several hard copy hardware devices. To select this option, highlight the "CREATE Event Trees" option on the IRRAS main menu or enter a <C> and press <Enter>. When you invoke this option, Figure 119 will be displayed. As shown, the following options are available:

Exit	This option returns you to the IRRAS main menu.
Create Event Trees	This option allows you to build and edit event tree diagrams.
Link Event Trees	This option allows you to define linkage rules and generate sequence logic.
Plot Trees	This option allows you to plot graphics' files or generate HPGL formatted files.
Graphics Load	This option allows you to load event tree graphic files (i.e., .ETG files).
eXtract Event Trees	This option allows you to extract event trees, clear extracted event trees, and display extracted event trees.
Define Plotter Pens	This option allows you to assign colors to your plotter pens.

Each of these options is discussed in the following paragraphs.

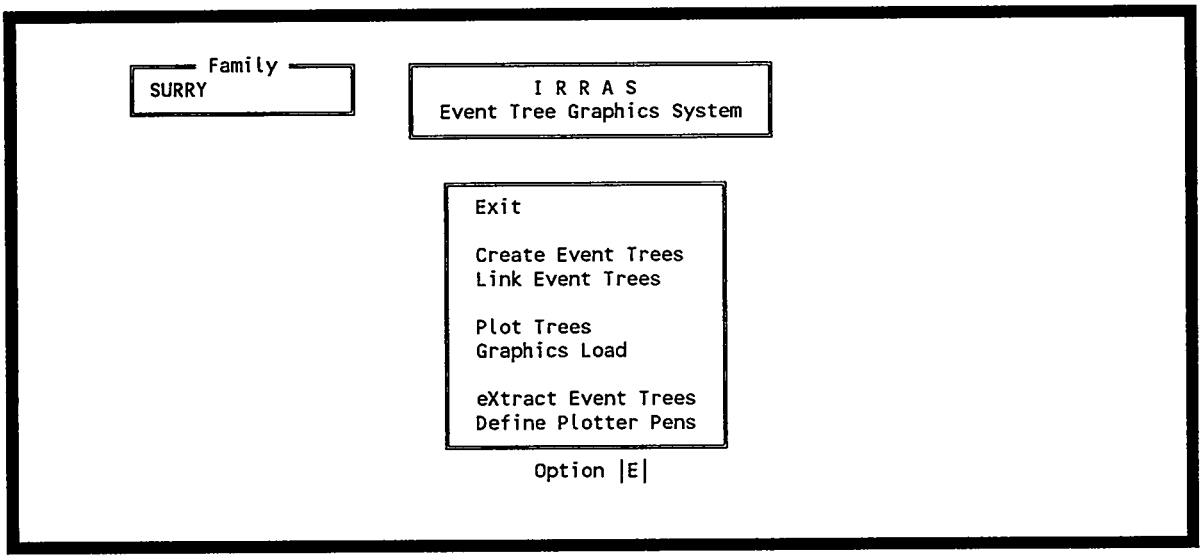


Figure 119. Event tree graphics system menu.

7.1 Exit

This option terminates the event tree option and returns you to the IRRAS main menu. To invoke this option, highlight the Exit option and press <Enter>.

7.2 Create Event Trees

This option allows you to construct or edit an event tree diagram. You may start building the diagram from scratch or from an existing file to generate or modify logic. When this option is selected, Figure 120 is displayed. The editing commands are shown in the left column, while the remaining screen is the drawing surface. The commands shown in all upper-case letters (excluding EXIT) have additional pop-up menus associated with them. The cursor is used to position pop-up menus and select menu options.

To invoke any of the editing commands (using a mouse), position the cursor over the desired editing command on the active menu. The active menu is the last menu you pulled up or moved. When the editing command box is highlighted (a white line outlines the box), press the left mouse button. The command is now invoked. Each editing command is described in the following paragraphs.

7.2.1 EXIT

This option terminates the editing session and returns you to the previous screen (Figure 119). To invoke this option, position the cursor over the EXIT box and press the left mouse button or <Enter>.

7.2.2 Move (↔)

The move command, which is represented by ↔, allows you to position the editing command menu anywhere on the screen. When you invoke this command, a white outline surrounds the entire editing column. Drag the cursor to position the outline at the desired location and press the left mouse button or <Enter>. The menu will be displayed at the new location.

7.2.3 Show

This command clears the screen and redisplays the currently defined diagram.

7.2.4 EDIT

This command allows you to make changes to the event tree. When you invoke this option, an additional pop-up menu is displayed (Figure 121). As shown, six options are available: EDIT, Add, Del, Copy, Pass, and Page.

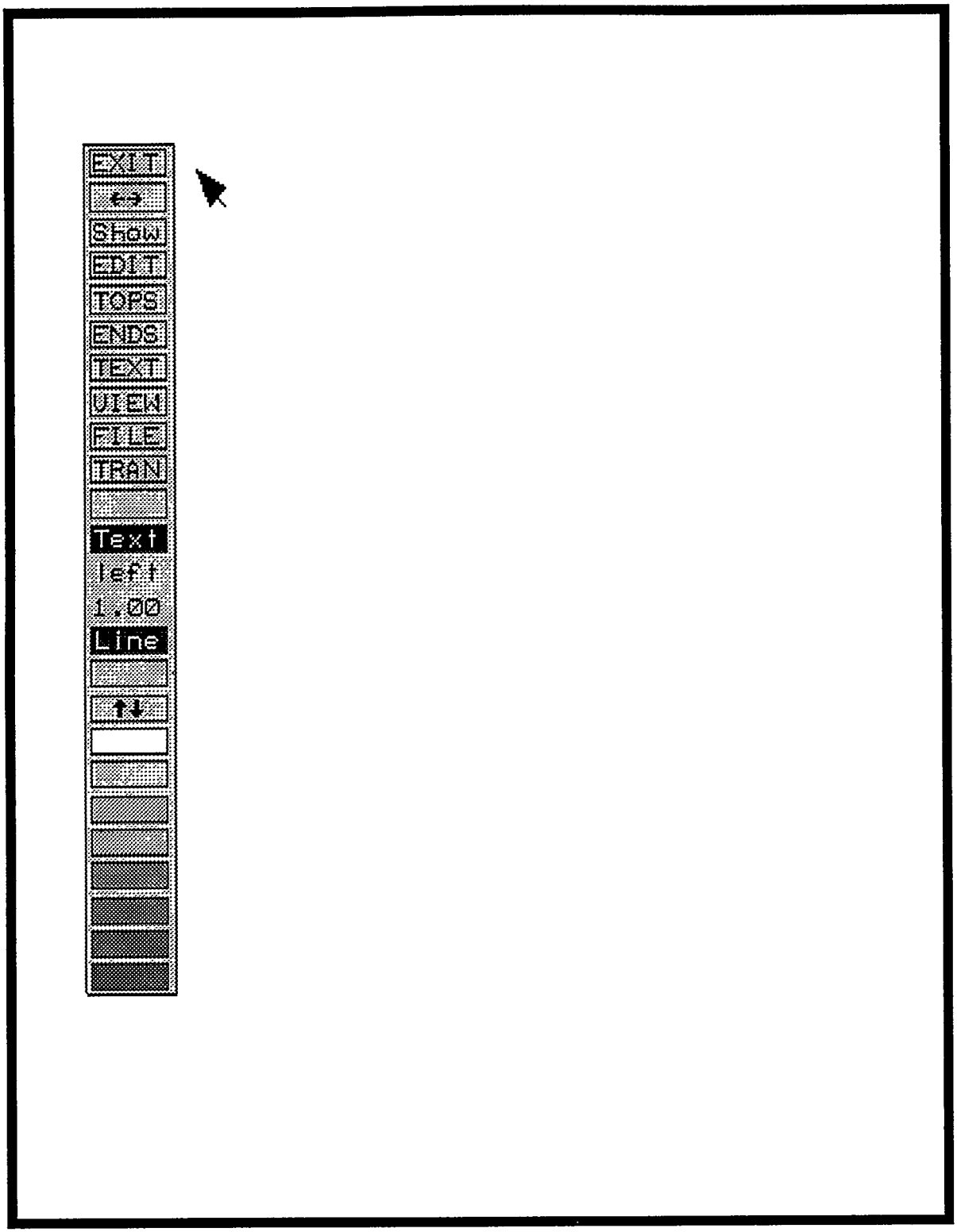


Figure 120. Create event tree editing commands.

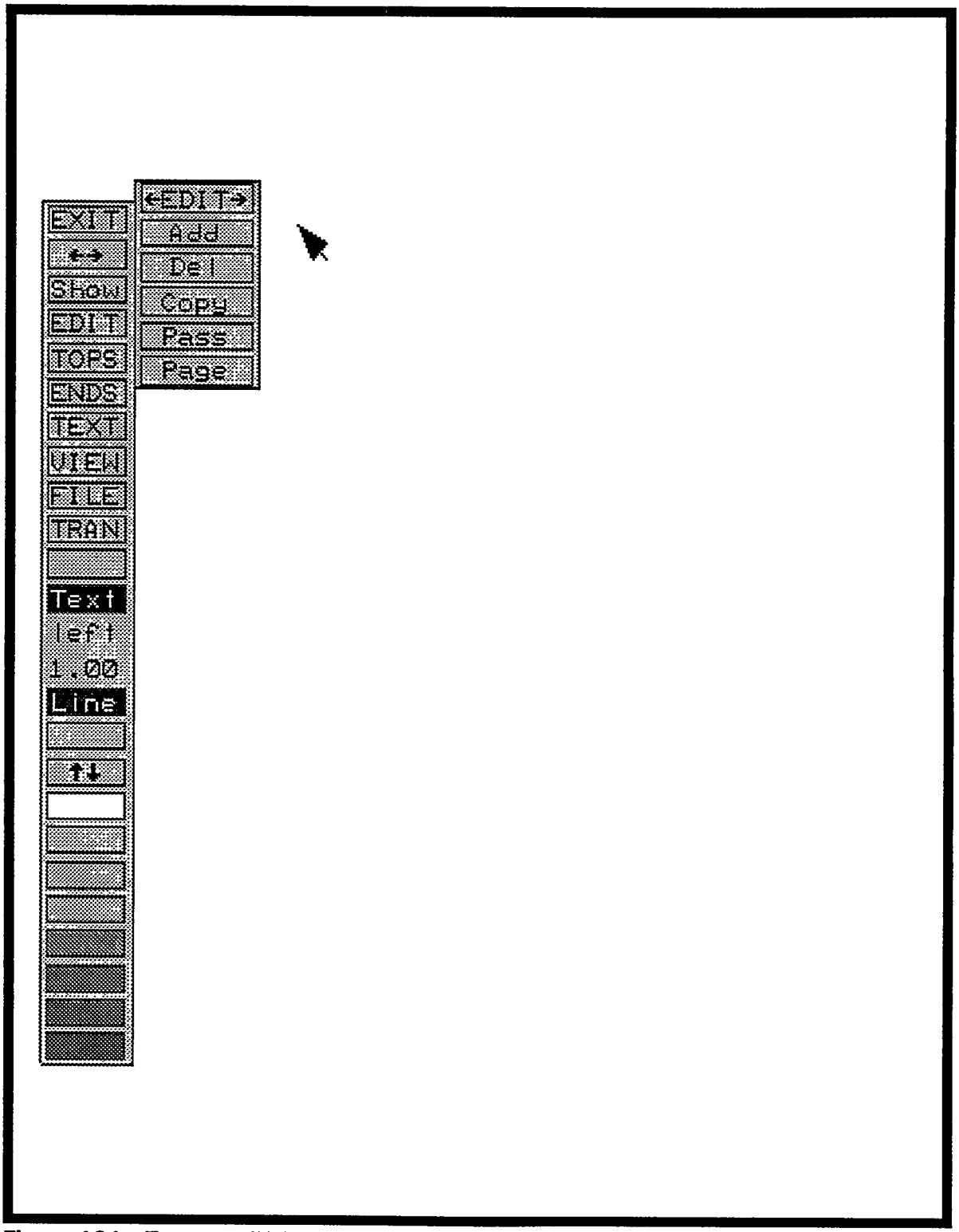


Figure 121. Event tree EDIT pop-up menu.

7.2.4.1 ←EDIT→. This option allows you to move the pop-up menu to a new location on the screen. To invoke this option, position the cursor on the ←EDIT→ box and press the left mouse button. An outline will appear. Move the outline to the new location on the screen and press the left mouse button. The menu will be moved to the new location.

7.2.4.2 Add. This option allows you to add a branch to the event tree. When you invoke this option, you will be prompted to **Pick the intersecting point of the new branch.** The cursor will change from a filled cursor arrow to an 'empty' cursor arrow. Position the cursor over the place where the new branch is to be added and press the left mouse button. A small box will appear. Next, you will be prompted to **Pick the vertical position of the new branch.** The vertical position determines whether the new branch will be added above or below the existing branch. Position the cursor at the desired vertical position and press the left mouse button. The diagram is redrawn with the new branch added. The prompt to **Pick the intersecting point of the new branch** will return. At this point, you can select another location to add a branch or press the right mouse button to terminate the add process.

7.2.4.3 Del. This option allows you to delete branches from the tree. When you invoke this option, you will be prompted to **Pick the branch to be deleted**. Position the cursor on the branch to be deleted and press the left mouse button. The selected branch will be highlighted and the message **Delete highlighted branch? Left = YES, Right = NO** will be displayed. If the highlighted branch should be deleted, press the left mouse button; if not, press the right mouse button. If you responded yes, the diagram will be redrawn to reflect the deletion. In either case, the prompt **Pick the branch to be deleted** will return. At this point, you may select another branch to delete, or press the right mouse button to terminate the deletion process.

7.2.4.4 Copy. This option allows you to copy existing branches of the tree to new locations. When you invoke this option, you will be prompted to **Pick beginning of the branch to copy**. Position the cursor at the start of the branch to be copied and press the left mouse button. Next, you will be prompted to **Pick copy location**. There are three ways to use the copy command. In each case you select the existing branch to be copied. Then you may either place the cursor over the start of a pass, at the start of a branch and replace the existing branch, or place the cursor at the start of a branch and add the copied logic to the branch. Depending on the copying method used, you will be prompted with **Replace = Left button, Add = Right button**. If this branch is a replacement for an existing branch, press the left mouse button. If this branch is an addition, press the right mouse button. If this branch is an addition, you will be prompted to **Pick vertical location of the start of new sub-tree**. Pick the new location and press the left mouse button.

7.2.4.5 Pass. This option allows you to change a branch to a pass. When you invoke this option you will be prompted to **Pick the branch that is to be made a pass**. Position the cursor on the branch to be converted and press the left mouse button. The entire branch is highlighted and you will be prompted with **Make highlight branch a pass? Left = YES, Right = NO**. If this is the branch you wish to change into a pass press the left mouse button; otherwise, press the right mouse button. If you respond yes, the branch is converted to a pass. If you respond no, the process is terminated. In either case, the prompt **Pick the branch that is to be made a pass** will return. At this point, you may select another branch, or press the right mouse button to terminate this procedure.

7.2.4.6 Page. This option allows you to separate a large drawing into separate pages. When you invoke this option, you will be prompted to **Pick beginning of the branch to page**. Position the

cursor at the branch where the new page is to start and press the left mouse button. The message **Create Transfer Here? [N]** will appear. If this is the point where the page should appear, press Y; otherwise enter an "N."

When you highlight a section of the drawing and enter a "Y" to transfer, the block will be moved to the next page and a transfer will be created automatically by the system. If you respond "N" to the transfer the diagram will not be broken up and a transfer will not be created. If you respond <Y>, the prompt **Enter the transfer file name>** appears. Enter the file name or press <Enter> to save it to the default *.ETG file. After the file is saved, the prompt **Pick beginning of the next branch to page** will appear. At this point, you may select another location to page or press the right mouse button to terminate the paging process.

7.2.5 TOPS

This option allows you to make changes to the top events. When you invoke this option, an additional pop-up menu will be displayed (Figure 122). As shown, the following options are available: TOPS, Add, Del, Edit, Name?,Width, Size, FONT, and DESC.

7.2.5.1 ←TOPS→. This option allows you to move the pop-up menu to a new location on the screen. To invoke this option, position the cursor on the ←TOPS→ box and press the left mouse button. An outline will appear. Move the outline to the new location and press the left mouse button. The menu will be moved to the new location.

7.2.5.2 Add. This option allows you to add a new event. For example, an event tree might have the existing events 1, 2, 3, and 4. A new event is needed between events 2 and 3. You select this event and will be prompted to **Pick the event that will follow the new event.** The cursor will change from an arrow to a cross hair. Position the cross hair at the desired event (in this example, we would pick event 3) and press the left mouse button. The prompt **Enter new event name:** will be displayed. Enter the event name (up to 16 characters are allowed) and press <Enter>. The diagram will be redrawn and displayed showing the newly added event and the event list will be updated.

7.2.5.3 Del. This option allows you to delete an event. To delete an event, all branch points that logically fall below the event must be converted to passes. When you invoke this option you will be prompted to **Pick the event that is to be deleted.** The cursor will change from an arrow to a cross hair. Position the cursor on the event to be deleted and press the left mouse button. If the branch points have not been converted to passes, the message **The event picked is currently being used in the tree** will be displayed. If you want to delete the event you must go back and convert the branch points using the PASS option under the EDIT command. When the deletion is successful, the tree will be updated and redisplayed.

7.2.5.4 Edit. This option allows you to change an event name. When you invoke this option you will be prompted to **Pick the event name to be edited.** The cursor changes from an arrow to a cross hair. Position the cursor on the event in the diagram or the event name displayed at the top to be renamed and press the left mouse button. The prompt **Enter new event name for xxx:** will be displayed. Enter the new name (up to 16 characters are allowed) and press <Enter>. The event name will be changed at the top of the diagram.

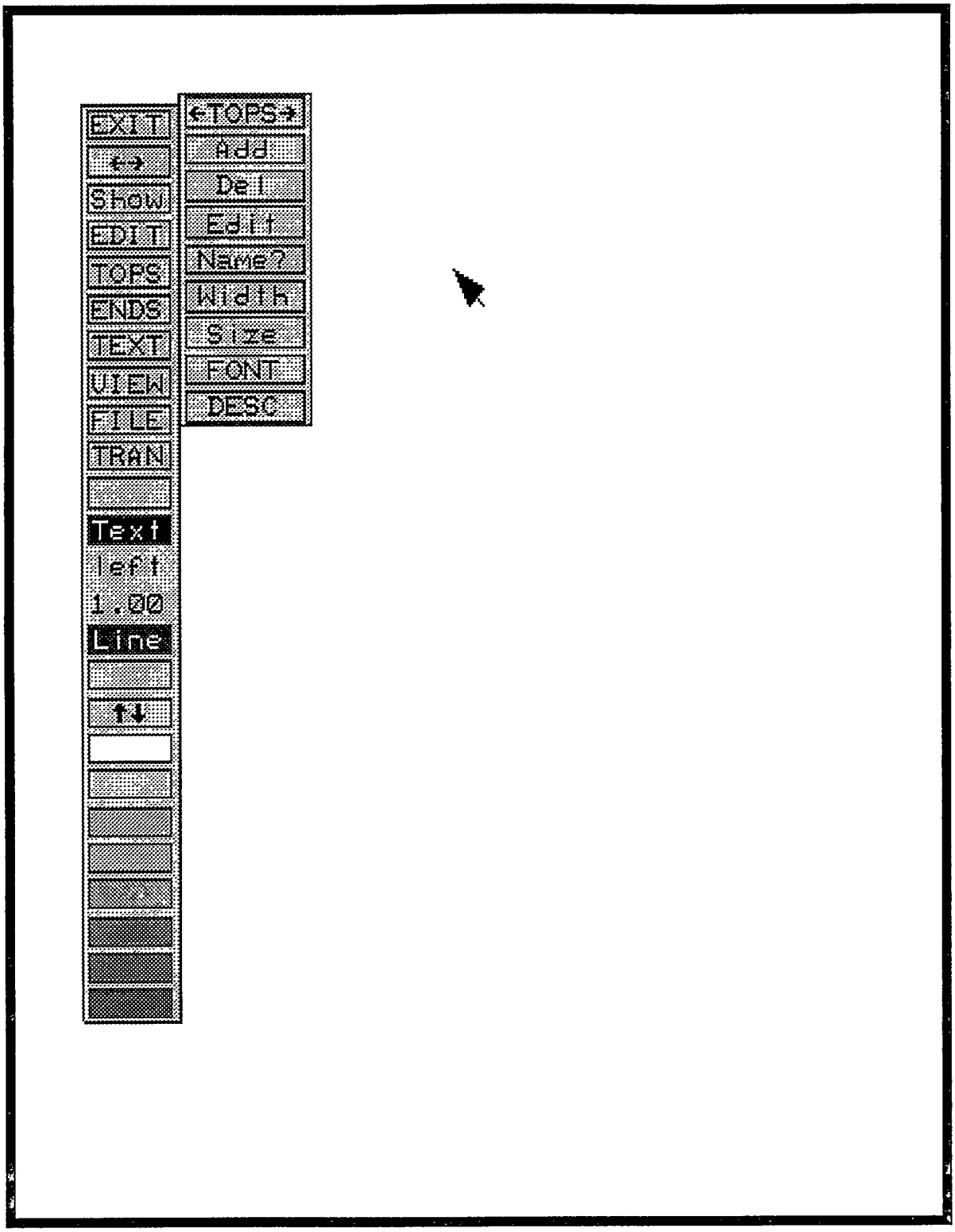


Figure 122. TOPS pop-up menu.

7.2.5.5 Name?. To conserve space on the diagram, a limited number (default is 5) of characters of the event name are displayed on the diagram. Use this option to display the complete event name (all 16 characters). When you invoke this option you will be prompted to **Pick an event name.** The cursor will change from an arrow to a cross hair. Position the cursor on the desired event name at the top of the diagram and press the left mouse button. The entire event name will be displayed on the prompt line at the bottom of the screen. The cross hair will remain so you may select additional event names to display or press the right mouse button to terminate the process.

7.2.5.6 Width. This option allows you to change the displayed width of the event names. When you invoke this option, you will be prompted to **Enter top width size <old size>**. Enter the new top width size and press <Enter>. You may enter a value greater than 1 (default is 5). If you press <Enter> without entering a value, the width does not change. If the width is changed, the tree will be redisplayed with the new width.

7.2.5.7 Size. This option allows you to change the text size of the event names. When you invoke this option, you will be prompted to **Enter new top name text size <old value>**. Enter the new text size and press <Enter>. You may enter a value of 0.01 to 9.00. If you press <Enter> without entering a new value, the text size does not change. If the text size is changed, the tree will be redisplayed with the new top text size.

7.2.5.8 FONT. This option allows you to select the font type for the event names and headers. When you select this option, an additional pop-up menu will be displayed (see Figure 123). Select the desired font type by positioning the cursor over the font and pressing the left mouse button. You must select a font (or cancel) to continue. If the font type is changed, the tree will be redisplayed with the new event name font type.

7.2.5.9 DESC. This option allows you to edit event description text and set various attributes of the descriptions. These attributes include text size, font type, and number of lines of description to display. When you invoke this option, an additional pop-up menu will be displayed (see Figure 124).

7.2.5.9.1 ←DESC→ —This option allows you to move the pop-up menu to a new location on the screen. To invoke this option, position the cursor on the ←DESC→ box and press the left mouse button. An outline will appear. Move the outline to the new location and press the left mouse button. The menu will be moved to the new location.

7.2.5.9.2 Edit—This option allows you to edit or add any event name descriptions contained in the displayed diagram. When you select this option, you will be prompted to **Pick the event description to be edited**. To select the event description to edit, move the cursor over the event or event description and press the left mouse button. A window will appear displaying the selected description and the prompt **Edit Description - Press <Esc> when done** will appear. If no description exists, enter a description. To modify the description, simply type over the existing description. Use the <Ins> and <Del> keys to add and delete characters as necessary. In addition, you may use the Backspace and End keys. The Backspace key deletes the character to the left of the cursor and moves the rest of the characters to the left one space. The End key positions the cursor at the end of the current line. When complete, press <Esc>. You will be prompted to **Pick the event description to be edited**. At this point, you may select another description to edit or press the right mouse button to terminate the process.

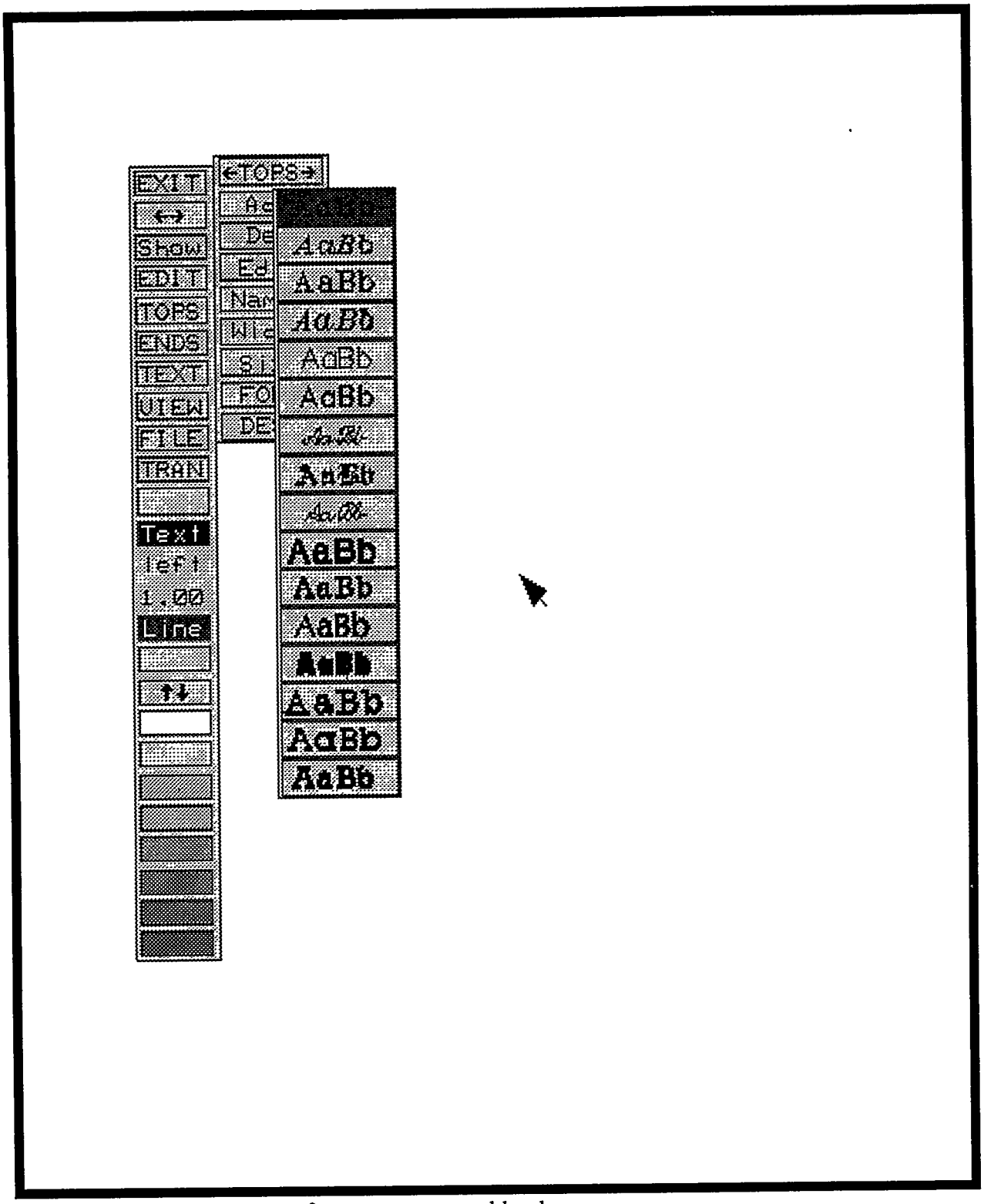


Figure 123. Font type menu for event names and headers.

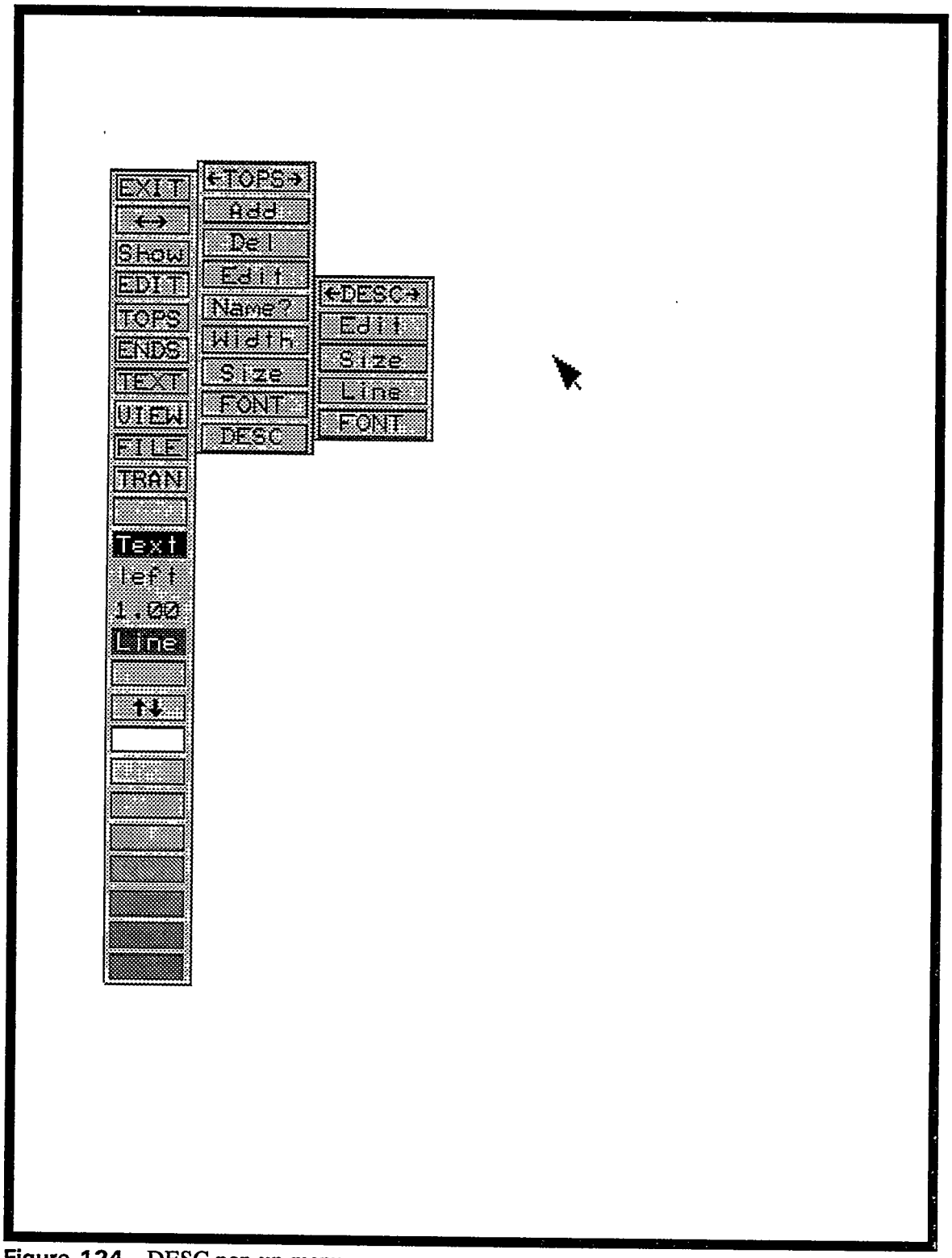


Figure 124. DESC pop-up menu.

7.2.5.9.3 Size—This option allows you to specify the height of the event descriptions in your diagram. The prompt **Enter new top description text size: <old size>** will be displayed. At this prompt, enter the desired text size and press <Enter>. You may enter a value of 0.01 to 9.0. The event descriptions will be displayed in the new size.

7.2.5.9.4 Line—This option allows you to specify the number of lines in event descriptions. When you invoke this option, you will be prompted to **Enter new top description line count: <old count>**. At this prompt, enter the desired line count and press <Enter>. You may enter a value of 0 or greater. The event descriptions will be displayed with the new line count.

7.2.5.9.5 FONT—This option allows you to select the font type for the event descriptions. When you select this option, an additional pop-up menu will be displayed (see Figure 125). Select the desired font type by positioning the cursor over the font and pressing the left mouse button. You must select a font (or cancel) to continue. If the font type is changed, the event descriptions will be redisplayed.

7.2.6 ENDS

A unique number and some textual information appears at the end of each sequence. This information includes the sequence name, end state name, and two other fields used for user-defined information. You may provide a sequence name or the software will use defaults of A, B, C, etc. (See Generating Sequence Logic section for a discussion of using numbers instead of names.) When a branch (sequence) is added, the names or "ends" are given defaults. Each default equates to a blank screen. Also, a display option is given to each end. This allows you to turn on or off the information. Usually you will have the text turned off while building your event tree. Each list or column of information has a header. The header may be placed at any horizontal location. Display information is associated with each header. Individual sequences and/or column information may be turned off or on. Sequence and header information, along with the display and placement attributes, are modified through the ENDS command. When you invoke this command, an additional pop-up menu is displayed (Figure 126). As shown, the following options are available: ENDS, End States, Edit Header, Place Header, Edit Height, Edit Size, and FONT.

7.2.6.1 ←ENDS→. This option allows you to move the pop-up menu to a new location on the screen. To invoke this option, position the cursor on the ←ENDS→ box and press the left mouse button. An outline will appear. Move the outline to the new location and press the left mouse button. The menu will be moved to the new location.

7.2.6.2 End States. This option allows you to display information about the end state. When you invoke this option you will be prompted to **Pick the leaf corresponding to the desired endstate information.** The cursor is placed on the tree at the end of the sequences. The cursor will only move in the vertical direction allowing you to pick only leaf branches. Position the cursor at the desired end state and press the left mouse button. A window will appear displaying the sequence names, end state names, and the data contained in the two user-defined fields for the selected end state. Next, you will be prompted to **Pick the box to be edited**. Position the cross hair over the box to be edited and press the left mouse button. If you choose to edit the sequence names, end state names, or frequency values you will be prompted to **Enter Text:**. Enter the desired text and press <Enter>. If a name already exists, it will be overwritten with the new name you entered.

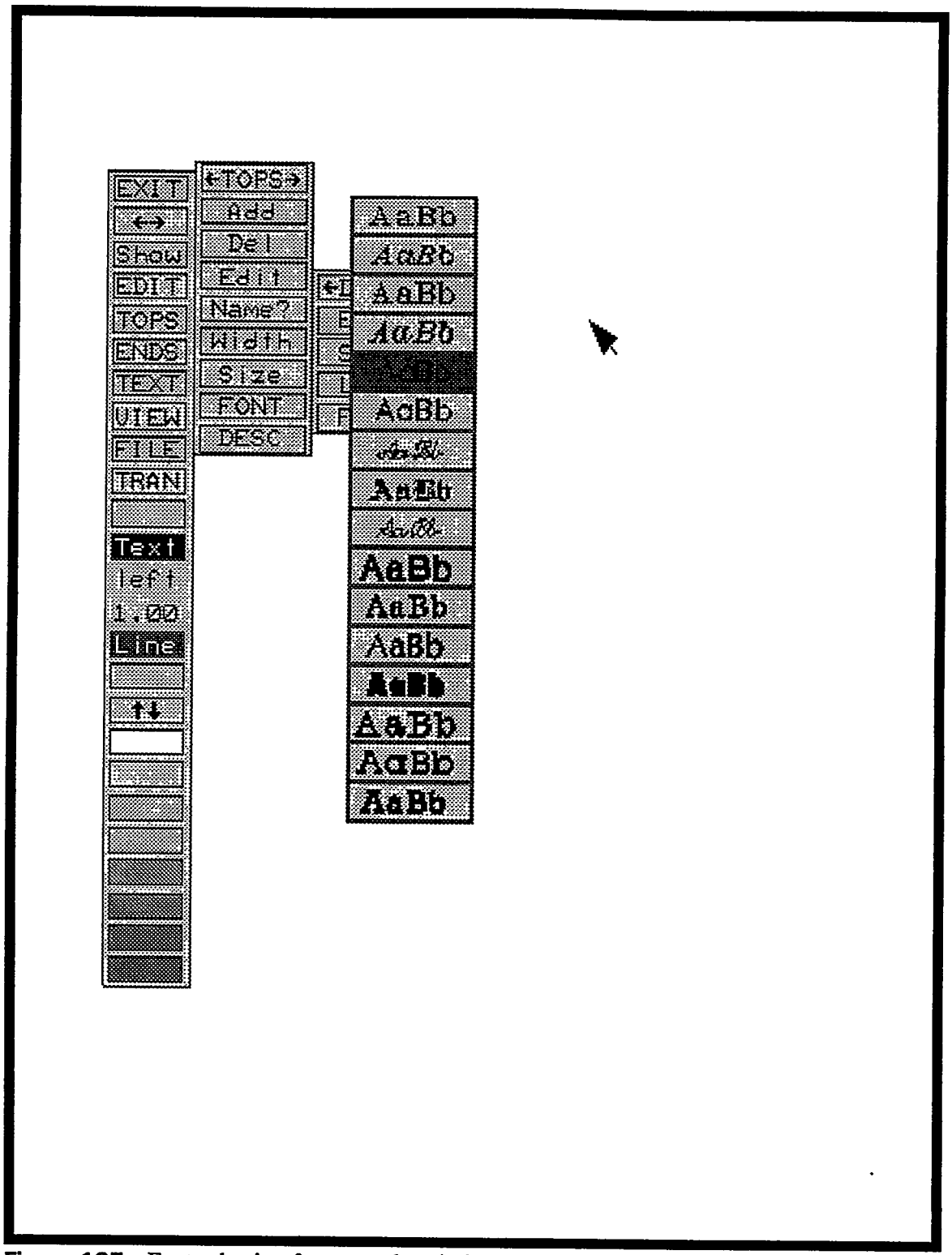


Figure 125. Font selection for event descriptions.

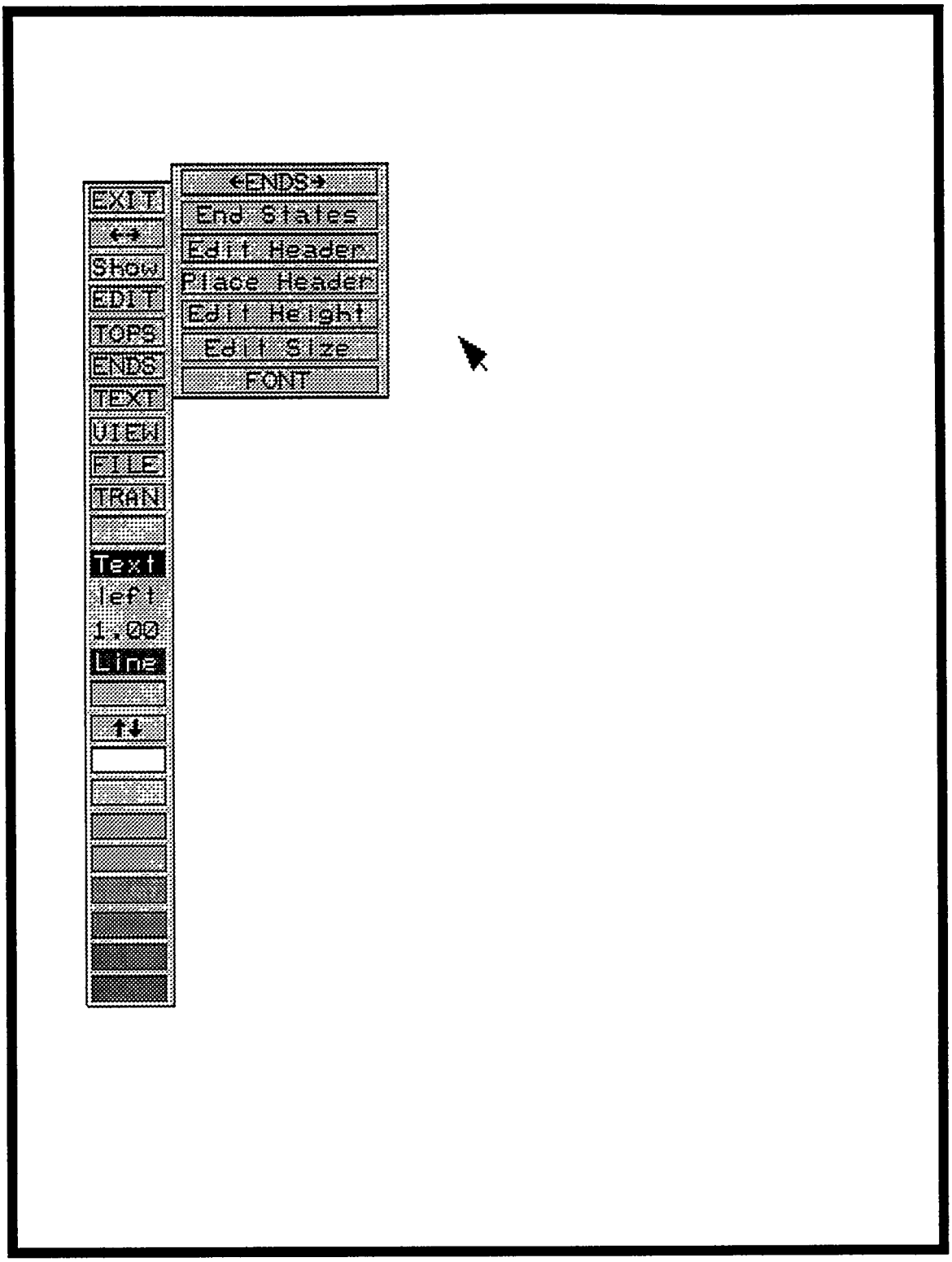


Figure 126. ENDS pop-up menu.

The two remaining fields are toggle switches. The toggles allow you to specify whether or not to display the item.

IRRAS provides four columns of information for the user to add additional information about each sequence in an event tree. IRRAS requires that the first column be the sequence name, the second must be the end state, the third is used to store the sequence frequency, and the fourth is user defined. The column names and positions may be changed by the user, but the information stored in each column must be as explained above.

To terminate this process, press the right mouse button. The window will disappear and you will be returned to the **Pick the leaf corresponding to the desired endstate information** prompt. At this point, you may select another end state or press the right mouse button to terminate the process.

7.2.6.3 Edit Header. This option allows you to edit header information. When you invoke this option, a window appears. This window contains sequence names, end state names, frequencies, and two user-defined fields contained in the header. Next, you will be prompted to **Pick the box to be edited.** Position the cross hair over the box to be edited and press the left mouse button. If you selected to edit sequence names, end state names, or frequency values you will be prompted to **Enter text:**. Enter the desired text and press <Enter>. If the box contained data, it will be replaced by the text you just entered. To terminate this process, press the right mouse button.

7.2.6.4 Place Header. This option allows you to move a header to another location on the screen. When you invoke this option you will be prompted to **Pick the header that is to be relocated.** Position the cross hair on the header contained in the listing on the right side of the screen or on the title to the left of the status/tops line at the top of the screen to be moved and press the left mouse button. You will be prompted to **Pick the placement point for the header**. Position the cursor on the desired location and press the left mouse button. The headers will be moved to the new location. The prompt **Pick the header that is to be relocated** will return. At this point, you may select another header to relocate or press the right mouse button to terminate the process.

7.2.6.5 Edit Height. This option allows you to specify the height or distance between branches (nodes) of the diagram. When you invoke this option, you will be prompted to **Enter new node height <old height> >**. At this prompt, enter the desired node height and press <Enter>. You may enter a value greater than 0.0. The tree will be redisplayed with the new node height.

7.2.6.6 Edit Size. This option allows you to specify the height of the end state text in your diagram. When you invoke this option, you will be prompted to **Enter new end state text size: <old value>**. At this prompt, enter the desired text size and press <Enter>. You may enter a value of 0.01 to 9.0. The tree will be displayed with the new end state text size.

7.2.6.7 FONT. This option allows you to select the font type for the end state text. When you select this option, an additional pop-up menu will be displayed (see Figure 127). Select the desired font type by positioning the cursor over the font and pressing the left mouse button. You must select a font (or cancel) to continue.

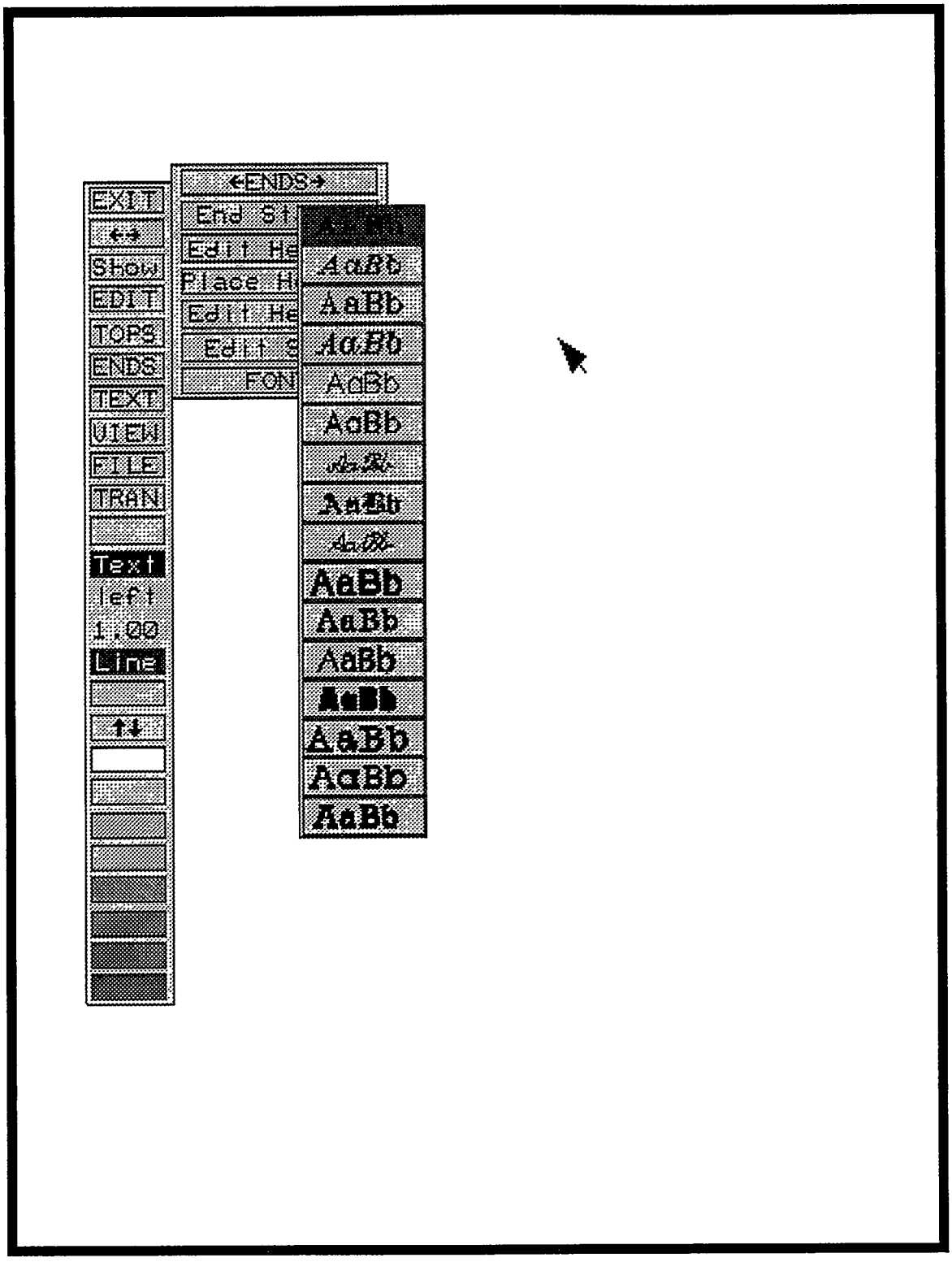


Figure 127. Font selection for end state text.

7.2.7 TEXT

This option allows you to add text to the diagram at any location, in any size and color. When you invoke this command, an additional pop-up menu is displayed (Figure 128). As shown, seven options are available: TEXT, FONT, Write, Move, Copy, Erase, and EDIT.

7.2.7.1 ←TEXT→. This option allows you to move the pop-up menu to a new location on the screen. To invoke this option, position the cursor on the ←TEXT→ box and press the left mouse button. An outline will appear. Move the outline to the new location and press the left mouse button. The menu will be moved to the new location.

7.2.7.2 FONT. This option allows you to select the font type for the text. When you select this option, a pop-up menu will be displayed (Figure 129). Select the desired font by positioning the cursor over the font and pressing the left mouse button. You must select a font (or cancel) in order to continue. All new text will be displayed in the selected font. Remember, you are changing the default font type. No existing text will be changed to this new font type. To change existing text, select the TEXT option and the EDIT suboption, and invoke the FONT command. You may then mark existing text to be changed to the default font.

7.2.7.3 Write. This option allows you to write text at any location on the screen. When you invoke this option you will be prompted to **Pick text placement location.** Position the cursor at the desired location and press the left mouse button. A window will appear in the top left corner of the screen. Enter the desired text. When complete, press <Esc>. If the show text option is turned on (see VIEW option), the newly added text will be displayed on the screen. Next, you will be prompted to **Pick next text placement location:**. At this point, you may select another location to write text or press the right mouse button to terminate the process.

7.2.7.4 Move. This option allows you to move the selected text to a new location on the screen. When you invoke this option you will be prompted to **Pick region to be moved - press CANCEL to quit.** You select the region by marking the opposite corners of the text to be moved. Position the cross hair at the text you want to move and press the left mouse button. A small dot appears. Drag the cursor across the desired text until the box totally surrounds the text. Press the left mouse button again. The message **Pick reference point - press CANCEL to quit** will be displayed. The reference point is used to give you some indication of the position of the text being moved relative to the box. Position the cross hair at the location where you want the selected text to be moved to. Next, you will be prompted to **Pick placement point - press CANCEL to reselect**. Use the mouse to move the box to the exact position where you want the box to appear. When you are satisfied with the new position press the left mouse button. The selected text will be moved to the new location. The prompt **Pick placement point - press CANCEL to reselect** will be displayed again. At this point, you may select another location to move the text, or press the right mouse button or <Esc> key to terminate the process.

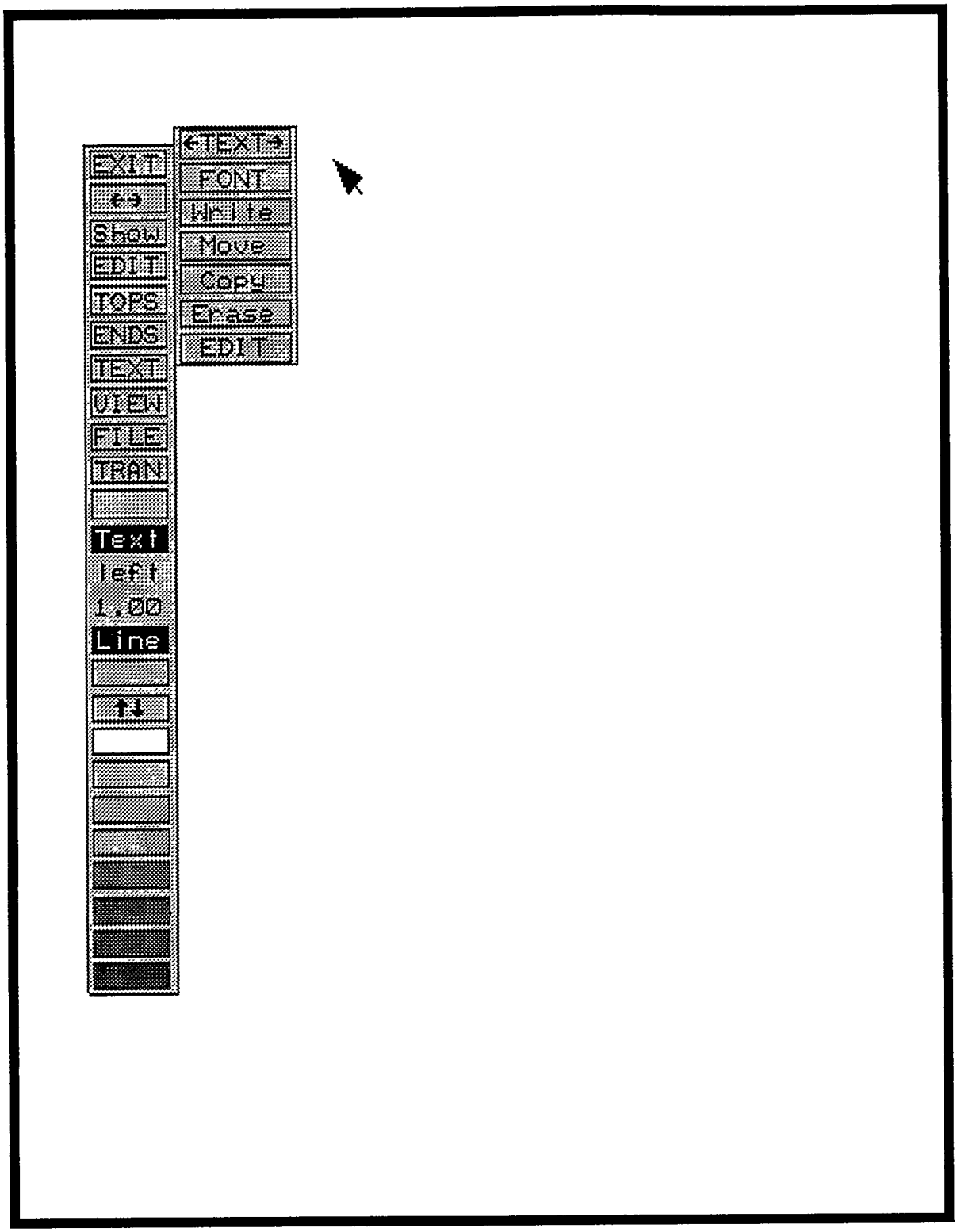


Figure 128. TEXT pop-up menu.

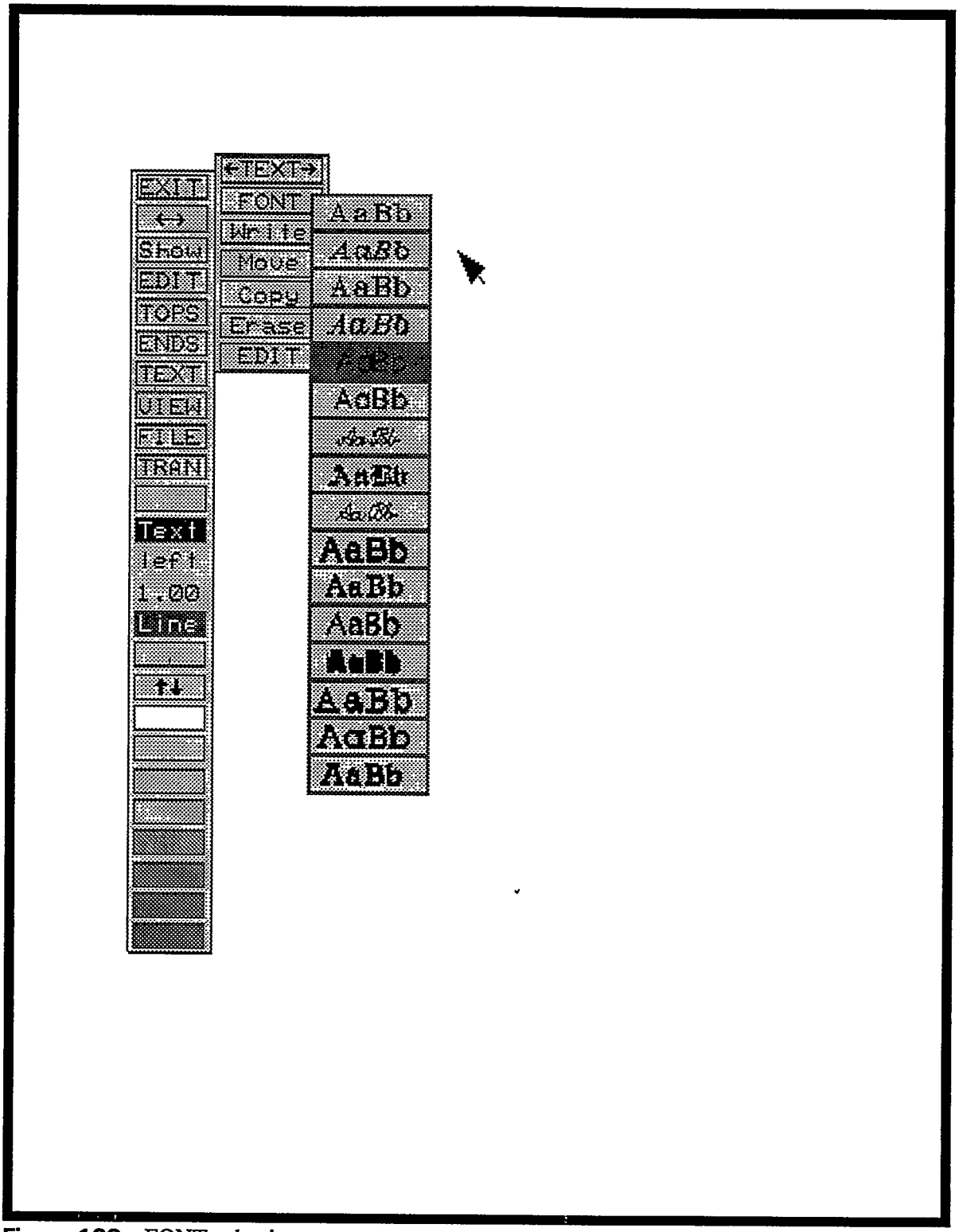


Figure 129. FONT selection screen.

7.2.7.5 Copy. This option allows you to copy the selected text to a new location on the screen. When you invoke this option you will be prompted to **Pick region to be copied - press CANCEL to quit.** You select the region by marking the opposite corners of the text to be copied. Position the cross hair at the text you want to copy and press the left mouse button. A small dot appears. Drag the cursor across the desired text until the box totally surrounds the text. Press the left mouse button again. The message **Pick reference point - press CANCEL to quit** will be displayed. The reference point is used to give you some indication of the position of the object being copied relative to the box. Position the cross hair at the location where you want the selected region to be copied to. Next, you will be prompted to **Pick placement point - press CANCEL to reselect.** Use the mouse to move the box to the exact position where you want the text to appear. When you are satisfied with the new position press the left mouse button. The selected text will be moved to the new location. The prompt **Pick placement point - press CANCEL to reselect** will be displayed again. At this point, you may select another location to copy the text to, or press the right mouse button or <Esc> key to terminate the process.

7.2.7.6 Erase. This option allows you to delete selected text. When you invoke this option you will be prompted to **Pick region to be deleted.** You select the region by marking the opposite corners of the text to be deleted. Position the cross hair at the text you want to move and press the left mouse button. A small dot appears. Drag the cursor across the desired text until the box totally surrounds the text. Press the left mouse button again. The message **Delete this region? Left = YES, Right = NO** will be displayed. If this is the text to be deleted, press the left mouse button; otherwise press the right button. Next, you will be prompted to **Pick next region to be deleted.** At this point, you may select more text to delete or press the right mouse button or <Esc> key to terminate the process.

NOTE: If the text is not deleted, check the size of the outline box used to mark the region. It must be large enough to encompass all the text desired; otherwise, no text will be deleted.

7.2.7.7 EDIT. This option allows you to edit text and set various attributes of the text including color, size, font, and justification. When you invoke this option, an additional pop-up menu will be displayed (Figure 130).

7.2.7.7.1 ←EDIT TXT→ —This option allows you to move the pop-up menu to a new location on the screen. To invoke this option, position the cursor on the ←EDIT TXT→ box and press the left mouse button. An outline will appear. Move the outline to the new location and press the left mouse button. The menu will be moved to the new location.

7.2.7.7.2 Text—This option allows you to edit any of the text contained in the displayed diagram. When you select this option you will be prompted to **Box text to be edited.** You select the text to be edited by boxing the opposite corners of the text region. Position the cross hair at the beginning of the text you wish to modify and press the left mouse button. A small dot will appear. Drag the cursor over the text until the outline surrounds the text you wish to modify. When the text is completely surrounded, press the left mouse button. A window will appear displaying the selected text. To modify the text, simply type over the existing text. Use the <Ins> and <Del> keys to add and delete characters as necessary. In addition, you may use the Backspace and End keys. The Backspace key deletes the character to the left of the cursor and moves the rest of the characters to the left one space. The End key positions the cursor at the end of the current line. When complete, press <Esc>. You will be prompted to **Pick next text to be edited.** At this point, you may select additional text to

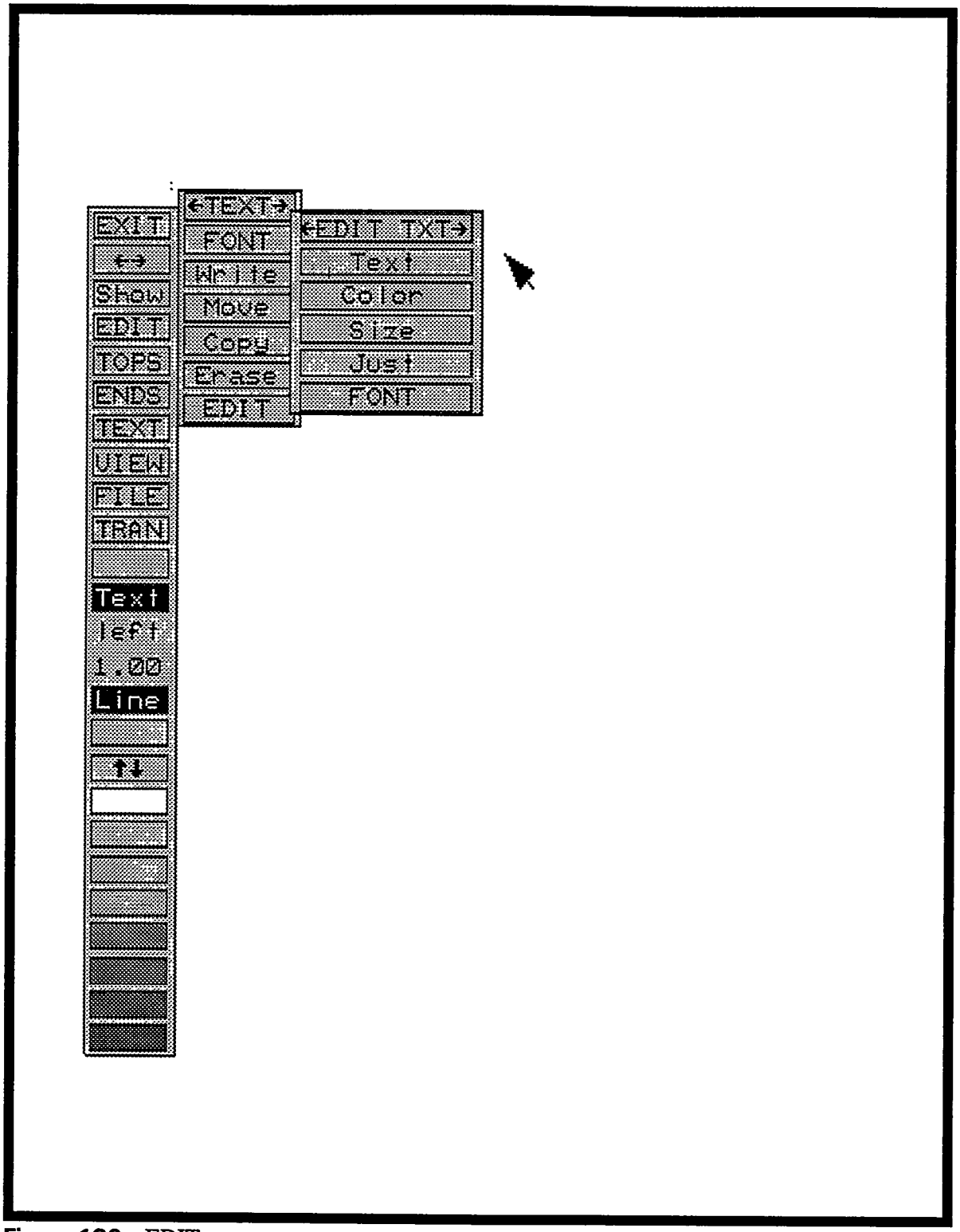


Figure 130. EDIT pop up menu.

edit or press the right mouse button to terminate the process.

7.2.7.7.3 Color—This option allows you to change the color of selected text in your event tree diagram. When you invoke this option you will be prompted to **Box the text to be changed**. Position the cursor at the beginning of the text you wish to change and press the left mouse button. A small dot will appear. Drag the cursor over the text until the outline box surrounds all the desired text. Press the left mouse button. Next, you will be prompted to **Pick the new text color from the color bar**. To select a color, position the cursor over the desired color and press the left mouse button. The text will immediately change to the new color. The prompt **Box next region to be changed** will be displayed. At this point, you may select more text to change or press the right mouse button to terminate the process.

7.2.7.7.4 Size—This option allows you to specify the height of selected text in your diagram. When you invoke this option, you will be prompted to **Box the text to be changed**. Position the cross hair at the beginning of the text you wish to change and press the left mouse button. A small dot will appear. Drag the cursor over the text until the outline surrounds all the desired text. When all the desired text is surrounded, press the left mouse button. Next, the prompt **Enter the new text size >** will be displayed. At this prompt enter the desired text size and press <Enter>. You may enter a value of .001 to 9.0. The selected text will be displayed in the new size. Next, you will be prompted to **Box next region to be changed**. At this point, you may select more text to be changed or press the right mouse button to terminate this process.

7.2.7.7.5 Just—This option allows you to justify selected portions of the text in your diagram. Justification is where the text will be placed offset from the placement point. When you invoke this option you will be prompted to **Box the text to be changed**. Position the cursor at the beginning of the text to be changed and press the left mouse button. A small dot will appear. Drag the cursor over the text until the outline completely surrounds it. When the desired text is completely surrounded press the left mouse button. You will be prompted to **Enter text justification -('L'=Left, 'R'=Right, 'C'=Center) >**. Enter the desired justification and press <Enter>. The prompt **Box next region to be changed** will be displayed. At this point, you may select additional text to modify or press the right mouse button to terminate this process. For a compete discussion on setting the justification, see Section 6.2.12.

7.2.7.7.6 FONT—This option allows you to select the font type for selected text. When you select this option, a pop-up menu will be displayed (Figure 131). Select the desired font type by positioning the cursor over the font and pressing the left mouse button. You must select a font (or cancel) in order to continue. Next, you will be prompted to **Box the text to be changed**. Position the cursor over the text to be changed and press the left mouse button. A small dot will appear. Drag the cursor over the text to be modified. When the box completely surrounds the desired text, press the left mouse button. The selected text will be displayed in the new font type. Next, you will be prompted to **Box next region to be changed**. At this point, you may select more text or press the right mouse button to terminate the process.

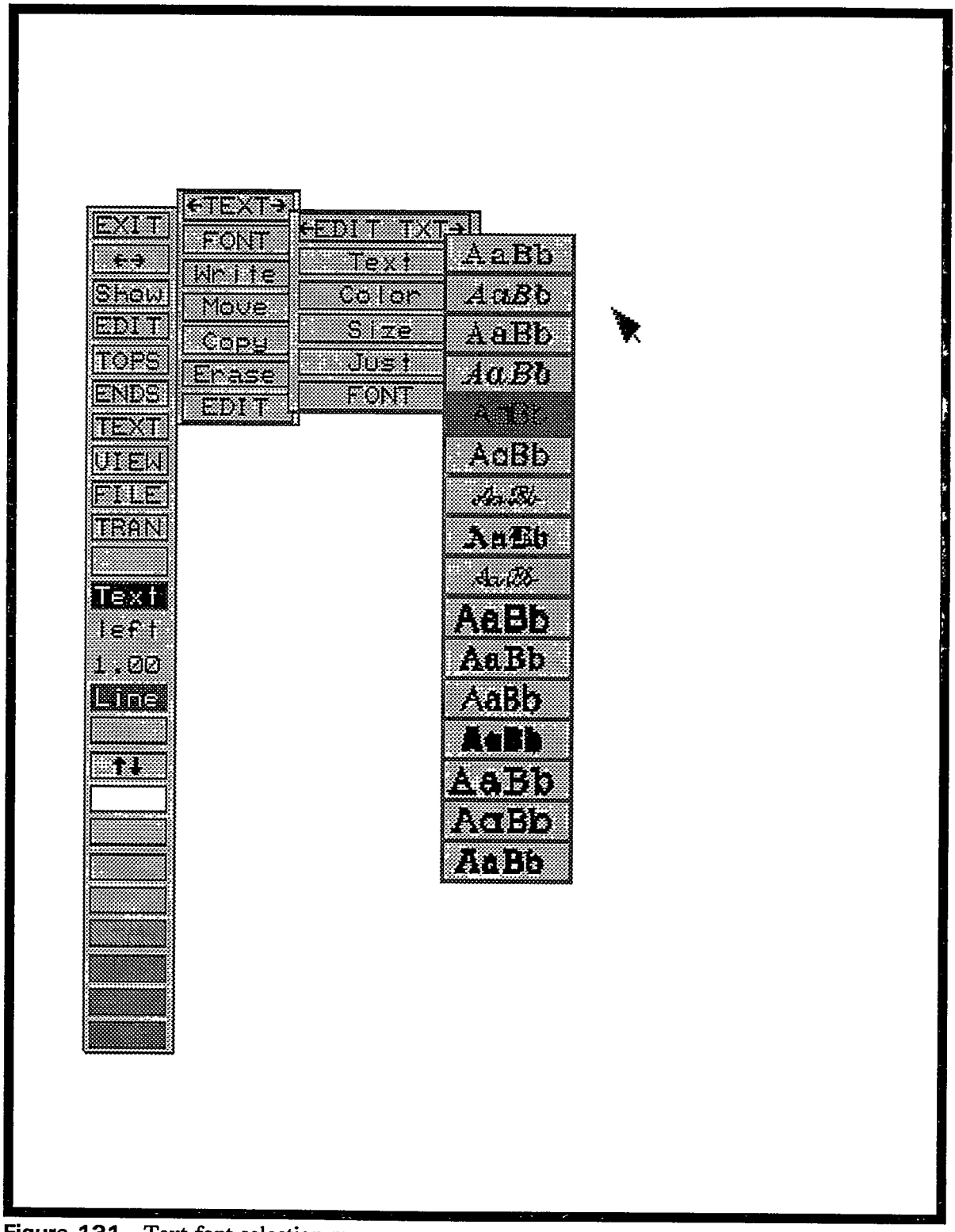


Figure 131. Text font selection menu.

7.2.8 VIEW

This option allows you to change the position and size of the displayed diagram. You may move the drawing up, down, right, left, zoom in, zoom out, or restore the drawing to its original size and/or position. You may also toggle to display/not display text and turn on and off the grid. When you select this option, Figure 132 will be displayed. The VIEW submenu consists of the following options:

- Page ↑: Invoking this option allows you to shift the diagram up one page (previous page). To invoke this option, position the cursor in the Page ↑ box and press the left mouse button <Enter>. The diagram's previous page will be displayed. If no previous page exist, only the header information will appear.

- Page ↓: Invoking this option allows you to shift the diagram down one page (next page). To invoke this option, position the cursor in the Page ↓ box and press the left mouse button or <Enter>. The diagram's next page will be displayed. If no next page exist, only the header information will appear.

- Page →: Invoking this option allows you to shift the diagram to the right one page (one screen). To invoke this option, position the cursor in the Page → box and press <Enter>. The diagram will shift to the right one screen. If no figure exists on this new screen, only the header information will appear.

- Page ←: Invoking this option allows you to shift the diagram to the left one page (one screen). To invoke this option, position the cursor in the Page ← box and press <Enter>. The diagram will shift to the left one screen. If no figure exists on this new screen, only the header information will appear.

- Scroll: Invoking this option allows you to move the diagram to another location on the screen, To invoke this option, position the cursor in the Scroll box and press the left mouse button. A white outline box appears, with a cross hair placed in the center of the outline. Position the cursor at the desired location and press the left mouse button. The cross hair serves as a reference point for placing the drawing. The reference point (+) is used to give you some indication of the position of the object being moved relative to the screen.

- Zoom in: Invoking this option allows you to fill the screen with a small portion of the original display (magnifies the selected portion of the screen). To invoke this option, position the cursor in the Zin (zoom in) box and press the left mouse button or <Enter>. The message **Pick first corner** will be displayed. Move the cursor at the start of the diagram to be enlarged and press the left mouse button. A small dot appears. Next, you will be prompted to **Pick next corner**. Drag the cursor across the desired area until it is completely surrounded by the outline box. Press the left mouse button. The portion of the original display enclosed by the box will now fill the entire screen. The display can be restored to its original size by invoking the Zres (zoom restore) option.

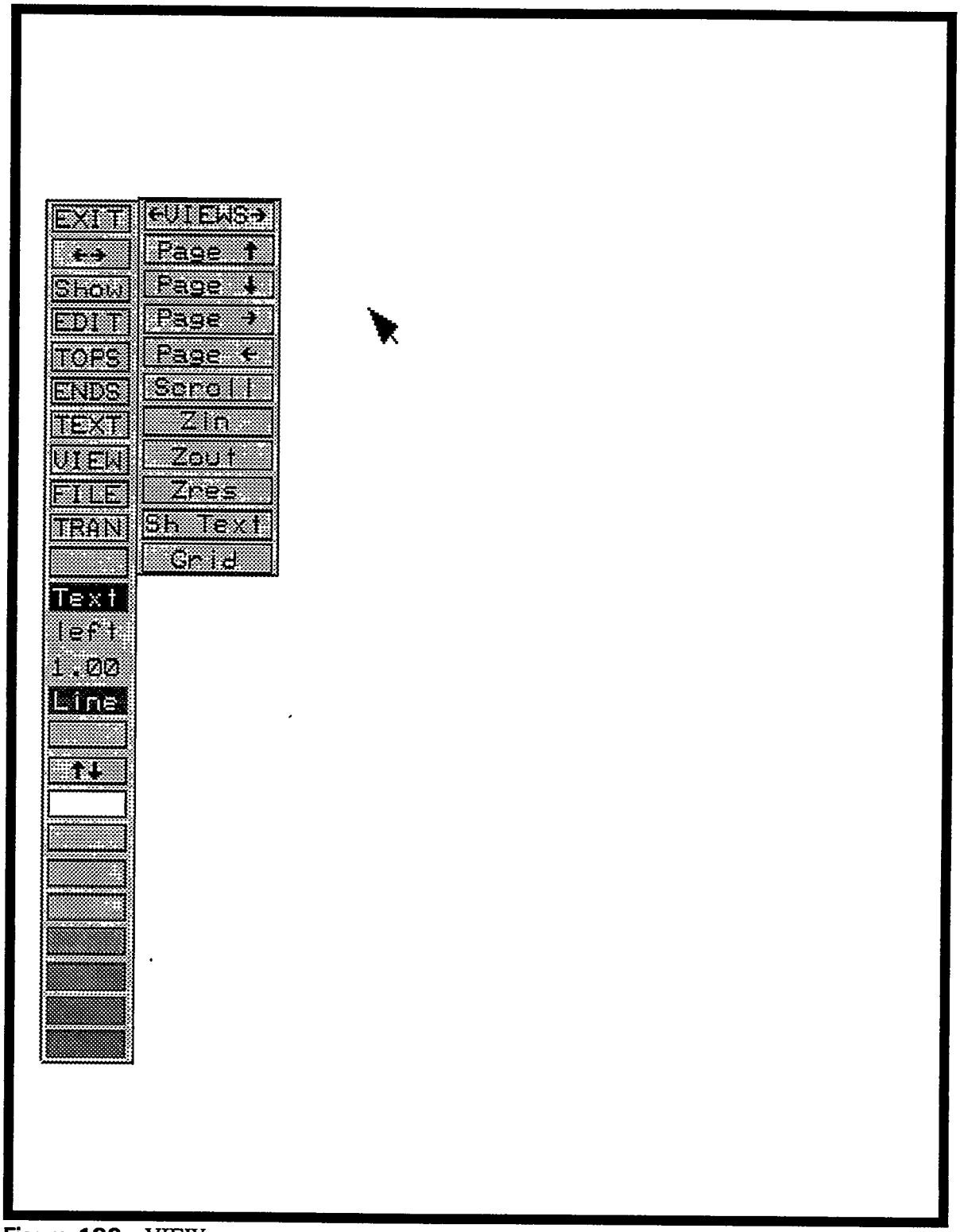


Figure 132. VIEW pop-up menu.

- Zoom out: Invoking this option allows you to shrink the screen by approximately 50%. To invoke this option, position the cursor in the Zout (zoom out) box and press the left mouse button or <Enter>. The entire display will be reduced, while the drawing space is increased. To restore the display to its original size, invoke the Zres option.

- Zoom Restore: This option restores any display created by zoom in or zoom out to the original display size or to the last saved file. To invoke this option, position the cursor in the Zres box and press the left mouse button or <Enter>.

- Sh Text: This option allows you to toggle the display the text setting from Sh Text to No Text. Sh Text displays all defined text. No Text does not display the text.

- Grid: This option displays a grid behind your diagram to allow you to line up symbols and text. This is a toggle switch. To turn the grid on, position the cursor in the Grid option box and press the left mouse button or <Enter>. To turn the grid off, repeat the same steps.

7.2.9 FILE

This option allows you to perform various file manipulation functions including loading, saving, listing and creating event tree files. When you invoke this option, an additional pop-up menu will be displayed (Figure 133). Each command is discussed in the following paragraphs.

7.2.9.1 ←FILE→. This option allows you to move the pop-up menu to a new location on the screen. To invoke this option, position the cursor on the ←FILE→ box and press the left mouse button. An outline will appear. Move the outline to the new location and press the left mouse button. The menu will be moved to the new location.

7.2.9.2 Load. This is one of the options that can be used to load a file. When you invoke this option, you will be prompted to **Enter file name >**. At this prompt, enter the file name and press <Enter>. You must know the name of the file before initiating this option. The LIST command also allows you to load a file, but in addition it will display a list of available files.

7.2.9.3 Save. This option allows you to save the current file. When you invoke this command you will be prompted to **Enter file name or CR for file *current file name***. At this point, you may enter a new file name or choose the default file name provided by pressing <Enter>. The file is then written to disk. If you enter a new file name, do not provide an extension. The extension ".ETG" is provided by IRRAS.

7.2.9.4 New. This option allows you to create a new event tree (file). When this command is invoked you will be prompted to **Enter Initiating Event or Top Name**. Enter the event or name and press <Enter>. You will then be asked **Is this an Initiating Event**. Respond with a Y or N. You will then be prompted to **Enter Event Name #1**. Enter an event name and press <Enter>. This prompt will repeat (with the event number increasing each time) until you press <Enter> without entering a name. The newly created event tree will then be displayed on the screen. The default form of an event tree will contain a success/fail branch at the first event and a don't care or pass extending through the ending event.

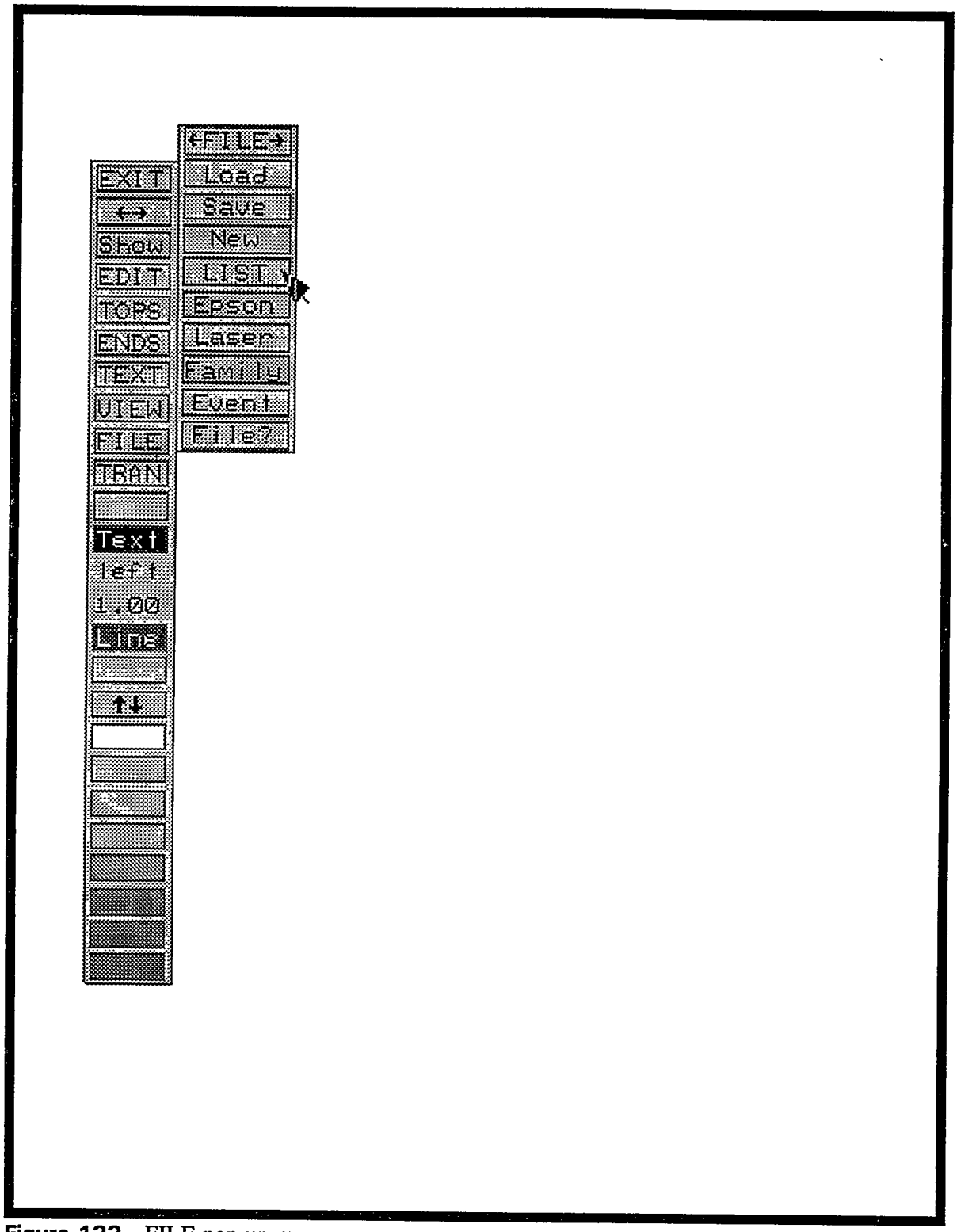


Figure 133. FILE pop-up menu.

7.2.9.5 LIST. This is one of the two options used to load an event tree diagram. When you invoke this option, an additional pop-up menu will be displayed listing the files available. You will be prompted to **Pick the file to load**. To select a file to be loaded, position the cursor on the desired file name and press the left mouse button. The selected diagram will be displayed on the screen. You may now proceed with other editing functions.

7.2.9.6 Epson. This option formats the current diagram for an Epson printer and sends it to the attached local Epson printer.

7.2.9.7 Laser. This option formats the current diagram for a laser printer and sends it to the local laser printer to be printed.

7.2.9.8 Family. This option allows you to view and change the name of the family corresponding to the current diagram. The default family name is provided. When you invoke this option you will be prompted to **Type in the New Name or <Return> for *family name*>**. Enter a new file name if desired, or press <Enter> to accept the default family.

7.2.9.9 Event. This option allows you to view and change the event tree file name. The current file name for the event tree is provided. When you invoke this option, you will be prompted to **Type in the New Name or <Return> for *current file name* >**. Enter a new file name and press <Enter> or leave blank and press <Enter> to keep the current file name.

7.2.9.10 File?. This option allows you to view the current file name. When this option is invoked the current file name is displayed at the bottom left corner of the screen. If no file name is assigned to the current diagram, the default file name of **NONAME.ETG** will be displayed.

7.2.10 TRAN

This option allows you to add, delete, and modify transfer file names as well as transfer to and from files that are added as transfers. When you invoke this option, an additional pop-up menu will be displayed (Figure 134). Each pop-up option is discussed in the following paragraphs.

7.2.10.1 Add. The add option allows you to place a transfer file name in the diagram. This transfer file name can then be selected and you can transfer back and forth between the two event tree diagrams or any number of diagrams (files) that are included in the transfer list. When you invoke this option you will be prompted to **Pick the leaf where the transfer is to be placed**. The cursor will move vertically along the end of the event branches. Position the cursor on the desired transfer point and press the left mouse button. The prompt **Enter transfer file name** will be displayed. Enter the appropriate file name and press <Enter>. A "T" is placed after the selected sequence number and the entered file name is placed in the corresponding end state slot. The prompt **Pick the leaf where the transfer is to be placed** will return. At this point, you may select another transfer point or press the right mouse button to terminate the process.

