



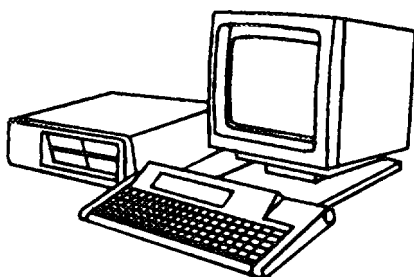
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PSAPACK 4.2

A Code for Probabilistic Safety Assessment Level 1

Users' Manual



International Atomic Energy Agency, 1995

PSAPACK 4.2

A Code for Probabilistic Safety Assessment Level 1

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FOREWORD

Only limited use has been made until now of the large amount of information contained in probabilistic safety assessments (PSAs). This is mainly due to the complexity of the PSA reports and the difficulties in obtaining intermediate results and in performing updates and recalculations.

Moreover, PSA software was developed for mainframe computers, and the files of information such as fault trees and accident sequences were intended for the use of the analysts carrying out PSA studies or other skilled PSA practitioners.

The increasing power and availability of personal computers (PCs) and developments in recent years in both hardware and software have made it possible to develop PSA software for use in PCs. Furthermore, the operational characteristics of PCs make them attractive not only for performing PSAs but also for updating the results and in using them in day-to-day applications.

The IAEA has therefore developed in co-operation with its Member States, a software package (PSAPACK) for PCs for use in performing a Level 1 PSA and for easy interrogation of the results.

Previous versions of the program were mainly used for training purposes or to cover only the basic needs of a Level 1 PSA. The current Version 4.2 of PSAPACK allows for two levels of processing: **Level A**, for operational safety management can update the plant status to reflect specific situations with components out of service and forecast their effect on core melt probability. Prior to using Level A, the PSA model has to be prepared using the tools available in **Level B**. Level B contains the necessary features for Level 1 PSA including fault and event tree graphic and text editors, fault tree analyses, accident sequence Boolean reduction and quantification and a built-in component reliability database.

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INTRODUCTION

The integrated fault tree software package PSAPACK (probabilistic safety analysis package) for performing Level 1 PSA using personal computers and for easy updating and recalculation has been developed by the International Atomic Energy Agency in co-operation with Member States.

Work was initiated in 1987 in the framework of an IAEA Interregional Technical Co-operation Programme on PSA. The software was basically intended for training purposes.

From the outset the framework defined for the project sought to integrate as far as possible existing software freely available from Member States and to avoid the use of commercial software, to permit the free distribution of the package being developed. The modular structure established for the package greatly facilitated this. An early version (1.0) of PSAPACK was used in an IAEA international training course on PSA in safety decisions held in the United Kingdom in 1988. Since then, various versions of PSAPACK with increasing capabilities have been developed in response to users' requirements, and have been widely distributed and used in IAEA Member States.

The current PSAPACK (Version 4.2) is an integrated fault/event tree package with capabilities for easy interrogation of results and recalculations. There are two levels of processing in the package:

- **Level A** is for operational safety management. It can update the plant status for specific components which are out of service and can forecast the effect on core melt frequency on the basis of minimal cut sets generated in Level B. Code features include: user friendly definition of plant status using component attributes such as system and room location; different types of importance measures to represent the results; display of results in graphic and text format.
- **Level B** contains the necessary features for performing a Level 1 PSA. The following main features are included: fault tree editor (graphic and text); fault tree analyzer (SETS code); event tree construction and analysis (graphic and text); accident sequence Boolean reduction and quantification; reliability database (generic data, unavailability evaluation, component attributes); utilities (help functions, on-line code manual and PSA procedures guide).

The most important modules in the package are as follows:

A reliability database (RDB) module is used for the management of reliability data. This module can create a user defined database or retrieve data from the IAEA generic reliability database. The RDB module is designed to develop RDBs for components, human actions, initiating events and attributes of components. Component unavailabilities can be calculated from the database reliability parameters using 10 types of predefined reliability models.

The fault tree editor (FTED) module edits and manages fault trees in the text format using a full screen user friendly menu driver. FTED has an automatic verification of the FT logic and it checks whether all components have been defined in the RDB. It is also possible to transfer the tree structure from graphics to text format.

The fault tree analyzer (FTA) module reduces the fault trees and generates the minimal cut sets. The cut sets generated are stored in the minimal cut set libraries. This process is performed by the well known codes SETS and FTAP. Control of cut sets is performed using truncation cut-off by probabilities or order. The choice of codes is controlled by the user according to the PC's specific capabilities. The FTA module can manage different gate types (OR, AND, N/M), switch gates and supercomponents.

The VIEW module is for quantification. All minimal cut sets are stored in the specific libraries for the fault trees, supercomponents and sequences. The VIEW module recalculates the point estimates in the various libraries each time it is used. The VIEW module also computes and displays

the Fussell-Vesely importance measures, risk increase and risk reduction (for components and initiating events) measures.

The event tree editor (ETED) module edits and manages the event trees in text format. It is possible to create ETs in two different ways. In text format inputting ("0", "1", "-") as a coding system, or in graphical format using the FEP module. The event trees can be changed from graphics to the text format or vice versa.

The boolean reduction (BOOL) module generates minimal cut sets for sequences combining the minimal cut sets (generated by the FTA module) using a Boolean algorithm. BOOL provides an automatic handling of success paths and it is possible to truncate the sequence minimal cut sets by probability or order.

The fault tree, event tree and piping & instrumentation diagram (P&ID) editor (FEP) is a program developed to provide a common access to the package of graphical tools developed for performing risk assessment. These tools include the graphical event tree, fault tree and P&ID editors. The event tree and fault tree editors are available through PSAPACK; The P&ID editor is only accessible through FEP. The event tree editor allows the analyst graphically to construct and modify event trees. The fault tree editor allows the user graphically to construct and modify fault trees. The P&ID editor allows the user to construct and modify plant drawings. These drawings can then be used to document the modelling used in a PSA.

The STATUS module permits the re-evaluation of a plant status given a specific plant configuration. The user can update the current plant status by selection of components out of service at a given time. By taking components out of service or by introducing human errors, the instantaneous core damage frequency and the relative importance of components and human actions can be recalculated. In the STATUS module it is possible to change the data of an existing plant status by selecting the basic events according to systems, initiating event, event code or attributes.

The core damage frequency graphics (CDFG) provides a graphical representation of the core damage frequency for various plant configurations at different points in time.

Note: In its present version (4.2), PSAPACK recalculates the plant core melt frequency using the list of cut sets previously generated in Level B. Therefore it is not possible to assess the impact of cut sets which might have been truncated during the generation of the cut sets. Moreover, special care must be taken in disabling many components or a full system (event tree headings). In these cases, the recalculation will not recognize that some sequences are no longer possible and the results will be wrong.

1. GETTING STARTED

PSAPACK is composed of a number of modules displayed in the main menus. Within each module there are one or more functions. Movement through the modules and functions is performed by using control keys. PSAPACK also makes extensive use of windows which display different types of information on the screen. Note that PSAPACK should only be run under DOS and not from DOS platforms inside other operating systems.

1.1. HARDWARE

Version 4.2 can be run on an IBM PC XT/AT, PS/2 or compatibles with the following minimum requirements:

- 640 KB RAM,
- color graphics monitor with CGA, EGA or VGA,
- 20 MB hard disk,
- matrix printer (EPSON FX compatible on LPT1:),
- A mouse (a mouse is only needed for graphical interface).

For large PSA models, the following is recommended:

- 80386 (with math-coprocessor) or 80486,
- at least 10 MB of FREE hard disk space + extended memory,
- Several MB of LIM/EMS4.0 compatible extended memory,
- A HP compatible laser printer or plotter.

1.2. MEMORY MANAGEMENT AND REQUIREMENTS

The INSTALL procedure will check the hardware available and the third screen will display how much memory (standard and expanded) is found. Regardless of how much memory your computer has, if it is not recognized in this screen, it will not be used by PSAPACK. To use both extended or expanded memory, a LIM/EMS 4.0 compatible driver is needed (HIMEM.SYS is not sufficient).

Depending on the memory size, one of the following possibilities can be used to solve fault trees:

- FTAP code: **450 KB** minimum (XT with 512 KB);
- SETS 286: **550 KB** minimum (AT-286 with 640 KB);
- SETS 286CP: **540 KB** minimum (AT-286 with 640KB and with math-coprocessor);
- SETS 386CP: **2 MB** minimum (AT-386 with math-coprocessor, HIMEN.SYS must be disabled, protected mode (DOS EXTENDED)).

These memory requirements must be checked against the MEMORY module in the main menu (Level B) to select the correct version to analyze fault trees. The minimum memory size required listed above must be smaller than that shown in the MEMORY module. A memory manager is included in the SETS 386CP version, and to avoid incompatibilities between different memory manager systems, HIMEM.SYS must be disabled. The SETS 386CP option does not have to be checked with the MEMORY module but 2 MB of hardware memory as a minimum have to be available in the computer.

The **BOOL** and, for large cut sets files, **VIEW** modules make extensive use of virtual memory — in expanded memory or on the hard disk. If your expanded memory driver does not leave enough free memory for **SETS**, yet **BOOL** and **VIEW** are too slow using the hard disk, it is possible to disable the expanded memory driver when running **SETS** (to free up memory) and enable it to use **BOOL** and **VIEW**. This requires two **CONFIG.SYS** files and rebooting the computer but can greatly improve the speed of **BOOL** and **VIEW**.

1.3. INSTALLATION

The package is distributed in three different sets depending on the type of floppy drive A in a particular computer:

- set of 5 1/4 inch DS/HD diskettes;
- set of 3 1/2 inch DS/DD diskettes;
- set of 3 1/2 inch DS/HD diskettes.

To install the package, insert the floppy disk labelled **MASTER DISK** in drive A, change to the A directory and type:

A: INSTALL

Press **<Enter>** and follow the instructions on the screen.

The install procedure is controlled by the "**INSTALL.DAT**" file. This file can be read and edited with a normal ASCII editor. If problems are encountered during installation, try modifying this file. Note that the distribution of files to install is different for each type of floppy disk set. Any modifications to **INSTALL.DAT** must be made in the section of the code which controls loading of your type of floppy disks.

The installation procedure will create the following directory structure starting with subdirectory **PSA42** on the logical hard drive specified in the installation dialogue.

WARNING: after installation and before running fault trees the appropriate version of **SETS** or **FTAP** must be set up into the **FTA** module according to the memory requirements (see Sections 1.2 and 4.1.3).

C:\PSA42	main subdirectory of the package with the majority of the executable files and some protocol, help and environmental files.
C:\PSA42\DATA	subdirectory with the PSAPACK database. Twelve interconnected libraries will be created for each environment.
C:\PSA42\TMP	subdirectory with the temporary files created during execution of different modules.
C:\PSA42\GRDB	subdirectory with the files of the IAEA generic reliability database (IAEARDB) and the user generic reliability database (UGDB).
C:\PSA42\GRAPHIC	subdirectory with the graphics files created by the PSAPACK graphics editors.
C:\PSA42\PRATOOLS	subdirectory with the PSAPACK graphics editing modules.
C:\PSA42\HALO88	subdirectory with the support files for the PSAPACK graphics modules.

System changes:

PATH = C:\PSA42 must be added to your boot **AUTOEXEC.BAT** file, where C:\PSA42 should be replaced by the logical drive and subdirectory where PSAPACK is installed.

The DOS file **COMMAND.COM** must be copied to the root directory where PSAPACK is installed.

DEVICE = ANSI.SYS should be added to your boot **CONFIG.SYS** file.

1.4. GLOBAL CONSTRAINTS

PSAPACK is constructed from a variety of codes, many of which have different constraints. If all parts of the package are to be used, the constraints listed below should not be exceeded. PSAPACK does not create automatically backup files and a session log-file to reestablish the databases and the actions of a session in case of a mistake or failure. Changes to the databases are immediately executed after completing an individual task. Therefore, it is highly recommended that the user periodically makes a backup copy of the databases to a disk (using the procedure described in the environments menu). If the database is subsequently corrupted, the copy can be loaded and used.

Fault trees

- * A maximum of 500 text fault trees in each environment and 500 graphic fault trees in all environments.

Gate labels

- * All gate labels must begin with the character "G".
- * Top event and transfer gate labels can have up to 20 characters, but to simplify the connection to the graphic fault trees a maximum of 8 characters (excluding tokens) should be used.
- * Gates labels internal to a fault tree can have up to 20 characters, but to simplify the connection to the graphic fault trees a maximum of 11 characters (excluding tokens) should be used.
- * All gate labels should include only capital letters.

Gate logic

- * A maximum of 20 inputs to any given gate.
- * A minimum of 2 inputs to any gate.
- * OR, AND, N out of M gates.
- * M/N (M out of N) gates are internally converted to basic gates. The number of additional gates created by decomposing the M/N gate into basic gates is given by the formula:

$$\binom{N}{M} = \frac{N!}{(N-M)!M!}$$

This number is limited to 100.

WARNING: more than 20 inputs to any gate in the graphic fault trees will cause difficulties when transferring the graphic tree into the text fault tree database. In general, not more than 10 inputs should be used.

Component labels

- * All component labels must have a maximum of 16 characters including tokens (to insure that tokens can always be added, a base label with a maximum of 11 characters is recommended).
- * Component labels must not begin with the character "G".
- * All component labels should include only capital letters.

Component parameters

- * Maximum of 40 characters for the component description.
- * Maximum of 20 reliability parameters (not all used during quantification).
- * Maximum of 10 user defined attributes.
- * Maximum of 5000 components and 2000 human actions in any environment.

WARNING: Do not type in more than 100 components into a RDB library without saving the library. Failure to occasionally save the library can result in a corrupted database.

1.5. STARTING PSAPACK

To start the package the user should go to the PSA42 subdirectory and type the following after the DOS prompt:

PSAPACK

NOTE: If FEP is to be used, a mouse driver must be loaded before PSAPACK is started.

To support the control key concept, PSAPACK has a context sensitive help function and several standardized function keys. The following keys work with most, but not all, screens.

<F1>: Opens a window on screen with a brief description of the current module/function.

<F2>: Opens a window on screen with a list of the control key functions available, each function is briefly explained.

In both windows, the **<Page Up>** and **<Page Down>** keys will work if all the information does not fit into the screen window. The use of **<F2>** in particular is highly recommended. Although most screens include a number of the most important function key definitions at the bottom of the screen — not all possible functions are shown.

There are also two similar — but not identical — function keys which control the exiting of a module/function.

<Esc>: This will exit the current function within a module.

<F3>: This will exit the current module.

NOTE: When a module has only one function or when in the highest function in a module, **<Esc>** and **<F3>** will appear identical. In general, if using one of these keys does not produce the desired result, try the other.

<Tab>: This will usually initiate an edit mode from which parameters or text can be changed. The major exception is in the user generic database (UGDB) module, where the **<Tab>** key supports movement through the component data records.

2. DATABASE, LIBRARIES AND FILES

PSAPACK uses a hierarchical database system to organize, access and manipulate the libraries in its database. A library is one or more linked data files with a well defined purpose, while the database is the complete collection of libraries for a given environment. It is not possible to directly change data in any of the computer files making up the libraries using any program other than PSAPACK.

2.1. GENERIC COMPONENT DATA LIBRARIES

The two generic component data libraries are located in the

C:\PSA42\GRDB

subdirectory and are accessible from all environments. Each generic library is also a single data file.

IAEARDB — the full IAEA generic library of databases (read only file).

UGDB — A generic component database library similar to the IAEA library but generated by the user. Currently, only one user database can be generated and is accessible from all environments. The generic component labels in this library are limited to 4 characters + "1", where "1" is the code number for the library. If the first character corresponds to the IAEA naming convention for components, the component type masking option can be used to access only data for specified generic component types such as valves, pumps, etc.

The IAEARDB library cannot be changed. The UGDB library can only be modified from the UGDB module. The two libraries are similar but not identical. The IAEARDB has no entry for component failure type while the UGDB does. Consequently, component failure type parameter must be manually input when the component will be linked to the IAEARDB.

2.2. USER COMPONENT RELIABILITY LIBRARIES

The three user component data libraries are located in the

C:\PSA42\DATA

subdirectory and are only accessible from within the corresponding environment. These libraries are composed of several data files and are filled in by the user.

Each component is linked to one of the libraries by using so-called tokens in the component labels. The HRB (human reliability database) token links the component to the human data library, the TMP (temporary) token to the temporary library and the RDB (or no token) to the component data library. When working within one of the data libraries, only those components with the matching token are manipulated by PSAPACK. Basic events which are in a fault tree, but not in these data libraries can be identified and subsequently transferred to each library from within the RDB module.

COMPONENT (RDB) — The primary component specific failure parameter library for an environment. All component labels in the PSA models with the RDB token (or no token) are located in this library. Components in this library can also be linked to generic components in the IAEARDB and UGDB libraries. The linkage allows failure parameters to be transferred from the generic to the specific components.

HUMAN (HRB) — The human action specific failure parameter library for an environment. All component labels in the PSA models with the HRB token are located in this library.

TEMPORARY (TMP) — The temporary component specific failure parameter library for an environment ID. All component labels in the PSA models with the TMP token are located in this library.

The failure parameters in these libraries are used for calculating point estimate average unavailabilities. These point estimates are subsequently used for the probability cut-off during model reduction (FTA and BOOL modules) and for the quantification of cut sets in the VIEW module. Model processing is not possible until all component labels have been entered into the appropriate library.

2.3. LOGIC MODEL LIBRARIES

The logic model data libraries are located in the

C:\PSA42\DATA

subdirectory and are only accessible from within the corresponding environment. Each library is composed of several data files.

FTT — The fault tree library for all fault trees in the environment. The fault trees are stored as lines of text which can be displayed and directly edited.

SCP — The supercomponent fault tree library. This is not a full fault tree library since it contains only a reference to those gates designated as supercomponents and not to the models themselves. Supercomponents can only be entered into the library by reducing a fault tree within which a supercomponent is defined. The fault tree within which the supercomponent can be found is included in the parentheses following the supercomponent gate label.

SEQ — The event tree sequence library for all sequences in the environment.

2.4. MINIMAL CUT SET LIBRARIES

The three minimal cut set libraries are located in the

C:\PSA42\DATA

subdirectory and are only accessible from within the corresponding environment. The libraries are composed of several data files.

Minimal cut set libraries cannot be edited, they can only be viewed from the VIEW module. Quantitative results are not saved in the minimal cut set libraries. Whenever the results are viewed, the cut set and top event unavailabilities are calculated using the current basic event unavailabilities in the various component data libraries.

MCS — Storage of all fault tree minimal cut sets in the environment. The cut sets are indexed to the fault trees in the text fault tree library. This library is filled in by PSAPACK when fault trees are processed.

SCP — Storage of all supercomponent minimal cut sets in the fault tree library. All components with the SCP token are found in this library. Unlike the other cut set libraries, this library also stores the quantitative results for each SCP event. The unavailability is not used during the fault tree or sequence reduction process (to avoid difficulties with cut-off probability truncation, the unavailability of all SCP events is set to 1.0 during processing) but is used when viewing the results. This library is filled in by PSAPACK when supercomponents are processed.

SEQ — Storage of all the sequence minimal cut sets in the environment. The cut sets are indexed to the sequences in each event tree. This library is filled in by PSAPACK when sequences are processed.

2.5. OTHER LIBRARIES

IEV — All the initiating events. The label for each initiating event, a description, and the frequency must all be entered by hand. The label must be defined before an event tree is developed.

ATT — Stores all the component specific attributes. This library is filled in by the user.

PLS — Components out of service. This is a Level A library.

3. OVERVIEW

3.1. LEVEL B (PSA ANALYST) — OVERVIEW

Level B was developed to perform Level 1 probabilistic safety assessments.

3.1.1. Environment

Creating an environment ID automatically creates a database coded with the one letter environment ID. To create an ID, simply enter a one letter code for environment in the environment selection menu. The database is composed of 12 linked data files called libraries. The graphic files created by the FEP module are not part of these libraries and are accessible from all environments.

Once created, an environment must be filled with the PSA logic models (fault trees and event trees) and quantitative reliability parameters. The FTA and BOOL modules generate results from the models and incorporate the results into the database. An overview of the PSA model input and result generation is given in Fig. 3.1.

Entire environments can be copied, moved, deleted, and loaded using the appropriate control keys from the environment selection menu. It is strongly suggested that the copy option be used to generate backup copies of the environments.

WARNING: The graphics from FEP (fault and event trees and P&I diagrams) and the user generic database are not part of any environment and are not affected by these commands. These files must be backed-up using normal DOS file manipulation routines.

3.1.2. Fault tree input

Fault tree model input into the database is performed using the FTED module as illustrated in Fig. 3.2. Graphic fault trees generated in the FEP module can be loaded into the database from within the FTED module. Fault trees from other computer code systems can be imported into PSAPACK by converting them to the FEP module's *.TRZ format and using FTED.

A fault tree gate is either completely internal to the fault tree or a transfer gate. Transfer gates are generally used when part of a fault tree appears in a number of places and are simply a convenient method for storing the repeated models. All transfer gates in a fault tree page are expanded (filled in) by the FTA module when a fault tree is eventually reduced and quantified.

New or modified text fault trees are created by:

- (1) entering or modifying the text fault tree with the text fault tree editor in the FTED module,
- (2) and/or entering or modifying the graphic fault tree in the FEP module, and loading the graphic tree into the text fault tree file library in the FTED module.

3.1.3. Component label and reliability data input

Before use in the reduction and quantification modules FTA (fault trees) and BOOL (sequences), all event labels must be entered into the appropriate data library. Reduction and quantification can be performed before the events have been assigned a point estimate unavailability. In this case, however, an unavailability of 1.0 is always used.

Each of the user component reliability libraries (component, human, temporary) is filled with component labels and failure parameters from within the RDB module as illustrated in Fig. 3.3.