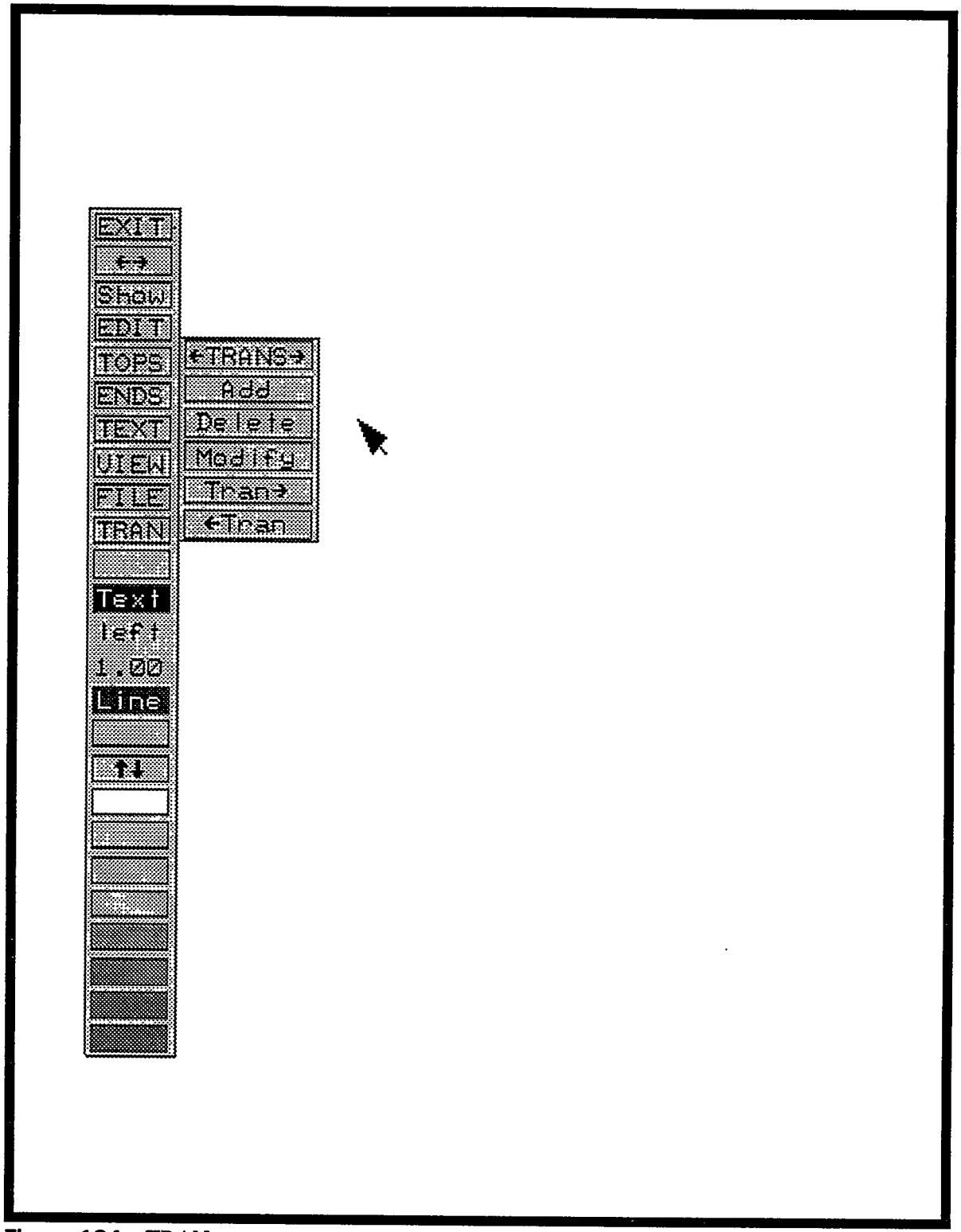


Figure 134. TRAN pop-up menu.

7.2.10.2 Delete. This option allows you to delete transfer file names from the diagram. When you invoke this option you will be prompted to **Pick the leaf corresponding to the transfer to be deleted**. Position the cursor on the leaf branch where a transfer has been previously added and press the left mouse button. The "T" will be deleted and the corresponding sequence name will be removed from the transfer list. You will be returned to the previous prompt. At this point, you may select another transfer point to delete or press the right mouse button to terminate the process.

7.2.10.3 Modify. This option allows you to change the transfer file name. When you invoke this option you will be prompted to **Pick the leaf corresponding to the transfer to be edited**. Position the cursor on the transfer leaf and press the left mouse button. The prompt **Type in the New Name or <Return> for *current transfer file name*** >. Enter the new transfer file name or press <Enter> to retain the existing file name.

7.2.10.4 Tran→. This option allows you to work with multiple files simultaneously. When you invoke this option you will be prompted to **Pick the leaf corresponding to the desired transfer file name**. The selected file is then loaded into the system. This option will allow you to transfer back and forth to various files.

7.2.10.5 ←Tran. After a transfer to another file has been made, you use this option to return to the previous file. When you invoke this option you will be prompted to **Pick the file to transfer to**. A pop-up window will appear showing you a list of available transfer files. Select a file by positioning the cursor on the desired file and pressing left mouse button. If no files exist, the message **No transfer files** will be displayed.

7.2.11 Text

This option allows you to set a default color for the text in your diagram. To invoke this option, position the cursor over the Text box and press the left mouse button. You will be prompted to **Pick a new color from the color bar**. Position the cursor on the desired color and press the left mouse button. (**NOTE:** The ↑↓ is active. Use this option to display additional color selections.) The Text box will change to the selected color. All text created in your diagram from now on will be displayed in this new color. Any existing text in your diagram will retain the old color. To change the color of the existing text, you must invoke the TEXT option and select the EDIT suboption and invoke the Color command (see Section 7.2.7).

7.2.12 cntr/left/rght

This option allows you to set the justification for your diagram. Justification is where the text will be placed offset from the placement point. This works as a toggle switch. To change justification, position the cursor over the cntr (left or rght) box and press the left mouse button. You will see the box change from cntr to rght (right). Press the left mouse button again and the box will change from rght to left.

Left justification means the text will be anchored at the left bottom corner, or the text will flow to the right of where it was placed. Center justification means the text will be centered about the placement point. Right justification means the text will be placed to the left of the placement point. Set the toggle switch for the desired justification.

7.2.13 Text Size

This option allows you to set a default text size for your diagrams. Text sizes range from .001 to 9.0. For writing general text in event trees, a text size of about 0.5 is appropriate. The size looks too small on the screen, but it is a good size for sending to a laser printer. When you invoke this option you are prompted to **Enter new text size >**. Enter the desired size and press <Enter>. The Text Size box will reflect the current default setting. Remember, you are setting the default text sizes. You may always change the text size for selected text by invoking the TEXT option, selecting the EDIT suboption, and invoking the Size command (see Section 7.2.7).

7.2.14 Line

This option allows you to select a color for the lines in your diagram. When you invoke this option you will be prompted to **Pick a new color from the color bar**. Position the cursor over the desired color and press the left mouse button. The Line box will change to reflect the newly selected color. (Remember, you may use the color feature (↑ ↓) to display additional colors). All new lines generated in your diagram will be this default color.

7.2.15 ↑ ↓ (Color)

This option allows you to scroll the color bar to display the additional color selections available. Position the cursor on the scroll box (↑ ↓) and press the left mouse button or <Enter> key. The next series of colors will be displayed.

NOTE: When you try to exit the Create Event Trees option without saving your changes, you will be prompted with **ARE YOU SURE? Enter "Y" to Quit anyway**. At this point, you may enter a <Y> to quit without saving or press <Enter> to terminate the exit procedure.

7.3 Link Event Trees

This option allows you to define linkage rules and generate sequence logic. When you invoke this option, Figure 135 will be displayed. As shown, four options are available: Exit, Generate Sequences, Rule Editor, and Sequence Editor. In addition, the following special function keys are available here and in the remaining functions discussed in Section 7.

<Esc>	The <Esc> key returns you to the Event Tree Graphics System Menu (Figure 119).
<F1>	This key displays on-line help messages.
<F2>	This key marks a file for further processing. When you mark a file, an asterisk will appear in front of the file name.
<F3>	This key marks all the displayed files for further processing.

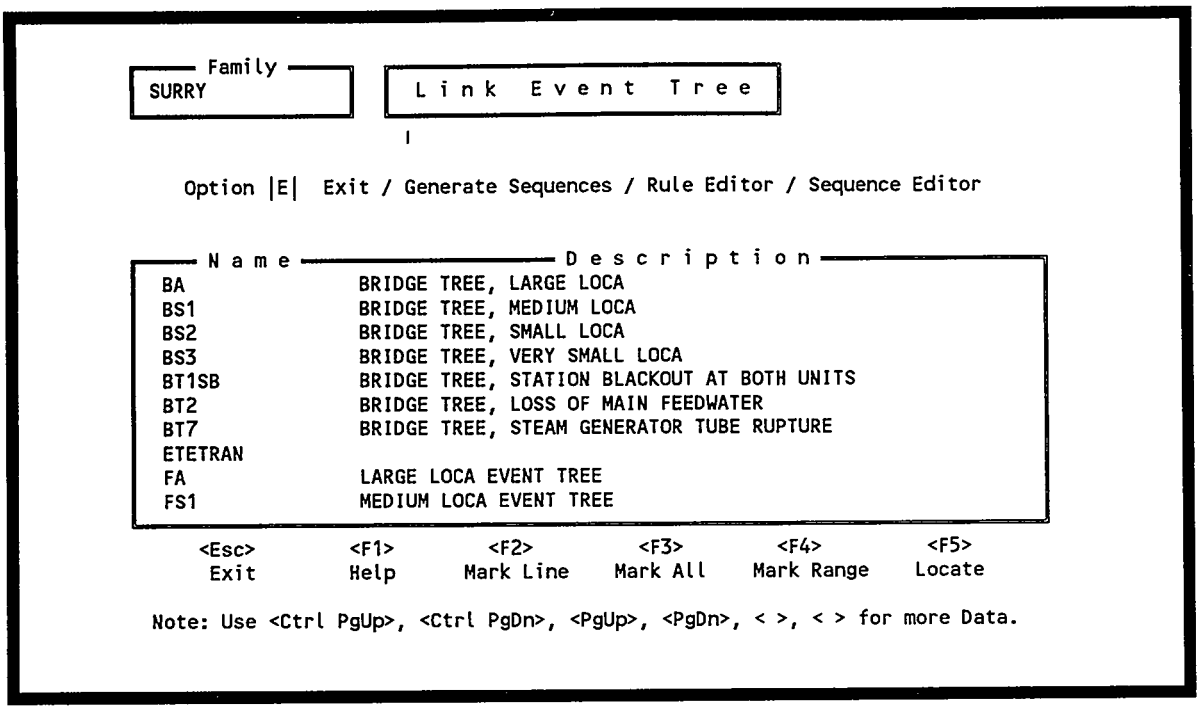


Figure 135. Link event tree screen.

<F4> This key allows you to mark a range of files for further processing.

<F5> This key allows you to locate a specific file for further processing. When you invoke this function, Figure 136 will be displayed. Enter the file name to locate and press <Enter>. The specified file will be highlighted. If the file name does not exist, then the next file name in alphabetical order will be highlighted.

To display additional event trees, use the <PgUp>, <PgDn> and arrow keys.

7.3.1 Exit

This option returns you to the Event Tree Graphics System menu (Figure 119). To invoke this option, enter an <E> in the option field and press <Enter>, or press the <Esc> key.

7.3.2 Generate Sequences

This option allows you to generate sequence logic for event trees. During sequence generation the sequence logic is created as specified in the event tree logic, and then the linkage rules are applied. To invoke this option for a single selected event tree, enter a <G> in the option field, highlight the desired event tree, and press <Enter>. To invoke this process for a group of event trees, mark the

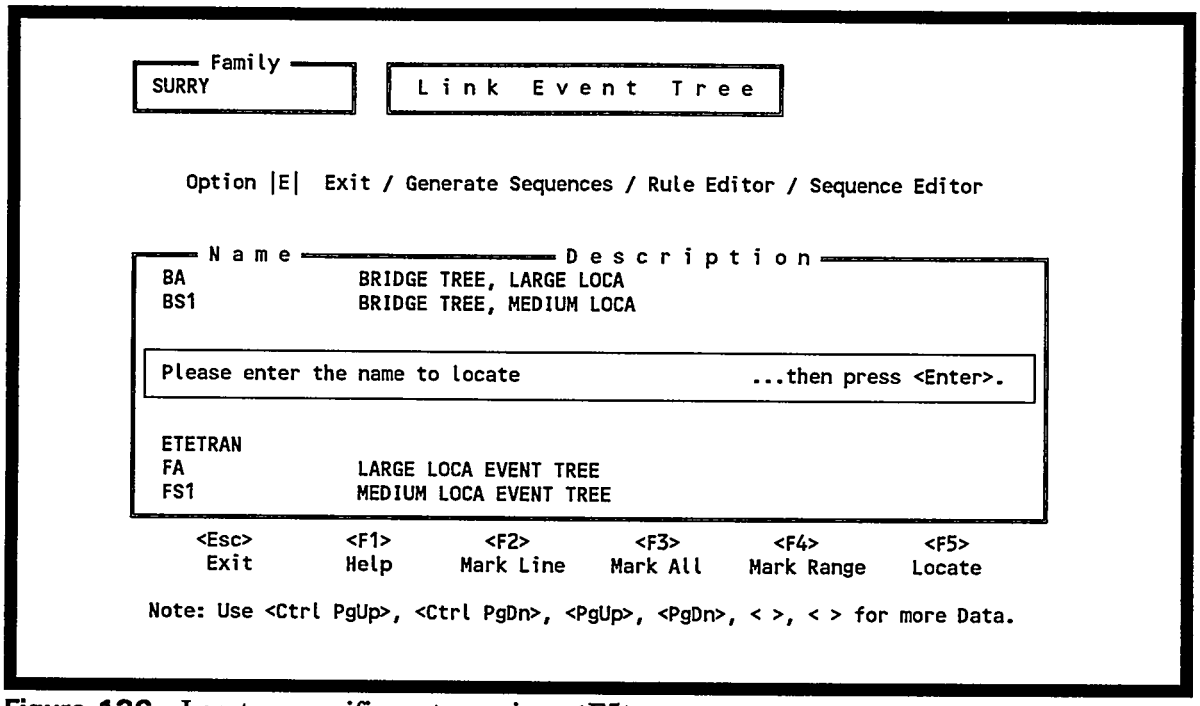


Figure 136. Locate a specific system using <F5>.

desired event trees using the function keys <F2>, <F3>, and <F4>, enter a <G> in the option field, and press <Enter>. To invoke this option for all event trees in the current family, clear all marked entries, type a <G> in the option field, and press <Enter>. A message **Process all records? (Y/N)** will appear at the bottom of the screen. Type a <Y> to generate sequences for all of the event trees, or type an <N> to terminate the sequence generation process.

In all three cases, after pressing <Enter>, Figure 137 will be displayed. On this screen you must enter a file name where the report will be written. The following options are provided:

CON	-	Sends the report to the screen.
PRN	-	Sends the report to the printer.
filename	-	Sends the report to the specified hard disk file name. A default name is provided, which can be changed by simply typing over the default name.
blank	-	No report is generated, but the sequences are generated.
<Esc>	-	Terminates the process without generating the sequences.

In addition, you can specify the following:

Use Number for Sequence Names? If you respond <Y>, IRRAS uses the sequence numbers to create a name. If you respond <N>, the sequence name is used. In either case, the value is created by taking the number or name and each time a transfer is encountered, it adds a "-" and an incremented number

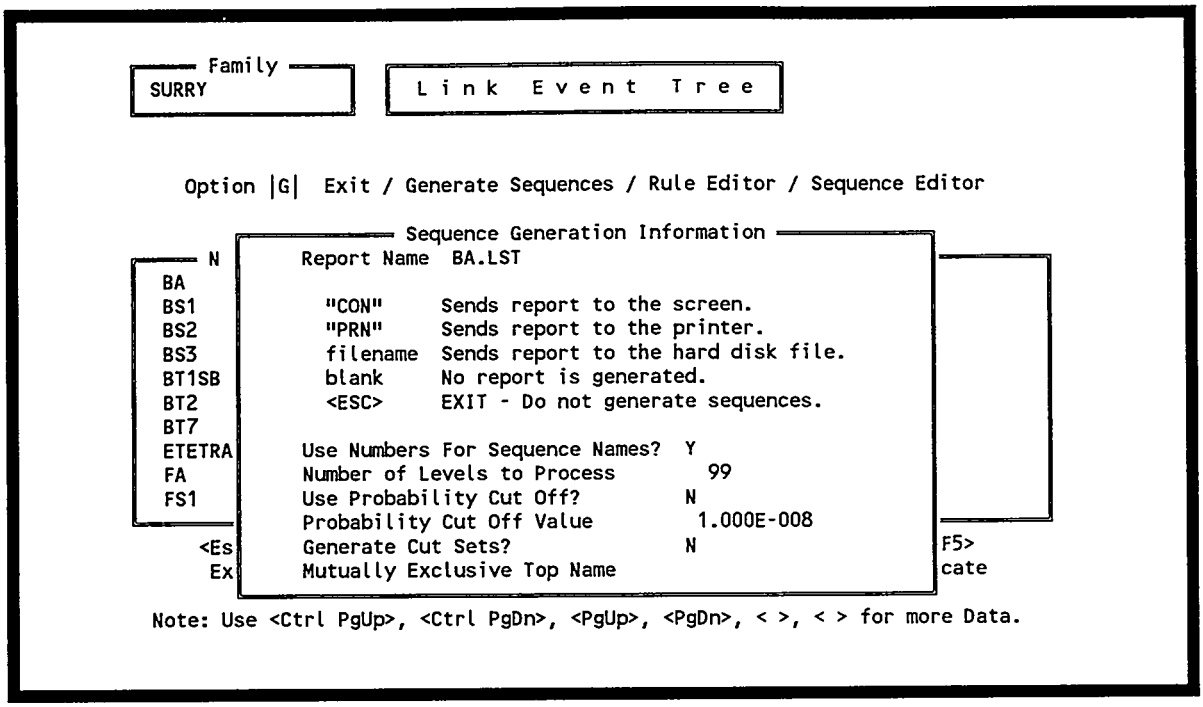


Figure 137. Generate sequences output screen.

for that transfer (e.g., K-X, 2-1, 2-2, 2-3 etc.).

Number of Levels to Process

A level is a transfer to a subtree. The default value of 99 will generate sequences whose logic will contain all tops for all the subtrees. If the level is set to less than 99, the generated sequences will contain only tops from subtrees less that the specified level.

Use Probability Cutoff

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 added to the logic, the probability for the sequence is checked to ensure that its probability is greater than the truncation value specified in the next field.

Probability Cutoff Value

Enter the truncation value. All sequences whose probability is less than the truncation probability are discarded and the logic is not followed.

Generate Cut Sets

If you respond <Y>, a sequence cut set will be generated when the sequence logic is generated. Each top, whether failed or successful, is treated as a basic

	event and placed in the cut set for the generated sequence.
Mutually exclusive top name	This allows the user to specify a top to add to the sequence logic. This top will appear in the logic as a complemented system and will be treated accordingly when the sequence is solved.

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

After sequence generation begins, a number of messages will be displayed at the bottom of the screen. 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. A name of the file containing the generating details of the sequence is displayed.

Invalid sequences can result in several ways. First, 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. Second, the user may have modified the event tree logic, reducing the number of sequences for the tree. Sequences that existed previously are invalid, also. Sequences that have an end state value of "OK," "SUCCESS" or begin with an "@" character are never generated by IRRAS.

7.3.3 Rule Editor

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. 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 systems 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. Or, 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.

You can only invoke this option for a single event tree (i.e., one event tree at a time). To invoke this option, enter an <R> in the option field, highlight the desired event tree, and press <Enter>. When you press <Enter>, Figure 138 will be displayed showing the rules (if any) for the event tree shown in the upper right hand corner. This screen is a free format line editor that provides you with an if-then-else logic structure. IRRAS provides type cast functions for event trees, initiators, systems, flags,or end states. With these functions you can define substitutions for the end state or flag set of a sequence, or define a new transfer event tree for the sequence.

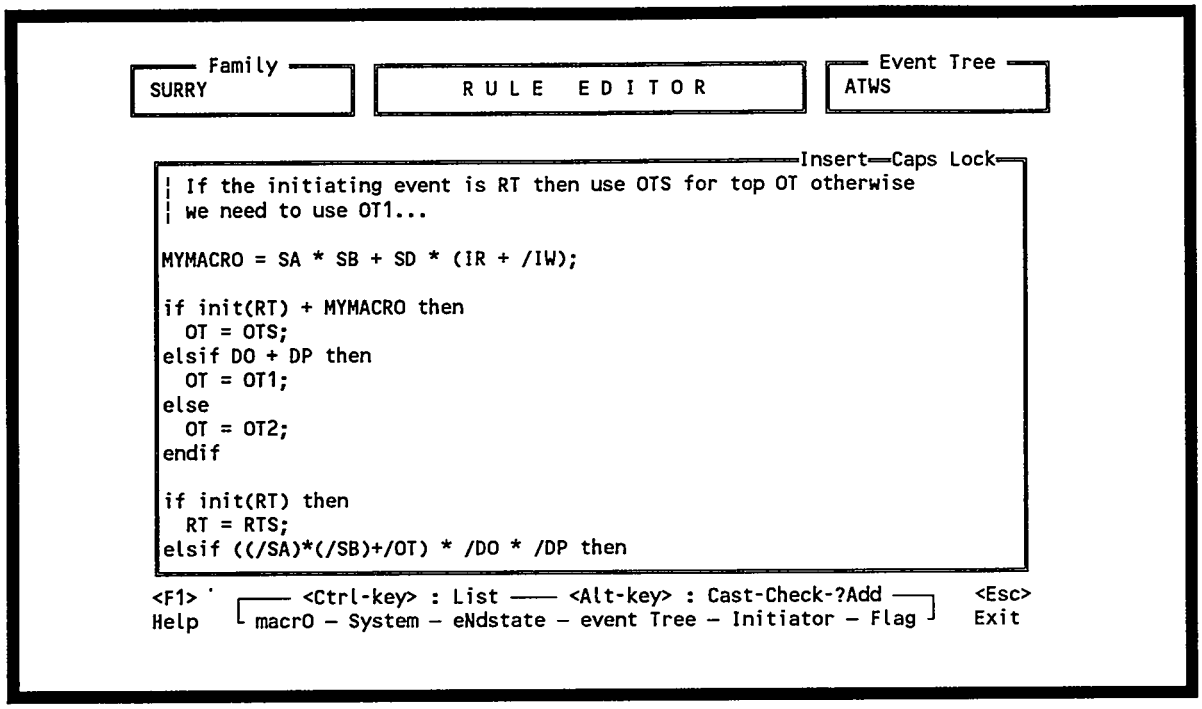


Figure 138. Macro based event tree rule editor.

From Figure 138, the following options are available:

<F1> - The <F1> key displays the editing keys (see Figure 139) available in the rule editor.

<Ctrl/O> - Pressing the <Ctrl/O> keys simultaneously allows you to insert a macro into the editor.

<Ctrl/S> - Pressing the <Ctrl/S> keys simultaneously brings up a help screen to select systems as top events and systems used to replace others instead of typing in the system names.

<Ctrl/N> - Pressing the <Ctrl/N> keys simultaneously brings up a help screen to select end states used to replace others instead of typing in the end state names.

<Ctrl/T> - Pressing the <Ctrl/T> keys simultaneously brings up a help screen to select event trees used to replace others instead of typing in the event tree names.

<Ctrl/I> - Pressing the <Ctrl/I> keys simultaneously brings up a help screen to select initiators used to replace others instead of typing in the initiator names.

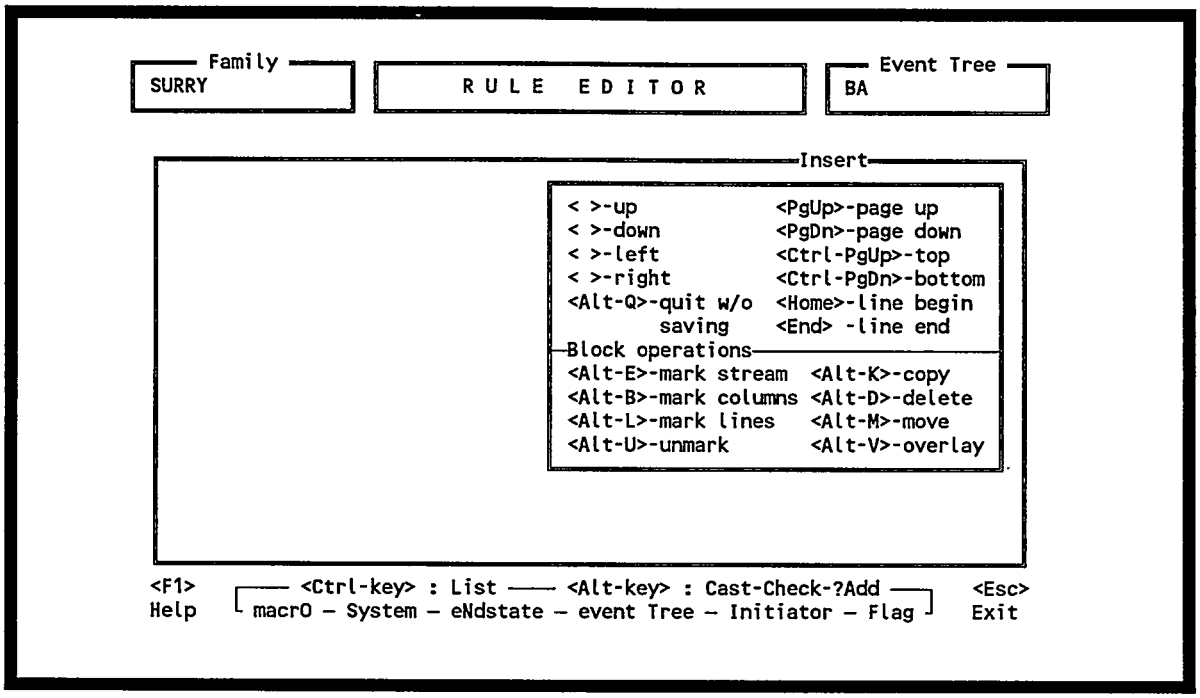


Figure 139. Rule editor help screen.

<Ctrl/F> - Pressing the <Ctrl/F> keys simultaneously brings up a help screen to select flags used to replace others instead of typing in the flag names.

NOTE: The <Alt> key in combination with the same keys shown above allow you to check if a name of the specified type exists in the database and optionally add it and cast the names to that type.

This editor is a macro based editor. This means that the user can define macros or variables that can be used in tests. The macro defined by the following syntax,

NO-FLOW = (SYS1 + SYS2) * (SYS3 + /SYS4);

indicates that "NO-FLOW" is to be true if the following conditions are true. (1) SYS1 or SYS2 occur and SYS3 occurs or SYS4 was successful. The "+" sign is used to indicate "or" logic, the "*" sign is used to represent "and" logic, and the "/" sign is used to represent the compliment or "not" logic. The user can also use the "~" character to indicate that the item following the character is not in the current logic. Once a macro is defined, it can be used in an "if" test. The following rule is an example of an "if" test using a macro.

```
if NO-FLOW then
   SYS5 = NEWSYS5;
   SYS6 = NEWSYS6;
endif
```

The information between the "if" and the "endif" clause defines the tops to be replaced. The user can put as many replacements as desired between these clauses. The user can also use two other clauses in a rule. The following rule demonstrates the usage of these clauses.

```
if NO-FLOW then
  SYS5 = NEWSYS5;
  SYS6 = NEWSYS6;
elsif SYS1 * SYS2 then
  SYS5 = OLDSYS5;
else
  SYS5 = OTHERSYS5;
endif
```

The "elsif" clause allows the user to specify an alternate test for the rule. The first condition that is met is used and the others are ignored. The "else" clause allows the user to specify a condition that is to be used if none of the previous conditions are met. If the user wants a condition to always be used then they can used the predefined macro "ALWAYS". The substitutions following this condition are always made. Blank lines are encouraged in the editor to improve readability and comments can be entered following the "|" character. All information on a line following the comment character is ignored.

By default the editor assumes that a name is the name of a system, if one exists. If a system 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. For instance, if the name "SYS5" was really the name of an initiating event then the user could change its default type with the following syntax; "init(SYS5)". The editor will then treat this name as an initiating event. Cast operators are provided for macros, systems, end states, event trees, initiating events, and flag sets. There is no limit to the number of rules the user may input to the editor. Each rule is processed in sequential order. The editor allows the user to list the names for a given type by using the <Ctrl> key in combination with a letter defining the data type to list. The <Alt> key in combination with the same key allows the user to check if a name of the specified type exists in the database and optionally add it and cast the name to that type.

To exit the editor and save the defined rules, press the <Esc> key. To exit without saving, press the <Alt/Q> keys together.

7.3.4 Sequence Editor

This option allows you to edit sequence names, end states, and assign frequencies after an event tree has been created. To invoke this option, enter an <S> in the option field, highlight the desired event tree, and press <Enter>. Figure 140 will be displayed showing all the sequence names and event states defined for the selected event tree.

NOTE: Any changes made using this option, will be made throughout the entire system (i.e., the corresponding drawing will be updated).

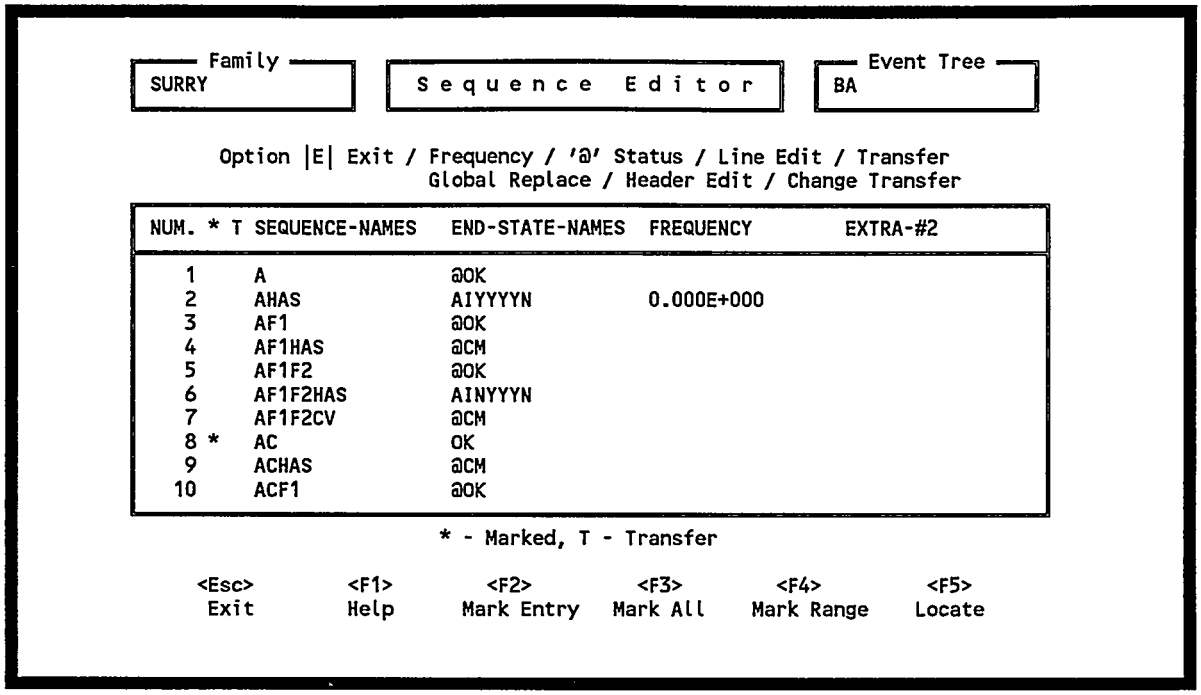


Figure 140. Sequence editor menu.

As shown, eight options are available. Each of these options is discussed in the following paragraphs.

7.3.4.1 Exit. This option terminates the sequence editor and returns you to Figure 135.

7.3.4.2 Frequency. This option will display the frequencies or min cut upper bound values associated with the selected sequence. To invoke this option, enter an <F> in the option field, highlight a sequence (or mark a series of sequences), and press <Enter>. The EXTRA-#1 column will now read FREQUENCY and the corresponding frequencies will be displayed. You may now invoke the Line Edit command to modify frequencies, if desired.

7.3.4.3 @Status. An "@" means that the corresponding sequence will not be generated; it will be ignored. This option allows you to toggle the current state of a sequence (i.e., sequence will be generated or ignored). To invoke this option, enter an "@" in the option field, highlight the sequence whose status is to be changed, and press <Enter>. Depending on the current status, an "@" will appear or disappear in front of the end state name.

7.3.4.4 Line Edit. This option allows you to edit the data displayed one line at a time. To invoke this option, enter an <L> in the option field, highlight the line you wish to edit using the arrow keys, and press <Enter>. The selected sequence will appear in a window. You may change any of the fields displayed by simply typing over the existing data. Press the <Tab> key to move from field to field. When complete, press <Esc> to exit without saving the changes made. Otherwise, press <Enter>. When you exit the Sequence Editor option, you will be asked whether or not you wish to save changes before exiting.

7.3.4.5 Transfer. This option will follow the transfer of the selected sequence. If changes were made to the current event tree, you will be asked if you wish to save those changes before following the transfer. To invoke this option, highlight a transfer sequence and press <Enter>.

7.3.4.6 Global Replace. This option allows you to replace a specified string at every occurrence with another string. To invoke this option, type a <G> in the option field and press <Enter>. Figure 141 will be displayed. First, you enter the string for which to search. Press the <Tab> key once and enter the replacement string. Press the <Tab> key once more, and enter 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 replacement string. If the string is not found, the message **No such string found** will be displayed at the bottom of the screen and you will be returned to the previous screen.

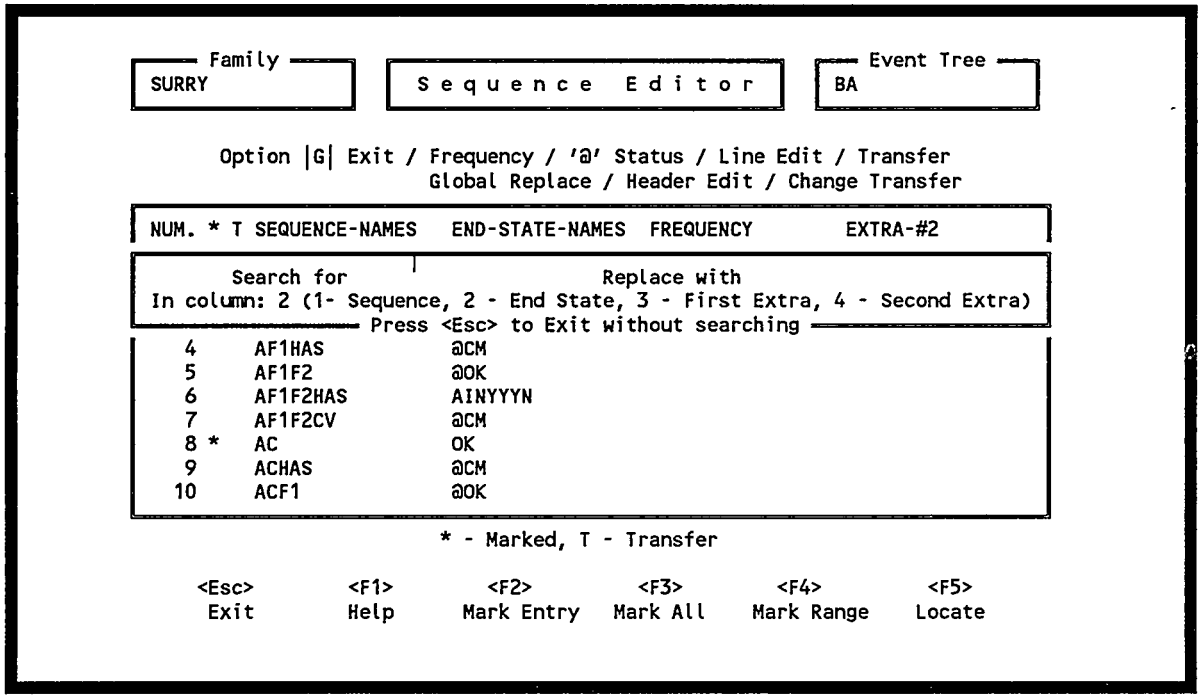


Figure 141. Global replacement using the sequence editor.

7.3.4.7 Header Edit. This option allows you to change the headers that appear across the top of the columns (note: EXTRA-#2 is a user-defined field). To invoke this option, type an <H> and press <Enter>. An outline will surround the headers that may be changed. Simply type over the existing header. Use the <Tab> key to move from field to field. When complete, press <Esc> to terminate without saving the header changes. When you exit the Sequence Editor you will be asked whether or not you wish to save all changes made before exiting.

7.3.4.8 Change Transfer. This works as a toggle switch to turn on and off transfer points. If the sequence was marked as a transfer, this option will turn off the transfer. If the sequence was not marked as a transfer, it turns on the transfer. A "T" appears in the column in front of the sequence names.

7.4 Plot Trees

This option allows you to plot graphics files. This option operates the same as the Plot Tree option for fault trees discussed in Section 5.2, except in this option you will be working with event trees. Refer to Section 5.2 for the detailed user instructions.

7.5 Graphics Load

This option allows you to load event tree graphic files. When you invoke this option, Figure 142 will be displayed. As shown, two options are available: Exit and Load.

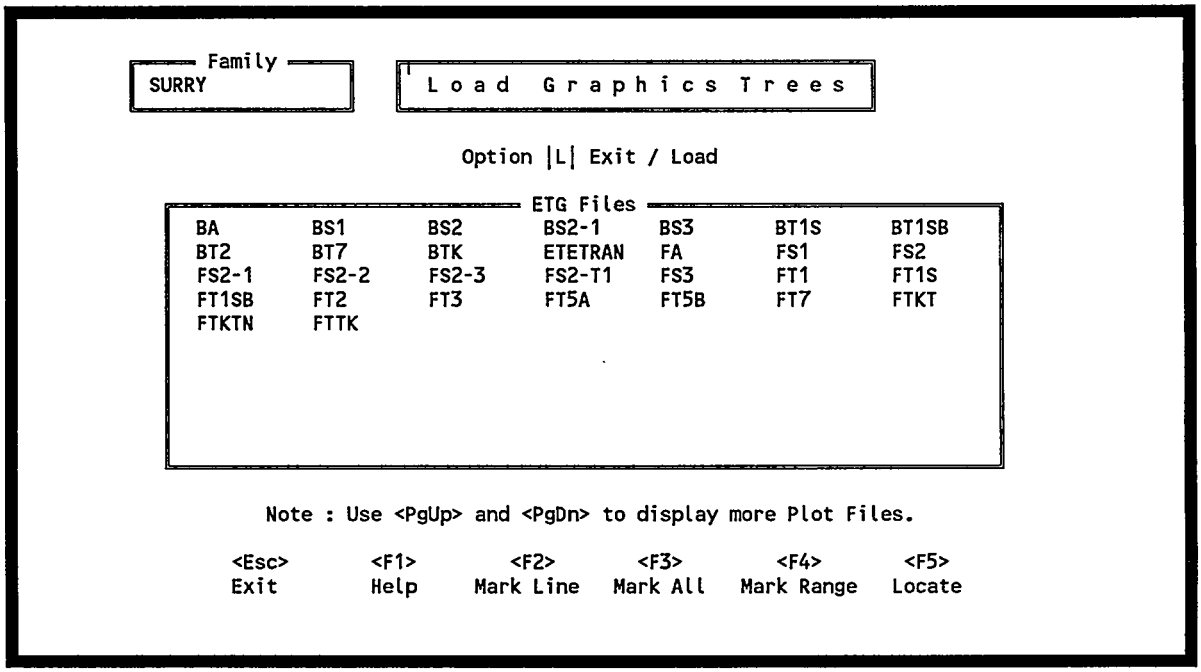


Figure 142. ETG files display.

7.5.1 Exit

This option returns you to the previous screen. To invoke this option, enter an <E> in the option field and press <Enter>, or press the <Esc> key.

7.5.2 Load

This option allows you to load event tree graphics into the system. A conversion of the selected file will be performed. To invoke this option, enter an <L> in the option field, highlight the file or mark the files to be loaded using the function keys, and press <Enter>. A message will be displayed telling you that the selected file(s) is being loaded.

7.6 eXtract Event Trees

This option allows you to extract event trees from the system. When you invoke this option, Figure 143 will be displayed. On this screen all the event trees residing in the current directory are displayed. Four options are available: Exit, eXtract Trees, Clear Extracted Trees, and Display Extracted Trees.

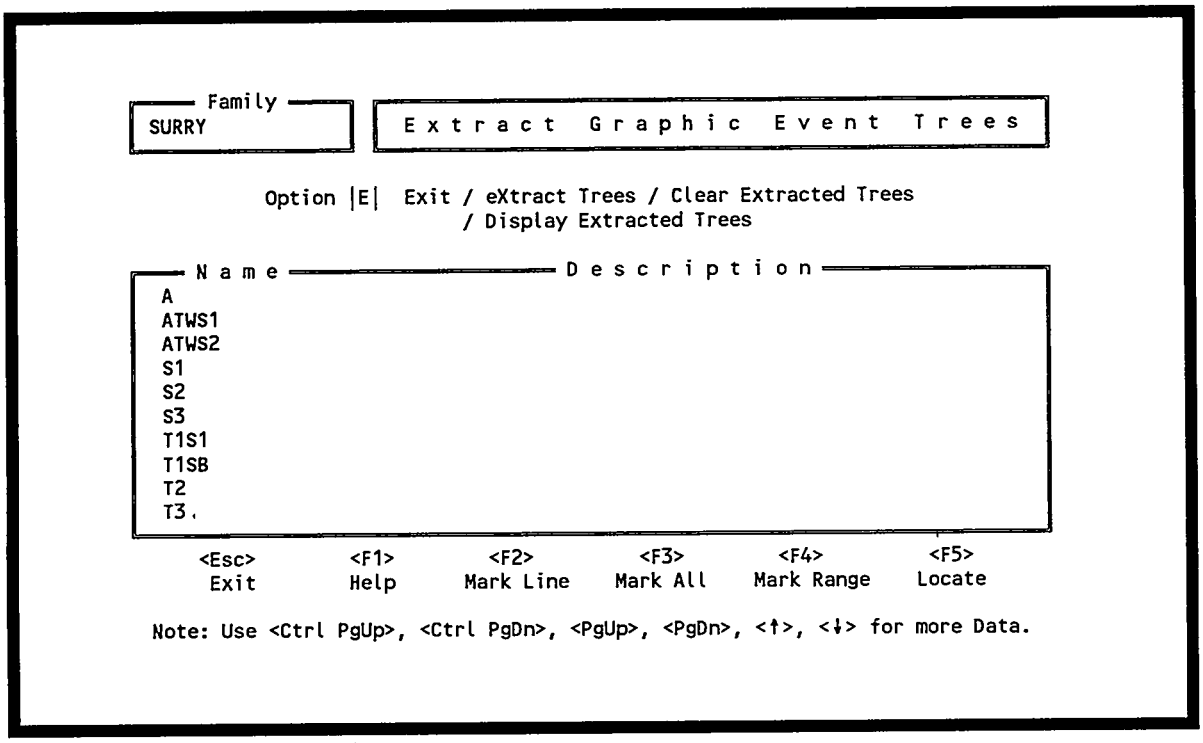


Figure 143. Extract graphic event trees screen.

7.6.1 Exit

This option returns you to the Event Tress Graphics System menu (Figure 119). To invoke this option, enter an <E> in the option field and press <Enter>, or press the <Esc> key.

7.6.2 eXtract Trees

This option allows you to remove specific event trees from the database. To invoke this option, enter an <X> in the option field, highlight the tree to be extracted or mark the trees to be extracted (using the function keys) and press <Enter>. A message will be displayed notifying you that the tree(s) was successfully extracted.

7.6.3 Clear Extracted Trees

This option allows you to clear all extracted trees from a file. To invoke this option, enter a <C> in the option field, highlight the file to be cleared or mark the files using the function keys, and press <Enter>. A warning screen will appear (Figure 144) telling you that all existing *.ETG files will be deleted. Enter a <Y> to delete or an <N> to terminate the process.

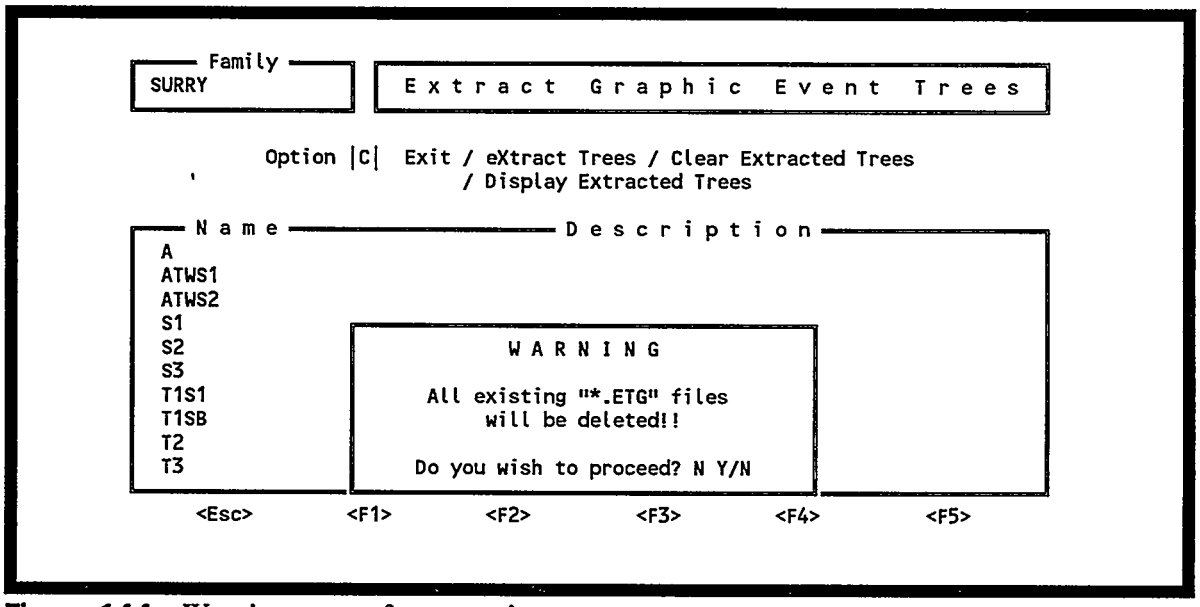


Figure 144. Warning screen for extracting trees.

7.6.4 Display Extracted Trees

This option allows you to display all the extracted trees to date. To invoke this option, enter a <D> in the option field and press <Enter>. A screen similar to the one shown in Figure 145 will be displayed. Press <Enter> to return to the previous screen.

7.7 Define Plotter Pens

This option allows you to assign colors to the plotter pens. When you invoke this option, a screen will be displayed showing 16 colors. Select the color to be mapped by positioning the cross hair over the desired color and pressing the left mouse button. You will then be prompted to **Enter number of pen >**. Enter the number of the pen that will contain the previously defined color. Continue this process until all pens have been defined. To terminate the process, position the cursor on the STOP symbol and press the left mouse button.

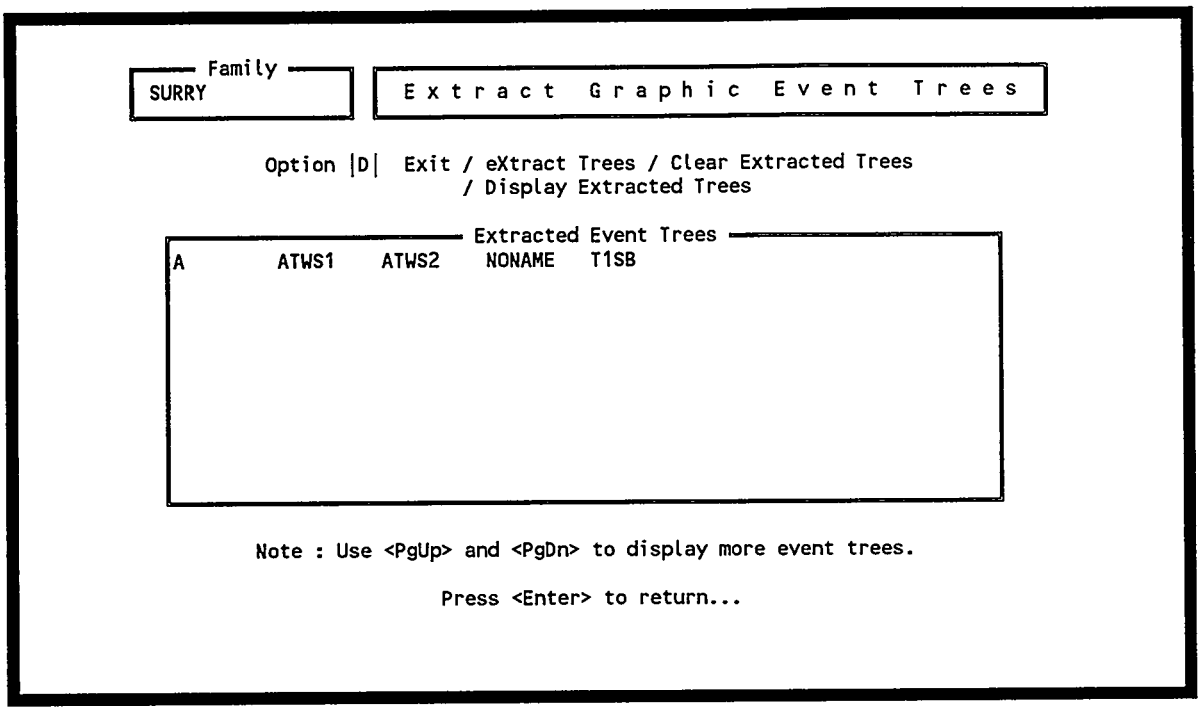


Figure 145. Display extracted trees screen.

8. ANALYZE SEQUENCES

The Analyze Sequences module consists of the following eight options:

1. Analyze Sequences includes updating the cut sets, quantifying the cut sets, and running uncertainty analyses.

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

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

4. Recover Cut Sets recovers a selected event or events based on sequence, applied, or derived rules.

5. Partition Cut Sets allows the user to define rules that define the end state for each sequence cut set.

6. Link Event Trees allows you to define linkage rules and generate sequence logic.

7. Event Tree Editor allows the user to edit the event tree logic in an alphameric format.

8. Seismic Plotting provides a means for plotting seismic curves. A seismic curve shows discrete points as a distribution and reflects the differences of opinion among experts for the frequency of earthquakes at a given site.

Keys that you will frequently use are

<Esc>	Escape cancels your last choice and returns you to the previous screen.
<F1>	Help briefly explains the function of a field and may show you examples of data entered.
<F2>	Mark/Unmark tags items for use in the selected option.
<F3>	Mark all of the events (*) for further processing. If all items are marked, this option will unmark all of the items.
<F4>	Mark/Unmark range of items quickly tags large numbers of items for processing.
<F5>	Locate an item displays a blank field in the center of the screen, and a message **Please enter name to locate** will appear. The user should enter all or part of the name to be located and then press <Enter>. This feature will place the highlight on the located name. If the required name is not found, then the next name in alphabetical order will be highlighted.

To invoke this option, highlight ANALYZE Sequences and press <Enter>. The event tree analysis main menu is shown in Figure 146. The options available from the event tree analysis main menu are: Exit, Analyze Sequences, Display Results, Cut Set Editor, Recover Cut Sets, Partition Cut Sets, Link Event Trees, and Seismic Plotting. These options and their functions will be discussed in the following paragraphs.

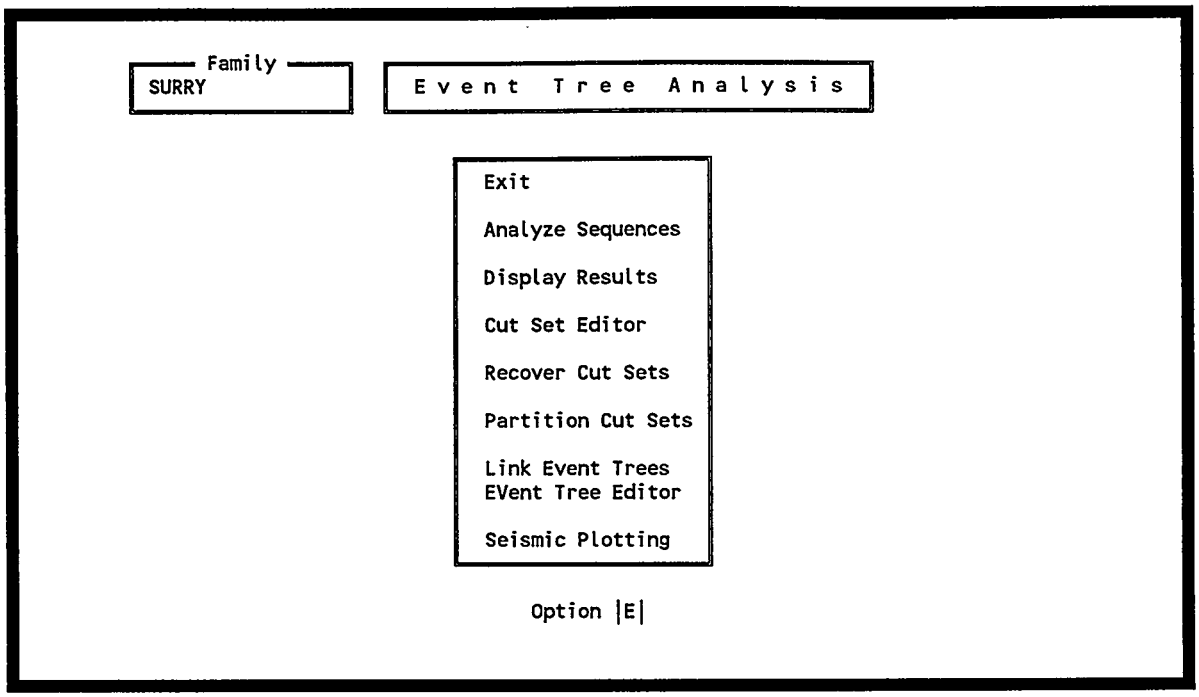


Figure 146. Event tree analysis main menu.

8.1 Exit

The Event Tree Analysis screen appears with Exit as the default choice in the command line (see Figure 146). Press <Enter> to return to the IRRAS main menu.

8.2 Analyze Sequences

This option provides the means to recalculate sequence values after events and/or cut sets have been modified. To invoke the option, highlight Analyze Sequences or type <A> in the option field, and press <Enter>. A screen similar to the one shown in Figure 147 will appear. This screen lists the sequences defined for the current family. The letters c, q, u, and + (in any combination) may precede a sequence name and are defined as follows:

c - flags the sequence as having cut sets that must be regenerated
q - flags the sequence as having cut sets that must be requantified
u - flags the sequence as needing uncertainty distributions recalculated
+ - flags the sequences with existing cut sets

Once these functions have been executed the corresponding letter is removed from the display. The options available from the Analyze Sequences screen are Exit, Generate Cut Sets, Cut Set Update, Quantification, Uncertainty Analysis, ENd State Uncertainty, Split Fraction, MinMax Quantification, Prune Cut Sets, and Analysis Type.

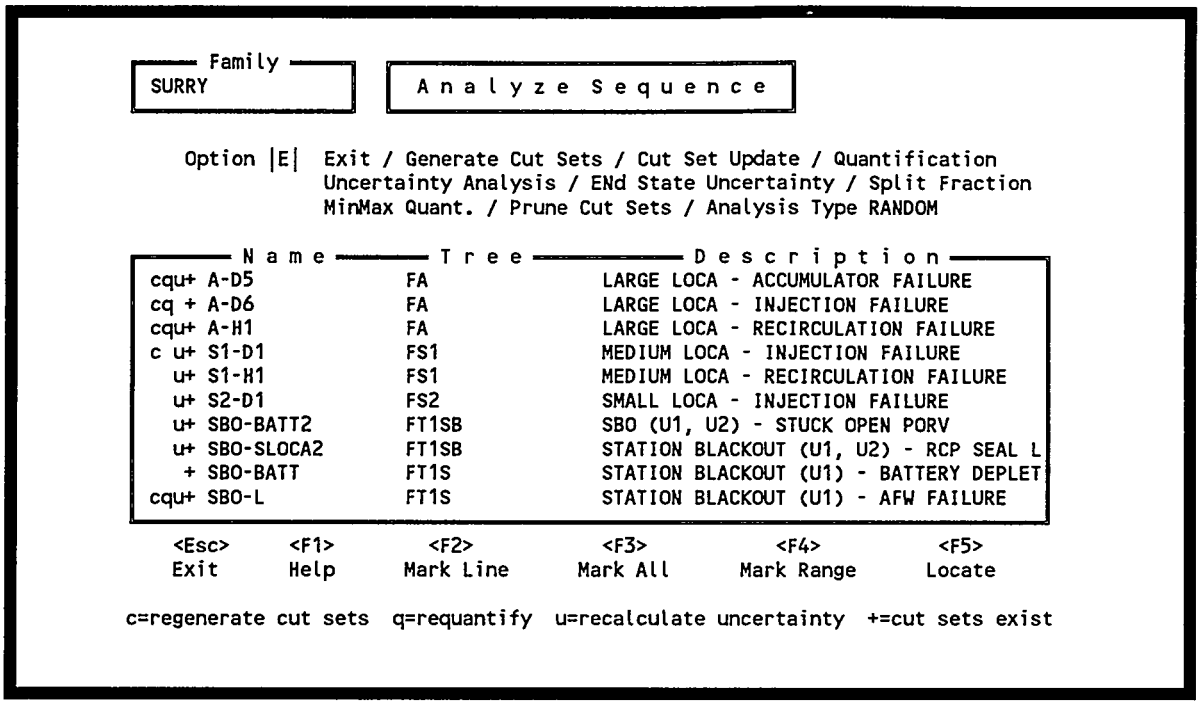


Figure 147. Sequence analysis main menu.

IRRAS writes the summary information generated during analysis to a file that the user can read to determine the results of a batch operation involving several systems or sequences. This file is called "SCREEN.CPY." When either Analyze Systems or Analyze Sequences is executed, IRRAS deletes a file in the current family subdirectory called "SCREEN.OLD." The file "SCREEN.CPY" is then renamed to "SCREEN.OLD." The summary screens for any operations performed during this session (using the Analyze option) are then written to the file "SCREEN.CPY." The user may exit IRRAS, change to the specified subdirectory, and print, edit, or review this file.

8.2.1 Exit

To return to the Event Tree Analysis menu, type an <E> (Exit) in the option field and press <Enter>, or press the <Esc> key.

8.2.2 Generate Cut Sets

This option allows you to generate the cut sets for a selected sequence based on cut set generation cutoff values. You are given the opportunity to specify several cut set generation cutoff values that will be used to determine if a cut set is to be retained or discarded from the selected sequence.

You are given the ability to generate cut sets for a selected sequence, a group of sequences, or all sequences within the current family. To invoke the Generate Cut Sets for a single selected sequence, type <G> (Generate Cut Sets) in the option field, highlight the desired sequence, and press <Enter>. To invoke this process for a group of sequences, mark the desired sequences using the function keys

<F2>, <F3>, and <F4>, type a <G> in the option field, and press <Enter>. To invoke this option for all sequences in the current family, clear all marked entries with the <F3> key, type <G> in the option field and press <Enter>. A message **Process all records? (Y/N)** will appear at the bottom of the screen. Type a <Y> to continue the Generate Cut Sets for all records that need processing (e.g., for <G> the sequences must have a "c" in front of the sequence name, etc.) or type an <N> to terminate the update for all sequences.

Whether you are generating cut sets for a single sequence, a group of sequences, or for all sequences, the Cut Set Generation Cutoff Values screen shown in Figure 148 will be displayed. You may change any of the data fields on this screen. Each field is described below. The default values that appear on this screen may be reset to new values by selecting the Utility Options from the IRRAS main menu and then invoking the Define Constants option.

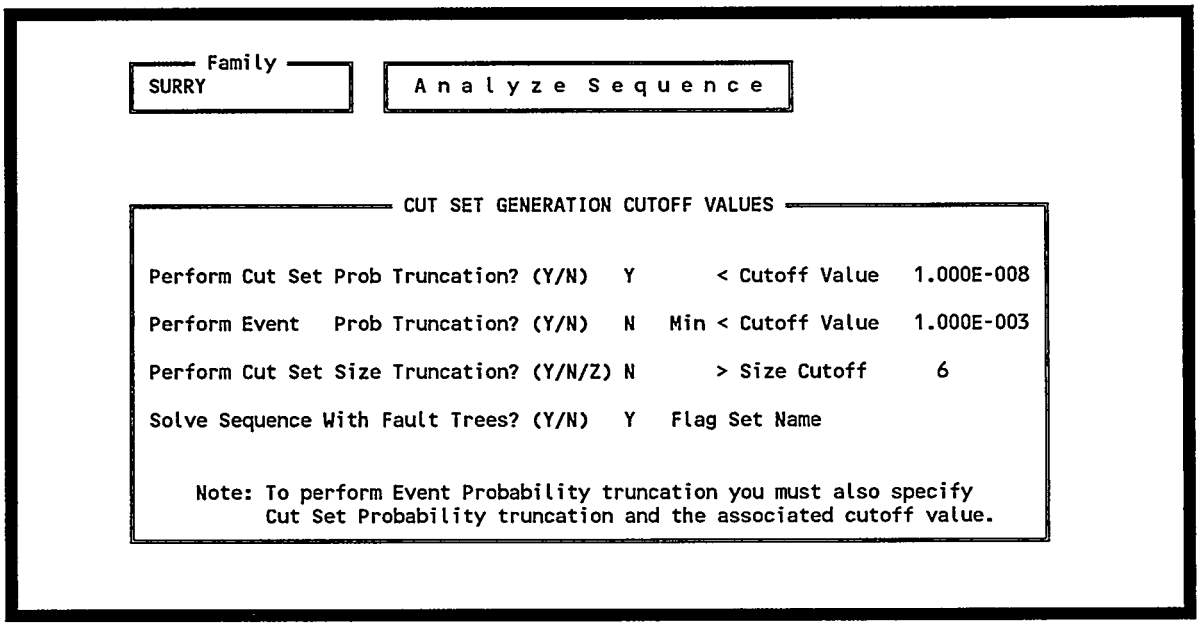


Figure 148. Cut set generation cutoff values.

Perform Cut Set Prob Truncation?

If you enter a <Y>, 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 enter an <N>, then the probability for the cut set will be irrelevant for determining if the cut set should be retained or discarded.

Perform Event Prob Truncation?

If you enter a <Y>, then you must also enter <Y> for "Perform Cut Set Prob Truncation." 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.

Perform Cut Set Size Truncation

If you enter a <Y>, then only the cut sets whose number of events is less than or equal to the value specified in the Size Cutoff field will be kept in the cut sets for that system. All other cut sets will be removed.

If you enter an <N>, then the number of events in a cut set will be irrelevant for determining if the cut set should be retained or discarded.

If you enter a <Z>, then only zone flagged events will be checked.

Solve Sequence With Fault Trees

If you enter a <Y>, IRRAS uses the system fault trees to solve the tree; otherwise the system cut sets are used.

Cutoff Value

Value set for probability truncation.

Min < Cutoff Value

Value set for event probability truncation.

> Size Cutoff

Value set for cut set size truncation.

Flag Set Name

The flag set name is the name of a change set (see Section 4.5.2) containing a set of events to be set to either "T," "F," or "I" and flags to be set to "X," "Y," or "I." These events must be individual settings (i.e., not class changes).

If this field is left blank, then IRRAS checks to see if there is a default setting for this sequence. The default can be set using the Event Tree Sequences suboption under the Modify Data Base option (see Section 9.3.6). If there is a default setting, then IRRAS uses it; otherwise, IRRAS uses no flags.

If the flag set name is set to "NONE," then no flags are used.

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.

During processing, the screen shown in Figure 149 is displayed and updated as the calculations proceed. Upon completion of the cut set generation, the results are displayed as shown in Figure 150.

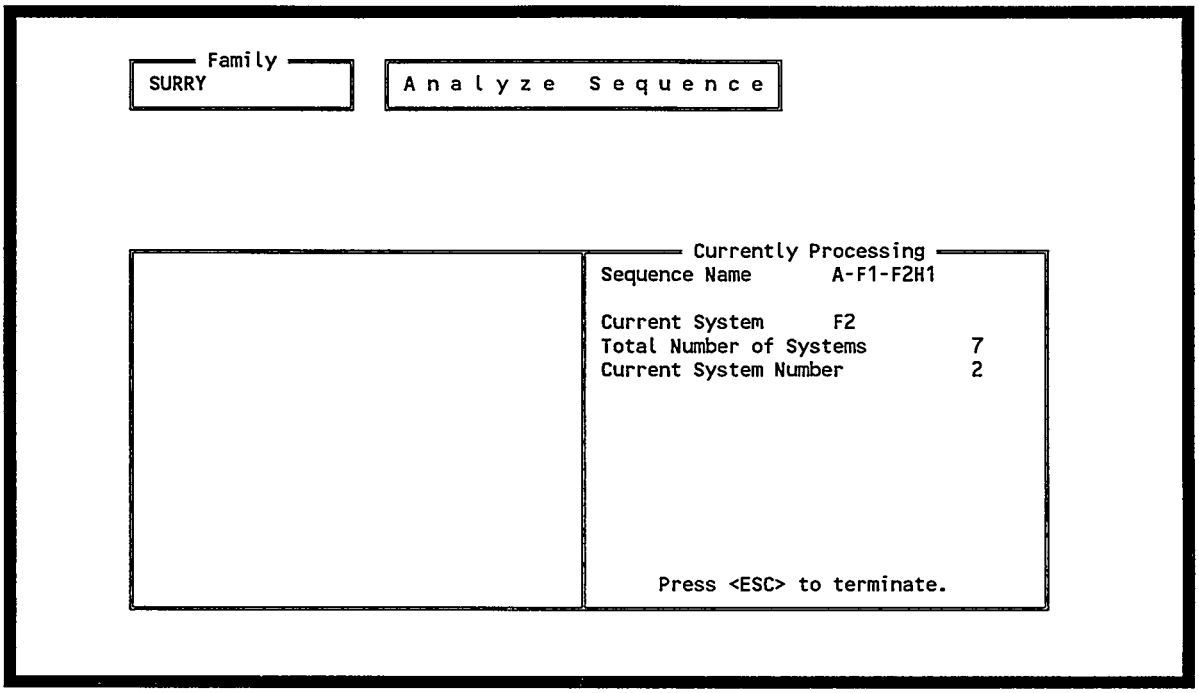


Figure 149. Status screen for cut set update.

8.2.3 Cut Set Update

This option will update the alternate cut sets for a selected sequence based on cut set generation cutoff values. This option operates the same for sequences as it does for systems. Rather than repeat the instructions, the reader is referred to Section 6.2.3.

8.2.4 Quantification

The quantification process will calculate a new minimum cut set upper bound for the sequence cut sets using the current data values (event change sets and alternate case cut sets). The new minimum cut set upper bound is saved with the alternate case cut sets for the selected sequence. This option operates the same for sequences as it does for systems. Rather than repeat the instructions, the reader is referred to Section 6.2.4.

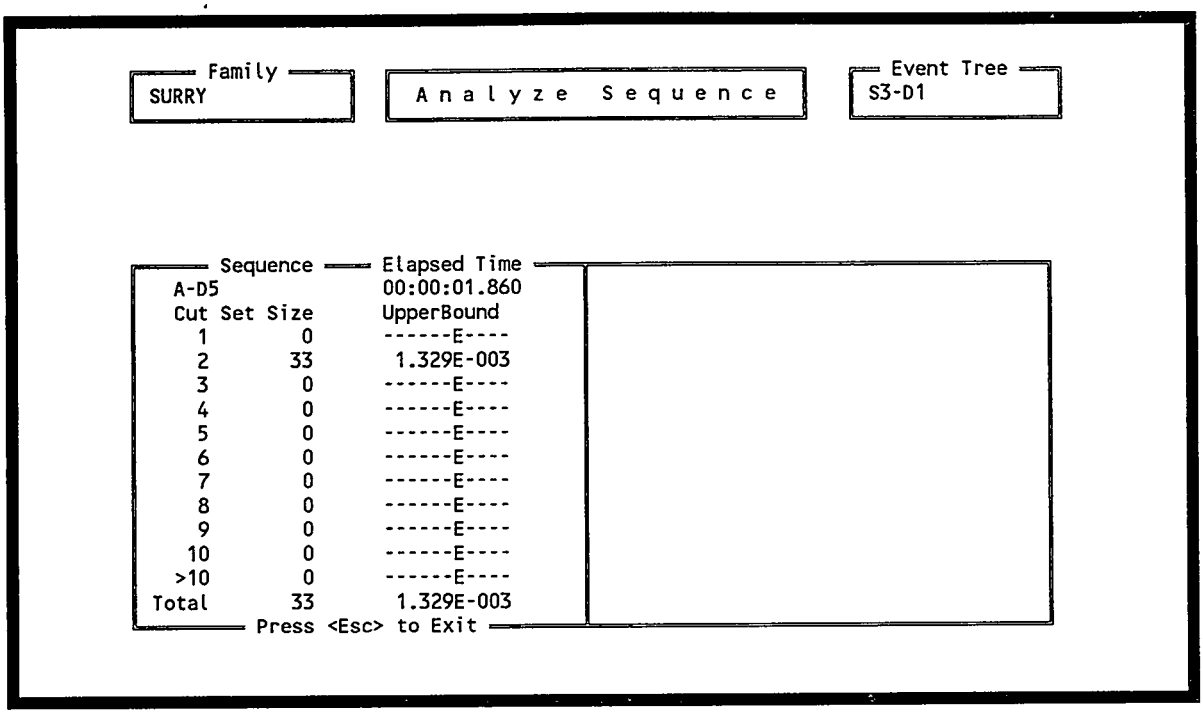


Figure 150. Results of the cut set update.

8.2.5 Uncertainty Analysis

This option allows you to run an uncertainty analysis for a sequence using one of the two sampling techniques provided. The two sampling techniques are the Monte Carlo simulation technique and the Latin Hypercube simulation technique. In addition, you may perform a seismic or normal uncertainty.

This option operates the same for sequences as it does for systems, except when multiple sequences are marked for processing. When multiple sequences are marked, Figure 151. On this screen, you may combine results using the group or family option. However, all other options operate the same. Rather than repeat the instructions, the reader is referred to Section 6.2.6.

8.2.6 ENd State Uncertainty

The end states are those defined at a sequence level, not the cut set level. To do a cut set level end state analysis, use the end state analysis option to gather cut sets.

This option allows you to run an uncertainty analysis on a sequence using one of the two sampling techniques provided. The two sampling techniques are the Monte Carlo simulation technique and the Latin Hypercube simulation technique. In addition, you may perform a seismic or normal uncertainty. To generate an overall uncertainty analysis for all of the sequences within a selected end state, enter an <N> in the option field. The End Uncertainty screen will be displayed (see Figure 152). This screen lists all the end states contained in the family. Use the <F2>, <F3>, and <F4> function keys to

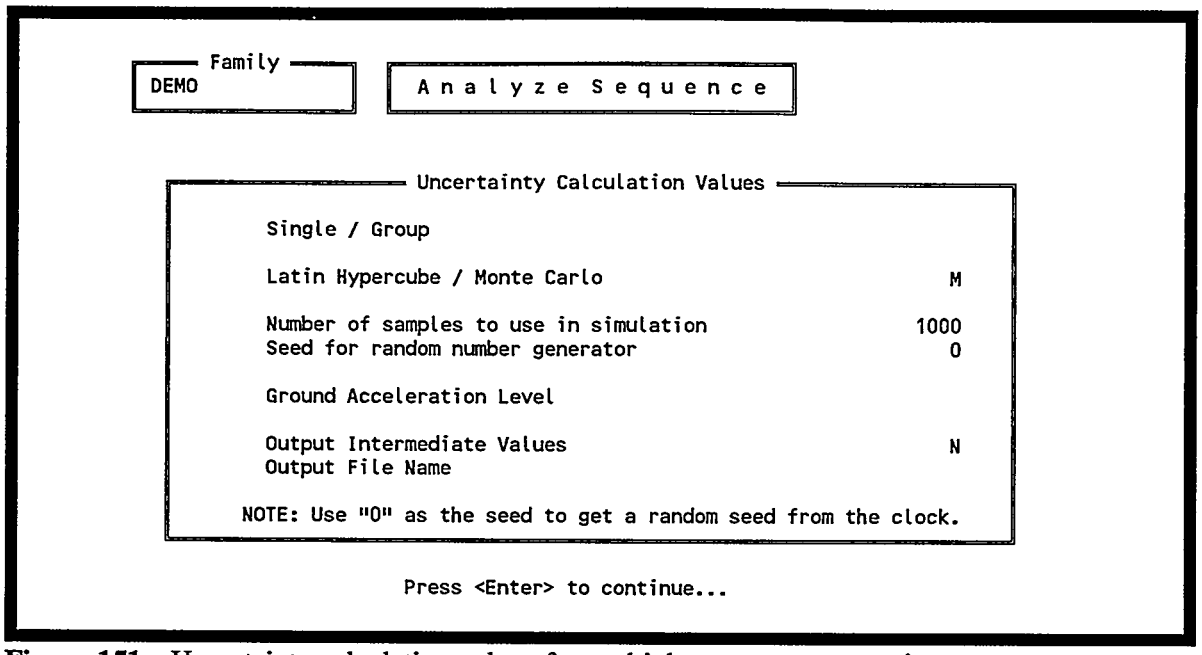


Figure 151. Uncertainty calculation values for multiple sequence processing.

mark the desired end states. When complete, press <Enter>. (<N> is the default value in the option field).

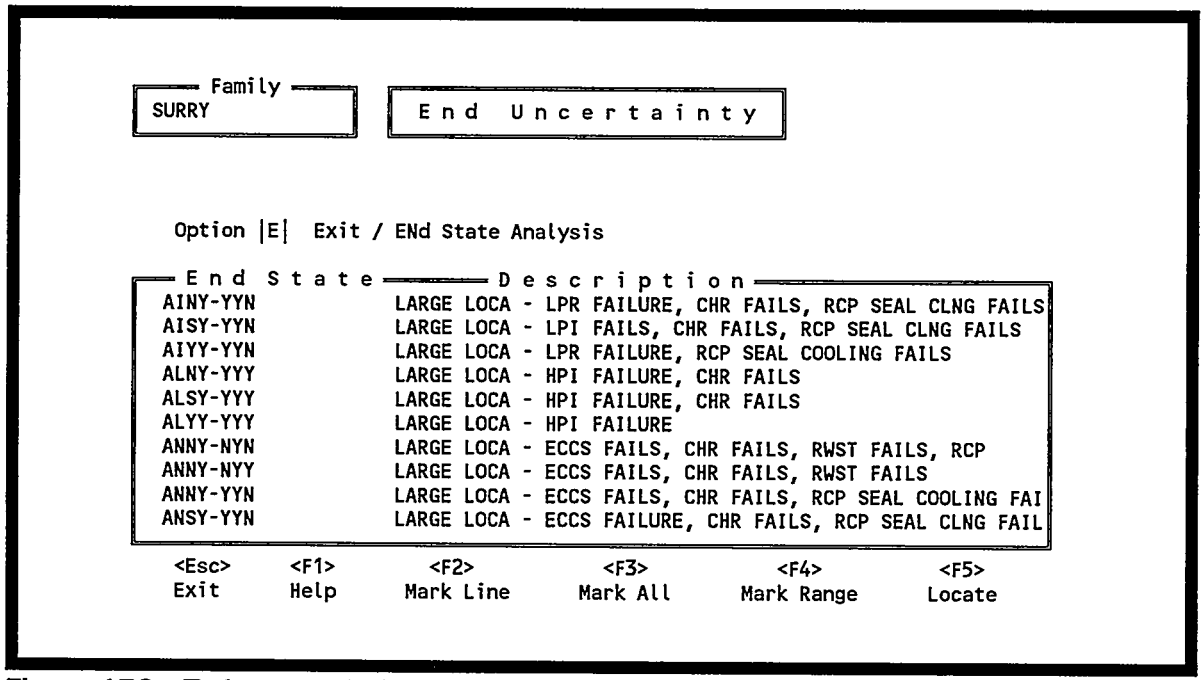


Figure 152. End state analysis screen.

Upon pressing <Enter>, the screen shown in Figure 153 will appear. On this screen, you must supply the following information:

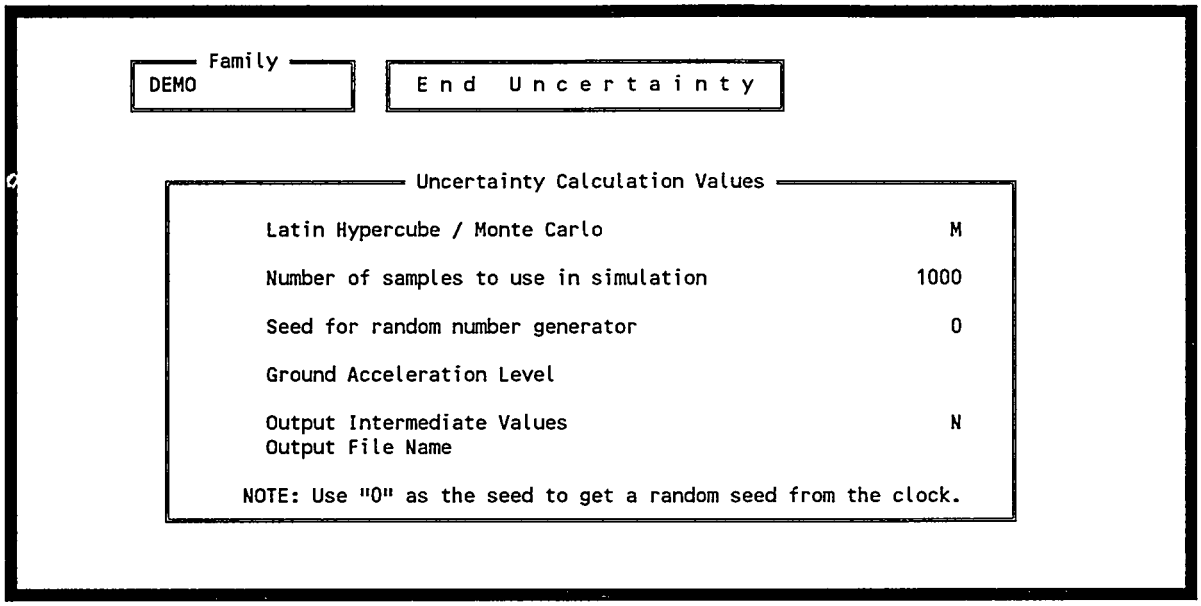


Figure 153. Uncertainty calculation values.

Latin Hypercube/Monte Carlo - To use the Monte Carlo sampling technique to obtain an uncertainty, enter an <M>. However, it you wish to use the Latin Hypercube sampling technique, type an <L> into this field.

Number of samples to use in simulation - A default value is provided for the number of samples. You may use this value or enter another value. You may change the default values for both the number of samples and the random seed in the Utility Options, Define Constants suboption.

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.

Ground Acceleration Level - If seismic uncertainty is selected, a ground level acceleration must be provided.

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

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

technique gives its best results if the number of samples is at least twice the total number of unique events.

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

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

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

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

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

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

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

8.2.7 Split Fraction

This option allows you to quantify the sequence cut sets using the mincut upper bound values that have been calculated for each successful or failed system 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.

To invoke this option, enter an <S> in the option field, highlight the desired sequence, and press <Enter>. The quantification results are shown in a screen similar to the one shown in Figure 154.

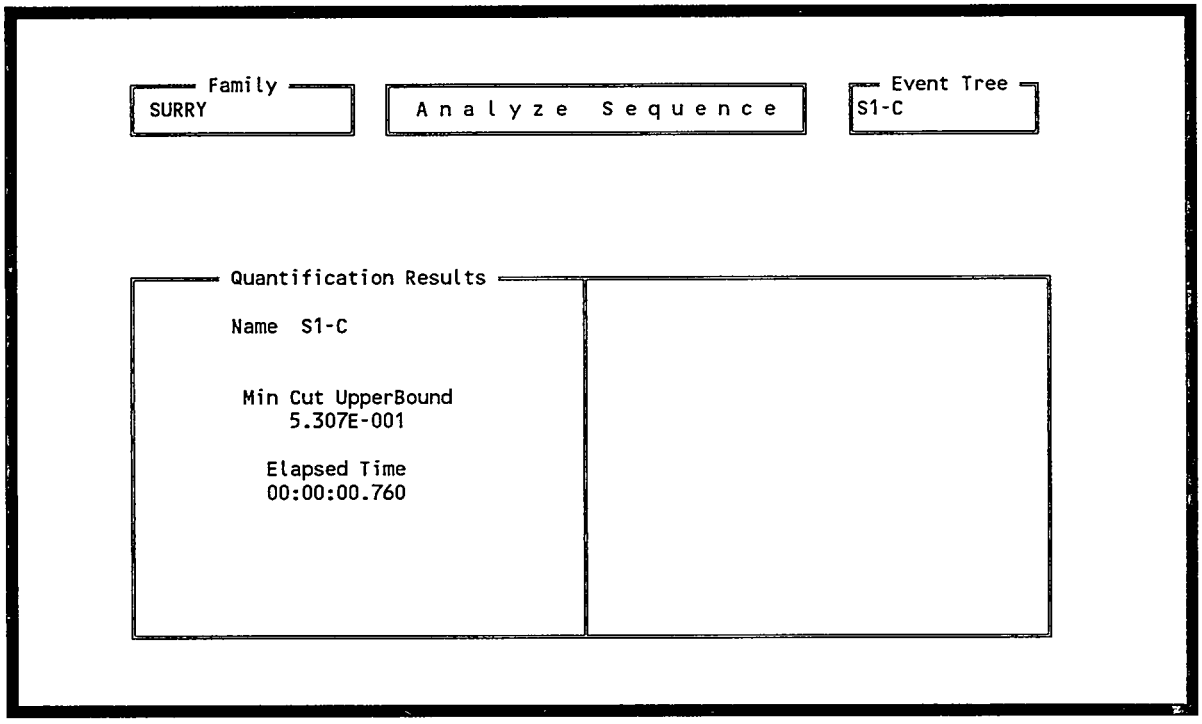


Figure 154. Split fraction display screen.

As with previous options, you may specify several sequences or a range of sequences using the <F2> and <F4> function keys, respectively. To process all sequences, enter an <S> in the option field and press <Enter>. The message **Process all entries?** will be displayed. At this prompt, enter a <Y>.

8.2.8 MinMax Quant.

This option allows you to perform a min max quantification of the minimum cut upper bound. You can set the number of intermediate terms IRRAS will calculate when determining the minimum and maximum quantification values for a sequence. When you invoke this option, Figure 155 will appear. On this screen, type a number from 1 to 10 to indicate the number of intermediate terms you want IRRAS to calculate. The higher the number, the more the calculation speed decreases and the accuracy increases.

IRRAS will perform the specified calculations and when complete will show the results on the quantification screen (see Figure 154).

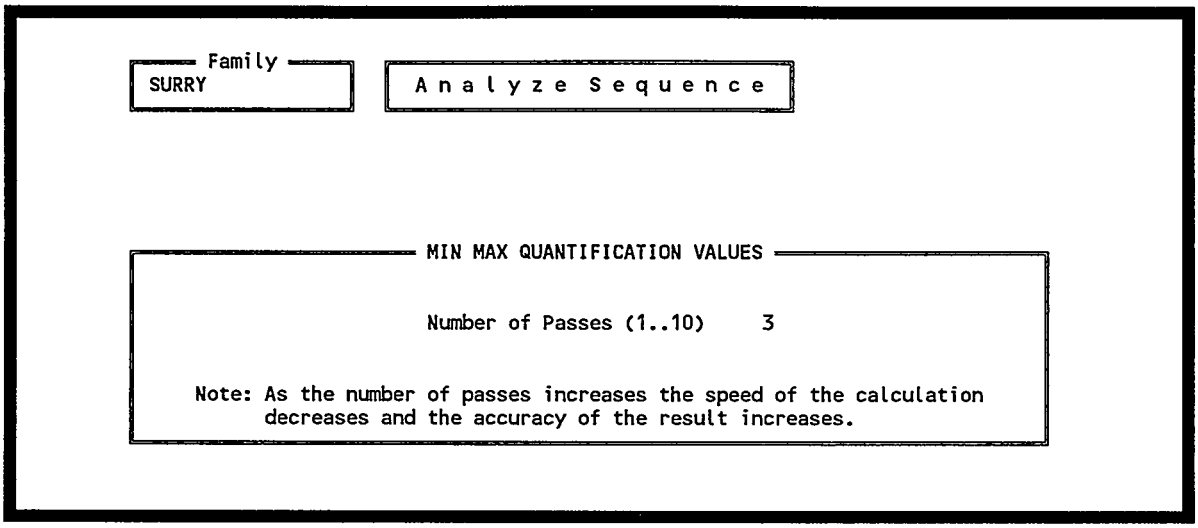


Figure 155. Indicate number of passes for sequence quantification.

8.2.9 Prune Cut Sets

This option allows you to prune cut sets for a selected sequence, for a group of sequences, or for all of the sequences within the current family. This option operates the same for sequences as it does for systems. Rather than repeat the user instructions, the reader is referred to Section 6.2.5.

8.2.10 Analysis Type

This option allows you to specify the type of analysis you wish to perform on the selected sequence. This option operates the same for sequences as it does for systems. Rather than repeat the user instructions, the reader is referred to Section 6.2.7.

8.3 Display Results

This option allows you to display the results of your sequence analysis. To display the results, highlight Display Results or type a <D> on the Event Tree Analysis menu and press <Enter>. The Display Sequence Results screen will be displayed showing the list of sequences available in the current family. This option operates the same for sequences as it does for systems. Rather than repeat the user instructions, the reader is referred to Section 6.3.