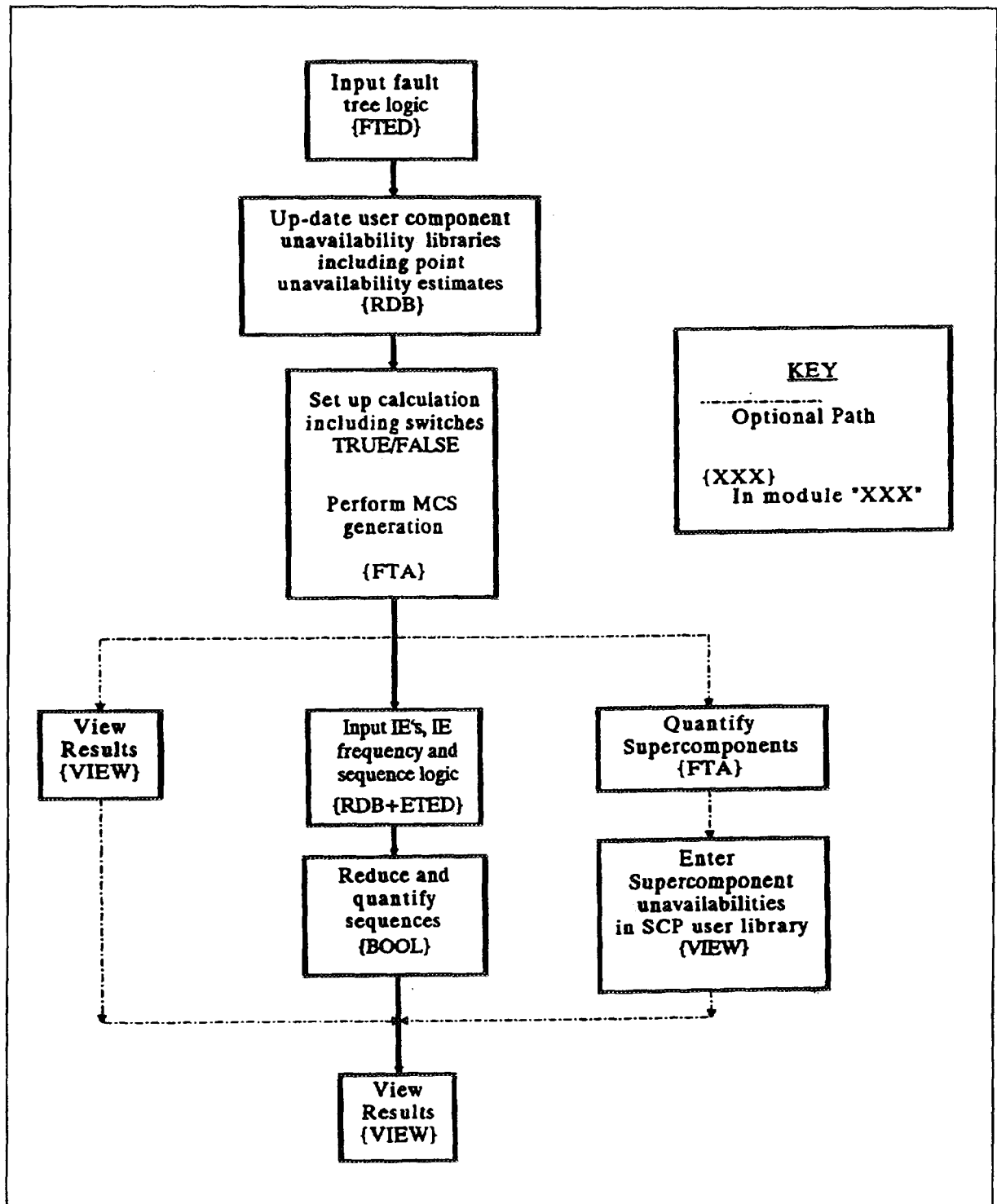


FIG. 3.1. Model input and quantification overview (Level B).

Component labels for the component, human and temporary libraries can be directly entered by hand from within the appropriate library in the RDB module. Initiating event labels must be entered manually in the RDB module. Supercomponent labels cannot be directly entered, they must be entered by reducing a tree which defines the supercomponent.

For the component, human and temporary libraries only, PSAPACK can be used to identify components in each text fault tree which are not in the appropriate data library and subsequently load these labels into the library indicated by the component token. Any label in the text fault trees which does not begin with a "G" is assumed to be a component label.

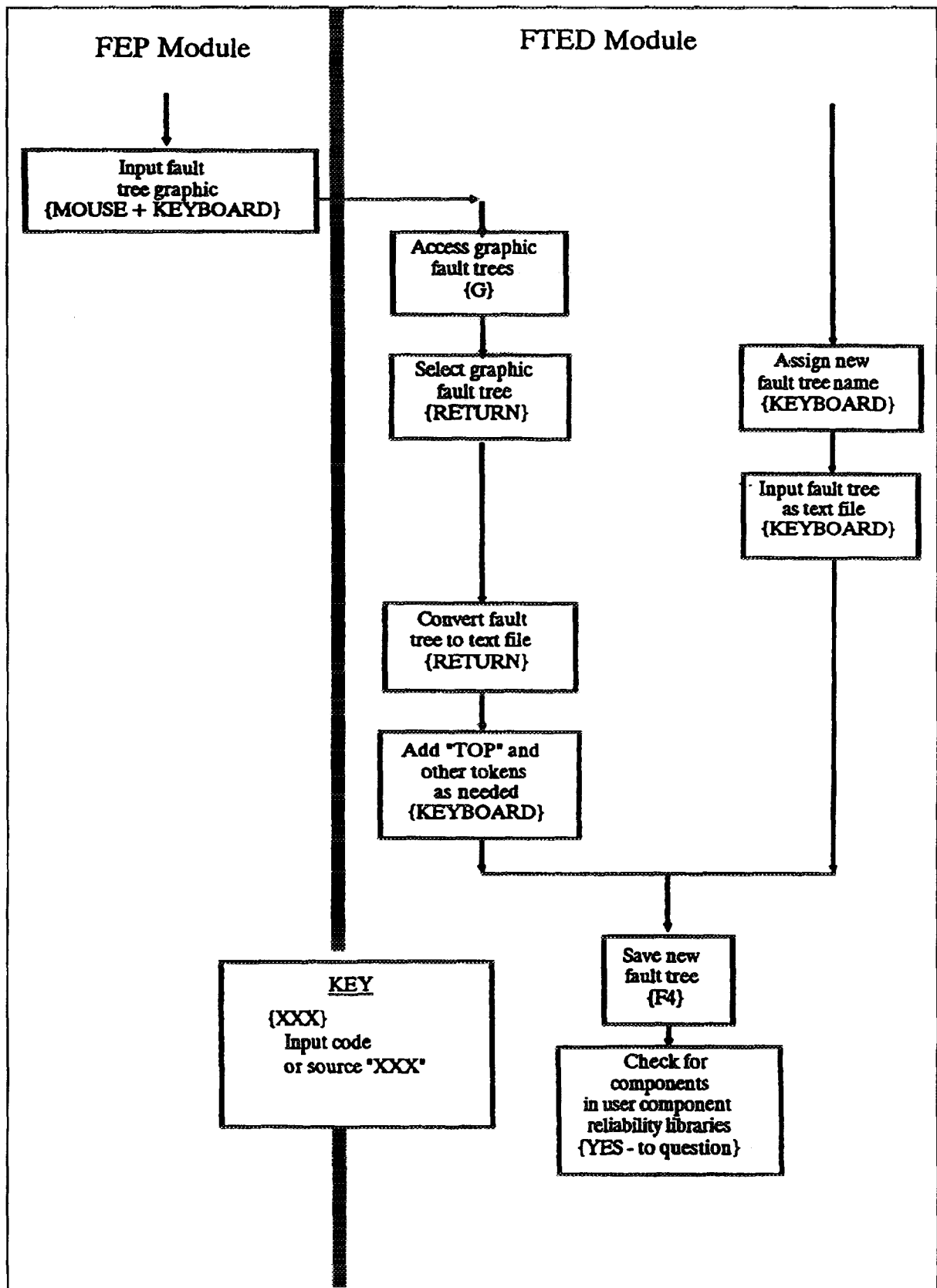


FIG. 3.2. Fault tree input.

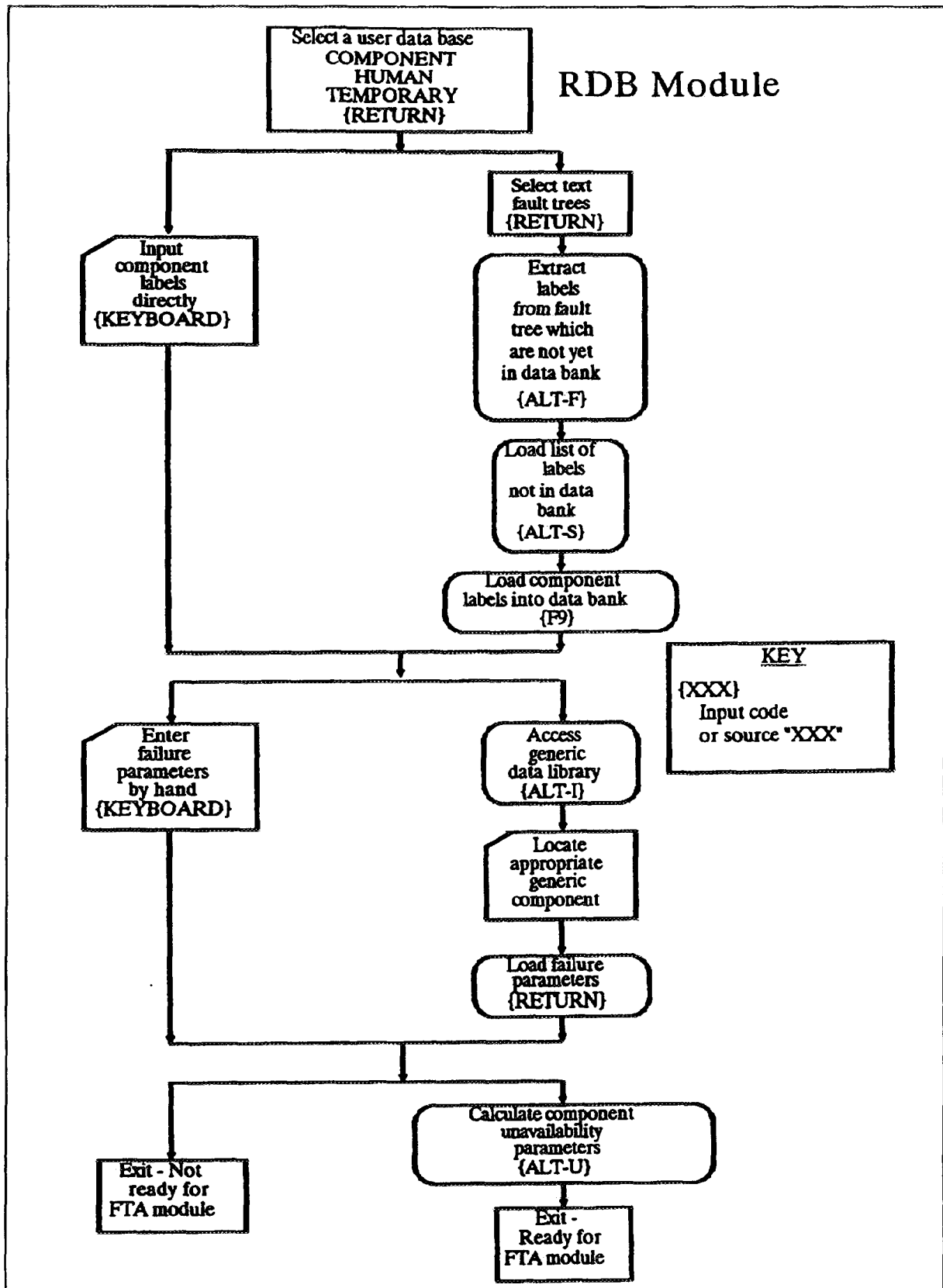


FIG. 3.3. Updating component reliability data into the user component reliability data libraries.

Failure parameters for all libraries (RDB, HRB, TMP, SCP, IEDB) can be entered by typing in the parameters by hand from within the RDB module.

For the component library only, it is possible to load parameters from either the UGDB or the IAEARDB to the user component data libraries in two steps.

- (1) The link from each component in the user library to the component type in the generic data library must be established by:
 - (a) typing in the generic component label; or
 - (b) selecting the target RDB component, accessing one of the generic data libraries, and finding the appropriate generic component (the source component). The linkage is established by pressing <Enter>. In this case, the generic label from the source component is written to the GRDB column for the target component in the user component library.
- (2) Once the linkage is in place, it is possible to globally transfer all current failure parameters from either the UGDB or the IAEARDB or both to all linked components in the user data library. This allows changes in a specific valve type's basic failure parameters, for example, to be quickly and accurately transferred to all the applicable basic events in the logic models.

The components in the two generic RDBs have various failure parameters associated with them. When the generic data are transferred to the user data libraries, the failure parameters available will be transferred regardless of the specified component type in the user data library. The existing failure parameter entries in the user data library will not be deleted and overwritten only if the generic data contains that parameter. All basic event component labels in the fault tree (including all supporting fault tree pages when transfer gates are used) must exist in the appropriate component reliability database or the fault tree cannot be reduced. Before processing a fault tree using a probability cut-off and/or quantifying the cut sets, point estimate unavailabilities for all components must be calculated based on the component failure parameters. This calculation is performed for all components in a library using the RDB module.

3.1.4. Fault tree quantification

PSAPACK's basic logic model unit is a fault tree. A fault tree is accessed as a single unit with a unique name in either text or graphic mode (normally, the text and the graphic fault trees should have the same name). The fault tree is comprised of gates and basic events.

Fault trees are reduced and the minimal cut sets are generated using the FTA module as illustrated in Fig. 3.4. The cut sets generated are stored in the minimal cut sets libraries. Adding, modifying or deleting cut sets directly is not possible.

The point unavailability estimates in the component data libraries at the time of execution are used to support the cut-off of MCSs based on cut-off probability but neither the MCS probabilities nor the top event results are saved. Instead the MCSs are saved and whenever the MCSs are viewed they are quantified (more precisely re-quantified) at that time.

PSAPACK does keep a record of the cut-off criteria and analysis methods. To repeat an earlier analysis, use the "Update Cut Set Option" in the FTA module.

WARNING: Supercomponents should be fully independent trees (i.e. trees whose basic events appear only in that supercomponent) or serious errors in quantification can occur.

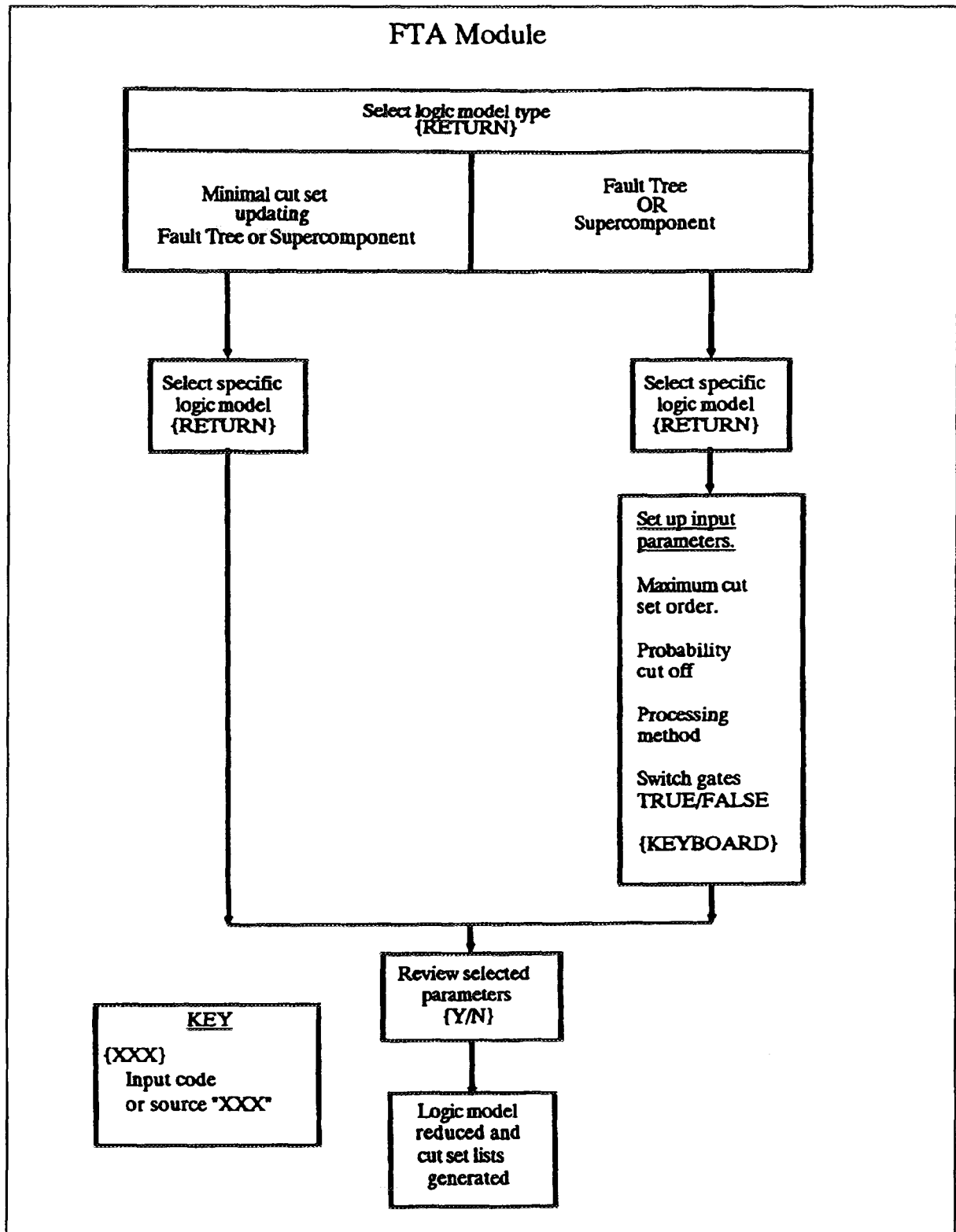


FIG. 3.4. Logic model quantification.

3.1.5. Event tree and sequence input

Event tree and sequence logic are created in the ETED module as illustrated in Fig. 3.5. As with fault trees, event trees can be created within the ETED module or imported from the FEP graphics package. In either case, the first step for **both methods** is to define the initiating event label in the initiating event library in the RDB module.

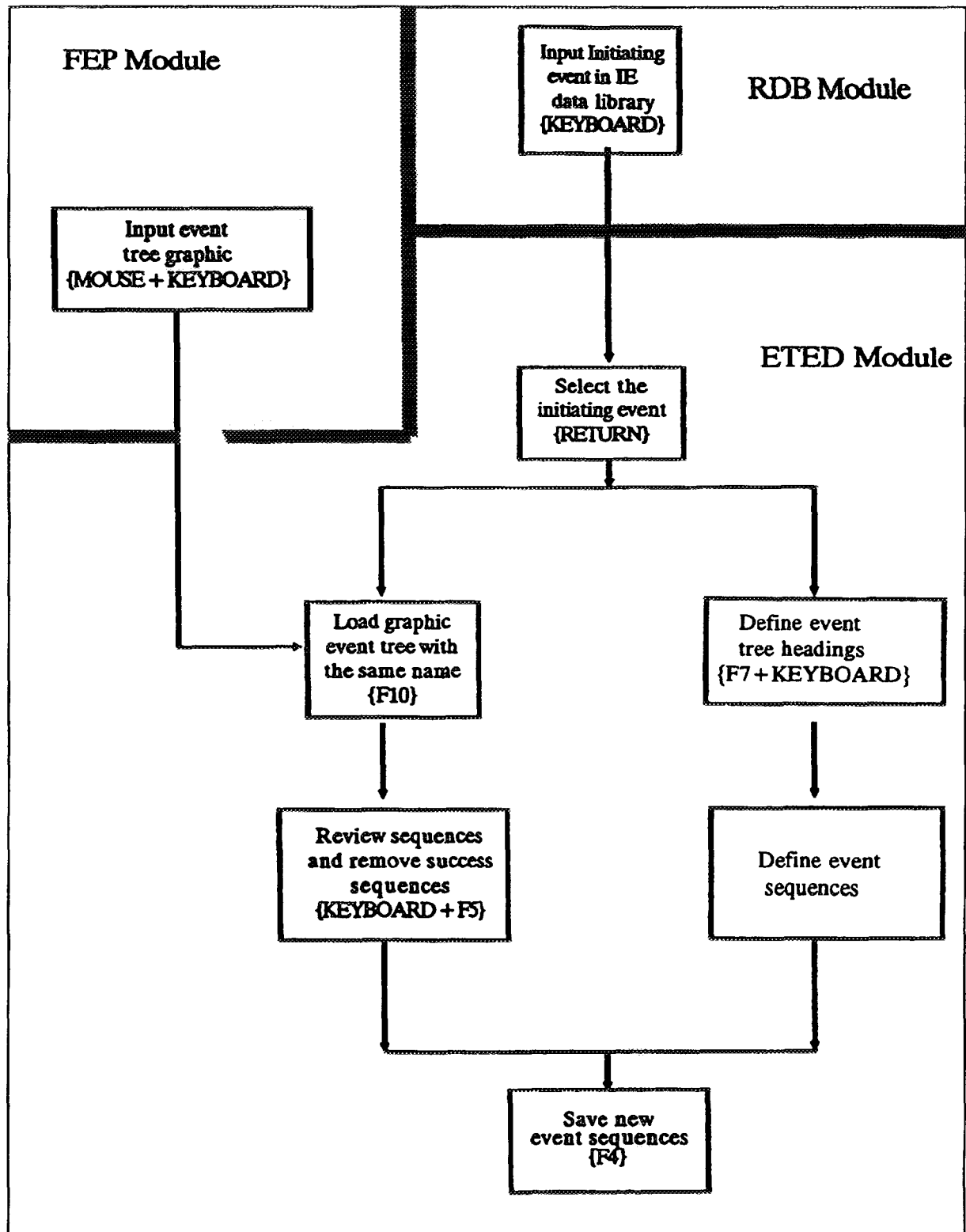


FIG. 3.5. Event tree and sequence input.

To create sequences within ETED the headers must first be defined. The user has to give tokens to the header labels or a default token is used. The token makes the reference to the input for the header event. The default token is MCS and the other tokens are RDB, HRB, TMP, and SCP. The headers are defined using the input model label from left to right. For example, if failure of the first header is the top event of a fault tree labelled GR322, the header label must be GR322(MCS). The headers are automatically also consecutively numbered 1, 2, 3, etc.