8.4 Cut Set Editor

The cut set editor provides you with the means to edit the base case/alternate sequence cut sets. This option operates the same for sequences as it does for systems. Rather than repeat the user instructions, the reader is referred to Section 6.4.

8.5 Recover Cut Sets

This option allows you to recover a selected event or events based on sequence, applied, or derived rules. This option operates the same for sequences as it does for systems, except that for sequences you may also apply event tree and family rules. Rather than repeat the user instructions, the reader is referred to Section 6.5.

8.6 Partition Cut Sets

The partition option allows you to define the end states to be associated with each cut set in a accident sequence. You can define a set of rules that map the cut sets for a sequence to an end state. The rules are defined using the same editor that is used for event tree rules definition. This editor is a macro-based editor. This means that you can define macros or variables that can be used in tests. The macro defined by the following syntax,

```
NO-FLOW = (EVENT1 + EVENT2) * (EVENT3 + /EVENT4);
```

indicates that "NO-FLOW" is to be true if the following conditions are true. (1) EVENT1 or EVENT2 appear in the cut set and EVENT3 appears or EVENT4 appears as a complemented event. The "+" sign is used to indicate "or" logic, the "*" sign is used to represent "and" logic, and the "/" sign is used to represent the complement or "not" logic. You can also use the "~" character to indicate that the item following the character is not in the current cut set. The "?" character can be used in the string substitution. This character is a place holder character and has no effect on the resulting string substitution. Once a macro is defined, it can be used in an "if" test. The following rule is an example of an "if" test using a macro.

```
if NO-FLOW then
  partition = "NO-FLOW-END";
endif
```

The information between the "if" and the "endif" clause defines the end state for the cut set. The user can either specify an entire end state name as in the example or substitute only certain character positions in the name. The following rules demonstrate the substitution process.

```
if ALWAYS then
  partition = "NO-FLOW-";
endif

if NO-FLOW then
  partition = "????????END";
elsif ~EVENT7 then
  partition = "????????START";
else
  partition = "????????NONE";
endif
```

This rule will result in one of three end states being assigned to a cut set. Either, "NO-FLOW-END", "NO-FLOW-START", or "NO-FLOW-NONE". A rule can contain some additional clauses as indicated above. The "elsif" clause allows you to specify an alternate test for the rule. The first condition that is met is used and the others are ignored. The "else" clause allows you to specify a condition that is to be used if none of the previous conditions are met. If you want a condition to always be used then they you can use the predefined macro "ALWAYS." The substitutions following this condition are always made. Blank lines are encouraged in the editor to improve readability and comments can be entered following the "|" character. All information on a line following the comment character is ignored.

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. For instance, if the name "EVENT5" was really the name of a system then you could change its default type with the following syntax; "system(EVENT5)". The editor will then treat this name as a system. Cast operators are provided for macros, systems, end states, events, and initiating events. There is no limit to the number of rules you may input to the editor. Each rule is processed in sequential order. The editor allows you to list the names for a given type by using the <Ctrl> key in combination with a letter defining the data type to list. The <Alt> key in combination with the same key allows you to check if a name of the specified type exists in the database and optionally add it and cast the name to that type.

To exit the editor and save the defined rules, press the <Esc> key. To exit without saving, press the <Alt/Q> keys together.

When you invoke this option, Figure 156 will appear. This screen lists all the end states defined for the selected family. The following options are available: Exit, Sequence Rules, EVent Tree Rules, Family Rules, Apply Rules, and Change Analysis Type.

8.6.1 Exit

This option terminates the partitioning option and returns you to the Event Tree Analysis menu.

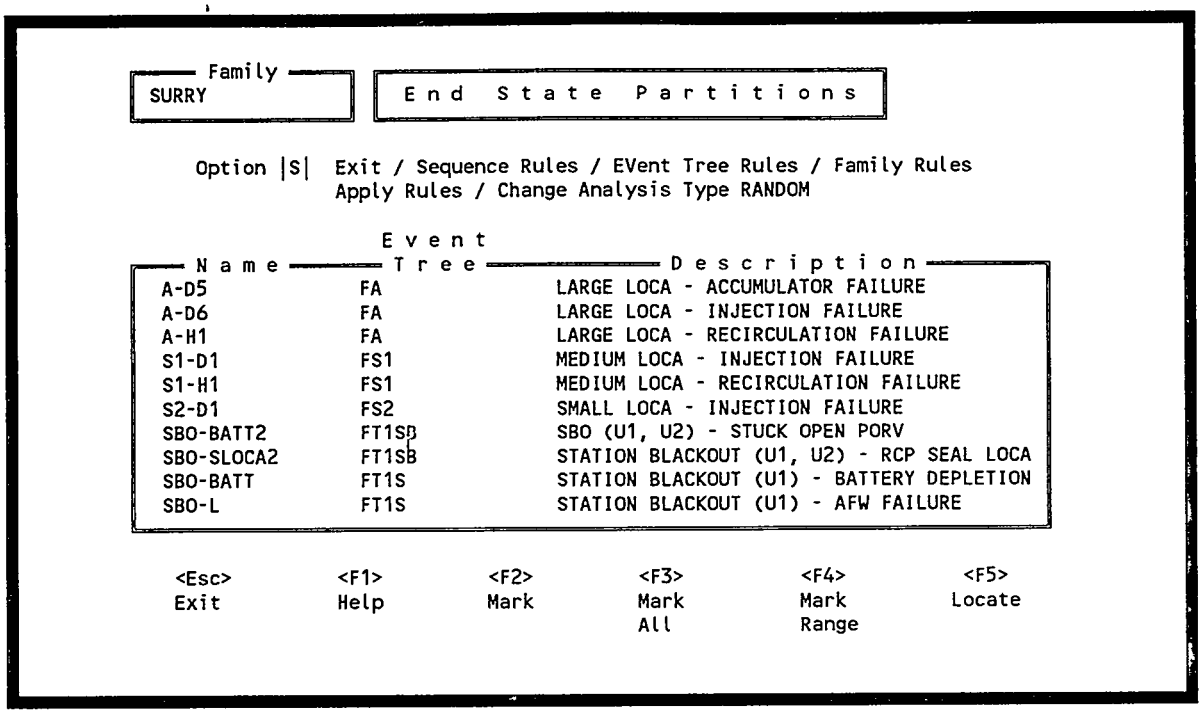


Figure 156. End states partition menu.

8.6.2 Sequence Rules

This option allows you to define rules for specific sequences. When you invoke this option, a screen similar to the one shown in Figure 157 will be displayed. This screen list all the events defined for the selected sequence. From this screen, you can define a sequence rule, event tree rule, family rule, or apply the rules currently defined.

8.6.2.1 Sequence Rule. When you invoke this option the screen shown in Figure 158 will appear. This screen shows the rules that map the cut sets for a sequence to an accident sequence. From this screen, you may modify the rules or input new rules. The following keys are available to help you with data entry:

<F1> - Displays the list of function keys available to you to perform various editing functions.

<Ctrl/O> - Displays a window showing a list of macros that have been previously defined. You may select a macro from the list to include in the partition.

<Ctrl/E> - Displays the event list containing all events defined for the sequence. From this window, you may select the mask to be used in the partition.

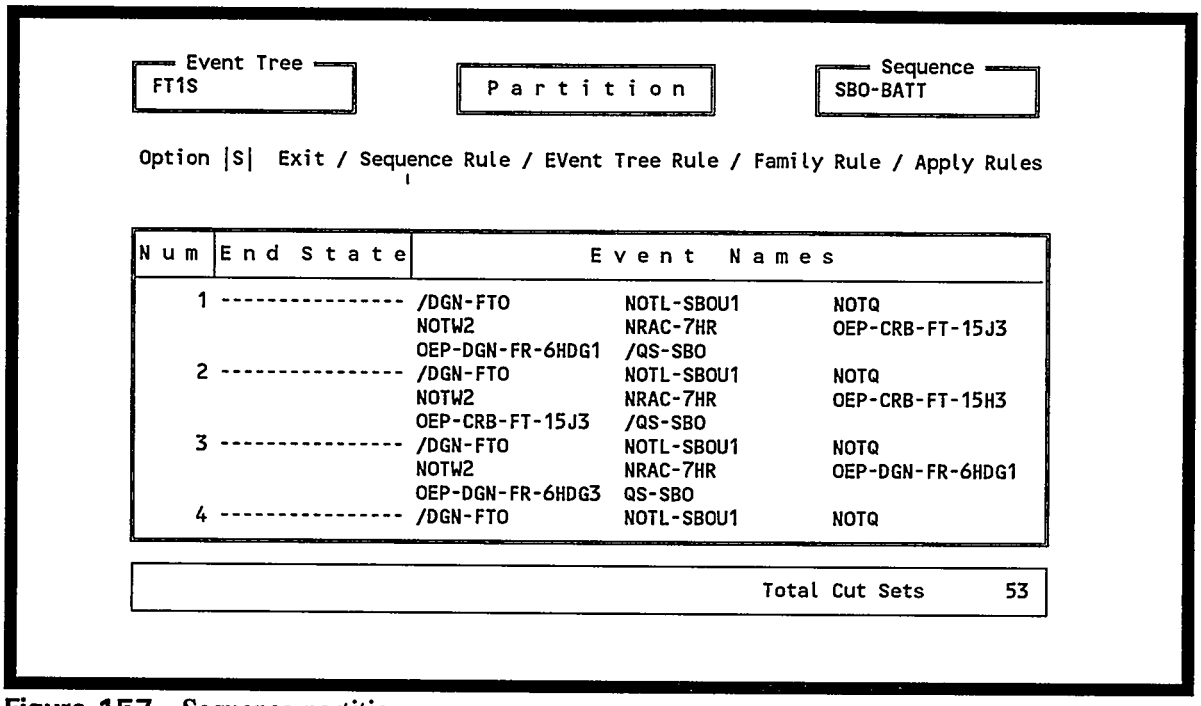


Figure 157. Sequence partition screen.

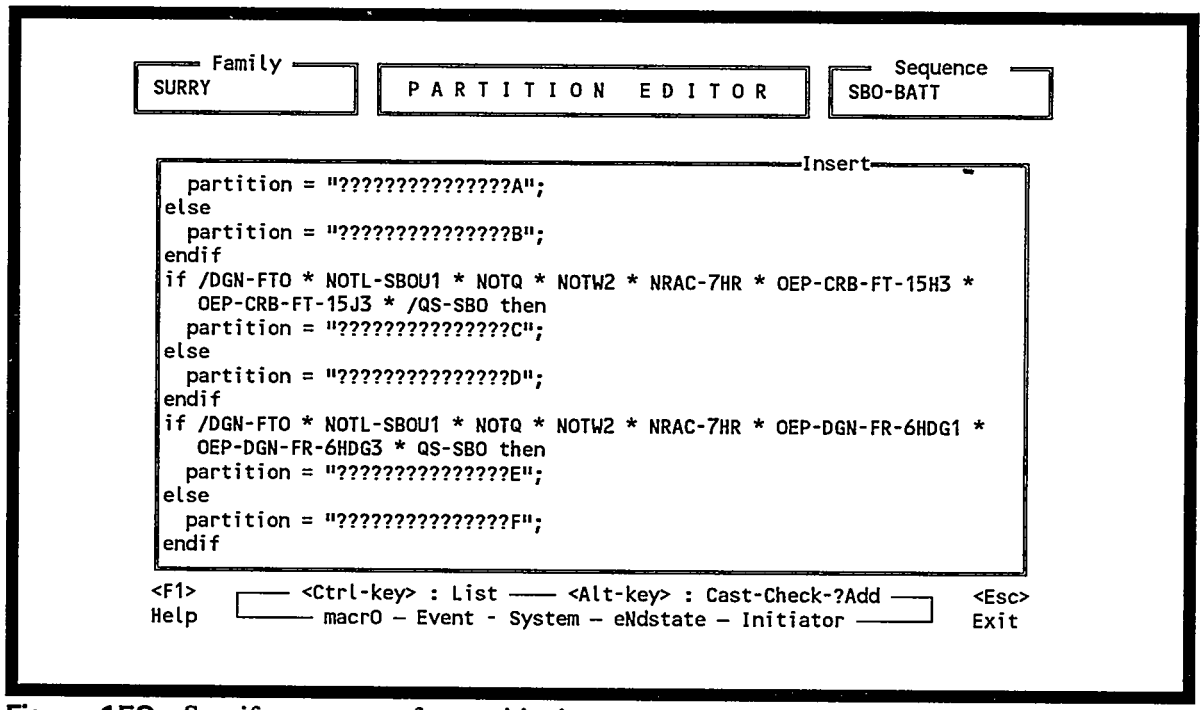


Figure 158. Specify sequences for partitioning.

<Ctrl/S> - Displays the system list containing all systems defined for the family. From this window, you may select the mask to be used in the partition.

<Ctrl/N> - Displays the end state list containing all end states defined for the family. From this window, you may select the mask to be used in the partition.

<Ctrl/I> - Displays the initiator list containing all initiators defined for the family. From this window, you may select the mask to be used in the partition.

From the systems, end states, and initiators lists you can add a new item to the list using the <F8> key or modify an existing item using the <F9> key.

NOTE: The <Alt> key in combination with the same keys shown above allow you to check if a name of the specified type exists in the database and optionally add it and cast the names to that type.

8.6.2.2 EVent Tree Rule. This option operates like the sequence rule described above, except here you are defining a rule for the event tree. Refer to Section 8.6.2.1 for operating instructions.

8.6.2.3 Family Rule. This option operates like the sequence rule described above, except here you are defining a rule for the family. Refer to Section 8.6.2.1 for operating instructions.

8.6.2.4 Apply Rules. This option applies the partition rules to the selected sequence.

8.6.3 EVent Tree Rules

This option allows you to interactively define event tree rules. When you invoke this option, the screen shown in Figure 159 will be displayed. If rules have already been defined they will be displayed on the screen. The same options are available here as described in Section 8.6.2.

8.6.4 Family Rules

This option operates in a similar fashion as described for event trees above. Using this option, however, you are defining rules for a family. See Section 8.6.3 for operating instructions.

8.6.5 Apply Rules

This option actually applies the partition rules to the marked sequence cut sets. Rules are sequentially applied; that is, family rules, followed by event tree rules, and finally sequence rules. If rules conflict, the latest applied rule will take precedence over earlier ones. When you invoke this option, a window will appear prompting you to enter a Y to continue or an N to terminate without applying the rules. Enter a Y and press <enter> to continue; or enter an N and press <Enter> to terminate.

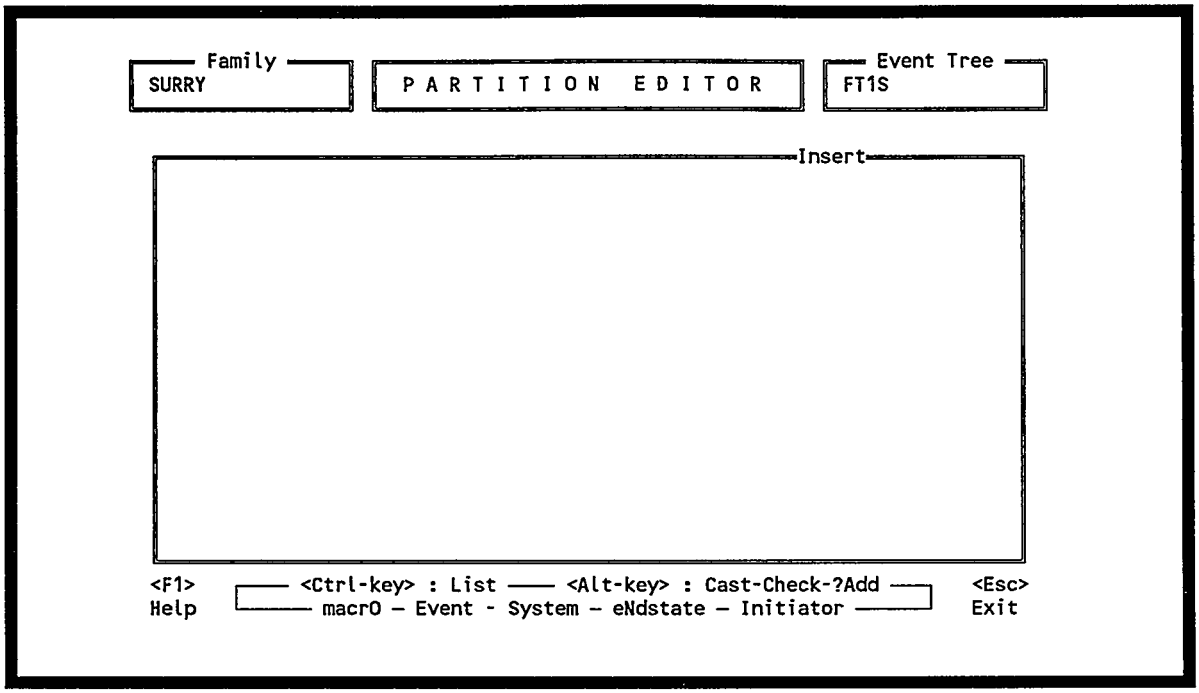


Figure 159. Enter a rule interactively.

8.6.6 Change Analysis Type

This option allows you to specify the type to analysis you wish to perform on the selected sequence. This option operates the same for sequences as it does for systems. Rather than repeat the user instructions, the reader is referred to Section 6.2.7.

8.7 Link Event Trees

This option allows you to define linkage rules and generate sequence logic. This option is identical to the Link Trees Option discussed in the Create Event Trees module in Section 7.3. Rather than repeat the user instructions, the reader is referred to Section 7.3.

8.8 Event Tree Editor

This option allows you to edit the logic for a selected event tree. When you invoke this option, Figure 160 appears. From this screen, three options are available: Exit, Logic Editor, and Switch Sub-Trees. Each option is discussed in the following paragraphs.

8.8.1 Exit

This option terminates the event tree editor option and returns you to the Event Tree Analysis menu (see Figure 146).

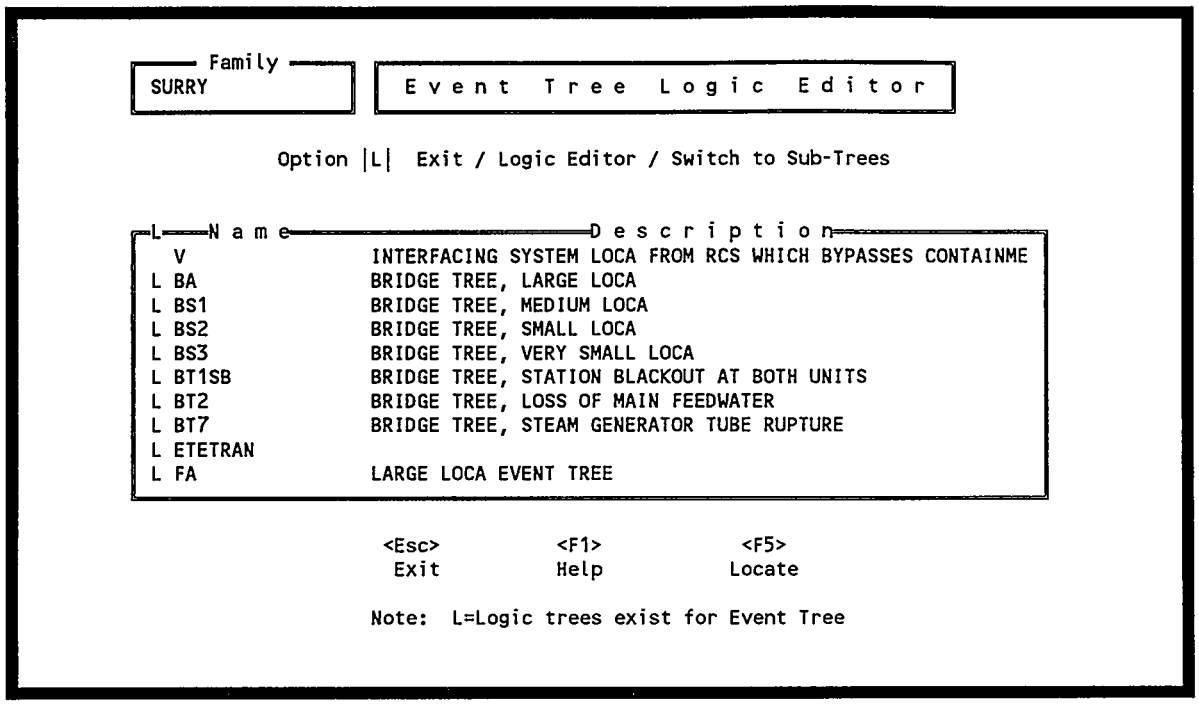


Figure 160. Event tree logic editor.

8.8.2 Logic Editor

This option allows you to change the logic tree for a selected event tree. To invoke this option, type an <L> in the option field, highlight the event tree to be modified, and press <Enter>. (**NOTE:** An "L" must appear in the column to the left of the event tree name. This indicates that a logic tree exists for the event tree). Upon pressing <Enter>, a screen similar to the one shown in Figure 161 appears. This screen shown the current logic for the selected event tree. Make any desired changes using the Ctrl keys described below:

<F1> - The <F1> key displays the editing keys available in the editor.

<Ctrl/P> - Pressing the <Ctrl/P> keys simultaneously displays a help screen to select parameters instead of typing in the parameters names.

<Ctrl/S> - Pressing the <Ctrl/S> keys simultaneously displays a help screen to select systems instead of typing in the system names.

<Ctrl/K> - Pressing the <Ctrl/K> keys simultaneously displays a help screen to select keywords instead of typing in the keyword names.

<Ctrl/I> - Pressing the <Ctrl/I> keys simultaneously displays a help screen to select initiators instead of typing in the initiator names.

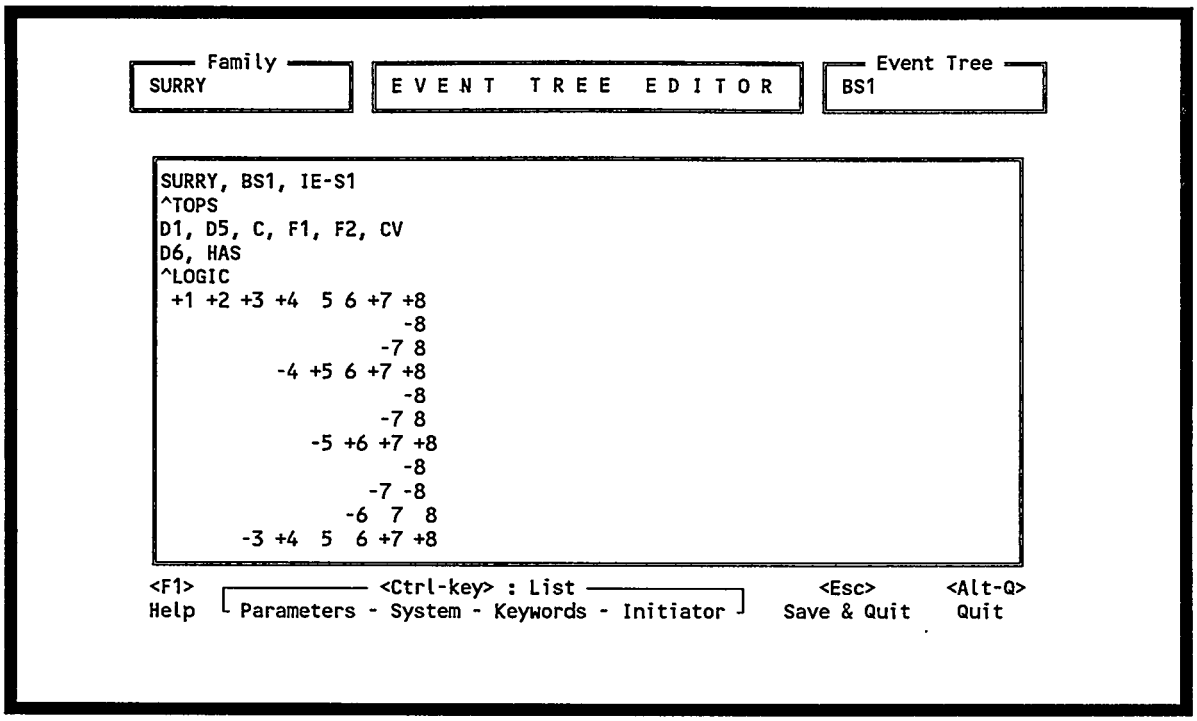


Figure 161. Event tree editor.

<Esc> - Pressing the <Esc> key saves the changes made and returns you to the previous screen.

<Alt/Q> - Pressing the <Alt/Q> keys simultaneously allows you to exit the editor without saving any of the changes made.

When finished modifying the logic tree, press <Esc> to save the changes and exit or press <Alt/Q> to exit without saving the changes.

8.8.3 Switch to Subtrees

This is a toggle function that allows you to switch the display to and from subtrees.

8.9 Seismic Plotting

This option operates the same for sequences as it does for systems. Rather than repeat the user instructions, the reader is referred to Section 6.7.

9. END STATE ANALYSIS

This option allows you to perform end state analysis on cut sets. To invoke this option, type <EN> in the option field or highlight ENDSTATE Analysis and press <Enter>. Figure 162 will be displayed. As shown, the end state analysis module consists of the following four options:

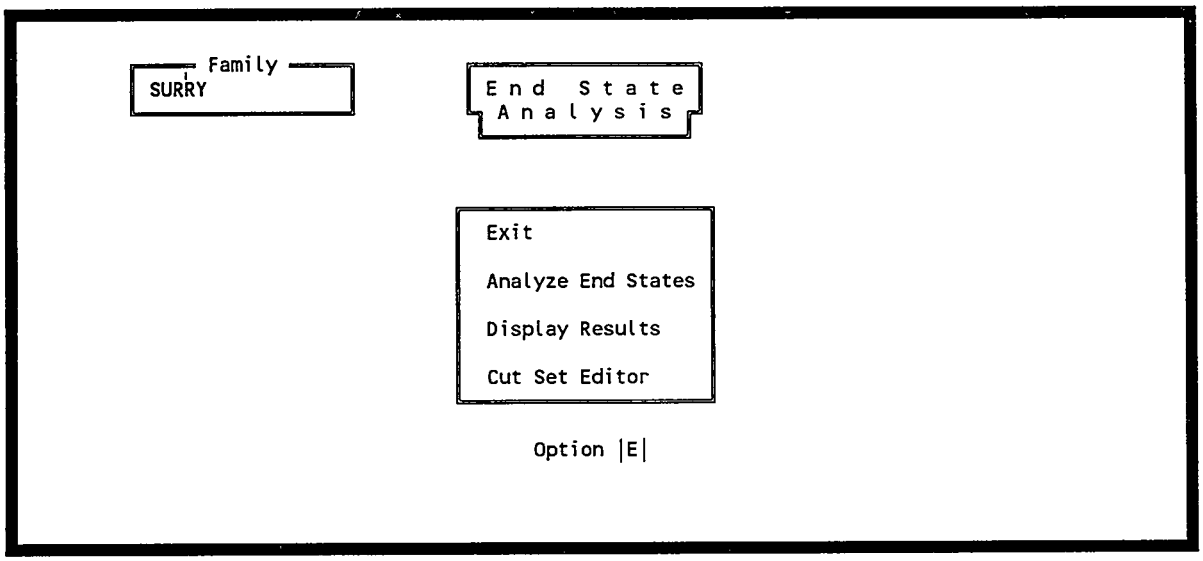


Figure 162. End state analysis main menu.

1. Exit terminates the option and returns you to the IRRAS main menu.

2. Analyze End States includes gathering cut sets, updating cut sets, quantifying the cut sets, and running uncertainty analyses.

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

4. Cut Set Editor provides the means to modify the end state cut sets.

Keys that you will frequently use are

<Esc>	Escape cancels your last choice and returns you to the previous screen.
<F1>	Help briefly explains the function of a field and may show you examples of data entered.
<F2>	Mark/Unmark tags items for use in the selected option.
<F3>	Mark all of the events (*) for further processing. If all items are marked, this option will unmark all of the items.
<F4>	Mark/Unmark range of items quickly tags large numbers of items for processing.

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

9.1 Exit

The Analyze End States screen appears with Exit as the default choice in the command line. Press <Enter> to return to the IRRAS main menu.

9.2 Analyze End States

This option provides the means to recalculate end state values after events and/or cut sets have been modified. To invoke this option, highlight Analyze End States or type <A> in the option field and press <Enter>. A screen similar to the one shown in Figure 163 will appear. This screen lists the end states defined for the current family. The available options are discussed in the following paragraphs.

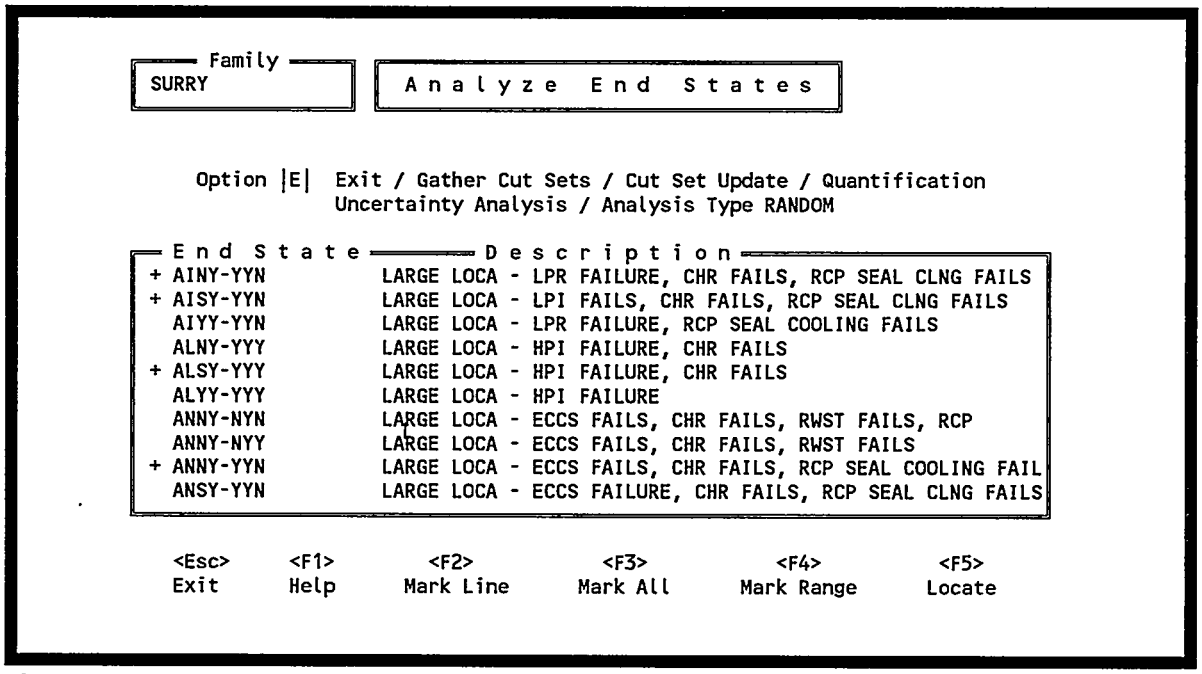


Figure 163. End states for current family and available options.

NOTE: The "+" symbol indicates that cut sets exists for the corresponding end state.

9.2.1 Exit

To return to the End State Analysis menu, type an <E> (Exit) in the option field and press

<Enter>, or press the <Esc> key.

9.2.2 Gather Cut Sets

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 family. To invoke the Generate Cut Sets for a single end state, type <G> (Generate Cut Sets) in the option field, highlight the desired end state, and press <Enter>. To invoke this process for a group of end states, mark the desired end states using the function keys <F2>, <F3>, and <F4>, type a <G> in the option field, and press <Enter>. To invoke this option for all end states in the current family, clear all marked entries with the <F3> key, type <G> in the option field and press <Enter>. A message **Process all records? (Y/N)** will appear at the bottom of the screen. Type a <Y> to continue the Generate Cut Sets for all records that need processing or type an <N> to terminate the update for all end states.

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 Cutoff Values screen shown in Figure 164 will be displayed. You may change any of the data fields on this screen. Each field is described below. The default values that appear on this screen may be reset to new values by selecting the Utility Options from the IRRAS main menu and then invoking the Define Constants option.

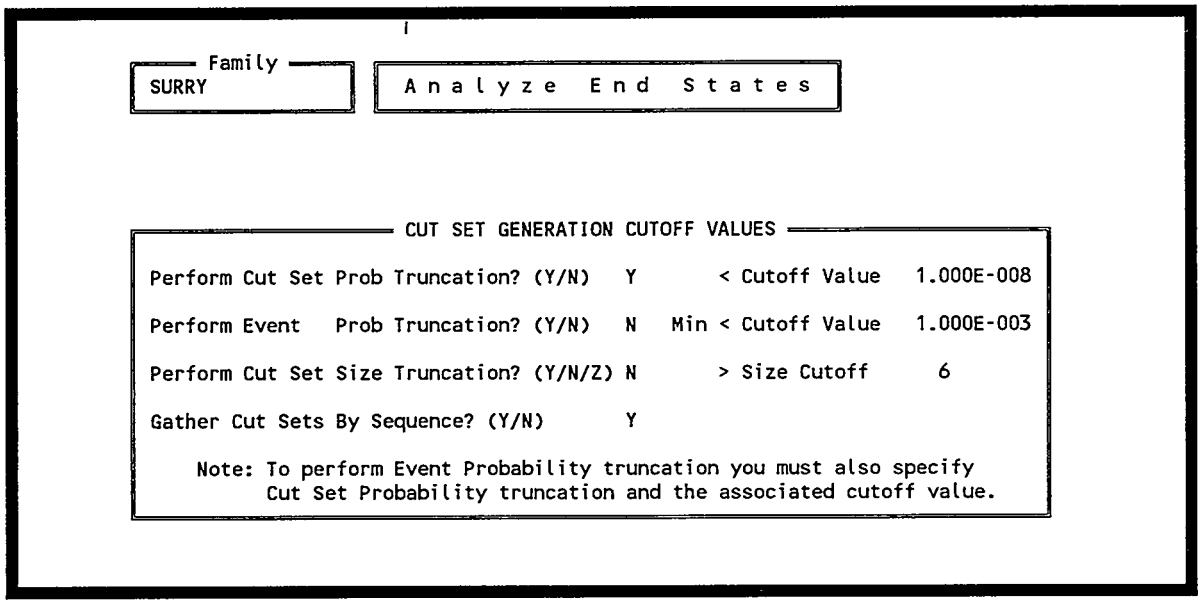


Figure 164. End state cut set generation cutoff values.

Perform Cut Set Prob Truncation?

If you enter a <Y>, then 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. All other cut sets will be removed. If you enter an <N>, then the probability for the cut set will be irrelevant for determining if the cut set should be retained or discarded.
Perform Event Prob Truncation?	If you enter a <Y>, then you must also enter <Y> for "Perform Cut Set Prob Truncation." 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.
Perform Cut Set Size Truncation?	If you enter a <Y>, then only the cut sets whose number of events is less than or equal to the value specified in the Size Cutoff field will be kept in the cut sets for that system. All other cut sets will be removed. If you enter an <N>, then the number of events in a cut set will be irrelevant for determining if the cut set should be retained or discarded.
Gather Cut Sets by Sequence	If you enter a <Y>, then IRRAS will gather cut sets by the end state assigned to each sequence. If you enter an <N>, then the end state of each cut set will be used for gathering. See Partition in Sequence Analysis for details.
Cutoff Value	Value set for probability truncation.
Min < Cutoff Value	Value set for event probability truncation.
> Size Cutoff	Value set for cut set size truncation.

During processing, the screen shown in Figure 165 is displayed and updated as calculations proceed. Upon completion of the cut set generation, the results are displayed as shown in Figure 166.

9.2.3 Cut Set Update

This option will update the alternate cut sets for a selected end state based on cut set generation cutoff values. This option operates the same for end states as it does for systems. Rather than repeat the instructions, the reader is referred to Section 6.2.3.

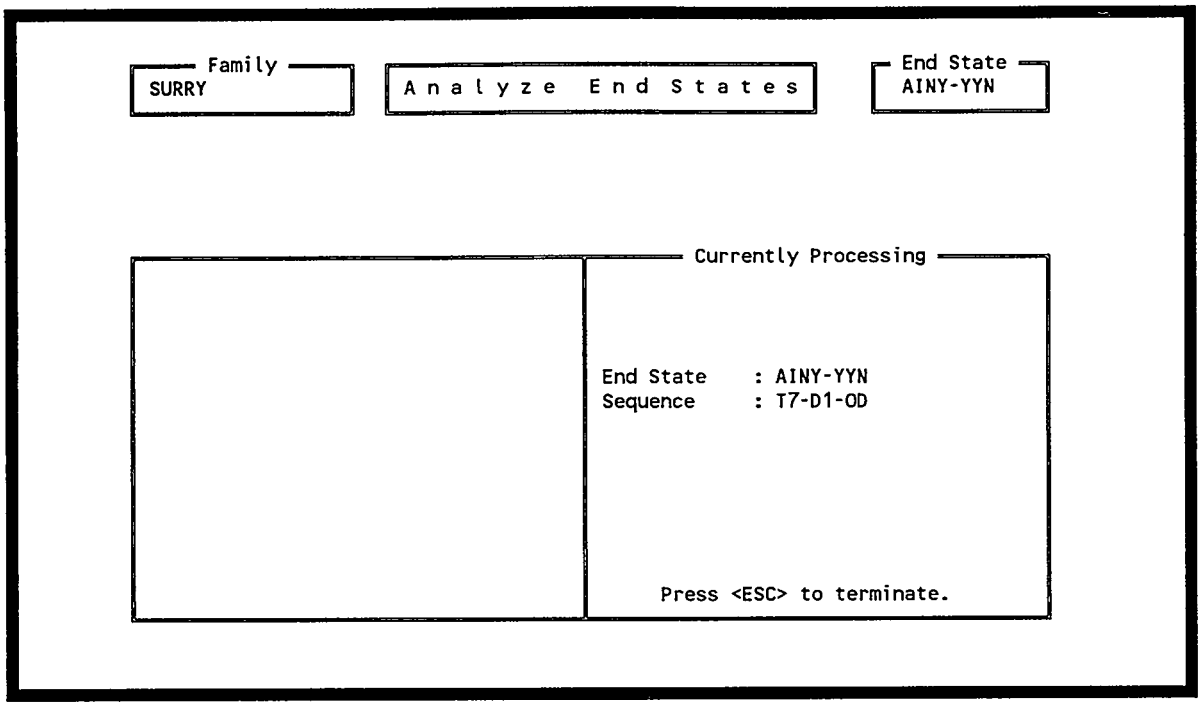


Figure 165. Status screen for end state cut set update.

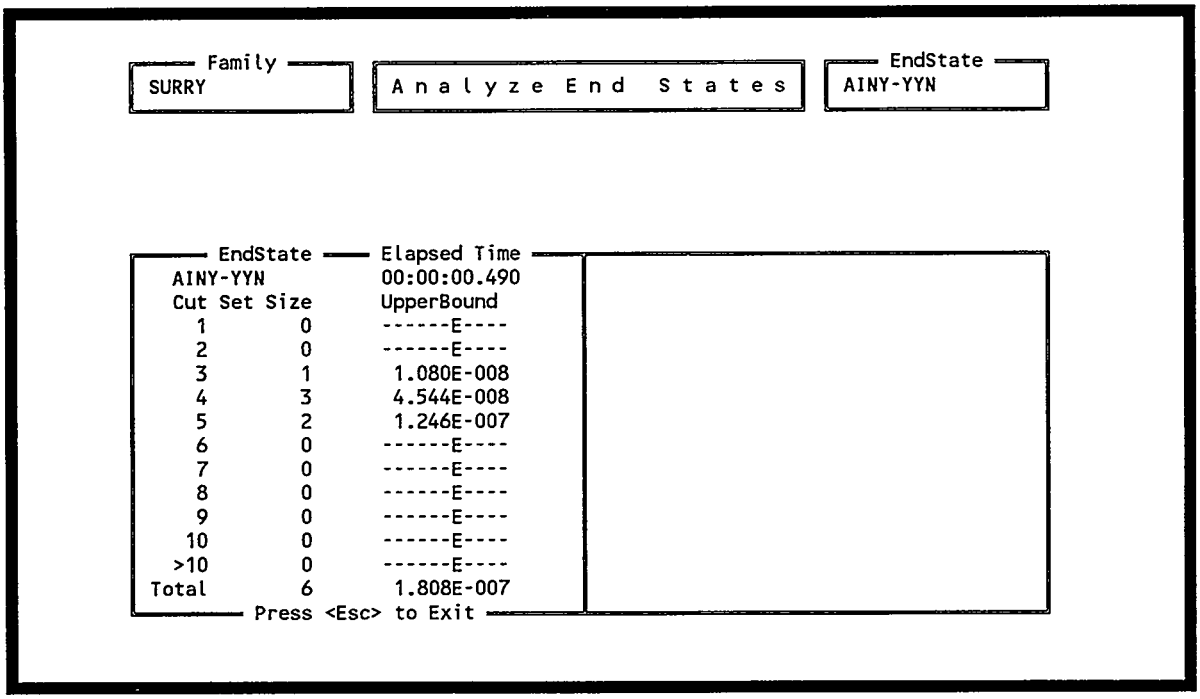


Figure 166. Results of end state cut set generation.

9.2.4 Quantification

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 alternate case cut sets). The new minimum cut set upper bound is saved with the alternate case cut sets for the selected end state. This option operates the same for end states as it does for systems. Rather than repeat the instructions, the reader is referred to Section 6.2.4.

9.2.5 Uncertainty Analysis

This option allows you to run an uncertainty analysis for an end state using one of the two sampling techniques provided. The two sampling techniques are the Monte Carlo simulation technique and the Latin Hypercube simulation technique. In addition, you may perform a seismic or normal uncertainty.

This option operates the same for sequences as it does for systems. Rather than repeat the instructions, the reader is referred to Section 6.2.6.

9.2.6 Analysis Type

This option allows you to indicate the type of analysis you wish to perform on the selected end states. This option operates the same for end states as it does for systems. Rather than repeat the instructions, the reader is referred to Section 6.2.7.

9.3 Display Results

To display the results of your end state analysis, highlight Display Results or type <D> on the End State Analysis menu and press <Enter>. The Display EndState Results screen will be displayed showing a list of the end states for the current family (see Figure 167). The following options are available: Exit, Cut Sets, Importance, Uncertainty, Seismic Importance, Seismic Uncertainty, and Analysis Type.

9.3.1 Exit

This option terminates the process and returns to the End State Analysis menu. To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

9.3.2 Cut Sets

This option operates the same for end states as described for systems. Rather than repeat the instructions here, the reader is referred to Section 6.3.2.

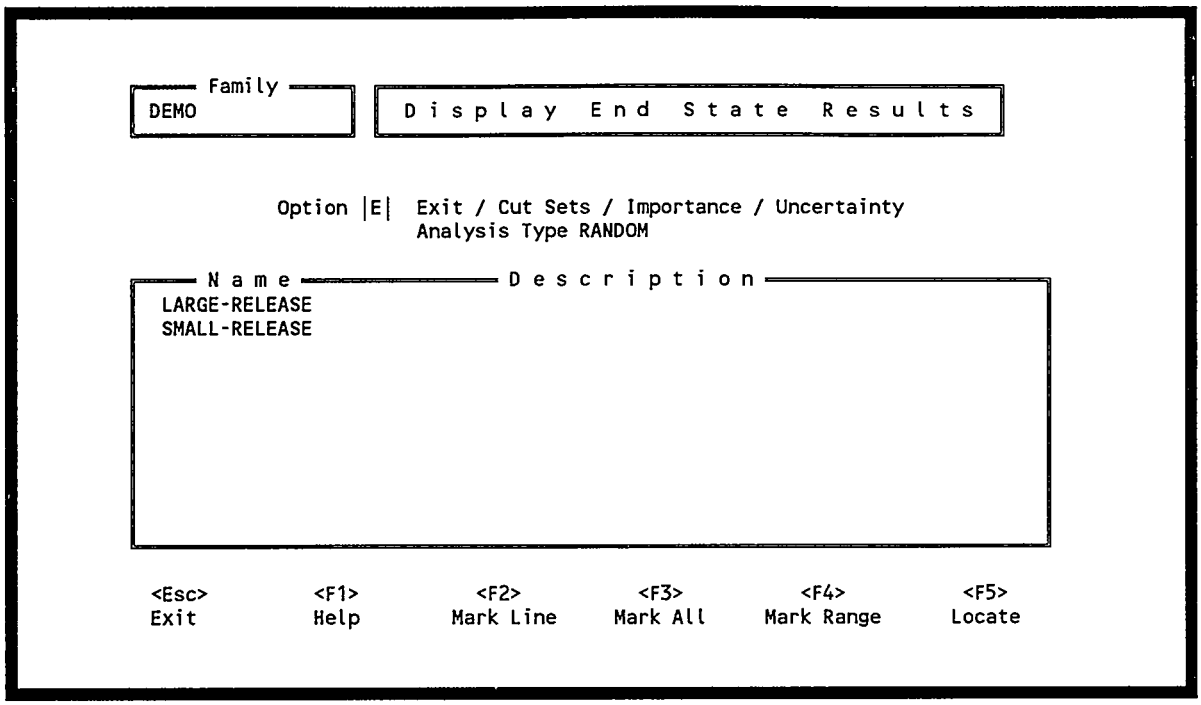


Figure 167. Display end state result menu.

9.3.3 Importance

This option operates the same for end states as described for systems. Rather than repeat the instructions here, the reader is referred to Section 6.3.3.

9.3.4 Uncertainty

The uncertainty option displays the distribution and confidence limits of an end state for both base and current case values. This option operates the same for end states as described for systems. Rather than repeat the instructions here, the reader is referred to Section 6.3.4.

9.3.5 Analysis Type

This option operates the same for end states as described for systems. Rather than repeat the instructions here, the reader is referred to Section 6.2.7.

9.4 Cut Set Editor

This cut set editor operates the same for end states as described for systems. Rather than repeat the instructions here, the reader is referred to Section 6.4.

10. MODIFY DATA BASE

This option allows you to modify the base or original family data files for a family, event trees, systems, end states, basic events, attributes, analysis types, gates, histograms, and piping and instrumentation diagrams (P&IDs). To invoke this option, type <M> in the option field or highlight Modify Database and press <Enter>. Figure 168 will be displayed.

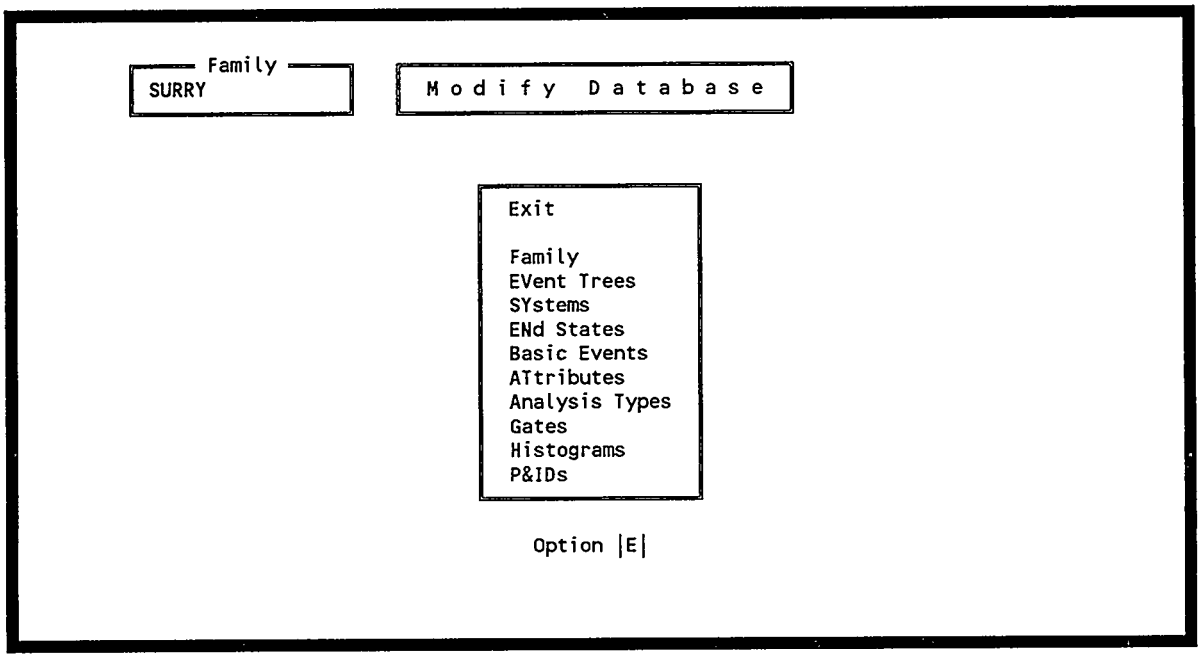


Figure 168. Modify data base main menu.

In general, the options shown in Figure 168 use the same modification functions: Exit, Add, Modify, Delete, and Locate. Some options have additional functions such as: Text and Sequences.

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

<Esc> This key exits the current option and returns you to the Modify Database screen.

<F1> This key displays associated help messages.

<F2> This key tags/untags items for use in the selected option.

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

<F4> This key quickly tags several items for processing.

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

10.1 Exit

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

10.2 Family

This option allows you to add, modify, and delete a family or modify the associated text. To invoke this option, type <F> in the option field or highlight Family and press <Enter>. Figure 169 will be displayed. This screen lists all the families currently stored in the database, the directory where each family is located, and a description of the family. A status field is displayed that shows the status of the database files (e.g., OnL means the database files for the corresponding family are on-line and ready to access, while Cmp means the files are compressed and must be decompressed before they can be accessed) (see Section 12.5). As shown five options are available. Each is discussed in the following paragraphs.

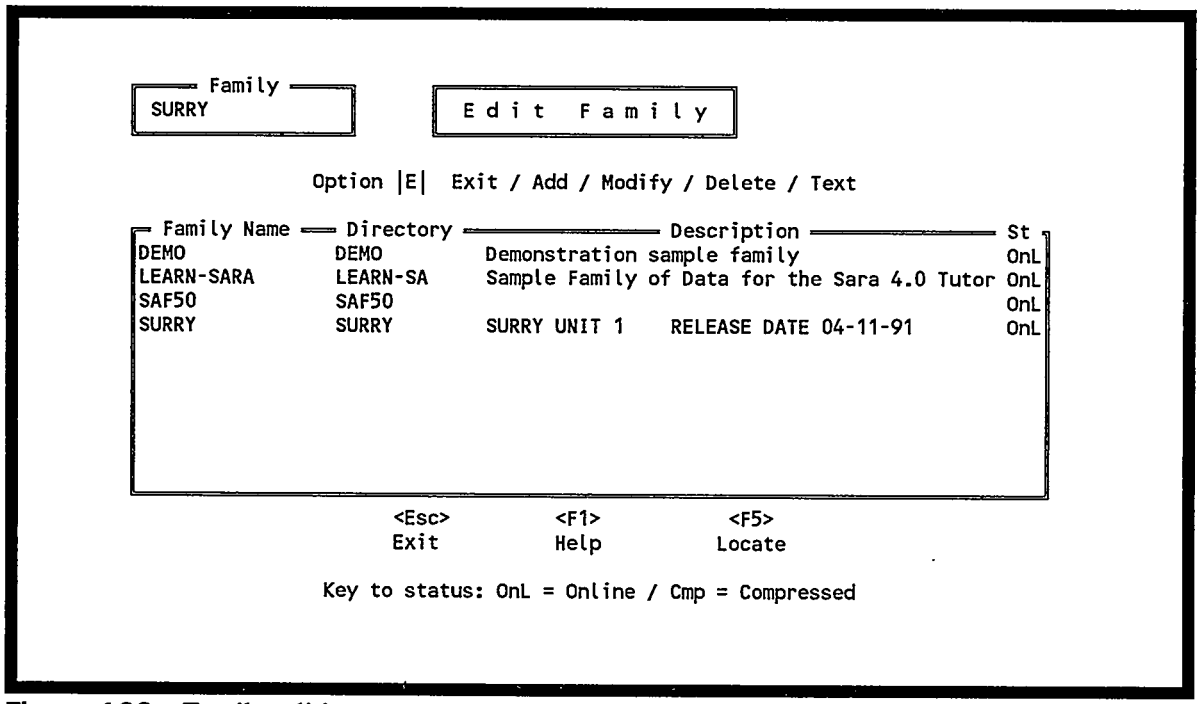


Figure 169. Family editing menu.

10.2.1 Exit

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

10.2.2 Add

This option allows you to add a family to the database. To invoke this option, type <A> in the option field and press <Enter>. The Add Family screen (shown in Figure 170) will be displayed. The only required information to be entered on this screen is the family name. The options at this point are Exit, Add, and Passwords.

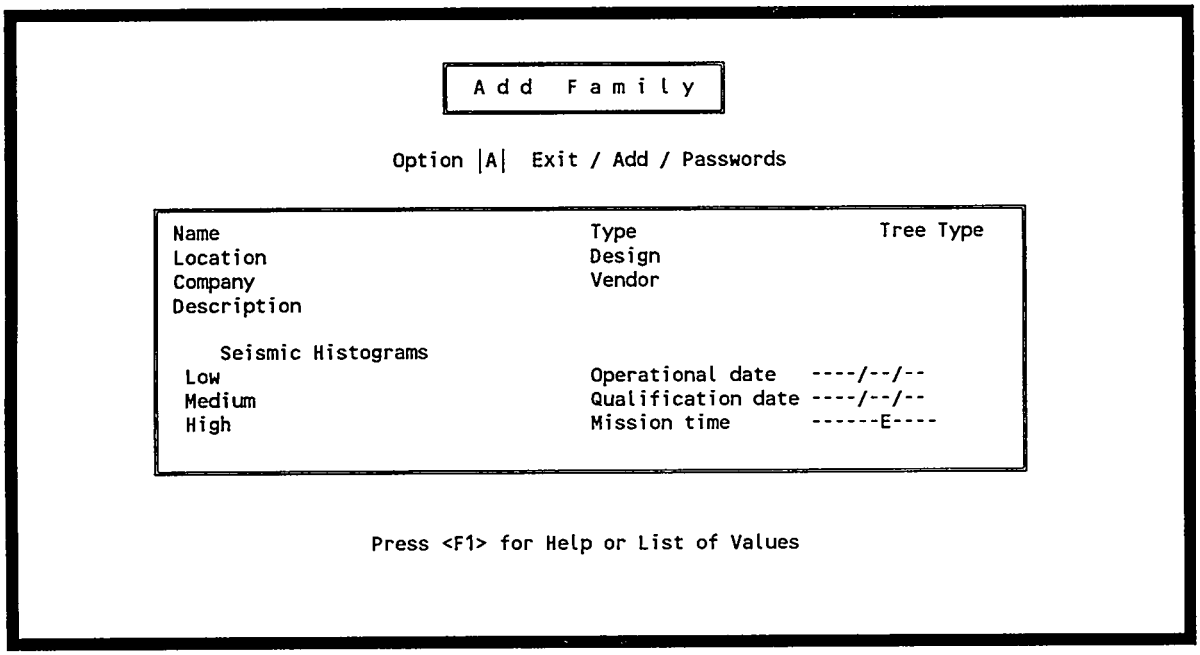


Figure 170. Editing screen for adding a family.

10.2.2.1 Exit. This option returns you to the Edit Family screen (Figure 169). To invoke this option, type <E> in the option field and press <Enter>, or press the <Esc> key.

10.2.2.2 Add. This option performs the actual addition of the family to the database. To invoke this option, type <A> in the option field, and supply the following information where applicable:

Name - This is the only required entry on this screen. A maximum of 16 characters (uppercase, alphanumeric) may be entered. The name should be descriptive so it can be readily identified.

Type - This is a user-defined three character (uppercase, alphanumeric) field used to classify the facility under study.

Location	-	This is a user-defined, 10-character (uppercase, alphanumeric) field used to specify the geographical location of the facility under study. (This field may contain blanks.)
Design	-	This is a user-defined, 10-character (uppercase, alphanumeric) field used to identify the facility's design type. (This field may contain blanks.)
Tree Type	-	This is a one-character field that determines the tree model to be used to analyze this family's data. The only valid entries are: "L" - large fault tree, small event tree "S" - large event tree, small fault tree
Company	-	This is a 10-character (alphanumeric) field used to identify the company responsible for the facility. (User-defined, blanks allowed)
Vendor	-	This is a five-character (uppercase, alphanumeric) field used to identify the company that built the facility.
Description	-	This is a 60-character (uppercase/lowercase, alphanumeric) field that describes the family.
Seismic Histogram	-	This is a 16-character field that identifies histograms to be used as hazard curves. Low, medium, and high histograms represent the differing views about susceptibility to earthquakes. This field is described in detail in Section 10.2.2.4.
Operational Date	-	Enter the date the facility became operational.
Qualification Date	-	Enter the qualification date of the facility.
Mission Time	-	Enter a mission time that will be used as a default value.

Upon completion, you are returned to the Edit Family screen, where the addition of the new family will be reflected.

10.2.2.3 Passwords. This option not yet available.

10.2.2.4 Seismic Histograms. This field represents the differing views about susceptibility to earthquakes (low, medium, or high). When positioned in any of the three seismic histogram fields, press <F1> to display a list of available histograms (see Figure 171). To select a histogram from the list, use the arrow keys to highlight the desired histogram and press <Enter>. Or, if there are many histograms in the list, you may want to invoke the speed search function. To invoke the speed search function, simply start typing the first few characters of the histogram name. As you type each letter, the

histogram that most closely matches your entry will be highlighted. When the desired histogram is highlighted, press <Enter>. Regardless of which selection method is used, upon pressing <Enter>, you will be returned to the previous screen where the selected histogram will be written into the corresponding histogram field. **NOTE:** In this case, the histogram is really a set of discrete values and not a true histogram.

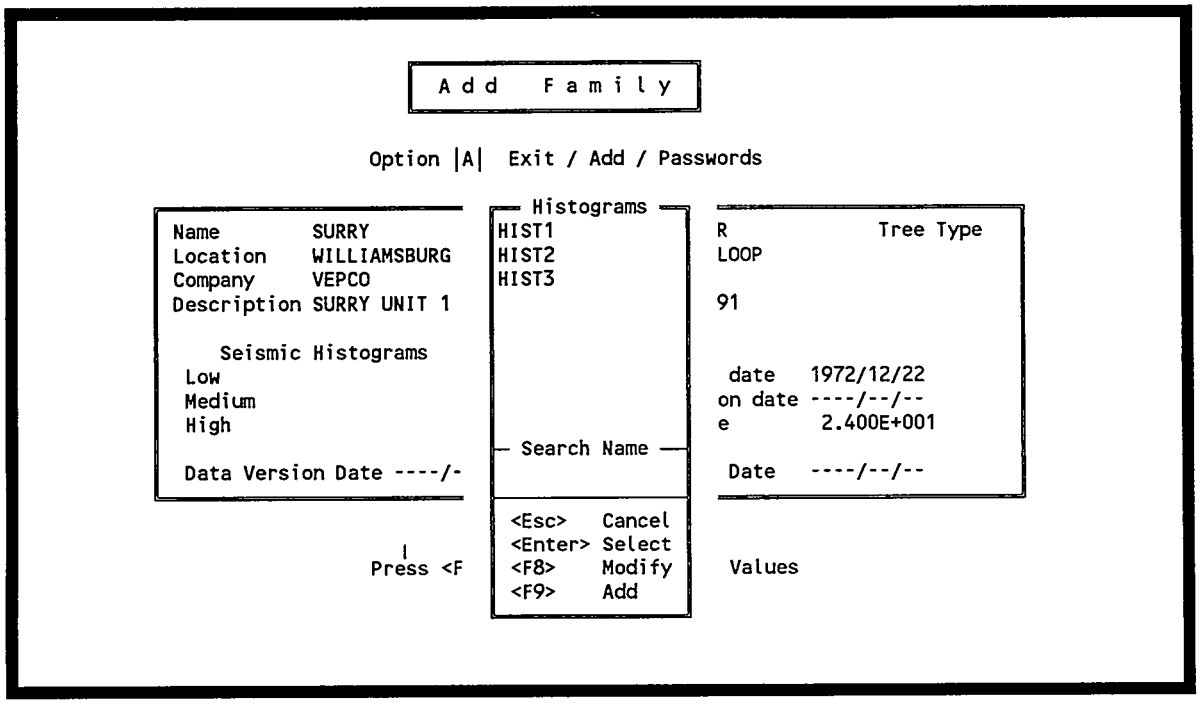


Figure 171. Histogram selection screen.

From the help screen, you may also add a new histogram or modify an existing histogram. To add a new histogram, simply press <F9>. The screen shown in Figure 172 will be displayed. Enter the acceleration rates and frequencies. The acceleration rate is the peak ground acceleration (i.e., magnitude of the earthquake). The frequency is the probability that an earthquake that exceeds the ground acceleration will occur.

From the add screen, you may modify a bin's associated event by pressing <F1>. Figure 173 will appear.

To modify an existing histogram, highlight the histogram to be modified and press <F8>. A screen similar to the one shown in Figure 172 will appear. Modify the acceleration or frequency rates and press <Enter> (Modify is the default option). Like the Add option described above, you may also modify a bin's associated event by pressing <F1>. Refer to the add option for operating instructions.

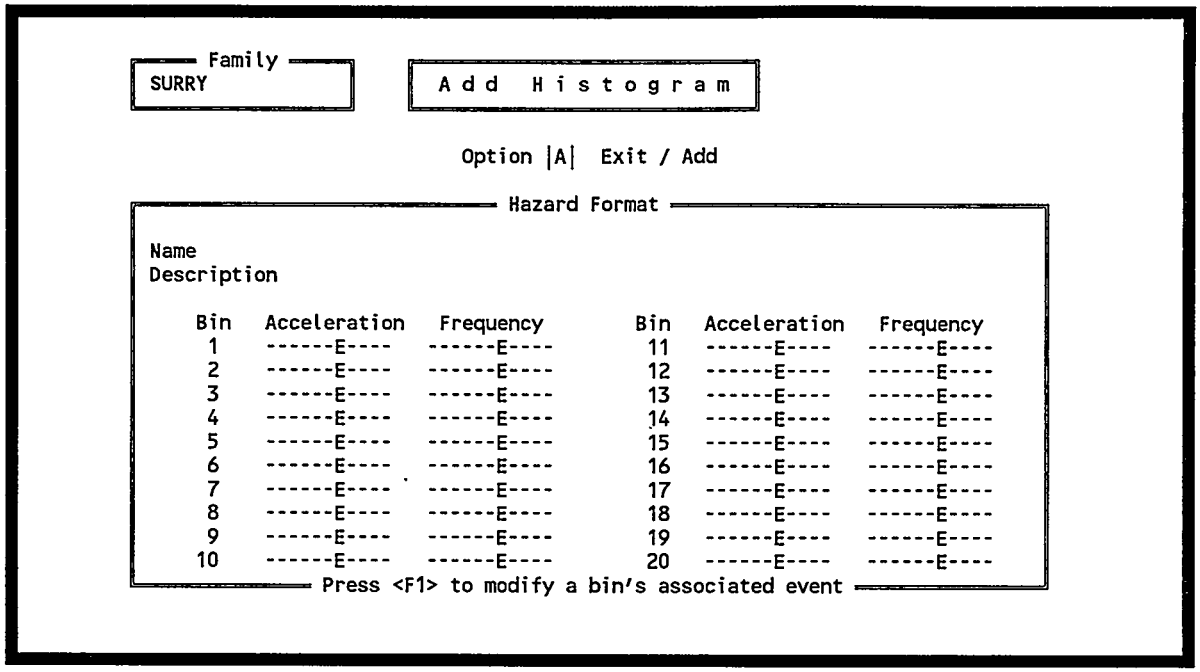


Figure 172. Add a new histogram.

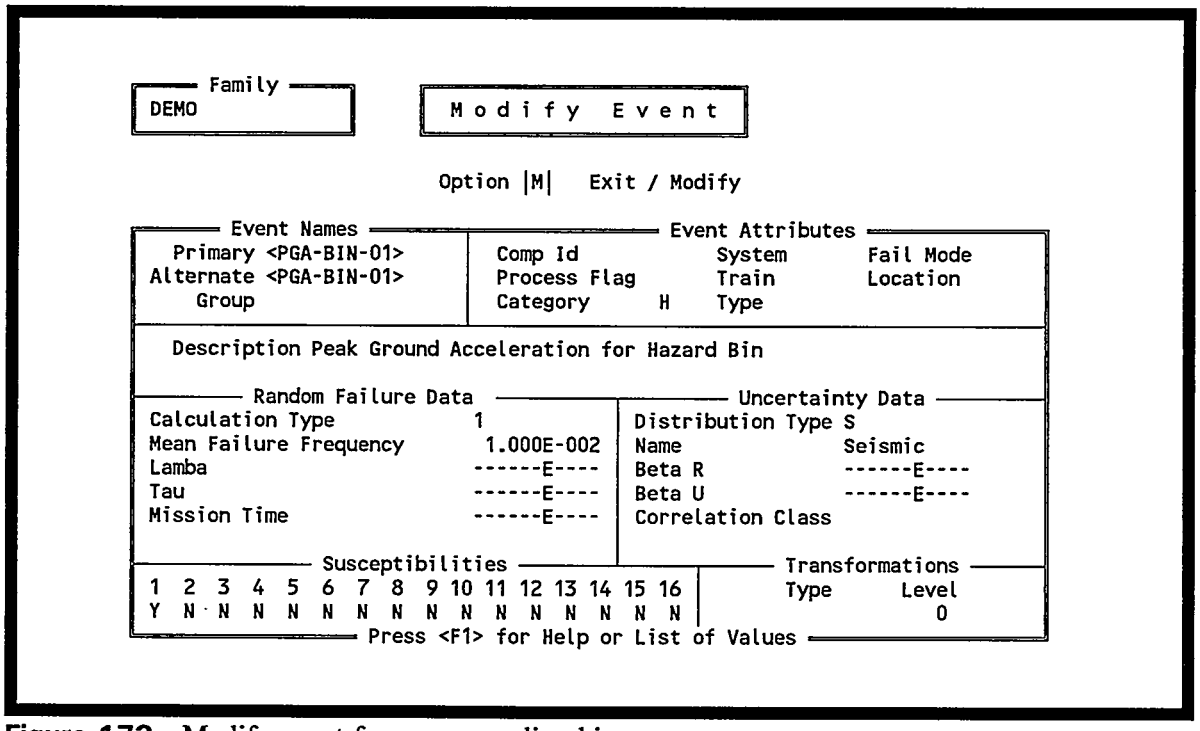


Figure 173. Modify event for corresponding bin.

10.2.3 Modify

This option allows you to modify the family data record. To invoke this option, type <M> in the option field, highlight the family you wish to edit, and press <Enter>. The Modify Family screen is shown in Figure 174. The options at this point are Exit, Modify, and Passwords.

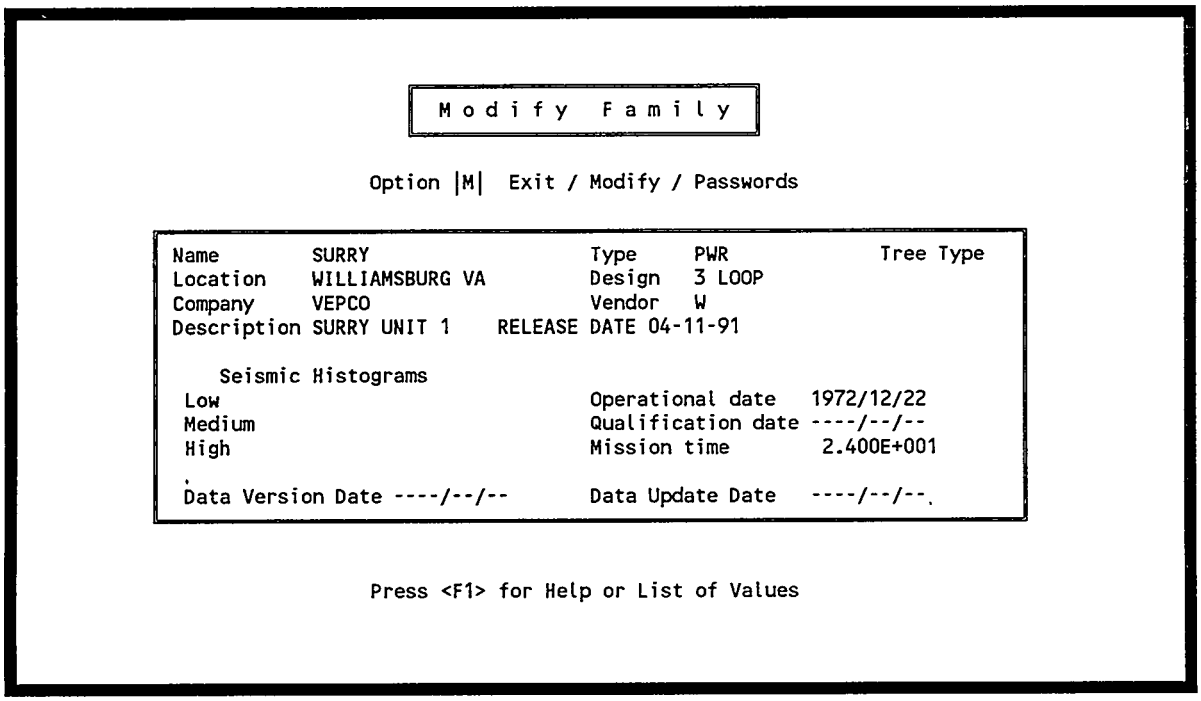


Figure 174. Editing screen for modifying a family.

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

10.2.3.2 Modify. This option applies the actual modification of the family data to the database. Modify any of the data fields on the screen and press <Enter> (Modify is the default option). In addition to the same fields as described in the Add option (see Section 10.2.2.2), this screen contains two additional fields: Data Version Date and Data Update Date. The data version date is the date the plant study was completed. The data update date is the date the plant study was last changed.

When finished modifying or adding data to this screen, press <Enter>. Upon pressing <Enter>, you are returned to the Edit Family screen.

10.2.3.3 Passwords. This option not yet available.

10.2.4 Delete

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

This option allows you to delete family data records from the database. To invoke this option, type <D> in the option field and press <Enter>. The Delete Family screen is shown in Figure 175. The options at this point are Exit and Delete.

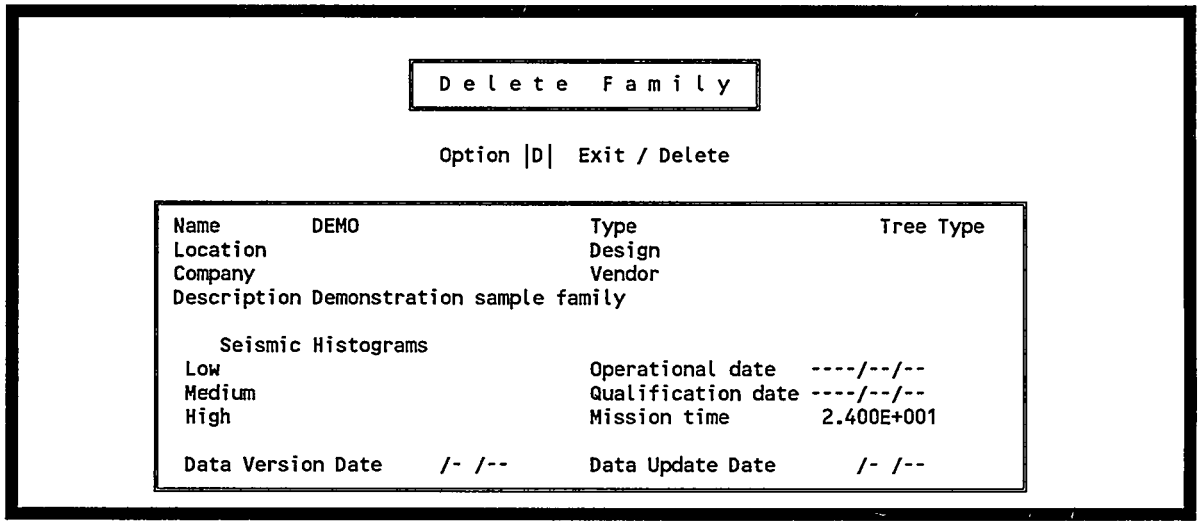


Figure 175. Editing screen for deleting a family.

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

10.2.4.2 Delete. This option verifies the delete family request. To invoke this option, press <Enter> (Delete is the default option). A warning screen is superimposed over the Delete Family screen allowing you to cancel the deletion process (Figure 176). Enter a <Y> and press <Enter> to delete the family or an <N> and press <Enter> to terminate the deletion process. If you respond with a <Y>, the message **Deletion completed** will be displayed at the bottom of the screen.

10.2.5 Text

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

The initial display for this option displays the first 15 lines of the text block. The following keys allow you to display additional lines of text:

PgDn	-	Presents the next 15 lines of text.
PgUp	-	Presents the previous 15 lines of text.

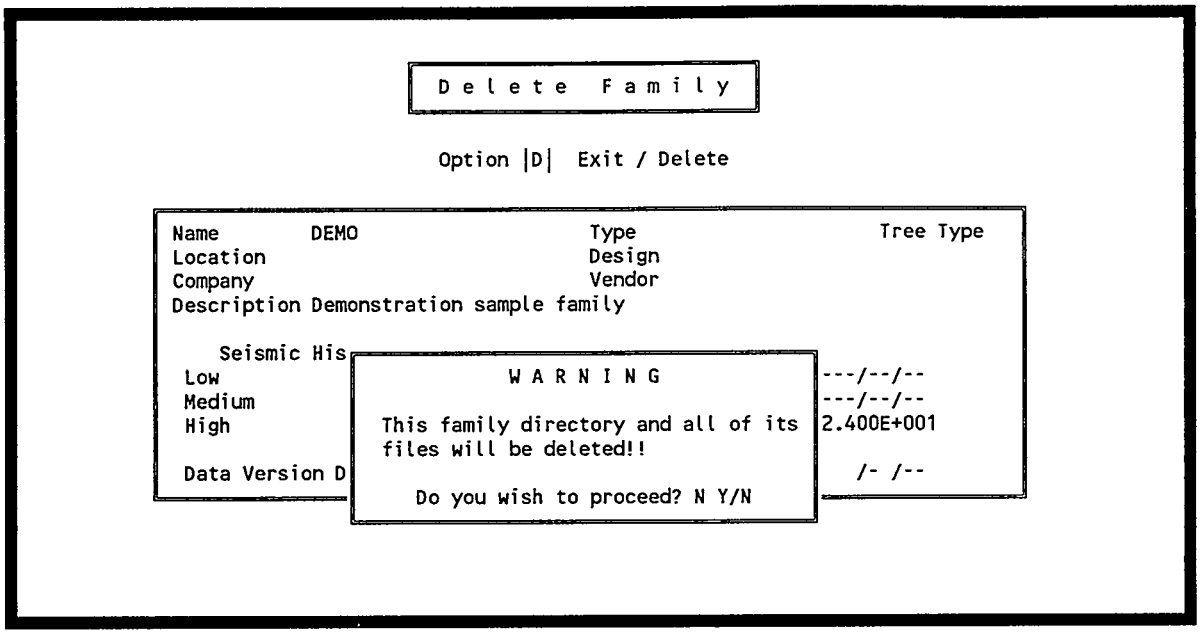


Figure 176. Warning screen for a family delete.

Ctrl-PgDn	-	Presents the last 15 lines of text.
Ctrl-PgUp	-	Presents the first 15 lines of text.
Ctrl-←	-	Moves to the beginning of the current line
Ctrl-→	-	Moves to the end of the current line

The editing keys are

Esc	-	Exits without saving changes.
Alt-E	-	Exits the text editing feature and saves the text information as it currently exists.
Alt-A	-	Adds a line before the line at the current cursor position.
Backspace	-	Deletes the character left of the current cursor position.
Alt-B	-	Blocks text for further processing. Press <Alt/B> to indicate the starting position of the text to be blocked. Next, position the cursor at the end of the text to be blocked and press <Alt/B>. The text appearing between the two <Alt/B> commands will be highlighted. Once the text is blocked, you can perform another command (e.g., copy, delete, etc.).
Ctl-C	-	Centers a line of text.
Ctl-Home	-	Clears blocked text (but does not delete the lines, just clears the text from the blocked lines).
Alt-C	-	Copies blocked text to a new location.
Alt-G	-	Deletes blocked text.
Del	-	Deletes a character at current cursor position
Alt-D	-	Deletes a line of text
Ctl-End	-	Deletes the text from the current cursor position to the end of the line.
F1	-	Displays the editing keys

Ins	-	Inserts a character at current cursor position.
Alt-J	-	Joins two lines at the current cursor position
Alt-L	-	Blocks one line of text
End	-	Positions the cursor at the end of the current line
Alt-M	-	Moves blocked text from its current location to the specified location
Alt-R	-	Restores deleted lines
Alt-S	-	Splits a line in two at the current cursor position
Tab	-	Indents the current line five spaces
Home	-	Moves the cursor to the top of the page
Alt/U	-	Unmarks a block of text

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

10.3 EVent Trees

This option allows you to modify event tree data records. To invoke this option, type <V> in the option field or highlight EVent Trees and press <Enter>. The Edit Event Trees screen, listing all of the event trees belonging to the current family, will be displayed (Figure 177). The modification options are: Exit, Add, Modify, Delete, Text, Sequences, Base Case Update, and Clear Alternate Case.

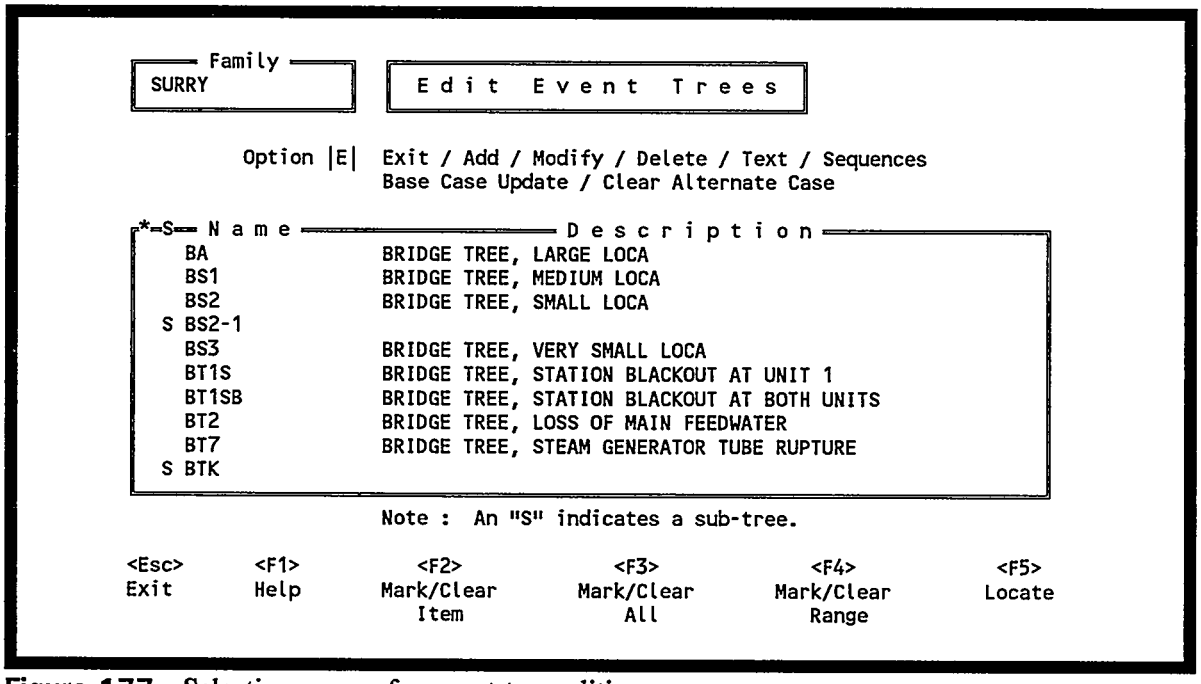


Figure 177. Selection screen for event tree editing.

10.3.1 Exit

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

10.3.2 Add

When the user creates event trees using the graphical event tree editor or loads a graphical event tree from another database, an event tree record is automatically added to the database. The user need only use this option if the graphical event tree format is not used. To invoke this option, type <A> in the option field and press <Enter>. The Add Event Tree screen will be displayed (Figure 178). The options at this point are Exit and Add.

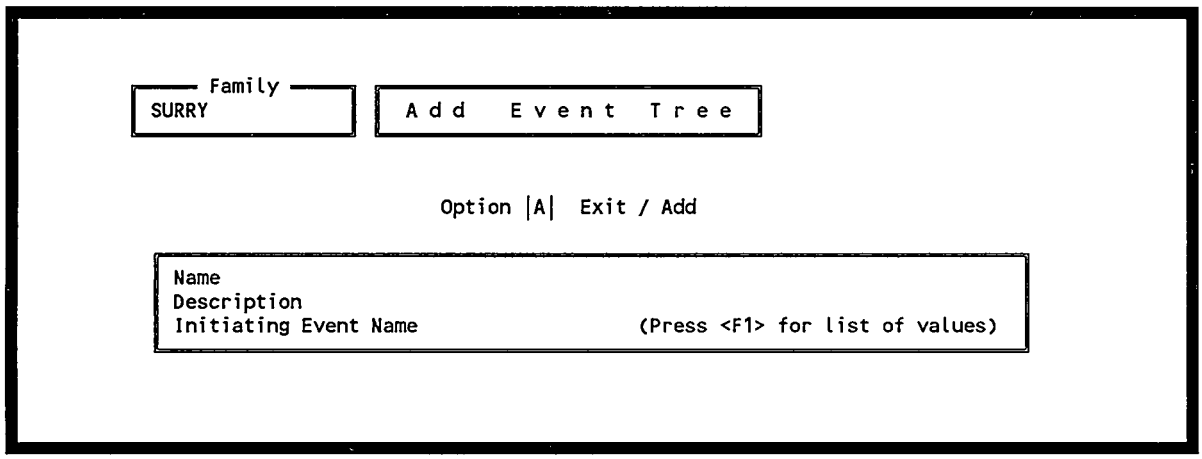


Figure 178. Editing screen for adding an event tree.

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

10.3.2.2 Add. This option performs the actual add of a new event tree record. Fill in the requested data fields and press <Enter> (Add is the default option). The required information for an event tree add is the name and initiating event. The following information may be supplied.

Name	-	Enter a maximum of 16 upper-case, alphanumeric characters (blanks are not allowed). This is a mandatory field.
Description	-	Enter a maximum of 60 upper- and lower-case, alphanumeric characters to describe the event tree.
Initiating Event Name	-	Press <F1> to display a screen listing initiating events (see Figure 179). This screen lists all initiating events for the current family.

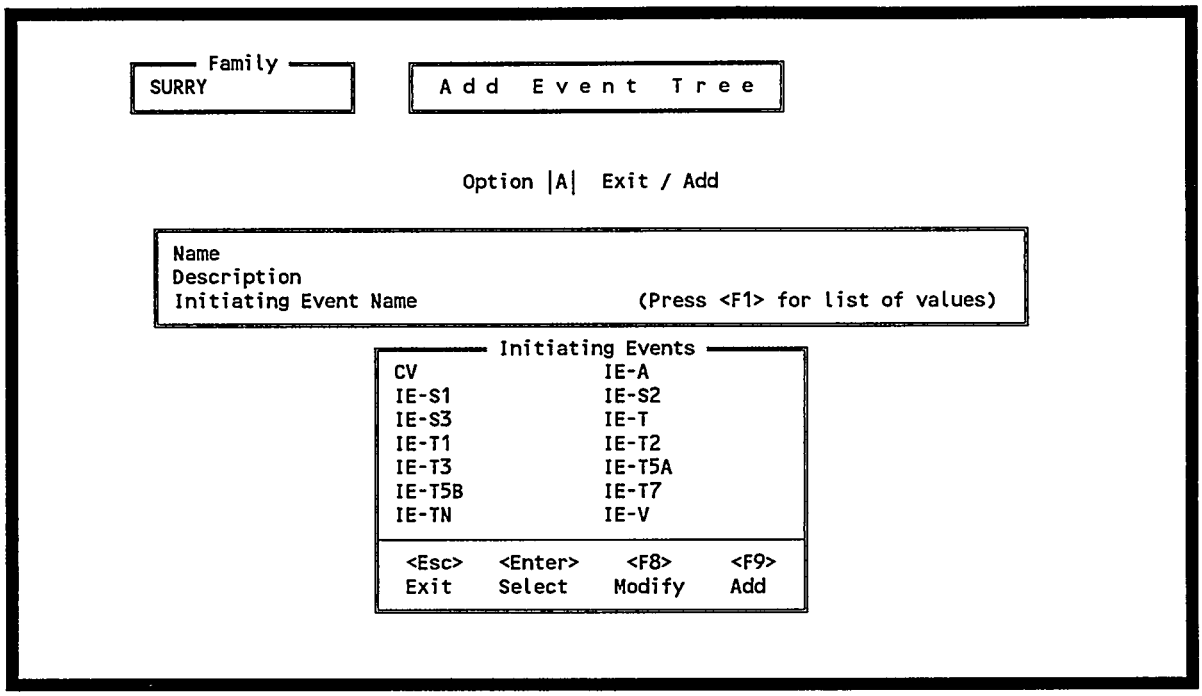


Figure 179. Selection screen for initiating events.

From this screen, the following options are available:

<Esc> - The <Esc> key exits the initiating event selection screen and returns to Figure 178.