Once the headers are defined the sequences can be specified. Each sequence can be input from left to right as a series of the following codes:

- A "1" means function failure, the WASH-1400 event tree branch down.
- A "-" means to ignore the function. *NOTE:* This is the WASH-1400 event tree branch up where function success is ignored.
- A "0" means function success. BOOL will first AND all the failed functions' cut sets. Next, all sequence cut sets which would have led to the failure of the successful function are removed.

An alternative method is to input graphical event trees in the FEP module and "load" them into PSAPACK from within the ETED module. For this method the following points are worth noting:

- (i) The name of the graphic event tree file must be identical with the name of the initiating event.
- (ii) The headers defined in the graphic event tree should include the token extensions. If they do not, PSAPACK will append (MCS) — the default extension.
- (iii) Event tree success (branch up) will be interpreted as a "0", only those functions for which branch points do not exist will be assigned a "-".
- (iv) If any changes are made to an event tree imported from FEP, the imported sequences will be lost. If an attempt is made to regenerate the sequences using the "build" option, all combinations of sequences (equivalent to a branch point at every header in the graphic tree) will be generated. If the graphic event tree is the primary model, editing should be done with FEP and the new event tree imported.

3.1.6. Sequence quantification

Sequences are reduced and quantified from the minimal cut set list for the event tree headers and depending on the logic for each sequence. PSAPACK generates sequence cut sets by ANDing and NOTing the cut set lists found in the header. Before sequences can be quantified, all referenced input sources must be defined and, where applicable, the models processed (i.e. the SCPs must exist in the SCP data library, the MCSs must exist in the MCS library, etc). Missing inputs will be identified by error messages.

In order to reduce the number of very low probability sequence cut sets, a cut-off probability is used for sequence analysis. Unlike the fault tree cut-off which is based on an absolute value, this is a relative cut-off. Each sequence cut set's probability is compared to the current, cumulative sequence probability. When the new cut set's probability is less than the given fraction of the cumulative sequence probability, the cut set is discarded.

NOTE: In some cases, during the course of the sequence evaluation due the changes in the cut-off value, the reported sequence probability can be much larger than the sum of the reported cut set probabilities. If this occurs, the sequence should be processed again with a lower cut-off.

As with fault tree results, quantitative sequence results are not saved, only the cut set lists are saved in a sequence minimal cut set library and the results (i.e. minimal cut set probabilities and the sequence occurrence probability) are calculated from the current point estimates in the component databases whenever the results are viewed.

3.2. LEVEL A (DECISION MAKER) — OVERVIEW

Level A was developed as a tool for the decision makers to interrogate the PSA concerning the current status of the plant considering the actual plant configuration (e.g. components out of operation).

Operations personnel can use PSAPACK Level A to investigate the risk impact of different plant configuration. For example, operators can consult PSAPACK Level A to determine the safety implications of removing specific equipment combinations from service for testing or maintenance at a particular time. Safety engineers and plant managers can use PSAPACK Level A to decide where to focus their efforts to enhance the safety of their plant.

The starting point of Level A is the date when the PSA Level 1 (base case) was finished. Once the user has specified the new plant status, PSAPACK computes new cut set frequencies using the list of cut sets obtained during Level B calculation and updates the PSA.

The environments ID used in Level A are the same environments that were used in Level B and an overview of the Level A is given in Fig. 3.6.

3.2.1. Monitoring a plant's safety status

Plant status input is performed using the MOST module into the Level B to prepare all the libraries to be used in Level A.

The user can update the current plant status by selection of the components out of order at a given time. Taking components out of service or introducing human errors the instantaneous core damage frequency and the relative importance of the components and human actions are recalculated. An overview of the STATUS module is given in the Fig. 3.7.

The STATUS module gives three possibilities:

- (1) Create a new plant status.
- (2) Update an existing plant status.
- (3) Change the date of an existing plant status.

To create or update the plant status, it is possible to select components or human actions by different subsets of basic events. These subsets are grouped according to the following classification:

- System,
- Initiating event,
- Wild character,
- Attributes,
- Select all.

After selection of one or more subsets all the basic events (components and human actions) that belong to the subset(s) selected are displayed. It is possible to take one or more basic events (components) out of service. In the case of using attributes, they should have been previously defined in the RDB module of Level B (see 4.1.1.6). Then PSAPACK calculates a new plant status with a new value of core melt frequency for this status.

Once the new plant status is determined, it is possible to go to CDFG to see the new points in a graphic representation of the frequency of core melt versus time.

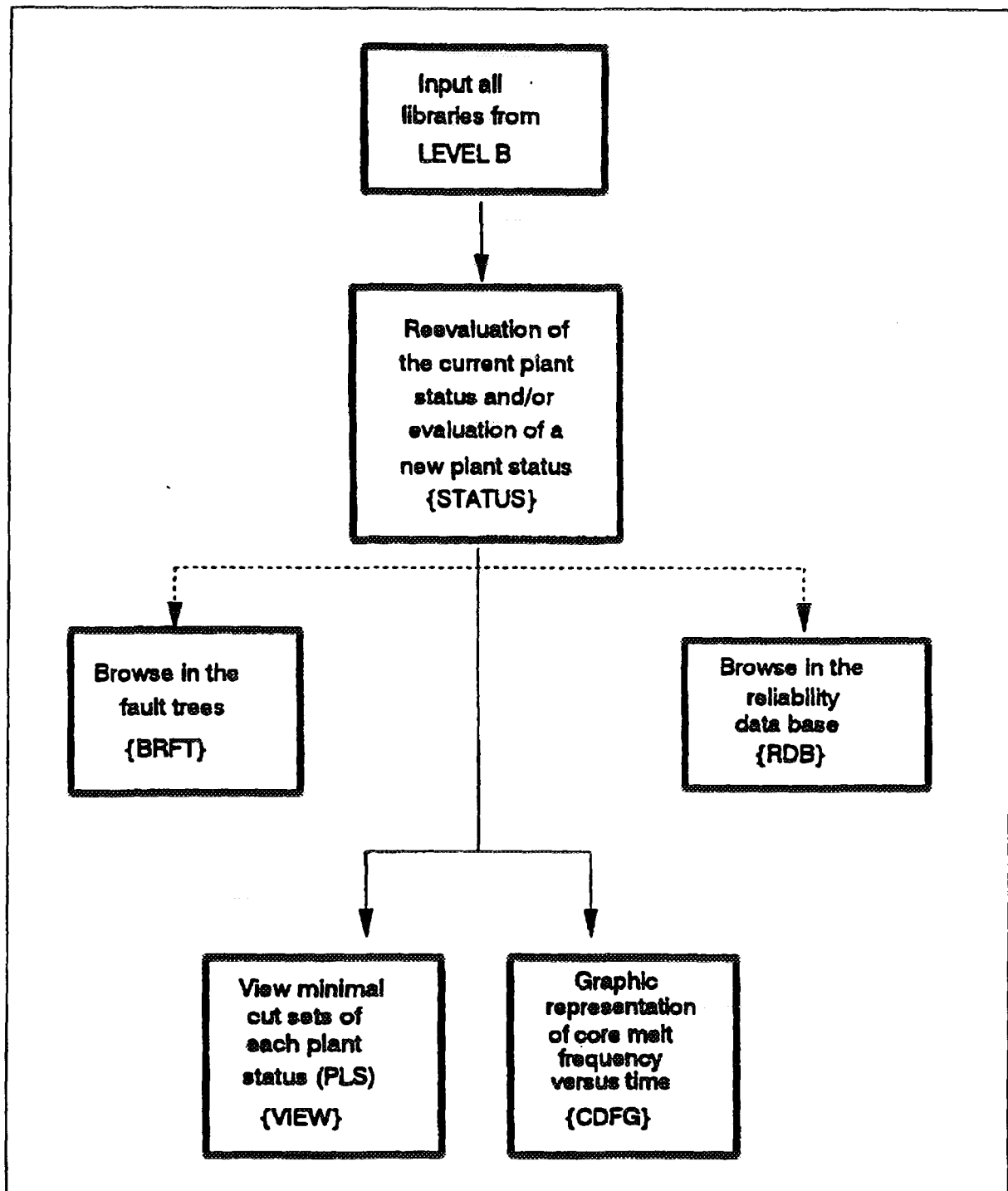


FIG. 3.6. Model input and quantification overview (Level A).

The results at the level of cut sets are in the VIEW module where it is possible to see all the cut sets of the plant for each plant status (PLSLIB). It is possible to calculate importance measures for each one of these cut sets for each plant status (see 4.1.4.4) and new relative importance of components and human actions.

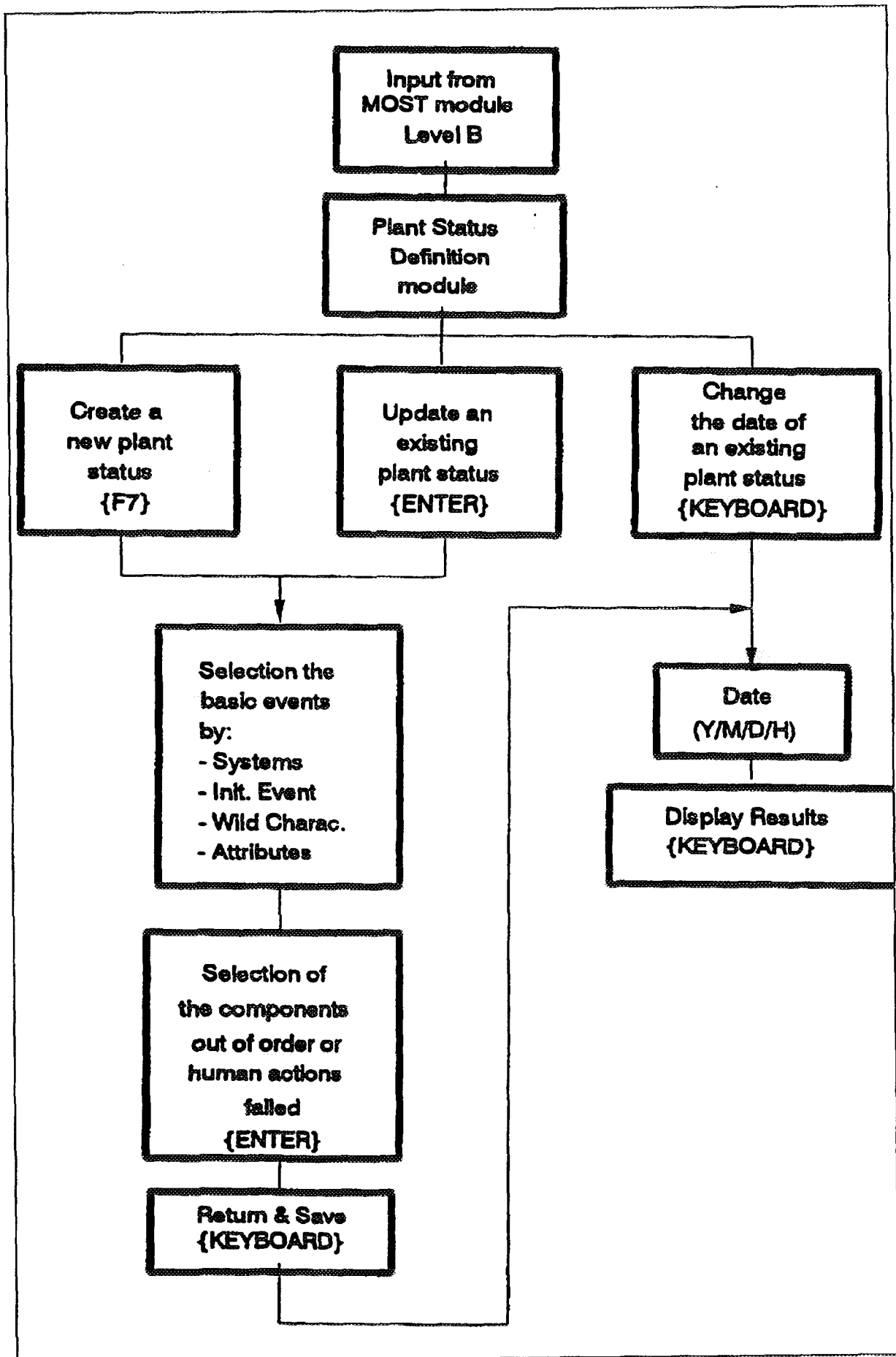


FIG. 3.7. Plant status definition module.

3.2.2. Browsing PSA information

Level A allows browsing through the following information:

- Component reliability data from different libraries.
- Fault tree data and structure.
- Minimal cut sets and sequences ordered by probabilities or by the number of components (number of basic events) in one minimal cut set.
- Different types of importance measures.
- Graphic representation of the core melt frequency versus time.

4. MODULES

4.1. LEVEL B (PSA ANALYST)

The very first menu of PSAPACK, see Fig. 4.1, gives the user the option of entering Level A (decision making) or Level B (PSA analyst).

```
PSAPACK Ver.4.2
522528 bytes available
PSAPACK Menu

PSAPACK User
A. Decision Maker
B. P S A Analyst

Enter your choice : F1 - manual; F3 - quit
```

FIG. 4.1. PSAPACK user menu.

To access and manipulate the PSA models, the user should enter a "B". This will produce a list of all current environments. An environment usually represents a plant.

To select an environment, see Fig. 4.2, highlight the desired environment and enter the password if applicable. To define a new environment (using the <F4> key) simply enter a new letter - this letter will be the new environment code letter. After entering the new environment code letter, you are asked to enter an optional description for the environment. You will also be asked to enter a password. If you do not want to use a password, simply press <Enter>. The following keys are available:

ARROWS

Move the highlighted bar to the environment within which you want to work and press <Enter> to enter the environment.

<Tab>

Provides access to the highlighted ID description for editing the text. The environment descriptions can be changed at any time without affecting the contents of the environment.

<F1>

General help.

ID	PSAPACK U. 4.2	ENVIRONMENT:
386464 Existing Environments		
ID	Short description	
F	SAMPLE PROBABILISTIC SAFETY ANALYSIS	
↑ -scroll; ↓ -sel; F1-help; F2-keys; F3-return; TAB-edit; F1-help; F2-hot keys; F4-new; Alt+F-copy from; Alt+T-copy to; Alt+D-delete;		

FIG. 4.2. Environment menu (after selecting Level B).

<F2>

Produces a list of the following function keys available from this screen with a short description of each key. The following function keys are available:

<ALT+F> and **<ALT+T>**
copy from and copy to.

<ALT+F>

requests the user to input an environment code letter. Afterwards it asks for the path including floppy disk drive, and then copies all the environment specific libraries from that path. The path requested is a subdirectory named with the environment identifier (environment identifier and environment code letter are synonymous), e.g. A:\F\ for an environment with the code letter F.

<ALT+T>

requests the user to input a path, including floppy disk drive, and then copies all the environment specific libraries to that path. This command can be used to make backup copies of an environment. The path requested is a subdirectory named with the environment identifier (environment identifier and environment code letter are synonymous). This path has to be predefined on the target disk, e.g. A:\F for an environment with the code letter F.

Another way to manipulate the environments using DOS commands is as follows:

(1) Backup an environment.

- (1.1) Enter the PSA42\DATA directory (PSA42 being the main PSAPACK directory).
- (1.2) Copy the *.ID* files to the desired target, where ID is the code letter of the environment to be backed-up.

Example: COPY *.F* A:\

This command copies the files with the extension beginning with "F". "F" is the environment identifier or code letter.

(2) Restore the backed-up environment.

- (2.1) Enter the PSA42\DATA directory (PSA42 being the main PSAPACK directory).
- (2.2) Copy the *.ID* files back to this directory from the source, where ID is the code letter of the environment to be restored.

Example: COPY A:*.F*

Being in directory PSA42\DATA this command copies from drive "A" the files for the "F" environment.

(3) Copy one environment to another.

- (3.1) Create a new environment in PSAPACK.
- (3.2) Exit PSAPACK.
- (3.3) Enter the PSA42\DATA directory.
- (3.4) Copy the files *.ID1* to *.ID2*, where ID1 is the source environment code letter and ID2 is the environment code letter of the target environment.

Example: COPY *.F* *.G*

This command copies the files of the "F" environment to the new "G" environment.

< ALT+D >

deletes all environment libraries after asking the user for confirmation.

< Esc >

returns the user to the PSAPACK user menu.

< F3 >

Exits PSAPACK and returns to DOS.

After selecting an environment, Fig. 4.3 is displayed. The following keys are available:

ARROWS

Move the highlighted bar to the desired module. Pressing <Enter> you select the module.

< F1 >

Enters a PSAPACK manual.

< F2 >

General help.

< F3 >

Exits PSAPACK and returns to DOS (after confirmation).

< Esc >

Returns the user to the PSAPACK user menu.

ID	P S A P A C K U. 4.2		ENVIRONMENT: F
P S A P A C K M e n u			
#	Name	Menu module	
1	RDB	- Reliability Data Base Management	
2	FTED	- Fault Tree Editor	
3	FTA	* Fault Tree Analyser (batch file)	
4	UIEW	- View/Quantify MCS/Sequences	
5	ETED	- Event Tree Analysis	
6	BOOL	- Boolean Reduction	
7	FEP	* FT /ET /P&ID Graphics	
8	DIRF	- File Directories	
A	ID	- Change ID	
B	ED	- Text Editor	
C	UGDB	* USER GENERIC DATA BASE	
D	HKID	- Clear in the RDB the erased components	
E	MOST	- Make the libraries for Decision Making	
↑↓ - select module; F1 - help; F2 - keys; F3 - quit;			

FIG. 4.3. Level B main menu.

4.1.1. RDB - Reliability database management

This module provides access to and modification of the user data libraries, see Fig. 4.4. Components are assigned to specific data libraries by the user by appending a token in parentheses after each component name (default token is RDB). A specific data library is selected by moving the highlighted bar to the function and pressing **<Enter>**. Fault trees should not be analyzed until all components are entered into the proper data library.

4.1.1.1. Component reliability DB

After selecting this option, Fig. 4.5 is displayed. The user can change any of the accessible parameter cells by placing the highlight on the cell and typing in the new information. **<F7>**, **<F8>** and **<F9>** are used to toggle between three accessible data fields. The default field is the reliability parameter field (**<F8>**). Descriptions of which parameters are accessible from the three fields can be found under the control key for each field. The following functions are available:

<F1>

Help screen.

<F2>

Display of the following set of HOT KEYS:

<ALT+A>

This function shows the point estimate unavailability which will be used by the VIEW and FTA modules. It is the only display of this information. In this window any attributes which are currently linked to the component are displayed. It is also possible to list the current set of attributes which must have been entered earlier in the ATTRIBUTE CATALOG and to link attributes to the component.

MODULE RDB	P S A P A C K 4.2	ENVIRONMENT : F
SAMPLE PROBABILISTIC SAFETY ANALYSIS		SEL
<div style="border: 1px solid black; padding: 5px; margin: 20px auto; width: 80%;"> COMPONENT RELIABILITY DB HUMAN RELIABILITY DB TEMPORARY DB SUPER COMPONENT DB INITIATING EVENT DB ATTRIBUTE CATALOG CUSTOMIZED DATA BASE ESCAPE TO MAIN MODULE </div>		
F1 - help F2 - keys ↑↓ - available ←→ - select choice F3-quit		

FIG. 4.4. Reliability database menu.

MODULE RDB	P S A P A C K 4.2	ENVIRONMENT : F
SAMPLE PROBABILISTIC SAFETY ANALYSIS		
COMPONENT RELIABILITY DB		
NUMBER OF COMP >> 255		IAEA GENERIC RDB CODE
NUMB COMP. RELIAB. CODE GRDB TYP LAMBDA	TST INTU MIS. TIME REP. TIME DEM FAIL	
1 H322AMAIN	JINT1 9	1.00E-04
2 546AAH0S1C	NS1C1 9	1.00E-04
3 H322AUSLAG	FLAG1 9	1.00E-02
4 H327PX2CCF	9	1.00E-04
5 322EA01PAY	FPAY1 9	3.70E-05
6 323CX01S1X	VS1X1 9	1.00E-08
7 H323UA1M4D	UM4D1 9	1.00E-04
8 316C000T1Y	FT1Y1 9	1.00E-08
9 H322BMAINT	JINT1 9	1.00E-04
10 546ABH0S1C	NS1C1 9	1.00E-04
11 H322BUSLAG	FLAG1 9	1.00E-02
12 322EB01PAY	FPAY1 9	3.70E-05
13 H323UB1M4D	UM4D1 9	1.00E-04
14 H322CMAINT	JINT1 9	1.00E-04
15 546ACH0S1C	NS1C1 9	1.00E-04
F1 help F2 hot key F3 exit(no save) F4 save ESC return(no save) F6 code on/off F7 name on/off F8 data on/off F9 add. on/off		

FIG. 4.5. Component reliability DB display screen.

< ALT+B >

Opens a window with an explanation of the current column.

< ALT+D >

Makes a copy of the selected component label at the end of the component list. This can be used when entering a number of labels with similar names.

WARNING: It is possible to enter duplicate component names in the component data library. PSAPACK will always use the first component label in the list.

< ALT+E >

Mark components for later deletion. Components to be deleted are marked with a "*" but will not be removed until selecting the HKID module in the main menu.

WARNING: HKID is a complex process that changes many pointers in the database. It is recommended that **< ALT+T >** in the environment selection menu be used first to make a backup copy of the database.

< ALT+F >

This function can be used to load new RDB components from the fault trees into the intermediate storage library. The **< ALT+S >** function described later is used to load the components from intermediate storage into the RDB library.

Entering this function produces a list of all fault trees in the environment. All components with the RDB token (or no token) in the selected fault tree will be compared with the components in the RDB library. The number of RDB token components in the tree but not in the library will be reported and the component labels placed in the intermediate storage.

The function can be used to load new RDB components from two or more trees. In this case, any new components in the second fault tree which are already in the intermediate storage will not be transferred a second time. Thus, the total number of components in intermediate storage may be less than the sum of the new components reported.

< ALT+I >

Provides access to both the IAEARDB and the UGDB generic databases. This function can be used to transfer the generic code from any source component in any generic library to a target component in the RDB library. In this case, the user must first place the highlighted bar in any data field of the target component before entering **< ALT+I >**. The target component will always be moved to the top of the RDB window.