<Enter> - The <Enter> key places the highlighted event into the Initiating Event Name field (see Figure 178). To scroll through the list of events, use the arrow keys or <PgUp> and <PgDn> keys. Once the desired event is highlighted, press <Enter>. Or, you may invoke the speed search function. To locate an event using this function, simply start typing the first few characters of the event name. As each letter is typed, the event that most closely matches the typed letters will be highlighted. Once the desired event is highlighted, press <Enter>. Regardless of the search method used, upon pressing <Enter> the selected event will be written into the corresponding field on the previous screen.

<F8> - The <F8> key allows you to modify an initiating event. When you press <F8>, the screen shown in Figure 180 will be displayed. You may modify any of the data displayed. (Refer to the <F9>-Add option for a description of the fields). When complete, press <Enter>. The message **Record Modified** will be displayed and you will return to the previous screen.

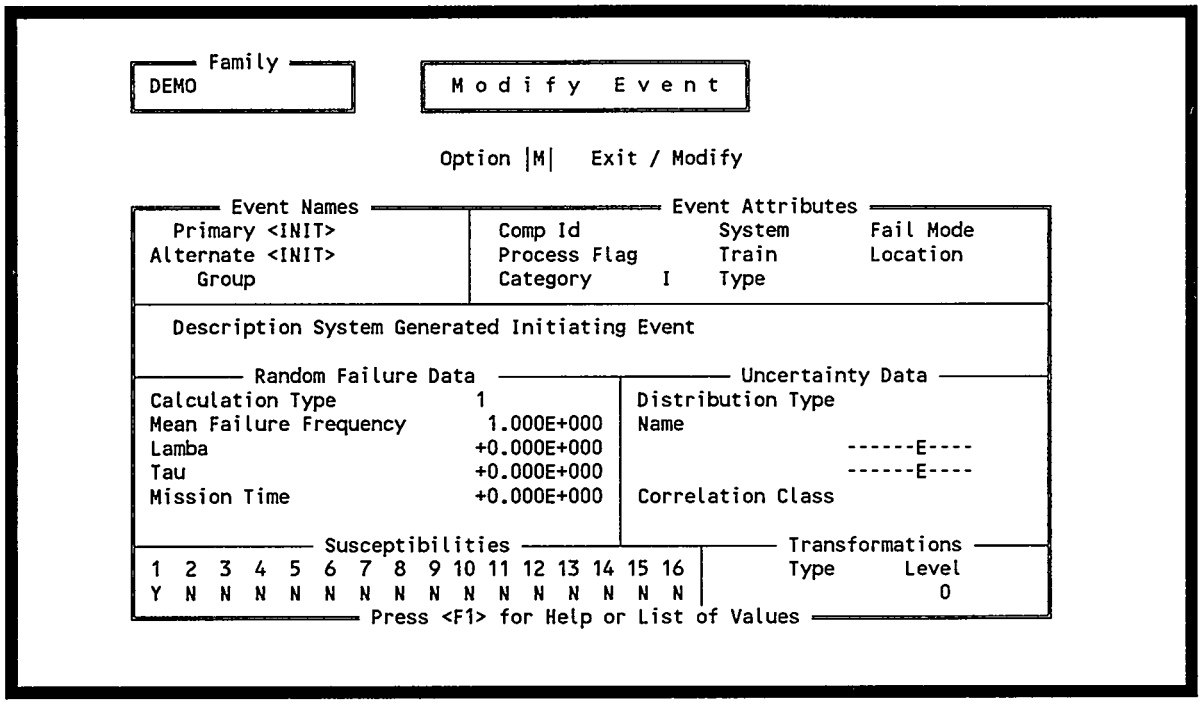


Figure 180. Modify an initiating event.

<F9> - The <F9> key allows you to add an initiating event to the current family. When you press <F9>, the screen shown in Figure 181 will appear. As shown, on this screen you may supply event data, failure data, seismic fragility, attributes, uncertainty data, transformation, and susceptibility information for the new event. For each field, extensive on-line help is available. When positioned in any of the fields, simply press <F1>. A window will appear containing an extensive help message or valid entries for the corresponding field. To exit the help screen, simply press <Esc> or <Enter>.

On Figure 181, you may provide the following information:

Names Primary - Enter up to 16 upper-case, alphanumeric characters to provide the primary event name (no blanks are allowed).

Alternate - Enter up to 16 upper-case, alphanumeric characters to provide the alternate event name (no blanks are allowed).

Process Flag - Enter one of the following characters to specify if certain processes should take special note of this event:

General:

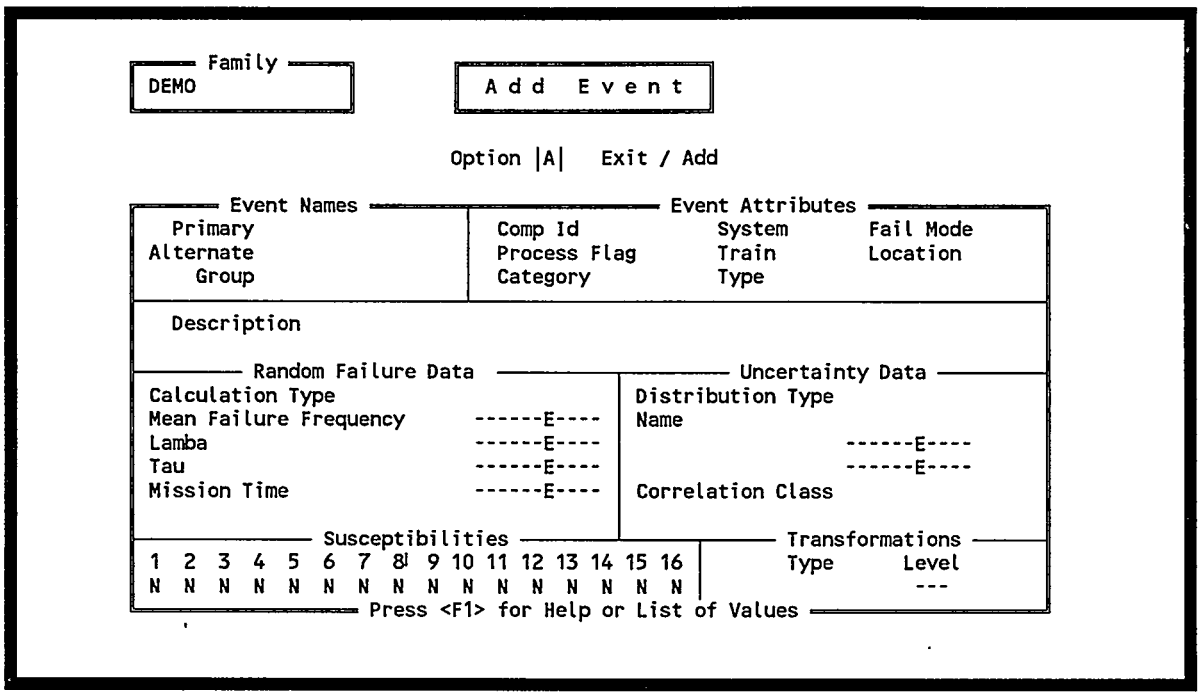


Figure 181. Add an initiating event to the current family.

S = sensitivity analysis. If an event is marked for sensitivity analysis, IRRAS will map a core damage frequency plot.

Z = zone flagged event. When IRRAS encounters a zone flagged event, it performs a transformation.

Sequence Top Events:

I = This tells IRRAS to use the system logic (if top event fails) or use the complement of the system logic (if top event succeeds).

W = This tells IRRAS to use the system logic (if top event fails) or use the complement of the developed event (if top event succeeds).

X = This tells IRRAS to use the developed event (if event fails) or use the delete term (if event succeeds). That is, an X tells IRRAS that the basic event is to be used for failure references, but success

references are to be treated the same as if the flag was blank.

Y = This tells IRRAS to use the developed event (if event fails) or use the 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.

Sequence and System Logic Body:

X = Always use developed event. Never expand the fault tree and solve; always use the event.

Category - Enter one of the following codes to specify the category or use of an event:

blank	=	general purpose event
I	=	initiating event
H	=	hazard event (system specified only)
R	=	recovery event

Component ID - Enter up to seven 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.

Group - Enter up to 16 upper-case, alphanumeric characters to specify the name of the event group.

Description - Enter up to 60 upper- and lower-case alphanumeric characters describing the event.

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

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

a = median killer acceleration (the approximate ground acceleration sufficient to cause the component to fail),
g = ground acceleration for screening,
Bu = confidence level that "a" is really the median killer acceleration,
Br = the amount the killer acceleration "a" can vary
ln = natural log.

Calculation Type - Enter one of the following calculation codes:

Calculation Type 1 $P = p$.
This calculation type uses the stated probability.

Calculation Type 2 $P = L * t_m$.
This calculation type is the rare event approximation for probability of failure of a nonrepairable component in a non-demand failure mode.

Calculation Type 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.

Calculation Type 4 $P = L * \text{Min}(t_m, T)$.
This calculation type is the rare event approximation to the failure probability for an operating component with consideration given to the ability to repair the component.

Calculation Type 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.

Calculation Type 6 $P = L * (T/2)$.
This calculation type is the rare event approximation to the failure probability for a standby component in a non-demand failure mode with consideration given to periodic testing.

Calculation Type 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.

Calculation Type 8 $P = bp + p$.
This calculation is one of the ways to establish a current case basic event probability using the base case calculation. The

current case basic event probability is calculated by adding a probability value to the base case probability. The probability change value is input with the "Probability" field. To make the current case probability lower than the base case, input a negative change value (e.g., -1.2E-002).

Calculation Type 9 P = bp * p.
This calculation type is one of the ways to establish a current case basic event probability using the base case calculation. The current case basic event probability is calculated by applying a multiplier to the base case probability. The multiplier is input with the "Probability" field. To make the current failure probability larger than the base case, use a multiplier greater than 1.0. To make the current case failure probability less than the base case, use a multiplier less than 1.0.

Calculation Type 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.

Calculation Type 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.

Calculation Type 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.

Calculation Type S P = 0.0 (find a system with the same name and use its current mincut upperbound as the probability)
This calculation type indicates that the basic event is to replace its matching system. If no matching system exists, the probability will be set to 0.0.

Calculation Type 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.

Calculation Type 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 family hazard curve.

Probability - Enter the probability of the event failing (use scientific notation).

Lambda - Enter the event's failure rate per hour (use scientific notation).

Tau - Enter the average time to repair in hours (use scientific notation).

Mission Time - Enter the mission time in hours (use scientific notation).

Attributes:

System - Enter the system code or press <F1> to bring up a selection screen.

Train - Enter the train or press <F1> to bring up a selection screen.

Type - Enter the event type or press <F1> to bring up a selection screen.

Failure Mode - Enter the failure mode or press <F1> to bring up a selection screen.

Location - Enter the location or press <F1> to bring up a selection screen.

Uncertainty Data

Distribution Type - Enter one of the following predefined distribution types:

L	=	log normal, error factor
N	=	normal, standard deviation
B	=	beta, b of beta (a,b)
G	=	Gamma, a of Gamma (a)
C	=	chi-squared, degrees of freedom
E	=	exponential
U	=	uniform, upper endpoint
H	=	histogram
M	=	Maximum entropy, lower/upper endpoints.
S	=	Seismic uncertainty, Br, Bu

Value1 - Enter the first parameter of the distribution, if one is required.

Value2 - Enter the second parameter of the distribution, if one is required.

Correlation Class - Used to account for data dependencies among like events in the database. Enter up to four upper-case, alphanumeric values. A blank correlation class indicates that there are no data dependencies.

Transformations

Type - This field indicates the required behavior of the collective events. Enter one of the following:

AND	=	All included events must fail
OR	=	Any included event must fail
ZOR	=	Events make up the zone.

Level - Enter an integer between 0 and 255 indicating the level of substitution for the transformation.

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:

1	=	Random (default)
2	=	Fire
3	=	Flood
4	=	Seismic
5	=	Reserved 1
6	=	Reserved 2
7	=	Reserved 3
8	=	Reserved 4
9-16	=	User-defined.

When complete, press <Enter> to add the event. The message **Record added** will be displayed at the bottom of the screen.

10.3.3 Modify

This option allows you to modify an event tree or subtree record. To invoke this option, type <M> in the option field, highlight an event tree name, and press <Enter>. The Modify Event Tree screen is shown in Figure 182. The options at this point are Exit and Modify.

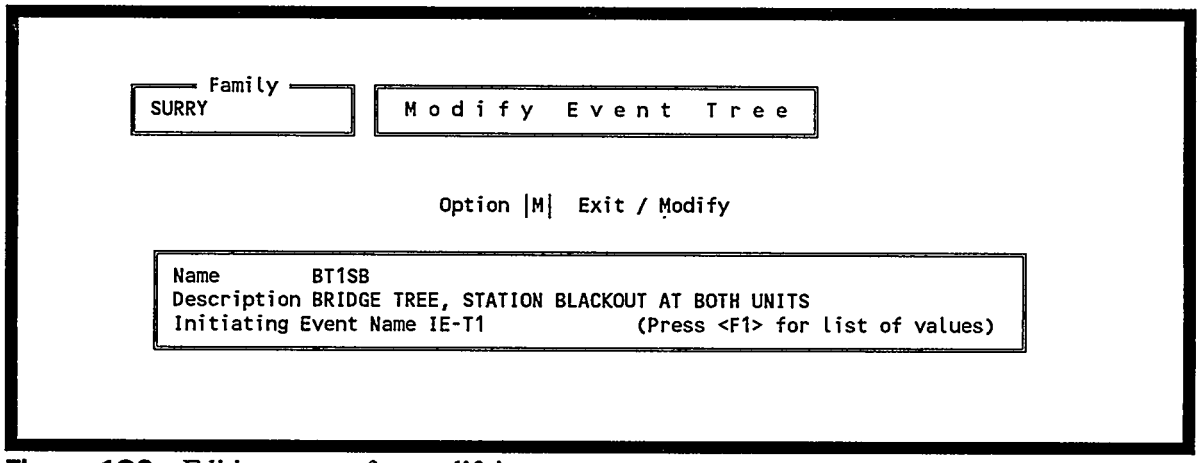


Figure 182. Editing screen for modifying an event tree.

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

10.3.3.2 Modify. This option performs the actual modification of the event tree record. Modify any of the data fields on the Modify Event Trees screen and press <Enter> (Modify is the default option).

To modify the initiating event field, type in the modification or press <F1> to bring up the selection screen as described in Section 10.3.2.2. When complete, press <Enter>. The message **Record modified** will be displayed at the bottom of the screen.

10.3.4 Delete

This option allows you to delete an event tree record and associated sequence records from the database. To invoke this option, type <D> in the option field, highlight an event tree, and press <Enter>. A warning screen will appear, allowing you to cancel the deletion at this point (Figure 183). Enter a Y (yes) and press <Enter> to continue or enter an N and press <Enter>, to terminate.

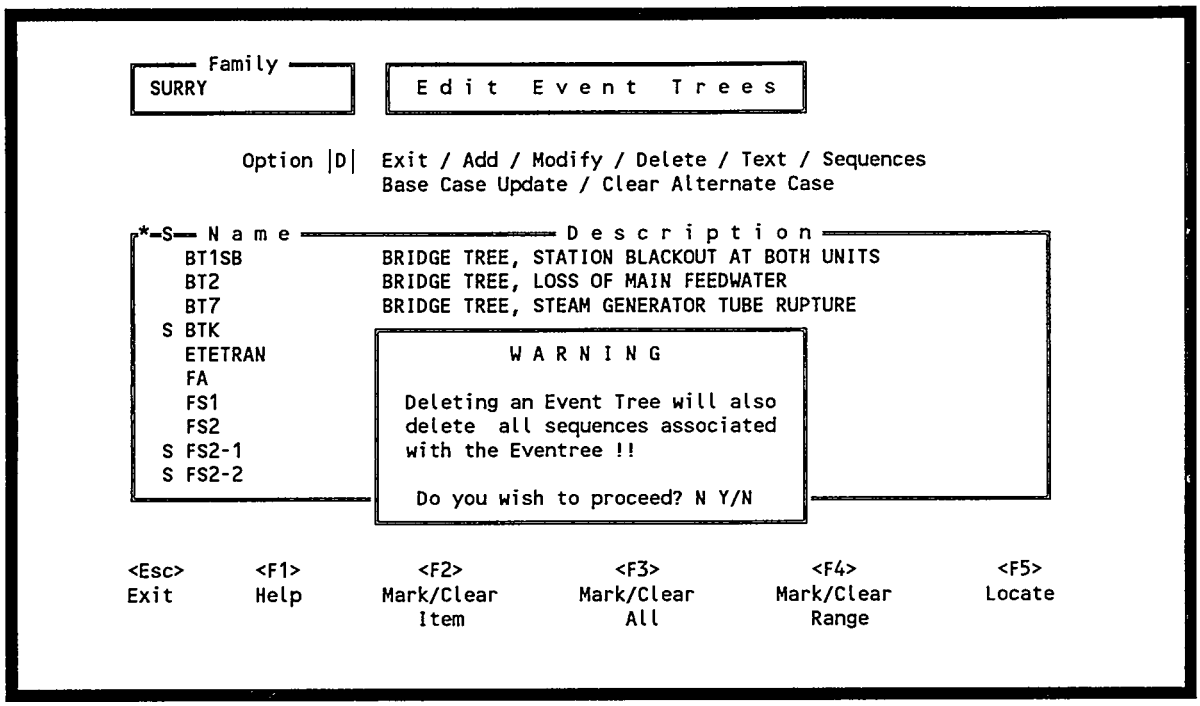


Figure 183. Warning screen for an event tree deletion.

If you mark event trees to delete using the <F2>, <F3>, or <F4> keys a similar warning message will be displayed. At this point, if you enter Y for yes another message will appear reminding you that all marked records will be deleted. If you respond Y (yes) at this prompt, all marked records will be deleted immediately.

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

10.3.4.2 Delete. This option performs the actual deletion of the event tree record. Once you enter a Y at the warning screen to continue with the deletion process, the delete event tree record is shown in Figure 184. The options at this point are Exit and Delete.

To delete the displayed record, press <Enter>. (The Delete option is the default when you enter this screen). All sequence records associated with the event tree will be deleted from the database. You will be returned to the Edit Event Trees screen with the message **Record deleted** displayed.

> **NOTE: You cannot delete a subtree (if it is used by another event tree) using this option.**

10.3.5 Text

This option allows you to view and edit any descriptive text associated with a specific event tree. This option operates the same as the Text option discussed in the Family section. Refer to Section 10.2.5.

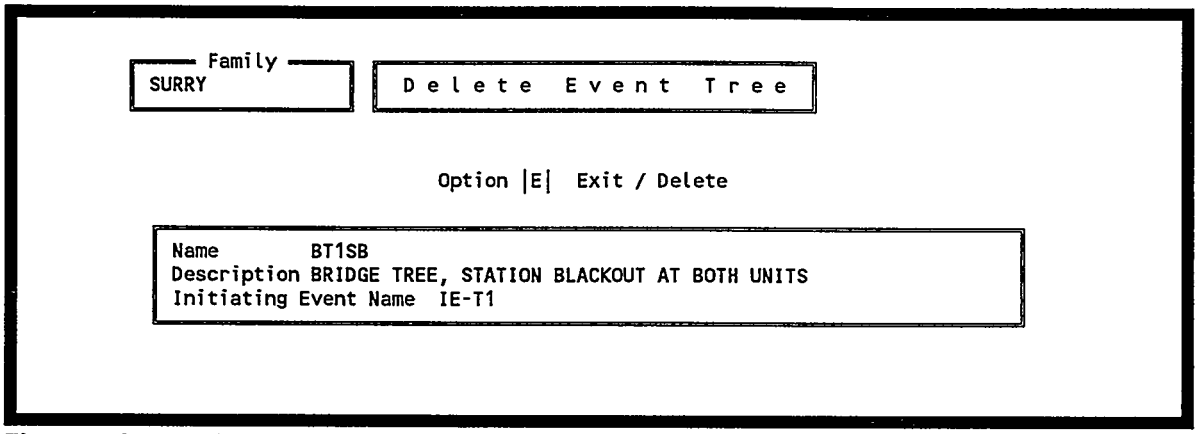


Figure 184. Editing screen for deleting an event tree.

10.3.6 Sequences

This option allows you to modify the sequences associated with an event tree. To invoke this option, type <S> in the option field, highlight an event tree name, and press <Enter>. If an event tree was not highlighted before pressing <Enter>, the message **An event tree must be highlighted first** will be displayed. After highlighting an event tree and pressing <Enter>, the Edit Sequences screen shown in Figure 185 will be displayed. The editing options for sequences are: Exit, Add, Modify, Delete, Text, Base Case Update, and Clear Alternate Case.

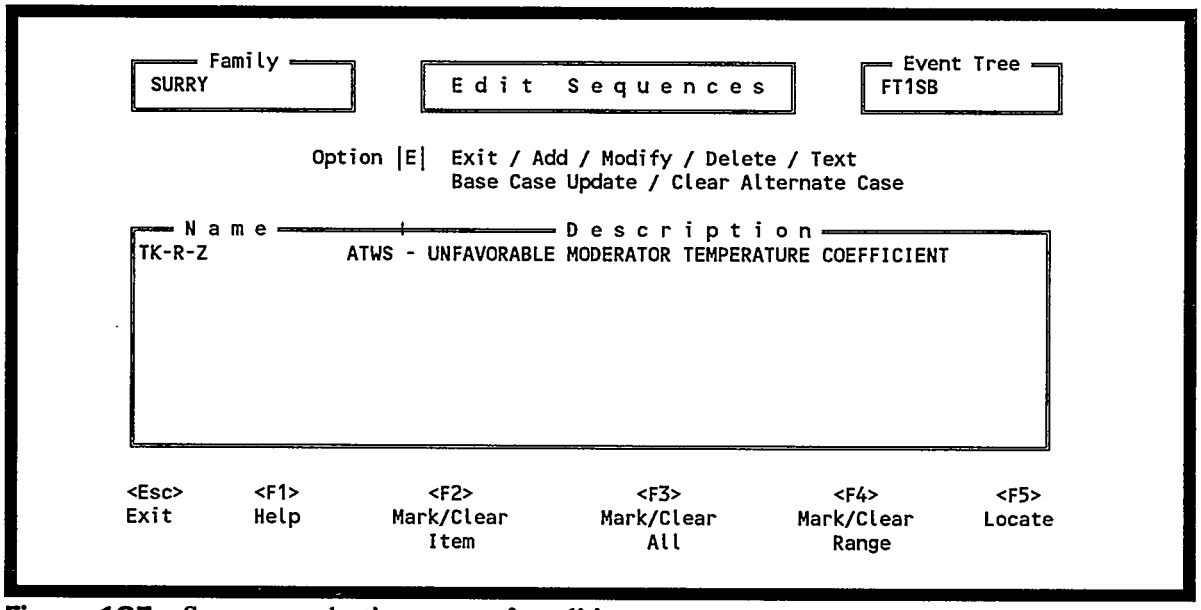


Figure 185. Sequence selection screen for editing.

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

10.3.6.2 Add. This option allows you to add a sequence record to the database. To invoke this option, type <A> in the option field and press <Enter>. The Add Sequence screen is shown in Figure 186. The options at this point are Exit and Add.

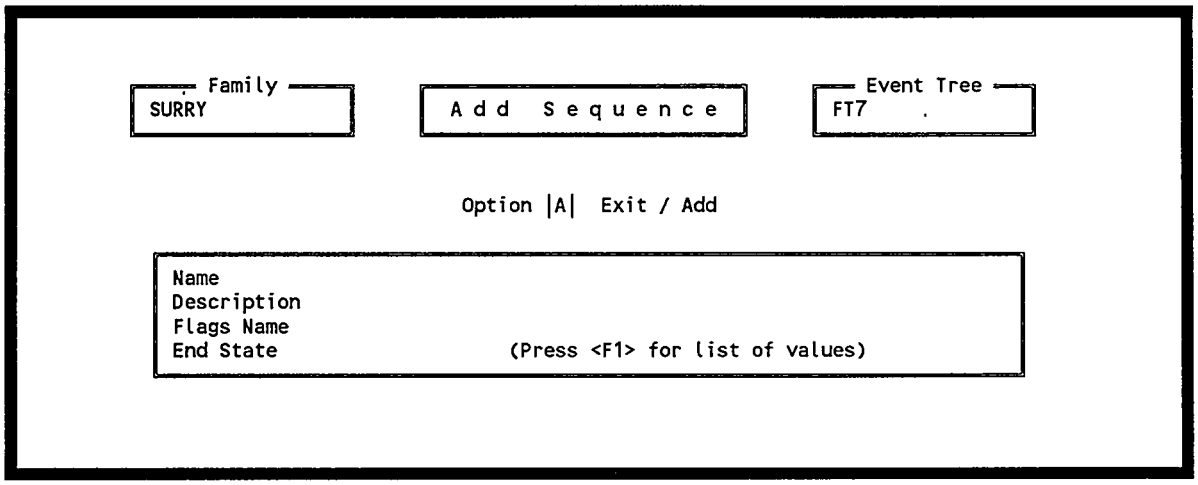


Figure 186. Editing screen for adding a sequence.

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

10.3.6.2.2 Add—This option performs the actual add of a new sequence record. Fill in the requested data fields and press <Enter>. The only required information for a sequence add is the name. On this screen, you may enter the following information:

Name - Enter up to 16 upper-case, alphanumeric characters to identify the sequence (blanks are not allowed).

Description - Enter a maximum of 60 upper- and lower-case, alphanumeric characters to describe the sequence.

Flags Name - Enter a maximum of 16 upper-case, alphanumeric characters (blanks are not allowed) to identify a change set. The Flags Name is the name of a change set containing flags to be used when generating cut sets for this sequence. IRRAS uses this default flag set name to modify or prune the fault tree logic for this sequence before it is solved (see Analyze Sequences). Enter a flag name or leave blank and press <Enter>.

End State - Enter a maximum of 16 upper-case, alphanumeric characters to identify the end state, or bring up the end state selection screen (see Figure 187) by pressing <F1>. To select an end state from this window, scroll

through the list using the arrow keys or the <PgUp> and <PgDn> keys. When the desired end state is highlighted, press <Enter>. If you have several screens of end states to scroll through, you may want to invoke the speed search function to locate the desired end state. To invoke the speed search function, simply start typing the first few characters of the end state name. As you type each character, the end state that most closely matches the typed characters will be located in the list and highlighted. At this point, press <Enter>. Regardless of the search method used, upon pressing <Enter>, the selected end state will be written to the corresponding field on the previous screen.

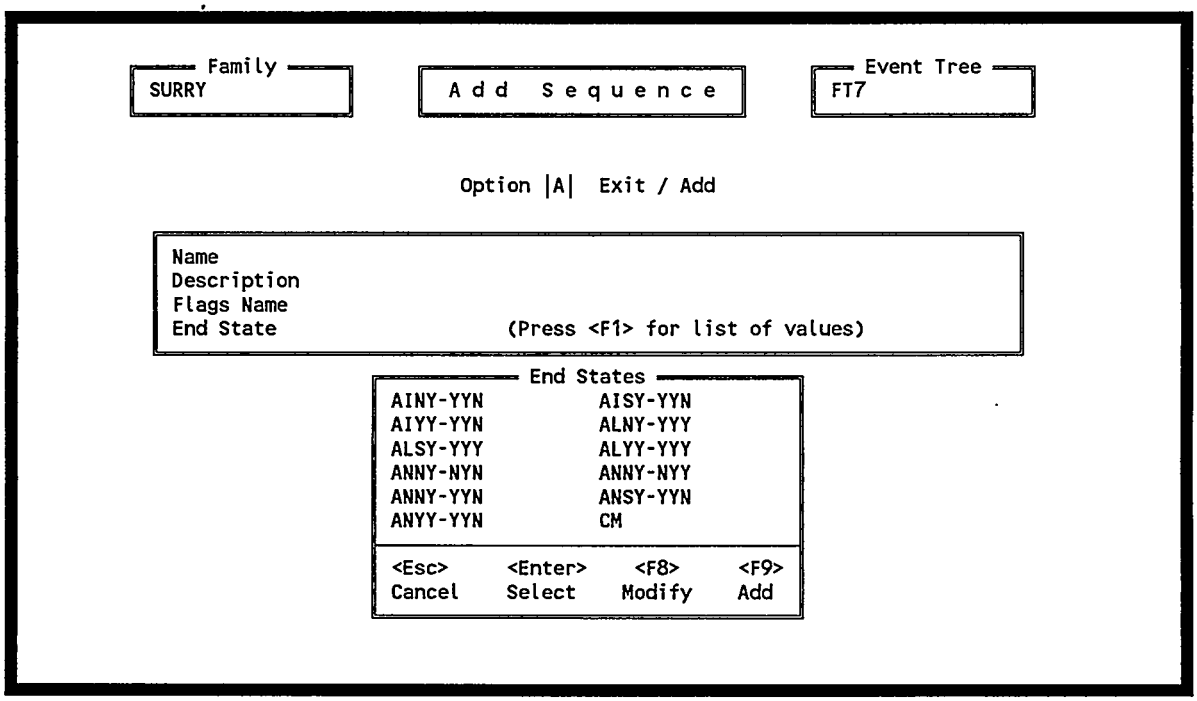


Figure 187. End states selection screen.

Additionally, the following functions are available from the help screen:

<F8> - The <F8> key allows you to modify an end state. To invoke this option, highlight the end state to modify and press <F8>. A screen similar Figure 188 will appear. On this screen, you may change the name and description. When complete, press <Enter> (Modify is the default option). You will return to the previous screen, where the message **Record Modified** will be displayed at the bottom of the screen.

<F9> - The <F9> key allows you to add an end state to the current family (see Figure 189). Enter a name (mandatory) and a description (optional). When complete, press <Enter> (Add is the default option).

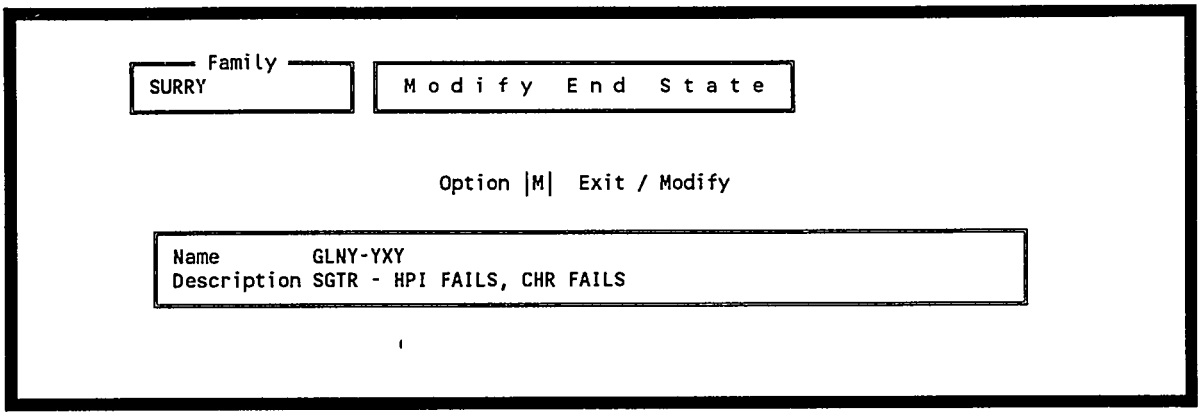


Figure 188. Modify end state.

You will be returned to the previous screen where the message **Record Added** will be displayed at the bottom of the screen.

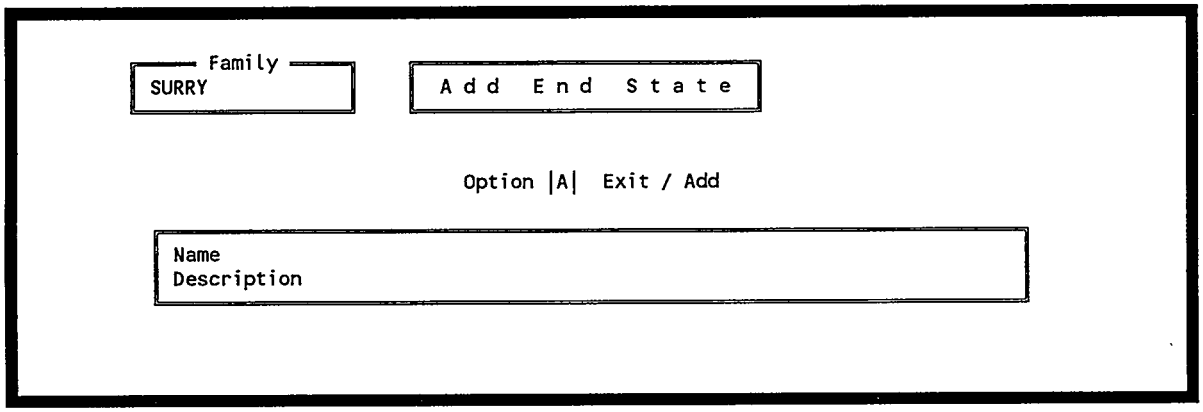


Figure 189. Add an end state.

10.3.6.3 Modify. This option allows you to modify a sequence record. To invoke this option, type <M> in the option field, highlight a sequence name, and press <Enter>. The Modify Sequence screen is shown in Figure 190. The options at this point are Exit and Modify.

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

10.3.6.3.2 Modify—This option performs the actual modification of the sequence record. Modify any of the data fields on the screen and press <Enter> (Modify is the default option). You will be returned to the Edit Sequences screen with the message **Record Modified** displayed at the bottom of the screen.

10.3.6.4 Delete. This option allows you to delete a sequence record. To invoke this option, type <D> in the option field, highlight a sequence name, and press <Enter>. The Delete Sequence screen is shown in Figure 191. Two options are available: Exit and Delete.

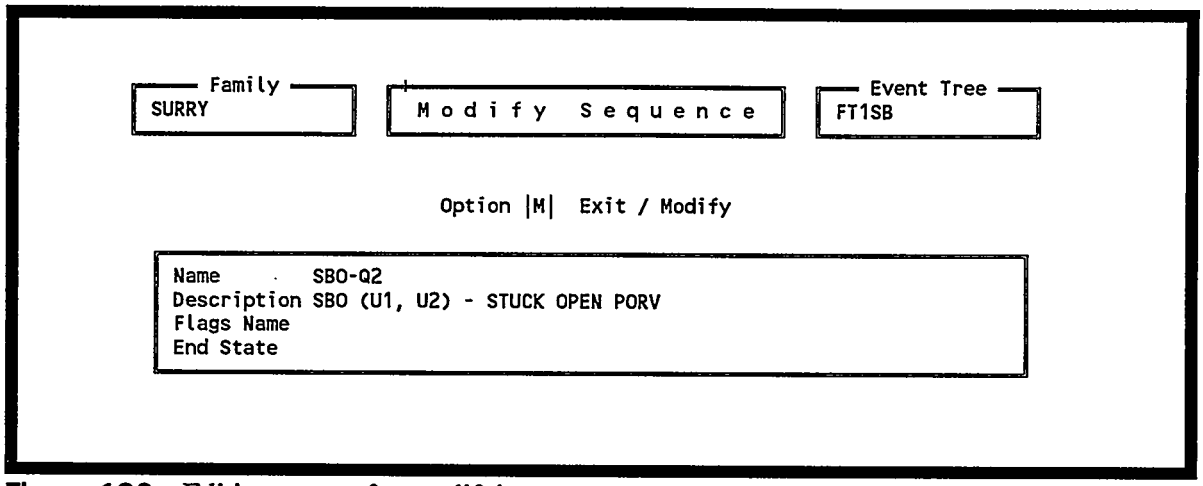


Figure 190. Editing screen for modifying a sequence.

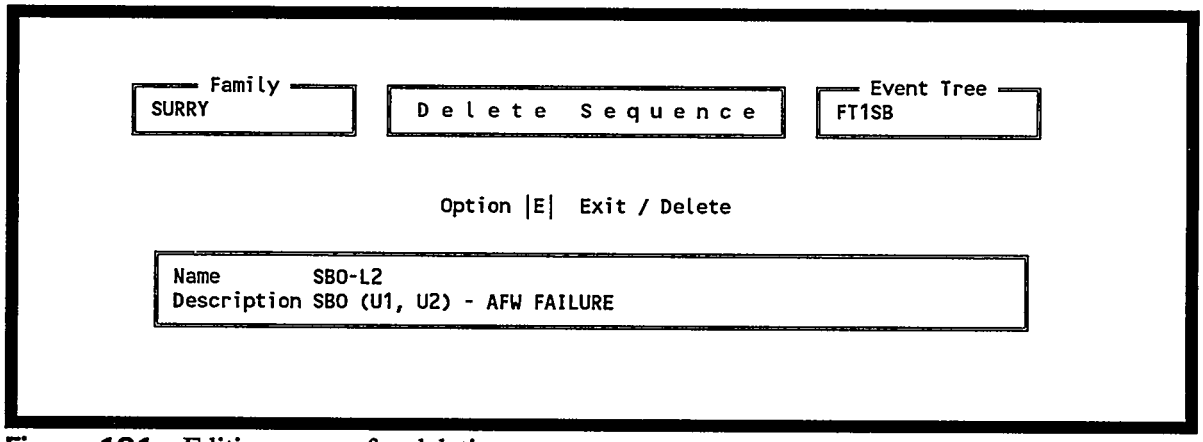


Figure 191. Editing screen for deleting a sequence.

If you marked sequence records to delete using the <F2>, <F3>, or <F4> keys the warning screen shown in Figure 192. To delete the marked records, enter a <Y> and press <Enter>; otherwise, enter an <N> and press <Enter>. If you respond Y, the sequence(s) will be deleted immediately.

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

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

10.3.6.5 Text. This option allows you to view and edit any descriptive text associated with a specific sequence. This option operates the same as the Text option discussed in the Family section. Refer to Section 10.2.5.

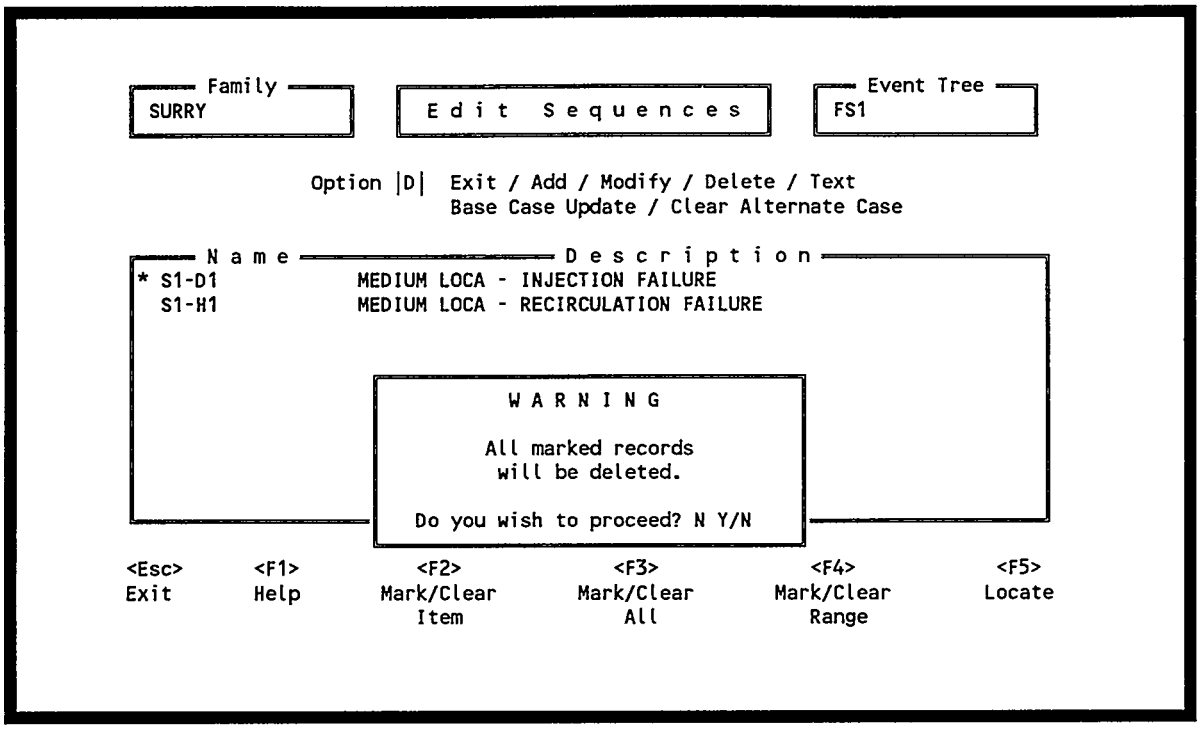


Figure 192. Warning screen for deletion of marked sequences.

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

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

A warning screen (Figure 193) will then be displayed asking for a (Y/N) confirmation before performing the update. In addition, you must indicate the analysis type. To terminate the update, type an <N> in the option field or press the <Esc> key. To initiate the base case update, type a <Y> in the option field. This will cause the current case data to overwrite the base case data. Upon completion of this process, a message **Base case update complete** will be displayed at the bottom of the screen.

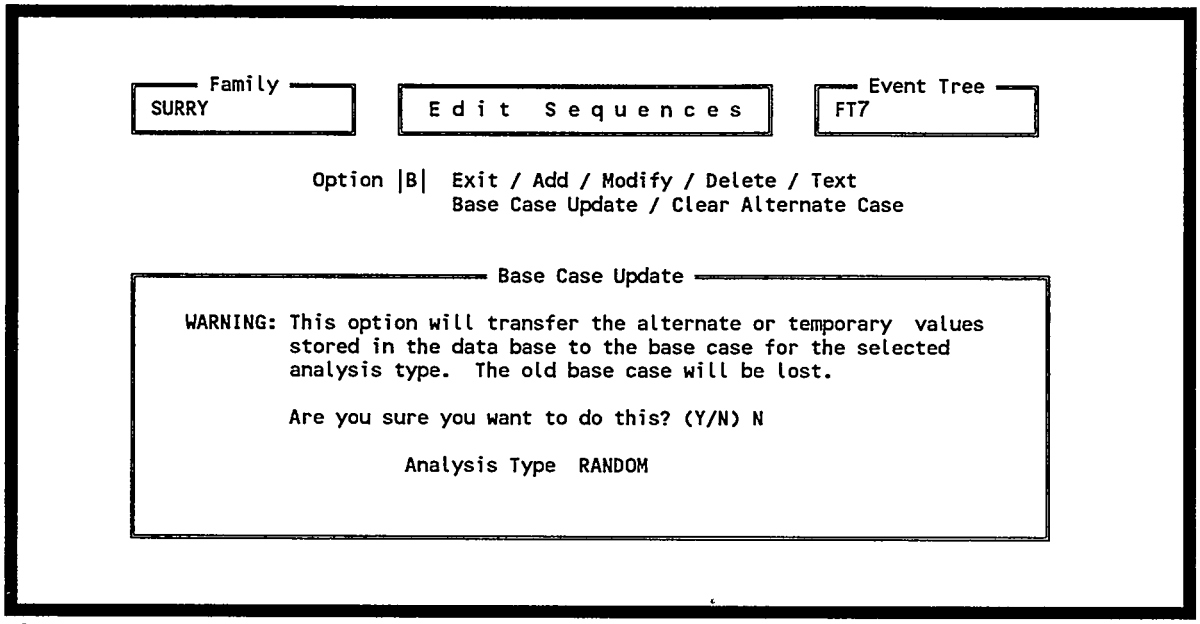


Figure 193. Base case update for sequences.

10.3.6.7 Clear Alternate Case. This option clears all alternate case information for the specified sequence(s) and analysis type. To invoke this option, type a <C> in the option field, highlight the desired sequence and press <Enter>. A warning will be displayed (see Figure 194). To continue enter a <Y> and press <Enter>; otherwise, enter an <N> and press <Enter> to terminate the process.

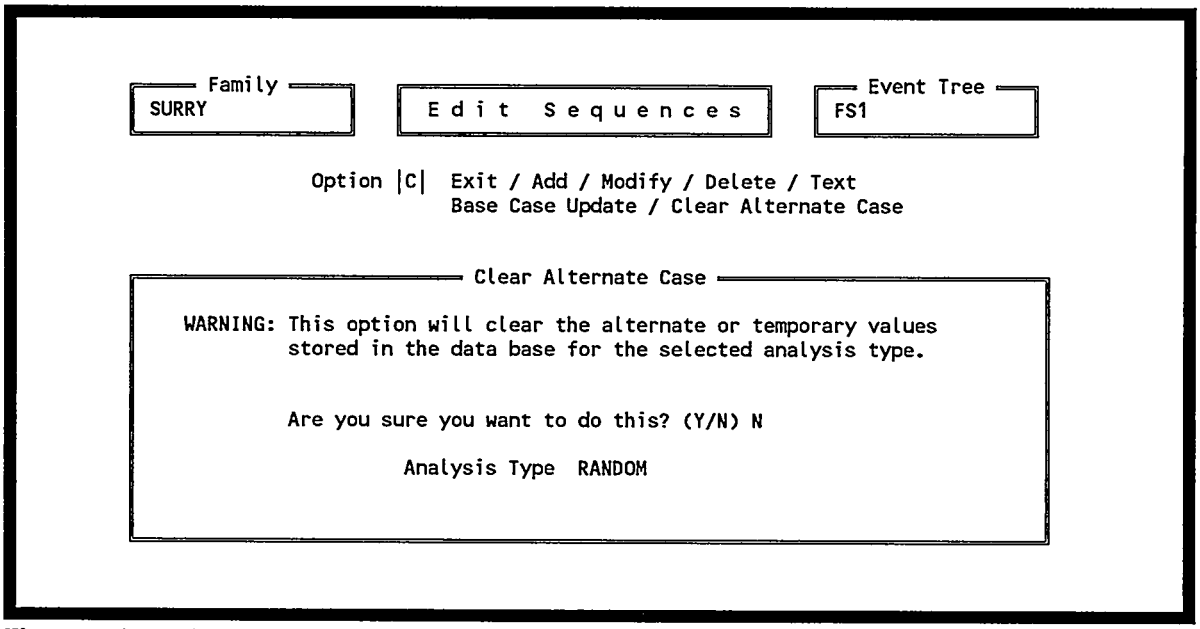


Figure 194. Clear alternate case for selected sequence(s).

10.3.7 Base Case Update

This option operates the same as described in Section 10.3.6.6, except all sequences for the specified event tree are updated (see Figure 195).

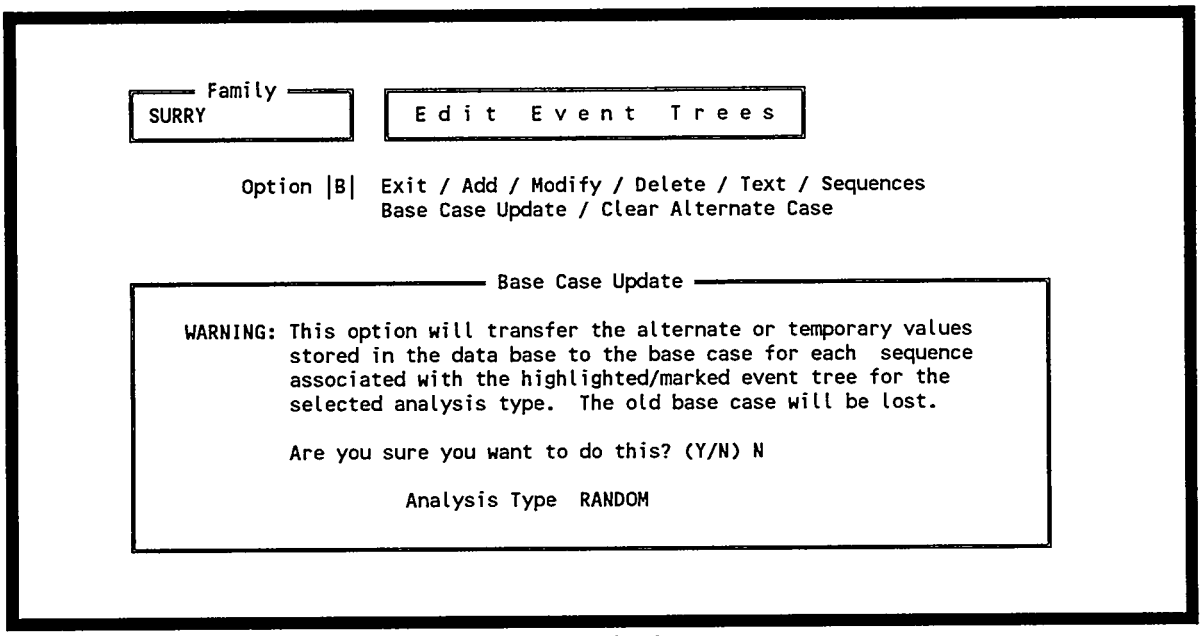


Figure 195. Base case update for all sequences in the event tree.

10.3.8 Clear Alternate Case

This option operates the same as described in Section 10.3.6.7, except it is performed for all sequences for the specified event tree (see Figure 196).

10.4 SYstems

This option allows you to modify system data records. To invoke this option, type <Y> in the option field or highlight SYstems and press <Enter>. The Edit Systems screen lists all of the systems contained in the current family (Figure 197). The modification options are: Exit, Add, Modify, Delete, Text, Base Case Update, and Clear Alternate Case.

10.4.1 Exit

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

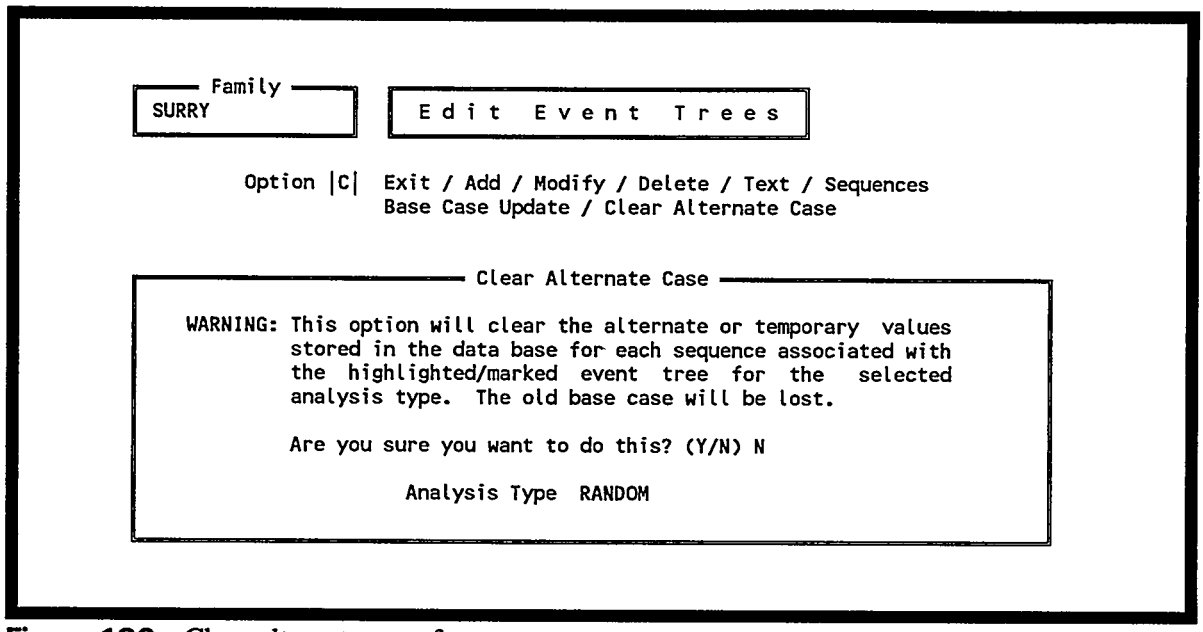


Figure 196. Clear alternate case for event trees.

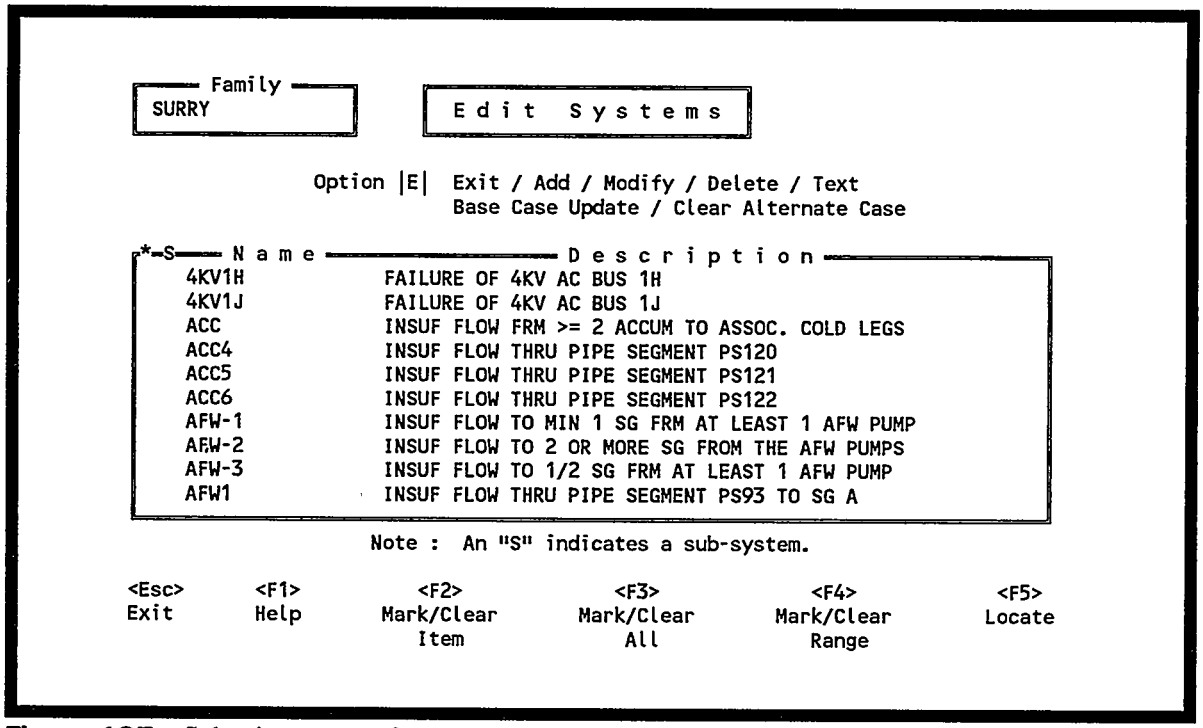


Figure 197. Selection screen for system editing.

10.4.2 Add

This option allows you to add a system record to the current family. To invoke this option, type <A> in the option field and press <Enter>. The Add System screen is shown in Figure 198. The options at this point are Exit and Add.

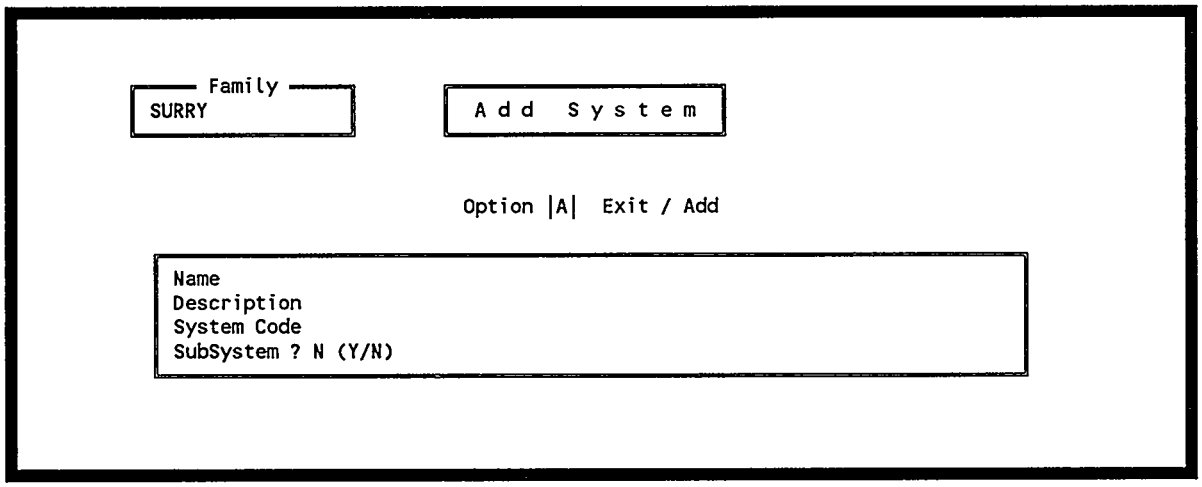


Figure 198. Editing screen for adding a system.

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

10.4.2.2 Add. This option performs the actual add of a new system record. Fill in the requested data fields and press <Enter> (Add is the default option). The following data may be entered:

Name	-	Enter up to 16 upper-case, alphanumeric characters (user-defined, blanks not allowed)
Description	-	Enter up to 60 upper- and lower-case characters that describe the system.
System Code	-	Enter up to three upper-case, alphanumeric characters to identify the graphic diagram display of the system.
Subsystem	-	Enter a Y to indicate this is a subsystem.

The only required information for a system add is the name. When complete, you will be returned to the Edit Systems screen with the message **Record Added** displayed.

10.4.3 Modify

This option allows you to modify a system record. To invoke this option, type <M> in the option field, highlight a system name, and press <Enter>. The Modify System screen is shown in Figure 199. The options at this point are Exit and Modify.

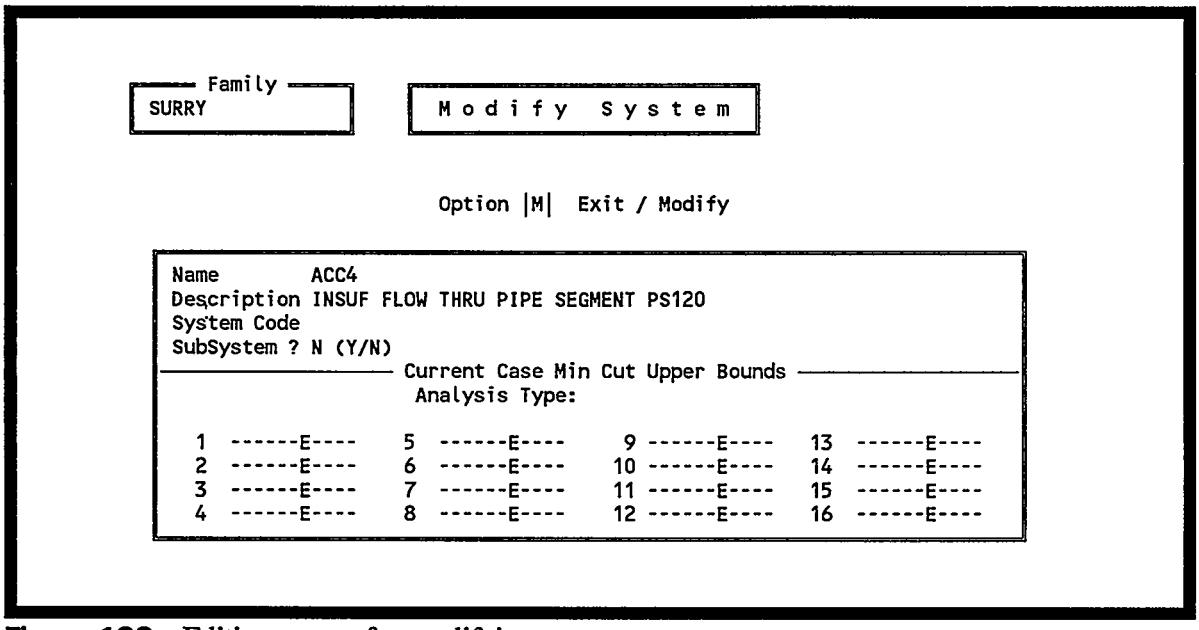


Figure 199. Editing screen for modifying a system.

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

10.4.3.2 Modify. This option performs the actual modification of the system record. Modify any of the data fields on the Modify System screen and press <Enter> (Modify is the default option). This option allows you to modify all the fields that were described for the Add above. In addition, you may specify the analysis type and specify the minimal cut set upper bounds. When completed, you will be returned to the Edit Systems screen with the message **Record modified** displayed.

10.4.4 Delete

This option allows you to delete a system record from the database. To invoke this option, type <D> in the option field, highlight a system and press <Enter>. The Delete System screen is shown in Figure 200. The options at this point are Exit and Delete.

If you marked systems to delete using the <F2>, <F3>, or <F4> keys, the screen shown in Figure 201 will appear. To continue with the deletion, enter a Y and press <Enter>; otherwise, enter an N. If you respond Y, the records will be deleted immediately.

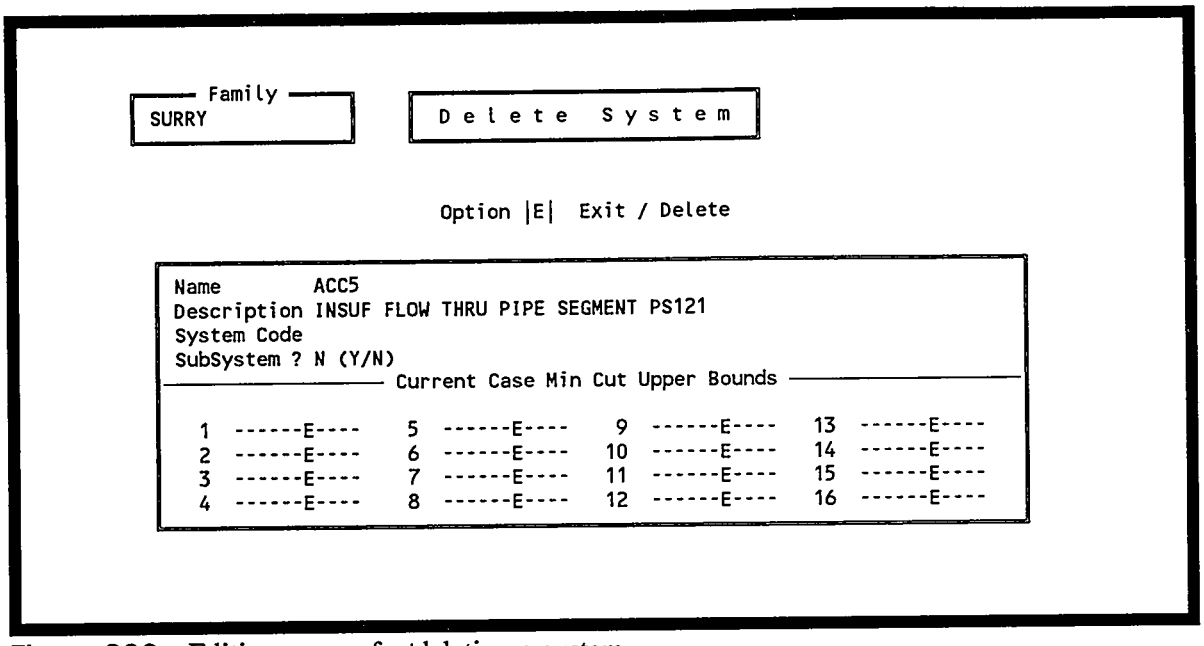


Figure 200. Editing screen for deleting a system.

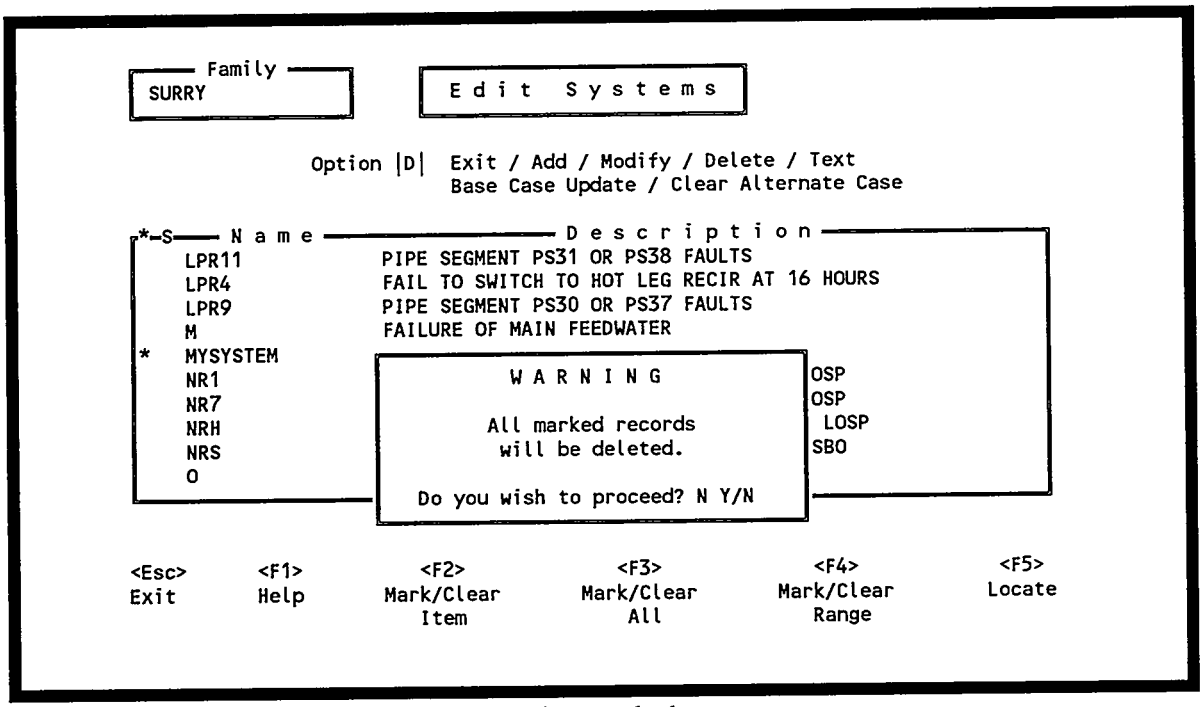


Figure 201. Warning message when deleting marked systems.

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

10.4.4.2 Delete. This option performs the actual deletion of the system record. To invoke this option, type <D> in the option field and press <Enter>. When complete, you will be returned to the Edit Systems screen with the message **Record deleted** displayed. **NOTE: IRRAS will not allow you to delete a system that is used by another system.**

10.4.5 Text

This option allows you to view and edit any descriptive text associated with a specific system. This option operates the same as the Text option discussed in the Family section. Refer to Section 10.2.5.

10.4.6 Base Case Update

This option operates the same as described for sequences in Section 10.3.6.6, except the update is performed on an entire system(s) for the specified analysis type.

10.4.7 Clear Alternate Case

This option operates the same as described for sequences in Section 10.3.6.7, except it is performed on an entire system(s) for the specified analysis type.

10.5 ENd States

This option allows you to modify the end state data records. To invoke this option, type <N> in the option field or highlight ENd States and press <Enter>. The Edit End State screen, which lists all of the end states belonging to the current family, is shown in Figure 202. The modification options are: Exit, Add, Modify, Delete, Text, Base Case Update and Clear Alternate Case.

10.5.1 Exit

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

10.5.2 Add

This option allows you to add an end state record to the current family. To invoke this option, type <A> in the option field and press <Enter>. The Add End State screen is shown in Figure 203. The options at this point are Exit and Add.

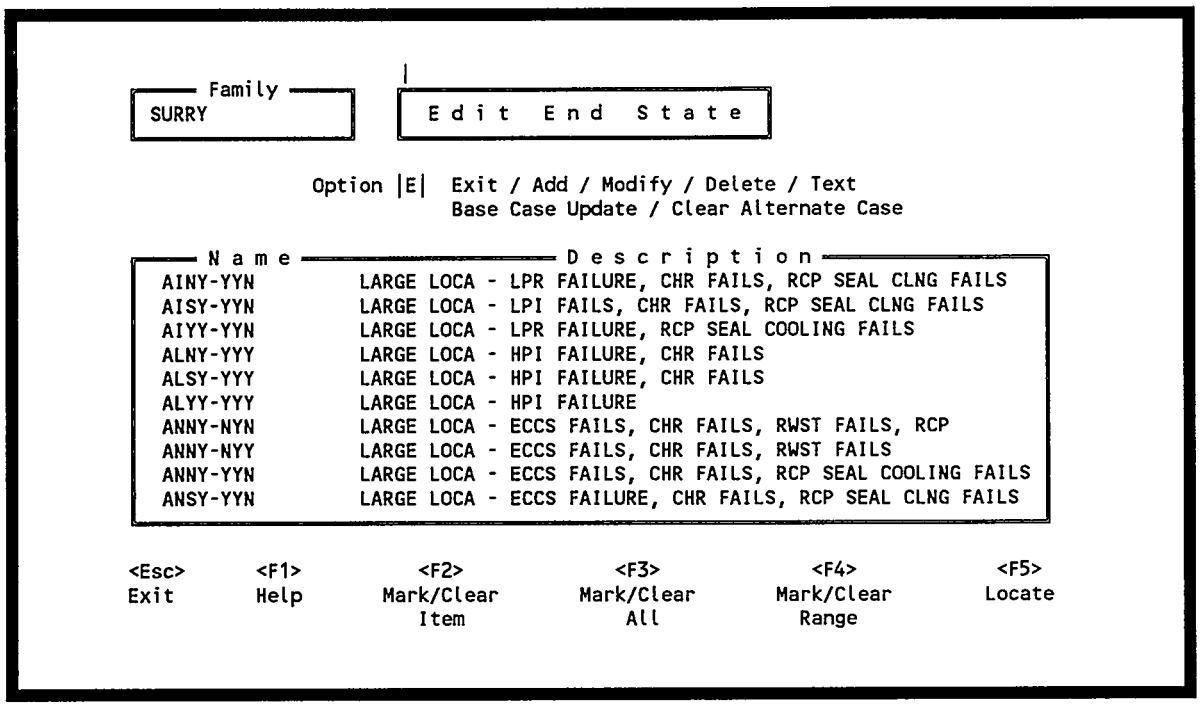


Figure 202. Selection screen for end state editing.

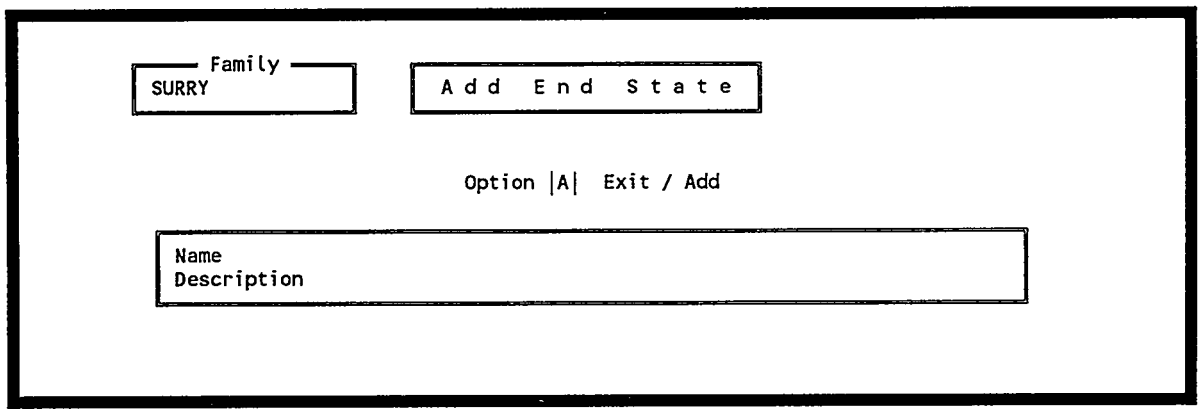


Figure 203. Editing screen for adding an end state.

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

10.5.2.2 Add. This option performs the actual addition of a new end state record. Supply a name (mandatory) and description (optional) and press <Enter> (Add is the default option). When complete, you will be returned to the Edit End State screen with the message **Record added** displayed.

10.5.3 Modify

This option allows you to modify an end state record. To invoke this option, type <M> in the option field, highlight an end state name, and press <Enter>. The Modify End State screen is shown in Figure 204. The options at this point are Exit and Modify.

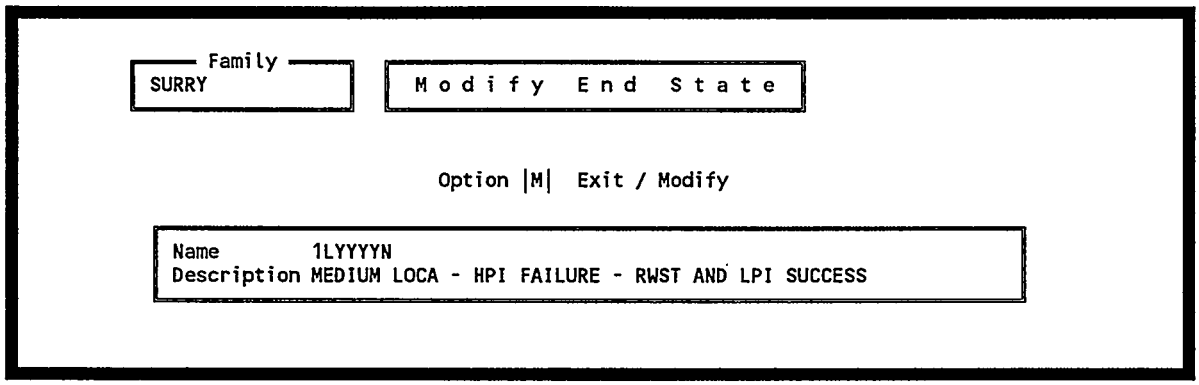


Figure 204. Editing screen for modifying an end state.

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

10.5.3.2 Modify. This option performs the actual modification of the end state record. Modify any of the data fields on the Modify End State screen, and press <Enter> (Modify is the default option). When complete, you will be returned to the Edit End State screen with the message **Record modified** displayed at the bottom of the screen.

10.5.4 Delete

This option allows you to delete an end state record from the database. To invoke this option, type <D> in the option field, highlight an end state and press <Enter>. The Delete End State screen is shown in Figure 205. The options at this point are Exit and Delete.

If you marked end states to delete using the <F2>, <F3>, or <F4>, the screen shown in Figure 206 will appear. Enter a Y and press <Enter> to delete all the marked records; otherwise, enter an N and press <Enter> to terminate without deleting.

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

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

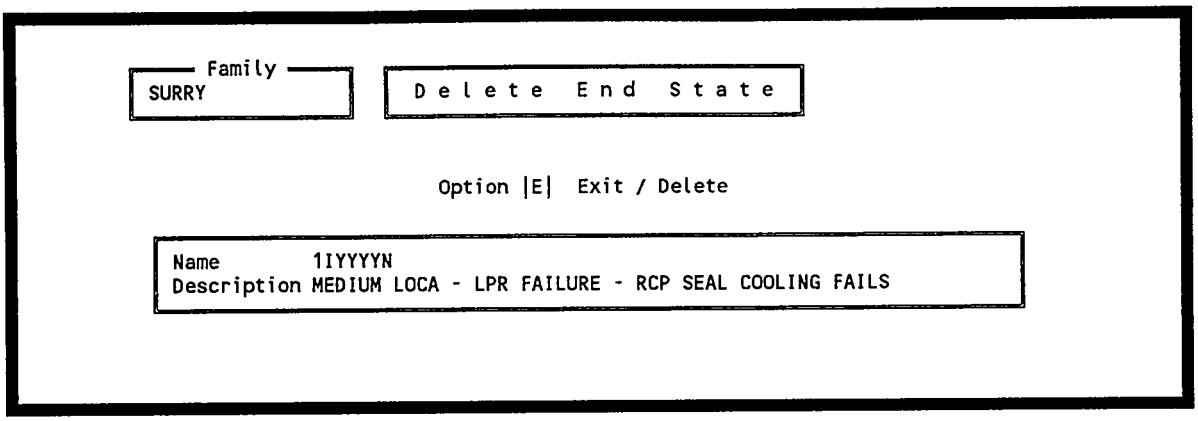


Figure 205. Editing screen for deleting an end state.

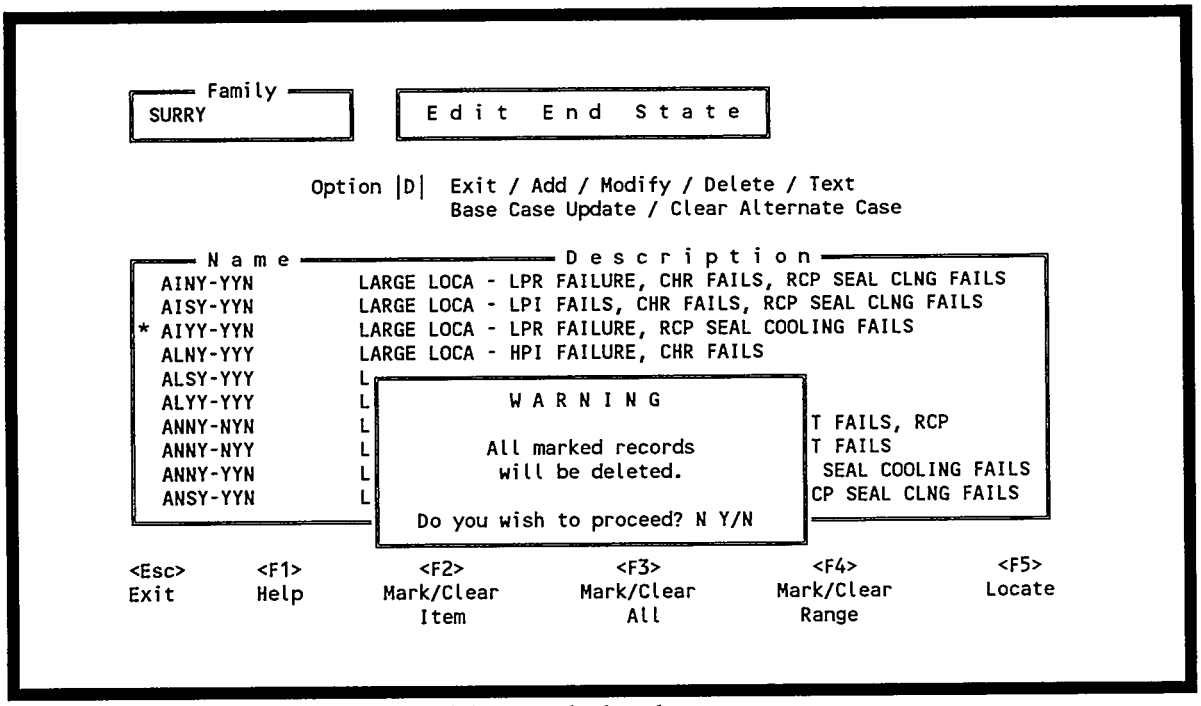


Figure 206. Warning message to delete marked end states.

10.5.5 Text

This option allows you to view and edit any descriptive text associated with a specific end state. This option operates the same as the Text option discussed in the Family section. Refer to Section 10.2.5.

10.5.6 Base Case Update

This option operates the same as described for sequences in Section 10.3.6.6, except the update is performed on end state(s) for a selected analysis type.

10.5.7 Clear Alternate Case

This option operates the same as described for sequences in Section 10.3.6.7, except it is performed on end state(s) for a selected analysis type.

10.6 Basic Events

This option allows you to modify the basic event data records. To invoke this option, type <B> in the option field or highlight Basic Events and press <Enter>. The Edit Events screen, listing all of the basic events belonging to the current family, is displayed (Figure 207). The modification options are: Exit, Add, Modify, Delete, Transformations, and Remove Unused Events.

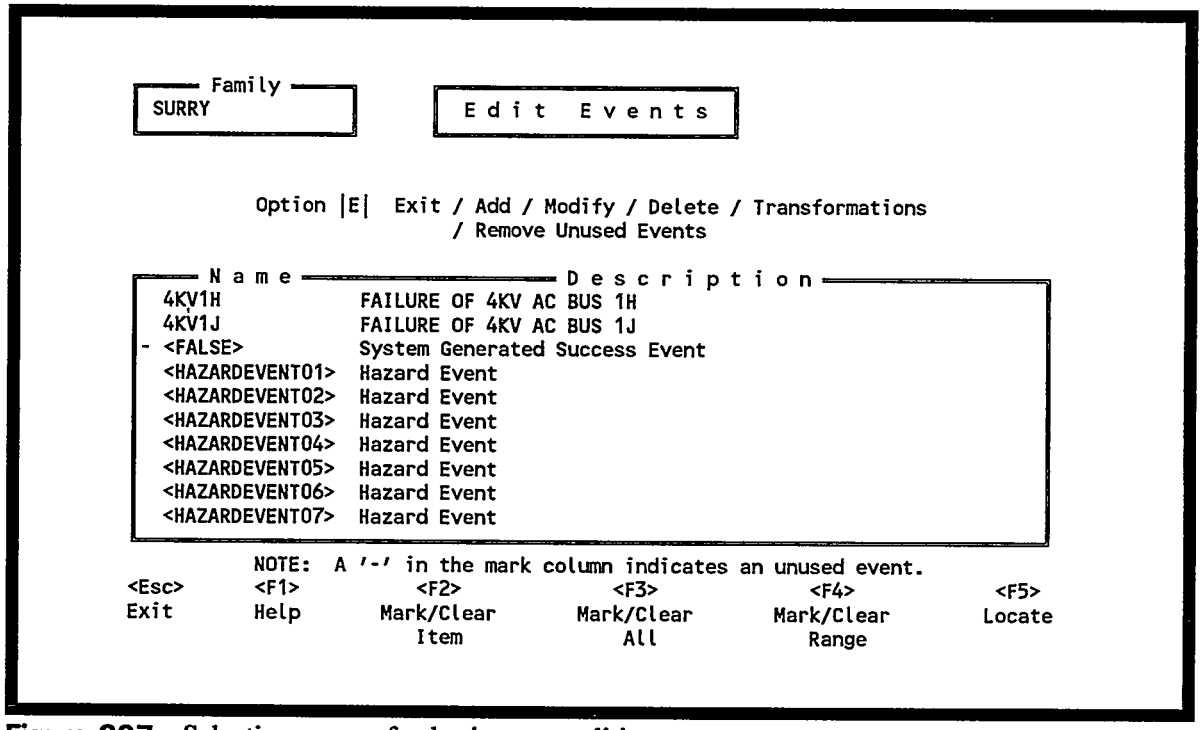


Figure 207. Selection screen for basic event editing.

10.6.1 Exit

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

10.6.2 Add

This option allows you to add a basic event record to the current family. To invoke this option, type <A> in the option field and press <Enter>. The Add Event screen is shown in Figure 208. The options at this point are Exit and Add.

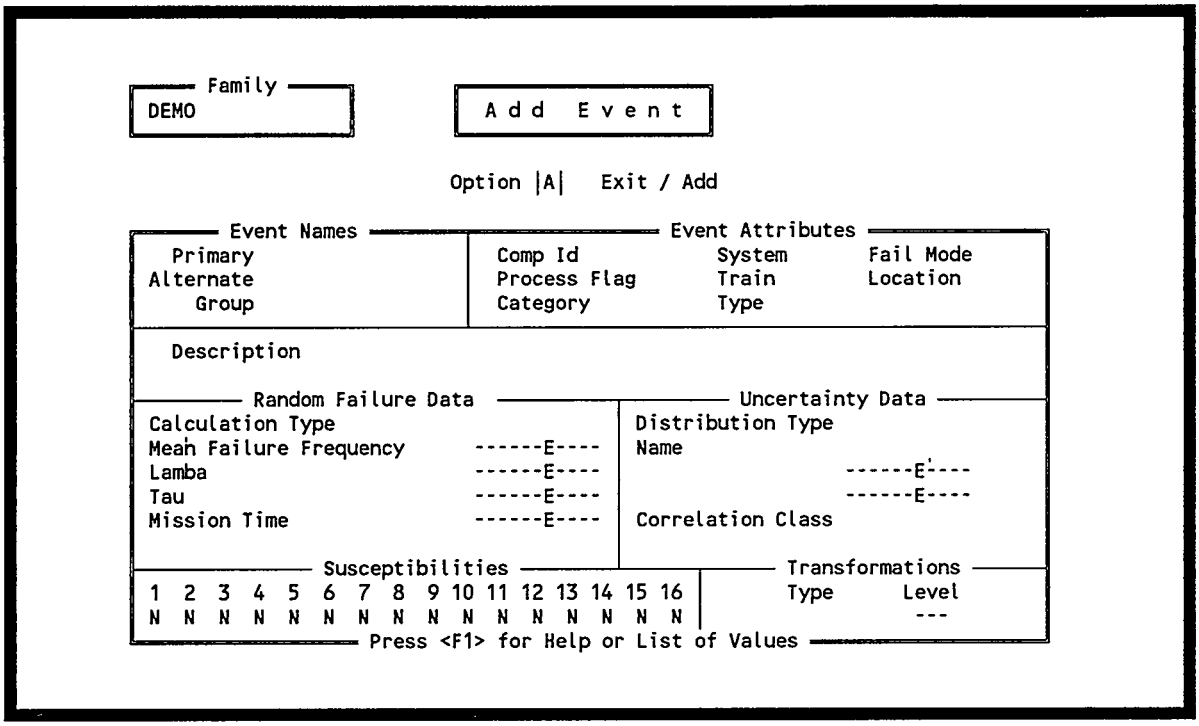


Figure 208. Editing screen for adding a basic event.

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

10.6.2.2 Add. This option performs the actual add of a new basic event record. Fill in the requested data fields and press <Enter>. On this screen, you may supply event data, failure data, seismic fragility, attribute, uncertainty data, transformation, and susceptibility information. These fields are discussed in detail in Section 10.3. Refer to that section regarding questions concerning field input. The only required information for a basic event add is the name. Extensive help forms are available to aid you with data entry. To invoke the on-line help function, simply press <F1> when positioned in a field. A window will appear defining the field content or presenting valid entries. Press <Esc> or <Enter> to exit the help form. When complete, press <Enter> (Add is the default option). You will be returned to the Edit Event screen with the message **Record Added** displayed at the bottom of the screen.

10.6.3 Modify

This option allows you to modify a basic event record. To invoke this option, type <M> in the option field, highlight a basic event name, and press <Enter>. The Modify Basic Event screen is shown in Figure 209. The options at this point are Exit and Modify.