The user is first presented with a list of the generic databases. After selecting a database, the user is presented with a list of component types. The user can select "all components" for access to all the components in the selected database or can specify one of the component types for access to only that component type. The component type is indexed to the first letter of the type name, so that screening option will only work with the UGDB when the IAEA component labelling system has been used.

Selecting a component type opens a window listing the components of this type along with the component description. The user can move through the list using the cursor keys. Entering **< F7 >**, a more detailed window including all component parameters can be opened. The user can move through these records using the cursor keys. The generic label can be transferred to the target component from either window by pressing **< Enter >**.

WARNING: Whenever **<ALT+I>** is used, a target component exists. Whenever **<Enter>** is pressed, the generic label will be transferred to the target component. If simply browsing through the databases, do not press **<Enter>**.

<ALT+L>

Using **<ALT+L>** you can view the description of the components. The right hand side of the screen changes and two columns are displayed, the first with the description and the second with the component unavailabilities. If you press **<ALT+L>** again, the screen changes to the first screen of the component reliability database.

<ALT+R>

The inverse of **<ALT+E>**. Components to be deleted are marked with a "*". This mark can be removed by placing the cursor on the marked component and using this control key.

<ALT+S>

Provides access to the intermediate storage as well as loading components from intermediate storage to the RDB library. A window will be opened displaying all the components in the intermediate storage. The user can move through the list using the cursor keys and can edit, add or delete the labels as appropriate.

All components in the intermediate storage are loaded into the RDB library using the **<F8>** key. The components are added to the end of the list of current components.

<ALT+T>

This function will update the failure parameters for all components in the RDB library which are linked to any generic component type. The linkage is through the generic label in the components' GRDB data field.

All parameters in the generic database will be transferred to the individual components. If there are already parameters in the individual components' fields, these parameters will be overwritten with the generic parameter. If there is no generic parameter in a field, the original parameter will not be deleted. Note that the parameters in the UGDB and the IAEARDB are not identical.

This function does not check whether the parameters are necessary and sufficient for a given parameter type nor does it calculate the component's point estimate unavailability. It will, however, identify generic labels that it could not find in any generic database.

<ALT+U>

This function calculates the point estimate unavailabilities for all components in the RDB library. **Before this calculation is performed, all components have point unavailability estimates of 0.0.**

This function also checks to make sure that the necessary failure parameters for each component type are available and produces an error message when they are not.

<ALT+Y>

This function displays the detailed generic data record for the selected component.

<ALT+Z>

This function is similar to **<ALT+I>** but will update the RDB failure parameters only. Descriptions are not updated.

<Tab>

Enters in edit mode. The highlighted bar must first be placed on the field to be edited.

<F3>

Returns to the previous screen without saving any changes made to the RDB library. Before exiting an edited library, the user is questioned whether the library should be saved. If answered with a "Y", the updates will be saved.

<F4>

Updates the RDB library with all changes.

<F6>

Provides access to the component label field. To enter new component labels, go to the end of the list, enter <F6> and type in the new names in the first blank field.

The following column is available with the <F6> key:

{COMP RELIAB. CODE}

The component label used in the fault tree. Since all component labels in this library have a RDB token, the token is not displayed.

<F7>

Turns on/off access to the component label field. The following columns are available with the <F7> key.

{COMP RELIAB. CODE}

The component label used in the fault tree. Since all component labels in this library have a RDB token, the token is not displayed.

{OWN NAME}

An auxiliary text field where additional text can be entered.

<F8>

Provides access to the default field parameters. The following columns are available with the <F8> key:

{GRDB}

Generic code name linking the component with a component type in the generic database.

{TYP} (see Section 6.4 for a detailed explanation)

- 0 = QUANTIFICATION NOT PERFORMED
- 1 = STAND-BY TEST COMPONENT
- 2 = ON LINE NON REPAIR COMPONENT
- 3 = STAND-BY NON TEST COMPONENT
- 4 = STAND-BY MONITORED COMPONENT
- 5 = ON LINE MONITORED COMPONENT
- 6 = STAND-BY (MONITORED)/ OPER. (NON REP.) COMPONENT
- 7 = STAND-BY (TEST)/ OPER. (MONITORED) COMPONENT
- 8 = STAND-BY (TEST)/ OPER(NON REPAIR) COMPONENT
- 9 = CONSTANT UNAVAILABILITY = FAIL PER DEMAND

{LAMBDA}

Failure rate per hour.

{TST INTV}

Time interval in days between the start of two consecutive periodic tests.

{MIS.TIME}

Time period (hours) that the component is required to operate (mission time).

{REP.TIME}

Average time in hours for unscheduled repair performed when a component is found to be failed.

<F9>

Turns on/off access to additional parameter field. The following columns are available with the **<F9>** key, see Fig. 4.6:

```

MODULE RDB                P S A P A C K 4.2                ENVIRONMENT : F
SAMPLE PROBABILISTIC SAFETY ANALYSIS
COMPONENT RELIABILITY DB
NUMBER OF COMP >> 255
ERROR FACTOR OF FAILURE RATE
NUMB COMP. RELIAB. CODE  TST FAIL TST OVR  TST H.ER TST PRD  ERR FACT
1 H322AMAIN
2 546AAHOS1C
3 H322AUSLAG
4 H327PX2CCF
5 322EA01PAV
6 323CX01S1X
7 H323UA1M4D
8 316C000T1Y
9 H322BMAINT
10 546ABHOS1C
11 H322BUSLAG
12 322EB01PAV
13 H323UB1M4D
14 H322CMAINT
15 546ACHOS1C
F1 help F2 hot key F3 exit(no save) F4 save ESC return(no save) F6 code on/off
F7 name on/off F8 data on/off F9 add. on/off

```

FIG. 4.6. Columns accessible with the **<F9>** key.

(DEM FAIL)

The time independent component unavailability or probability of failure on demand.

NOTE: The **{DEM FAIL}** column does not appear until after using the **<F9>** key.

{TST FAIL}

The probability of a failure occurring during periodic tests which requires an unscheduled repair following the test.

{TST OVR}

The probability that a good component cannot be used for its intended functions because it is in testing and fails to override the test.

{TST H.ER}

Probability of an human error occurring during the test which will fail the component.

{TST PRD}

The average duration in hours of scheduled periodic testing and maintenance.

{ERR FACT}

Error factor (not used in the present PSAPACK version).

4.1.1.2. Human reliability DB

After selecting this option, Fig. 4.7 is displayed.

MODULE RDB		P S A P A C K 4.2		ENVIRONMENT : F	
SAMPLE PROBABILISTIC SAFETY ANALYSIS					
HUMAN RELIABILITY DB		EXTRA INFORMATION			
# ELEMENTS	>>	73			
NUMB	HUMAN ERROR	CODE	DESCRIPTION	PROBAB.	
5001	322UAD01H3U		MANUAL VALVE A1 IN CLOSED POSITION	0.10E-02	
5002	322VB01H3U		MANUAL VALVE B1 IN CLOSED POSITION	0.10E-02	
5003	322VC01H3U		MANUAL VALVE C1 IN CLOSED POSITION	0.10E-02	
5004	322VD01H3U		MANUAL VALVE D1 IN CLOSED POSITION	0.10E-02	
5005	H322XLOKAL		NO LOCAL ACTION TO START 322	0.10E-01	
5006	H322MSG		NO MANUAL SIGNAL TO START 322	0.10E-02	
5007	323UA06H4U		MANUAL VALVE A6 IN CLOSED POSITION	0.10E-03	
5008	323VB06H4U		MANUAL VALVE B6 IN CLOSED POSITION	0.10E-03	
5009	323VC06H4U		MANUAL VALVE C6 IN CLOSED POSITION	0.10E-03	
5010	323VD06H4U		MANUAL VALVE D6 IN CLOSED POSITION	0.10E-03	
5011	323UA02H3U		MANUAL VALVE A2 IN CLOSED POSITION	0.10E-02	
5012	323VB02H3U		MANUAL VALVE B2 IN CLOSED POSITION	0.10E-02	
5013	323VC02H3U		MANUAL VALVE C2 IN CLOSED POSITION	0.10E-02	
5014	323VD02H3U		MANUAL VALVE D2 IN CLOSED POSITION	0.10E-02	
5015	H323MSG		NO MANUAL SIGNAL TO START 323	0.10E+00	
F1 help F2 hot key F3 exit(no save) F4 save ESC return(no save) F6 code on/off					

FIG. 4.7. Human reliability DB display screen.

The following keys are available:

<F3>

Returns to the previous screen without saving any changes made to the HRB library. Before exiting an edited library, the user is questioned whether the library should not be saved. If answered with a "Y", the updates will not be saved. If the answer is "N" then the updates will be saved.

<F4>

Updates the HRB library with all changes.

<F6>

Provides access to the human error event code field. To enter new human error events, go to the end of the list, enter <F6> and type in the new names in the first blank field. When followed by the <Tab> key, previously entered human error event codes can be edited.

The following **HOT KEYS** are available:

<ALT+A>

This function shows the point estimate unavailability which will be used by the VIEW and FTA modules. In this data library the point estimate is entered for the human error event. Any attributes which are currently linked to the human error event are displayed. It is also possible to list the current set of attributes which must have been entered earlier in the ATTRIBUTE CATALOG and to link attributes to the human error event.

< ALT+F >

This function can be used to load new HRB human error events from the fault trees into the intermediate storage. The **< ALT+S >** function described later is used to load the human error events from intermediate storage into the HRB library.

Entering this function produces a list of all fault trees in the environment. All events with the HRB token in the selected fault tree will be compared with the human error events in the HRB library. The number of HRB token events in the tree but not in the library will be reported and the event labels placed in the intermediate storage.

The function can be used to load new HRB events from two or more trees. In this case, any new events in the second fault tree which are already in the intermediate storage will not be transferred a second time. Thus, the total number of human error events in intermediate storage may be less than the sum of the new human error events reported.

< ALT+S >

Provides access to the intermediate storage as well as loading human error events from intermediate storage to the HRB library. A window will be opened displaying all the human error events in the intermediate storage. The user can move through the list and can edit, add or delete the labels as appropriate.

All events in the intermediate storage are loaded into the HRB library using the **< F8 >** key. The events are added to the end of the list of current events.

< Tab >

Enters in edit mode. The highlighted bar must first be placed on the field to be edited.

4.1.1.3. Temporary DB

After selecting this option, Fig. 4.8 is displayed.

The following keys are available:

< F3 >

Returns to the previous screen without saving any changes made to the TMP library. Before exiting an edited library, the user is questioned whether the library should not be saved. If answered with a "Y", the updates will not be saved. If the answer is "N" then the updates will be saved.

< F4 >

Updates the TMP library with all changes.

< F6 >

Provides access to the component label field. To enter new components, go to the end of the list, enter **< F6 >** and type in the new names in the first blank field. When followed by the **< TAB >** key, previously entered component labels can be edited.

The following **HOT KEYS** are available:

< ALT+A >

This function shows the point estimate unavailability which will be used by the VIEW and FTA modules. In this data library the point estimate is entered for the component. Any attributes which are currently linked to the component are displayed. It is also possible to list the current set of attributes which must have been entered earlier in the ATTRIBUTE CATALOG and to link attributes to the component.

MODULE RDB		P S A P A C K 4.2		ENVIRONMENT : F	
SAMPLE PROBABILISTIC SAFETY ANALYSIS					
TEMPORARY		DB		EXTRA INFORMATION	
# ELEMENTS	>>	4			
NUMB	TEMPOR.	COMP.	CODE	DESCRIPTION	UNAV.
7001	S314S				0.10E-03
7002	S312S				0.50E-03
7003	TEMP				0.10E+00
7004	TEMP2				0.10E+00

F1 help F2 hot key F3 exit(no save) F4 save ESC return(no save) F6 code on/off

F1 help F2 hot key F3 exit(no save) F4 save ESC return(no save) F6 code on/off

FIG. 4.8. Temporary DB display screen.

<ALT+F>

This function can be used to load new TMP components from the fault trees into the intermediate storage. The <ALT+S> function described below is used to load the components from intermediate storage into the TMP library.

Entering this function produces a list of all fault trees in the environment. All components with the TMP token in the selected fault tree will be compared with the components in the TMP library. The number of TMP token components in the tree but not in the library will be reported and the component labels placed in the intermediate storage library.

The function can be used to load new TMP components from two or more trees. In this case, any new components in the second fault tree which are already in the intermediate storage will not be transferred a second time. Thus, the total number of components in intermediate storage may be less than the sum of the new components reported.

<ALT+S>

Provides access to the intermediate storage as well as loading components from intermediate storage to the TMP library. A window will be opened displaying all the components in the intermediate storage. The user can move through the list using the cursor keys and can edit, add or delete the labels as appropriate.

All components in the intermediate storage are loaded into the TMP library using the <F8> key. The components are added to the end of the list of current components.

<Tab>

Enter in edit mode. The highlighted bar must first be placed on the field to be edited.

4.1.1.4. Supercomponent DB

After selecting this option, Fig. 4.9 is displayed.

MODULE RDB		P S A P A C K 4.2		ENVIRONMENT : F	
SAMPLE PROBABILISTIC SAFETY ANALYSIS					
SUPER COMPONENT		DB		USER DEFINED CODE	
# ELEMENTS	>>	0			
NUMB	TRANSF.	GATES	CODE	DESCRIPTION	UNAV.

F1 help F2 hot key F3 exit(no save) F4 save ESC return(no save)

FIG. 4.9. Supercomponent DB display screen.

The supercomponent (SCP) data library is a special library. Supercomponent labels can only be inserted into the SCP library by running the FTA module for a tree within which the supercomponent is defined. It is not possible to enter SCP labels in this function.

Whenever a supercomponent is found when a fault tree is processed, the point unavailability of the supercomponent is set to 1.0 regardless of what unavailability is in the SCP data library.

When a supercomponent fault tree is processed and quantified using the "quantify supercomponent" option in FTA, the result is not directly entered into the supercomponent SCP library. The results must be viewed in VIEW, at which time the result is entered in the SCP data library. The point estimate unavailability for the supercomponent in this library will be used in the quantification of all minimal cut sets.

Supercomponent unavailability may also be typed into the SCP library from within the RDB module, but later viewing of the results will overwrite the typed-in value (or any old value).

The following keys are available:

<F3>

Returns to the previous screen without saving any changes made to the SCP library. Before exiting an edited library, the user is asked whether the library should not be saved. If answered with a "Y", the updates will not be saved. If the answer is "N" then the updates will be saved.

<F4>

Updates the SCP library with all changes.

WARNING: The fields in the SCP library should not be modified.

4.1.1.5. Initiating event DB

After selecting this option, Fig. 4.10 is displayed.

MODULE RDB		P S A P A C K 4.2		ENVIRONMENT : F	
SAMPLE PROBABILISTIC SAFETY ANALYSIS					
INITIATING EVENT DB					
# ELEMENTS	>>	1	EXTRA INFORMATION		
NUMB	INITIATING	EVENT	DESCRIPTION	FREQ.	
11001	INIT1		SAMPLE EVENT 1	9.10E-02	

F1 help F2 hot key F3 exit(no save) F4 save ESC return(no save) F6 code on/off

FIG. 4.10. Initiating event DB display screen.

All initiating event labels in an environment are entered into the initiating event library from this function. Before an event tree for an initiating event can be created, the initiating event label must be entered in this library.

For each initiating event the description and frequency are also entered into the environment's library from this function.

The following keys are available:

<F3>

Returns to the previous screen without saving any changes made to the IEDB library. Before exiting an edited library, the user is questioned whether the library should not be saved. If answered with a "Y", the updates will not be saved. If the answer is "N" then the updates will be saved.

<F4>

Updates the IEDB library with all changes.

<F6>

Provides access to the initiating event label field. To enter new initiating event labels, go to the end of the list, enter <F6> and type in the new names in the first blank field.

4.1.1.6. Attribute catalog

This function, see Fig. 4.11, allows the definition of attribute labels and accompanying descriptions. These attributes can be subsequently linked to all types of components. Entering this mode produces a list of all attributes already defined with one attribute code and the description of these attributes.

MODULE RDB		P S A P A C K 4.2		ENVIRONMENT : F	
SAMPLE PROBABILISTIC SAFETY ANALYSIS					
ATTRIBUTE CATALOG			EXTRA INFORMATION		
# ELEMENTS	>>	5			
NUMB ATTRIBUTE CODE			DESCRIPTION		
1	LOCATION		ROOM NUMBER		
2	FIRE RISK		INTEGRITY OF COMPONENTS IN A FIRE EVENT		
3	HUMIDITY		DEGRADATION OF COMPONENTS BY HUMIDITY		
4	COMMON CAUSE		LIST OF COMMON CAUSE GROUPS		
5	A1		ATTRIBUTE A1		

F1 help F2 hot key F3 exit(no save) F4 save ESC return(no save)

FIG. 4.11. Attribute catalog display screen.

The following keys are available:

<Tab>

Enter in edit mode. The highlighted bar must first be placed on the field to be edited.

<F3>

Returns to the previous screen without saving any changes made to the ATTRIBUTE CATALOG. Before exiting an edited ATTRIBUTE CATALOG, the user is questioned whether the ATTRIBUTE CATALOG should not be saved. If answered with a "Y", the updates will not be saved. If the answer is "N" then the updates will be saved.

<F4>

Updates the ATTRIBUTE CATALOG with all changes.

<F6>

This function can be used to load new attribute codes.

<ALT+A>

When one attribute code and its description has been catalogued, it is possible to define partitions for this attribute in order to specify different categories in relation with this attribute, see Fig. 4.12.

<Page Up> / <Page Down>

Moves the windows through the attribute partition lists.

MODULE RDB		P S A P A C K 4.2		ENVIRONMENT : F	
SAMPLE PROBABILISTIC SAFETY ANALYSIS					
ATTRIBUTE CATALOG					
# ELEMENTS	>>	5	EXTRA INFORMATION		
NUMB ATTRIBUTE CODE			DESCRIPTION		
1 LOCATION		ROOM NUMBER			
2 FIRE RISK		INTEGRITY OF COMPONENTS IN A FIRE EVENT			
3 HUMIDITY		DEGRADATION OF COMPONENTS BY HUMIDITY			
4 COMMON CAUSE		LIST OF COMMON CAUSE GROUPS			
5 A1		ATTRIBUTE A1			
	LOCATION		UNAVAILABILITY >>	0	
	ROOM NUMBER				
ATTRIBUTE					
A 1 S023	MAIN CONTROL ROOM				
A 1 S154	MAIN FEEDWATER PUMP 1A BOX				
A 1 S199	SECONDARY SWITCHBOARD				
A-1					
F1 - help F2 - hot key ESC - esc					
TAB ↑↓ PGUP PGDN - availables					

FIG. 4.12. Attribute partitions.

4.1.1.7. Customized database

It is possible to customize the RDB module so that it can extract some information from the component labels. For example, you might have the code for the generic component type in the component label itself, if so, this function allows you to extract that name from the label instead of having to enter the type in the GRDB column for every component.

In this case, the generic code in the component label must be precisely 5 characters long to match the length in the generic databases' code. Furthermore, the last character in the code must be "X" for the IAEARDB or "1" for the UGDB database.

It is also possible to extract other information from the component label. In theory any of the columns in the RDB library can be filled in that way. In practice, component type dependent parameters such as failure rate are perhaps better accessed through the UGDB data library. Other candidates such as mission time are more fault tree than component dependent. Repair time may, however, be a candidate since nominally identical components may have quite different repair times due to access problems. Finally the limit on the length of the component label limits the number of parameters that can be packed into them. The following functions are available:

<Tab>

Activates the parameter code selection. Once activated, the up/down arrows move through the various column headings in the RDB library.

<Enter>

Fixes the column for which information is to be extracted from the component labels and activates the mask field. Two options are available for extracting information.

- (1) The position in the label where the information can be found can be entered. In this case the first character position from the left is entered followed by a comma followed by the last

character position. For example, { 3,7 } will extract the 3rd to the 7th characters from the component label and insert them into the specified column.

- (2) The characters to be extracted can be preceded by either a "/" or "-" (as specified by the user). The number of characters to be extracted is then specified. For example { /6 } will take the 6 characters following the "/" in the label and insert them into the specified column in the RDB library.

4.1.1.8. Escape to main module

This is the same function as <F3>.

4.1.2. FTED - Fault tree editor

Entering this module will open a window with a list of all current fault trees in the environment, see Fig. 4.13.

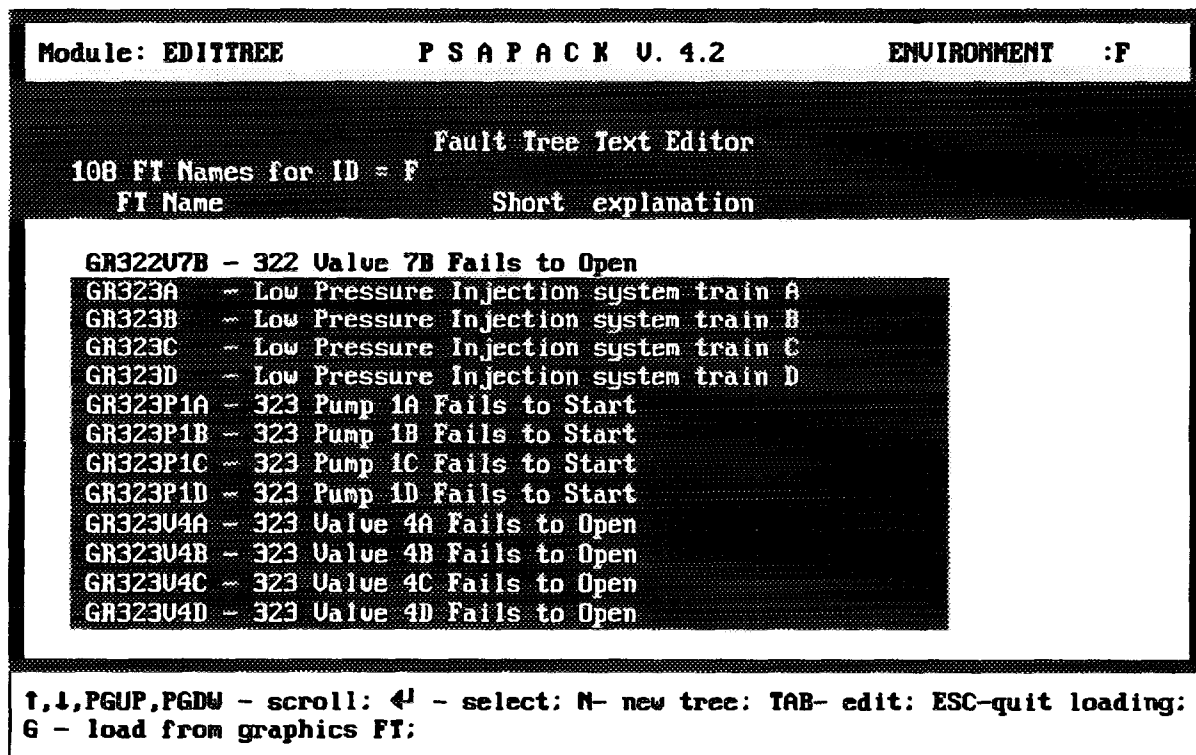


FIG. 4.13. Fault tree selection display screen.