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

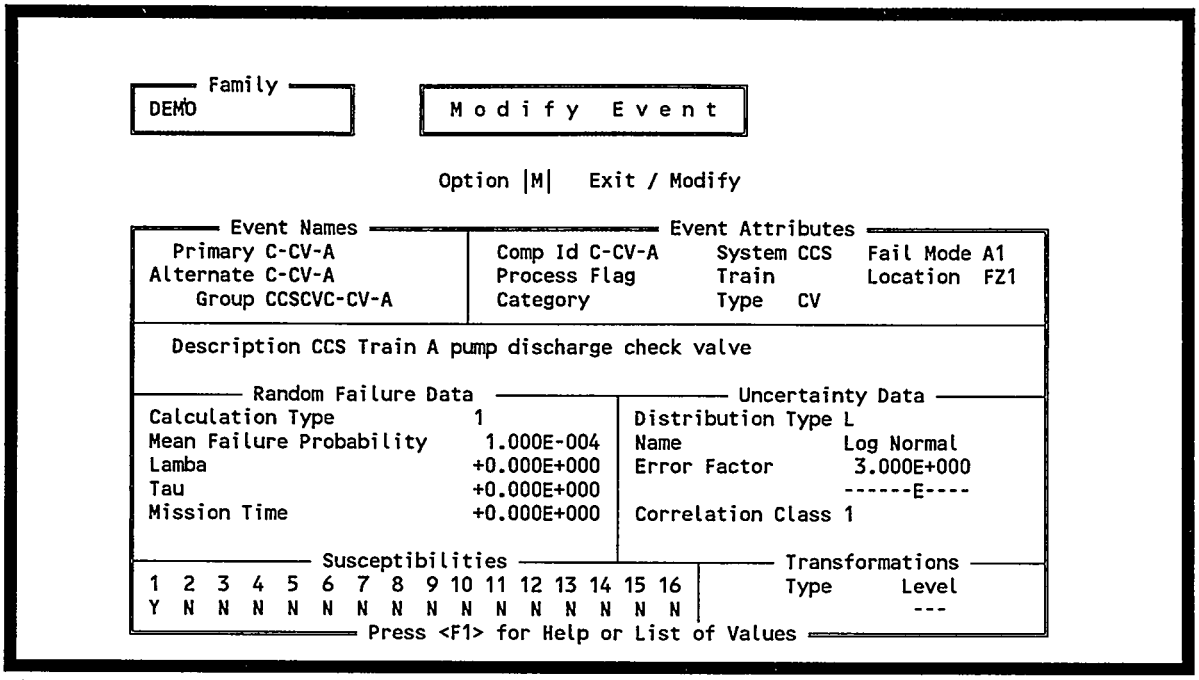


Figure 209. Editing screen for modifying a basic event.

10.6.3.2 Modify. This option performs the actual modification of the basic event record. Modify any of the data fields on the Modify Event screen and press <Enter>. Refer to the Add option above (Section 10.6.2.2) for field descriptions. When complete, you will be returned to the Edit Events screen with the message **Record Modified** displayed at the bottom of the screen.

10.6.4 Delete

This option allows you to delete a basic event record from the current family. To invoke this option, type <D> in the option field, highlight a basic event and press <Enter>. The Delete Event screen is shown in Figure 210. The options at this point are Exit and Delete.

NOTE: You can only delete unused events.

If you used the <F2>, <F3>, or <F4> keys to mark records for deletion, the screen shown in Figure 211 will appear. To continue with the deletion, enter a <Y> and press <Enter>; otherwise, enter an <N>. If you respond Y, the records will be deleted immediately.

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

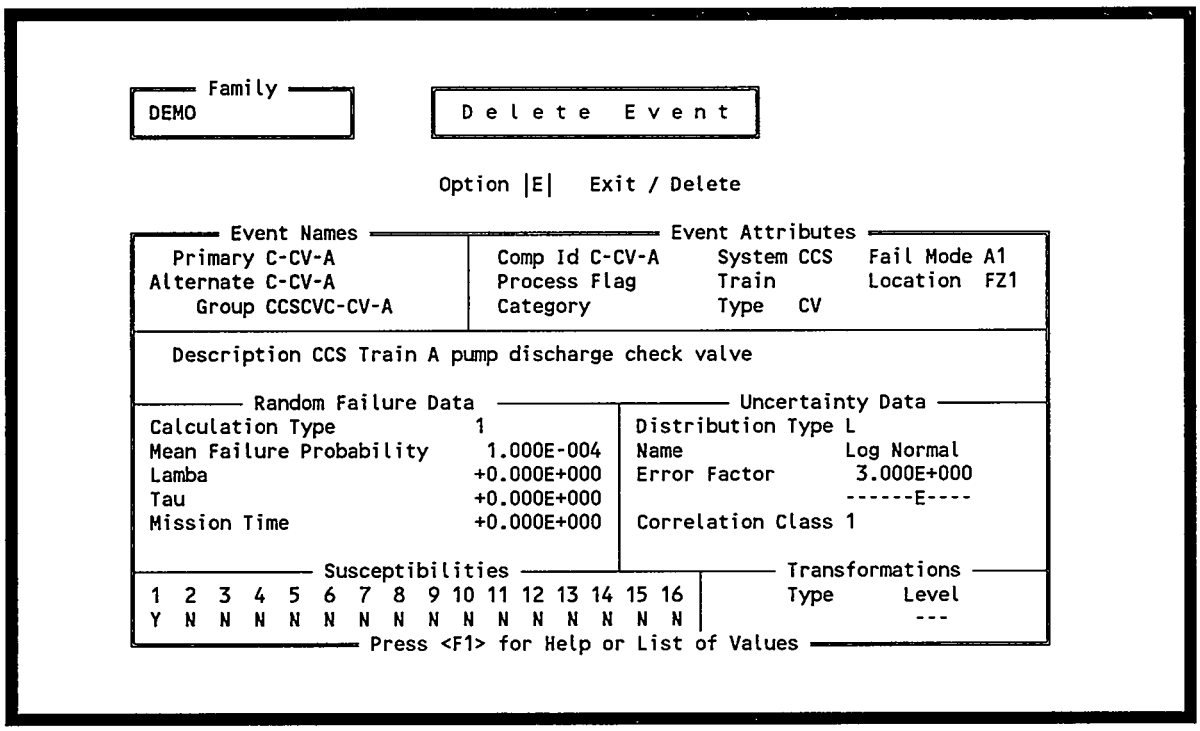


Figure 210. Editing screen for deleting a basic event.

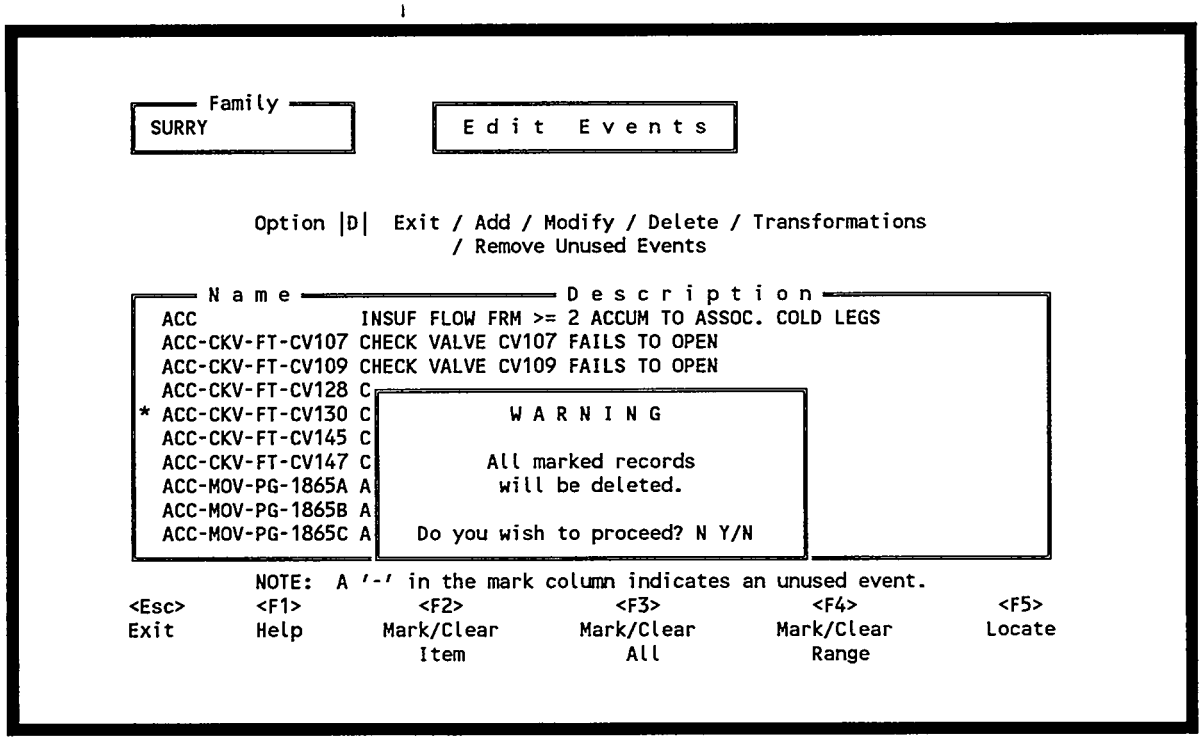


Figure 211. Warning message to delete marked basic events.

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

10.6.5 Transformations

A transformation is a replacement or addition 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.

When you invoke this option, Figure 212 will appear. This screens lists the events that have been marked as replacements for an event or series of events marked on the previous screen. From this screen, you may perform one of the following:

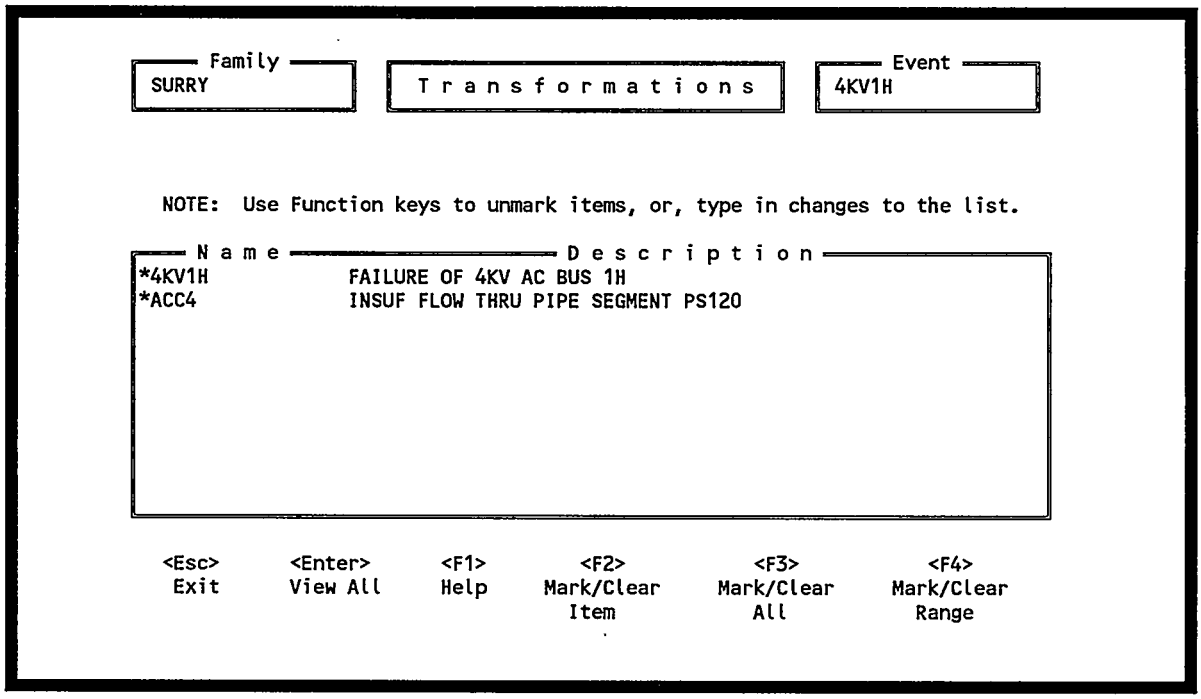


Figure 212. Initial transformation screen.

<Enter> - When you press <Enter>, all events defined for the current family will be displayed (see Figure 213). From this screen, you may mark additional events to be included as replacements, mark a new range, or clear all marked events and essentially start over.
<Enter> is a toggle between marked events and all events.

<Esc> - When you are finished marking replacements events for the transformation, press <Esc> to continue. Figure 214 will be displayed.

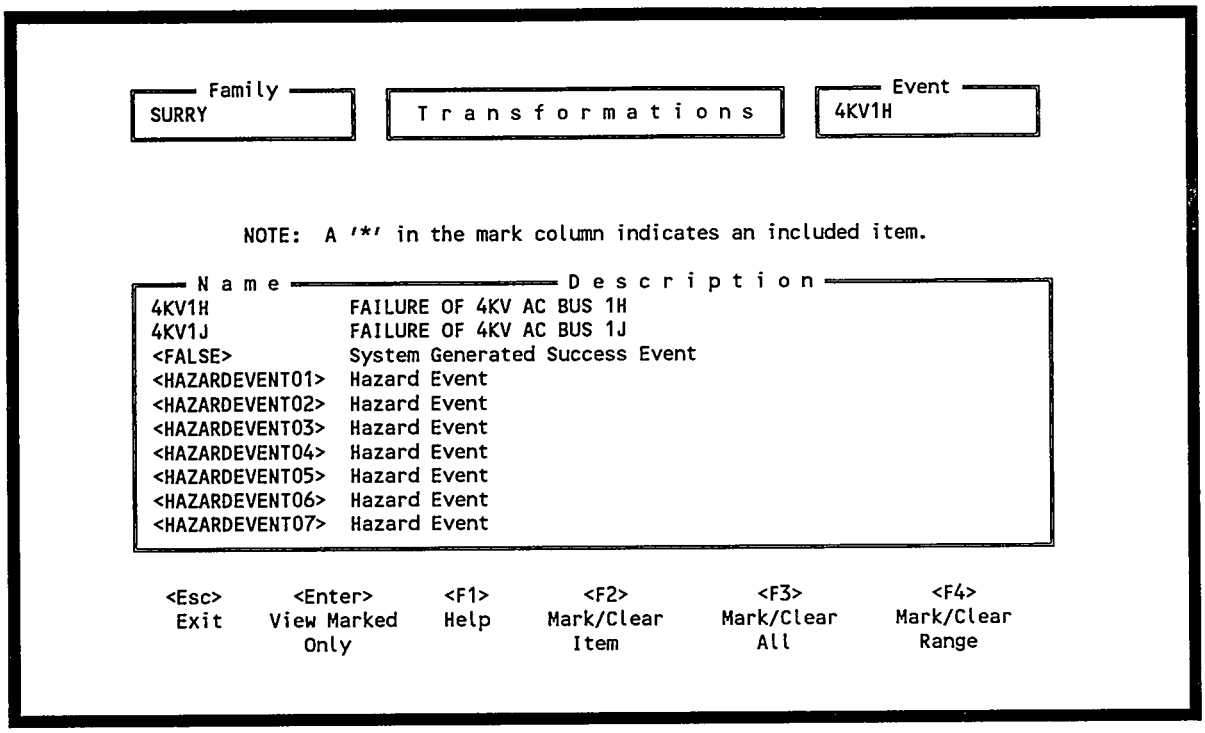


Figure 213. Listing of all basic events.

On this screen, you enter the transformation type and level. The following transformation types are available:

AND - Event is replaced with an AND gate, with all marked events as inputs.

OR - Event is replaced with an OR gate with all marked events as inputs.

ZOR - If any events in the list fail, all events fail.

The transformation level is an integer between 0 and 255. This number indicates the level of substitution for the transformation.

IRRAS now 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:

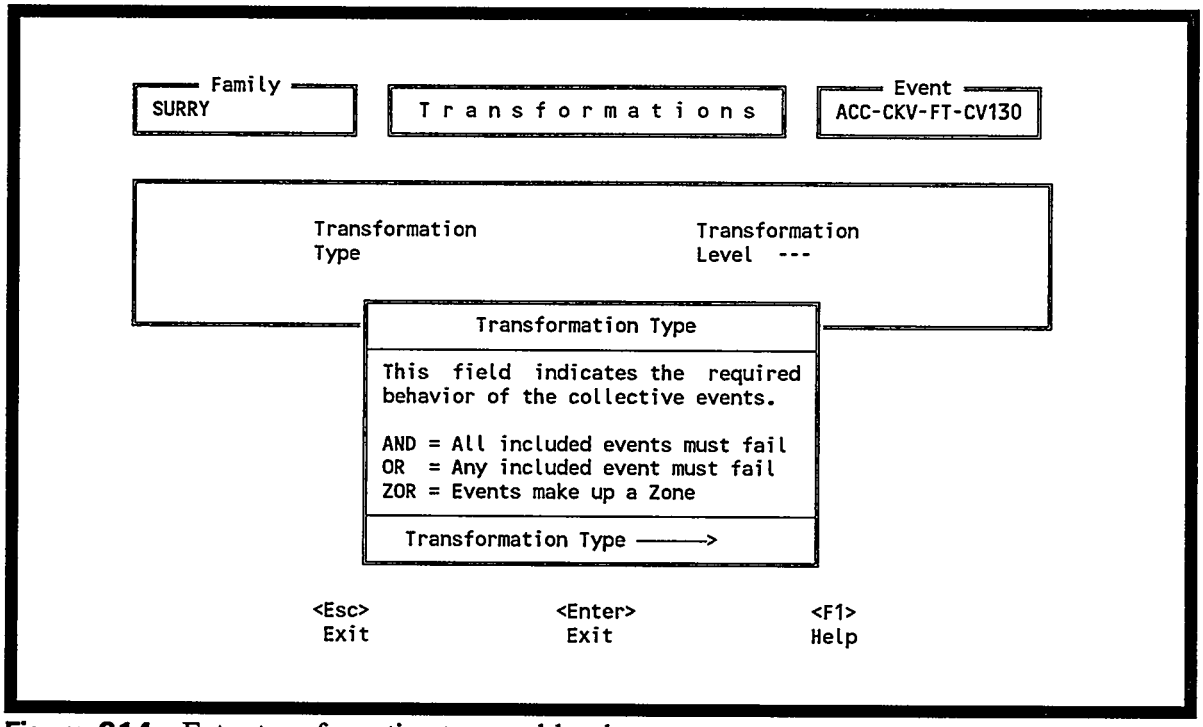


Figure 214. Enter transformation type and level.

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 events transformation to apply to a Fire analysis, then they must specify that the particular event is susceptible to Fire by setting the fire susceptibility flag to "Y".

10.6.6 Remove Unused Event

This option looks at all references to an event in the current family and deletes any events that are not referenced by anything. When you invoke this option, a warning screen will be displayed telling you that all records that are marked as unused will be deleted. At this prompt, enter a <Y> to continue the deletion process, or enter an <N> to terminate without deleting the unused events (Figure 215).

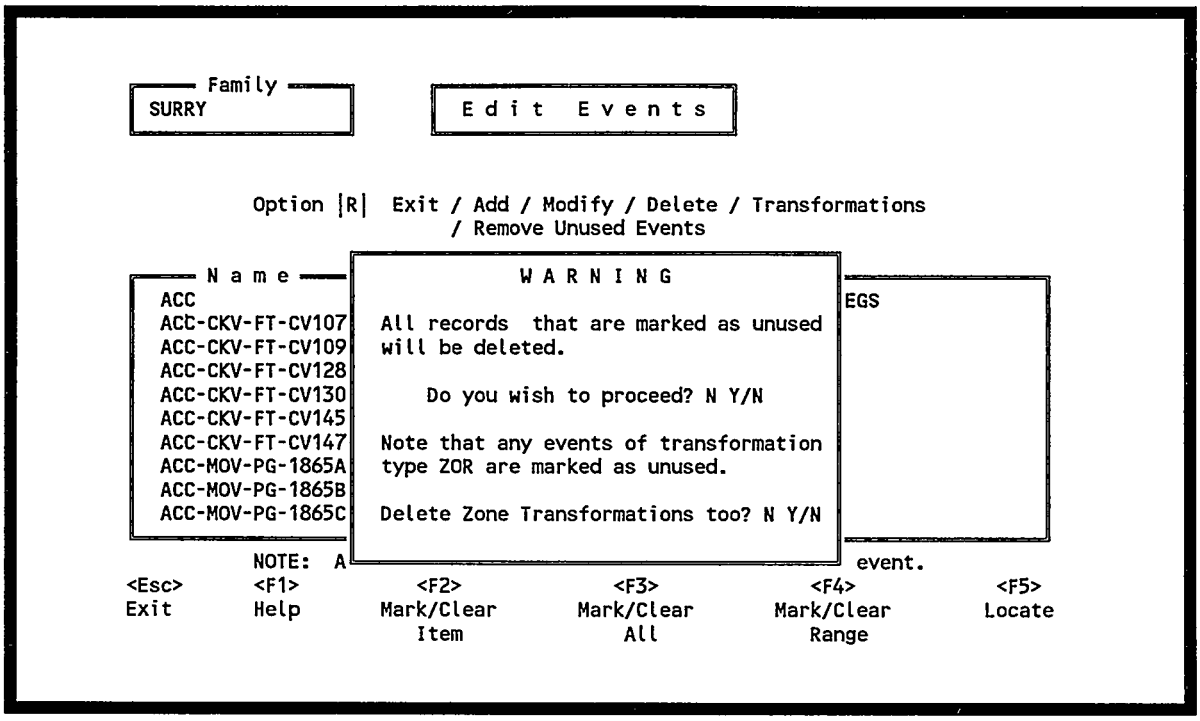


Figure 215. Remove unused events prompt.

10.7 Attributes

This option allows you to edit the five attributes in the current family (Figure 216): Systems, Locations, Failure Modes, Basic Event Types, and Trains. The options available within each of these attributes are: Exit, Add, Modify, and Delete.

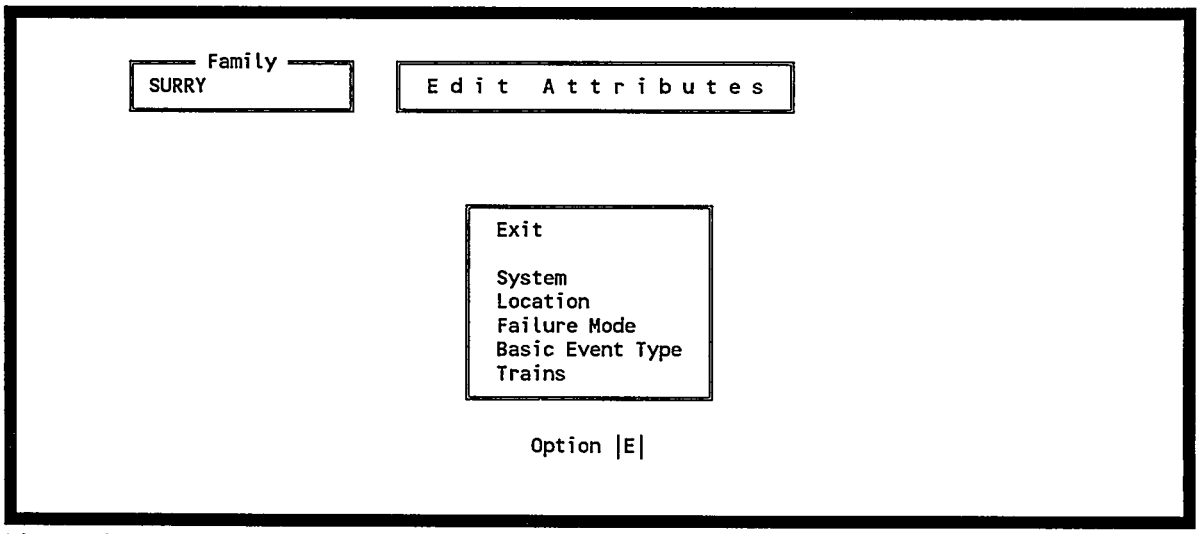


Figure 216. Attribute selection for editing.

The Edit Attributes screen shown in Figure 216 and succeeding screens (Figure 217 - Figure 220) are consistent throughout the attributes option for each of the five categories. Because this option operates the same for all five attribute categories, a generic write-up is presented.

To invoke this option, type <T> in the option field or highlight ATtributes and press <Enter>. This will display a list of attribute categories (see Figure 216). Highlighting a category or typing a category's highlighted letter and pressing <Enter> displays the list of attributes available under the selected category. For each attribute category, the following options are available: Exit, Add, Modify, and Delete.

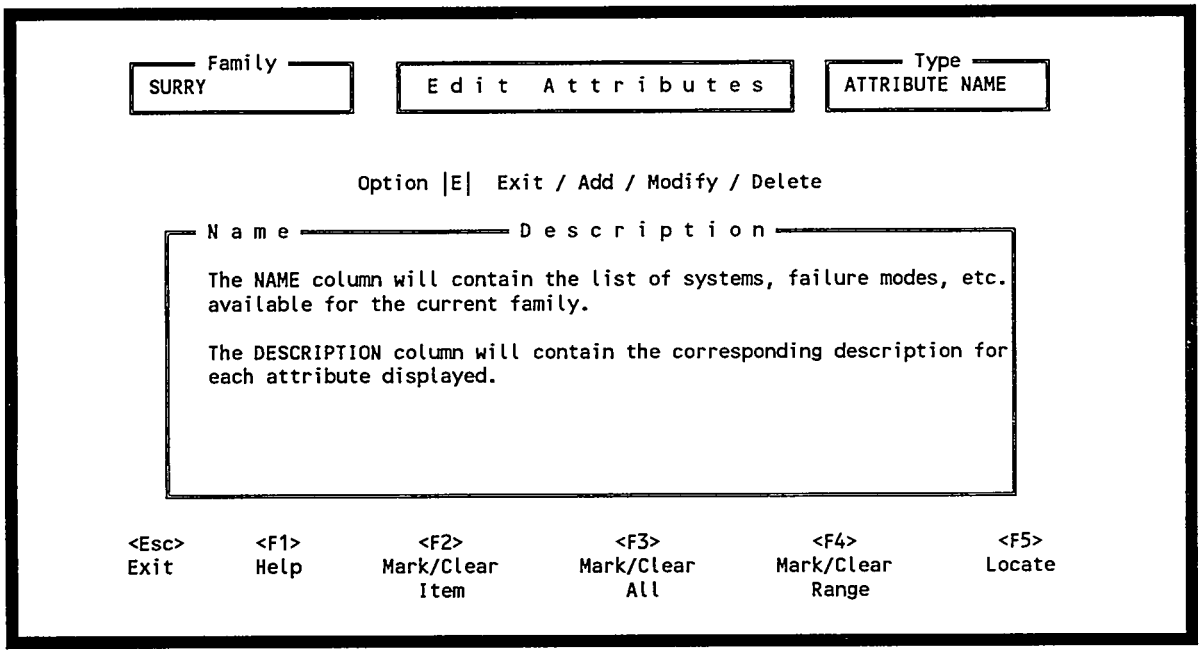


Figure 217. Selection screen for attribute editing.

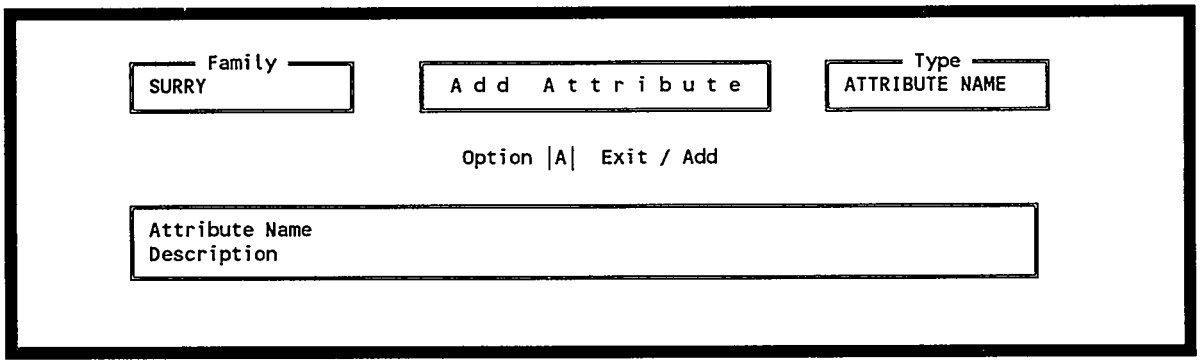


Figure 218. Editing screen for adding an attribute.

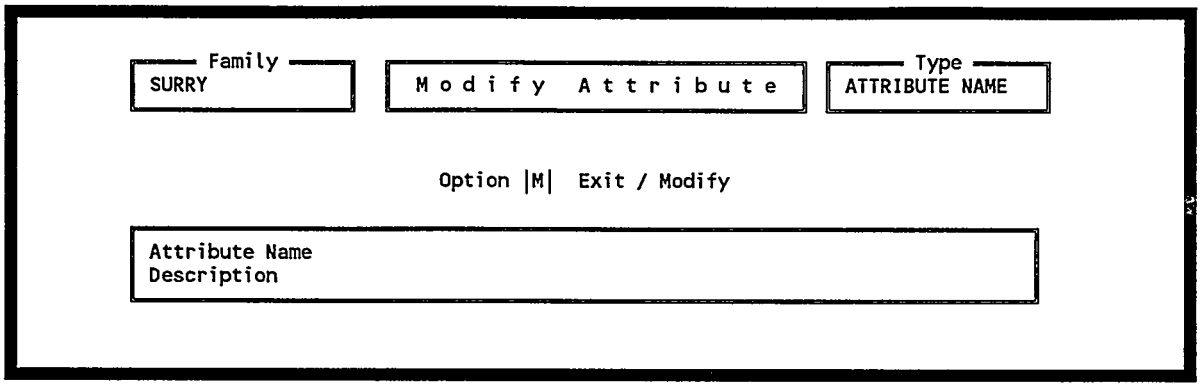


Figure 219. Editing screen for modifying an attribute.

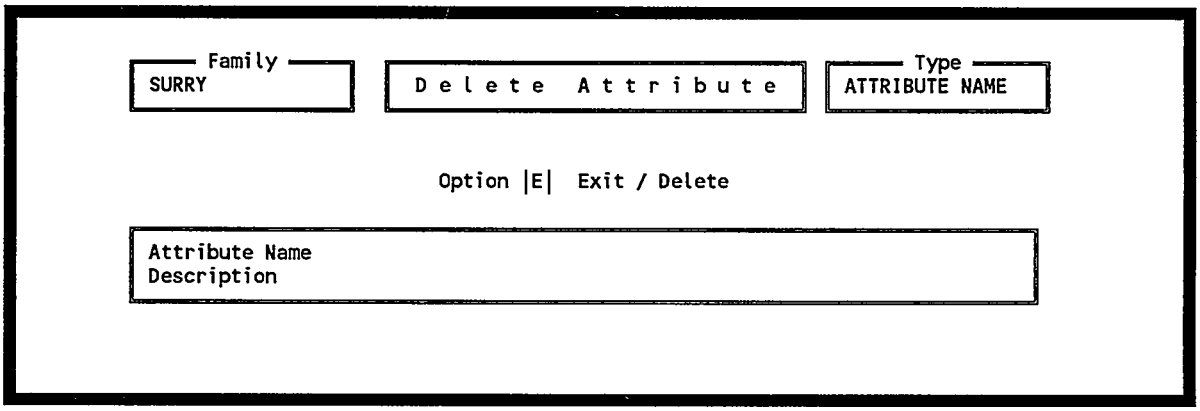


Figure 220. Editing screen for deleting an attribute.

10.7.1 Exit

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

10.7.2 Add

The add option allows you to add a new attribute record to the current family. To invoke this option, type <A> in the option field and press <Enter>. The Add Attribute screen is shown in Figure 218. The options at this point are Exit and Add.

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

10.7.2.2 Add. This option performs the actual add of a new attribute record. Fill in the requested data fields and press <Enter> (Add is the default option). The only required information for

an attribute add is the name. When complete, you will be returned to the Edit Attributes screen with the message **Record added** displayed at the bottom of the screen.

10.7.3 Modify

This option allows you to modify an attribute record. To invoke this option, type <M> in the option field, highlight an attribute name, and press <Enter>. The Modify Attribute screen is shown in Figure 219. The options at this point are Exit and Modify.

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

10.7.3.2 Modify. This option performs the actual modification of the attribute record. Modify any of the data fields on the screen and press <Enter> (Modify is the default option). When complete, you will be returned to the Edit Attributes screen with the message **Record modified** displayed at the bottom of the screen.

10.7.4 Delete

This option allows you to delete an attribute record from the current family. To invoke this option, type <D> in the option field, highlight an attribute and press <Enter>. The Delete Attribute screen is shown in Figure 220. The options at this point are Exit and Delete.

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

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

10.8 Analysis Types

This option allows you to modify analysis types. In earlier versions, IRRAS performed random analysis only. In version 5.0, IRRAS offers four additional predefined analysis types and eight user-defined analysis types. To invoke this option, type an <A> or highlight Analysis Type and press <Enter>. The Edit Analysis Types screen, listing the available types, is displayed (see Figure 221). The options are Exit and Modify.

10.8.1 Exit

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

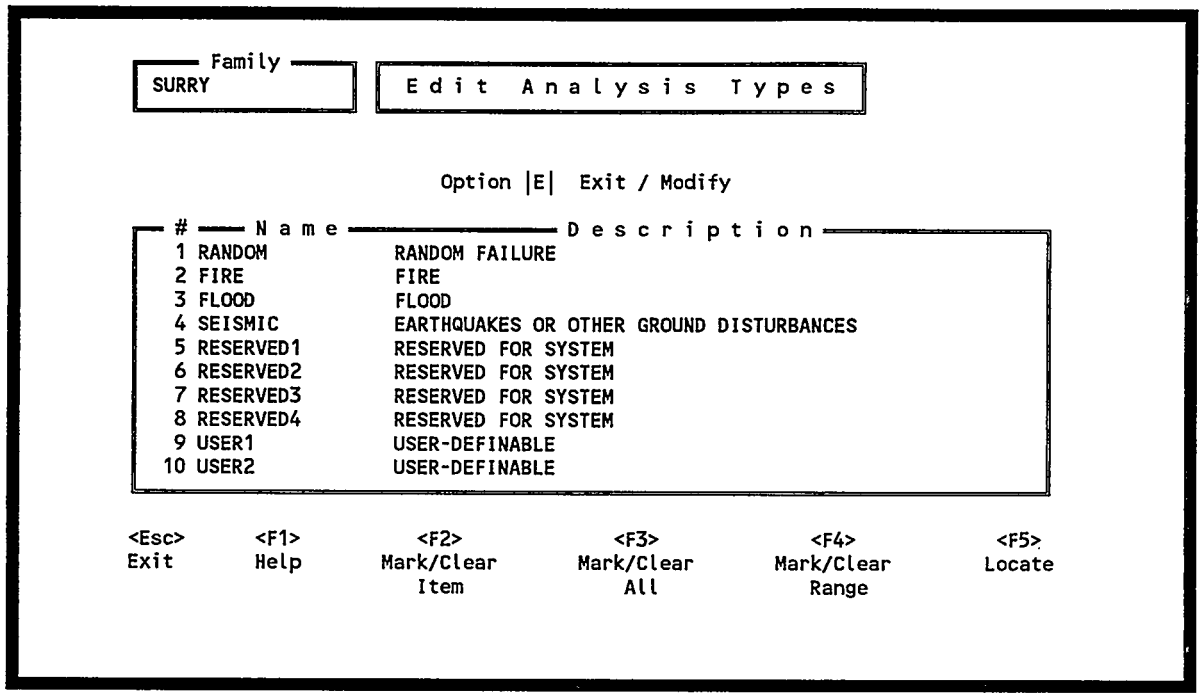


Figure 221. Edit analysis types.

10.8.2 Modify

This option performs the actual modification of the analysis type. To invoke this option, type an <M> in the option field, highlight the analysis type to modify, and press <Enter>. Figure 222 will be displayed. On this screen, you may change the name and description. When complete, press <Enter> (Modify is the default option). You will return to the Edit Analysis Types screen with the message **Record Modified** displayed at the bottom of the screen.

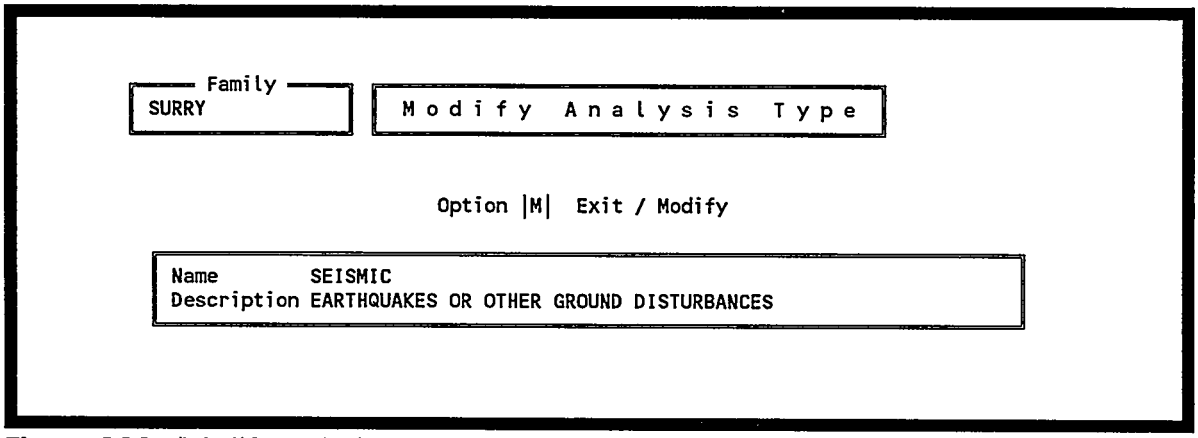


Figure 222. Modify analysis type.

10.9 Gates

This option allows you to modify gate records. To invoke this option, type <G> in the option field or highlight Gates and press <Enter>. The Edit Gates screen, listing all of the gates belonging to the current family, is displayed (Figure 223). The modification options are: Exit, Add, Modify, Delete, and Remove Unused Gates.

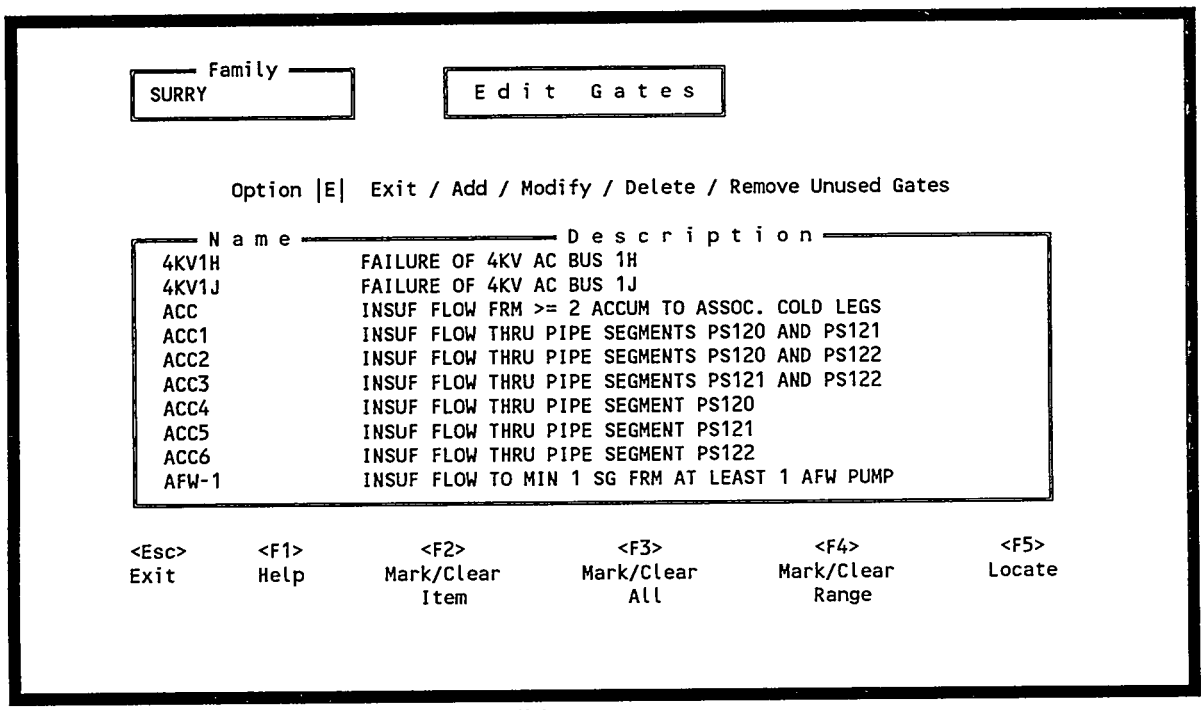


Figure 223. Selection screen for gate editing.

10.9.1 Exit

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

10.9.2 Add

This option allows you to add a gate record to the current family. To invoke this option, type <A> in the option field and press <Enter>. The Add Gate screen is shown in Figure 224. The options at this point are Exit and Add.

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

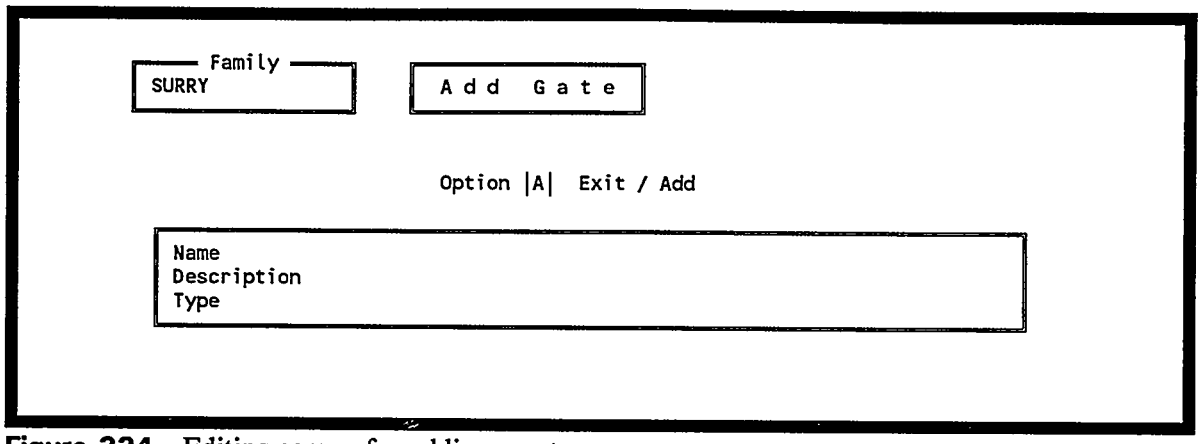


Figure 224. Editing screen for adding a gate.

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

10.9.3 Modify

This option allows you to modify a gate record. To invoke this option, type <M> in the option field, highlight a gate name, and press <Enter>. The Modify Gate screen is shown in Figure 225. The options at this point are Exit and Modify.

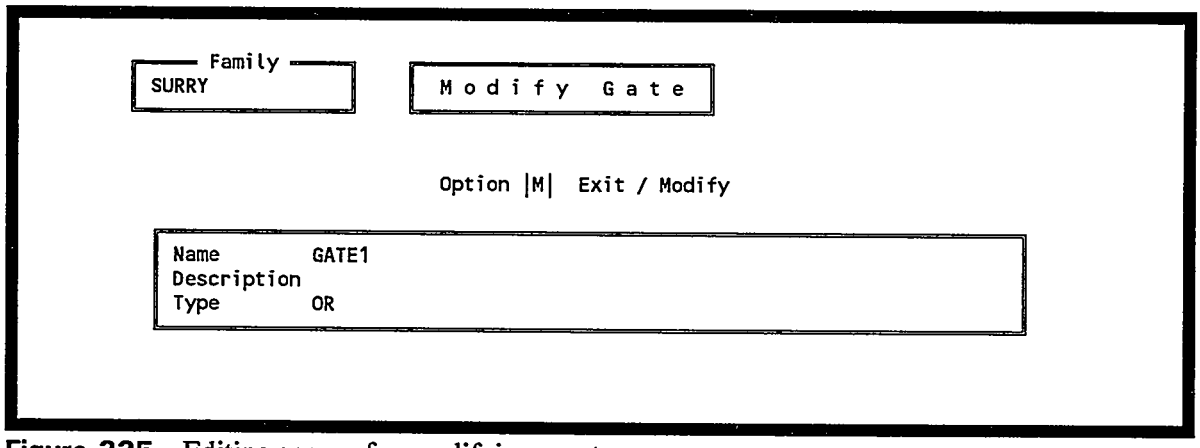


Figure 225. Editing screen for modifying a gate.

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

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

10.9.4 Delete

This option allows you to delete a gate record from the current family. To invoke this option, type <D> in the option field, highlight the gate to be deleted, and press <Enter>. The Delete Gate screen is shown in Figure 226. The options at this point are Exit and Delete.

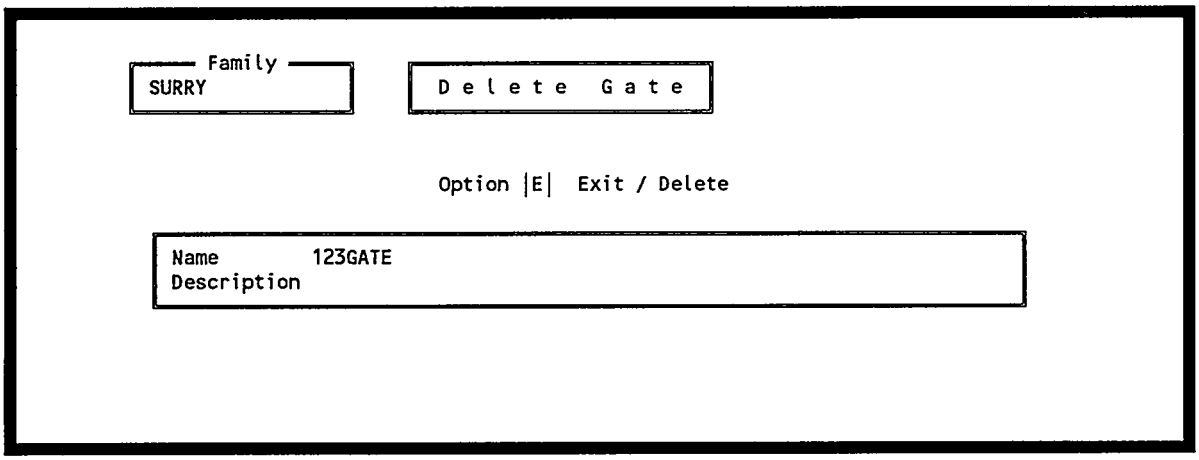


Figure 226. Editing screen for deleting a gate.

If you marked gates to be deleted using the <F2>, <F3>, or <F4> keys, the warning message shown in Figure 227 will be displayed. To continue with the deletion, enter a Y and press <Enter>; otherwise, enter an N. If you respond Y, the gate records will be deleted immediately.

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

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

10.9.5 Remove Unused Gates

This option allows you to delete all unused gates. To invoke this option, type an <R> and press <Enter>. Figure 228 appears. On this screen, a warning message is displayed telling you that all the unused gates for the selected event will be deleted. At this point, press <Y> and <Enter> to continue with the deletion; otherwise enter an <N> and pres <Enter> to terminate the process.

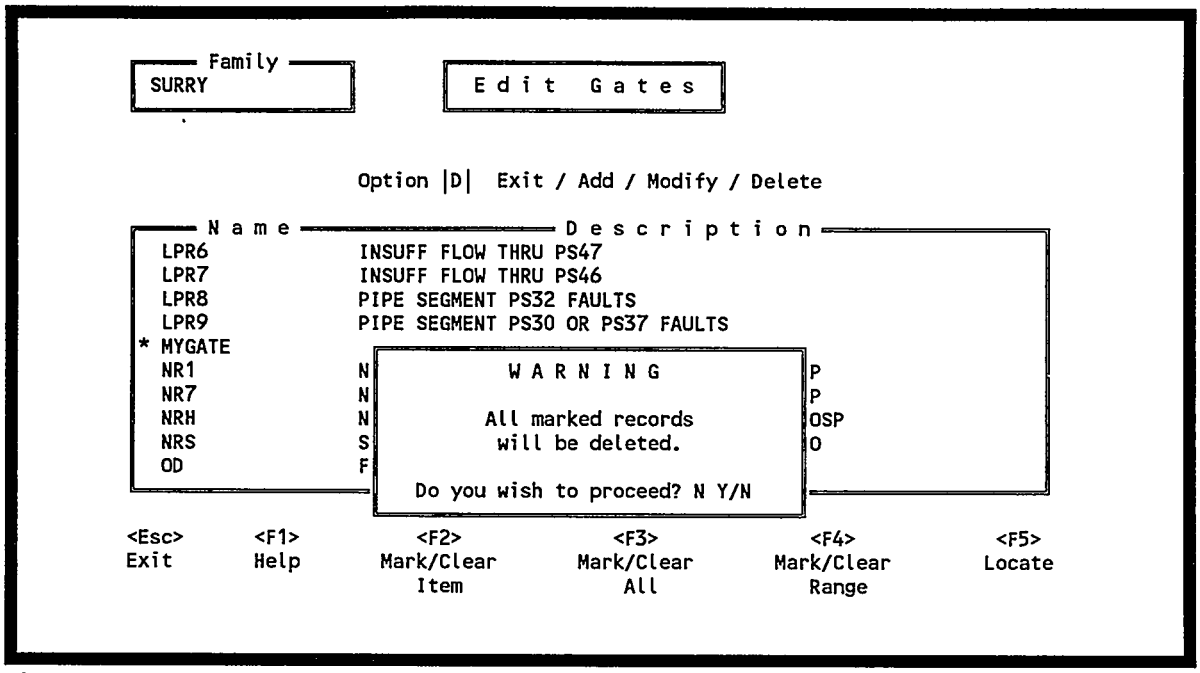


Figure 227. Warning message to delete marked gates.

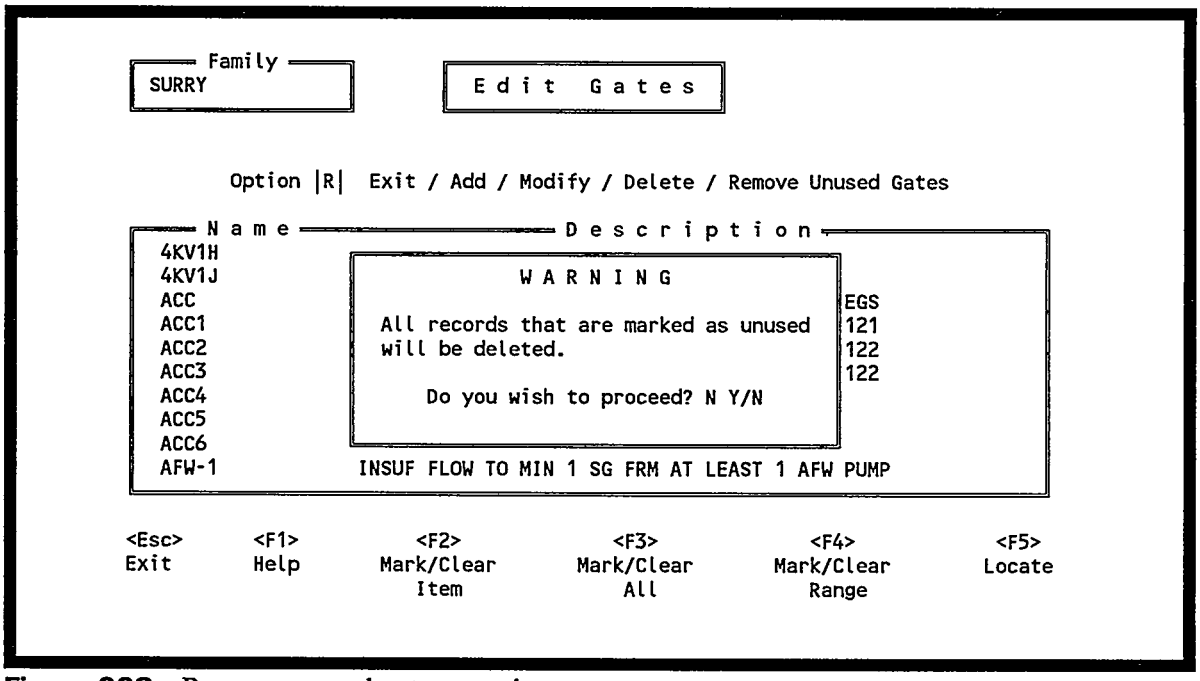


Figure 228. Remove unused gates warning message.

10.10 Histograms

This option allows you to create, modify, and delete user-defined histograms. This is a useful option for allowing you to input your own distribution for a variable that cannot be expressed with one of the predefined distribution types. The Edit Histograms screen (Figure 229) displays the names of all the currently existing histograms with their associated format type. As shown, four options are available: Exit, Add, Modify, and Delete.

To invoke this option, type an <H> (Histograms) in the option field or highlight Histograms and press <Enter>. Figure 229 will be displayed.

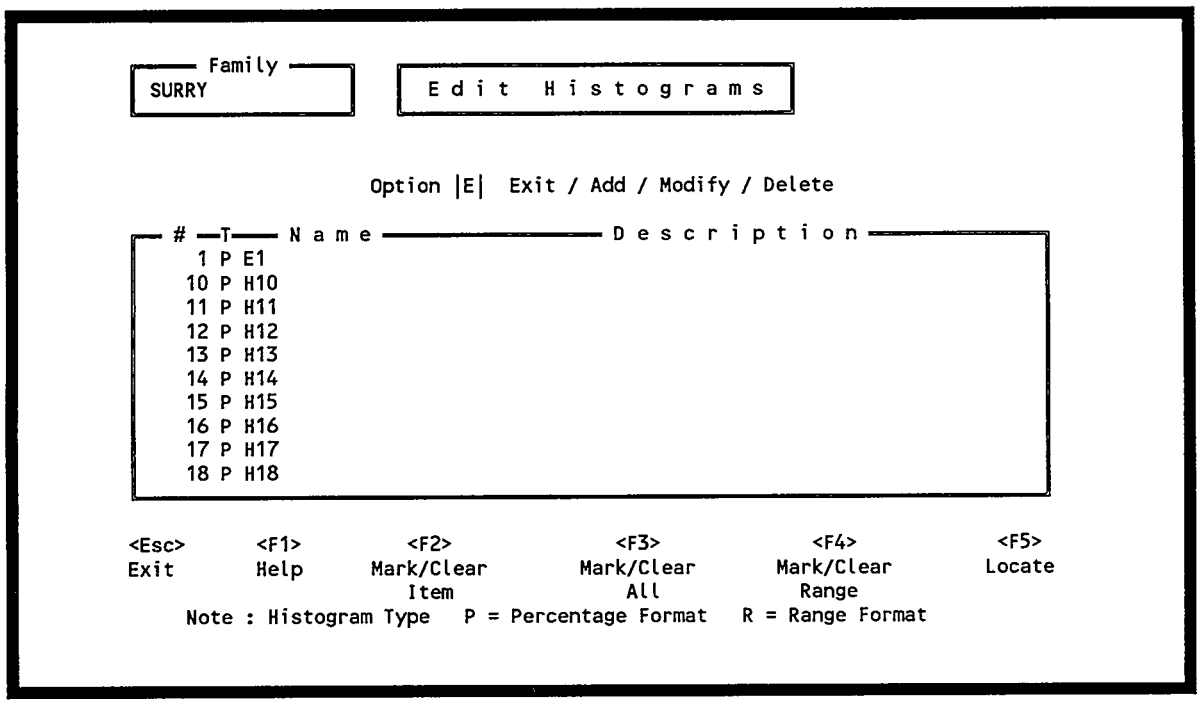


Figure 229. Edit histograms menu.

10.10.1 Exit

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

10.10.2 Add Histograms

This option allows you to create a user-defined distribution type. To add a new histogram to the database, type an <A> (Add) in the option field and press <Enter>. At this point, Figure 230 is displayed and you are given the choice of adding the histogram data in either a percentage, range, area, or hazard format.

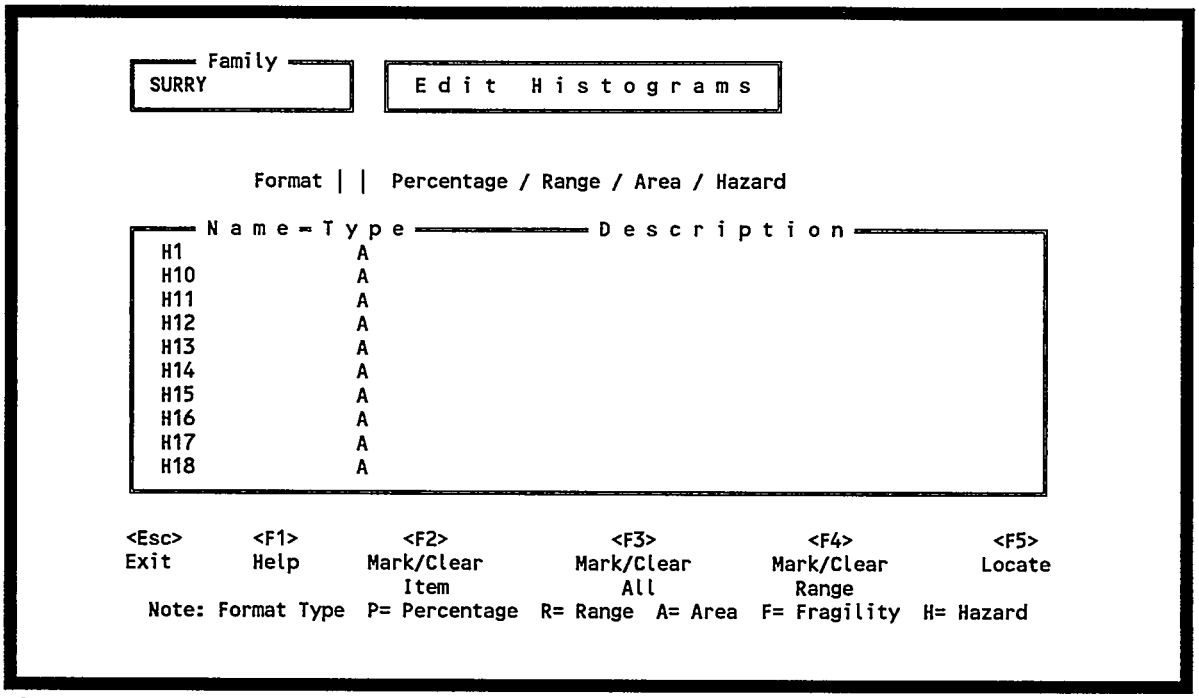


Figure 230. Select type of histogram to add.

10.10.2.1 Percentage Histogram. If you wish to add a percentage histogram to the database, enter a <P> (Percentage) in the option field. Entering a <P> in the option field will cause a Percentage Format Histogram screen to appear. From this screen you should type in a name and a description for the new histogram. Enter the percentages for the histogram along with the corresponding probabilities. Figure 231 demonstrates how to enter a percentage histogram, given that 15% of the data points have a probability of 0.04, 46% of the data points have a probability of 0.12, 36% of the data points have a probability of 0.02, and the remaining 3% of the data points have a probability of 0.8. The sum of the percentages entered must total 100%, in order for the histogram to be accepted as a valid percentage histogram (Figure 232). In the upper right-hand area of the screen is a box that shows the current sum of the percentages that have been input and the remaining percentage needed to reach the 100% total. **NOTE: This format is a discrete distribution on the values entered. The percents give the degree of belief of each value.**

10.10.2.2 Range Histogram. Another way to input a histogram is to use the range format. To add a range histogram to the database, enter an <R> (Range) in the option field of the Add Histogram screen. This action will bring up a Range Format Histogram screen (Figure 233). On this screen, type in a name and description for the range histogram. Then, enter the starting probability point, the ending probability point, and the height associated with the first bin of the histogram. Next, for each successive bin of the histogram, an ending probability point and a height should be entered. There is a maximum of 20 bins allowed for each range histogram. Figure 233 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).

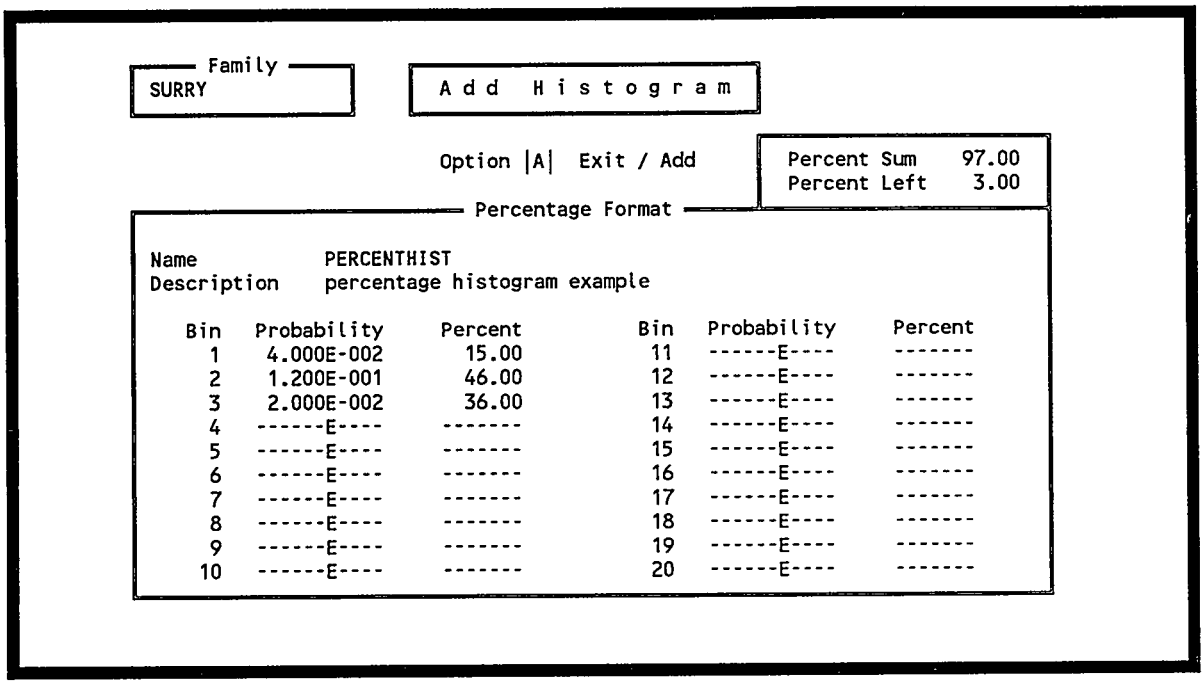


Figure 231. Adding a percentage histogram.

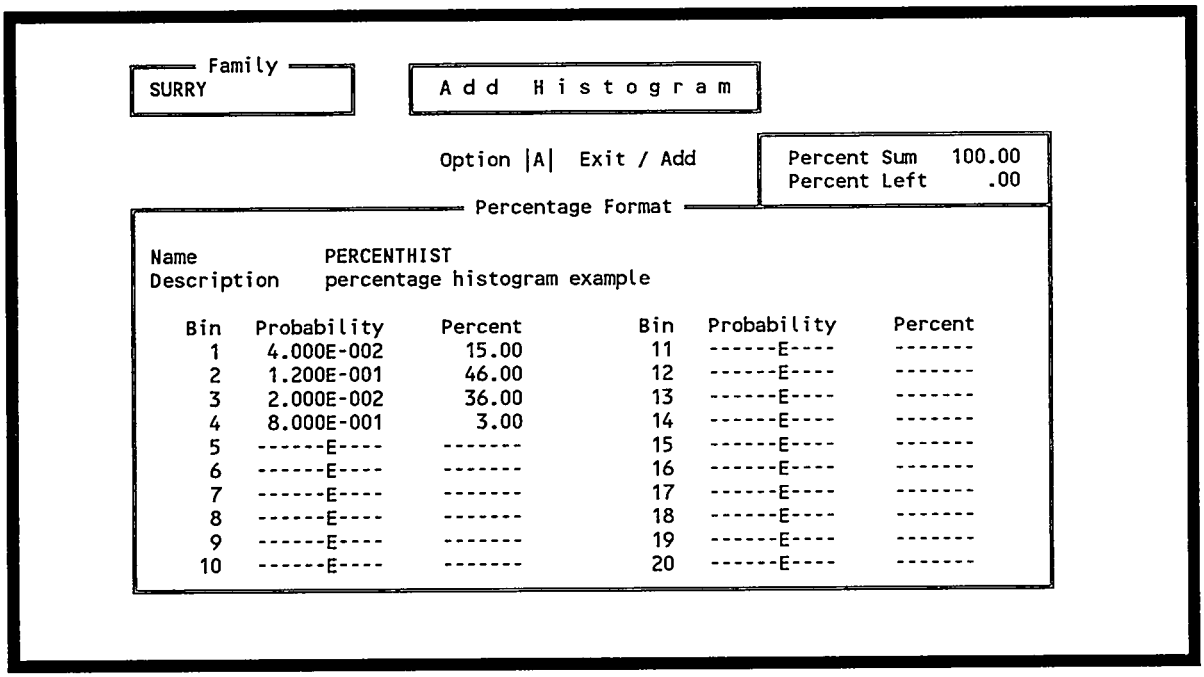


Figure 232. Add the remaining percent to create a valid histogram.

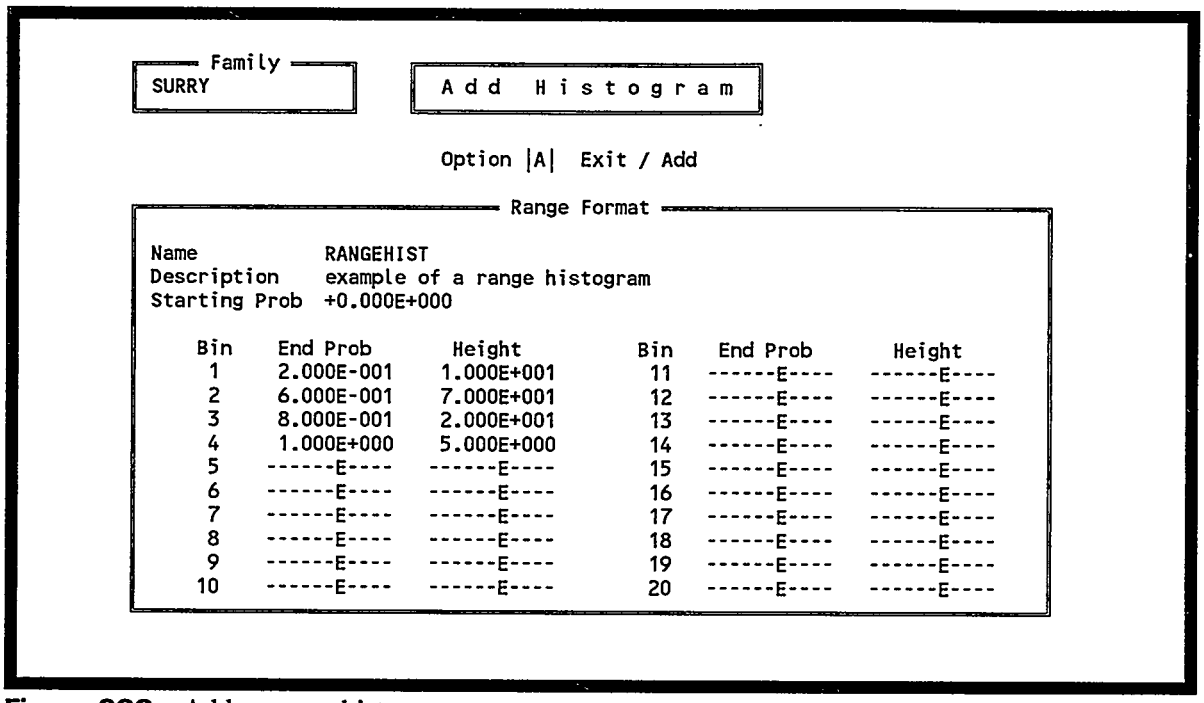


Figure 233. Add a range histogram.

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

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

10.10.2.3 Area Histogram. Another way to input a histogram is to use the area format. To add an area histogram to the database, enter an <A> (Area) in the option field of the Add Histogram screen. This action will bring up an Area Format Histogram screen (Figure 234). On this screen, 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. Figure 234 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). The code normalizes the area of each bin so the sum of the areas equals 1.0.

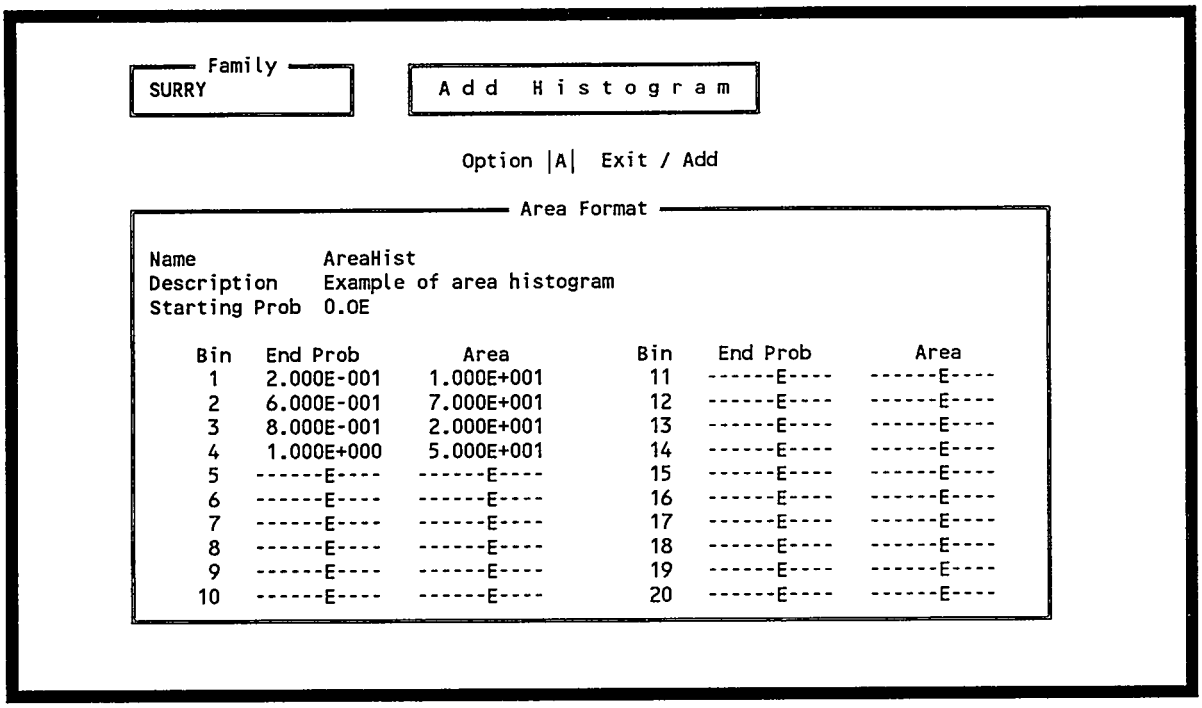


Figure 234. Adding an area histogram.

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

10.10.2.5 Hazard Histogram. The Hazard histogram option is used to enter the site seismic hazard curve data for a family. This data consists of a table of values representing the G-level and associated frequency of occurrence. Note, the hazard histogram consists of discrete values. To add a hazard histogram to the database, enter an <H> (Hazard) in the option field of the Add Histogram screen. This action will bring up an Hazard Format Histogram screen (Figure 235). On this screen, 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 should be entered. There is a maximum of 20 bins allowed for each hazard histogram. Figure 235 is an example of inputting 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.

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

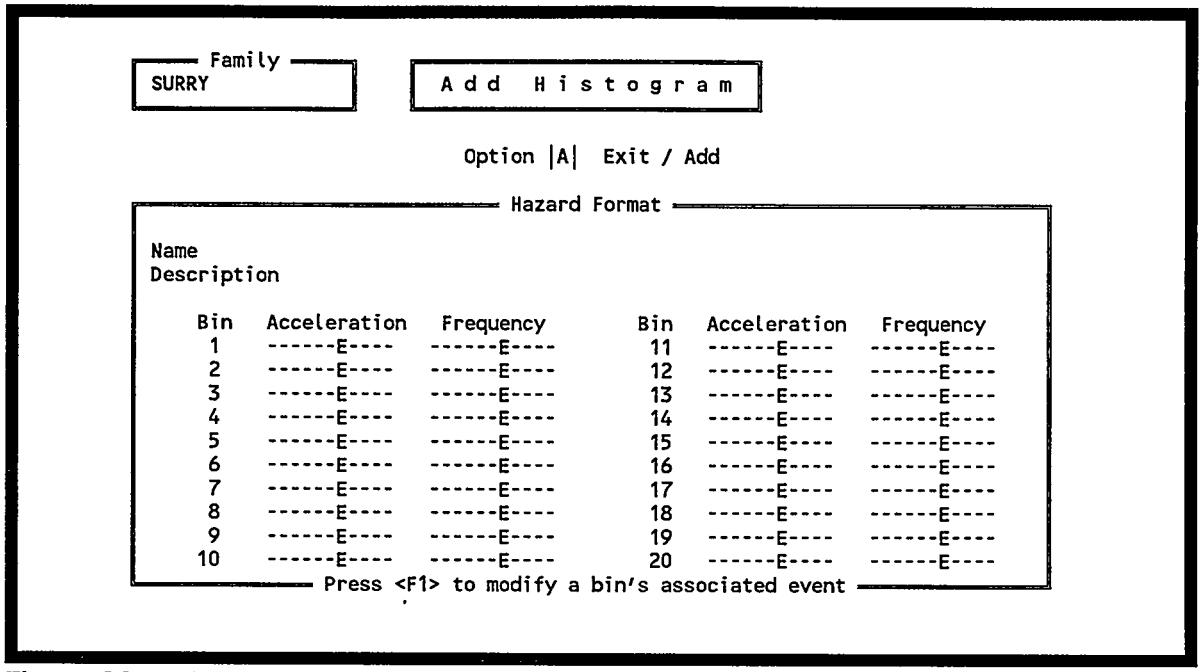


Figure 235. Adding a hazard histogram.

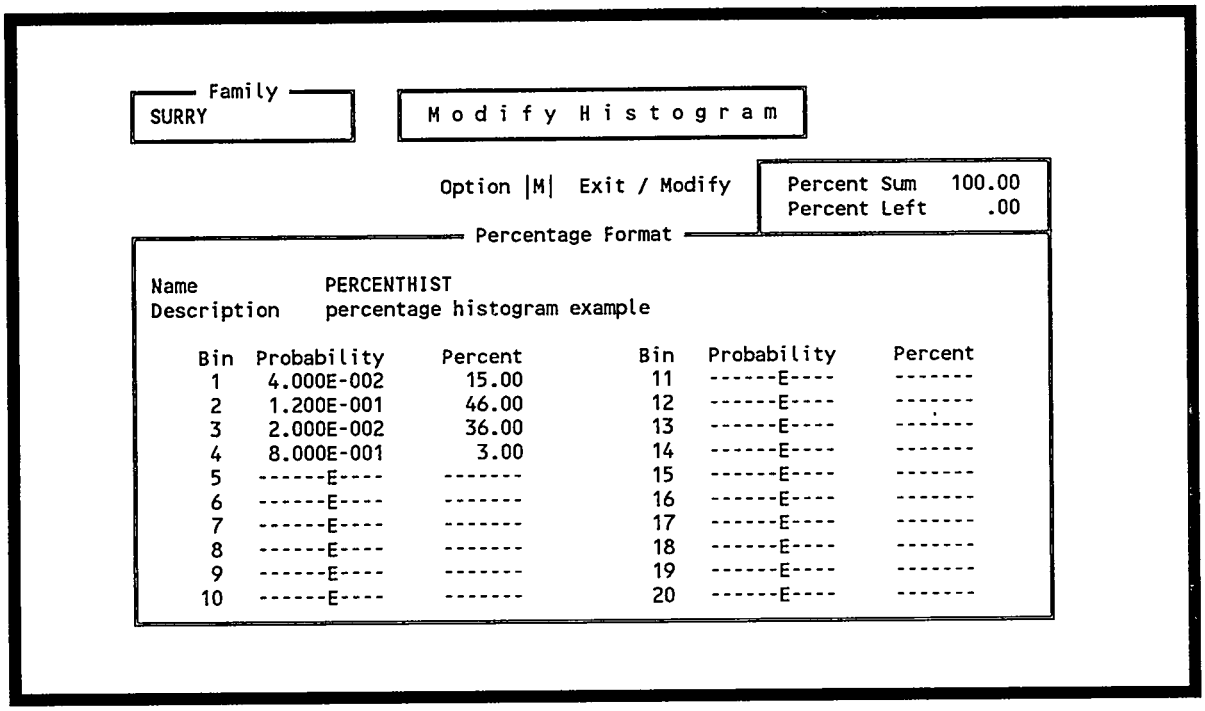
10.10.3 Modify Histograms

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

If you selected to modify a percentage histogram, then the histogram data will be displayed in percentage format. You may make modifications to the histogram's name, description, or any of the probabilities or percentages. The percentages must still total 100% before it will be accepted as a valid percentage histogram. Figure 236 demonstrates the screen for modifying histograms in percentage format.

If you selected to modify a range histogram, then the histogram data will be displayed in range format. You may change the histogram's name, description, and any of the bins' starting points, ending points or probabilities. Figure 237 demonstrates the screen for modifying histograms in range format. The remaining histogram types (area, fragility, and hazard) operate in a similar fashion.

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



Family
SURRY

Modify Histogram

Option |M| Exit / Modify

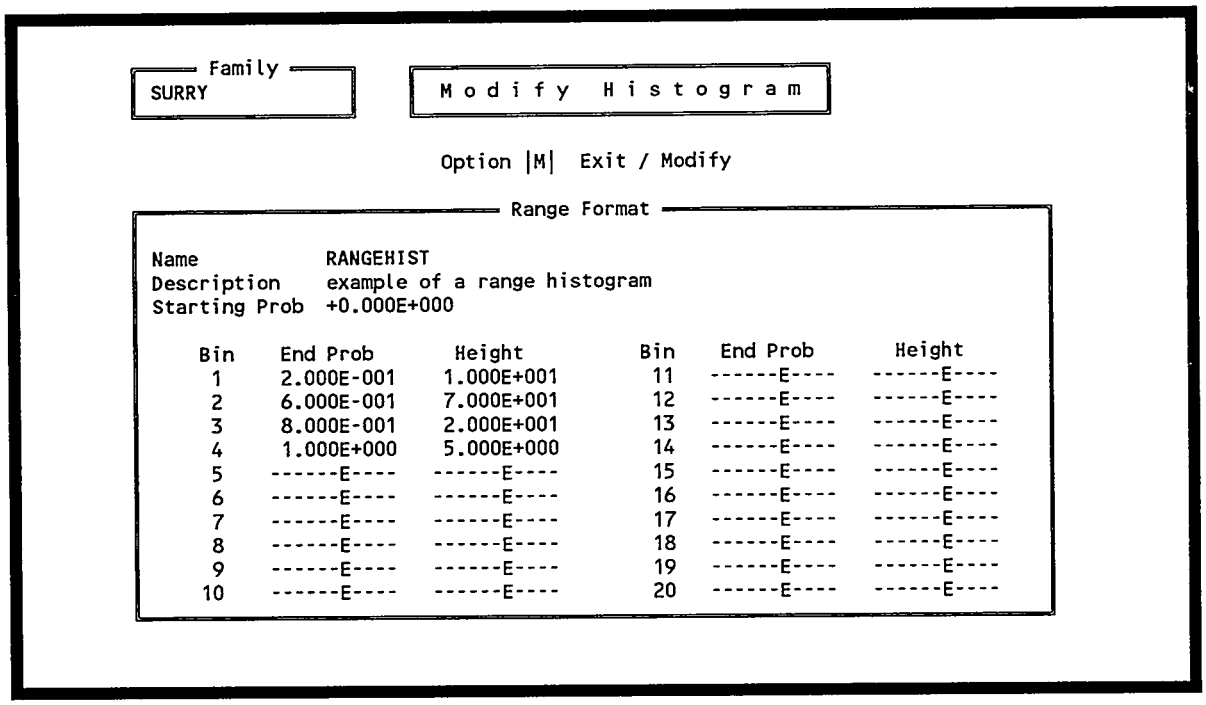
Percent Sum 100.00
Percent Left .00

Percentage Format

Name PERCENTHIST
Description percentage histogram example

Bin	Probability	Percent	Bin	Probability	Percent
1	4.000E-002	15.00	11	------E----	-------
2	1.200E-001	46.00	12	------E----	-------
3	2.000E-002	36.00	13	------E----	-------
4	8.000E-001	3.00	14	------E----	-------
5	------E----	-------	15	------E----	-------
6	------E----	-------	16	------E----	-------
7	------E----	-------	17	------E----	-------
8	------E----	-------	18	------E----	-------
9	------E----	-------	19	------E----	-------
10	------E----	-------	20	------E----	-------

Figure 236. Modify a percentage histogram.



Family
SURRY

Modify Histogram

Option |M| Exit / Modify

Range Format

Name RANGEHIST
Description example of a range histogram
Starting Prob +0.000E+000

Bin	End Prob	Height	Bin	End Prob	Height
1	2.000E-001	1.000E+001	11	------E----	------E----
2	6.000E-001	7.000E+001	12	------E----	------E----
3	8.000E-001	2.000E+001	13	------E----	------E----
4	1.000E+000	5.000E+000	14	------E----	------E----
5	------E----	------E----	15	------E----	------E----
6	------E----	------E----	16	------E----	------E----
7	------E----	------E----	17	------E----	------E----
8	------E----	------E----	18	------E----	------E----
9	------E----	------E----	19	------E----	------E----
10	------E----	------E----	20	------E----	------E----

Figure 237. Modify a range histogram.

10.10.4 Delete Histograms

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

This action will result in displaying the selected histogram in the appropriate format on the Delete Histograms screen. To delete the histogram, type a <D> (Delete) in the option field and press <Enter>. When complete, you will be returned to the Edit Histograms screen with the message **Record Deleted** displayed at the bottom of the screen. To exit the Delete Histograms screen without deleting the histogram being displayed, press the <Esc> key or enter an <E> (Exit) in the option field and press <Enter>. Figure 238 shows an example of the Delete Histograms screen for percentage histograms.

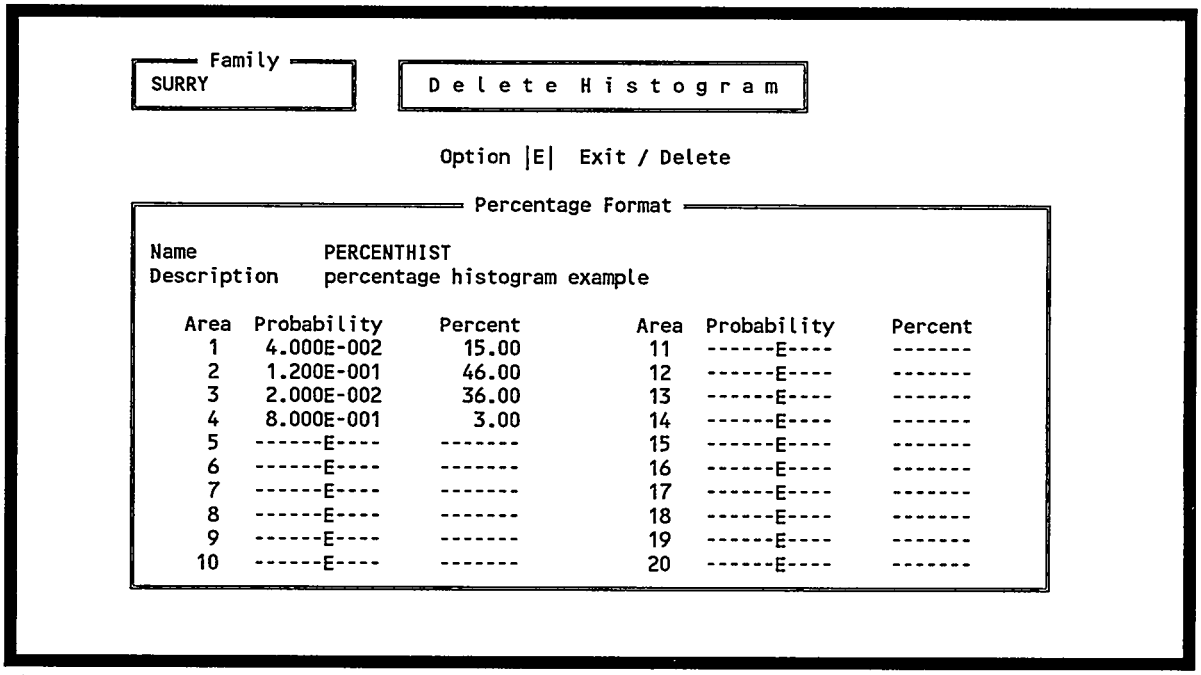


Figure 238. Delete a percentage histogram.

10.11 P&IDs

This option allows you to edit P&ID graphic records. To invoke this option, type <P> in the option field or highlight P&ID and press <Enter>. A screen similar to the one shown in Figure 239 will be displayed. The options available are: Exit, Add, Modify, and Delete.