The following commands are available to manipulate the fault tree library:

ARROWS

Move the highlighted line through the fault tree list.

<Enter>

Loads the highlighted fault tree into the editor and starts the fault tree editor function.

<N>

Adds a new tree at the end of the fault tree list. After entering a new name and, optionally, a description, the fault tree editor function is started.

<Tab>

Allows editing of the highlighted fault tree description.

<Esc>

Returns to the main menu.

<G>

Opens a window with a list of all graphics trees in the GRAPHIC subdirectory. The cursor keys can be used to move through the list of graphic fault trees and **<Enter>** loads the tree (maintaining the same graphic trees name) and starts the fault tree editor function. Appendix I contains a description of the fault tree graphics module and of details regarding the transfer of graphic fault trees to the fault trees in text format as handled in FTED.

It is possible to overwrite an existing tree with a new graphics fault tree by reloading the new graphic tree.

The fault tree editor is started when a fault tree has been loaded, see Fig. 4.14.

Module: EDITTREE

PSAPACK Ver.4.2

ENVIRONMENT :F

Tree name: GR322A

Fault Tree Text Editor

Row: 1

Gate name	Type	Input 1	Input 2	Input 3	Input 4	Input 5
GR322A	OR	GR322A10	GR322A12			
GR322A10	OR	GR322A30	GR322U2A			
GR322A12	OR	H322AMAIN	546AAH0S1C	GA322A24		
GR322A30	OR	GR322U7A	GR322A40	GR322A42		
GA322A24	AND	H322AUSLAG	H327PX2CCF			
GR322A40	OR	GR322A50	GR322P1A			
GR322A42	OR	322EA01PAY	GR721AB			
GR322A50	OR	GR322A60	322UA01H3U			
GR322A60	OR	323CX01S1X	H323UA1M4D	316C000T1Y		

GR322A(TOP)

F1- help; F2- keys; F3- quit; F4- save; F5- Del.cell; TAB- edit; F9- other;

FIG. 4.14. Text fault tree editor display screen.

The following functions are available to edit the fault trees:

<F1>

General help about the text editor.

<F2>

A list of the HOT KEYS. The following **HOT KEYS** are available:

<ALT+I>

Inserts a blank row at the highlighted cell position.

< ALT+ E >

Erases the row at the highlighted cell position.

< Page Up > / < Page Down >

Previous/next screen.

< ALT+ C >

Edits the highlighted cell label.

< ALT+ D >

A window in the lower part of the screen appears, where you can edit the current cell text description. Every cell in PSAPACK can have a 40 character description text. When a cell is highlighted, the text is displayed in the upper part of the window.

NOTE: It is not possible to transfer any text from the FEP graphic fault trees to the text fault trees.

< ALT+ 1 >

This function can be used to fill in text fault trees with component labels in the RDB library. It opens a window displaying the component labels and descriptions in the RDB library. Using the cursor keys it is possible to move through the library. Pressing **< Enter >** will load the highlighted component label into the fault tree cell which was highlighted when **< ALT+ 1 >** was activated.

< ALT+ 2 >

This function can be used to fill in text fault trees with component labels in the HRB library. It opens a window displaying the component labels and descriptions in the HRB library. Using the cursor keys it is possible to move through the library. Pressing **< Enter >** will load the highlighted component label into the fault tree cell which was highlighted when **< ALT+ 2 >** was activated.

< ALT+ 3 >

This function can be used to fill in text fault trees with component labels in the TMP library. It opens a window displaying the component labels and descriptions in the TMP library. Using the cursor keys it is possible to move through the library. Pressing **< Enter >** will load the highlighted component label into the fault tree cell which was highlighted when **< ALT+ 3 >** was activated.

< F3 >

Exits to the PSAPACK main menu without saving the tree.

< F4 >

Saves the current fault tree. Whenever a tree is saved, the question "Do you want to check if all basic events are in the libraries ?" is asked. If you enter "Y", all components in the tree will be compared to the respective component data libraries (depending on the token). If one or more component labels are not found in the libraries, the component(s) will be identified in a message and the tree will be saved with a warning flag. When trying to analyze the tree with FTA, any tree saved with a warning flag will generate a warning message.

If you answer "N", the tree will be saved with a warning - even if it was verified earlier that all components are in the library. In this case, analyzing the tree with the FTA module will generate a warning message but, as long as all the components are in the proper data libraries, the tree can still be successfully processed.

<F5>

Deletes the highlighted cell. Gate definition cells (to the left of the gate type) and the gate type cannot be deleted. To delete a gate definition, the entire row must be deleted.

<Tab>

Edits the highlighted cell.

The following gate definitions are operational in PSAPACK 4.2:

- OR gates,
- AND gates,
- N/M gates,
- Switch gates,
- Supercomponent type gates, and
- Transfer gates.

For the N/M (N out of M) gates, N and M have to be entered as integer numbers. N equal 0 or M are not accepted. Section 6. contains a description of switch gates, supercomponent type gates and transfer gates.

<F9>

Activates the submenus shown in Fig. 4.15.

Module: EDITTREE		P S A P A C K Ver.4.2		ENVIRONMENT :F			
Tree name: GR322A		Fault Tree Text Editor					
Row: 1	Gate name	Type	Input 1	Input 2	Input 3	Input 4	Input 5
	GR322A	OR	GR322A10	GR322A12			
	GR322A10	OR	GR322A30	GR322U2A			
	GR322A12	OR	H322AMAINT	546AAH0S1C	GA322A24		
	GR322A30	OR	GR322V7A	GR322A40	GR322A42		
	GA322A24	AND	H322AUSLAG	H327PX2CCF			
	GR322A40	OR	GR322A50	GR322P1A			
	GR322A42	OR	322EA01PAY	GR721AB			
	GR322A50	OR	GR322A60	322VA01H3U			
	GR322A60	OR	323CX01S1X	H323UA1M4D	316C000T1Y		

Transfer-menu, Delete-cell, Row-menu, Edit-cell, Help, Quit
(Input any highlighted letter or ESC to exit the menu...)

FIG. 4.15. Text fault tree submenu screen.

Transfer-menu

Activates the following submenu:

Load

Loads a fault tree from any environment given the environment ID and fault tree name.

Save

Saves the current fault tree in any environment given the environment ID and fault tree name and then exits.

Print-tree

Prints the current tree as an ASCII text file to any printer on LPT1:

Delete-tree

This function deletes the current fault tree from the environment. Unlike the component and cut set library delete, this delete function removes the tree immediately. No confirmation is requested before the tree is deleted but it is possible to "undelete" the tree by saving it again before exiting this function.

Merge-tree

This will initiate a series of screens displaying the available fault trees. The user has to find the tree into which the current tree has to be merged. This function will load the current fault tree onto the top of the target tree and changes from the current tree to the target tree. The current fault tree will neither be saved nor deleted.

NOTE: When merging large trees, follow the instructions below.

- (1) immediately after the merge is complete, save the new tree,
- (2) the tree can now be reloaded and edited.

Delete-cell

Deletes the highlighted cell. Gate definition cells (to the left of the gate type) and the gate type cannot be deleted. To delete a gate definition, the entire row must be deleted.

Row-menu

Activates the following submenu.

Insert-row

Inserts a row at the highlighted cell position.

Delete-row

Deletes the row at the highlighted cell position.

Edit-cell

Copies the contents of the highlighted cell into the lower left corner of the screen and allows editing of the cell contents using <Insert>, <Delete> and ARROW keys (the <Tab> key can be used for the same purposes).

Help

Displays the help screen.

Quit

Exits from the fault tree text editor to the environment selection screen. On selecting a new (or the same) environment, the fault tree text editor will be automatically started with a list of the available fault trees.

4.1.3. FTA * Fault tree analyzer

After selecting this option, Fig. 4.16 is displayed.

FTAA	P S A P A C K U. 4.2	ENVIRONMENT: F
300784	*** SAMPLE PROBABILISTIC SAFETY ANALYSIS ***	
FTA input option parameters		
<div style="position: absolute; top: 10%; right: 10%; border: 1px solid black; padding: 5px; width: 300px;"> <div style="text-align: center; font-weight: bold; margin-bottom: 5px;">Faulttree processing</div> <div style="margin-bottom: 5px;">Supercomponent processing</div> <div style="margin-bottom: 5px;">Minimal cut set updating</div> <div style="margin-bottom: 5px;">Event sequence processing</div> <div style="margin-bottom: 5px;">Write text fault tree on/off OFF</div> <div style="margin-bottom: 5px;">FTA using SETS /386 PC +CP</div> <div style="margin-top: 5px;">ESC</div> </div>		

FIG. 4.16. Fault tree analyzer main menu.

4.1.3.1. Fault tree processing

This function begins the processing of a fault tree. A window is opened on a list giving all text fault trees currently in the environment. The appropriate fault tree can be located in the list using the cursor keys. The fault tree to be processed is highlighted and selected with **<Enter>**.

As the selected tree is loaded, all transfer gates are filled in. In the upper right corner of the menu, the name of each transfer gate will appear as it is loaded and the cumulative number of fault tree pages will be displayed.

If any fault tree was saved with a warning, processing will be halted and a message that the tree was saved with warnings given. Processing of the tree can be halted or continued.

Once the entire tree is loaded, the following questions regarding how the analysis is to be performed are asked.

Maximum cut set order >

The user can specify the maximum number of components in the cut sets. Cut sets with more than this number will be discarded.

Truncation probability for the MCS >

The user can specify the minimum probability of each cut set to be saved. Cut sets with less than this probability will be discarded. The default is 0.0001.

Set the fault tree processing method (1/2/3)

Three processing methods are available:

- 1: TOP DOWN
- 2: BOTTOM UP
- 3: TOP DOWN + BOTTOM UP

In general, "TOP DOWN" is the fastest for small trees but the other two can reduce larger trees. In general, if one method does not work the other methods should be tried. Which method works best depends on the tree size and structure.

Switches

If any of the loaded fault trees, or the supercomponents in the loaded fault trees, contain switch gates, the name of each switch gate is given and the user must specify whether the gate should be set to activated or not activated, see Section 6.3 for more explanation.

Each switch gate combination represents a unique fault tree. When switch gates are encountered, the MCS file name is modified by an extension. This extension (discussed further in Section 6.3) is not under user control.

Process parameter review table

After the switch gate status is entered (where applicable) a display summarizing the analysis process is given. If the summary is correct, the analysis is started by pressing **<Enter>**.

Results of the analysis - the cut sets - are written directly into the fault tree MCS library and must be displayed by exiting to the main module, entering the VIEW module, and accessing the fault tree MCS library.

4.1.3.2. Supercomponent processing

This function begins the processing of a supercomponent. Before a supercomponent can be processed, a fault tree containing the supercomponent must have been previously processed to enter the name of the supercomponent in the SCP library.

A window is opened with a list of all the supercomponents currently in the environment. The appropriate supercomponent can be located in the list using the cursor keys. The supercomponent to be processed is selected with **<Enter>**.

Once the supercomponent is selected, the process is identical to fault tree processing except that the resulting cut sets are not written to the fault tree MCS library but to the supercomponent MCS library.

4.1.3.3. Minimal cut set updating

Using this function, a previous analysis can be repeated. This is particularly useful when switches have been used. When this function is selected, a list of all fault trees which have been processed appears. Selecting a fault tree from the list displays the processing parameters previously used (i.e. cut-off type and size/probability, reduction option, number of switches activated/non activated etc.). It is not possible to change these parameters from within this function. To re-analyze a fault tree with different processing parameters, the FAULT TREE PROCESSING function must be used.

4.1.3.4. Write text fault tree on/off

This function is provided to document an analysis and can be used for detailed checking of the models. When turned "ON", this function writes a copy of the fault tree structure and all the component point estimate unavailabilities to the TMP sub-directory.

WARNING: The file always has the same name, FT.TXT. Each time a fault tree is processed, the old file is overwritten. To document the analysis, it is necessary to use a utility (e.g. DOS command) to change the name of the file between processing different trees.

4.1.3.5. FTA using SETS or FTAP codes

This function allows to select one of the four options to analyze fault trees. These options and the related memory requirements are described in Section 1.2. By pressing <Enter> it is possible to **change** options. The option shown in the line on the screen is the one PSAPACK uses for execution.

4.1.4. VIEW - View/quantify MCS/sequences

After selecting this option, Fig. 4.17 is displayed.

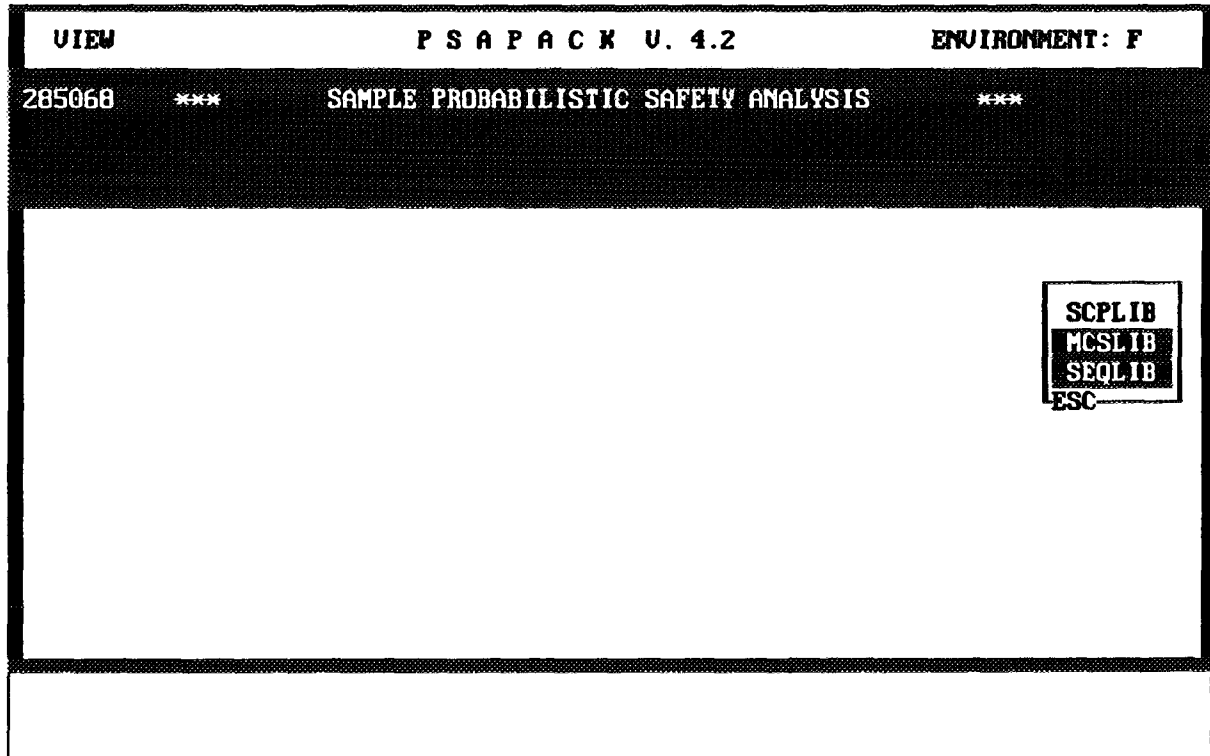


FIG. 4.17. VIEW main menu.

All minimal cut sets are stored in one of the 3 MCS cut set libraries. The fault tree/supercomponent/sequence unavailabilities displayed by VIEW are calculated each time VIEW is used from the **current** point estimates in the various reliability libraries. Note that view collects and sorts the cut sets each time it is used. For long cut set lists (> 1000) this process can take some minutes.

4.1.4.1. SCPLIB

Produces a list of the supercomponents which have been defined. Selecting a supercomponent which has not yet been processed produces a message that there are no cut sets. Selecting a supercomponent which has been processed will display the cut sets (like the one shown in Fig. 4.18 for MCSLIB) and will insert the supercomponent's unavailability into the supercomponent library. Whenever a fault tree or sequence which includes that supercomponent is subsequently displayed, the unavailability calculated by the last VIEW access will be used.

ARROWS

Moves the cursor through the cut set list.

<Page Up> / <Page Down>

Pages up and down through the cut set list.

<F3>

Exits the function.

<F4>

Orders the minimal cut sets by probability (the default order).

<F5>

Orders the minimal cut sets by cut set order.

<F6>

Opens a window displaying the fault tree analysis parameters.

<F7>

Opens a window with a list of all possible cut-set orders and gives the number of cut sets in this model for each order.

<F8>

Deletes the cut set list from the libraries.

WARNING: The entire cut set list is deleted without asking for confirmation.

<F9>

Prints the cut set list as an ASCII file to LPT1.

<F10>

Opens a window to select the importance measure desired, see Fig. 4.19. After selecting the importance measure the importances will be calculated and displayed as it is shown in Fig. 4.20 for MCSLIB. For a detailed explanation regarding importances see Section 4.1.4.4.

<Enter>

Opens a window within which the components in the selected cut set are further identified including each component's point estimate unavailability and description.

4.1.4.2. MCSLIB

Produces a list of all fault trees which have been processed. Selecting a fault tree will generate the cut set list, see Fig. 4.18, quantified with the current component unavailabilities.

ARROWS

Moves the cursor through the cut set list.

<Page Up> / <Page Down>

Pages up and down through the cut set list.

<F3>

Exits the function.

<F4>

Orders the minimal cut sets by probability (the default order).

<F5>

Orders the minimal cut sets by cut set order.

VIEW		P S A P A C K U. 4.2		ENVIRONMENT: F	
255820		***	SAMPLE PROBABILISTIC SAFETY ANALYSIS		***
GR323A*					
AVERAGE UNAVAILABILITY		0.013		DISPLAY MCS	
NUMB	UNAVAIL.	COMPONENT	COMPONENT	COMPONENT	
1	4.90E-003	323UA04M3A			
2	3.10E-003	323PA01C3A			
3	1.00E-003	323UA02H3U			
4	9.10E-004	323UA05B2A			
5	9.10E-004	323UA03B2A			
6	4.40E-004	H323MSG	H516ALOGRC		
7	4.00E-004	H323XLOKAL	677SAW1S4Y		
8	2.00E-004	H323XLOKAL	672SAW1S3Y		
9	2.00E-004	H323XLOKAL	673SAW1S1Y		
10	1.00E-004	H323UA1M4D			
11	1.00E-004	546AAHOS1C			
12	1.00E-004	323UA06H4U			
13	1.00E-004	H323XLOKAL	H663AMAIN		
14	1.00E-004	H661AMAIN			
15	1.00E-004	H323AMAIN			

4↑ PGDW -scroll: 4↓ -sel: F1-hlp: F2-keys: F3-return:

F4-probab F5-ord/pro F6-cut F7-show ord F8-del F9-prt F10-Importance

FIG. 4.18. Cut set list display.

< F6 >

Opens a window displaying the fault tree analysis parameters.

< F7 >

Opens a window with a list of all possible cut-set orders and gives the number of cut sets in this model for each order.

< F8 >

Deletes the cut set list from the libraries.

WARNING: The entire cut set list is deleted without asking for confirmation.

< F9 >

Prints the cut set list as an ASCII file to LPT1.

< F10 >

Opens a window to select the importance measure desired, see Fig. 4.19. After selecting the importance measure the importances will be calculated and displayed as it is shown in Fig. 4.20. For a detailed explanation regarding importances see Section 4.1.4.4.

< Enter >

Opens a window within which the components in the selected cut set are further identified including each component's point estimate unavailability and description.

4.1.4.3. SEQLIB

Produces a list of the initiating event. Selecting an initiating event produces a list of the sequences in that initiating event's event tree. Selecting a sequence which has not yet been processed produces a message that there are no cut sets. Selecting a sequence which has been processed will display the cut sets from that sequence.

ARROWS

Moves the cursor through the cut set list.

<Page Up> / <Page Down>

Pages up and down through the cut set list.

<F3>

Exits the function.

<F4>

Orders the minimal cut sets by probability (the default order).

<F5>

Orders the minimal cut sets by cut set order.

<F6>

Opens a window displaying the fault tree analysis parameters.

<F7>

Opens a window with a list of all possible cut-set orders and gives the number of cut sets in this model for each order.

<F8>

Deletes the cut set list from the libraries.

<F9>

Prints the cut set list as an ASCII file to LPT1:

<F10>

Opens a window to select the importance measure desired, see Fig. 4.19. After selecting the importance measure the importances will be calculated and displayed as it is shown in Fig. 4.20 for MCSLIB. For a detailed explanation regarding importances see Section 4.1.4.4.

<Enter>

Opens a window within which the components in the selected cut set are further identified including each component's point estimate unavailabilities and description.

4.1.4.4. Importance measures

Quantitative importance are the importances of risk contributors and changes which are derived from the quantitative results of the PSA. Pressing **<F10>** PSAPACK offers five importance measures, see Fig. 4.19, and the highlighted importance is selected with **<Enter>**.

4.1.4.4.1. Importances for components in operation

Indicates how many times the core melt frequency or the failure probability of the system will increase (risk increase ratio) if a component is failed (failure probability equal to 1).

Note: Only the components with significant impact on the total probability (> 1%) are shown.

4.1.4.4.2. Importances for components out of service

This option is not implemented in the present version.