10.11.1 Exit

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

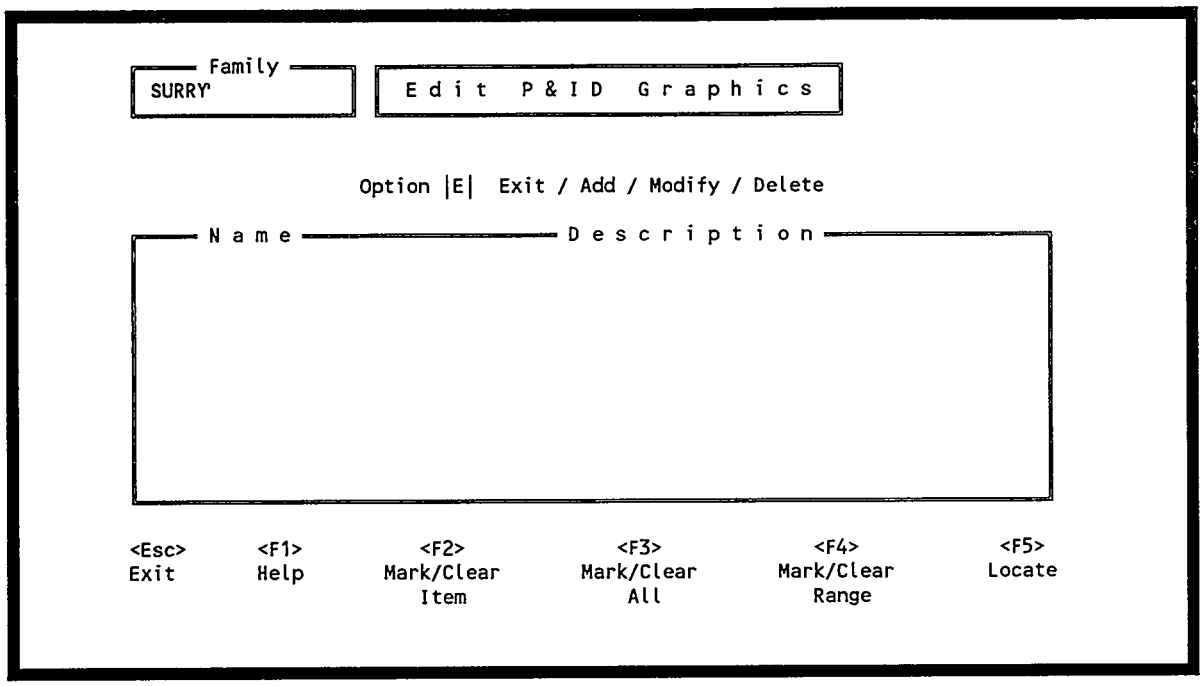


Figure 239. Selection of graphics picture for editing.

10.11.2 Add

This option allows you to add a graphics picture record to the database. To invoke this option, type <A> in the option field and press <Enter>. The Add Graphic Picture screen is shown in Figure 240. The options at this point are Exit and Add.

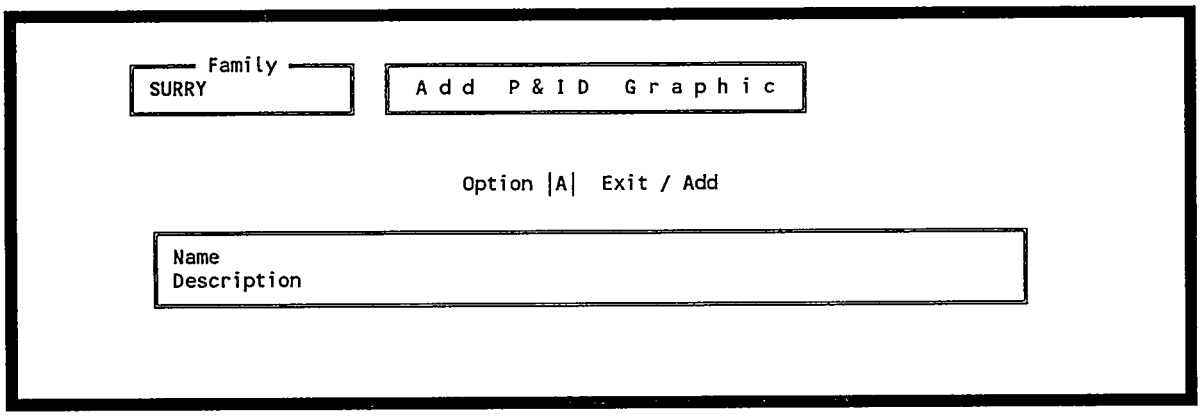


Figure 240. Add a P&ID graphic.

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

10.11.2.2 Add. This option performs the actual add of a new graphics picture record. Fill in the requested data fields and press <Enter> (Add is the default option). The only required information for a graphic add is the name. When complete, you will be returned to the Edit Graphics screen with the message **Record added** displayed at the bottom of the screen.

10.11.3 Modify

This option allows you to modify a graphics picture record. To invoke this option, type <M> in the option field, highlight a graphics picture name, and press <Enter>. The Modify P&ID Graphic screen is shown in Figure 241. The options at this point are Exit and Modify.

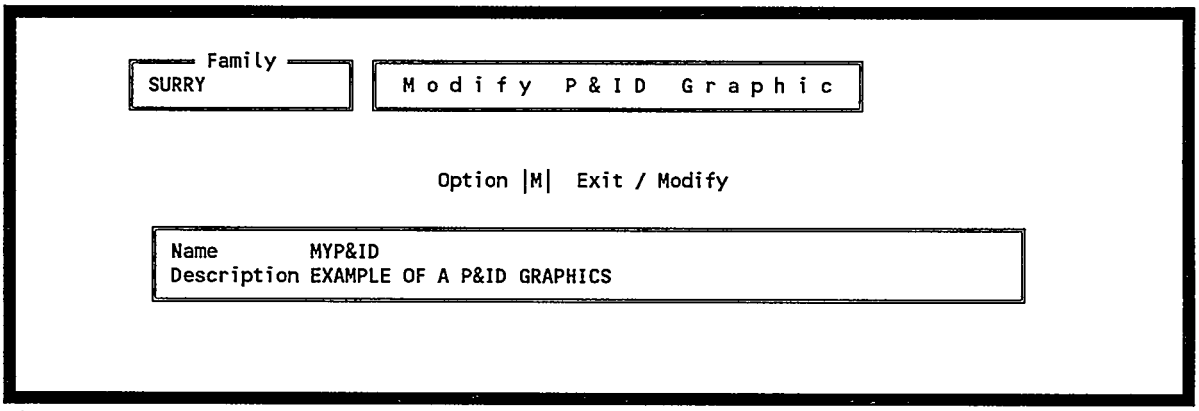


Figure 241. Modify P&ID graphic.

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

10.11.3.2 Modify. This option performs the actual modification of the graphics picture record. Modify any of the data fields on the screen and press <Enter> (Modify is the default option). When complete, you will be returned to the Edit P&ID Graphics screen with the message **Record modified** displayed at the bottom of the screen.

10.11.4 Delete

This option allows you to delete a graphics picture from the database. To invoke this option, type <D> in the option field, highlight a graphics picture and press <Enter>. The Delete Graphic Picture screen is shown in Figure 242. The options at this point are Exit and Delete.

If you marked P&IDs to delete using the <F2>, <F3>, and <F4> keys, the warning screen shown in Figure 243 will be displayed. To continue with the deletion process, enter a <Y> and press <Enter>; otherwise, enter an N. If you respond with a <Y>, the records will be deleted immediately.

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

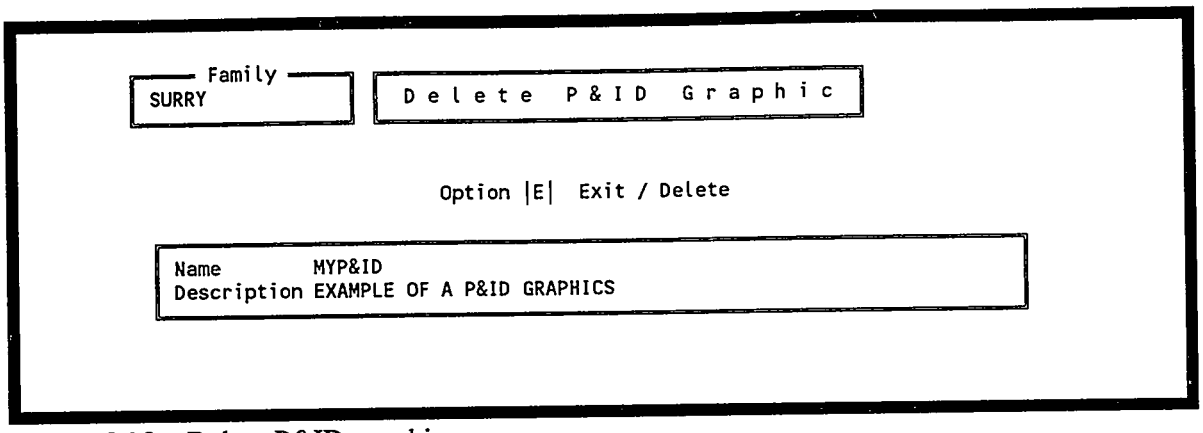


Figure 242. Delete P&ID graphic.

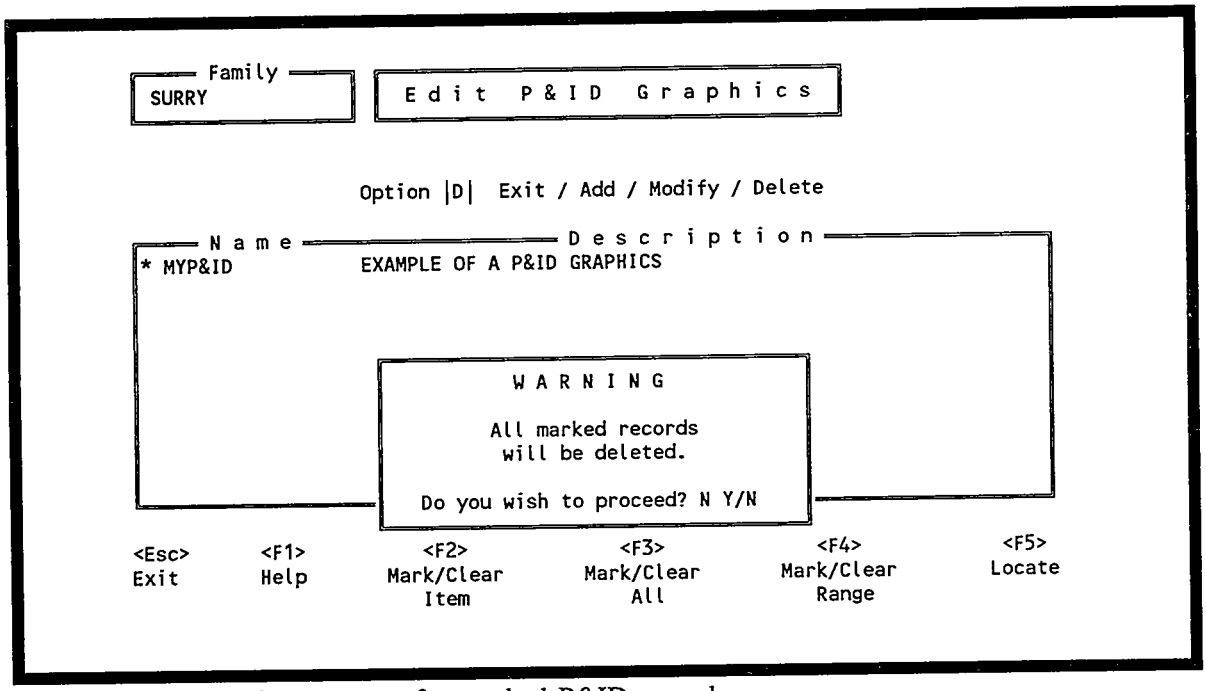


Figure 243. Warning message for marked P&ID records.

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

11. REPORT ON DATA BASE

This option allows you to obtain information about the selected family. Reports are available for family, basic events, attributes, systems, event trees, sequences, end states, gates, histograms, and user information. To invoke this option, type an <R> or highlight REPORTS on the IRRAS main menu and press <Enter>. The REPORTS main menu is shown in Figure 244. Each report is discussed in the following paragraphs.

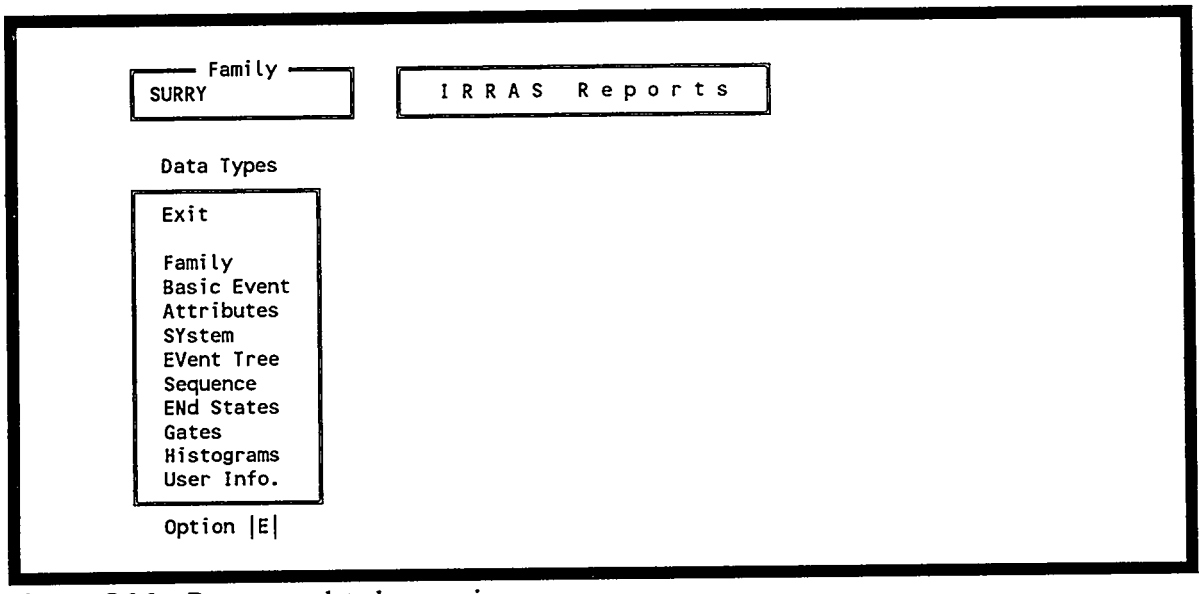


Figure 244. Report on data base main menu.

The following special function keys are available:

Esc	Escape exits the Family Reports option and returns you to the IRRAS Reports menu.
<F1>	Help briefly explains the function of a field and may show examples of data entered.
<F2>	Mark Family tags items for use in the selected option.
<F3>	Mark All removes the mark (*) from the listed items. If no items are marked, this option will mark all of the items.
<F4>	Mark Range quickly tags large numbers of items for processing.
<F5>	Locate will display a blank field in the center of the screen, and a message **Please enter the name to locate** will appear. The user should enter the name to be located and then press <Enter>. This feature will place the highlight on the located name. If the required name is not found, then the next name in alphabetical order will be highlighted.

These function keys are available in all report options.

11.1 Exit

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

11.2 Family

This option generates a family summary report listing all the families and associated descriptions contained in the current database or a report containing any descriptive text associated with the family. When you invoke this option, Figure 245 will be displayed. As shown, three options are available: Summary, Text, and StAtistics. When you invoke the family report option by pressing <Enter>, Figure 246 will be displayed. This screen lists all the families currently contained in the database.

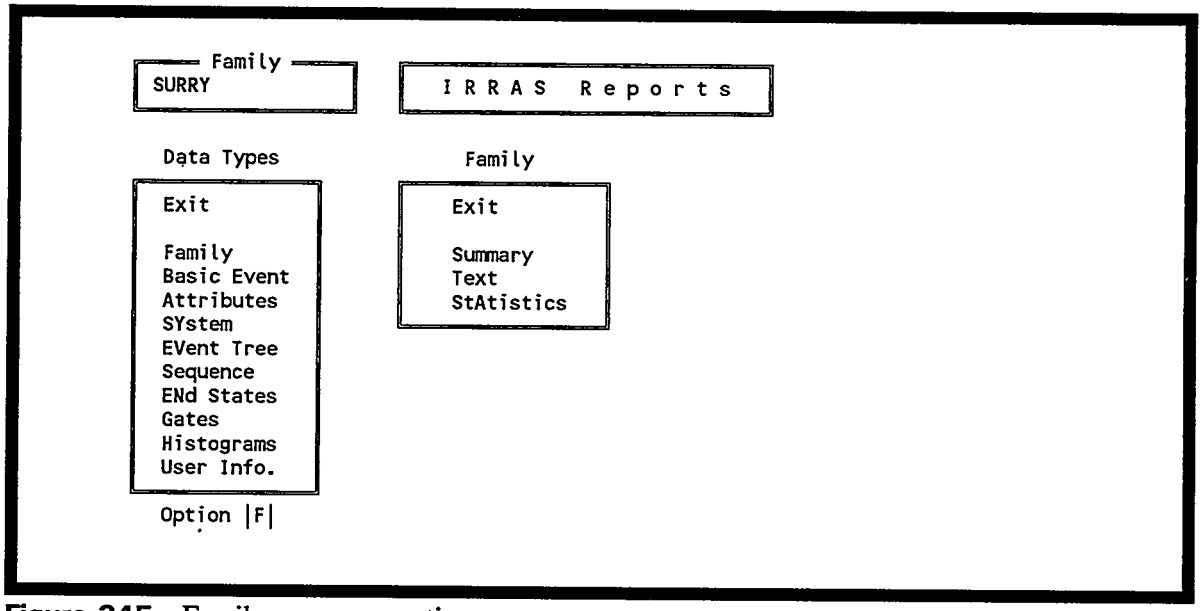


Figure 245. Family summary option.

11.2.1 Exit

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

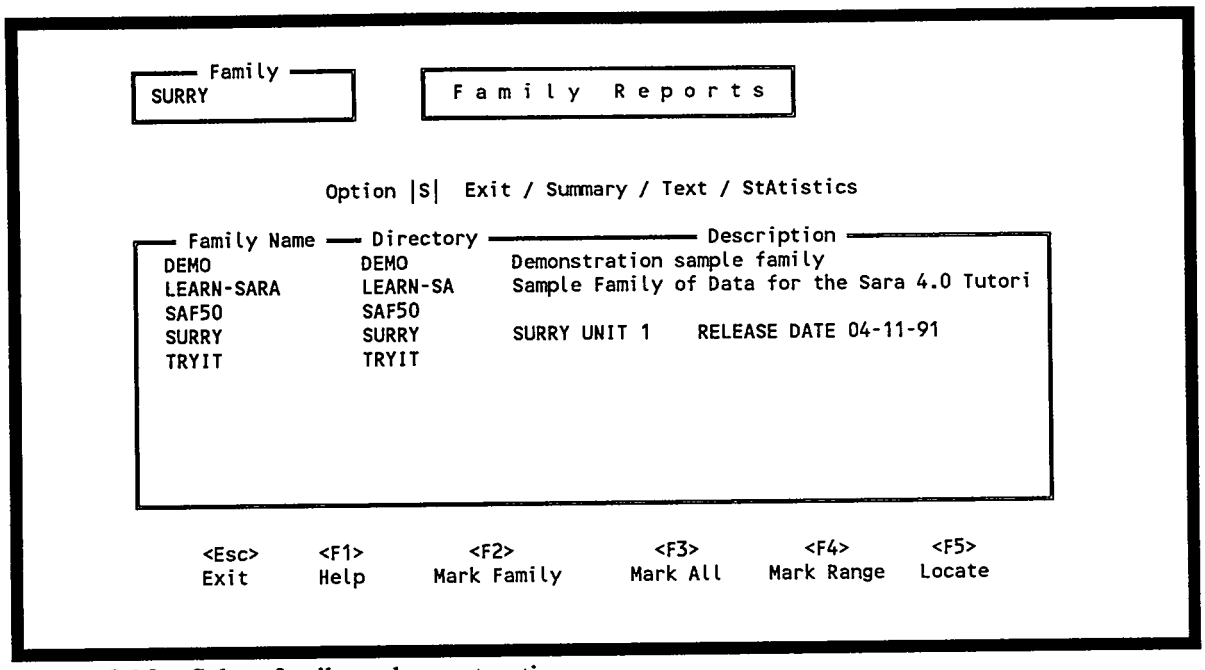


Figure 246. Select family and report option menu.

11.2.2 Summary

This option generates a summary report listing the family name and associated description for the selected family(s). When you invoke this option, Figure 247 will be displayed. On this screen you must specify the output destination for the report. The following output destinations are provided:

CON	-	The report will be sent to the screen.
PRN	-	The report will be sent to the printer.
blank	-	The option will be terminated and you will be returned to the Reports Main Menu without generating the report.
<Esc>	-	The option will be terminated and you will be returned to the main menu (same as blank).
other	-	The report will be copied to the specified file name.

NOTE: **These output options are available throughout the Report module.**

11.2.3 Text

This option allows you to view the descriptive text associated with a specific family. To invoke this option, enter a <T> in the option field, highlight or mark a family(s), and press <Enter>. The output destination screen will appear. Select the desired destination and press <Enter>. The report contains all descriptive text associated with the selected family.

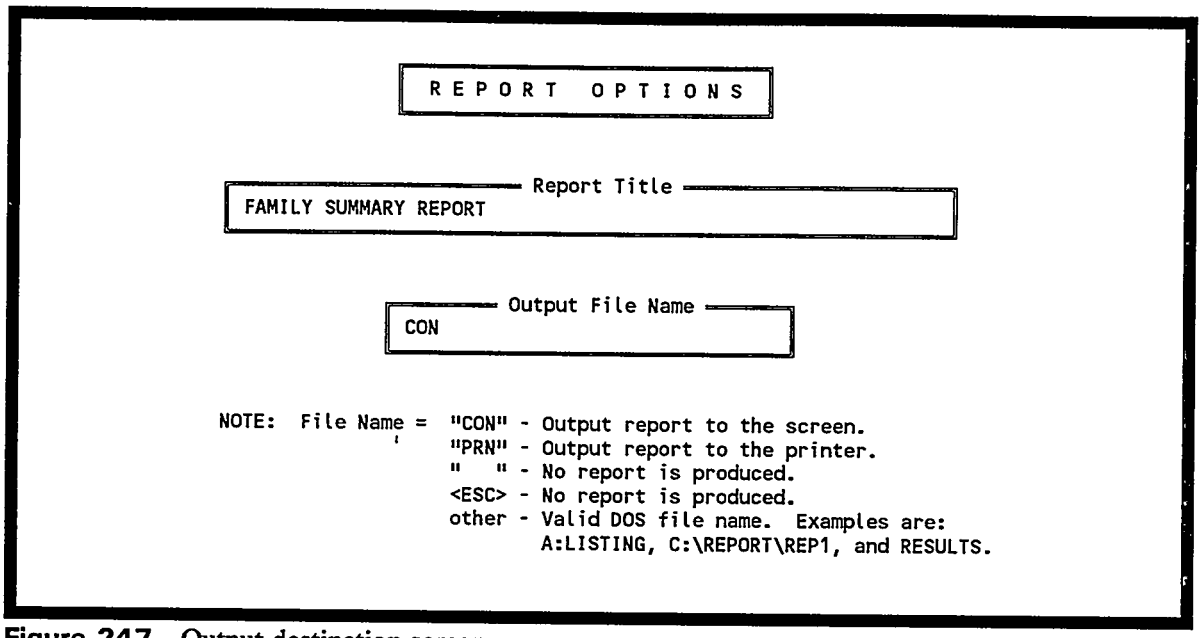


Figure 247. Output destination screen.

11.2.4 StAtistics

This option allows you to view or print the Family Statistics Report. 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 selected family. To invoke this option, enter an <A> in the option field, highlight or mark a family(s), and press <Enter>. The output destination screen will appear. Select the desired destination and press <Enter>. The report will be generated and displayed or printed.

11.3 Basic Event

The basic event report option allows you to generate an overview, probabilities, uncertainty data, seismic data, transformation data, and cross reference reports (Figure 248). On this screen, highlight the basic event report you want to generate and press <Enter>.

11.3.1 Basic Event Overview

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. To invoke this option, highlight Overview and press <Enter>. Figure 249 will be displayed. Two options are available: Exit and Overview. Exit terminates the process and returns you to the previous menu. Overview generates the report based on your event selections. On this screen, you must do one of the following:

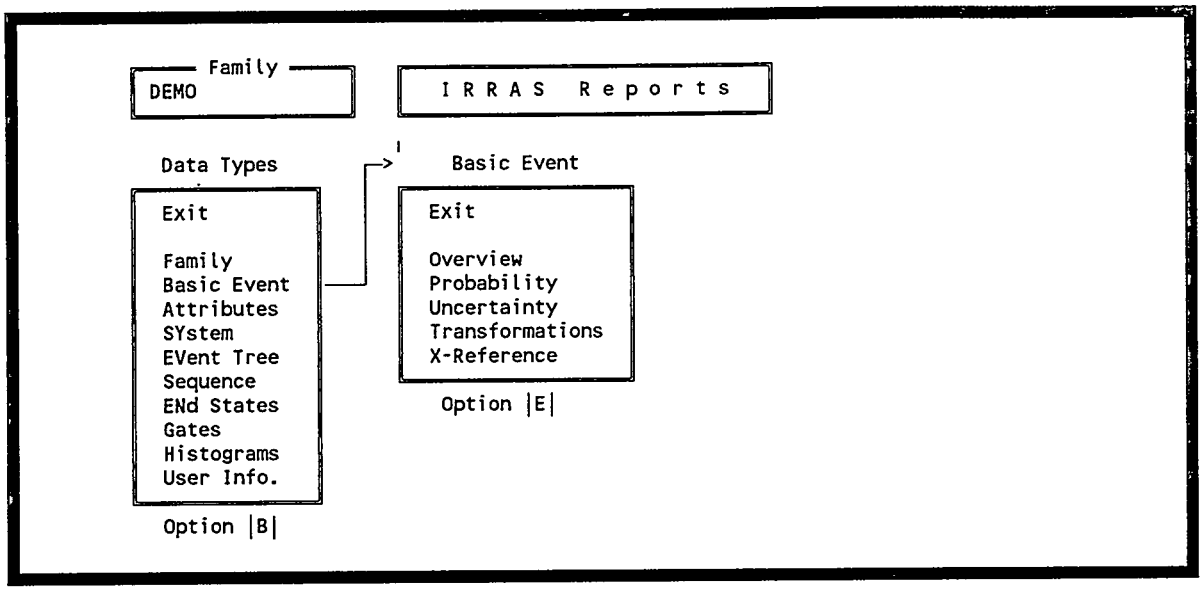


Figure 248. Basic event selection screen.

1) Position cursor in the option field and press <Enter> to report all basic events.
2) Highlight a basic event and press <Enter>.
3) Mark a group of basic events and press <Enter>.

NOTE: For most report options, you must perform the selection process described above.

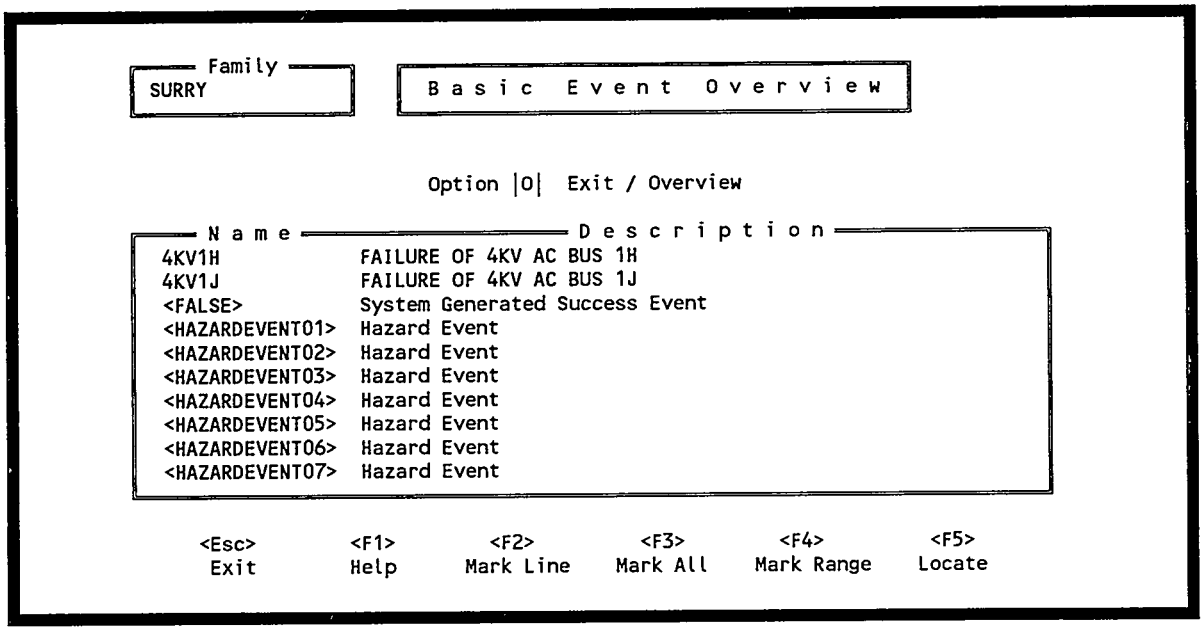


Figure 249. Basic event overview screen.

After a basic event(s) has been selected, the output destination screen will be displayed. Indicate the desired destination and press <Enter>.

11.3.2 Basic Event Probability Report

This option generates 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. To invoke this option, highlight Probability and press <Enter>. Figure 250 will be displayed. Four options are available: Exit, Probability, Description, and Toggle Alternate Case. Exit terminates the process and returns you to the previous menu. Probability generates the report based on the event selections. Select the events as described in Section 11.3.1.

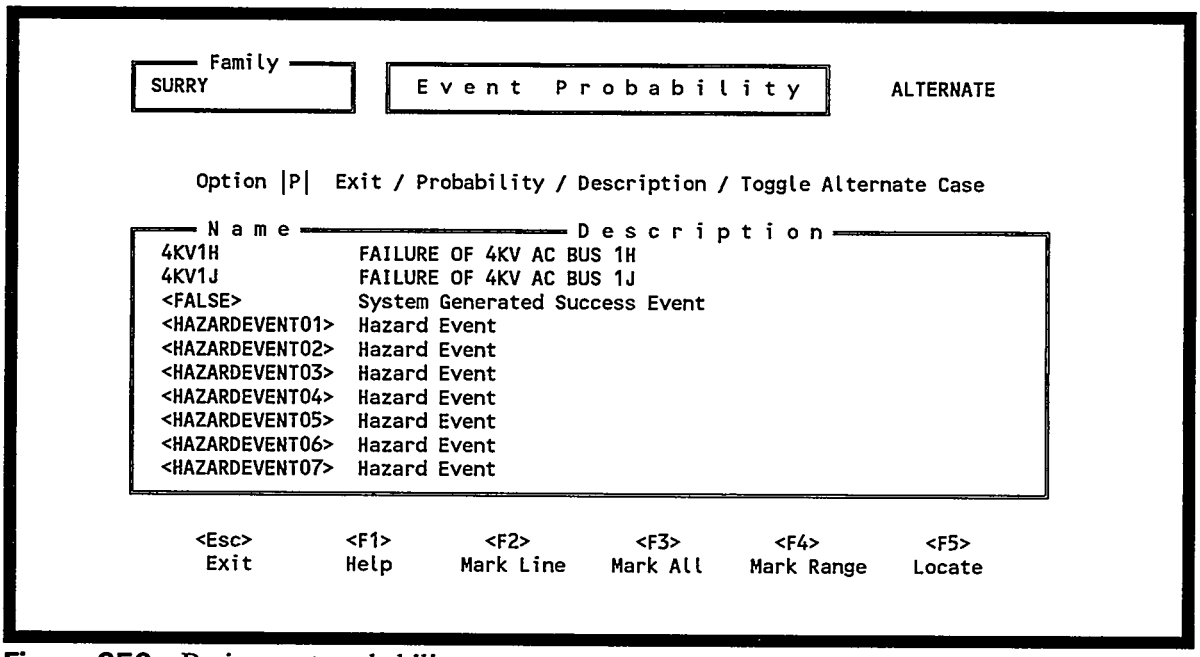


Figure 250. Basic event probability screen.

After a basic event(s) has been selected, the output destination screen will be displayed. Type in the desired destination and press <Enter>. This report shows the event number, primary name, calculation type, mean probability, and lambda and tau values. The Description report generates a similar report, but also includes the description for each event selected.

Toggle alternate case allows you to toggle from the alternate to base case values. Depending upon the current setting, the alternate or base case values will be used for all calculations. To invoke this option, type a <T> in the option field and press <Enter>. The case will change from ALTERNATE to BASE (or vice versa), which is shown in the upper right corner of the screen.

11.3.3 Basic Event Uncertainty Report

This option generates a basic event uncertainty report. The report shows the event number, primary name, distribution type, mean probability, uncertainty value, and correlation class. To invoke this option, highlight Uncertainty and press <Enter>. Three options are available: Exit, Uncertainty, and Toggle Alternate Case (see Figure 251). Exit terminates the process and returns you to the previous menu. Uncertainty generates the report based on your event selections. Select the events as described in Section 11.3.1. Toggle alternate case allows you to toggle from the alternate to base case values. Depending upon the current setting, the alternate or base case values will be used for all calculations. To invoke this option, type a <T> in the option field and press <Enter>. The case will change from ALTERNATE to BASE (or vice versa), which is shown in the upper right corner of the screen.

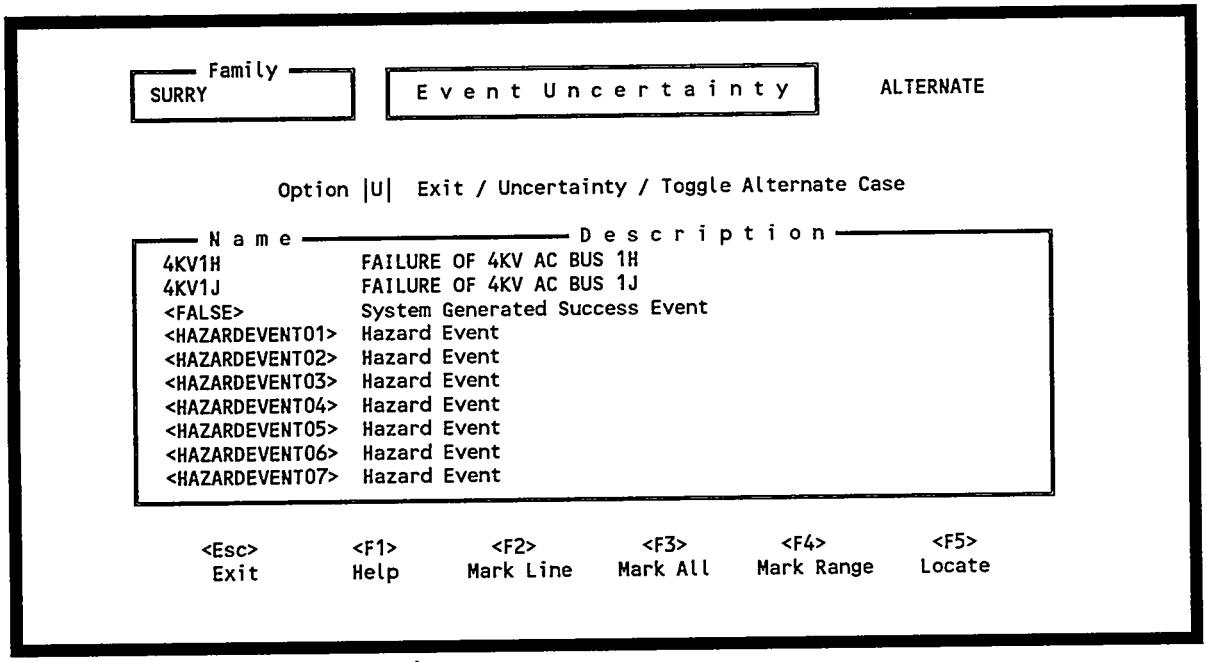


Figure 251. Basic event uncertainty report.

After a basic event(s) has been selected, the output destination screen will be displayed. Select the desired destination and press <Enter>. When the report is complete, you will be returned to the Basic Event Uncertainty screen. At this point, you may select another event or enter an <E> in the option field and press <Enter> to return to the IRRAS Report Menu.

11.3.4 Transformations

This option generates the event transformation reference report. The report shows the event number and name, event type, level, susceptibilities, and any referenced events. To invoke this option, highlight Transformations and press <Enter>. Figure 252 will be displayed. Two options are available: Exit and Transformations. Exits terminates the process and returns you to the previous screen. Transformations generate the report based on your event selections. Select the events as described in Section 11.3.1.

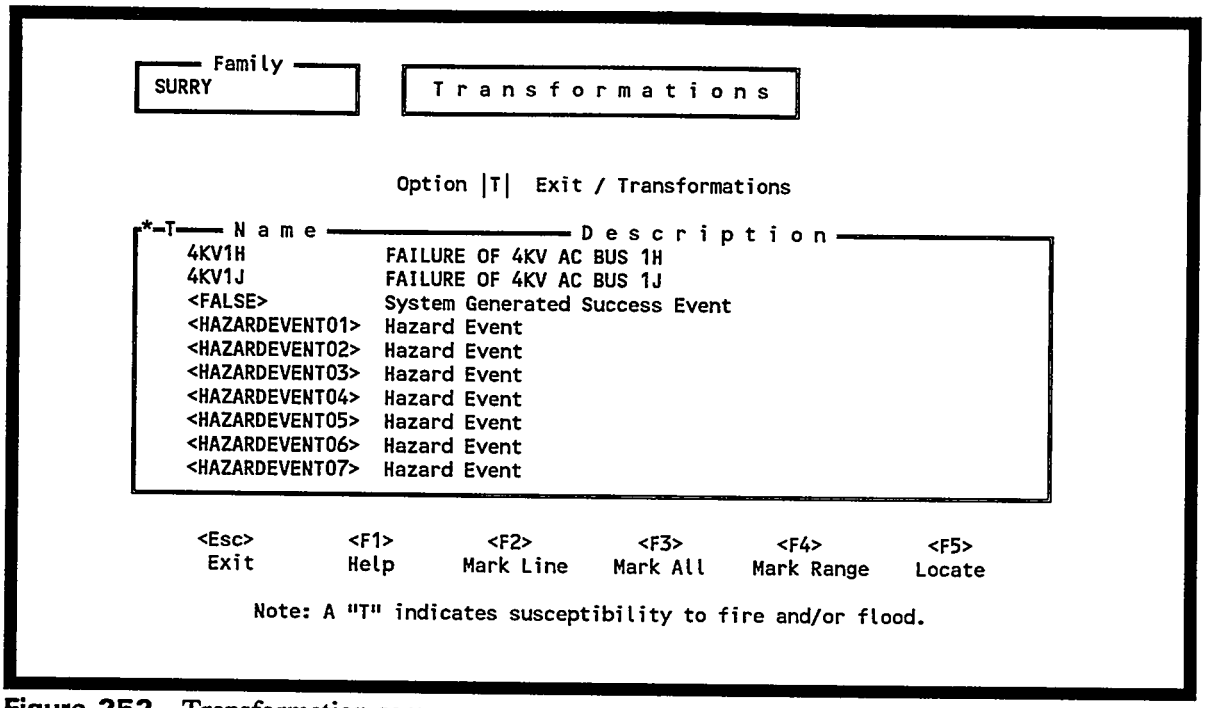


Figure 252. Transformation screen.

If you choose to process all events, a message will be displayed that allows you to report on all events. Enter a <Y> to process all records, or an <N> to terminate.

After a basic event(s) has been selected, the output destination screen will be displayed. Select the desired destination and press <Enter>. When the report is complete, you will be returned to the Transformations screen. At this point, you may select another event or enter an <E> in the option field and press <Enter> to return to the IRRAS Reports Menu.

11.3.5 Basic Event Cross Reference Report

This option generates a basic event cross reference report. To invoke this option, highlight X-Reference and press <Enter>. Figure 253 will be displayed. As shown, there are three cross-reference reports available: Sequence Cut Set, System Cut Set, and System Logic. In addition, you may change the case values from alternate to base and also change the analysis type. Select the events as described in Section 11.3.1.

11.3.5.1 Sequence Cut Set. This option produces an event to sequence cross reference report. The report will include the event number, event name and associated sequence names. To invoke this option, mark the desired event(s), enter an <S> in the option field, and press <Enter>. You may include all sequences by entering an <S> in the option field and pressing <Enter>. The message **Process all records** will be displayed. Enter a <Y> to include all sequences in the report or enter an <N> to terminate the process. In any case, upon pressing <Enter>, the output destination screen will

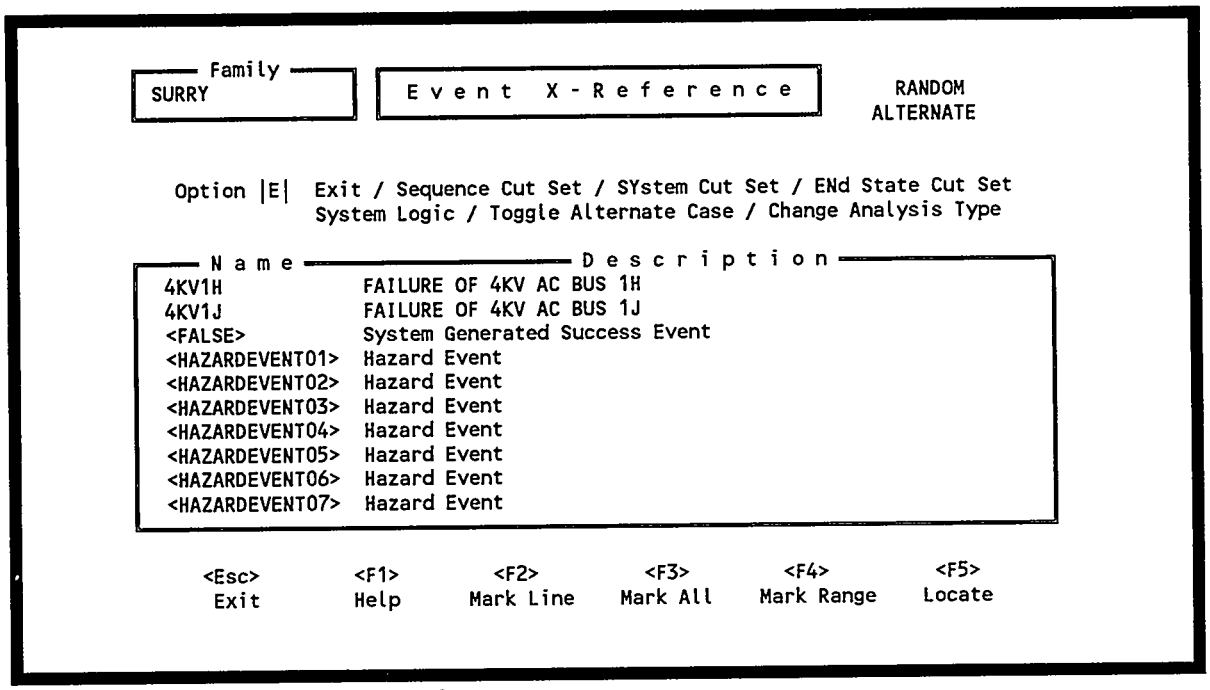


Figure 253. Basic event cross reference screen.

be displayed. Select the desired destination and press <Enter>.

11.3.5.2 System Cut Set. This option produces an event to system cross reference report. The report includes the event number, the event name and the corresponding system name. To invoke this option, mark the desired event(s), enter a <Y> in the option field, and press <Enter>. You may include all systems by entering a <Y> in the option field and pressing <Enter>. The message **Process all records** will be displayed. Enter a <Y> to include all systems in the report or enter an <N> to terminate the process. In any case, upon pressing <Enter>, the output destination screen will be displayed. Select the desired destination and press <Enter>.

11.3.5.3 ENd State Cut Set. This option produces 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). To invoke this option, mark the desired event(s), enter an <N> in the option field, and press <Enter>. You may include all events by entering a <Y> in the option field and pressing <Enter>. The message **Process all records** will be displayed. Enter a <Y> to include all events in the report or enter an <N> to terminate the process. In any case, upon pressing <Enter>, the output destination screen will be displayed. Select the desired destination and press <Enter>.

11.3.5.4 System Logic. This option produces an event to system logic cross reference report. The report includes the event number, the event name and the corresponding system names. To invoke this option, mark the desired event(s), enter an <L> in the option field, and press <Enter>. You may include all system logic by entering an <L> in the option field and pressing <Enter>. The message **Process all records** will be displayed. Enter a <Y> to include all system logic in the report or enter an <N> to terminate the process. In any case, upon pressing <Enter>, Figure 254 will be displayed.

On this screen, you must indicate whether you wish to include the references events or the unused events. Enter an <R> or a <U> and press <Enter>. The output destination screen will be displayed. Select the desired destination and press <Enter>.

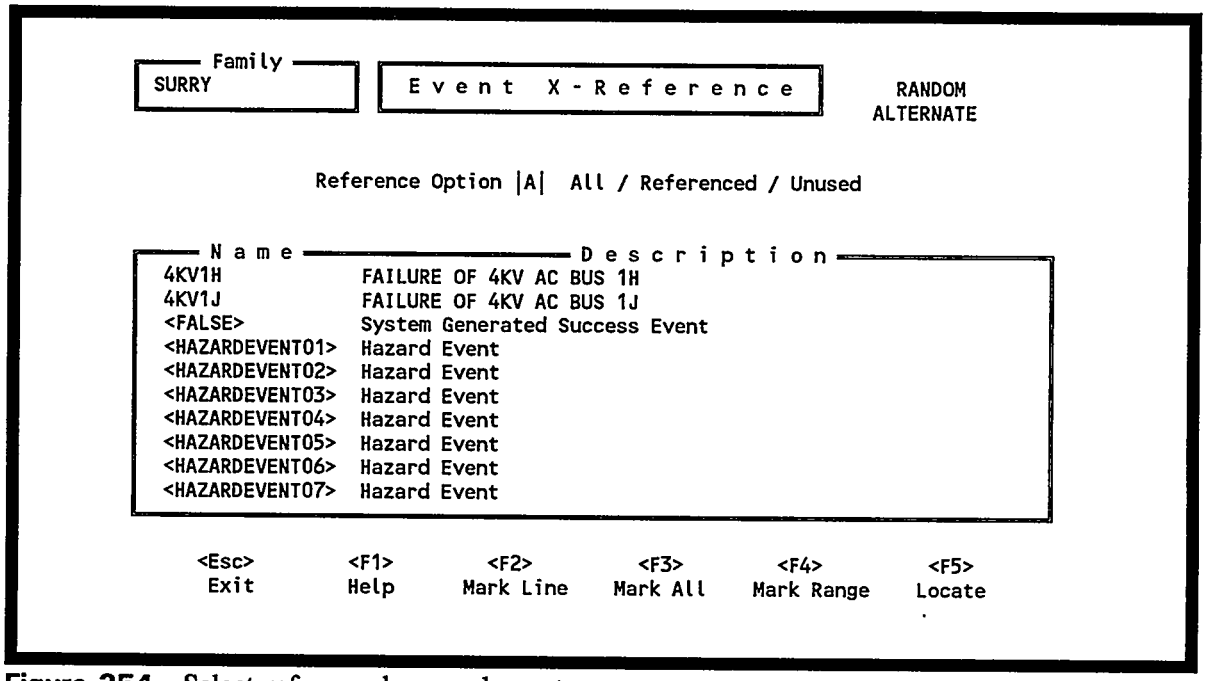


Figure 254. Select referenced or used events.

11.3.5.5 Toggle Alternate Case. Toggle alternate case allows you to toggle from the alternate to base case values. Depending upon the current setting, the alternate or base case values will be used for all calculations. To invoke this option, type a <T> in the option field and press <Enter>. The case will change from ALTERNATE to BASE (or vice versa), which is shown in the upper right corner of the screen.

11.3.5.6 Change Analysis Type. This option allows you to select the analysis type on which to base the cross reference. To invoke this option, enter a <C> in the option field. The window shown in Figure 255 will be displayed. Select the desired analysis type and press <Enter>. The subsequent cross reference reports will be based on the selected analysis type.

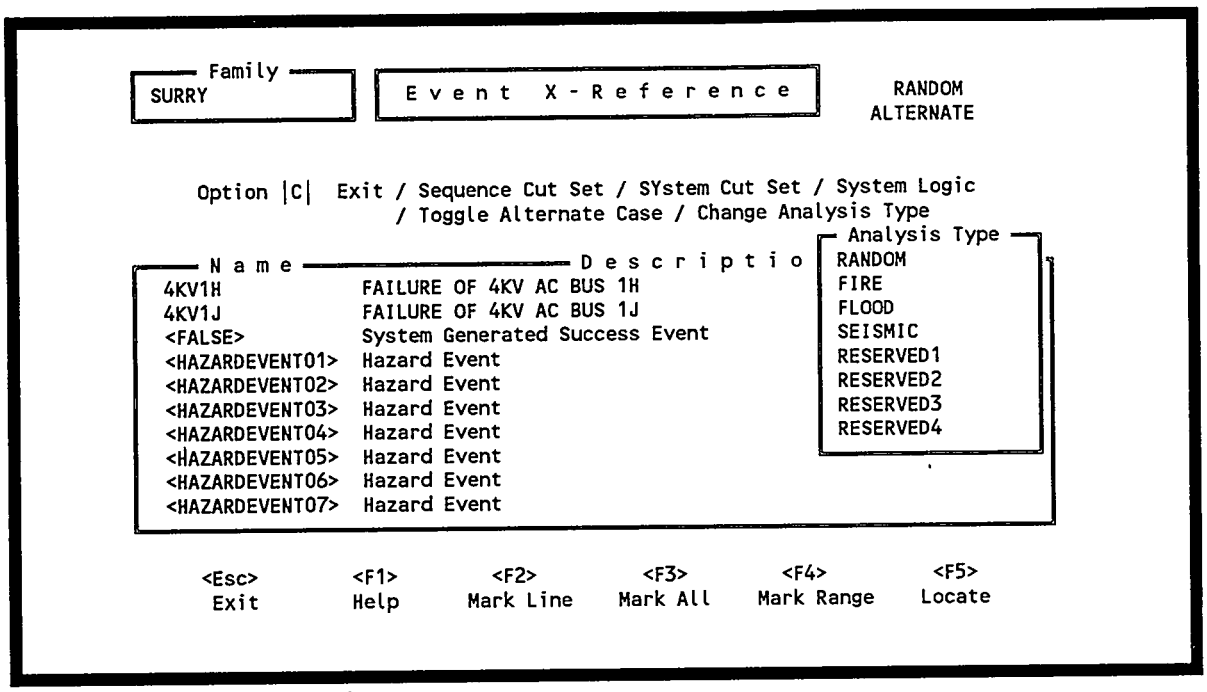


Figure 255. Select analysis type.

11.4 Attributes

This option generates a variety of attribute summary reports. These include reports based on systems, locations, failure modes, basic event types, and trains. When you invoke this option, Figure 256 will be displayed. Indicate the attribute report you want to generate by highlighting the desired report using the arrow keys and pressing <Enter>.

11.4.1 System Attributes

This option generates a system attribute summary report. This report shows the system name and description for each system in the current family. When you invoke this option, the output destination screen will be displayed. Select the desired destination and press <Enter>.

11.4.2 Location Attributes

This option generates a location attribute summary report. This report shows the location and description for each location in the current family. When you invoke this option, the output destination screen will be displayed. Select the desired destination and press <Enter>.

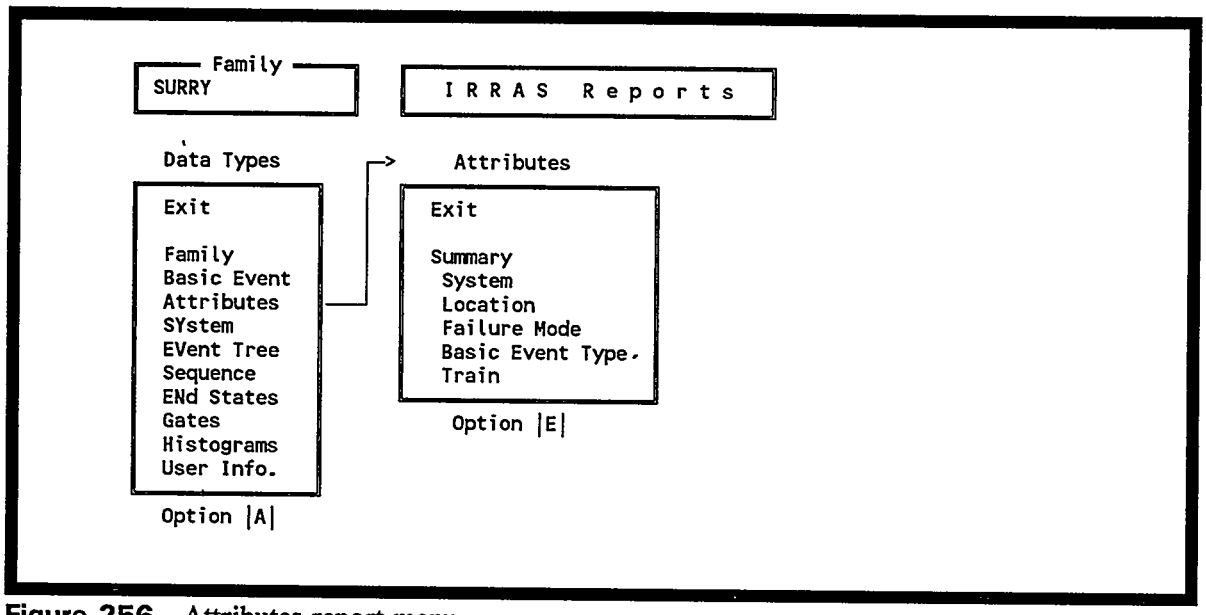


Figure 256. Attributes report menu.

11.4.3 Failure Mode Attributes

This option generates a failure mode attributes summary report. This report shows the failure modes and descriptions for each failure mode in the current family. When you invoke this option, the output destination screen will be displayed. Select the desired destination and press <Enter>.

11.4.4 Basic Event Type Attributes

This option generates a event type attributes summary report. This report shows the basic event type and descriptions for each event type in the current family. When you invoke this option, the output destination screen will be displayed. Select the desired destination and press <Enter>.

11.4.5 Train Attributes

This option generates a train attributes summary report. This report shows the train name and description for each train in the current family. When you invoke this option, the output destination screen will be displayed. Select the desired destination and press <Enter>.

11.5 SYstem

This option generates a variety of system reports. These include summary, logic, cut sets, importance, and cross reference reports. When you invoke this option, Figure 257 will be displayed. Select the desired system report by highlighting the report using the arrow keys and pressing <Enter>.

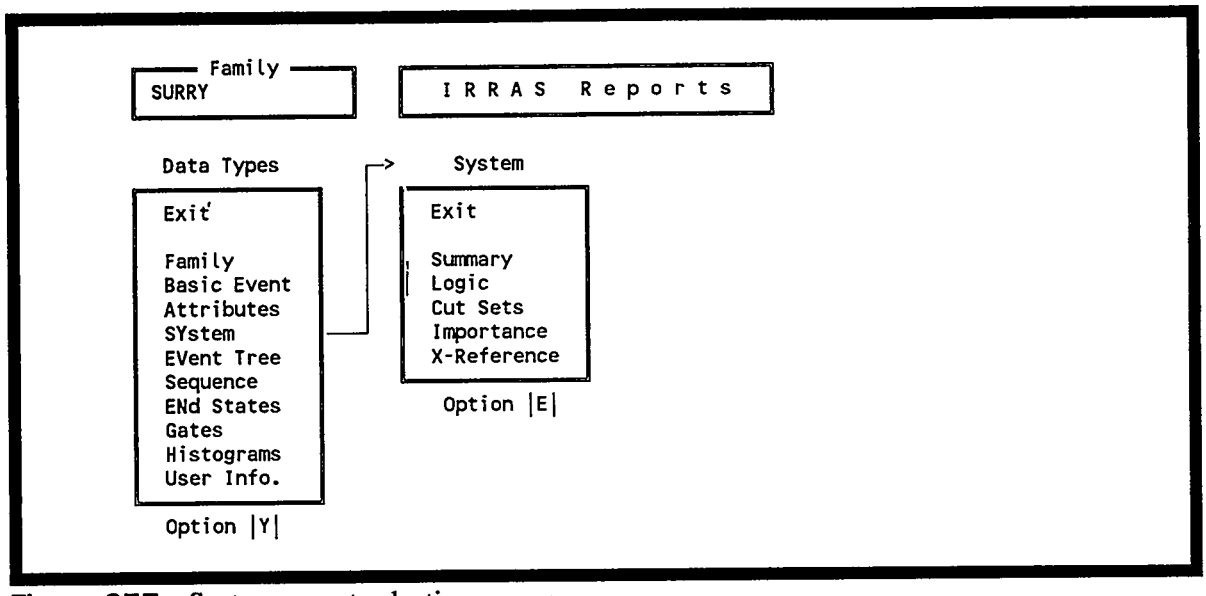


Figure 257. System report selection screen.

11.5.1 System Summary Report

This option generates a system summary that can be based on current or base case values for a specified analysis type. When you invoke this option, Figure 258 will be displayed. Three system summary reports are available: Summary, Combination, and Uncertainty. Select the desired system option and press <Enter>.

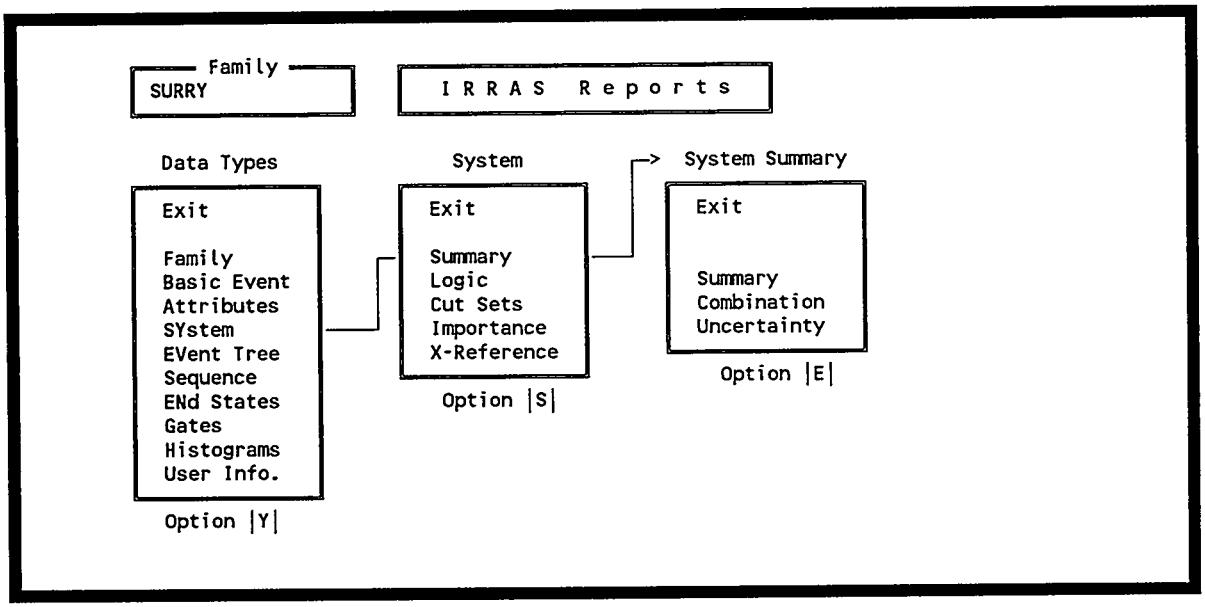


Figure 258. System summary report selection screen.

11.5.1.1 Summary. This option generates the System Brief Summary Report. This report contains the names of the systems residing in the current family, the associated minimum cut set upper bound, and the system description. When you invoke this option, the System Summary screen will appear (see Figure 259). From this screen, you can toggle from base case to alternate values and change the analysis type. To change the base case to alternate values, press <T> (Toggle Alternate Case). The word ALTERNATE or BASE will appear in the upper right corner of the screen. To change the analysis type, enter an <A> in the option field and press <Enter>. A window will be displayed listing the available analysis types (Figure 260). Select the desired type and press <Enter>.

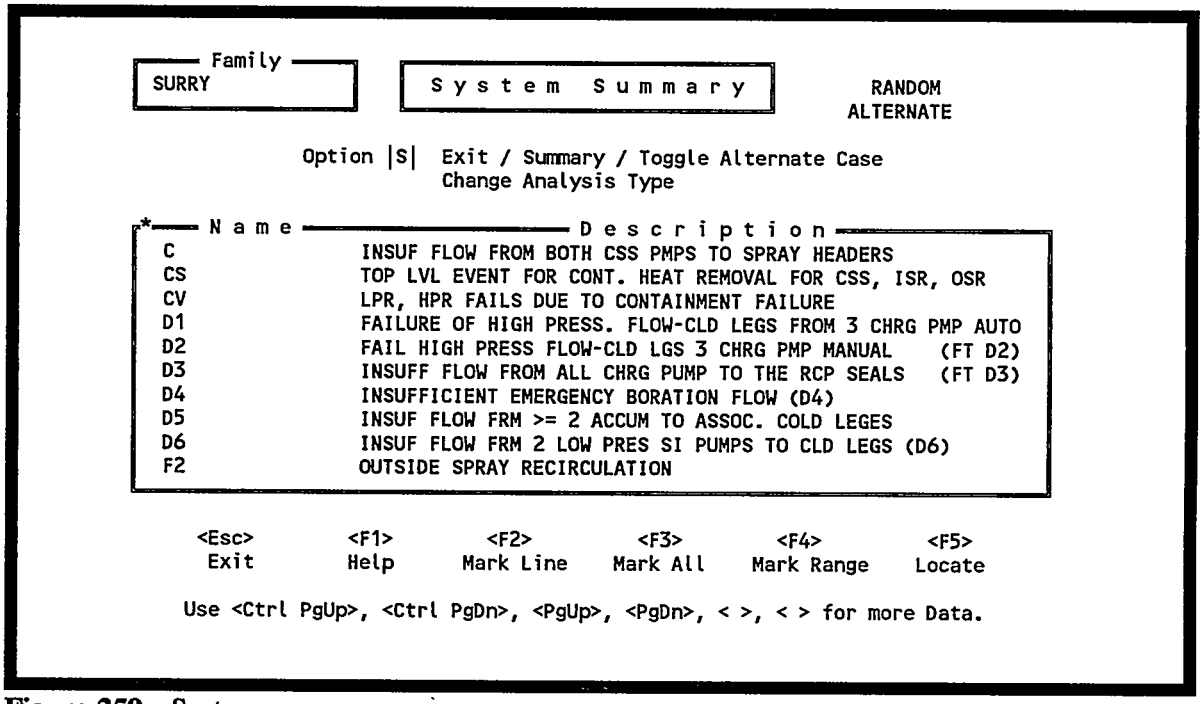


Figure 259. System summary screen.

Once the case and analysis type are set, select a system (or systems) and press <Enter>. The output destination screen will be displayed. On this screen, you must indicate the desired output destination (see Section 11.2.2).

11.5.1.2 Combination. This option generates the System Combination Report. This report contains all systems in the current family, the minimum cut set, mean, and number of cut sets in the system. When you invoke this option, a screen similar to Figure 259 will appear. The same options are available here as described in Section 11.5.1.1. Refer to that section for operating instructions.

11.5.1.3 Uncertainty. This option generates the System Uncertainty Value Report. This report contains all systems in the current family, the mean and median values, standard deviation, the 5th and 95th percentile, the minimum and maximum values, and the seed size. When you invoke this option, a screen similar to Figure 259 will appear. The same options are available here as described in Section 11.5.1.1. Refer to that section for operating instructions.

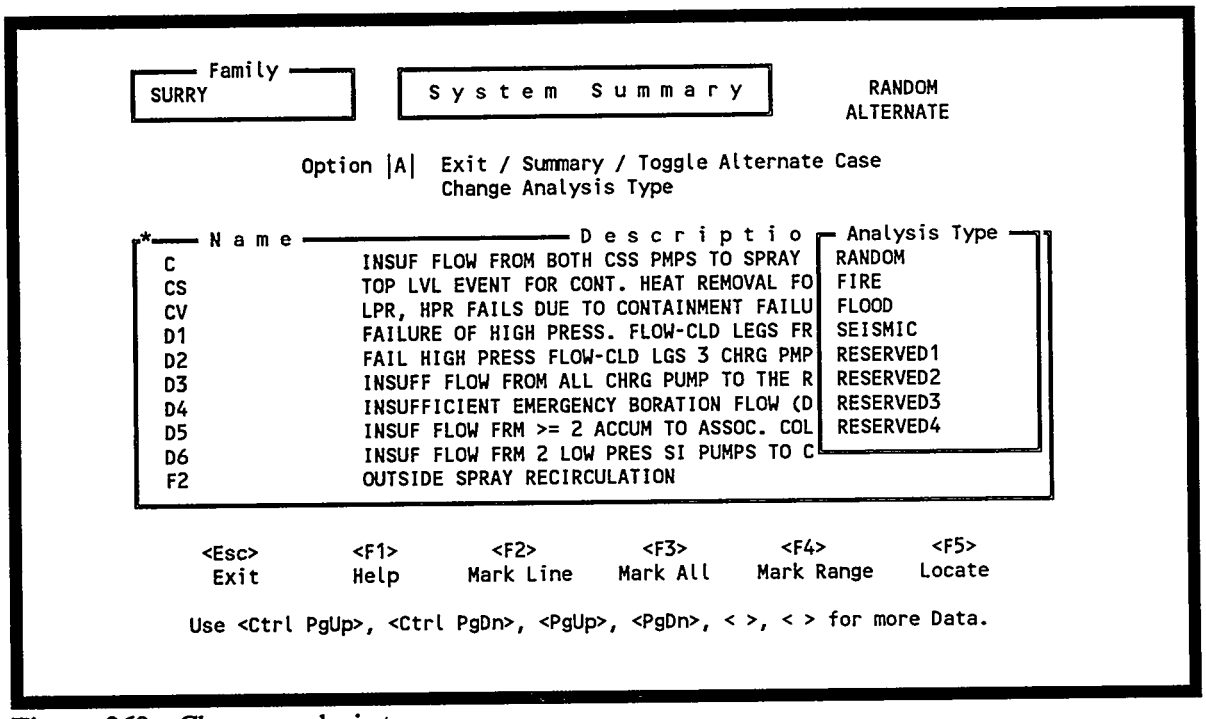


Figure 260. Change analysis type.

11.5.2 System Logic Report

This option generates system logic reports. When you invoke this option, Figure 261 will be displayed. On this screen, all systems names contained in the current family are displayed.

As shown, three report options are available: Logic, Expanded, and Modified.

11.5.2.1 Logic. This option generates the System Logic Report consisting of the gate names, types, and inputs for the specified system(s) or subtree(s). When you invoke this option, the output destination screen will be displayed. On this screen, you must indicate the desired output destination (see Section 11.2.2).

To invoke this option, mark the system(s) or subtrees to include, enter an <L> in the option field and press <Enter>.

11.5.2.2 eXpanded. This option generates the System Expanded Logic Report consisting of the gate names, types, and inputs for the specified system(s). When you invoke this option, you will be prompted to enter a starting gate for the report. You may specify a gate or press <Enter> to include all gates. Next, the output destination screen will be displayed. On this screen, you must indicate the desired output destination (see Section 11.2.2).

To invoke this option, mark the system(s) or subtree(s) to include, enter an <X> in the option field, and press <Enter>.

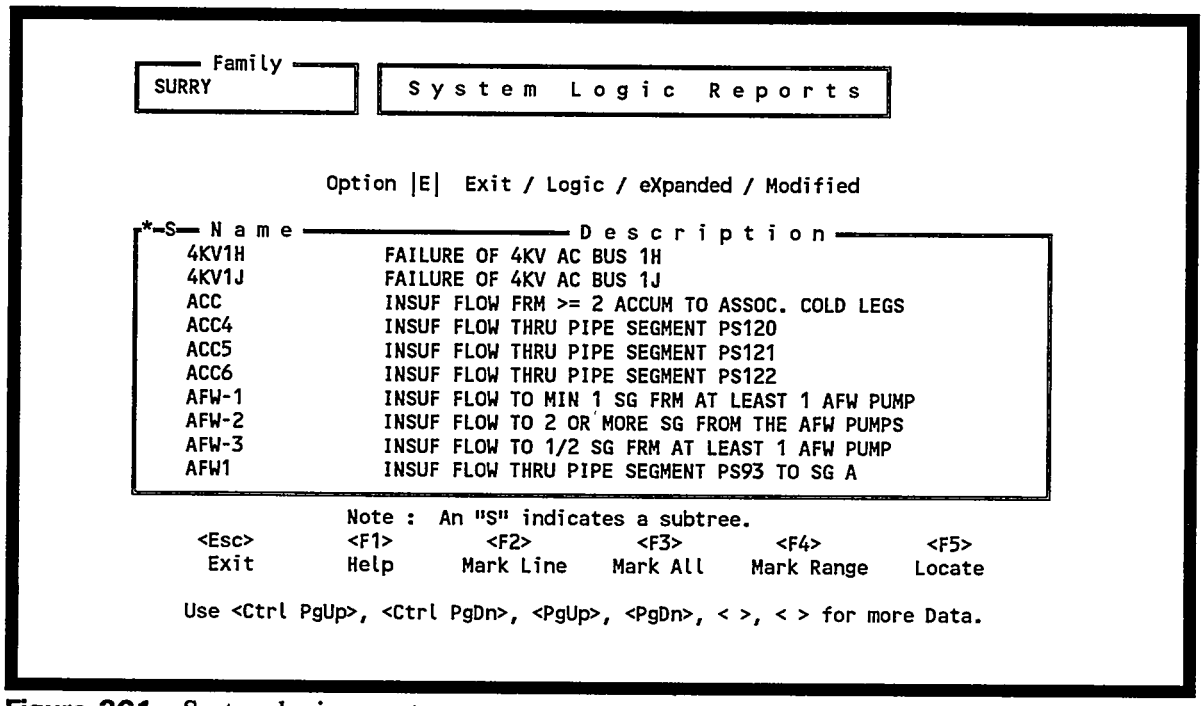


Figure 261. System logic report screen.

11.5.2.3 Modified. This option generates the System Modified Logic Report consisting of the gate names, types, and inputs for the specified system(s). When you invoke this option, you will be prompted to enter a starting gate for the report. You may specify a gate or press <Enter> to include all gates. Next, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

To invoke this option, mark the system(s) or subtree(s) to include, enter an <M> in the option field, and press <Enter>.

11.5.3 Cut Sets Report

This option generates cut set reports based on alternate or base case values. Use the <T>oggle Alternate Cut Set option to set the values to alternate or base case. The word ALTERNATE or BASE will appear in the upper right corner. In addition, you may change the analysis type on which to base the report. To change the analysis type, simple type an <A> in the option field and press <Enter>. A window will be displayed listing the available analysis types. Select the desired type and press <Enter>. See Section 11.3.6.5 for operating instructions.

When you invoke this option, Figure 262 will be displayed. On this screen, all names of the systems residing in the current family will be displayed. On this screen, you must select the systems to include in the report (see Section 11.3.1).

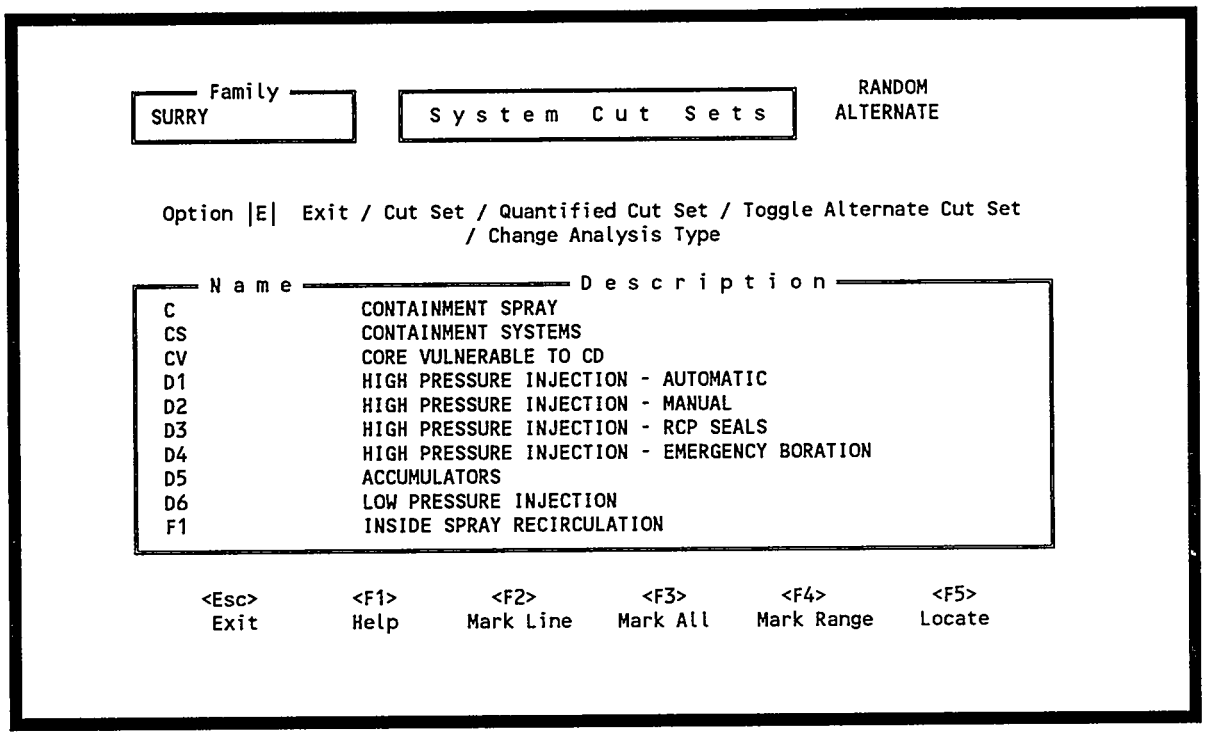


Figure 262. Cut sets report screen.

As shown, two report options are available: Cut Set or Quantified Cut Set.

11.5.3.1 Cut Set. This option generates the System Cut Sets Report which consists of the cut set number, size, and all corresponding cut sets (alternate or base). When you invoke this option, Figure 263 will be displayed. You can modify any of the default values provided by typing over the existing data. Upon pressing <Enter>, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

To invoke this option, mark the system(s) to include, enter a <C> in the option field, and press <Enter>.

11.5.3.2 Quantified Cut Set. This option generates the System 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 all associated cut sets (alternate or base) for the selected system(s). When you invoke this option, Figure 263 will be displayed. You can modify any of the default values provided by typing over the existing data. Upon pressing <Enter>, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

To invoke this option, mark the system(s) to include, enter a <Q> in the option field, and press <Enter>.

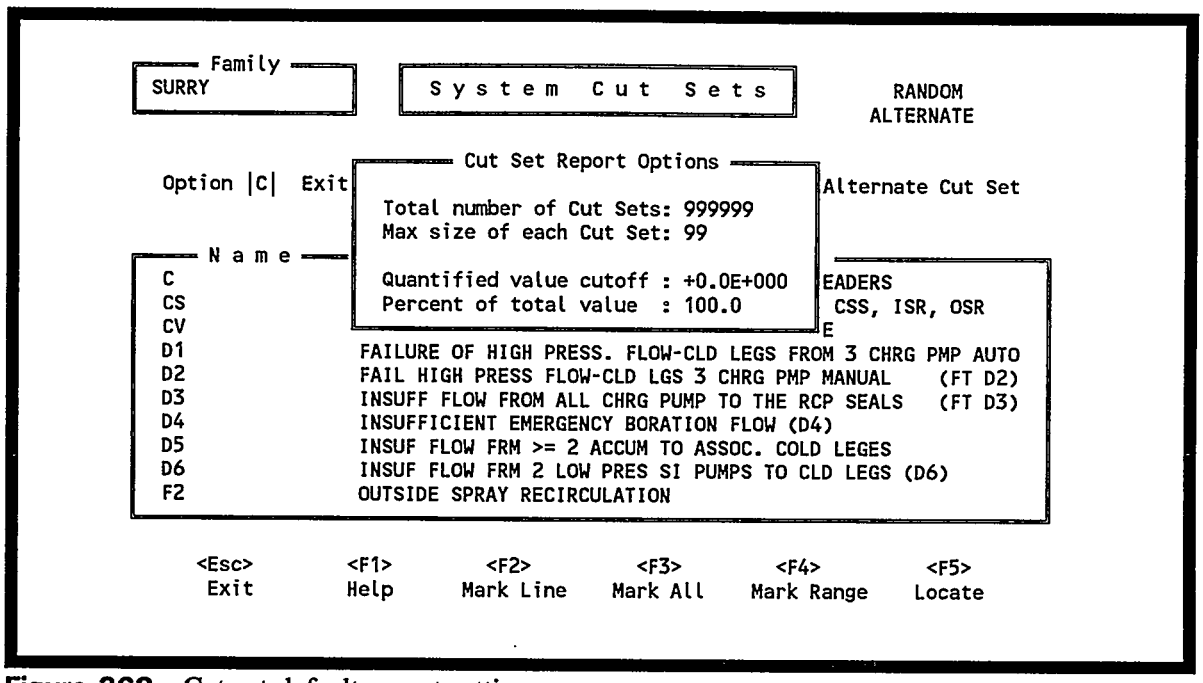


Figure 263. Cut set default report settings.

11.5.4 System Importance

This option generates importance reports based on alternate or base case values. Use the <T>oggle Alternate Cut Set option to set the values to alternate or base case. The word ALTERNATE or BASE will appear in the upper right corner. In addition, you may change the analysis type on which to base the report. To change the analysis type, simple type a <C> in the option field and press <Enter>. A window will be displayed listing the available analysis types. Select the desired type and press <Enter>. See Section 11.3.6.5 for operating instructions.

When you invoke this option, Figure 264 will be displayed. On this screen, all names of the systems residing in the current family will be displayed. On this screen, you must select the systems to include in the report (see Section 11.3.1).

As shown, two report options are available: Importance and Sort Criteria.

11.5.4.1 Importance. This option generates the System Importance Measures report consisting of event names, number of times the event occurs, probability of failure, Fussell-Vesely importance value, risk reduction interval, and risk increase interval for the selected system(s). When you invoke this option, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

To invoke this option, mark the system(s) to include, enter an <I> in the option field, and press <Enter>.

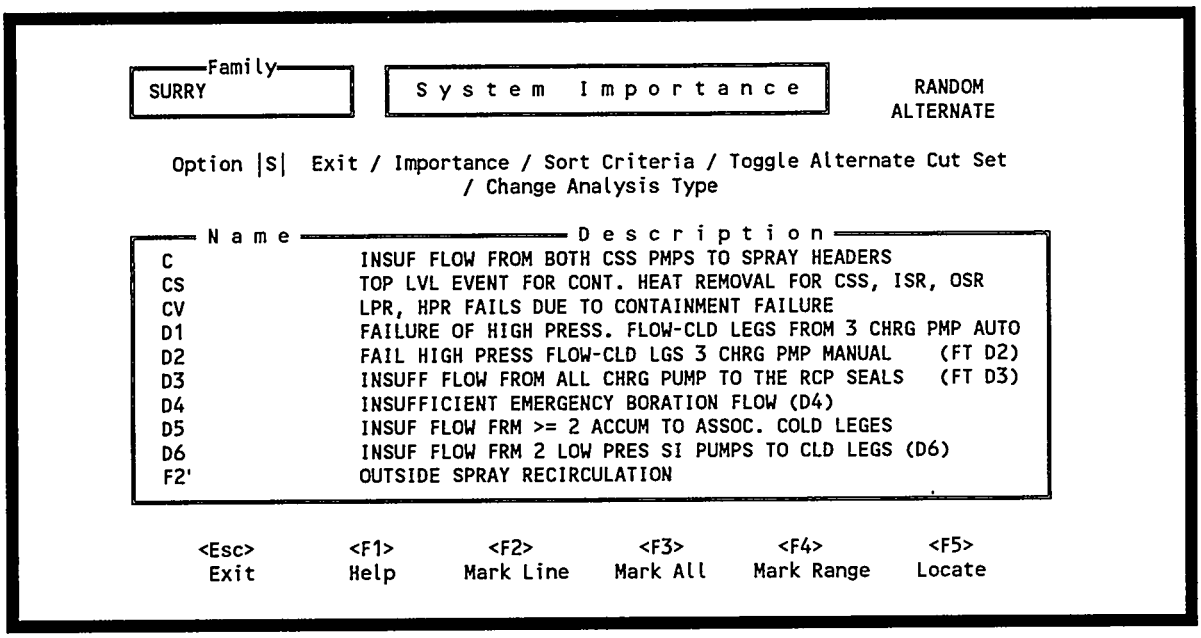


Figure 264. System importance screen.

11.5.4.2 Sort Criteria. This option allows you to select the sort order in which to display the System Importance Measures Report. When you invoke this option, Figure 265 will be displayed.

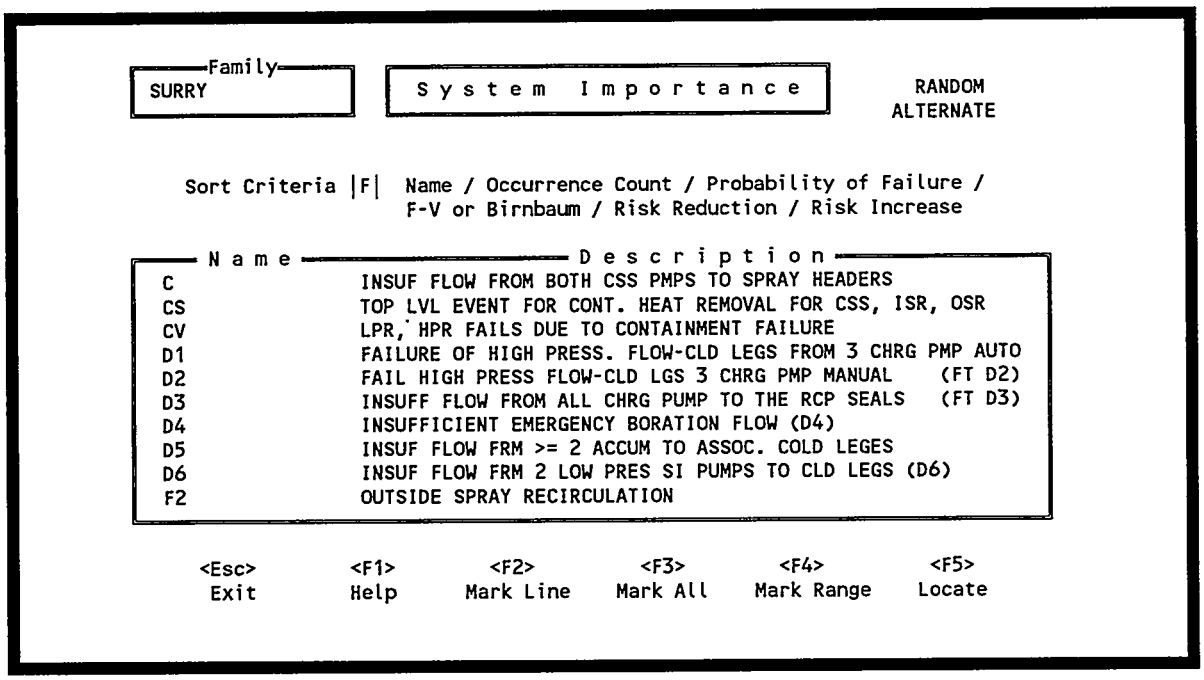


Figure 265. Sort selection screen.

As shown, the following sort options are available:

Name	-	Sorted by event name
Occurrence Count	-	Sorted by the number of occurrences (most to fewest)
Probability of Failure	-	Sorted by the probability failures
F-V or Birnbaum	-	Sorted in Fussell-Vesely or Birnbaum order
Risk Reduction	-	Sorted in risk reduction ratio order
Risk Increase	-	Sorted in risk increase ratio order

11.5.5 X-Reference

This option generates cross reference reports for either systems or subsystems. When you invoke this option, Figure 266 will be displayed. You may use the Level option to toggle between systems and subsystems. Two types of reports are available: Uses and Used By.

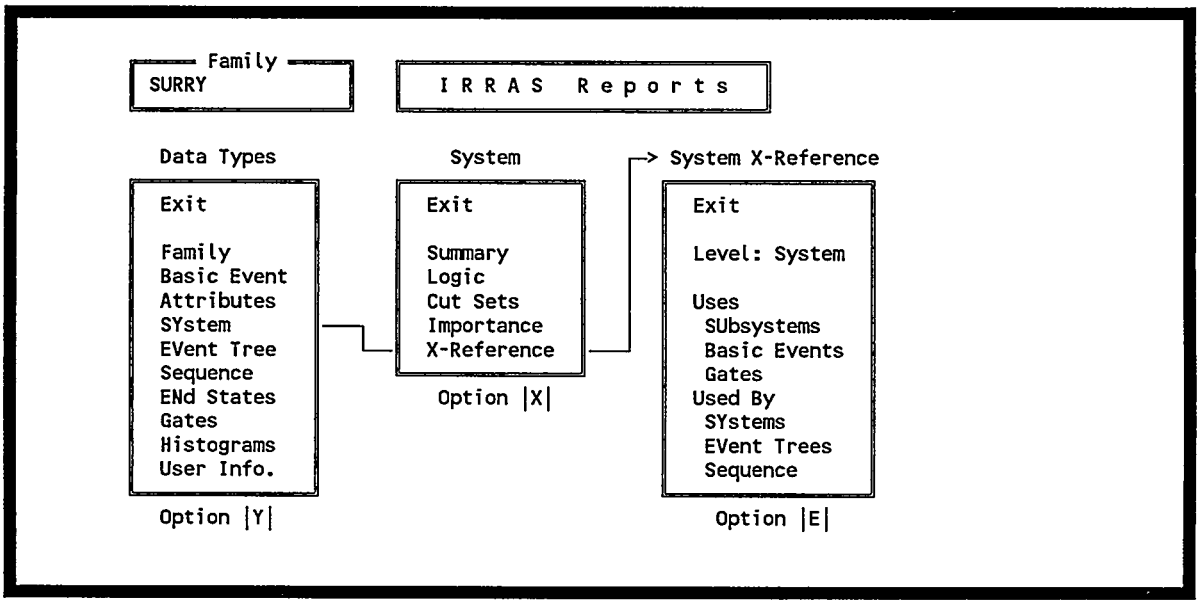


Figure 266. System cross reference report selection screen.