VIEW		P S A P A C K U. 4.2		ENVIRONMENT: F	
255820	***	SAMPLE PROBABILISTIC SAFETY ANALYSIS		***	
GR323A*					
AVERAGE UNAVAILABILITY		0.013		DISPLAY MCS	
NUMB	UNAVAIL.	COMPONENT	COMPONENT	COMPONENT	
1	4.90E-003	323UA04M3A	<div>1. Importance components in operation 2. Importance components in service 3. Risk reduction (for components in operation) 4. Risk reduction (for initiating events) 5. FUSSELL-VESELY importance ESC</div>		
2	3.10E-003	323PA01C3A			
3	1.00E-003	323UA02H3U			
4	9.10E-004	323UA05B2A			
5	9.10E-004	323UA03B2A			
6	4.40E-004	H323MSG			
7	4.00E-004	H323XLOKAL			
8	2.00E-004	H323XLOKAL			
9	2.00E-004	H323XLOKAL			
10	1.00E-004	H323UA1M4D			
11	1.00E-004	546AAH0S1C			
12	1.00E-004	323UA06H4U			
13	1.00E-004	H323XLOKAL		H663AMAIN	
14	1.00E-004	H661AMAIN			
15	1.00E-004	H323AMAIN			

LF PGDW -scroll:4J-sel:F1-hlp:F2-keys:F3-return:
F4-probab F5-ord/pro F6-cut F7-show ord F8-del F9-prt F10-Importance

FIG. 4.19. Importance measure selection menu.

VIEW		P S A P A C K U. 4.2		ENVIRONMENT: F	
255820	***	SAMPLE PROBABILISTIC SAFETY ANALYSIS		***	
GR323A*					
# of comp.=000057				DISPLAY MCS	
NUMB	UNAVAIL.	COMPONENT	COMPONENT	COMPONENT	
1	4.90E-003	323UA04M3A			
2	3.10E-003	323PA01C3A			
3	1.00E-003	323UA02H3U			
4	9.10E-004	323UA05B2A			
FUSSELL-VESELY importance					
323UA04M3A	3.841769e-001	VALUE FAILS TO OPEN			
323PA01C3A	2.434904e-001	PUMP FAILS TO START			
323UA02H3U	7.871073e-002	MANUAL VALVE A2 IN CLOSED POSITION			
323UA03B2A	7.163322e-002	CHECK VALVE FAILS TO OPEN			
323UA05B2A	7.163322e-002	CHECK VALVE FAILS TO OPEN			
H516AL06RC	3.451485e-002	LOGIC EQUIPMENT FAILS			
H323MSG	3.339069e-002	NO MANUAL SIGNAL TO START 323			
577SAW1S4Y	3.150320e-002	220/380 V POWER SUPPLY FAILS			
573SAW1S1Y	1.733039e-002	24 V POWER SUPPLY FAILS			
572SAW1S3Y	1.575492e-002	110 V POWER SUPPLY FAILURE			
LF PGDW -scroll:4J-sel:F1-hlp:F2-keys:F3-return:					

FIG. 4.20. Importance list.

4.1.4.4.3. Risk reduction (for components)

Indicates how many times the core melt frequency or the failure probability of a system will decrease (risk reduction ratio) if a component is made 100% reliable (failure probability equal to 0).

Note: Only the components with significant impact on the total probability ($> 1\%$) are shown.

4.1.4.4.4. Risk reduction (for initiating events)

This option is only functional in Part A. It indicates how many times the core melt frequency will decrease if a particular initiating event does not occur.

Note: Only initiating events with significant impact are shown.

4.1.4.4.5. Fussel-Vesely importance

This is a calculation of the fraction of a minimal cut set (or sequence frequency) that involves the basic event of concern. In other words, it is the importance obtained with "importance for components in operation" (risk increase ratio) multiplied by the appropriate event probability.

Note: Only initiating events with significant impact on the total probability ($> 1\%$) are shown.

4.1.5. ETED - Event tree analysis

After selecting this option, Fig. 4.21 will be displayed. This module provides for the construction and modification of text event trees. Before an event tree can be constructed, the initiating event must have been defined in the INITIATING EVENT DB, from within the RDB module.

ETED P S A P A C K U. 4.2 ENVIRONMENT: F

315064 **** SAMPLE PROBABILISTIC SAFETY ANALYSIS ****

SELECT THE INITIATING EVENT

INIT1
ESC

FIG. 4.21. Event tree text editor main selection screen.

Upon entering this module a window is opened listing all the initiating events defined in the initiating event library. The user must select the initiating event - and thus the event tree - to work on. The current sequences for that event tree are displayed, see Fig. 4.22.

<Page Down>

Moves the window through the sequences when there are too many sequences to list on one screen.

<F3>

Returns to the main menu. Note that, in this module, there is no control on whether the edited event tree has been saved. If the module is exited without saving (<F4>), all changes will be lost.

<F5>

Deletes the highlighted sequence.

ETED		P S A P A C K U. 4.2		ENVIRONMENT: F	
315064 *** SAMPLE PROBABILISTIC SAFETY ANALYSIS ***					
INITIATING EVENT >>INIT1			# of sequences =09		
# of headers =05			EDIT SEQUENCES		
SEQUENCE DESCRIPTION					
1 0100-					
2 0101-					
3 011-					
4 10-0					
5 10-1					
6 11000					
7 11001					
8 1101-					
9 111-					
10 *****					
↑ PGDN -scroll; ↓ -sel; F1-help; F2-keys; F3-return; TAB-edit; F4-save; F5-del; F6-headers; F7-input data; F8-build; F9-save graph; F10-retrieve graph;					

FIG. 4.22. Event tree editing screen.

<F6>

Opens a window displaying the status of each of the header events in the highlighted sequence (0,1, or -).

<F7>

Opens the function for constructing or modifying the event tree. A window is initially opened showing the following three options (Options 2 and 3 are not implemented in the present version):

- (1) Event tree heading names
- (2) Dependency matrix
- (3) Success function

Selecting the ET headings name option (1) produces a screen with the consecutively numbered list of current function header labels. The first item in the list (numbered HD00) is the initiating event label. The following keys are available:

ARROWS

Moves the cursor through the function header list.

<Page Up> / <Page Down>

Pages up and down through the function header list.

<F3>

Exits the function. If editing changes have been made but not saved using **<F4>**, no confirmation will be requested and all changes will be lost.

<Tab>

Allows the highlighted header label to be edited. If a new sequence needs to be entered, edit the last line marked with asterisks.

<F4>

Saves the current event tree with any changes.

<F5>

Deletes the highlighted header name.

<F8>

This option is not implemented in the present version.

<F9>

Creates a graphic event tree from the current sequences which can be loaded into the FEP event tree editor.

<F10>

Converts a graphic event tree with the same name as the current initiating event into a list of sequences. All sequences except for the top sequence are transferred into PSAPACK. Function failure (branch down) are transferred as "1", function success (branch up) are transferred as "0", and no branch point is transferred as a "-". Any sequences which represent success paths must be individually deleted using the delete sequence option **<F5>**.

4.1.6. BOOL - Boolean reduction

This function generates minimal cut set lists for sequences by combining the minimal cut set lists (or components when the appropriate token is used in the function headers) connected to the event tree headers. It is also possible to edit sequences (and save the edited sequences) from this module. Major event tree structure changes including editing of the function header labels must be performed from within the ETED module.

The user is first presented with a list of the initiating event. Selecting an initiating event produces a list of the sequences for that event on the screen, see Fig. 4.23.

<Enter>

Processes the highlighted sequence. This will initiate the following questions to control the processing.

MAX VIRTUAL MEM recommended > > 10 MB (Y/N)

The recommended virtual memory (including both extended memory and free hard disk space) is 10 MB. If you have more than 10 MB available and want PSAPACK to use only 10, answer "Y".

BOOL		P S A P A C K U. 4.2		ENVIRONMENT: F	
278896 *** SAMPLE PROBABILISTIC SAFETY ANALYSIS ***					
INITIATING EVENT >>INIT1				# of sequences =09	
# of headers =05				EDIT SEQUENCES	
SEQUENCE		DESCRIPTION			
1		0100-			
2		0101-			
3		011-			
4		10--0			
5		10--1			
6		11000			
7		11001			
8		1101-			
9		111-			
10		*****			
If PGDW -scroll:4 -sel:F1-hlp:F2-keys:F3-return; F6-headers:F7 - make all mcs					

FIG. 4.23. List of sequences.

MAX DISK FREE IS > > XX MB (Y/N)

PSAPACK checks how much memory is actually available and places this where "XX" is above. The response to this question is irrelevant since it will always be followed by the next question.

enter new MAX Virtual Memory

Any number (in MB) which is less then "XX" may be entered. Generally, "XX" should be entered.

order cutoff= (cutoff/output prob.) 1.000000E-002 (Y/N)

In order to reduce the number of very low probability sequence cut sets, a cut-off probability is used. Unlike the fault tree cut-off which is based on an absolute value, this is a relative cut-off. Each sequence cut set's probability is compared to the current, cumulative sequence probability. When the new cut set's probability is less than 1/100 th (in this example) of the cumulative sequence probability, the cut set is discarded.

NOTE: This technique can sometimes produce what appears to be anomalous results due to the constantly changing value of the cut-off. In some cases, the reported sequence probability can be much larger than the sum of the reported cut set probabilities. If this occurs, the sequence should be processed again with a lower cut-off.

ARROWS

Moves the cursor through the sequence list.

<Page Up> / <Page Down>

Pages up and down through the sequence list.

<F3>

Exits the function.

Opens a window displaying the full function header names in the event tree. The status of each of the functions in the highlighted sequence (0,1, or -) is also displayed.

Processes all the sequences in the sequence list.

4.1.7. FEP * FT /ET /P&ID graphics

Fig. 4.24 shows the main FEP menu. In this section the FEP options and the interaction between these options and PSAPACK are discussed. For detailed information regarding the individual options the reader should refer to the Appendices I to IV.

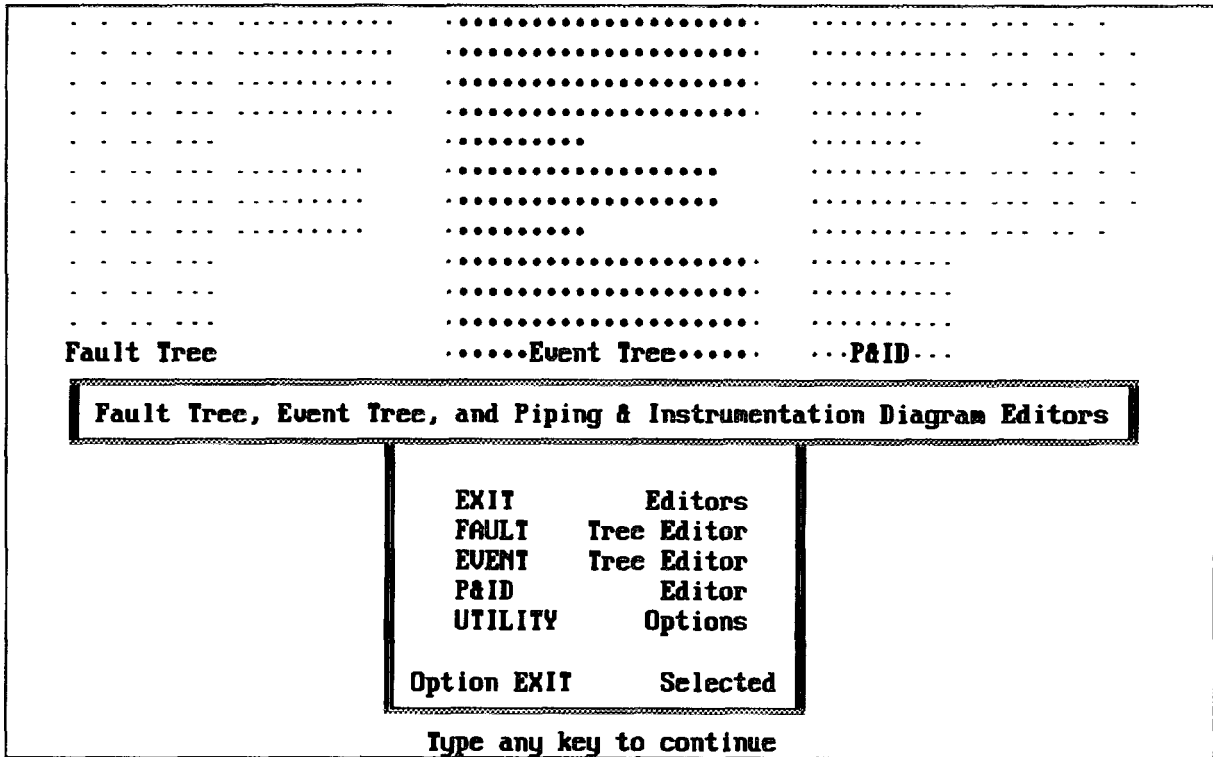


FIG. 4.24. FEP main menu.

The PSAPACK ID for identifying a PSAPACK environment (usually a plant) has no effect on the data files from this package. In other words, all graphical files in the GRAPHIC sub-directory are accessible (and listed) regardless of the current user environment.

4.1.7.1. FAULT tree editor

The graphical fault trees are an excellent tool to document an analysis but must be transferred to the PSAPACK text format before they can be processed and quantified. This transfer is performed with the FTED module. The text in the fault trees is not transferred.

FEP allows up to 20 characters in the gate and event labels. The interaction between the graphic fault trees and PSAPACK places some additional constraints on the graphic fault trees.

GATE AND EVENT LABELS

It is possible to include PSAPACK's tokens in the gate and event labels in the graphic tree. FEP accepts the parentheses required for tokens in the labels, but the labels must not be more than

20 characters including the parentheses and the token. If all labels are 10 characters or less, there should be no problems with adding the token.

WARNING: When PSAPACK loads a fault tree with transfer gates, it must assume that the transfer gates label and the transfer gates file name are identical, and that there is a gate with the same label as the transfer gate in the transfer gate's file. If this is so, all transfer gates in the graphic fault trees will be correctly linked in PSAPACK's text fault trees (although each fault tree must be individually loaded). If this is not so, substantial editing of the text files will be necessary.

In general, it is recommended that all fault tree files contain only one fault tree, and that the tree's top event label be the same as the fault tree file name. Although this limits top event labels to 8 characters (the DOS file name limit) it will reduce the potential for confusion. As with the other PSAPACK tokens, it is still possible to add the "(TOP)" token to the top event's label but only to the top event's label. This produces a total top event label length of 13 (i.e. 8 + 5) and will be accepted by the FEP module. A detailed description of the FEP fault tree editor is given in Appendix I.

4.1.7.2. EVENT tree editor

As with fault trees, graphic event trees can be developed with FEP and later transferred into PSAPACK. In this case, the initiating event label and the file name for that initiating event must have the same label, INIT1 for example. No token is required or possible. The initiating event label entered into the initiating event library from within the RDB module must also have the same label (also INIT1). When all the labels match, the event tree can be loaded into PSAPACK by choosing the "< F10 > - retrieve graph" option in the ETED module.

SEQUENCES

All sequences except for the top sequence are transferred into PSAPACK. Function failure (branch down) are transferred as "1", function success (branch up) are transferred as "0", and no branch point is transferred as a "-". Any sequences which represent success paths must be individually deleted using the delete sequence option within ETED.

FUNCTION HEADERS

Function headers can have any name in FEP. It is, however, not possible to edit the function headers in PSAPACK's ETED module without losing all the sequences. Therefore, the function headers used in FEP should correspond precisely to the requirements of the ETED module - particularly the tokens.

PSAPACK function headers identify the name of the model to be used and the token identifies the library within which the name can be found. The standard header model is the result of fault tree processing and can be found in the MCS library. Therefore headers which have no token are assigned a "(MCS)" token when the tree is loaded into PSAPACK. Headers can also have RDB, HRB, TMP, or SCP tokens. If the header model is to be found in one of these libraries, the tokens must be entered or edited in FEP. A detailed description of the FEP event tree editor is given in Appendix II.

4.1.7.3. P&ID editor

The piping and instrumentation diagrams are only for printing and documentation. A detailed description of the FEP P&ID editor is given in Appendix III.

4.1.7.4. UTILITIES

After selecting this option Fig. 4.25 is displayed showing the options of the utility module of FEP. The following options are available in the utilities menu:

on the screen. You are prompted to select the color box shown on the screen. Using the **ARROW** keys you can place the cursor at the box and pressing **<Enter>** or clicking the left mouse button the box is selected. You will be prompted to select a new pen number for the color shown.

After making the necessary changes quit this function and return to the utilities menu by positioning the cursor at the **STOP** sign and press **<Enter>** or click the left mouse button.

4.1.8. DIRF

This module allows the user to search for DOS files from within PSAPACK. Using wild cards (i.e. *.TRZ) the user can search a sub-directory for files. The sub-directory must, however, be fully defined specified.

4.1.9. ID - Change ID

ID is the environment code letter. All graphic fault trees and the two generic data libraries (IAEARDDB and UGDB) are accessible from all IDs. All other libraries are only accessible from within a single environment.

4.1.10. ED - Text editor

Opens a window to the general text editor supplied with PSAPACK. The available functions from within the text editor can be displayed using **<ALT+H>**.

4.1.11. UGDB - User generic database

This module provides for inputting and modifying generic component types into the user generic library (UGDB), see Fig. 4.26.

USERGRDB		P S A P A C K Ver (4.2)		ENVIRONMENT		<ALL>																																													
GENERIC USER DEFINED RELIABILITY DATA BASE																																																			
<table><tr><td>GENERIC CODE</td><td>.....</td><td>1</td><td></td></tr><tr><td>COMMON TYPE</td><td>.....</td><td></td><td></td></tr><tr><td>FAILURE TYPE</td><td>.....</td><td></td><td></td></tr><tr><td>FAILURE RATE (1/H)</td><td>.....</td><td></td><td></td></tr><tr><td>TEST INTERVAL(Days)</td><td>.....</td><td></td><td></td></tr><tr><td>MISSION TIME (H)</td><td>.....</td><td></td><td></td></tr><tr><td>REPAIR TIME (H)</td><td>.....</td><td></td><td></td></tr><tr><td>FAILURE PER DEMAND</td><td>.....</td><td></td><td></td></tr><tr><td>PROB. OF TEST CAUSED FAILURE</td><td>.....</td><td></td><td></td></tr><tr><td>DURATION OF TEST (H)</td><td>.....</td><td></td><td></td></tr><tr><td>DESCRIPTION</td><td colspan="3">.....</td></tr></table>								GENERIC CODE	1		COMMON TYPE			FAILURE TYPE			FAILURE RATE (1/H)			TEST INTERVAL(Days)			MISSION TIME (H)			REPAIR TIME (H)			FAILURE PER DEMAND			PROB. OF TEST CAUSED FAILURE			DURATION OF TEST (H)			DESCRIPTION		
GENERIC CODE	1																																																	
COMMON TYPE																																																		
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PROB. OF TEST CAUSED FAILURE																																																		
DURATION OF TEST (H)																																																		
DESCRIPTION																																																		
				<table><tr><td>ADD</td></tr><tr><td>Change</td></tr><tr><td>Delete</td></tr><tr><td>Inquire</td></tr><tr><td>Exit</td></tr></table>				ADD	Change	Delete	Inquire	Exit																																							
ADD																																																			
Change																																																			
Delete																																																			
Inquire																																																			
Exit																																																			
F1 Help Arrows Select Enter Accept Esc Exit						SELECT																																													

FIG. 4.26. UGDB editing window.

Generic components must be input manually from this module. Once entered, they may be referenced as source components similar to those in the IAEA generic library (which cannot be modified). That is, the available failure parameters from the source component type may be transferred to one or more target components in the user component data library. Also as with the IAEA generic library, eventual changes in the failure parameters in the user generic library can be globally transferred to all the target components, allowing for accurate up-dating of many failure parameters.

There is a difference in the content of the IAEA and the user generic libraries. The user generic component library includes the component type (1-9) while the IAEA generic library does not.

It is also recommended that the first letter of the IAEA component labeling scheme (following table) be consistently used. This allows the same component type searches in both the IAEA and the user generic component libraries.

A record of a user generic component contains the following fields:

{GENERIC CODE}

Four characters - the first character should correspond to the IAEA convention, see the generic code table below.

{COMMON TYPE}

Free form short text description which can be used in the "Delete", "Inquire" and "Change" options to locate components.

{FAILURE TYPE}

Controls which reliability model is used to calculate the components point estimate unavailability. The choices are 1 to 9. There is no error checking that the parameters which are eventually entered correspond to the type.

{FAILURE RATE (H)}

The failure rate in hours.

{TEST INTERVAL (DAYS)}

The test interval in days.

{MISSION TIME (H)}

The time span in hours that a component must operate following an initiating event.

{REPAIR TIME (H)}

The time span in hours that a component must be taken out of service for repair after it fails or is discovered failed.

{FAILURE PER DEMAND}

The time independent probability that a standby component fails when called upon to operate.

{PROB. OF TEST CAUSED FAILURE}

The probability per test that a human error during the test left the component in an undetected failed state following the test.

{DURATION OF TEST}

The duration of a test in hours during which a component is out of service.

{DESCRIPTION}

A short description of the generic failure. Since the description will appear on the short list format when accessing the database, a meaningful description should be used.

GENERIC CODE TABLE

COMPONENT TYPE	TYPE CODE
ALL COMPONENTS	no code
MECHANICAL COMPONENTS	F,H,O,P,Q,V,Y,J
PIPING	F
HEAT EXCHANGERS	H
CONTROL ROD AND DRIVE MECHANISMS	O
PUMPS	P
HVAC AND AIR HANDLING EQUIPMENT	Q
VALVES	V
STRAINERS, FILTERS	Y
OTHER MECHANICAL EQUIPMENT	J
ELECTRICAL COMPONENTS	T,R,M,C,B,K,E
TRANSFORMERS	T
RELAYS	R
MOTORS	M
CONNECTORS	C
BATTERIES AND CHARGERS	B
CIRCUIT BREAKERS	K
OTHER ELECTRICAL EQUIPMENT	E
I&C COMPONENTS	A,I,L,N,S,U
SENSORS	A
INSTRUMENTATION (CHANNEL)	I
TRANSMITTERS	L
SIGNAL CONDITIONING SYSTEMS	N
SWITCHES	S
OTHER I&C EQUIPMENT	U
EMERGENCY POWER SUPPLIES	D

< F1 >

Help screen.

ARROWS

Moves the highlighted bar through the function selection panel to the right on the screen.

< Enter >

Pressing **< Enter >** will activate the function currently highlighted in the function selection panel. The functions are described in the following paragraphs.

< Esc >

Exits the module.

4.1.11.1. Add

Selecting this function will highlight the first field of the record. It is now possible to enter the component information.

WARNING: All letters in the generic code name must be typed in capital letters.

<F1>

Help screen.

<Tab>

Moves the highlighted bar one line up.

<Enter>

Terminates editing a field and moves the highlighted bar to the next line down the form. When the highlighted bar is on the last line, see **SAVE** description below.

<Esc>

Returns the user to the function menu.

SAVE

There is no save key in this screen. When the highlighted bar is on the last line in the form, **<Enter>** will generate a question on whether this item should be added to the database. Answering "Y" will directly save the new entry.

WARNING: In Version 4.2, it is not advisable to delete components from the user generic data library and it is not possible to change the generic code. Deleting components may corrupt the UGDB library and the code name is not accessible from the change option.

4.1.11.2. Change

Selecting this function will open a window requesting the type of label mask to use to find the appropriate component. You have to select whether the mask will be applied to the generic code or the common type entries. Afterwards a second window is opened to choose whether the mask must be an exact match or a partial match. The exact mask option should be chosen and subsequently entered because the partial match will only find the first partial match in the database.

The generic component record identified will be displayed on the screen with the lines in the component form numbered 2 - 11. Entering a number between 2 and 11 will place the cursor on the corresponding numbered line.

WARNING: It is not possible to change (nor delete) generic component labels once they have been saved. Errors or unusable generic components must be left in the database.

<F1>

Help screen.

<Enter>

Terminates editing a field and moves the highlighted bar to the next line down the form. When the highlighted bar is on the last line **<Enter>** moves the bar to line 2.

<Tab>

Moves the highlighted bar one line up.

<Esc>

When the editing is complete, **<Esc>** will generate a question on whether this item should be added to the database. Answering "Y" will directly save the modified entry. To exit the function without saving the modifications, enter "N".

4.1.11.3. Delete

Selecting this function will open a window requesting the type of label mask to use to find the appropriate component. You have to select whether the mask will be applied to the generic code or the common type entries. Afterwards a second window is opened to choose whether the mask must be an exact match or a partial match. The exact mask option should be chosen and subsequently entered because the partial match will only find the first partial match in the database.

< F1 >

Help screen.

< Enter >

Pressing **< Enter >** will generate a question on whether this item should be deleted from the database. Answering "Y" will directly delete the entry.

< Esc >

Exits the function.

4.1.11.4. Inquire

Selecting this function will open a window requesting the type of label mask to use to find the appropriate component. You have to select whether the mask will be applied to the generic code or the common type entries. Afterwards a second window is opened to choose whether the mask must be an exact match or a partial match.

The inquire function accesses the generic labels in alphabetical order and it is possible to move through the various records. Therefore, in this function, the partial match can be useful.

< F1 >

Help screen.

< Enter >

Pressing **< Enter >** will display the next generic record in the database.

< Tab >

Displays the previous record in the database.

< Esc >

Exits the function.

4.1.12. HKID - Clear erased components in the RDB

This module removes all components in the reliability databases which have been marked for removal from within the RDB modules.

WARNING: A copy of all environments in a database should be made before using this function.

4.1.13. MOST - Make the libraries for decision making

This module prepares data and libraries for Level A.

After selecting this option you will be prompted to answer the following question:

MAX VIRTUAL MEM recommended > > 10 MB
(Y/N)

If you answer "N", you will be prompted to enter a new MAX virtual memory specification. If you answer "Y", the program continues. After writing some information on the screen, you will be prompted to enter the password for the destination. This password will be used later in Level A.

4.1.14. PSAM - PSAPACK manual browser

Opens the PSAPACK text editor and loads a PSAPACK manual into the editor.

4.1.15. PSAG - PSA guidelines browser

Opens the PSAPACK text editor and loads a PSA Guidelines into the editor.

4.1.16. IMPT - Import of FTAP files

This option is not verified in the present version of PSAPACK.

4.1.17. MEMORY * Display memory

Checks the available DOS memory, see Section 1.2 for the explanation of memory requirements.

4.2. LEVEL A (DECISION MAKER)

To access and manipulate decision making modules, the user should enter an "A", see Fig. 4.1. This will produce a list of all current environments, see Fig. 4.27. This option is **only** applicable when MOST module was run from Level B.

ID	PSAPACK V. 4.2	ENVIRONMENT:
324960	Existing Environments	
ID	Short description	
F -	SAMPLE PROBABILISTIC SAFETY ANALYSIS	
↑ PGDN -scroll; ← -sel; F1-hlp; F2-keys; F3-return; F1-help; F2-hot keys;		

FIG. 4.27. Environment menu (after selecting Level A).

To select an environment, highlight the desired environment and enter the password if applicable. After selecting an environment, Fig. 4.28 is displayed.

The following keys are available:

ID	PSAPACK U. 4.2		ENVIRONMENT: F
PSAPACK Menu			
#	Name	Menu module	
1	STAT	- Review Plant Status	
2	VIEW	- Browse in the MCS	
3	CDFG	- Core Damage Frequency Graphics	
4	TOPT	- Optimization of Test Intervals	
A	RDB	- Reliability data base	
B	BRFT	- Browse in the fault trees	
C	PSAM	* Access to PSA Manual	
D	ID	- Select ID	
↑↓ - select module; F1 - help; F2 - keys; F3 - quit;			

FIG. 4.28. Main Level A menu.

ARROWS

Move the highlighted bar to the desired module. Pressing <Enter> you select the module.

<F1>

Enters a PSAPACK manual.

<F2>

General help.

<F3>

Exits PSAPACK and returns to DOS (after confirmation).

<Esc>

Returns the user to the PSAPACK user menu.

4.2.1. STATUS - Plant status definition module

After selecting this option, Fig. 4.29 is displayed.

This module permits re-evaluation of the current plant status and evaluation of a new plant status for a given date.

ARROWS

Select the DATE and press <Enter>. A window will appear, see Fig. 4.30, showing the different possibilities to select components.

<F3>

Exit from this module.

STAT		P S A P A C K U. 4.2		ENVIRONMENT: F1	
257328 ***		TEST CASE		***	
Plant Status Definition Module					
oDATEo	FREQUENCYo	DESCRIPTIONo			
00\00\00		2.68E-006 ** ALL COMPONENT IN OPERATION **			
92\06\24	12hs	1.42E-004 COMPONENTS SYSTEM 322 OUT OF SERVICE			
92\09\12	05hs	6.45E-005 ATTRIBUTE FIRE (HIGH RISK COMP.)			
91\07\14	12hs	4.22E-002 ATTRIBUTE FIRE (HIGH RISK)			
91\11\09	09hs	2.68E-006 ATTRIBUTE HUMIDITY			
92\03\20	07hs	3.33E-002 TEST 1			
92\04\10	19hs	1.41E-002 TEST 2			
92\04\25	23hs	5.14E-006 TEST A			
92\05\10	15hs	2.11E-002 TEST B			
92\05\12	18hs	2.68E-006 TEST C			
92\05\19	00hs	4.22E-002 ATTRIBUTE LOCATION			
92\06\27	14hs	1.12E-002 TEST D			
92\07\25	22hs	5.10E-005 TEST K			
00\12\23	00hs	7.02E-001 sgdsfedy			

1f PGDW -scroll:4l-sel:F1-hlp:F2-keys:F3-return:TAB - update date

F7-new point:ENTER-update;

FIG. 4.29. Plant status selection screen.

<Tab>

Updates only the date of the highlighted row.

<F7>

Enters a new plant status with a new date.

When the option <F7> is selected, a menu is displayed, see Fig. 4.30, with different possibilities to select components.

<Enter>

Updates the highlighted date.

When running the STATUS module for the first time the data screen is displayed with a single row with the basic data. This line cannot be modified.

With the options 1 to 5 different selection principles are available regarding the components to be put out of service. For all these options you are finally asked to select specific components to be put out of service in a component selection screen as shown in Fig. 4.31. The different selection options are explained in the following paragraphs.

(1) Given Systems

Retrieves the list of components for a given system to assist the user in selecting the components to be put out of service.

(2) Given Initiating Event

Retrieves the list of components for a given initiating event to assist the user in selecting the components to be put out of service.

STAT		P S A P A C K U. 4.2		ENVIRONMENT: F1	
<div style="display: flex; justify-content: space-between;"> 313792 *** SAMPLE PROBABILISTIC SAFETY ANALYSIS *** </div>					
				# of comp. select=>000	
oDATEo	FREQUENCYo	DESCRIPTIONo			
90\00\00	2.68E-006	*** ALL COMPONENT IN OPERATION ***			
91\03\02 20hs	2.68E-006	SYSTEM 322 OUT OF SERVICE			
91\04\04 18hs	6.45E-005	SYSTEM 327 OUT			
91\07\14 12hs	2.68E-006	ATTRIBUTE FIRE	<div style="border: 1px solid black; padding: 5px;"> <ol style="list-style-type: none"> 1. Given System 2. Given Initiating Event 3. Given Wild Character 4. Given Attribute 5. Select all 6. Already select 7. Return(&save) 8. Return(&no save) </div>		
91\11\09 09hs	2.68E-006	ATTRIBUTE HUMI			
92\03\20 07hs	3.33E-002	TEST 1			
92\04\10 19hs	1.41E-002	TEST 2			
92\04\25 23hs	5.14E-006	TEST A			
92\05\10 15hs	2.11E-002	TEST B			
92\05\12 18hs	2.68E-006	TEST C			
92\05\19 00hs	4.22E-002	ATTRIBUTE LOCA			
92\06\27 14hs	1.12E-002	TEST D	ESC		
92\07\25 22hs	5.10E-005	TEST K			
Lt PGDW -scroll:←-sel:F1-hlp:F2-keys:F3-return:TAB - update date F7-new point:ENTER-update;					

FIG. 4.30. Component selection menu.

STAT		P S A P A C K U. 4.2		ENVIRONMENT: F1	
<div style="display: flex; justify-content: space-between;"> 313792 *** SAMPLE PROBABILISTIC SAFETY ANALYSIS *** </div>					
# of comp. =000125		# of comp. select=>000			
SELECT THE INITIATING EVENT					
90\00\00	2.68E-006	*** ALL COMPONENT IN OPERATION ***			
91\03\02 20hs	2.68E-006	SYSTEM 322 OUT OF SERVICE			
91\04\04 18hs	6.45E-005	SYSTEM 327 OUT OF SERVICE			
91\07\14 12hs	2.68E-006	ATTRIBUTE FIRE (HIGH RISK)			
oo	SELECT COMPONENTS OUT OF ORDERo				
546AAH0S1C 323CX01S1X H323VA1M4D 316C000T1Y 546ABH0S1C H323VB1M4D 546ACH0S1C H323VC1M4D 546ADH0S1C H323VD1M4D					
Lt PGDW -scroll:←-sel:F1-hlp:F2-keys:F3-return: F4- save;					

FIG. 4.31. Component selection screen.

(3) Given Wild Character

Retrieves the list of components that contain a given string anywhere in the label to assist the user in selecting the components to be put out of service.

(4) Given Attribute

Retrieves the list of components that have the same attribute to assist the user in selecting the components to be put out of service.

(5) Select All

Retrieves the list of all components to assist the user in selecting the components to be put out of service.

(6) Already Select

Displays the list of all components already selected to assist the user in selecting or unselecting the components that are out of service.

(7) Return (& Save)

Assigns the actual list of selected components to the list of components out of service for the current date.

REMARK: If the list is empty and there is no new date, the old list is preserved.

(8) Return (& No Save)

Unselects all components already selected.

The selection options are illustrated in the following paragraphs.

4.2.1.1. Select components given system

Selection of this option displays fault tree names for the current environment, see Fig. 4.32. For this selection option it is assumed that fault trees are representative for systems or subsystems or parts of them. When a fault tree is selected, the list of components for this tree is displayed similarly to Fig. 4.31.

4.2.1.2. Select components given initiating event

The list of existing initiating events is displayed, see Fig. 4.33. In this case, there is only one initiating event named **INIT1** representing this list. After selection of the initiating event, the list of related components for this initiating event is displayed similarly to Fig. 4.31.

4.2.1.3. Select components given wild character

The components can be selected by matching string or by a mask with "*" and "?" symbols allowed, see Figs. 4.34 and 4.35. The selection results in a list of components similar to Fig. 4.31.

4.2.1.4. Select components given attribute

If attributes were defined in RDB module, it is possible to select components by means of that attributes, see Fig. 4.36.

4.2.1.5. Select all

This option selects all components.

STAT		P S A P A C K U. 4.2		ENVIRONMENT: F1	
313792		*** SAMPLE PROBABILISTIC SAFETY ANALYSIS ***		# of comp. select=>000	
SELECT THE FAULT TREE					
00\00\00	2.68E-006	** ALL COMPONENT IN OPERATION **			
01\03\02 20hs	2.68E-006	SYSTEM 322 OUT OF SERVICE			
01\04\04 18hs	6.45E-005	SYSTEM 327 OUT OF S			
01\07\14 12hs	2.68E-006	ATTRIBUTE FIRE (HIG		GR322A	
01\11\09 09hs	2.68E-006	ATTRIBUTE HUMIDITY		GR322B	
02\03\20 07hs	3.33E-002	TEST 1		GR322C	
02\04\10 19hs	1.41E-002	TEST 2		GR322D	
02\04\25 23hs	5.14E-006	TEST A		GR322P1A	
02\05\10 15hs	2.11E-002	TEST B		GR322P1B	
02\05\12 18hs	2.68E-006	TEST C		GR322P1C	
02\05\19 08hs	4.22E-002	ATTRIBUTE LOCATION		GR322P1D	
02\06\27 14hs	1.12E-002	TEST D		GR322U2A	
02\07\25 22hs	5.10E-005	TEST K		ESC-PGUP-PGDW	

J↑ PGDW -scroll:↓-sel:F1-hlp:F2-keys:F3-return:
 F4- save:

FIG. 4.32. System (fault tree) selection window.

STAT		P S A P A C K U. 4.2		ENVIRONMENT: F1	
313792		*** SAMPLE PROBABILISTIC SAFETY ANALYSIS ***		# of comp. select=>000	
SELECT THE INITIATING EVENT					
00\00\00	2.68E-006	** ALL COMPONENT IN OPERATION **			
01\03\02 20hs	2.68E-006	SYSTEM 322 OUT OF SERVICE			
01\04\04 18hs	6.45E-005	SYSTEM 327 OUT OF S			
01\07\14 12hs	2.68E-006	ATTRIBUTE FIRE (HIG		INIT1	
01\11\09 09hs	2.68E-006	ATTRIBUTE HUMIDITY		ESC	
02\03\20 07hs	3.33E-002	TEST 1			
02\04\10 19hs	1.41E-002	TEST 2			
02\04\25 23hs	5.14E-006	TEST A			
02\05\10 15hs	2.11E-002	TEST B			
02\05\12 18hs	2.68E-006	TEST C			
02\05\19 08hs	4.22E-002	ATTRIBUTE LOCATION			
02\06\27 14hs	1.12E-002	TEST D			
02\07\25 22hs	5.10E-005	TEST K			

J↑ PGDW -scroll:↓-sel:F1-hlp:F2-keys:F3-return:
 F4- save:

FIG. 4.33. Initiating event selection window.

STAT	P S A P A C K U. 4.2		ENVIRONMENT: F1
313792	***	SAMPLE PROBABILISTIC SAFETY ANALYSIS	***
		# of comp. select=>000	
SELECT THE INITIATING EVENT			
00\00\00	2.68E-006	** ALL COMPONENT IN OPERATION **	
01\03\02 20hs	2.68E-006	SYSTEM 322 OUT OF SERVICE	
01\04\04 18hs	6.45E-005	SYS	
01\07\14 12hs	2.68E-006	ATT 1. Search for maching string	
01\11\09 09hs	2.68E-006	ATT 2. Search using a mask (*,? allowed)	
02\03\20 07hs	3.33E-002	TES-ESC	
02\04\10 19hs	1.41E-002	TEST 2	
02\04\25 23hs	5.14E-006	TEST A	
02\05\10 15hs	2.11E-002	TEST B	
02\05\12 18hs	2.68E-006	TEST C	
02\05\19 08hs	4.22E-002	ATTRIBUTE LOCATION	
02\06\27 14hs	1.12E-002	TEST D	
02\07\25 22hs	5.10E-005	TEST K	

↑ P6DW -scroll; ↓ -sel; F1-hlp; F2-keys; F3-return;
F4- save;

FIG. 4.34. Selection of components by matching string or mask.

STAT	P S A P A C K U. 4.2		ENVIRONMENT: F1
313792	***	SAMPLE PROBABILISTIC SAFETY ANALYSIS	*** EDIT REPLACE
		# of comp. select=>000	
SELECT THE INITIATING EVENT			
00\00\00	2.68E-006	** ALL COMPONENT IN OPERATION **	
01\03\02 20hs	2.68E-006	SYSTEM 322 OUT OF SERVICE	
01\04\04 18hs	6.45E-005	SYSTEM 327 OUT OF SERVICE	
01\07\14 12hs	2.68E-006	ATTRIBUTE FIRE (HIGH RISK)	
01\11\09 09hs	2.68E-006	ATTRIBUTE HUMIDITY	
02\03\20 07hs	3.33E-002	TEST 1	
02\04\10 19hs	1.41E-002	TEST 2	
02\04\25 23hs	5.14E-006	TEST A	
02\05\10 15hs	2.11E-002	TEST B	
02\05\12 18hs	2.68E-006	TEST C	
02\05\19 08hs	4.22E-002	ATTRIBUTE LOCATION	
02\06\27 14hs	1.12E-002	TEST D	
02\07\25 22hs	5.10E-005	TEST K	

INPUT THE MATCHING STRING > p; F2-keys; F3-return;
F4- save;

FIG. 4.35. Screen for inputting matching string.

STAT		P S A P A C K U. 4.2		ENVIRONMENT: F1	
313792		*** SAMPLE PROBABILISTIC SAFETY ANALYSIS ***		# of comp. select=>000	
SELECT THE ATTRIBUTE					
90\00\00	2.68E-006	** ALL COMPONENT IN OPERATION **			
91\03\02 20hs	2.68E-006	SYSTEM 322 OUT OF SERVICE			
91\04\04 18hs	6.45E-005	SYSTEM 327 OUT OF S			
91\07\14 12hs	2.68E-006	ATTRIBUTE FIRE (HIG			
91\11\09 09hs	2.68E-006	ATTRIBUTE HUMIDITY			
92\03\20 07hs	3.33E-002	TEST 1			
92\04\10 19hs	1.41E-002	TEST 2			
92\04\25 23hs	5.14E-006	TEST A			
92\05\10 15hs	2.11E-002	TEST B			
92\05\12 18hs	2.68E-006	TEST C			
92\05\19 08hs	4.22E-002	ATTRIBUTE LOCATION			
92\06\27 14hs	1.12E-002	TEST D			
92\07\25 22hs	5.18E-005	TEST K			

LOCATION
 FIRE RISK
 HUMIDITY
 COMMON CAUSE
 ESC

↑ PGDN -scroll; ↓ -sel; F1-help; F2-keys; F3-return;
 F4- save;

FIG. 4.36. Selection of components by attributes.

4.2.1.6. Already selected

This option displays components already selected from the previous updating.

4.2.1.7. Return (& Save)

This option saves the selection and returns to the plant status selection screen.

4.2.1.8. Return (& No Save)

This option returns to the plant status selection screen without saving.

4.2.2. VIEW-Browse in the MCS

After selecting this option, Fig. 4.37 will be displayed. This option works in the same way as the option described in Section 4.1.4 with the additional menu option for screening the plant status. After selecting the PLSLIB option, Fig. 4.38 is displayed. In contrast to the options described in Section 4.1.4 for Level B, for the option PLSLIB the initiating events are included here in the minimal cutsets and consequently also in the importance evaluation. Furthermore, the risk reduction importance for initiating events can be assessed.

4.2.3. CDFG-Core melt frequency graphics

The module provides graphical representation of the core damage frequency versus time, see Fig. 4.39. The base case is represented by a red line parallel to the time axes. All time points are displayed at the beginning (max. 200). If there are more than 10 time points the following control key can be used:

ARROWS

Move the graphics cursor around the screen.

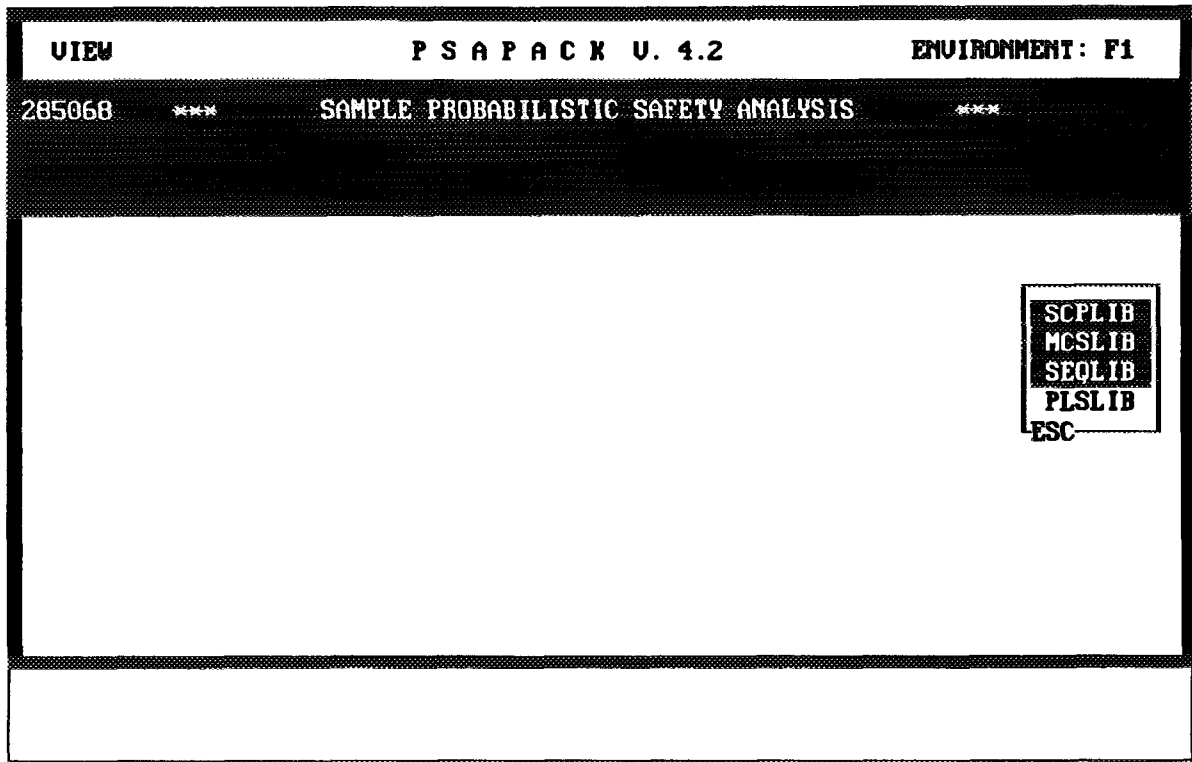


FIG. 4.37. VIEW main menu (Level A).