11.5.5.1 Uses. This type of report allows you to list either the subsystems, basic events, or gates that a subsystem references, or uses.

11.5.5.1.1 Subsystems—This option generates the System Hierarchy Report consisting of a system/subsystem and a list of all subsystems it uses. When you invoke this option, a list of systems or subsystems will be displayed. On this screen you must select the desired systems or subtrees (see Section 11.3.1). After a subsystem(s) has been selected, the output destination screen will be displayed. Select the desired destination and press <Enter>.

11.5.5.1.2 Basic Events—This option generates the System/Basic Event Reference Report consisting of a system/subsystem and a list of all basic events that it uses. When you invoke this option, a list of systems or subsystems will be displayed. On this screen you must select the desired systems or subtrees (see Section 11.3.1). After a subsystem(s) has been selected, the output destination screen will be displayed. Select the desired destination and press <Enter>.

11.5.5.1.3 Gates—This option generates the System/Gate Reference Report consisting of the selected system/subsystems and a list of gates that it uses. When you invoke this option, a list of systems or subsystems will be displayed. On this screen you must select the desired systems or subtrees (see Section 11.3.1). After a subsystem(s) has been selected, the output destination screen will be displayed. Select the desired destination and press <Enter>.

11.5.5.2 Used By. This type of report allows you to list all the systems/subsystems, event trees, or sequences that use a particular system/subtree.

11.5.5.2.1 Systems—This option generates the SubTree Cross Reference Report consisting of a subsystem and a list of all systems/subtrees that reference or use it. When you invoke this option, a list of systems or subsystems will be displayed. On this screen you must select the desired systems or subtrees (see Section 11.3.1). After a subsystem(s) has been selected, the output destination screen will be displayed. Type in the desired destination and press <Enter>.

11.5.5.2.2 Event Trees—This option generates the System/Event Tree Reference Report consisting of the selected systems or subsystems and the corresponding event tree logic or rules that reference or use it. When you invoke this option, a list of systems or subsystems will be displayed. On this screen you must select the desired systems or subtrees (see Section 11.3.1). After a subsystem(s) has been selected, the output destination screen will be displayed. Type in the desired destination and press <Enter>.

11.5.5.2.3 Sequences—This option generates the System/Sequence Reference Report consisting of the selected systems/subsystems and a list of event trees and sequences that reference or use it. When you invoke this option, a list of systems or subsystems will be displayed. On this screen you must select the desired systems or subtrees (see Section 11.3.1). After a subsystem(s) has been selected, the output destination screen will be displayed. Type in the desired destination and press <Enter>.

11.6 EVent Tree

This option generates a variety of event tree reports. When you invoke this option, Figure 267 will be displayed. You indicate which event tree report you want to generate by highlighting the desired report using the arrow keys and pressing <Enter>. As shown, the following reports may be generated: Logic/Rules, Initiating Events, and Cross Reference.

11.6.1 Logic/Rules

This option generates the Event Tree Logic Report and the Event Tree Rules report. When you invoke this option, Figure 268 will be displayed. On this screen all event trees contained in the current family are displayed. On this screen, you must select the event trees to include in the report (see Section 11.3.1).

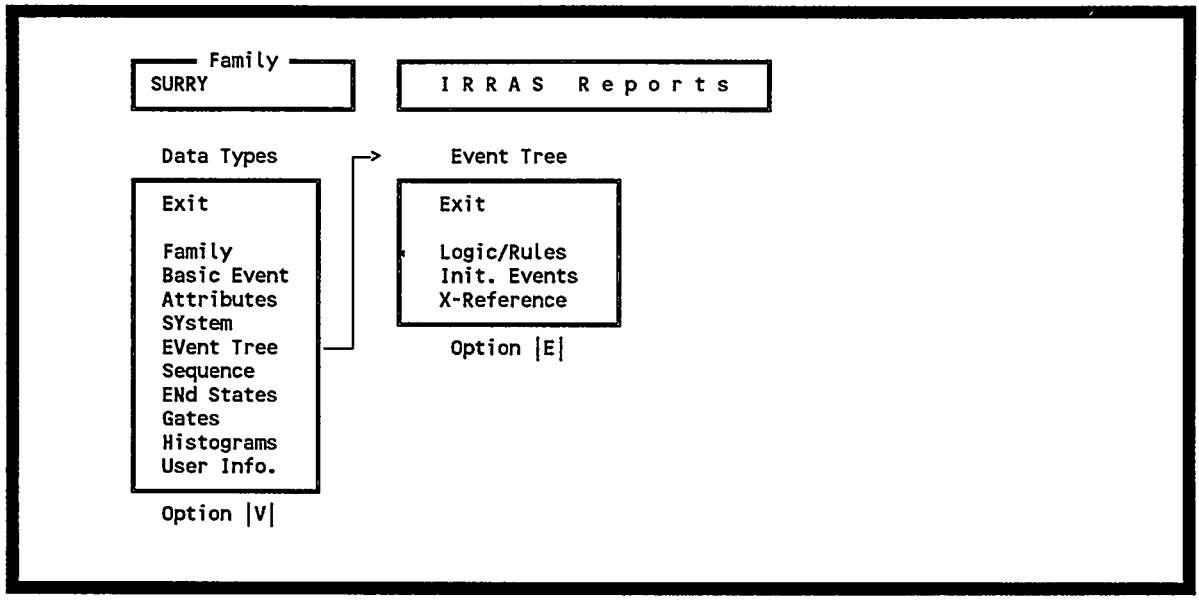


Figure 267. Event tree report selection screen.

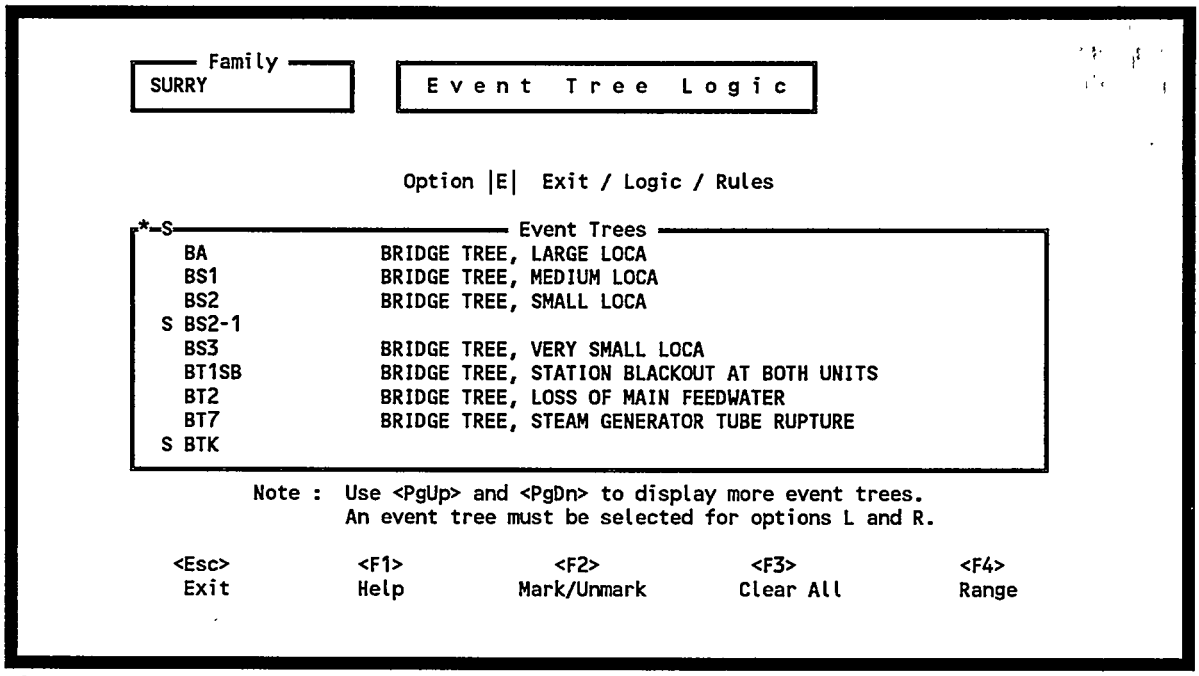


Figure 268. Logic/Rules selection screen.

As shown, two report options are available: Logic and Rules.

11.6.1.1 Logic. This option produces the Event Tree Logic Report. This report lists all sequence names and the associated logic (pass/fail) associated with each selected event tree. To invoke this option, mark the event trees, enter an <L> in the option field, and press <Enter>. When you invoke this option, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

11.6.1.2 Rules. This option produces the Event Tree Linkage Rules Report. This report lists all linkage rules (exceptions) associated with each selected event tree. To invoke this option, mark the event trees, enter an <R> in the option files, and press <Enter>. The same output options are available as described in Section 11.2.2.

11.6.2 Initiating Event Report

This option generates 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 family. When you invoke this option, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

11.6.3 Cross Reference

This option generates a cross reference report for event trees or subtrees. When you invoke this option, Figure 269 will be displayed. You may use the Level option to toggle between event trees and subtrees. To toggle, highlight level and press <Enter>. Two types or reports are available: Uses and Used by.

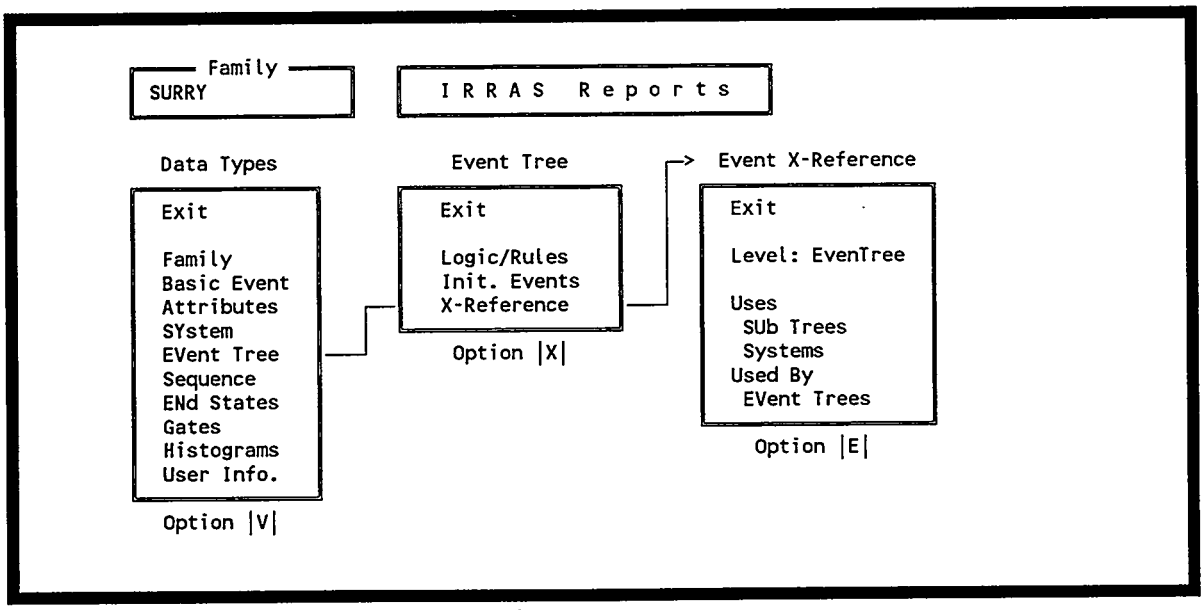


Figure 269. Event tree/subtree cross reference reports.

11.6.3.1 Uses. This type of report allows you to list either subtrees or systems that an event tree or subtree uses.

11.6.3.1.1 Subtrees—This option generates the Sub/Event Tree Hierarchy Report consisting of selected event trees/subtrees and a list of subtrees it uses. When you invoke this option, a list of events/subtrees will be displayed. On this screen, you must select the desired event tree or subtree (see Section 11.3.1). After an event/subtree has been selected, the output destination screen will be displayed. Select the desired destination and press <Enter>.

11.6.3.1.2 Systems—This option generates the Event Tree/Subtree System Reference Report consisting of an event tree/subtree and a list of systems that it uses. When you invoke this option, a list of events/subtrees will be displayed. On this screen, you must select the desired event tree or subtree (see Section 11.3.1). After an event/subtree has been selected, the output destination screen will be displayed. Select the desired destination and press <Enter>.

11.6.3.2 Used By. This type of report allows you to list all the event trees that use a particular subtree.

11.6.3.2.1 EVent Trees—This option generates the Sub-Tree Cross Reference Report consisting of the selected subtree or event tree and the trees that use it. When you invoke this option, a list of events/subtrees will be displayed. On this screen, you must select the desired event tree or subtree (see Section 11.3.1). After an event/subtree has been selected, the output destination screen will be displayed. Select the desired destination and press <Enter>.

11.7 Sequence

This option generates a variety of sequence reports. When you invoke this option, Figure 270 will be displayed. You indicate which sequence report you want to generate by highlighting the desired report using the arrow keys and pressing <Enter>. As shown, the following reports may be generated: Summary, Logic, Cut Sets, and Importance.

11.7.1 Summary

When you invoke this option Figure 271 will be displayed. As shown four different summary reports may be generated: Brief, Summary, Combination and Uncertainty.

11.7.1.1 Brief Summary. This option generates the Sequence Brief Summary Report. The report lists each event name, sequence name, and event name contained in the current family and the minimum cut set upper bound. When you invoke this option, Figure 272 will be displayed. From this screen, you can toggle from base case to alternate values and change the analysis type. To change the base case to alternate values, press <T> (Toggle Alternate Case). The word ALTERNATE or BASE will appear in the upper right corner of the screen. To change the analysis type, enter an <A> in the option field and press <Enter>. A window will be displayed listing the available analysis types (Figure 260). Select the desired type and press <Enter>.

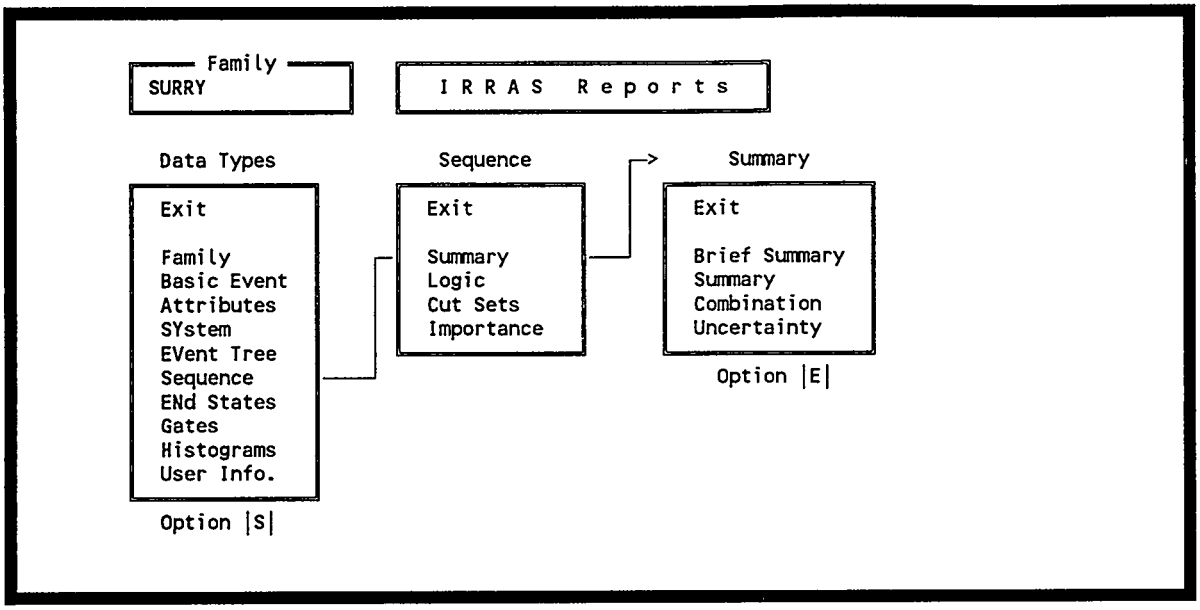


Figure 270. Sequence report selection screen.

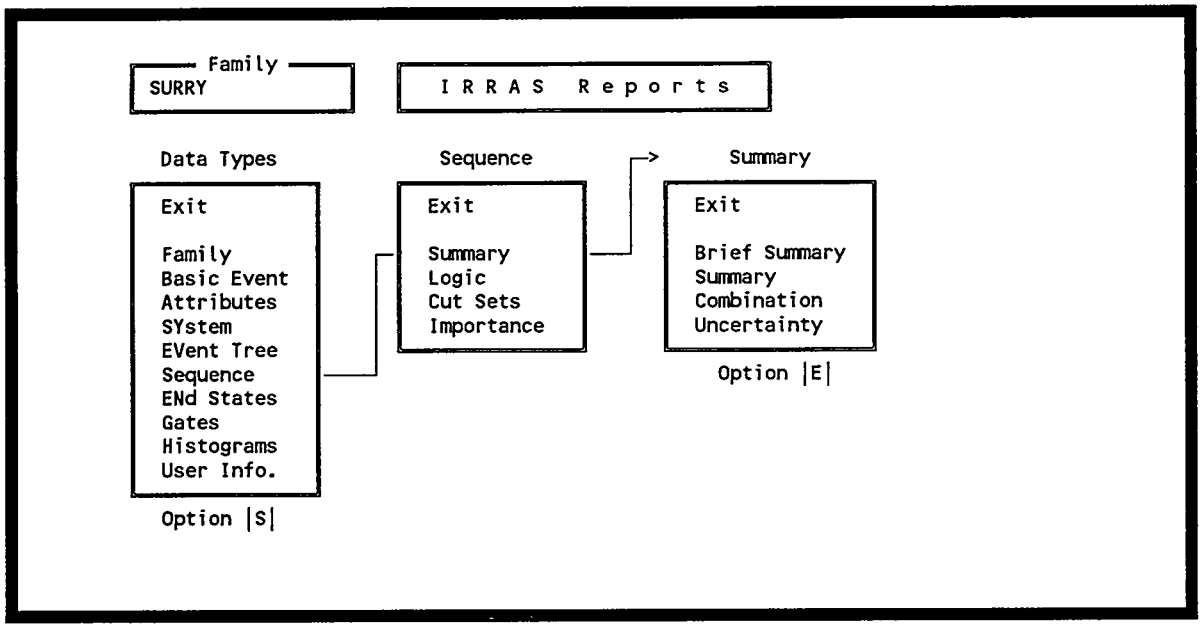


Figure 271. Sequence summary report selection menu.

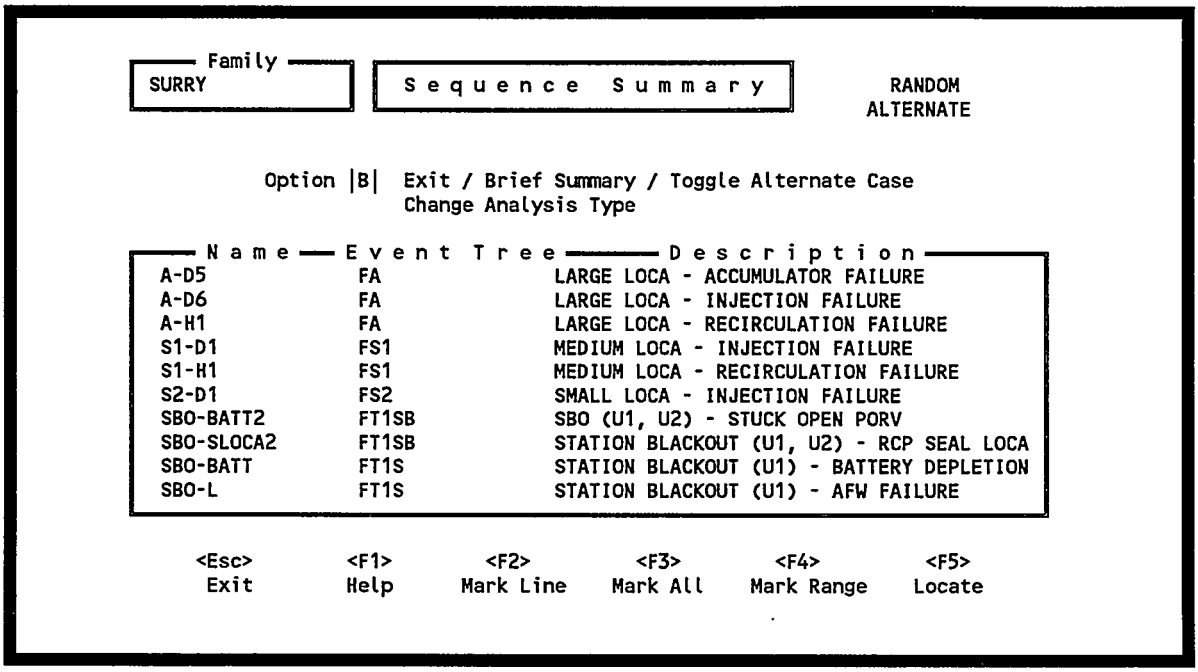


Figure 272. Sequence summary screen.

To generate the report, type a <B> in the option field, highlight or mark the sequences to be included in the report, and press <Enter>. The output destination screen will be displayed. On this screen you must select the desired output destination (see Section 11.2.2).

11.7.1.2 Summary. This option generates the Sequence Summary Report. The report lists each sequence number, event tree, and sequence name contained in the current family, and the minimum cut set upper bound. When you invoke this option, the same screens and options are available as described in Section 11.7.1.1. Refer to that section for details.

11.7.1.3 COmbination. This option generates the Sequence Combination Report. The report lists each sequence number, event tree, and sequence name contained in the current family, the minimum cut set value, the mean cut set value, and the number of cut sets contained in each sequence. When you invoke this option, Figure 273 will be displayed. From this screen, you can toggle from base case to alternate values and change the analysis type. To change the base case to alternate values, press <T> (Toggle Alternate Case). The word ALTERNATE or BASE will appear in the upper right corner of the screen. To change the analysis type, enter an <A> in the option field and press <Enter>. A window will be displayed listing the available analysis types (Figure 260). Select the desired type and press <Enter>.

To generate the report, type a <C> in the option field, mark or highlight the sequences to be included in the report and press <Enter>. The output destination screen will be displayed. On this screen you must select the desired output destination (see Section 11.2.2).

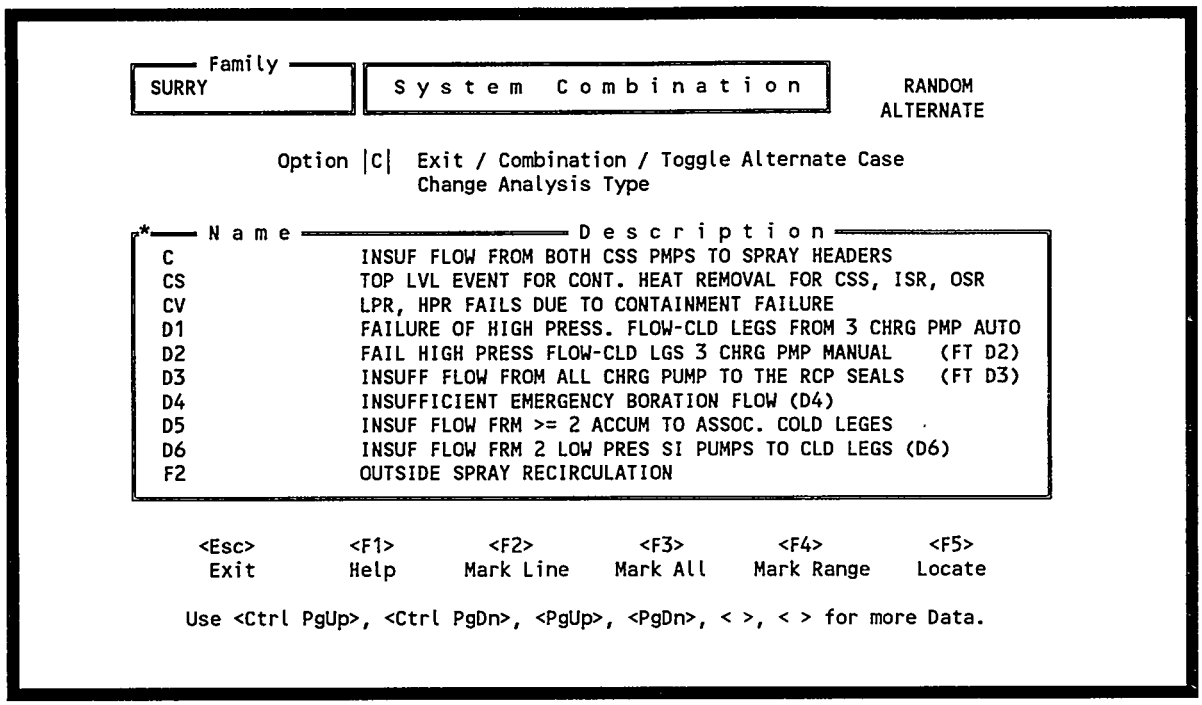


Figure 273. System combination screen.

11.7.1.4 Uncertainty. This option generates the Sequence Uncertainty Values Report. The report lists each sequence number, event tree, and sequence name contained in the current family, the mean and median values, standard deviation, 5th and 95th percentile, minimum and maximum range values, and the seed size. From this screen (Figure 274), you can toggle from base case to alternate values and change the analysis type. To change the base case to alternate values, press <T> (Toggle Alternate Case). The word ALTERNATE or BASE will appear in the upper right corner of the screen. To change the analysis type, enter an <A> in the option field and press <Enter>. A window will be displayed listing the available analysis types (Figure 260). Select the desired type and press <Enter>.

To generate the report, type a <U> in the option field, highlight or mark the sequences to be included and press <Enter>. The output destination screen will be displayed. On this screen you must select the desired output destination (see Section 11.2.2).

11.7.2 Logic

This option generates the Sequence Logic Report. This report contains the selected sequence number, event tree, and sequence name contained in the current family, and the logic paths (pass/fail) for the event tree, initiating event, and flag set name. When you invoke this option, a list of sequences will be displayed. On this screen, you must select the desired sequence(s) (see Section 11.3.1). After the sequence has been selected, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

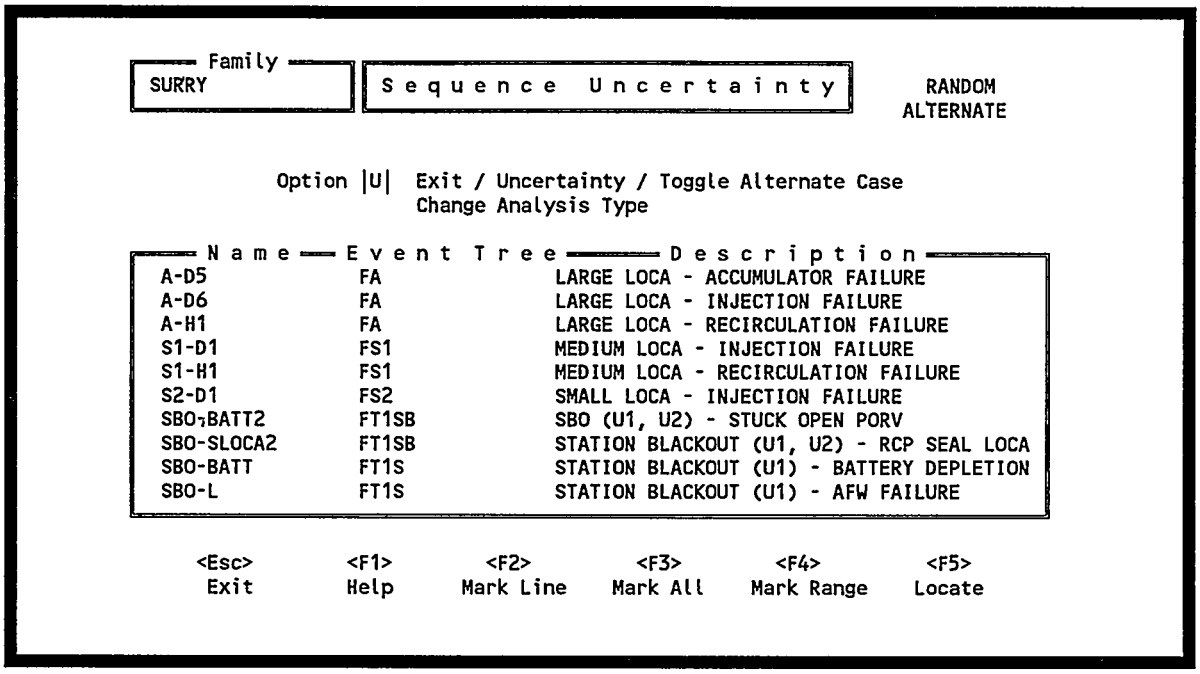


Figure 274. Sequence uncertainty screen.

11.7.3 Cut Sets

This option generates two sequence cut set reports using alternate or base cut set values. Use the Toggle Alternate Cut Set option to set the desired values to alternate or base case. The word ALTERNATE or BASE will appear in the upper right corner. In addition, you can base the report on a selected analysis type (see Section 11.7.1 for details). When you invoke this option, Figure 275 will be displayed. All sequences contained in the current family are displayed. On this screen, you must indicate the sequences to include in the report. As shown, two options are available: Cut Set and Quantified Cut Set.

11.7.3.1 Cut Set. This option generates the Sequence Cut Sets Report, which consists of the cut set number, size and cut set name for each selected sequence. To invoke this option, mark the sequence(s) to include, enter a <C> in the option field, and press <Enter>. When you invoke this option, Figure 276 will be displayed. You can modify any of the default values provided by typing over the existing data. Upon pressing <Enter>, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

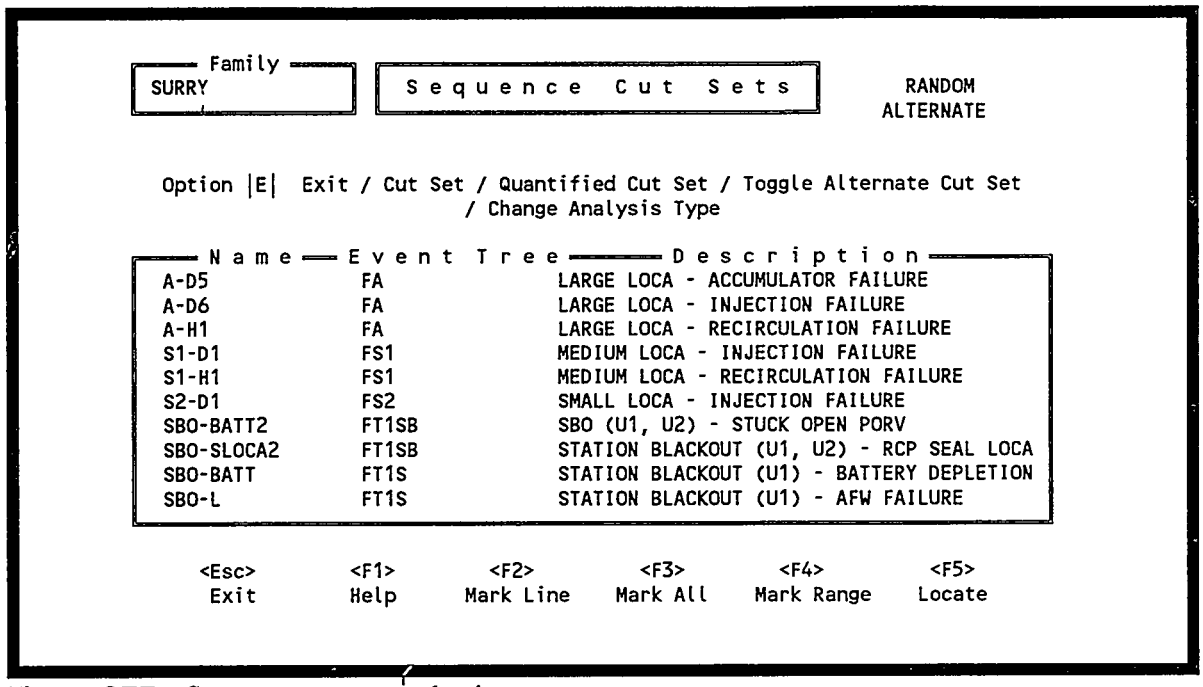


Figure 275. Sequence cut sets selection screen.

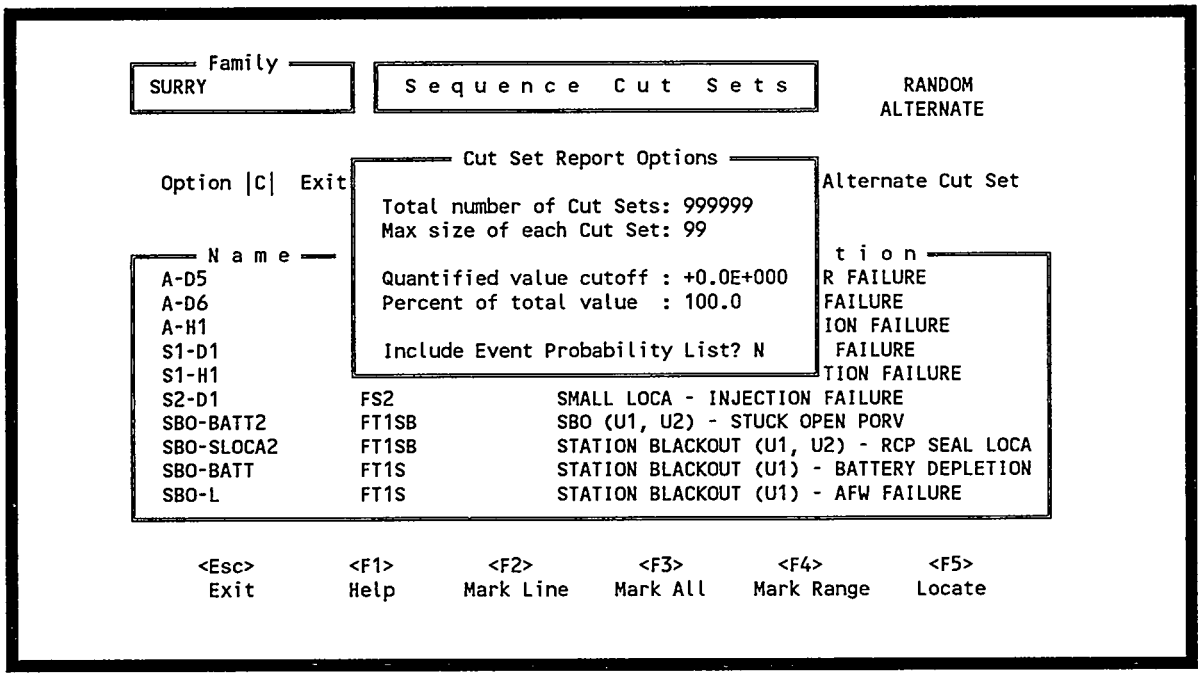


Figure 276. Cut set report options.

11.7.3.2 Quantified Cut Set. This option generates the Sequence Cut Sets (Quantification) Report, which consists of the cut set number, percent of total, percent of cut set, probability/frequency and all associated cut sets (alternate or base) for the selected sequence(s). To invoke this option, mark the sequence(s) to include, enter a <Q> in the option field, and press <Enter>. When you invoke this option, a screen similar to the one shown in Figure 276 will be displayed. You can modify any of the default values provided by typing over the existing data. Upon pressing <Enter>, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

11.7.4 Importance

This option generates reports based on alternate or base case values. Use the Toggle Alternate Cut Set to set the values to alternate or base case. The word ALTERNATE or BASE will appear in the upper right corner (Figure 277). In addition, you can base the report on a selected analysis type (see Section 11.7.1 for details). When you invoke this option, Figure 277 will be displayed. On this screen, all sequence names residing in the current family will be displayed. On this screen, you must select the sequences to include in the report (see Section 11.3.1).

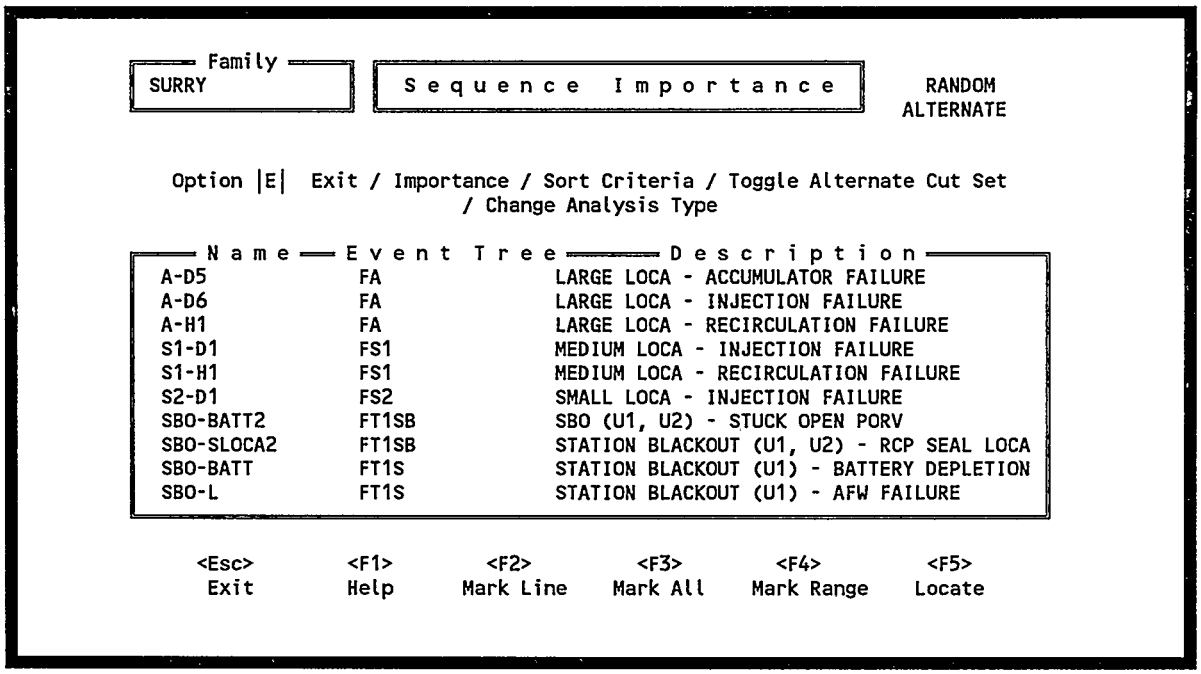


Figure 277. Sequence importance selection screen.

As shown, two options are available: Importance and Sort Criteria.

11.7.4.1 Importance. This option generates the Sequence Importance Measures Report which consists of event names, number of times the event occurs, probability of failure, Fussell-Vesely importance value, risk reduction interval, and risk increase interval for the selected sequence(s). To invoke this option, mark the sequence(s) to include, enter an <I> in the option field, and press

<Enter>. When you invoke this option, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

11.7.4.2 Sort Criteria. This option allows you to select the sort order in which to display the Sequence Importance Measures Report. When you invoke this option, Figure 278 will be displayed.

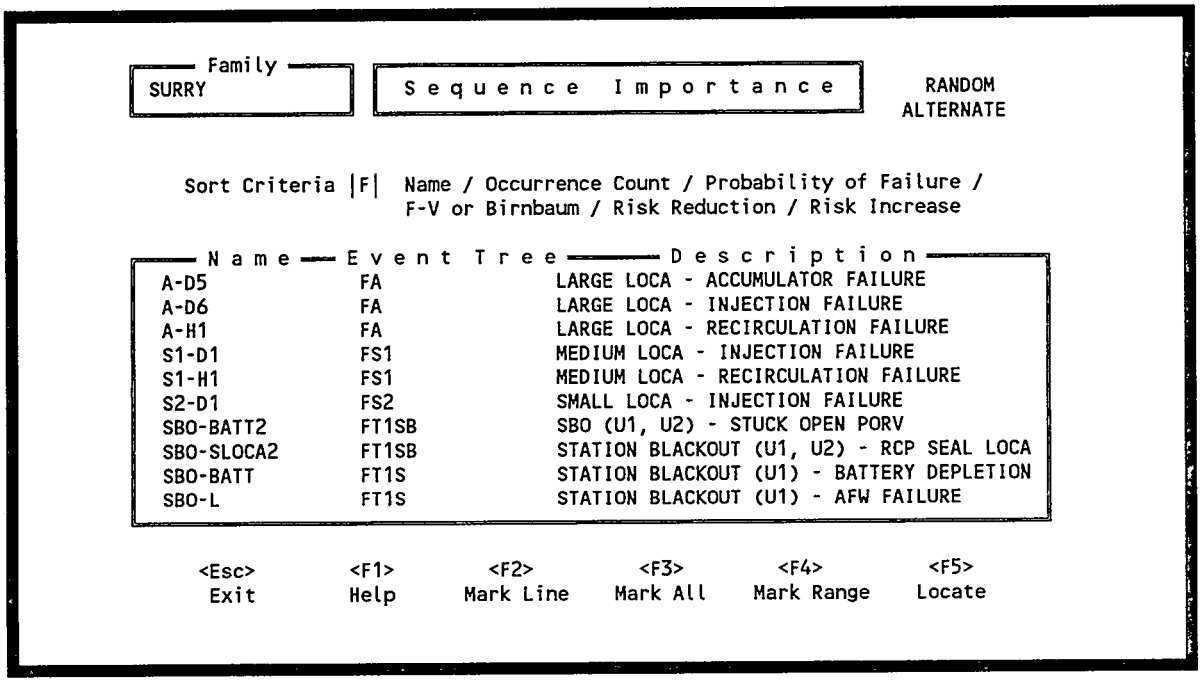


Figure 278. Sort criteria selection screen.

As shown, the following sort options are available:

Name	-	Sorted by event name
Occurrence Count	-	Sorted by the number of occurrences (most to fewest)
Probability of Failure	-	Sorted by probability failures
F-V or Birnbaum	-	Sorted by Fussell-Vesely or Birnbaum values
Risk Reduction	-	Sorted in risk reduction ratio order
Risk Increase	-	Sorted in risk increase ratio order

11.8 ENd States

This option generates end state reports. When you invoke this option, Figure 279 will be displayed. Indicate the end state report you want to generate by highlighting the desired report using the arrow keys and pressing <Enter>. Each report can be generated using the current or base case values. In addition, you can base the report on a specific analysis type (see Section 11.7.1.1).

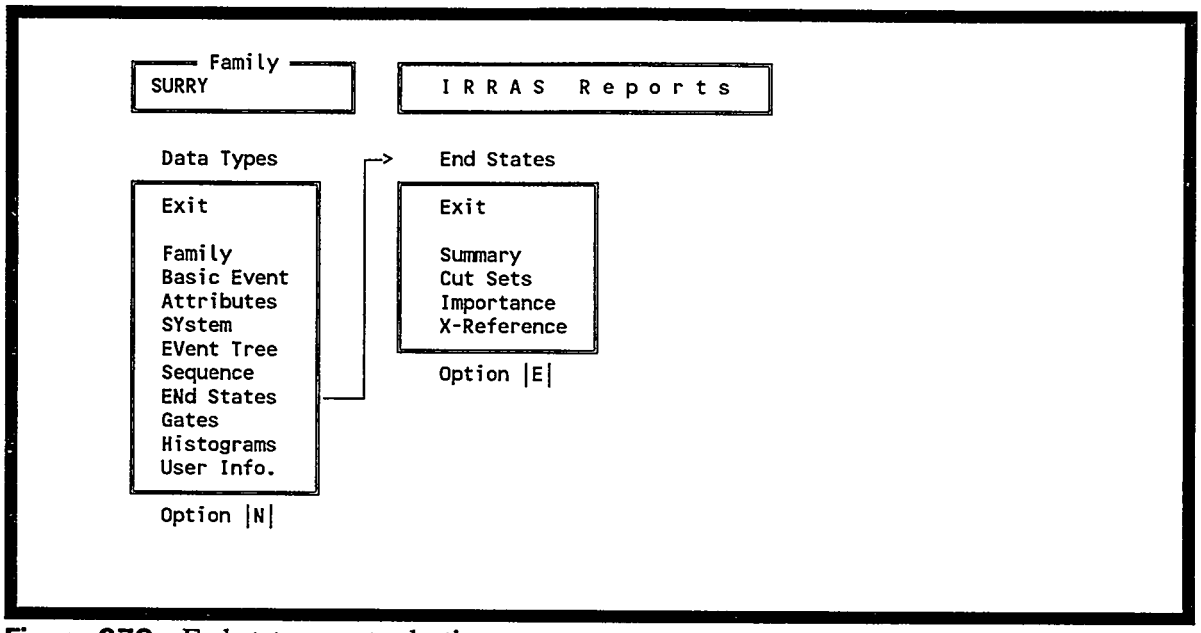


Figure 279. End state report selection screen.

11.8.1 End State Summary Report

This option generates an end state summary based on current or base case values for a specified analysis type. When you invoke this option, Figure 280 will be displayed. Three system summary reports are available: Summary, Combination, and Uncertainty. Select the desired report and press <Enter>.

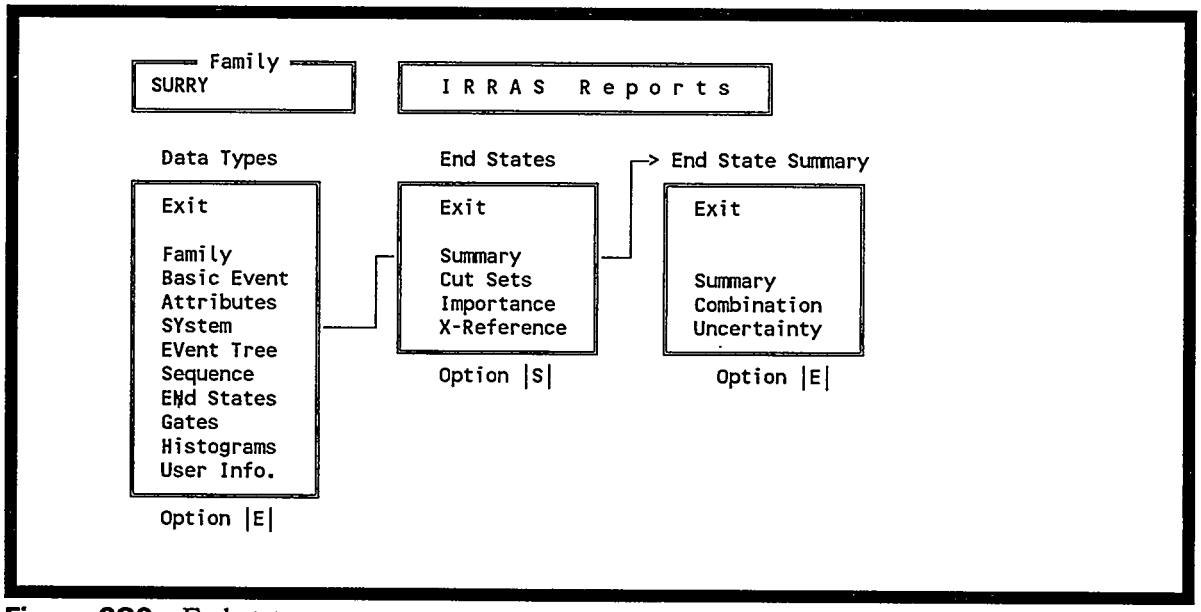


Figure 280. End state summary menu.

11.8.1.1 Summary. This option generates the End State Brief Summary Report. This report contains the names of the end states residing in the current family, the end state description, and the associated minimum cut set upper bound. When you invoke this option, the End State Summary screen will appear (Figure 281). From this screen, you can toggle from base case to alternate values and change the analysis type. To change the base case to alternate values, press <T> (Toggle Alternate Case). The word ALTERNATE or BASE will appear in the upper right corner of the screen. To change the analysis type, type an <A> in the option field and press <Enter>. A window will be displayed listing the available analysis types. Select the desired type and press <Enter>.

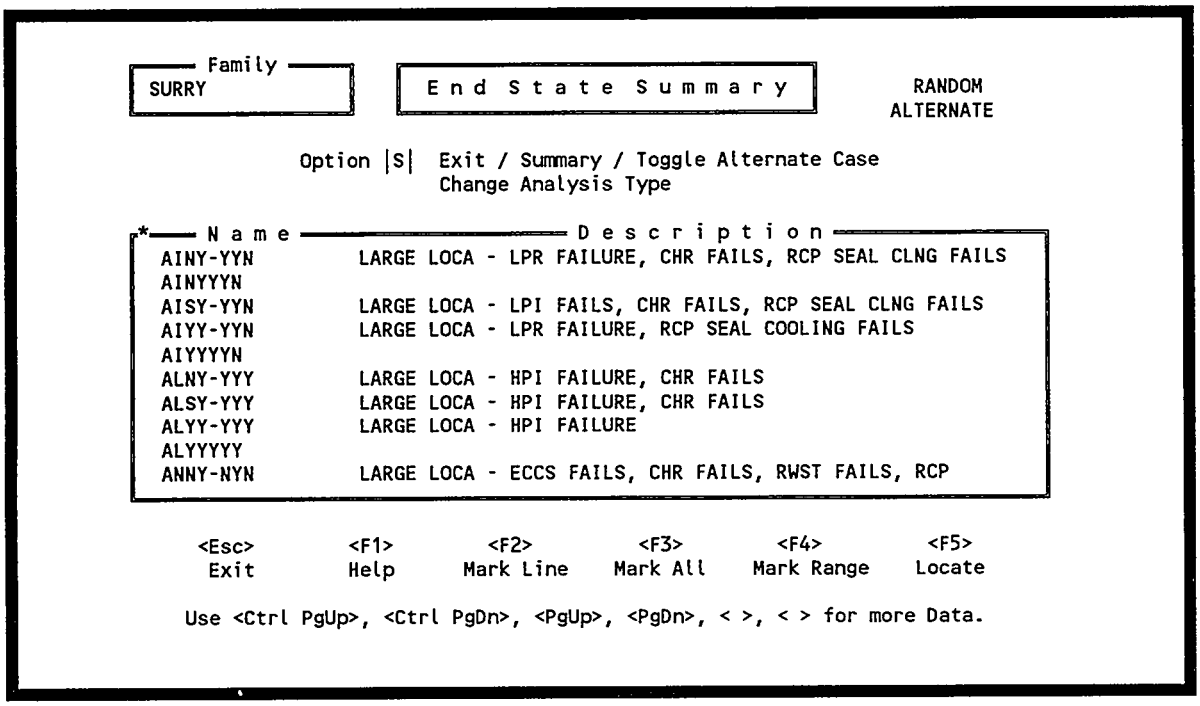


Figure 281. End state summary.

Once the case and analysis type are set, select an end state and press <Enter>. The output destination screen will be displayed. On this screen, you must indicate the desired output destination (see Section 11.2.2).

11.8.1.2 Combination. This option not yet implemented.

11.8.1.3 Uncertainty. This option generates the End State Uncertainty Values Report. This report contains all end states in the current family, the mean and median values, standard deviation, the 5th and 95th percentile, the minimum and maximum values, and the seed size. When you invoke this option, a screen similar to Figure 282 will appear. The same options are available here as described in Section 11.5.1.1. Refer to that section for operating instructions.

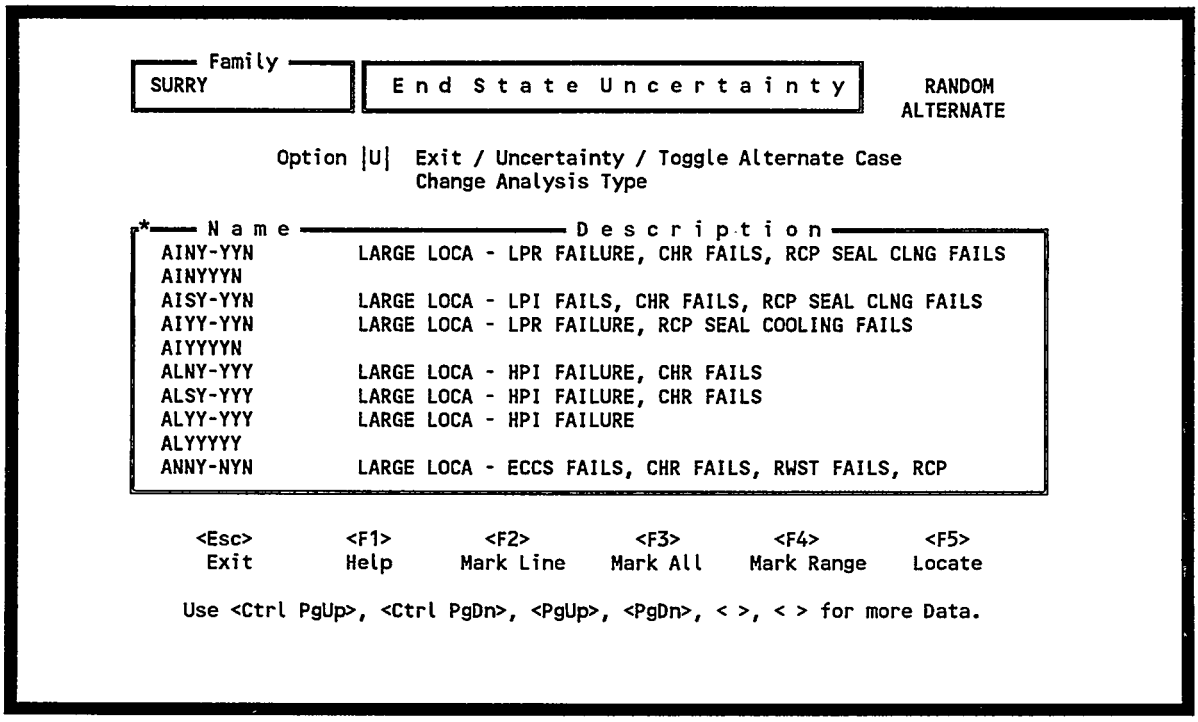


Figure 282. End state uncertainty menu.

11.8.2 Cut Sets Report

This option generates cut set reports based on alternate and base case values. Use the <T>oggle Alternate Cut Set option to set the values to alternate or base case. The word ALTERNATE or BASE will appear in the upper right corner. In addition, you may change the analysis type on which to base the report. To change the analysis type, press <A> in the option field and press <Enter>. A window will be displayed listing the available analysis types. Select the desired type and press <Enter>. See Section 11.3.6.5 for operating instructions.

When you invoke this option, Figure 283 will be displayed. On this screen, all event trees residing in the current family will be displayed. On this screen, you must select the systems to include in the report (see Section 11.3.1). As shown, two reports are available: Cut Set or Quantified Cut Set.

11.8.2.1 Cut Sets. This option generates the End State Cut Set Report that consists of the cut set number, size, and all corresponding cut sets (alternate or base). When you invoke this option, Figure 284 will be displayed. You can modify any of the default values provided by typing over the existing data. Upon pressing <Enter>, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

To invoke this option, mark the event tree(s) to include, enter a <C> in the option field, and press <Enter>.

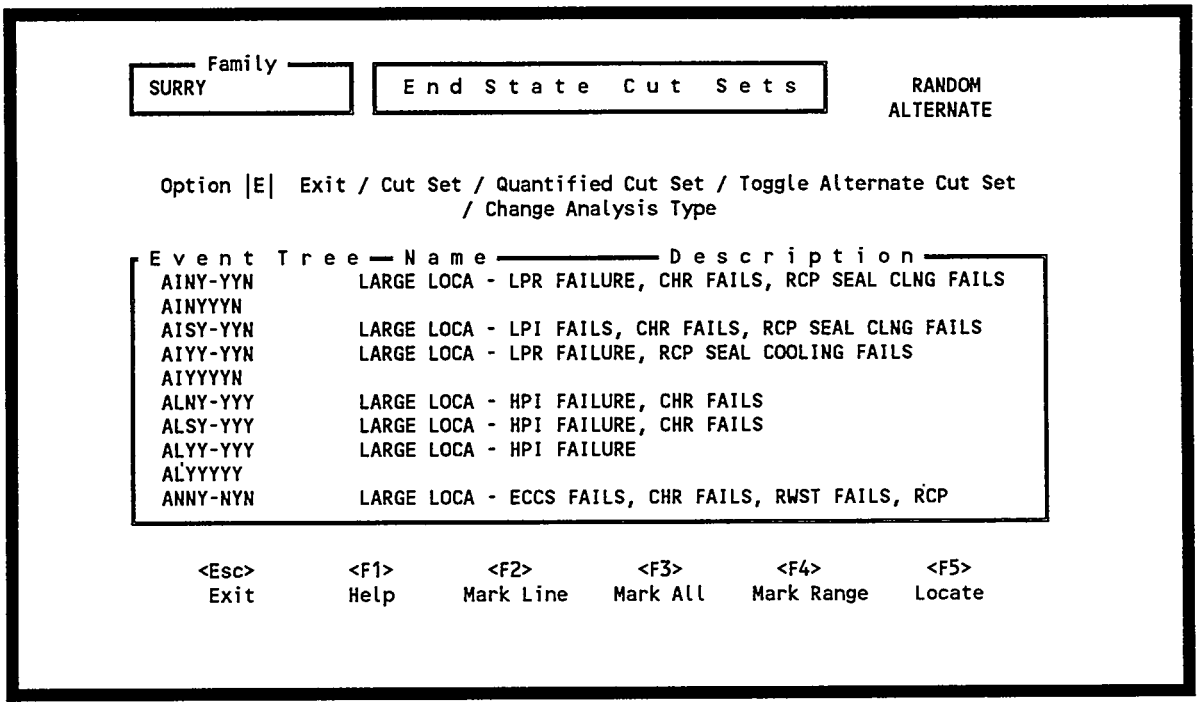


Figure 283. End state cut sets screen.

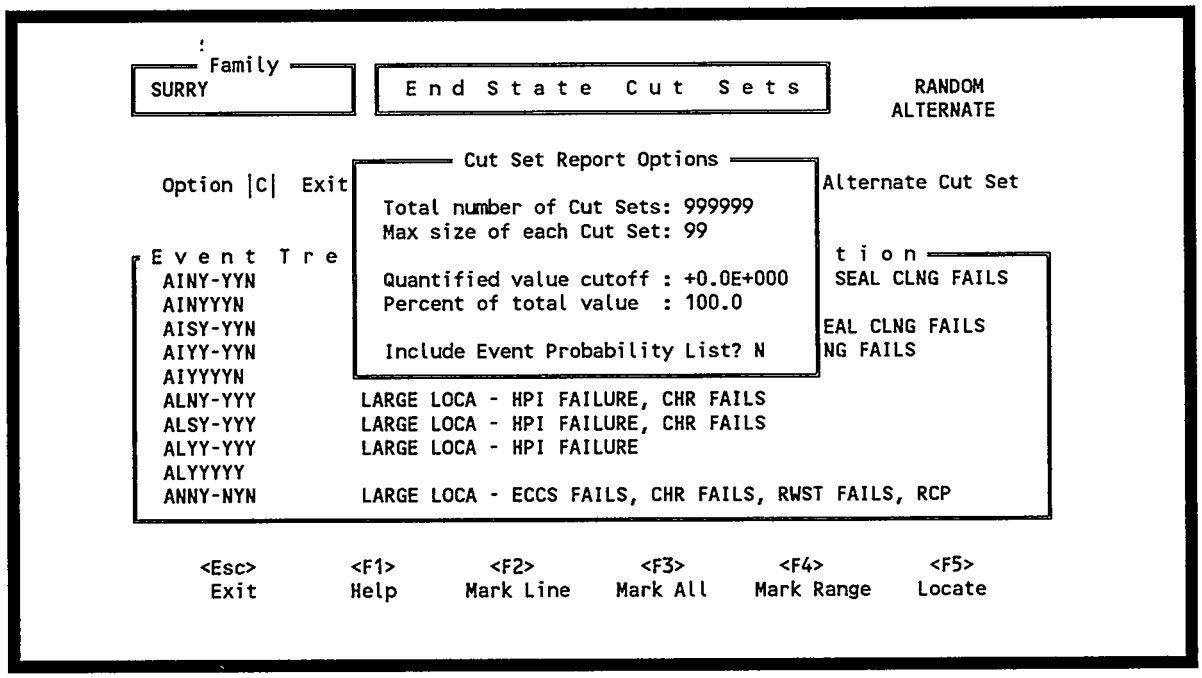


Figure 284. End state cut sets default values.

11.8.2.2 Quantified Cut Set. This option generates 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 all associated cut sets (alternate or base) for the selected end state(s). When you invoke this option, Figure 284 will be displayed. You can modify any of the default values provided by typing over the existing data. Upon pressing <Enter>, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

To invoke this option, mark the end state(s) to include, enter a <Q> in the option field, and press <Enter>.

11.8.3 Importance

This option is not available.

11.8.4 X-Reference

This option generates a cross reference report consisting of the end state number, end state name, and a list of sequences for each selected end state. When you invoke this option, the End State Cross Reference screen will appear (Figure 285). From this screen, you can toggle from base case to alternate values and change the analysis type. To change the base case to alternate values, press <T> (Toggle Alternate Case). The word ALTERNATE or BASE will appear in the upper right corner of the screen. To change the analysis type, enter an <A> in the option field and press <Enter>. A window will be displayed listing the available analysis types. Select the desired type and press <Enter>.

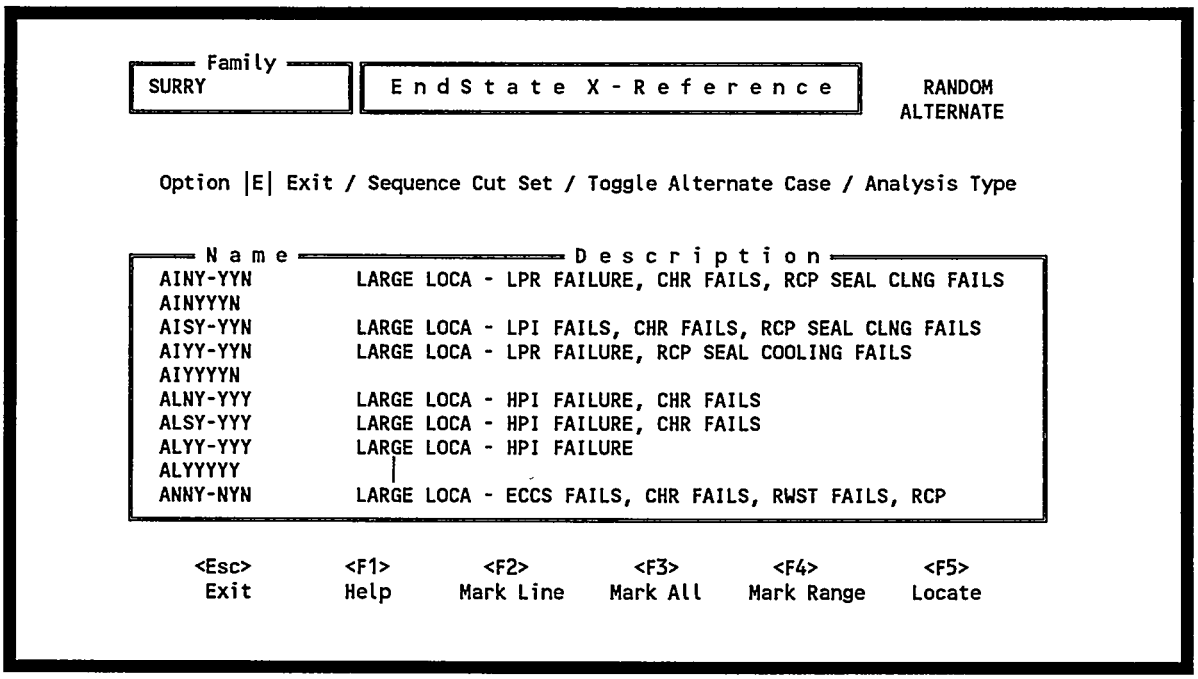


Figure 285. End state cross reference menu.

Once the case and analysis type are set, select an end state (or end states), type an <S> in the option field and press <Enter>. The output destination screen will be displayed. On this screen, you must indicate the desired output destination (see Section 11.2.2).

If you choose to process all end sates, a message will be displayed that allows you to report on all events or a specific group of events. Enter a <Y> to process all records, or an <N> to terminate. In any case, upon pressing <Enter> Figure 286 will appear. On this screen, indicate whether you wish to include all events, referenced events, or unused events. Enter an <A>, <R>, or a <U> and press <Enter>. The output destination screen will be displayed. Select the desired destination and press <Enter>.

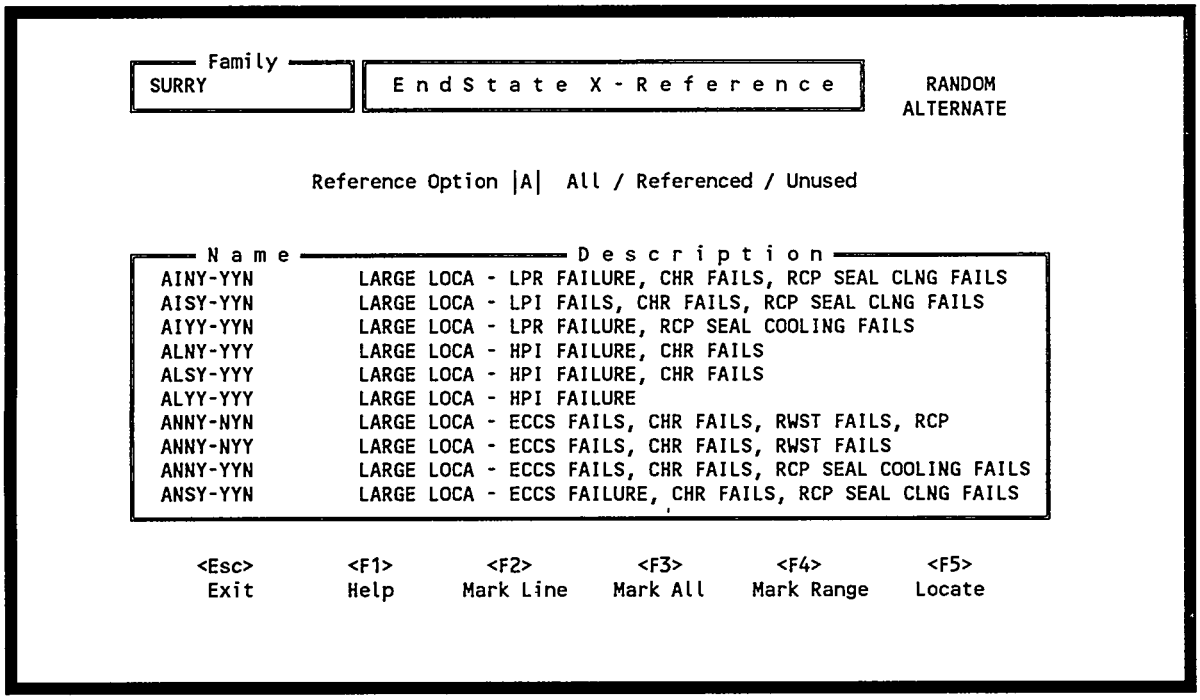


Figure 286. End state reference option for cross reference.

11.9 Gates

This option generates the Gate-System Logic Reference Report. This report lists the selected gate's number and name and the system that references the gate. When you invoke this option, Figure 287 will appear. Highlight X-reference and press <Enter>. A screen will appear listing the gates contained in the current family (see Figure 288). On this screen, you must select the gates to include in the report (see Section 11.3.1). Once the gate has been selected, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

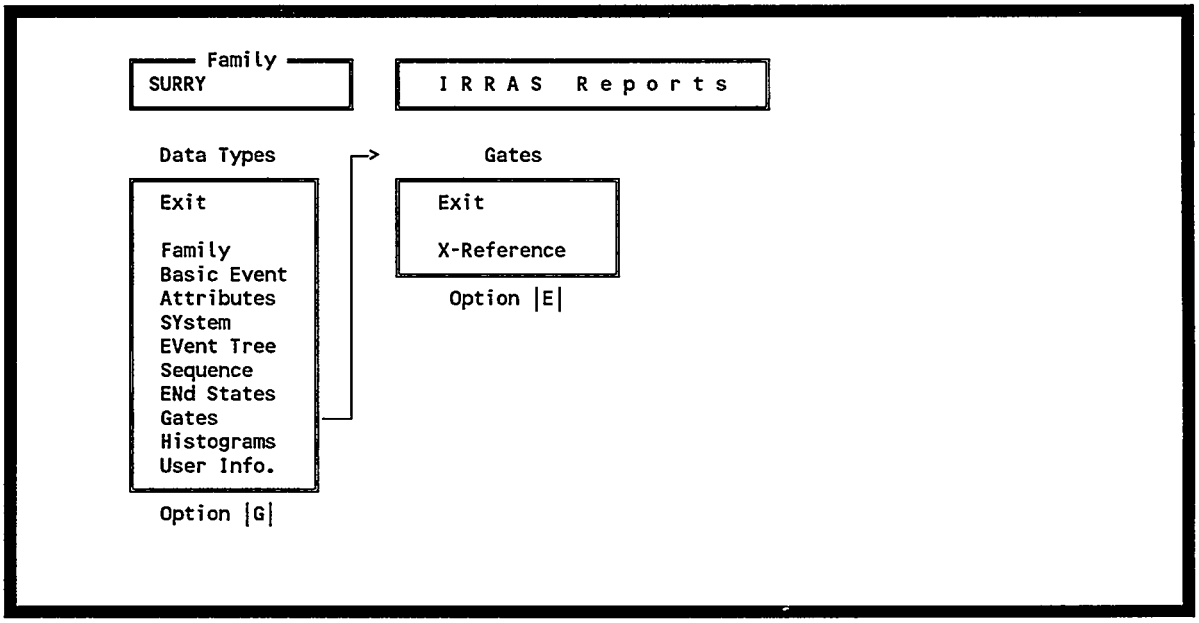


Figure 287. Gate report menu.

11.10 Histograms

This option generates two histogram reports: Summary and Detail. When you invoke this option, Figure 289 will be displayed. You indicate the histogram report to generate by highlighting the desired report using the arrow keys and pressing <Enter>.

11.10.1 Summary

This option generates the Histogram Summary Report. This report lists the histogram type and subtype, its name and description for each histogram defined in the current family.

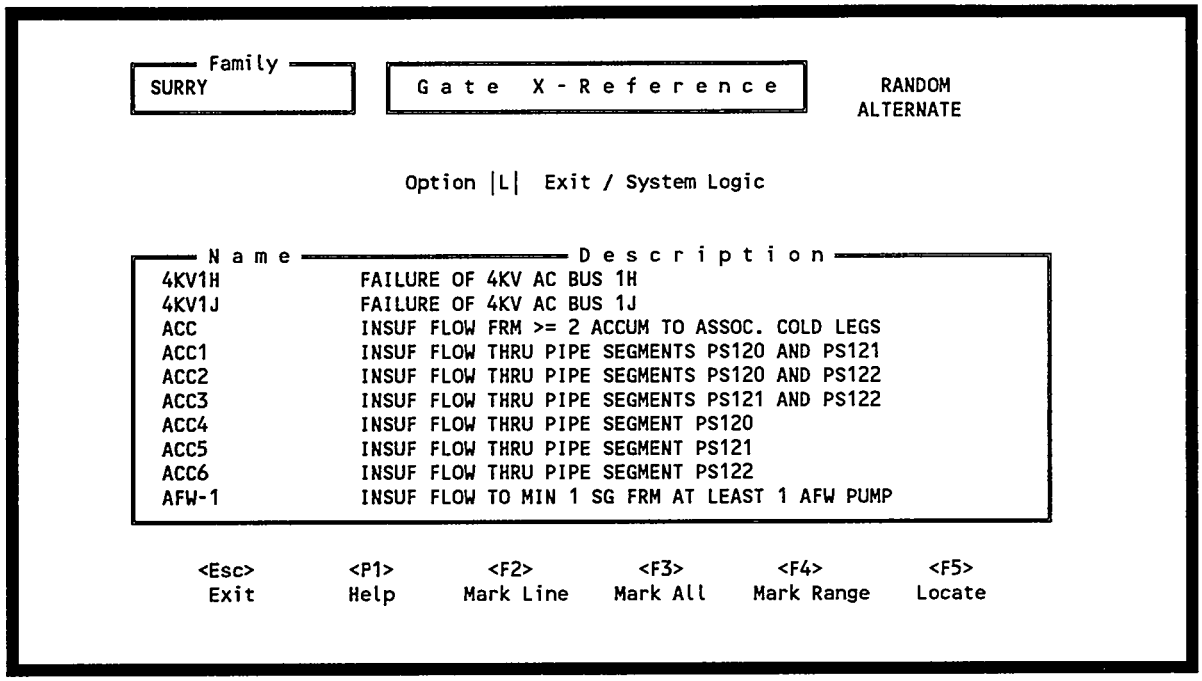


Figure 288. List of available gates.

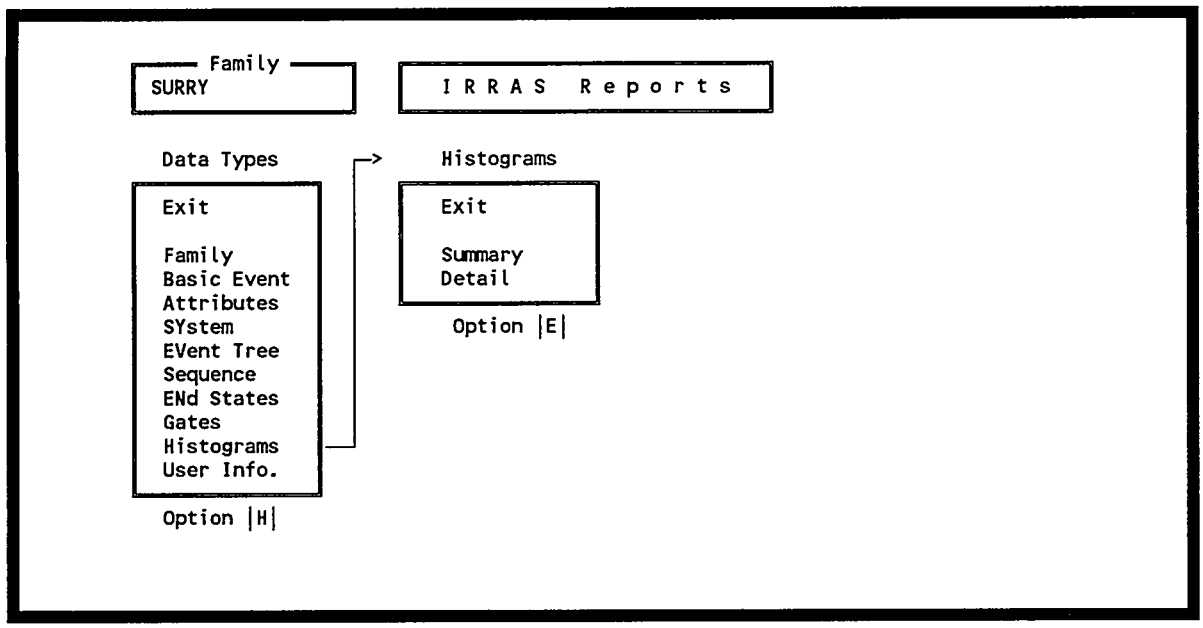


Figure 289. Histogram reports.

11.10.2 Detail

This option generate the Histogram Detail Report. When you invoke this option, a screen will be displayed listing all the histograms defined for the current family. On this screen, you must select the histogram on which to base the report (see Section 11.3.10).

Once the histogram(s) has been selected, the output destination screen will be displayed. On this screen, you must indicate the desired output destination (see Section 11.2.2).

11.11 User Info

This option generates the User defined Constants report. This report list the user's name, hardware configuration, default file locations, archive information, default values for cut set generation and uncertainty calculations, and default flag settings. When you invoke this option, the output destination screen will be displayed. On this screen, you must select the desired output destination (see Section 11.2.2).

12. UTILITY OPTIONS

The IRRAS Utility Options allow you to perform routine functions that are required by IRRAS such as defining constants, archiving the database, recovering the database, and MAR-D data exchange. When you invoke this option, Figure 290 will be displayed.

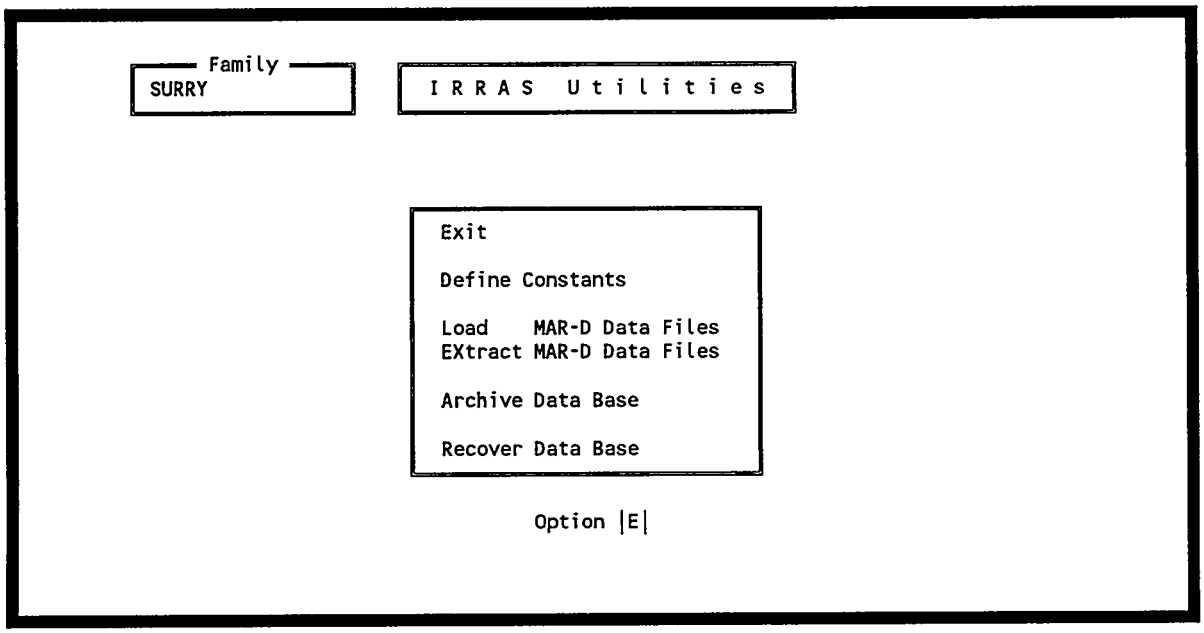


Figure 290. Utility options main menu.

12.1 Exit

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

12.2 Define Constants

The Define Constants <D> option allows you to define what hardware the system uses as well as specifying file locations and archive information, and defining uncertainty settings, cut set constants, and default values for the graphics editor. After choosing this option, the User Information Constants screen shown in Figure 291 is displayed. Table 3 provides a brief description of each of the fields in Figure 291.

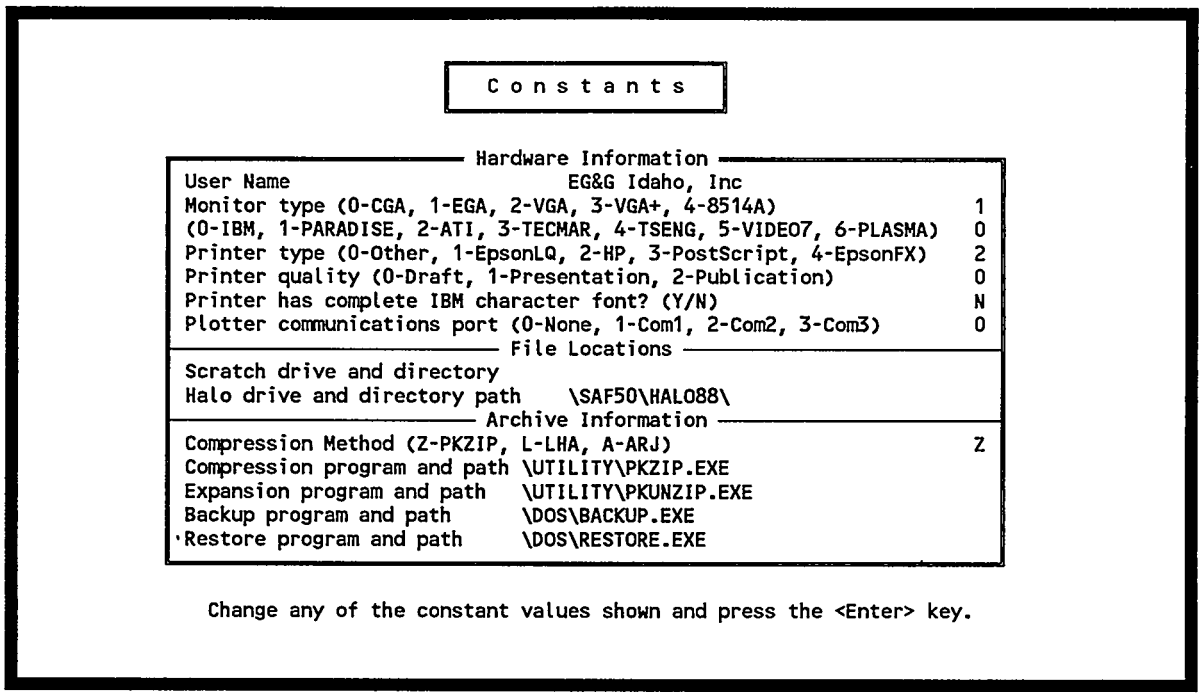


Figure 291. User information constants screen.

Table 3. User Information field descriptions for constants option

FIELD	DESCRIPTION
User Name	36 character user identification (optional) field
Monitor type	0 - Enhanced graphics monitor 1 - DEFAULT - Standard color graphics monitor 2 - Video graphics monitor (2640 x 480) 3 - Video graphics monitor plus (800 x 600) 4 - 8514A
Card type	0 - IBM 1 - Paradise 2 - ATI 3 - TECMAR 4 - TSENG 5 - VIDEO-7 6 - PLASMA
Printer type	0 - Other 1 - Epson 2 - HP Laser (DEFAULT)
Printer Quality	0 - Draft 1 - Presentation 2 - Publication
Printer has complete IBM character font?	Y - Yes N - No (DEFAULT)
Plotter communications port	0 - No Plotter connected to port (DEFAULT). 1 - Plotter connected to Com1 port. 2 - Plotter connected to Com2 port. 3 - Plotter connected to Com3 port.
Scratch drive and directory	36 character field indicating the drive and path to the scratch directory where files will be stored (DEFAULT set to blanks)
Halo drive and directory path	36 character field indicating the drive and path to the Halo graphics that IRRAS 5.0 should use (\HALO88\)
Compression Method	The compression method (package) you will be using. 'Z' = PKZIP 'L' = LHA 'A' = ARJ
Compression program and path	40 character field indicating the drive, path, and executable used to compress files.

Table 3. (continued)

FIELD	DESCRIPTION
Expansion program and path	40 character field indicating the drive, path, and executable used for file expansion.
Backup program and path	40 character field indicating the drive, path, and executable used for backing up files.
Restore program and path Size cutoff	40 character field indicating the drive, path, and executable used for restoring files.

After setting the hardware configuration, file locations, and archive information press <Enter>. The next constants screen will appear (see Figure 292). On this screen, you supply default values and flag settings for cut set generation, transformations, uncertainty and other miscellaneous information. Table 4 provides a brief description of each of the fields in Figure 292.

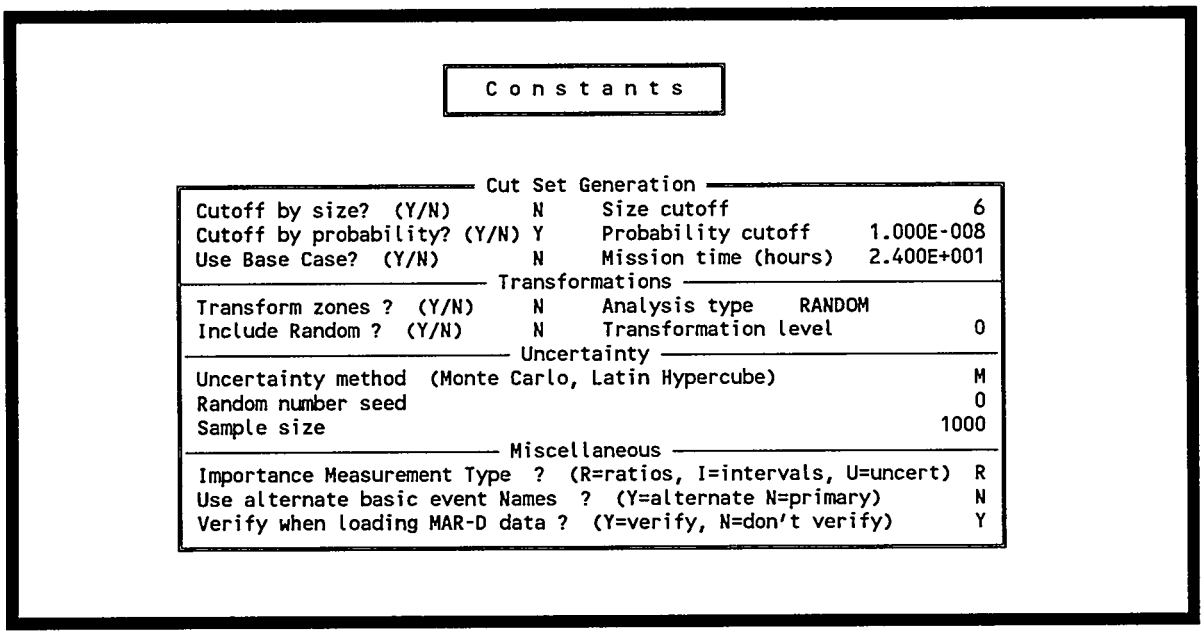


Figure 292. Set default values and flags.

Table 4. Default values and flag settings.

FIELD	DESCRIPTION
Cutoff by size?	Y - Do not generate fault tree or sequence cut sets containing more basic events than indicated in the Size cutoff field (DEFAULT). N - Generate all cut sets for the fault tree or sequence that meet the probability cutoff criteria (if in effect).
Size cutoff	The default maximum number of basic events allowed in cut set generation when size cutoff is in effect. DEFAULT = 6
Cutoff by probability?	Y - Do not generate fault tree or sequence cut sets that have a probability less than the cutoff indicated in the probability cutoff field (DEFAULT) N - Generate all cut sets that meet the size cutoff criteria (if in effect) regardless of the cut set probability.
Probability cutoff	The default minimum cut set probability allowed in cut set generation when probability cutoff is in effect. (DEFAULT = 000E-015)
Use Base Case?	Y - Uses base case values for the analysis N - Uses the alternate case values for the analysis.
Mission time (hours)	The default mission time to be used in the calculation of basic event probabilities (when appropriate). DEFAULT = 2.400E+001
Transform zones	Y - Perform zone transformation during cut set generation. N - Will not perform zone transformation during cut set generation.
Analysis Type	The type of analysis to perform. Default is RANDOM.

Table 4. (continued)

FIELD	DESCRIPTION
Include Random	When performing location transformations this flag indicates whether or not to include random failures of this event in the transformations. Y includes random failures; N does not include random failures.
Transformation level	The level of the transformations to be performed.
Uncertainty method	The uncertainty method to be used in the analysis. M - Monte Carlo L - Latin Hypercube
Random number seed	5 digit numeric field indicating the first random number in the seed to be used in the Monte Carlo calculation. 0 (default) indicates that the random number will be the current value of the real clock.
Sample size	6 digit numeric field indicating the default number of Monte Carlo samples to be run in the uncertainty analyses. Sample size may range from 1 to 999999 (DEFAULT = 1,000).
Importance Measurement	R - Ratios (DEFAULT) I - Intervals U - Uncertainty
Use alternate basic event names?	Y - Alternate name will be used. N - Primary name will be used (DEFAULT).
Verify when loading MAR-D data?	Y - File dependency will be checked. N - No file cross checking will done. (DEFAULT)

After setting the User Information constants, press <Enter>. The next screen displays the Fault Tree Graphics Constants (Figure 293). Table 5 provides a brief description of each of the fields in Figure 293.

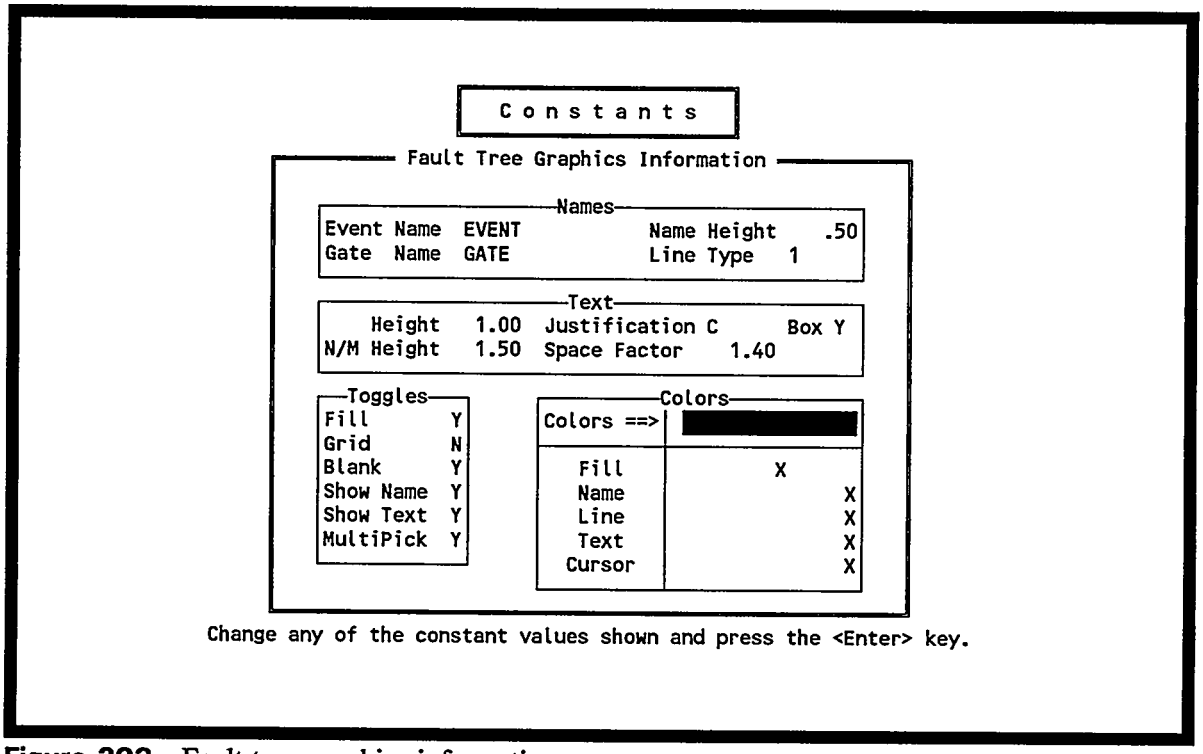


Figure 293. Fault tree graphics information.

Table 5. Fault tree graphics information field descriptions

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

Table 5. (continued)

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

After setting the Fault Tree graphics information constants press <Enter>. The next screen displays Event Tree graphics information (Figure 294). Make any changes needed and press <Enter>. Table 6 provides a brief description of each of the fields in Figure 294.

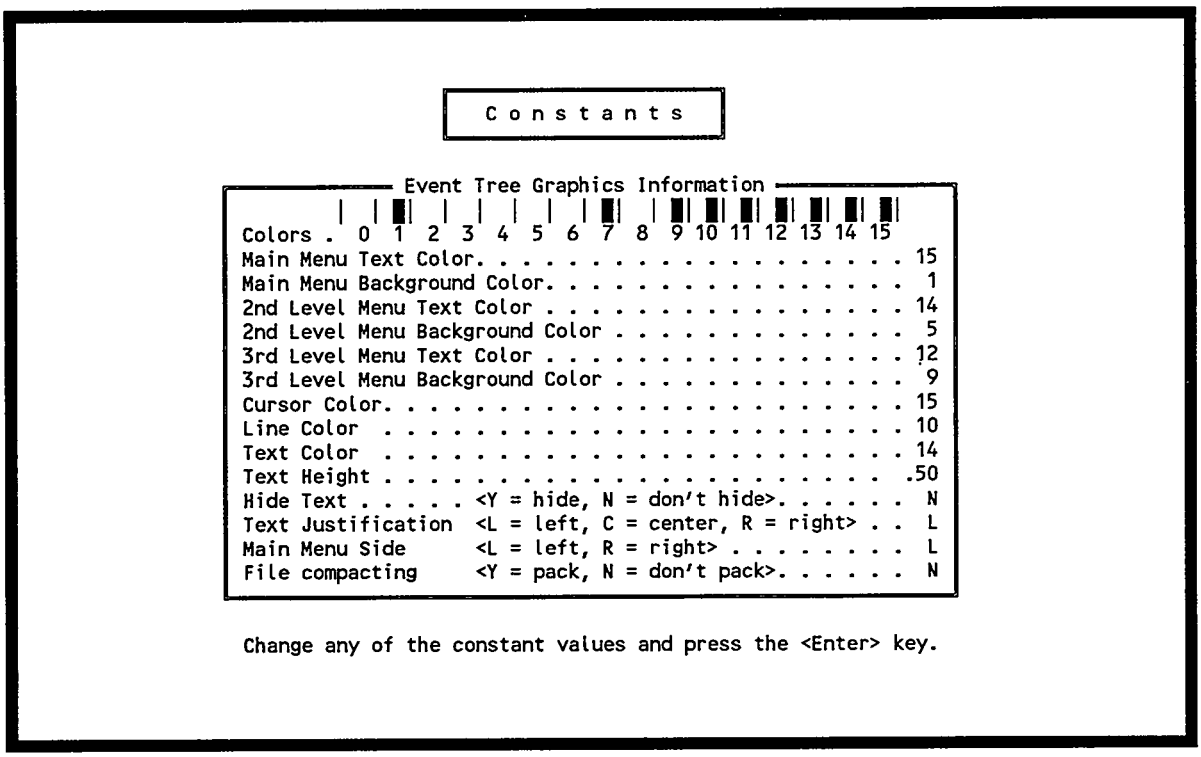


Figure 294. Event tree graphics information.

Table 6. Event tree graphics information field descriptions

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

12.3 Load MAR-D Data Files

The Load MAR-D Data Files option facilitates loading of Probabilistic Risk Assessment (PRA) data from the Models and Results Data Base (MAR-D). The process converts information from the generic format found in the MAR-D database to the IRRAS database format. When you select this option, Figure 295 will be displayed.

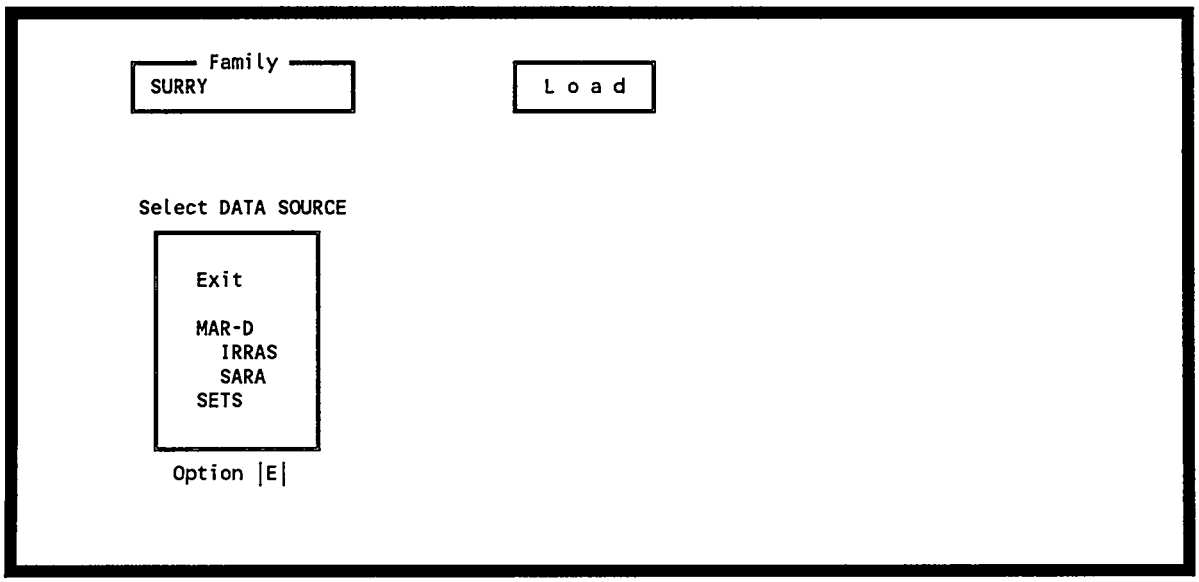


Figure 295. Load MAR-D main menu.

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

Upon entering the LOAD module, Figure 295 will be displayed. As you cursor down through the data tools, autohelp menus will appear to the right, listing the types of data that can be loaded (Figure 296). The right arrow or <Enter> will take you to this second menu (Figure 297). Again, as you cursor down through the data types, menus will appear listing the specifics of what types of data can be loaded (Figure 298). After choosing the data to load (Figure 299), the form in Figure 300 will appear listing the files that contain that data and have the proper extension.

Each of the subsections below contains additional information on loading various types of data. In general, new data loaded into the database overwrites old data of the same name.

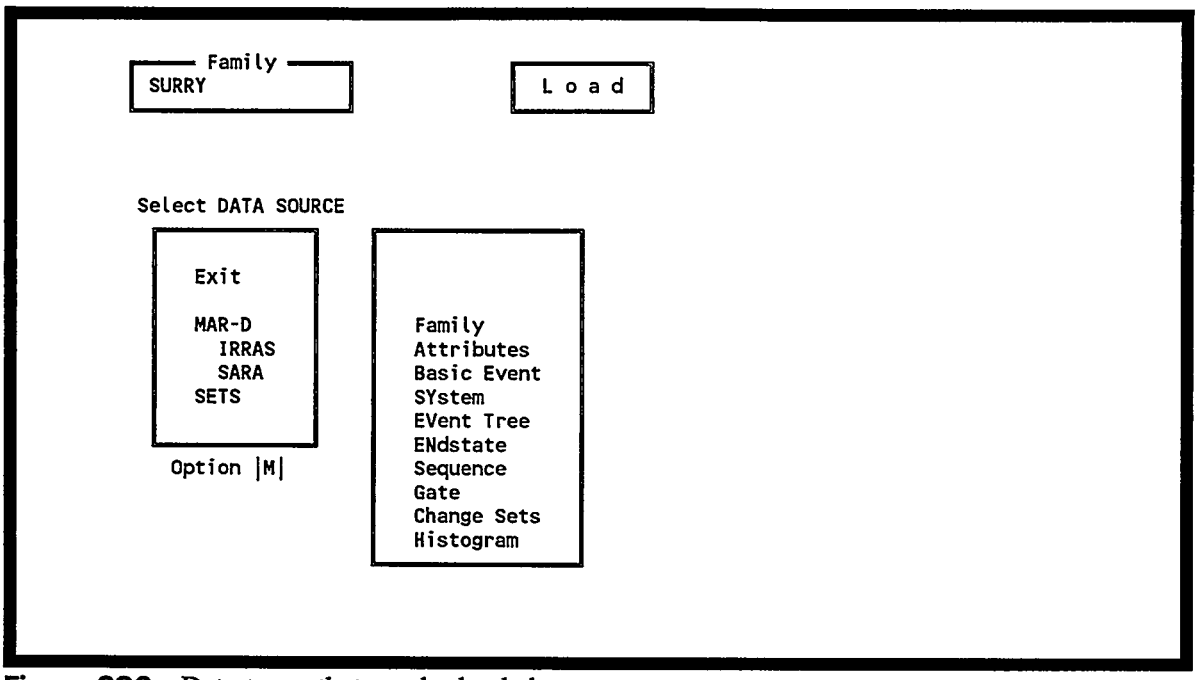


Figure 296. Data types that can be loaded.

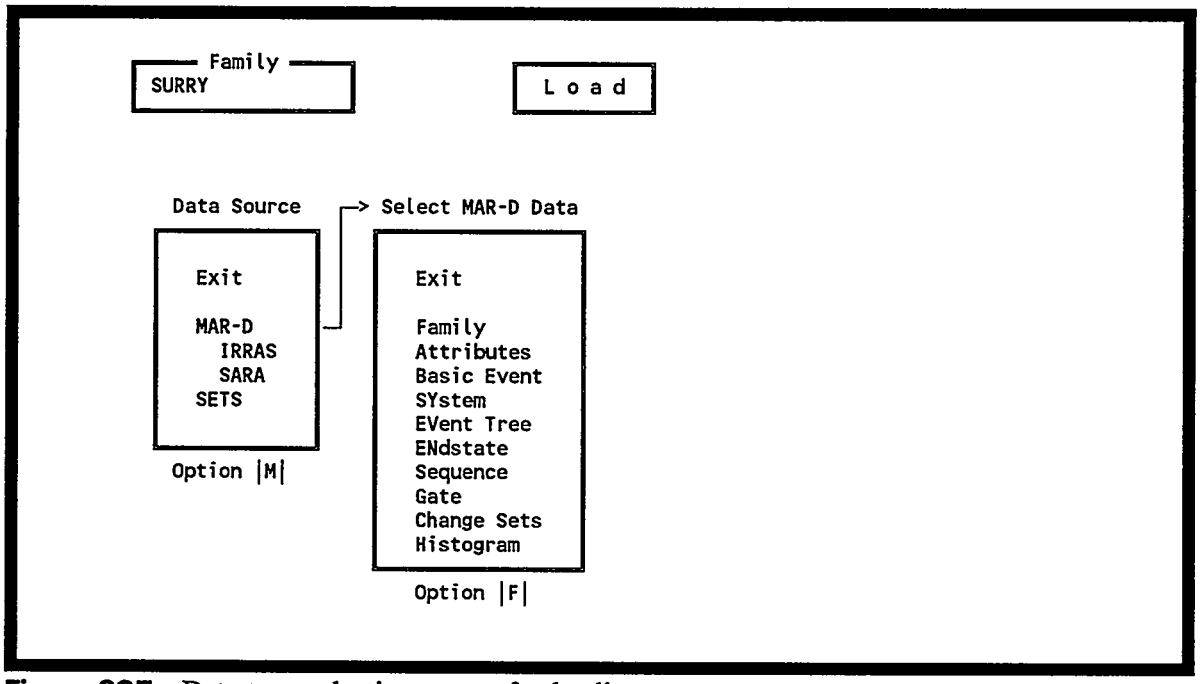


Figure 297. Data type selection screen for loading.

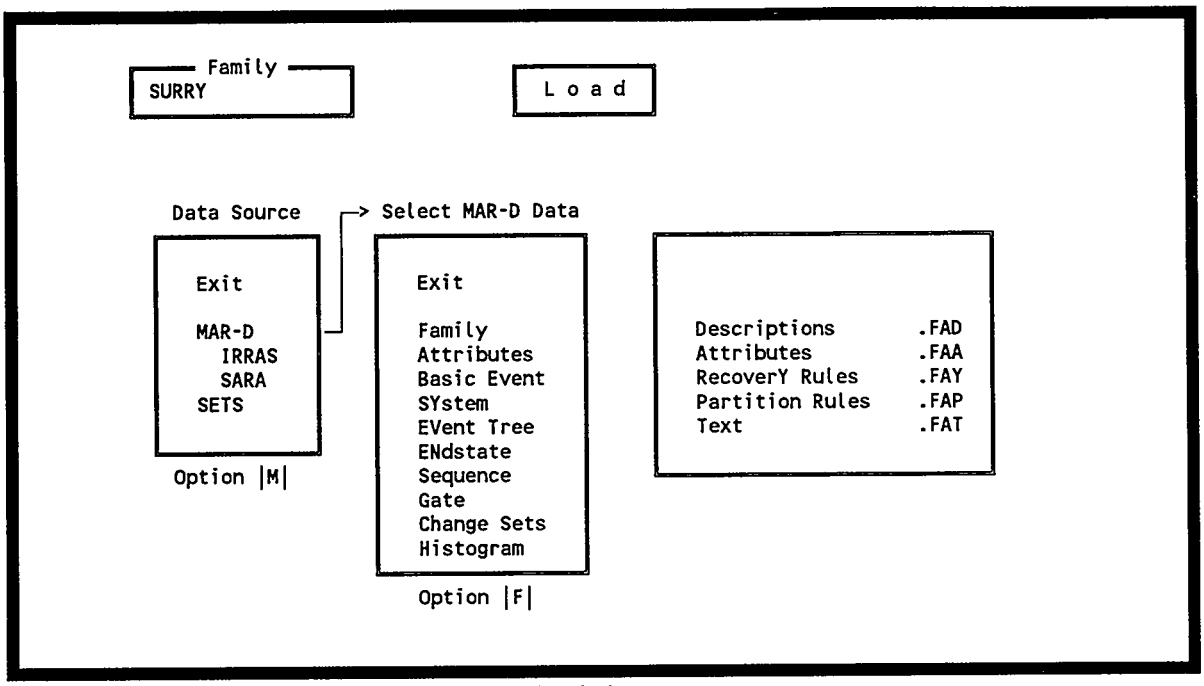


Figure 298. Actual data files that can be loaded.

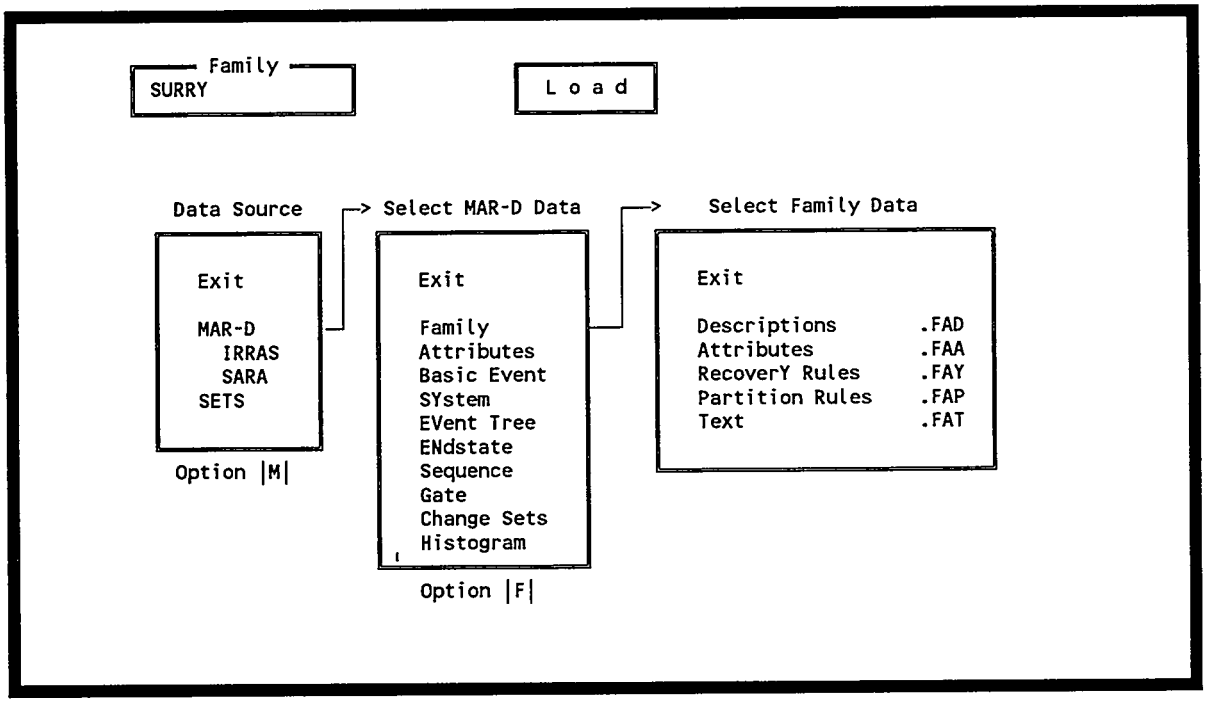


Figure 299. Actual data files that can be loaded.

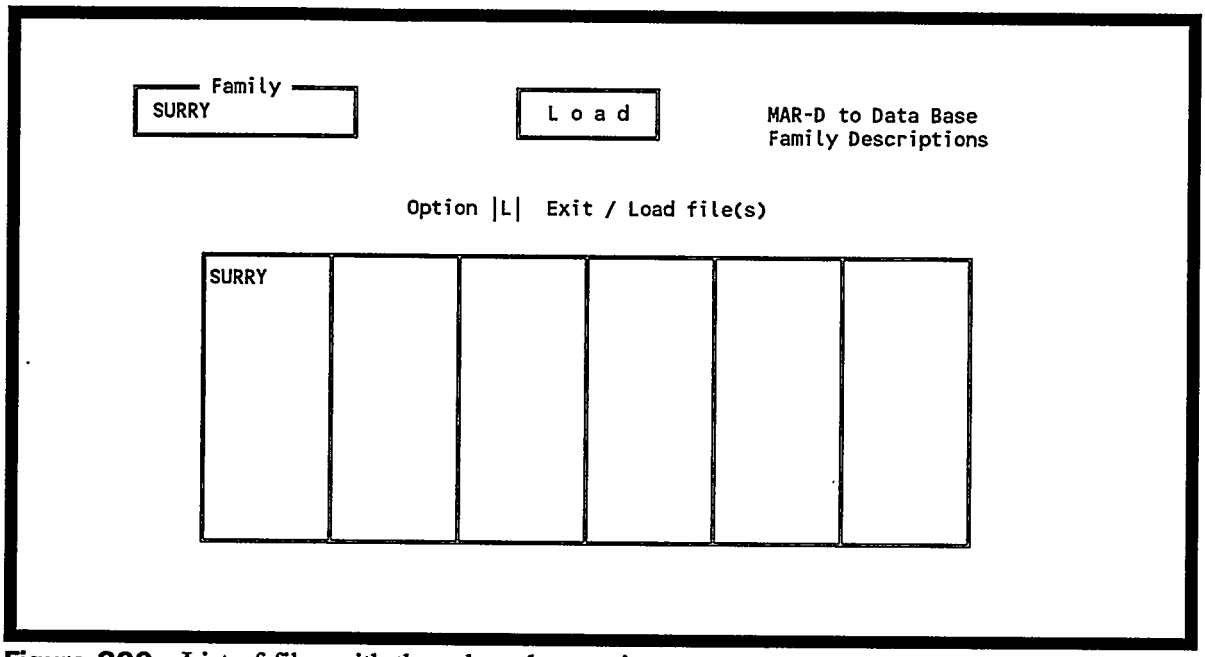


Figure 300. List of files with the selected extension.

12.3.1 Load Verification

Consistency checking for names contained in multiple files can be done by setting "Verify when loading MAR-D data?" to "Y" using the Utility Constants option (Figure 292). Data files that have no prerequisite loaded files (*.CTD, *.FTD, *.BED, etc.) are assumed to be correct and are loaded directly into the database without any field checking taking place. Data files having prerequisite loaded files contain dependent fields referenced in those data files (e.g., the *.BEI file contains event names also contained in the *.BED file). See Table 7 for a listing of files and their prerequisite files and dependent fields.

Table 7. MAR-D files load order dependencies

Group	File	Prereq. files	Dependent fields
Family:	.FAD	----	----
	.FAT	----	----
	.FAA	----	----
	.FAY	----	----
	.FAP	----	----
	.FTT	----	----
NOTE: consistency checking for family names is active for all files.			
Attributes:	.TTD	----	----
	.CTD	----	----
	.FMD	----	----
	.LCD	----	----
	.STD	----	----
BasicEvents:	.BED	----	----
	.BEI,	.BED	Event Name
	.BEA	.BED	Event Name
		.CAD	Class Attr
		.CTD	Comp Type

```
                        .FMD          Fail Mode
                        .LCD          Location
                        .STD          System Type

-------------------------------------------------------------------------------------------------
Systems:      .FTD      ----          ----
              .DLS      ----          ----
              .FTL      .BED          Event Name
              .FTC      .FTD          System Name
                        .BED          Event Name
              .FTA      .FTD          System Name
              .FTT      .FTD          System Name
              .FTY
              .PID
NOTE:  .DLS and .FTL files are put into graphic relation
       instead of system relation. No cross relational cross
       checking available for graphics name.
-------------------------------------------------------------------------------------------------
EventTrees:   .ETD      ----          ----
              .ETA      .ETD          Event Tree Name
                        .BEI          Init Event
              .ETG      .ETD          Event Tree Name
              .ETL      .ETD          Event Tree Name
                        .BEI          Init Event: unless Top
                        .FTD          System Name for TOPS
              .ETR
              .ETY
              .ETP
              .ETT      .ETD          Event Tree Name
NOTE:  .ETG is currently loaded as text. .ETL should look exactly like .ETG file.
-------------------------------------------------------------------------------------------------
EndStates:    .ESD      ----          ----
              .ESI      ????          ????
              .EST      .ESD          End State Name
-------------------------------------------------------------------------------------------------
Sequences:    .SQD      .ETD          Event Tree Name
              .SQC      .ETD          Event Tree Name
                        .SQD          Sequence Name
                        .BED          Event Name
              .SQA      .ETD          Event Tree Name
                        .SQD          Sequence Name
                        .ESD          End State Name
              .SQL
              .SQY
              .SQP
              .SQT      .ETD          Event Tree Name
                        .SQD          Sequence Name
```

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

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

12.3.2 Family

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

12.3.3 Attributes

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

12.3.4 Basic Event

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

12.3.5 SYstem

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

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

12.3.6 EVent Tree

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

12.3.7 ENdstate

End state names, descriptions, and text can be loaded into the database. Formats for end state information have not yet been determined.

12.3.8 Sequence

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

The event tree initiating event must have been entered into the database prior to loading sequence cut sets and, therefore, does not need to be included; any found will be removed from the cut set data.

The event tree initiating event will be included in each cut set term for SETS *.DNF format output.

12.3.9 Gate

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

12.3.10 Change Sets

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

12.3.11 Histograms

Histogram descriptions and information can be loaded into the database. The file format is described in Appendix B.

12.4 EXtract MAR-D Data Files

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

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

The EXTRACT menus are identical with the LOAD menus (see Figure 301 through Figure 305). A data tool type is selected, then a data type, and finally the specific data to be output. In outputting some data, a fourth menu appears. Read the note at the bottom of the screen as well as the appropriate section on extracting that data type.

12.4.1 Family

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

12.4.2 Attributes

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

12.4.3 Basic Event

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

instead of the primary name for descriptions and failure rates. Primary names will be output.

12.4.4 SYstem

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

12.4.5 EVent Tree

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

12.4.6 ENdstate

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

12.4.7 Sequence

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

12.4.8 Gate

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

12.4.9 Change Sets

All change set information used in the GENERATE option can be output for an entire family. For further details see *Models and Results Data Base (MAR-D) Version 5.0, Reference Manual.*

12.4.10 Histograms

Histogram descriptions and information can be output for an entire family.

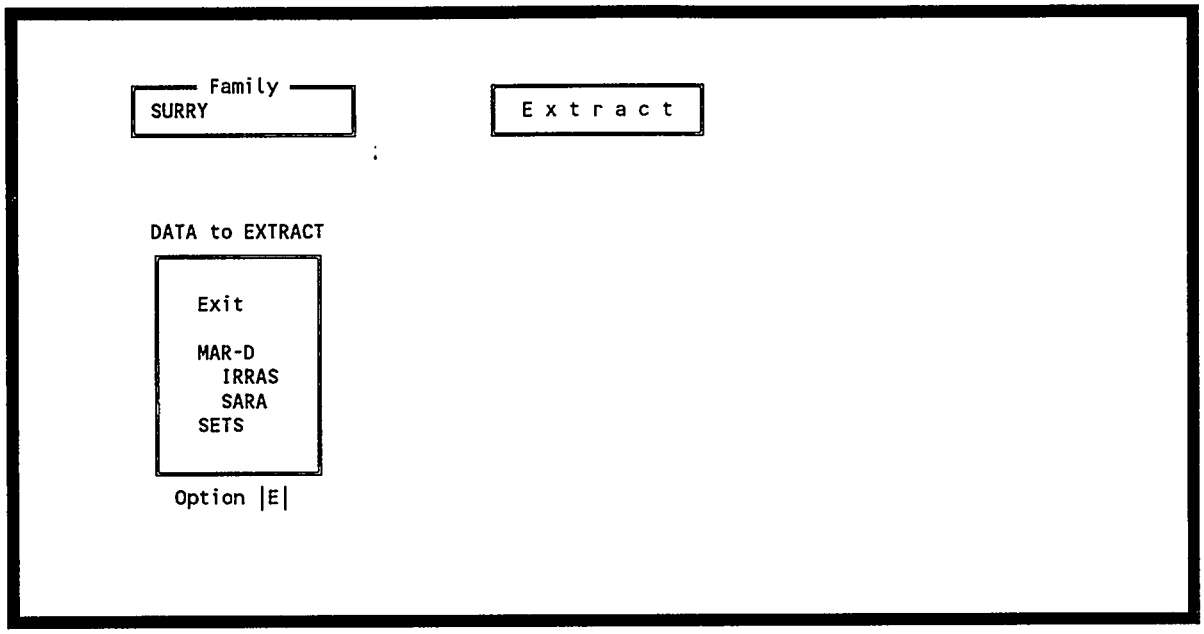


Figure 301. Extract main menu.

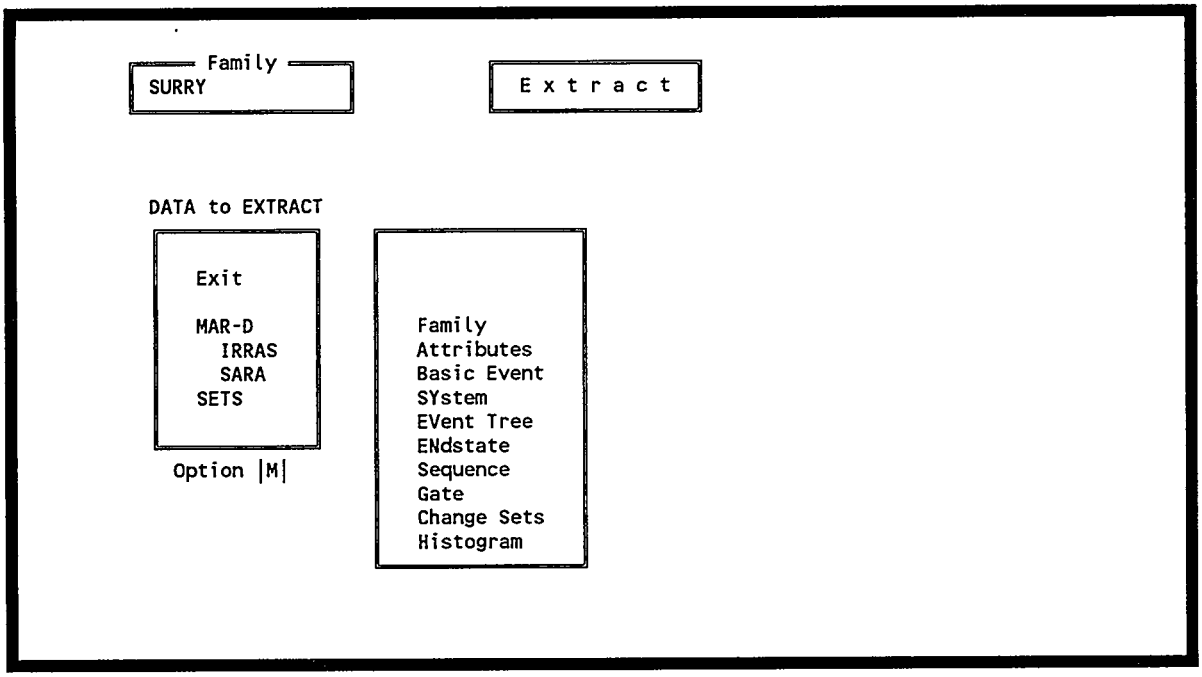


Figure 302. Data types that can be extracted.

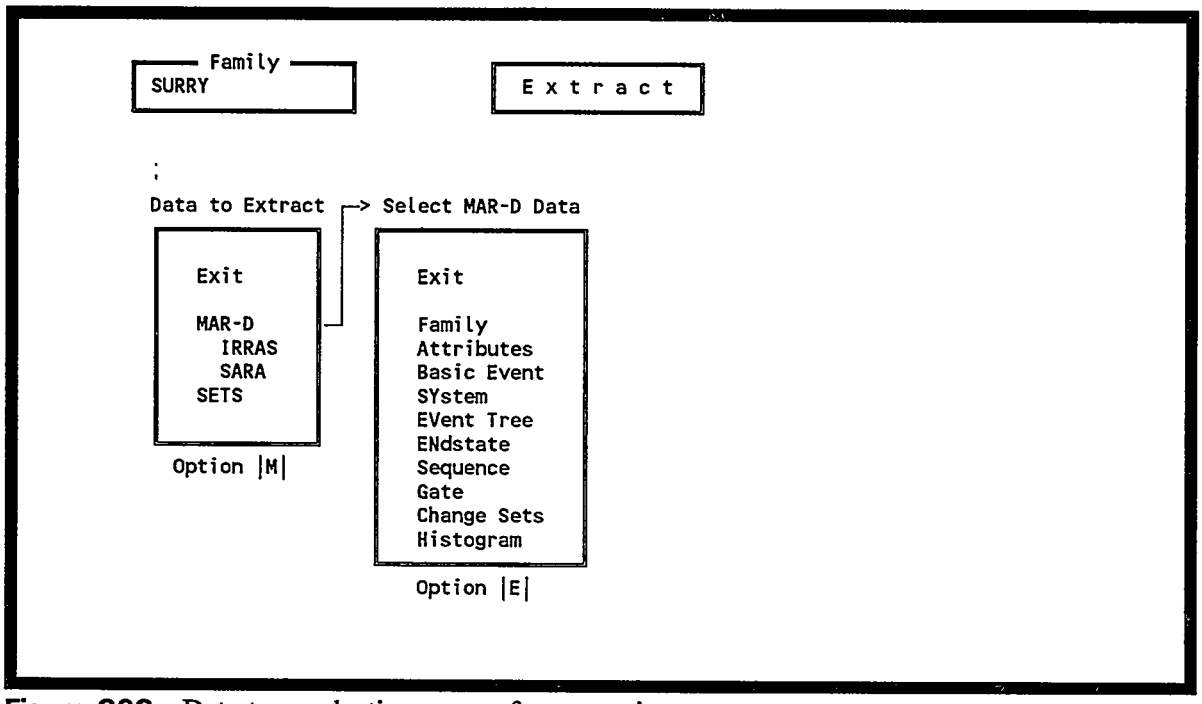


Figure 303. Data type selection screen for extracting.

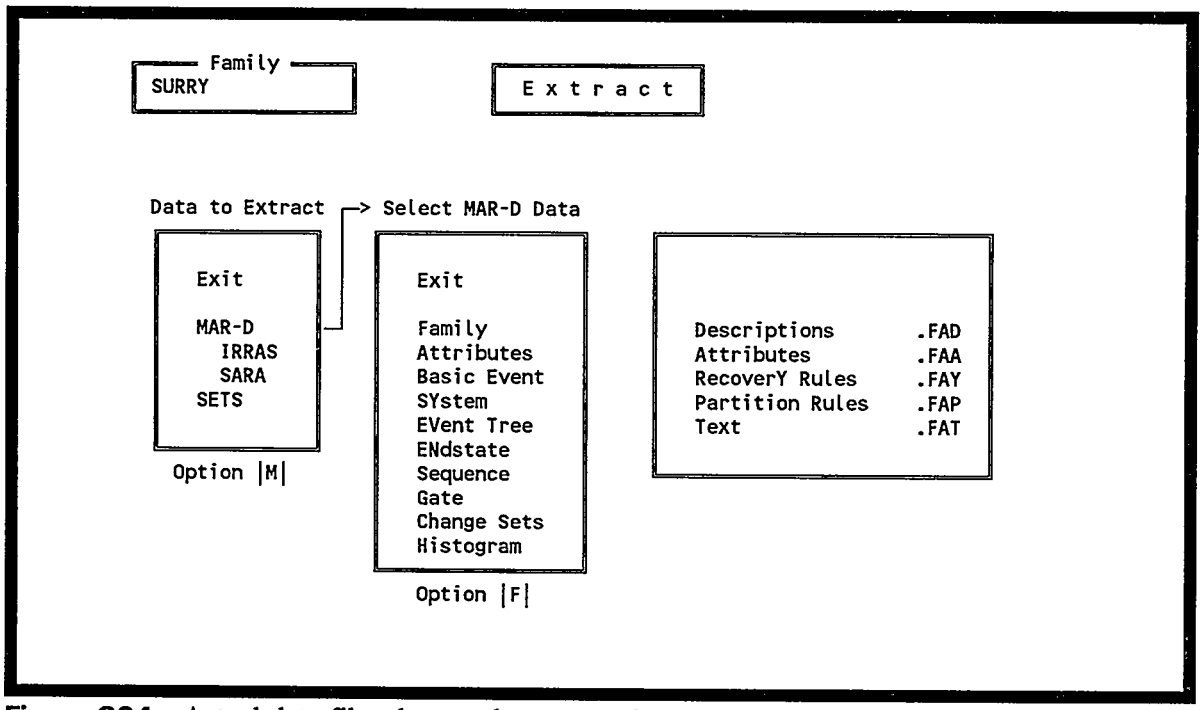


Figure 304. Actual data files that can be extracted.

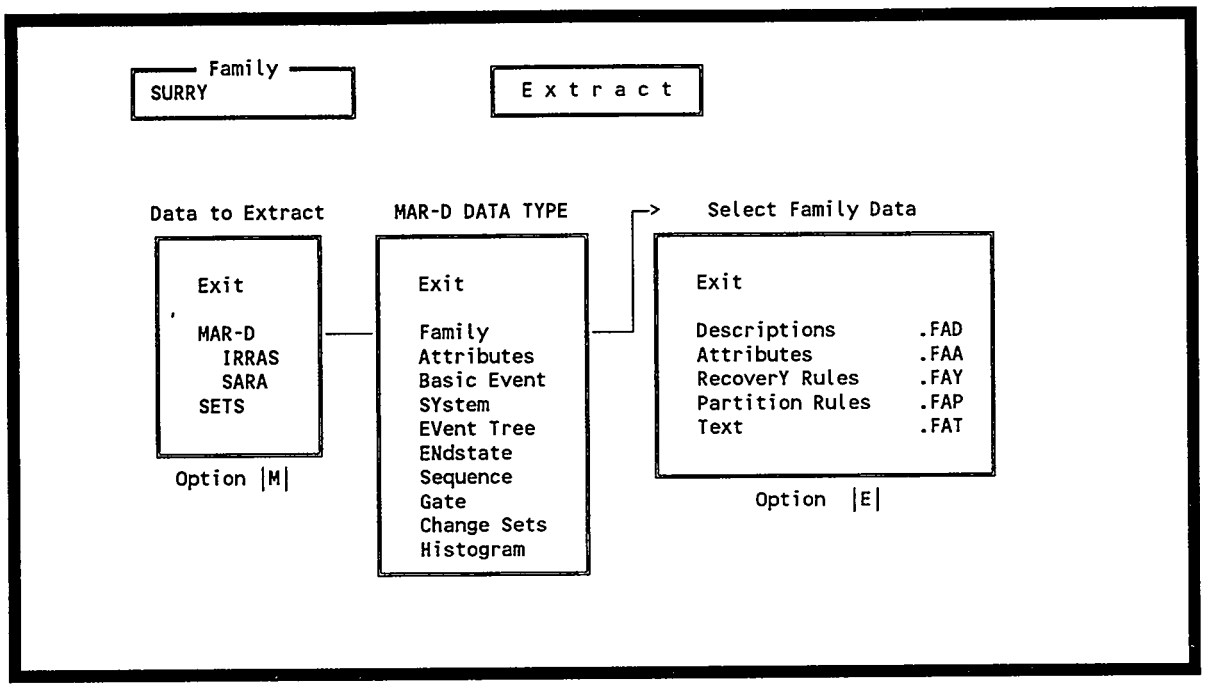


Figure 305. Selection of the data file type to extract.

12.5 Archive Data Base

The archive option allows you to compress, backup, restore, or expand data files for a family. Depending upon the current status of the file, different options can be performed. When you invoke this option, Figure 306 will be displayed.

This screen lists all the families currently defined, along with the directory name, description, and status. The status column can contain one of the following codes:

OnL - This means that the data files for the corresponding family are on-line. The data files for these families can be accessed immediately.

Cmp - This means that the data files for the family have been compressed into an archive file. These types of files must be de-compressed before they can be accessed. PKZIP, LHA (LHARC), and ARJ compression packages are all supported by IRRAS. The decompressed data files are deleted.

Depending on the status of the data files, a number of different archiving options can be invoked. These archiving options are discussed in the following paragraphs. From Figure 306, the following function keys are available:

<Esc> - The <Esc> key terminates the archive option and returns you to the Utility menu.

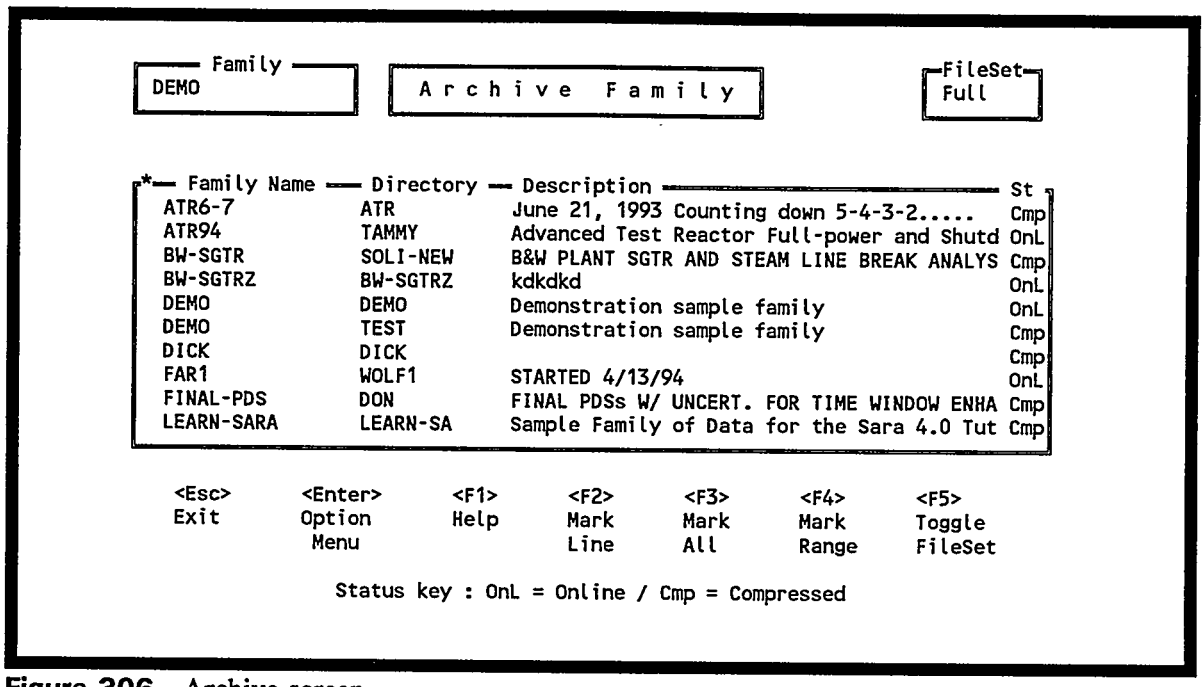


Figure 306. Archive screen.

<Enter> - The <Enter> key displays the archiving options available. The archiving options are discussed in detail in Section 12.5.1.

<F1> - The <F1> key displays on-line help messages.

<F2> - The <F2> key allows you to mark a family for further processing. The <F2> is a toggle that mark or unmarks a family. When a family is marked, an asterisk appears in the first column.

<F3> - The <F3> key marks or unmarks ALL of the families for further processing.

<F4> - The <F4> key marks a range of families for further processing. Highlight the first item in the range and press <F4>. The message "Range selected - Highlight end of range..." will appear. Highlight the last item in the range and press <F4>. All families within the selected range will be marked for further processing.

<F5> - The <F5> key toggles the file set (shown in the upper-right corner) from Full to Minimal. When the file set is set to full, IRRAS will use all files in the family directory in the subsequent archiving process. When the file set is set to minimal, IRRAS will use only the *.DFL, *.IDX, *.DAT, *.BLK, and *.CUT files in the subsequent archiving process.

12.5.1 Archiving Options

Once the desired families have been marked using the <F2>, <F3>, and <F4> keys and press <Enter>, a screen similar to Figure 307 will be displayed. As shown, the following archiving options are available:

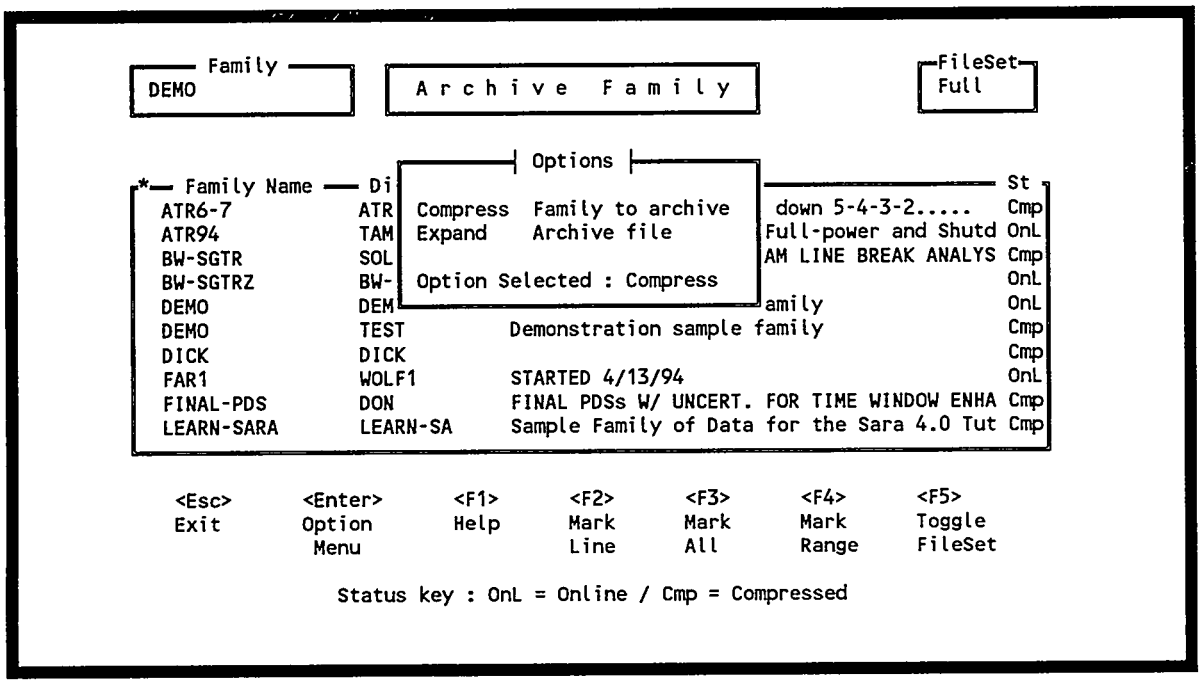


Figure 307. Archiving options.

Compress - This option compresses the data files of the highlighted family and stored the compressed files in an archive file. PKZIP, LHA, and ARJ are all supported by IRRAS. The decompressed data files are deleted. To invoke this option, highlight Compress and press <Enter>. When the compression is complete, the message "Compress Complete" will be displayed at the bottom of the screen and you will return to the previous screen. The status column (St) for the selected family(s) will be changed to Cmp.

Expand - This option extracts and expands the data files stored in the archive created by the Compress option described above. To invoke this option, highlight "Expand" and press <Enter>. (Note: You must have marked a file with a status of Cmp for the expand option to work.) When the expansion is complete, the message "Expand Complete" will be displayed at the bottom of the screen and you will return to the previous screen. The status column (St) for the selected family(s) will be changed to OnL.

12.6 Recover Data Base

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

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

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

You may rebuild the database anytime because the rebuild process compacts the data and generally helps the software run faster. This option performs all the recovery methods shown on the screen. This option will recover all key indexes and then recover the cross references. This option will take several minutes to complete. If your database has not been damaged, this option will restructure and optimize your database.

When you invoke this option, a warning screen will be displayed (see Figure 308). At the prompt, enter a <Y> and press <Enter> to continue with the recovery, or enter an <N> and press <Enter> to terminate the process. If you type <Y> and press <Enter>, status messages will appear as the recover process proceeds.

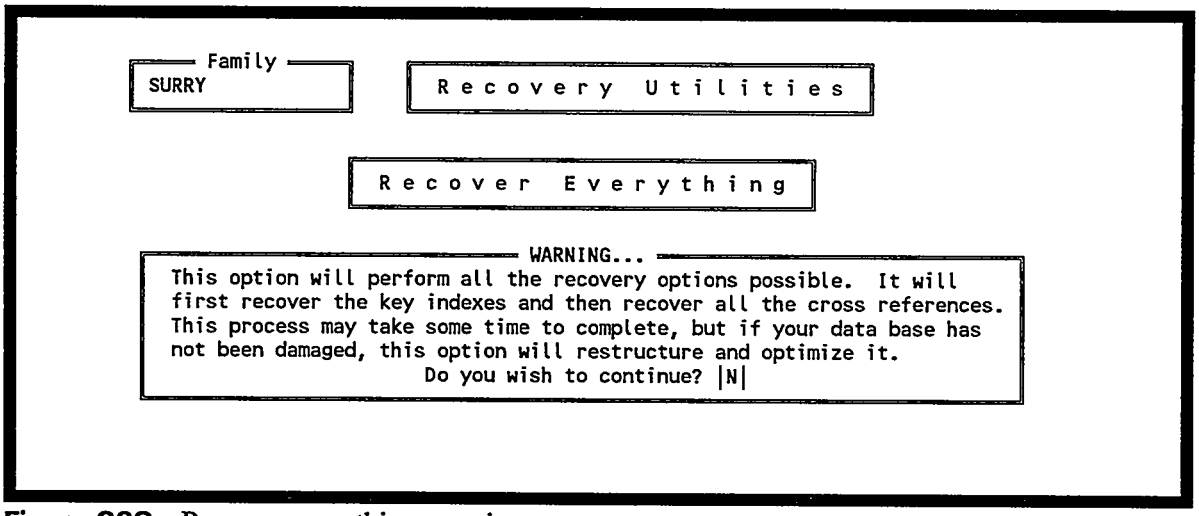


Figure 308. Recover everything warning screen.

APPENDIX A

HARDWARE REQUIREMENTS AND INSTALLATION PROCEDURES

APPENDIX A

HARDWARE REQUIREMENTS AND INSTALLATION PROCEDURE

The IRRAS 5.0 system requires the following hardware configurations:

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

If an enhanced graphics adapter is used, it must have the memory expansion option to extend the standard 4 colors to 16. This option is an upgrade to the IBM EGA board, but is usually standard on boards manufactured by other vendors. IRRAS 5.0 does not support the 4-color mode on the EGA adapter.

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

NOTE: The IRRAS 5.0 system requires the above specified amount of random access memory (RAM). This memory must be available for the program and not used by memory resident programs. Also, certain memory resident programs may interfere with the execution of IRRAS 5.0. These should be unloaded before using IRRAS 5.0. The MS/DOS command "MEM" can be used to display the amount of memory available on your machine.

To install the IRRAS 5.0 software on your computer, perform the following steps:

1. Insert disk #1, and type

   x:install and press **<Enter>**

   where x is the drive containing the installation diskette(s).

   Figure A-1 appears. On this screen, fill out the following information:

   Source drive - Enter the drive containing the installation diskettes.

   Destination Drive - Enter the drive where the IRRAS files will be installed.

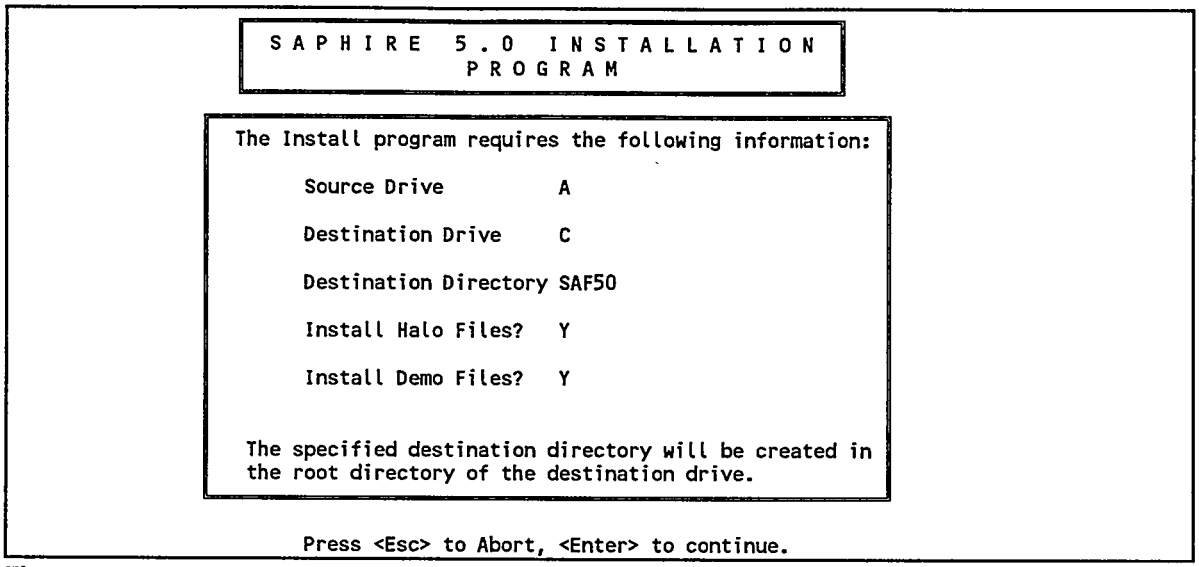


Figure A-1. Installation screen.

Destination Directory - Enter the directory name where the IRRAS program files will be written. The specified destination directory will be created in the root directory of the destination drive.

Install HALO Files - Enter a **<Y>** to install HALO files; otherwise enter an **<N>**. These files are required by the graphical displays generated by IRRAS.

Install Demo Files - Enter a **<Y>** to load the demonstration database. The DEMO database contains sample data.

When complete, press **<Enter>** to continue.

3. The program files on the installation diskette(s) are compressed. The installation procedure de-compresses these files and copies them onto the hard drive. The de-compression process is indicated by the listing of files being "exploded" or "inflated". These terms are used by the de-compression software to indicate the process used when the files were compressed.

4. When complete, a prompt will appear asking you to insert the next diskette (e.g., DISK #002). Insert the disk and press <Enter> to continue to start the de-compression process for this diskette.

5. Repeat Steps 1 - 4 until all installation disks have been loaded.

6. When complete, you will be returned to the destination directory.

NOTE: If you are loading IRRAS from a network, you will not be loading diskettes; however, the process is the same.

After the installation is completed, you need to locate and modify your CONFIG.SYS file. This file is in the root directory. If you do not have a file by this name, you must create one. In either case, the following parameters must be included in the file, if not already present.

```
FILES=35
BUFFERS=15
DEVICE=ANSI.SYS
```

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

The installation procedure will create a batch procedure, IRRAS.BAT, for executing IRRAS 5.0 in the \SAF50 directory. This procedure may be used directly or adapted to meet your specific needs. If you choose not to modify the procedure, the following format is used to execute IRRAS 5.0. Type:

```
CD\SAF50
IRRAS
```

This completes the installation of the IRRAS 5.0 software. The user must now ensure that the proper graphics input device is hooked up and ready for use. When this is done, the IRRAS 5.0 system is ready for use. Refer to Section 11.2 for a discussion on defining constants for your configuration.

APPENDIX B

DATA INTERCHANGE FORMATS

I R R A S

PRA Models and Results Data Base
Data Interchange Formats. March 14, 1994

B.1 MAR-D (IRRAS, SARA)

B.1.1 General Format Rules

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

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

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

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

These rules apply to all files unless specifically stated otherwise.

B.1.2 Family (Plant) Information

B.1.2.1 Family Names and Descriptions.

File Name:
xxxxxx.FAD
File Format:
name,description
where

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

B.1.2.2 Family Attribute File.

File Name:
xxxxxx.FAA
File Format:
family=
name,mission,newSum,co,loc,type,design,vendor,AE,OpDate,QualDate
where

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

B.1.2.3 Family Textual Information.

File Name:
xxxxxx.FAT
File Format:
family =
-- text --
where

family	- 16 character	Family name

B.1.2.4 Family Recovery Rules

File Name:
xxxxxxxx.FAY
File Format:
family =
-- recovery rule text --
where
family - 16 character Family name

B.1.2.5 Family Partition Rules

File Name:
xxxxxxxx.FAP
File Format:
family =
-- partition rule text --
where
family - 16 character Family name

B.1.3 Basic Event Information

B.1.3.1 Basic Event Names and Descriptions.

File Name:
xxxxxx.BED
File Format:
family =
name,description
. . . , . . .
where

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

B.1.3.2 Basic Event Rate Information.

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

File Name:
xxxxxx.BEI
File Format:
family =
name, calc, udC, udT, udV, prob, lambda, tau, mission, init, Flag, udV2
. . . , . . . , . . . , . . . , . . . , . . . , . . . , . . . , . . . , . . . , . . .
where

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

1 - Probability
2 - Lambda * Mission Time
3 - 1 - Exp(-Lambda * Mission Time)
4 - Lambda * Min(Mission Time, Tau)
5 - Operating component with full repair
6 - Lambda * Tau / 2.0
7 - 1+(EXP(-Lambda*Tau)-1.0)/(Lambda*Tau)
8 - Base Probability * Probability
9 - Base Probability * Probability
T - Set to House Event (Failed, Prob=1.0)
F - Set to House Event (Successful,Prob=0.0)
I - Set to ignore
S - Use system mincut upperbound
G - Seismic event-Enter g level for screening
M - Seismic event-Use medium site hazard curve for screening

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

udT - 1 character Uncertainty distribution type

L	- Log normal, error factor
N	- Normal, standard deviation
B	- Beta, b of Beta(a,b)
G	- Gamma, a Gamma(a)
C	- Chi-squared, degrees of freedom
E	- Exponential, none
U	- Uniform, Upper end pt.
H	- Histogram
M	- Maximum entropy

udV	-	Floating point Uncertainty distribution value
prob	-	Floating point Probability value
lambda	-	Floating point Basic event failure rate per hr.
tau	-	Floating point Time to repair in hours
mission	-	Floating point Mission time
init	-	Boolean Initiating event flag (Y/N)
Flag	-	1-character process flag
udV2	-	Floating point Uncertainty distribution value #2

General Rules:

1. The name field is mandatory.

B.1.3.3 Basic Event Attribute Codes.

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

File Name:

xxxxxx.BEA

File Format:

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

where

family	- 16 character	Family name
name	- 16 character	Event name
Aname	- 16 character	Alternate event name
type	- 3 character	Event component type
sys	- 3 character	Event component system
fail	- 3 character	Failure mode
loc	- 3 character	Component location
compID	- 7 character	Component ID
Gname	- 16 character	Event group identifier
train	- 3 character	Train identifier

att1..att16	- Class attribute flags--16 values of Y or N (yes or no) indicate whether the attribute described in the class attribute file is applicable.	

General Rules:

1. The name field is mandatory.

B.1.3.4 Basic Event Transformations.

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

Site Name:

xxxxxx.BET

File Format:

family =
name1,level,type
bename1, bename2, . . . ,
. . . , benameN
^EOS
name2,level,type
bename1, bename2, . . . ,
. . . , benameN
^EOS

where

family	- 16 character	Family name
name	- 16 character	Event name
type	- 4 character	Transformation type
level	- 3 character	Transformation level
bename1..N	- 16 character	Event name

B.1.4 Event Attribute Descriptions

B.1.4.1 Failure Mode Descriptions.

File Name:

xxxxxx.FMD

File Format:

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

where

family	- 16 character	Family name
fail	- 3 character	Failure mode identifier

description	- 60 character	Failure mode description

B.1.4.2 Component Type Descriptions.

File Name:

xxxxxx.CTD

File Format:

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

where

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

B.1.4.3 System Type Descriptions.

File Name:

xxxxxx.STD

File Format:

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

where

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

B.1.4.4 Location Descriptions.

File Name:

xxxxxx.LCD

File Format:

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

where

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

B.1.4.5 Class Attribute Descriptions.

File Name:
xxxxxx.CAD
File Format:
family =
Attr#,description
. . . , . . .
where

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

B.1.5 Fault Tree Information

B.1.5.1 Fault Tree Names and Descriptions.

File Name:
xxxxxx.FTD
File Format:
family =
name,description[,s]
. . . , . . .
where

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

B.1.5.2 Fault Tree Graphics.

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

File Name:
xxxxxx.DLS
File Format:
IRRAS 2.5/4.0/5.0 Fault Tree Graphics file (DLS format)

B.1.5.3 Fault Tree Logic.

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

File Name:

xxxxxx.FTL

File Format:

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

where

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

General Rules:

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

B.1.5.4 Fault Tree Cut Sets.

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

File Name:

xxxxx.FTC

File Format:

family, fault tree, analysis =
eventname * eventname +

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

where

family	- 16 character	Family name
fault tree	- 16 character	Fault tree name
analysis	- 1 character	Analysis type
	1 - Random	
	2 - Fire	
	3 - Flood	
	4 - Seismic	
	5 through 8 - Reserved	
	9 through 16 - user-defined	
eventname	- 16 character	Event names in the cut set

General Rules:

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

B.1.5.5 Fault Tree Attributes.

File Name:

xxxxx.FTA

File Format:

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

where

family	- 16 character	Family name
analysis	- 1 character	Analysis type
	1 - Random	
	2 - Fire	
	3 - Flood	
	4 - Seismic	
	5 through 8 - Reserved	
	9 through 16 - user-defined	
name	- 16 character	Fault tree name
level	- Integer 2	0 = top level tree

mission	- Floating point	Mission time
mincut	- Floating point	Mincut upper bound
proCut	- Floating point	Probability cut off value
sample	- Integer 4	Sample size
seed	- Integer 8	Random number seed
sizecut	- Integer 2	Size cut off value
sys	- 3 character	System identifier
cuts	- Integer 5	Base number of cut sets
events	- Integer 5	Base number of events
value	- Floating point	Base uncertainty values

B.1.5.6 Fault Tree Textual Information.

File Name:

xxxxxx.FTT

File Format:

family, fault tree =

-- text --

^EOS

family, fault tree2 =

. . .

where

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

B.1.5.7 Fault Tree Graphical P&ID

File Name:

xxxxxxxx.PID

File Format:

IRRAS 4.0/5.0 P&ID Graphics file (PID Format)

B.1.5.8 Fault Tree Recovery Rules

File Name:

xxxxxxxx.FTY

File Format:

family =

-- recovery rule text --

where

family - 16 character Family name

B.1.6 Event Tree Information

B.1.6.1 Event Tree Names and Descriptions.

File Name:
xxxxxx.ETD
File Format:
family =
name,description[,s]
. . . , . . .
where

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

B.1.6.2 Event Tree Attributes.

File Name:
xxxxxx.ETA
File Format:
family =
name,init
. . . , . . .
where

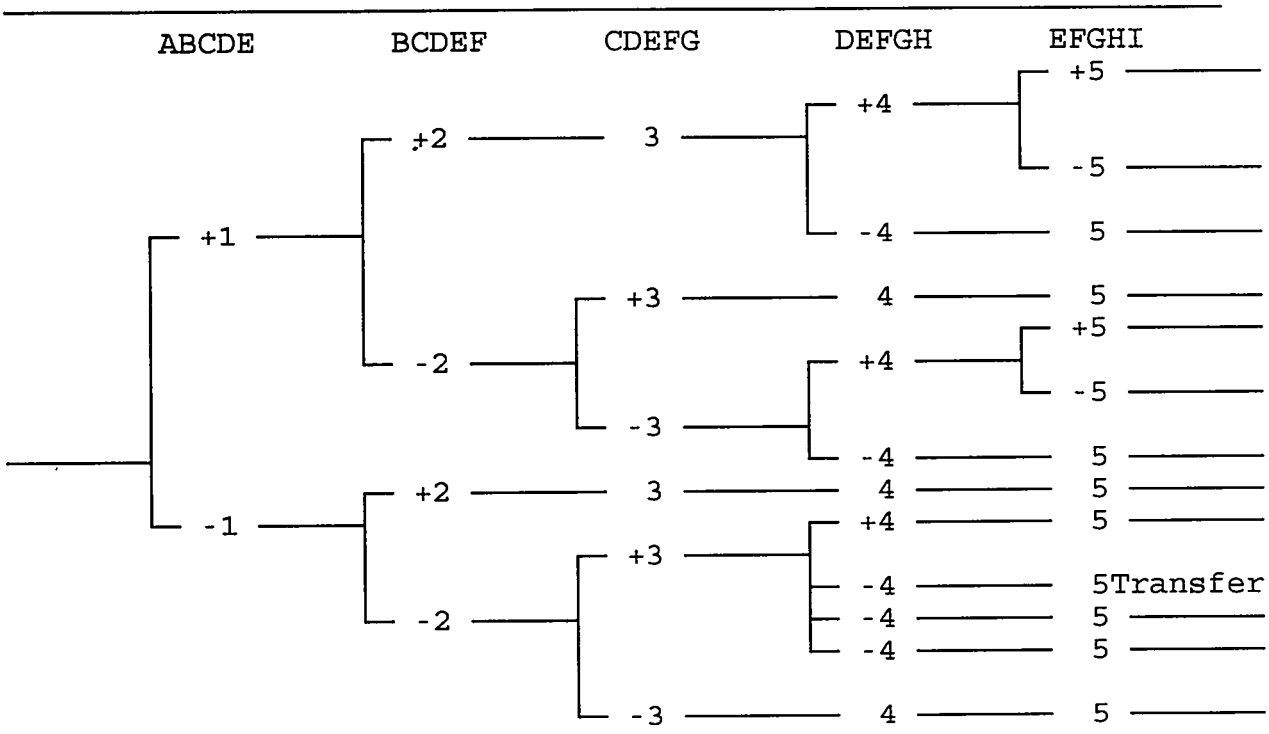
family	- 16 character	Family name
name	- 16 character	Event tree name
init	- 16 character	Initiating event name

B.1.6.3 Event Tree Graphics.

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

File Name:
xxxxxx.ETG
File Format:
See file format for the Event Tree Logic

SAMPLE GRAPHICAL EVENT TREE



B.1.6.4 Event Tree Logic.

File Name:

xxxxxx.ETL

File Format:

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

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

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

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

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

where

family	- 16 character	Family name
event tree	- 16 character	Event tree name
init event	- 16 character	Initiating Event
[,T]	- 1 character	Optional flag indicating init event name is a Top event system
TOPS	- 16 character	Top event/system names
Y/N	- Boolean	End state text displayed?
header	- 16 character	Sequence header
sequence	- 16 character	Sequence name
endstate	- 16 character	End state name
tran file	- 16 character	Name of transfer file
xdata1	- 16 character	Information (optional)

xdata2	- 16 character	Information (optional)

General Rules:

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

B.1.6.5 Event Tree Rules.

File Name:

xxxxxxxx.ETR

File Format:

```
family, event tree =
-- event tree rule text
        . . .
^EOS
family, event tree2
```

where:

family	- 16 character	Family name
event tree	- 16 character	Event tree name
tops	- 16 character	Top event/system names

B.1.6.6 Event Tree Textual Information.

File Name:

xxxxxx.ETT

File Format:

```
family, event tree =
        -- text --
^EOS
family, event tree2 =
        -- text --
```

where

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

B.1.6.7 Event Tree Recovery Rules

File Name:

xxxxxxxx.ETY

File Format:

family, event tree =
-- recovery rule text --
^EOS
family, event tree2 =

where

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

B.1.6.8 Event Tree Partition Rules

File Name:

xxxxxxxx.ETP

File Format:

family, event tree =
-- partition rule text --
^EOS
family, event tree2 =

where

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

B.1.7 End State Information

Each sequence can be tied to a single plant damage state. The cut sets for a sequence can be partitioned to map to separate end state. The name and description data are loaded with the SARA *.PDS file.

B.1.7.1 End State Names and Descriptions.

File Name:
xxxxxx.ESD
File Format:
family =
name,description
. . . , . . .
where

family	- 16 character	Family name
name	- 16 character	End state name
description	- 60 character	End state description

B.1.7.2 End State Information.

File Name:
xxxxxx.ESI
File Format:
family =
********** will be defined later **********

B.1.7.3 End State Textual Information.

File Name:
xxxxxx.EST
File Format:
family, end state =
-- text --
^EOS
family, end state2 =
where

family	- 16 character	Family name
end state	- 16 character	End State name

B.1.7.4 End State Cut Sets.

The end state cut sets are the minimal cut sets for end state logic as derived from the fault tree logic. The cut sets are stored in the block data file of the ENdState relation.

The MAR-D end state cut sets are in a format similar to that of the fault tree cut sets described

in Section 5.1.5.

File Name:

xxxxxx.ENC

File Format:

```
family, event tree, end state =
eventname * eventname +
eventname * eventname * eventname *
eventname +
eventname * eventname.
^EOS
family, event tree2, end state =
```

where

family	- 16 character	Family name
event tree	- 16 character	Event tree name
end state	- 16 character	End state name
eventname	- 16 character	Event names in the cut set

General Rules:

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

B.1.8 Sequence Information

B.1.8.1 Sequence Names and Descriptions.

File Name:

xxxxxx.SQD

File Format:

family,eventree =
name,description
. . . , . . .
^EOS

where

family	- 16 character	Family name
eventree	- 16 character	Event tree name
name	- 16 character	Sequence name
description	- 60 character	Sequence description

B.1.8.2 Sequence Cut Sets.

The sequence cut sets are the minimal cut sets for sequence logic as derived from the fault tree logic. The cut sets are stored in the block data file of the Sequence relation.

The MAR-D sequence cut sets (.SQC) are in a format similar to that of the fault tree cut sets described in Section 5.1.5.

File Name:

xxxxxx.SQC

File Format:

family, event tree, sequence, analysis =
eventname * eventname +
eventname * eventname * eventname *
eventname +
eventname * eventname.
^EOS
family, event tree2, sequence2 =

where

family	- 16 character	Family name
event tree	- 16 character	Event tree name
sequence	- 16 character	Sequence name
analysis	- 1 character	Analysis type
	1 - Random	
	2 - Fire	
	3 - Flood	
	4 - Seismic	
	5 through 8 - Reserved	
	9 through 16 - user-defined	

eventname	- 16 character	Event names in the cut set

General Rules:

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

B.1.8.3 Sequence Attributes.

File Name:

xxxxxx.SQA

File Format:

family, event tree, analysis =
name,endstate,mincut,mission,procut,sample,seed,size,cuts,
events,value1, . . . ,value9,default flags, used flags
. . . , . . . , . . . , . . . , . . . , . . . , . . . , . . .
^EOS
family, event tree2 =

where

family	- 16 character	Family name
event tree	- 16 character	Event tree name
analysis	- 1 character	Analysis type
	1 - Random	
	2 - Fire	
	3 - Flood	
	4 - Seismic	
	5 through 8 - Reserved	
	9 through 16 - user-defined	
name	- 16 character	Sequence name
endstate	- 16 character	End State name
mincut	- Floating point	Mincut upper bound
mission	- Floating point	Mission time in hours
procut	- Floating point	Probability cut off value
sample	- Integer 4	Sample size
seed	- Integer 8	Random number seed
size	- Integer 2	Size cut off value
cuts	- Integer 5	Base number of cut sets
events	- Integer 5	Base number of events
value	- Floating point	Base uncertainty values
value1	- 5th percentile	
value2	- Median	
value3	- Mean	

value4 - 95th percentile
value5 - Minimum sample
value6 - Maximum sample
value7 - Standard deviation
value8 - Skewness
value9 - Kurtosis
Default flags - Default flag set for this sequence
Used flags - Flag set used to generate these cut sets

B.1.8.4 Sequence Logic.

File Name:
xxxxxxxx.SQL
File Format:
family, event tree, sequence=,
sys1 sys2 /sys3 sys4
. . .
^EOS
family, event tree2, sequence2=
where

family	- 16 character	Family name
event tree	- 16 character	Event tree name
sequence	- 16 character	Sequence name
sys	- 16 character	System name

General Rules:
1. Complemented systems are prefixed with "/".

B.1.8.5 Sequence Textual Information.

File Name:
xxxxxx.SQT
File Format:
family, event tree, sequence=
--- text ---
^EOS
family, event tree2, sequence2=
--- text ---
where

family	- 16 character	Family name
sequence	- 16 character	Sequence name
event tree	- 16 character	Event tree name

B.1.8.6 Sequence Recovery Rules

File Name:
xxxxxxxx.SQY
File Format:
family, event tree, sequence =
-- recovery rule text --
^EOS
family, event tree, sequence2. =

where
family - 16 character Family name
event tree - 16 character Event tree name
sequence - 16 character Sequence name

B.1.8.7 Sequence Partition Rules

File Name:
xxxxxxxx.SQP
File Format:
family, event tree, sequence =
-- partition rule text --
^EOS
family, event tree, sequence2 =
where
family - 16 character Family name
event tree - 16 character Event tree name
sequence - 16 character Sequence name

B.1.9 Piping and Instrumentation Diagrams

B.1.9.1 P&ID.

The piping and instrumentation diagrams is a graphics file in binary format. It will be loaded and output as-is: no conversion will be performed.

File Name:
xxxxxx.PID
File Format:
(P&ID Editor format)

B.1.10 Gate

B.1.10.1 Gate Description.

File Name:
xxxxxx.GTD

File Format:
family=
name,description

where

family	- 16 character	Family name
name	- 16 character	Gate name
description	- 60 character	Gate description

B.1.10.2 Gate Attributes.

File Name:
xxxxxx.GTA

File Format
family=
name,attribute

where

family	- 16 character	Family name
name	- 16 character	Gate name
attribute	- 4 characters	Gate type

B.1.11 Change Sets

B.1.11.1 Change Set Description.

File Name:
xxxxxx.CSD
File Format:
family=
name,description
...,...

where

family	- 16 character	Family name
name	- 16 character	Change set name
description	- 60 character	Change set description

B.1.11.2 Change Set Information.

File Name:

xxxxxx.CSI

File Format:

```
family,change=
^PROBABILITY
eventname,calc,udT,prob,lambda,tau,udV,udC,mission,init
^CLASS
eventname,group,compType,compId,system,location,failMode,train,init,att1,..att16
calcType,udT,prob,lambda,tau,udV,udC,mission,init
^EOS
family,change2=
```

where

change	- 16 character	change set name
eventname	- 16 characters	name mask
group	- 16 characters	event group mask
compType	- 7 characters	component type mask
compId	- 3 characters	component ID mask
system	- 3 characters	system mask
location	- 3 characters	location mask
failMode	- 2 characters	failure mode mask
train	- 2 characters	train mask
init	- 1 character	initiating event (Y/N)
att1..att16	- Class attribute flats--16 values of Y or N (yes or no) indicate whether the attribute described in the class attribute file is applicable.	

calc - 1 character — Calculation type

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

L - Use low site hazard curve
M - Use medium site hazard curve
H - Use high site hazard curve

udT		1 character	Uncertainty distribution type
		L -	Log normal, error factor
		N -	Normal, standard deviation
		B -	Beta, b of Beta(a,b)
		G -	Gamma, a Gamma(a)
		C -	Chi-squared, degrees of freedom
		E -	Exponential, none
		U -	Uniform, Upper end pt.
		H -	Histogram
		M -	Maximum entropy

prob	-	Floating point Probability value
lambda		- Floating point Basic event failure rate per hr.
tau	-	Floating point Time to repair in hours
udV	-	Floating point Uncertainty distribution value
udC	-	4 characters Uncertainty correlation class Events in same class are 100% correlated.
mission	-	Floating point Mission time
init	-	Boolean (T/F) Initiating event

B.1.12 Histograms

B.1.12.1 Histogram Description

File Name:

xxxxxxxx.HID

File Format:

family =
name, type, subtype, description

where

family	- 16 character	Family name	
name	- 16 character	Histogram name	
type	- 1 character	Histogram type	
			H - Hazard
			U - Uncertainty
			F - Fragility
subtype	- 1 character	Histogram subtype	
			P - Percent
			A - Area
			R - Range

B.1.12.2 Histogram Information

File Name:

xxxxxxxx.SQP

File Format:

family, histogram =
type, subtype
bin1 value1, bin1 value2
bin1 value2, bin1 value2
...
bin20 value1, bin20 value2
^EOS
family, histogram2 =

where

family	- 16 character	Family name
histogram	- 16 character	Histogram name
type	- 1 character	Histogram type H - Hazard U - Uncertainty F - Fragility
subtype	- 1 character	Histogram subtype P - Percent A - Area R - Range
bin value1	- Exponential	first value for bin
bin value2	- Exponential	second value for bin

B.2 SETS

B.2.1 Sequences

B.2.1.1 Sequence Cut Sets.

File Name:
xxxxxx.DNF.

The format of the SETS output cut sets file (.DNF) is dependent upon the command issued within SETS. The factored form is

$$A * (B + C)$$

The disjunctive normal form is

$$A * B + A * C.$$

ONLY the disjunctive normal form is accepted by the MAR-D at this time.

File Format:
sequence-name =
eventName * eventName +
eventName * eventName.
where
. . . . .

General Rules:
1. An asterisk ("*") separates event names. Spaces are ignored.
2. A plus sign ("+") separates cut sets.
3. A period (".") denotes the end of a sequence.
4. An asterisk ("*") in the first column denotes a comment.

B.2.2 Fault Trees

B.2.2.1 Fault Tree Logic.

File Name:
xxxxxx.SET.
File Format:
FAULT TREE$ fault-tree-name.
COMMENT$ descriptive material $
gate-type $ gate-name. IN$ input-1, input-2, . . . , input-n.
OUT$ output-1, output-2, . . . , output-n.
event-type $event-name. OUT$ output-1, . . . , output-n.

where

fault-tree-name	- The name of the fault tree.
gate-type	- The type of gate being defined. AG = AND gate OG = OR gate EOR = Exclusive OR gate (converted to SG) EAG = Exclusive AND gate (converted to SG) SG = Special Gate
gate-name	- The name of the gate being defined (16 characters) input-n - The names of the gates or primary events that are the immediate inputs to the gate being defined (16 characters)
output-n	- The names of the gates that are the immediate outputs of the gate or primary event being defined (16 characters).
event-type	- The type of primary event being defined. BE = Basic Event CE = Conditional Event UE = Undeveloped Event DE = Developed Event EE = External Event
COMMENT$	- Defines a comment. Must follow a "." delimiter.

B.2.2.2 Fault Tree Cut Sets.

The fault tree cut sets are stored in the System relation in the block data file. The format of the cut set file (.DNF) is given above.

B.2.3 Basic Events

B.2.3.1 Basic Event Failure Rates.

File Name:

xxxxxxx.VBK.

File Format:

VALUE BLOCK$ value-block-name
prob $ name-list$
prob $ name-list$

where

prob	- point value probability estimate
name-list	- list of event names separated by commas

B.2.4 Output Reports

Output reports can be converted to other formats or loaded by the user. They are not stored intact in the database. The cut sets are stripped from the listing file (.LIS) and stored in the Sequence relation. A variable occurrence table is written to file "sequence-name.VOT" in the family directory.

File Name:

xxxxxx.LIS.

File Format:

```
. . . Header information
      EXECUTE
      LDBLK (sequence name, sequence name, . . .)
. . .
      COMTRMVAL (sequence name)
      -- blank line --
      /OMEGA means empty cut set
      -- 12 blank lines --
      Variable Occurrence Table--Output as is
      -- 5 lines to cut set table --
      41 character leader + 1 space + basic event name

      THE MAXIMUM TERM--ends the cut sets
. . .
```

General Rules:

1. A plus sign ("+") followed by a blank line separates cut sets.
2. Cut set terms can be continued on separate lines.
3. An asterisk ("*"), plus sign ("+"), or blank (" ") separates basic event names.
4. A period (".") denotes the last cut set.

NRC FORM 335 (2-89) NRCM 1102, 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

(See instruction on the reverse)

1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)
NUREG/CR-6116
EGG-2716
Vol. 2

2. TITLE AND SUBTITLE
Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE) Version 5.0

Integrated Reliability and Risk Analysis System (IRRAS) Reference Manual

3. DATE REPORT PUBLISHED
MONTH: July
YEAR: 1994

4. FIN OR GRANT NUMBER
L1429

5. AUTHOR(S)
Kenneth D. Russell
Kellie J. Kvarfordt
Nancy L. Skinner
S. Ted Wood
Dale M. Rasmuson*

6. TYPE OF REPORT
Technical

7. PERIOD COVERED (Inclusive Dates)

8. PERFORMING ORGANIZATION - NAME AND ADDRESS (If NRC provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address, if contractor, provide name and mailing address.)
Idaho National Engineering Laboratory
EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, Idaho 83415

*U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

9. SPONSORING ORGANIZATION - NAME AND ADDRESS (If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)
Division of Safety Issue Resolution
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

The Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE) refers to a set of several microcomputer programs that were developed to create and analyze probabilistic risk assessments (PRAs), primarily for nuclear power plants. The Integrated Reliability and Risk Analysis System (IRRAS) is a state-of-the-art, microcomputer-based probabilistic risk assessment (PRA) model development and analysis tool to address key nuclear plant safety issues. IRRAS is an integrated software tool that gives the user the ability to create and analyze fault trees and accident sequences using a microcomputer. This program provides functions that range from graphical fault tree construction to cut set generation and quantification to report generation. Version 5.0 of IRRAS provides the same capabilities as earlier versions and adds the ability to perform location transformations, seismic analysis, and provides enhancements to the user interface as well as improved algorithm performance. Additionally, version 5.0 contains new alphanumeric fault tree and event tree editors, and a powerful set of macro-based rule editors. These editors are used for event tree rules, recovery rules, and end state partitioning.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)
PRA, SAPHIRE, IRRAS

13. AVAILABILITY STATEMENT
Unlimited

14. SECURITY CLASSIFICATION
(This Page)
Unclassified
(This Report)
Unclassified

15. NUMBER OF PAGES

16. PRICE

NRC FORM 335 (2-89)