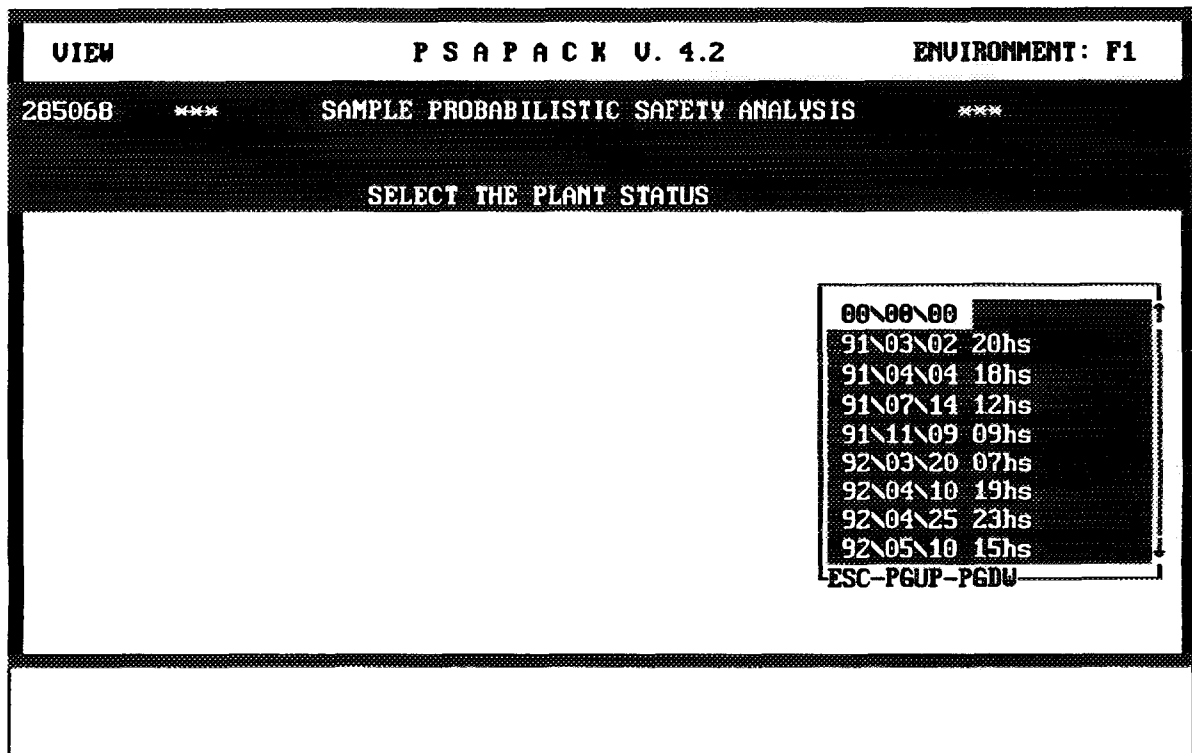


FIG. 4.38. Plant status selection screen.

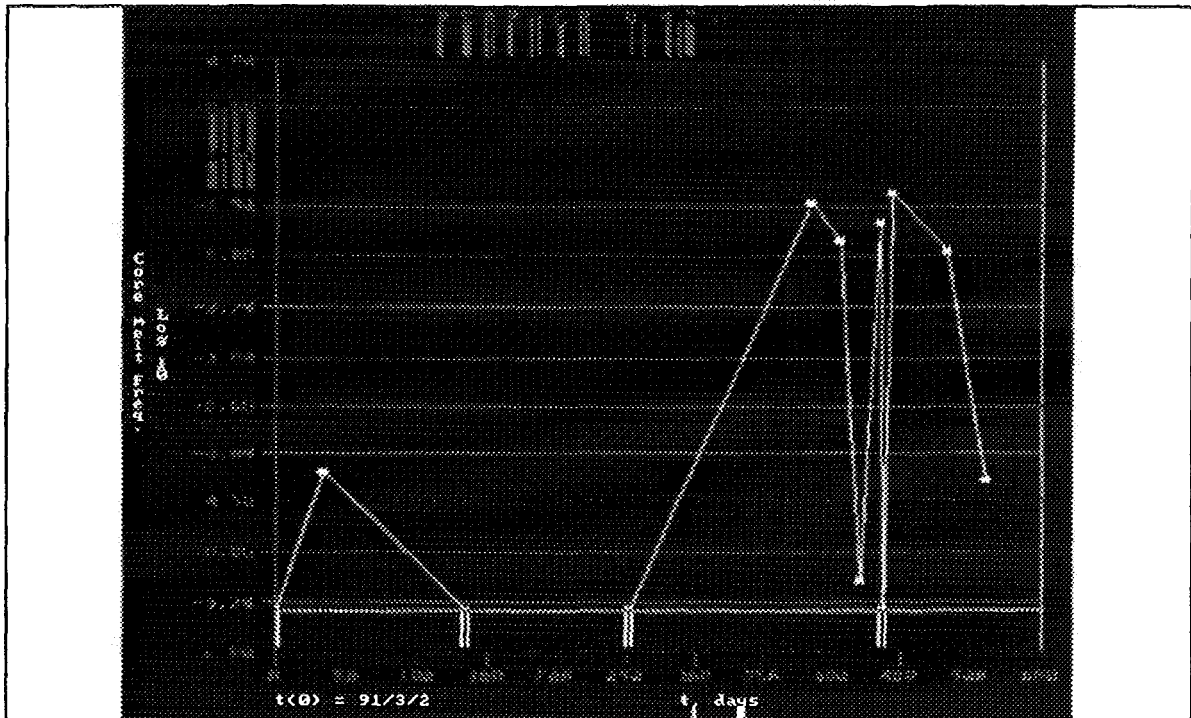


FIG. 4.39. Core damage frequency versus time.

<Enter>

Displays in the upper left corner the date and the core damage frequency of the nearest data point to the cursor position.

<ALT+M>

Displays in the right side the menu for screen manipulation. Pressing **<Enter>** or left mouse button when the cursor is inside the boxes the following happens:

HOME:	Displays the first ten time points
LEFT:	Move ten time points to the left
RIGHT:	Move ten time points to the right
END:	Move to the last ten points
EXIT:	Exit from the module

<ALT+X>

Exits from the module.

4.2.4. TOPT-Optimization of test intervals

This option is not implemented in the present version of PSAPACK.

4.2.5. RDB-Reliability database

This module works in the same way as in Level B but has only browsing capabilities.

4.2.6. BRFT-Browse in the fault trees

This module works in the same way as in Level B but has only browsing capabilities.

4.2.7. PSAM-PSAPACK manual

Access to a PSAPACK manual.

5. SPECIFIC TASK DESCRIPTIONS

5.1. LOADING GRAPHIC FAULT TREES INTO THE TEXT FAULT TREE LIBRARY

- (1) Select "FTED - Fault tree editor" from the main menu.
- (2) If this is an empty (i.e. new) environment, a list of all graphic trees will appear on the screen. If the environment is not empty, the list can be obtained by entering **<G>**.
- (3) Select your graphic fault tree of interest from the list of graphic trees by placing the cursor on the fault tree name and pressing **<Enter>** - the text tree will appear on the screen. It is difficult to exit this screen without saving the tree but tree should nevertheless be saved using **<F4>**.
- (4) If the text tree already exists in the environment, you will be asked if you want to overwrite the old tree. If you do not want to overwrite the old tree you must go to FEP, save the graphics tree under a new name and repeat the procedure with the new name.

NOTE: It is possible to transfer previously developed fault trees logic into PSAPACK by converting the trees into the same format as the *.TRZ format and using the option to import fault trees from graphics. Only trees with a maximum of 250 gates can be transferred in this manner. Larger trees must be broken up and can later be merged or linked with transfer gates.

5.2. LOADING COMPONENTS FROM FAULT TREES INTO COMPONENT LIBRARY

- (1) Go to the RDB module for the appropriate environment.
- (2) Select the component, human or temporary data library as appropriate. The appropriate library depends on the component label tokens in the fault tree. The component data library will only recognize RDB token components, the human only HRB, and the temporary only TMP token components. If all three types are present, the process must be repeated for each library.
- (3) A list of all components currently in this data library will appear on the screen.
- (4) Enter **<ALT+F>** - a list of your environment's text fault trees will appear on the screen.
- (5) Put the cursor on the fault tree of interest and press **<Enter>**.
- (6) A message will appear telling you if, and how many, components with the matching token in the selected tree are not in the data library and the components will be placed in the temporary storage library. If more than 1 fault tree's components are to be loaded, repeat step 5 for each tree.
- (7) Enter **<Esc>** twice to return to the component listing in the data library.
- (8) Enter **<ALT+S>** - a cumulative list of the components in the temporary storage library will be given in a window. The components in this list can be deleted or edited as desired.
- (9) Enter **<F8>** - the components in temporary storage will be added to the end of the list of components in the data library.

5.3. CONNECTING RDB COMPONENTS WITH THE GENERIC LIBRARIES

- (1) Select the RDB-Reliability data base management option from the main menu.

- (2) Select Component data library (RDB). This option is only available for the RDB library. This will open a window to the RDB library and the first 20 components in the library will be displayed.
- (3) Using the cursor keys, move through the component list to the target component, i.e. the basic event label which you want to connect to a generic component type.
- (4) Enter **<ALT+I>** which will open a window with the list of generic component types (valve, pump, etc.). Only the generic component labels which match the selected component type will be listed.
- (5) Select "ALL COMPONENTS" or the component type of interest.
- (6) This will open a window with a list of all generic data libraries, including the generic user data library.
- (7) Select the desired generic library.
- (8) This will open a window with a list of source components of the selected type in the selected generic library. The target component in the user library will now appear at the top of the background window, still displaying the components in the user data library.
- (9) Using the cursor keys, move through the source component list to your desired source component. Entering **<F7>** will display the detailed data records for the generic components. The cursor keys will also allow you to move through the detailed records.
- (10) When you have found your desired source component, select the component with **<Enter>**.
- (11) The generic component's label will be transferred to the target component's RGDB column which is the link between the two.
- (12) To return to the RDB library to select a second target component, it is necessary to enter **<ESC>** (or **<F3>**). This will put you back to step 3 above.

Before RDB components linked to generic components are ready to quantify cut sets the following steps are also necessary. These steps simultaneously effect all components in the RDB library and do not need to be performed for each component.

- (13) To actually transfer the failure parameters from the target to the source components enter **<ALT+T>** (to update from both the IAEARDB and the UGDB) or **<ALT+Z>** (to update only from the UGDB). Any component which can not be found in the generic databases will be identified.
- (14) To calculate the point estimate unavailabilities, enter **<ALT+U>**. Any component whose available failure parameters do not match the failure type will be identified.

5.4. LOADING GRAPHIC EVENT TREES INTO THE EVENT TREE LIBRARY

New event trees

- (1) Select the Initiating event DB in the RDB module.
- (2) Using **<F6>** to obtain access to the label column, go to the first blank line and define an initiating event with exactly the same name as the graphic event tree file. Press **<Enter>** to fix the new name.

- (3) Save the modified initiating event DB with **<F4>**.
- (4) Go to the ETED module and select the new initiating event.
- (5) You will get a message that there are no headers for this event followed by the choice,
Y - create; N - retrieve graph (Y/N)
- (6) Enter "N" to retrieve the graphic event tree.
- (7) A list of all sequences (except the top) from top to bottom in the graphic tree will appear on the screen as sequences of 1' s, 0' s, and -' s. The function header labels loaded should be checked with the **<F6>** key.
- (8) If the header labels are satisfactory, identify the success sequences in the sequence list and delete each one using the **<F5>** key.
- (9) Save the new sequences with the **<F4>** key.

Replacing an event tree

- (1) Make sure that the graphic event tree with the appropriate name exists (there is no select from list option in this module).
- (2) Go to the ETED module and select the corresponding initiating event. The current list of sequences will appear on the screen.
- (3) Enter **<F10>**. A list of all sequences (except the top) from top to bottom in the graphic tree will appear on the screen as sequences of 1' s, 0' s, and -' s. The function header labels loaded should be checked with the **<F6>** key.
- (4) If the header labels are satisfactory, identify the success sequences in the sequence list and delete each one using the **<F5>** key.
- (5) Save the new sequences with the **<F4>** key.

5.5. DEFINING AND QUANTIFYING SUPERCOMPONENTS

NOTE: Supercomponents cannot be entered by hand into the supercomponent data library.

- (1) Identify the fault tree within which the top gate for the supercomponent will be placed.
- (2) Add the SCP token to the gate which is to be replaced by a supercomponent.
- (3) Run FTA to reduce and quantify the fault tree with the new supercomponent.
- (4) FTA will write the supercomponent label into the supercomponent data library as well as in the Supercomponent fault tree library.
- (5) Reduce and quantify the supercomponent by using the supercomponent option in FTA.
- (6) Use the supercomponent option in VIEW to view the results of the FTAP or SETS run. Write down the total unavailability.

- (7) Finally the supercomponent point estimate unavailability from the FTA run must be entered by hand into the SCP database by selecting the supercomponent option in RDB.

5.6. USING SUPERCOMPONENTS TO REPLACE TRANSFER GATES

There are a number of ways to use supercomponents. One way is to use supercomponents to replace transfer gates, allowing, for example, replacing the "Train A power supply" fault tree with a supercomponent, thus greatly reducing the size of the models. To accomplish this, it is not possible to simply add the supercomponent token to the top event in the transfer tree and process the transfer tree.

This can be accomplished through the following steps.

- (1) Add the SCP token to the top event label in the "Train A power supply" fault tree.
- (2) Locate a fault tree which has, at any level, a transfer to "Train A power supply".
- (3) Use the process fault tree option in the FTA module to process this fault tree (this will define the supercomponent and place the label in the SCP library).
- (4) Use the "Process supercomponent" option in the FTA module to process the "Train A power supply" supercomponent.
- (5) Use the SCPLIB option in the VIEW module to view the results for the "Train A power supply" supercomponent (this will load the calculated unavailability into the SCP data library).
- (6) Now, whenever the "Train A power supply" transfer is found when processing a fault tree, it will be replaced by a supercomponent. As with supercomponents in general, the supercomponent will be assigned an unavailability of 1.0 during processing but, when the resulting cut sets are viewed, the correct unavailability from the SCP library will be used.
- (7) If, for some reason, it is desirable to process fault trees with the entire "Train A power supply" fault tree, simply remove the SCP token from the top event.

NOTE: It is possible to add the SCP token to the graphic trees in the FEP module.

6. SPECIAL TECHNIQUES

6.1. TOKENS

Tokens are text extensions to the gate and component labels which provide auxiliary control. Tokens are always added to the end of a label and enclosed in parenthesis. There are two basic types of tokens, those associated with gate labels and those associated with component labels.

Gate label tokens

G...(TOP) - the top event in a fault tree, there must be one and only one such token in a fault tree.

G...(SWT) - a switch TRUE token, auxiliary control of the tree structure by setting the status of the output of any gate to TRUE.

G...(SWF) - a switch FALSE token, auxiliary control of the tree structure by setting the status of the output of any gate to FALSE.

G...(SCP) - a supercomponent identifier, used to replace a sub-model at that gate with a single event to simplify the model. The supercomponent must be defined before it can be processed with the FTA module supercomponent option. Supercomponents can only be defined and entered into the supercomponent databases by processing a tree with the SCP using the FTA module. After the supercomponent is defined, the results must be viewed with the VIEW module to enter the unavailability into the SCP library.

G...(Filename) - the transfer gate token where the transfer tree is found in the fault tree "Filename". When using graphical trees from FED, this token is automatically written during the conversion from graphic to text fault tree files.

Basic event label tokens

xxxx(RDB) - the component xxxx is located in the RDB library.

xxxx(HRB) - the component xxxx is located in the HRB library.

xxxx(TMP) - the component xxxx is located in the TMP library.

6.2. QUANTIFICATION

It is important to understand that PSAPACK does not quantify logic models in the traditional manner, that is by inputting failure parameters, quantifying the cut sets, and sorting and storing all the results. Instead, component failure parameters are first converted to point estimate unavailabilities from within the RDB module.

The FTA module converts fault trees into minimal cut sets using the component unavailabilities in the component data libraries at the time when the tree is processed (with the exception of supercomponents which are assigned an unavailability of 1.0 regardless of what might be in the SCP library). Only the list of minimal cut sets are saved - all quantitative results are discarded.

The BOOL module generates sequence results through logical manipulations of minimal cut set lists for the event tree headers. In this case, the current unavailabilities of the components (including now any unavailabilities for the supercomponent events stored in the SCP library) are used and, here also, only the sequence level minimal cut sets are saved and all quantitative results are discarded.

Whenever quantitative results are viewed, both at the fault tree and the sequence levels, the cut sets are re-quantified using the point estimates in the various component data libraries at the time of the viewing. If the component parameters have been changed - and the point estimate unavailabilities up-dated - between two views of the same cut sets, the quantitative results will be different (assuming that the changes are large enough to notice).

6.3. SWITCH GATES

There are two types of switch gates, a switch FALSE gate (SWF) and a switch TRUE (SWT) gate. As the names suggest, SWF gates can be switched to "FALSE" and SWT gates can be switched to "TRUE". "TRUE" and "FALSE" refer to the logical status assigned to the switch gate which will be subsequently input into its parent gate. Switch gates provide a powerful tool to control which fault tree branches will be included in a given reduction and quantification run. Since they can be as confusing as they are powerful, they should be used with care.

The impact of a switch gate is tightly coupled to its parent gate. If you switch a SWT gate to "TRUE" (i.e. give it a TRUE status) which inputs into an OR gate, for example, not only will all other input branches to that gate be discarded, the TRUE will effectively propagate upwards, discarding branches until it reaches an AND gate. Similarly, switching a SWF gate to "FALSE" which inputs into an AND gate will discard all fault tree branches until the first OR gate. This property of switch gates is precisely why there are two types.

A good general rule which limits the switch gate's impact to the removal of only the branch under the switch gate is:

only use switch FALSE (SWF) gates as input to an OR gate, to remove the branch, switch the SWF gate to FALSE,

and only use switch TRUE (SWT) gates as input to an AND, to remove the branch, switch the SWT gate to TRUE.

A switch gate is created as a normal AND or OR gate, depending on what is needed at that point in the fault tree. It is turned into a switch gate by the addition of a SWT or SWF gate token.

When a fault tree is reduced and quantified, the FTA module identifies all switch gates in the final fault tree. After choosing the method of reduction (TOP DOWN, BOTTOM UP, etc.), the user will be presented with the label of each switch gate and, for SWF gates, the question if you want to turn the gate FALSE, for SWT gates, the question if you want to turn the gate TRUE.

If the switch gates are located under parent gate types as described above, answering "Y" will always remove the branch and answering "N" will always keep the branch as a normal input. If the gates are located under any other type of gate, it is best to experiment with the technique on small trees to identify the desired effect.

The different "positions" of switch gates produce different fault tree models. When no switches are in the models, PSAPACK always creates a `fault_tree_label` (MCS) library entry which can be later VIEWed. Re-running `fault_tree_label` will overwrite the old `fault_tree_label` (MCS). When there are switches in the model, PSAPACK records all switch gates which were switched "TRUE" and "FALSE" and creates library MCS files specific to each combination that has been used. The first time the model is run the minimal cut set file will be assigned the label `fault_tree_label.1` (MCS), the second time (with different switch settings) the label `fault_tree_label.2` (MCS), etc.

NOTE: It is planned to eventually display the switch positions in the MCS file. Until this is implemented, careful records of the switch positions for each cut set file must be kept.

The "Update MCS" option in the FTA module can be used to repeat a previous analysis with the same switch positions. In this case, the fault trees available in the MCS library will include fault_tree_label.1, fault_tree_label.2, etc. from which to choose.

6.4. COMPONENT FAILURE TYPES

There are 9 component types (or reliability models) available in PSAPACK, labelled 1 to 9 in the user component data libraries. The various component types are used to convert the failure parameters into point estimate unavailabilities in the RDB module. These unavailabilities are subsequently used for all model reduction and quantification. An unavailability of 1.0 will be assigned to any component with a 0 or blank failure type.

When all the required failure parameters needed to calculate an unavailability for the given component type are not present in the component data library an error message will be given. This error message is only given in RDB when the "convert to point estimate" option is chosen. If more failure parameters exist than required, no message is generated.

The following symbols and meanings are used in the formulas below:

λ_s	Standby failure rate (per h)
λ_o	Operating failure rate (per h)
T	Component test interval (d)
T_M	Mission time (h)
T_P	Fault exposure time, called test interval in PSAPACK (d)
T_R	Repair time (h)
τ	Test duration (h)
q	Failure probability per demand
q_o	Failure probability to override test
P_H	Human induced unavailability (due to a test)
P_R	Failure probability due to test or repair

(1) STAND-BY TEST COMPONENT

$$U = 1 - \frac{1 - e^{-\lambda_s T}}{\lambda_s T} + q + P_H + \frac{q_o \tau}{T + \tau} + (P_R + \lambda_s T) \frac{T_R}{T + T_R}$$

The following values must be > 0 in the RDB:

- test interval,
- failure rate,

OR

- failure per demand.

(2) ON-LINE NON-REPAIR COMPONENT

$$U = 1 - e^{-\lambda_o T_M}$$

The following values must be > 0 in the RDB:

- mission time,
- failure rate.

(3) *STAND-BY NON-TEST COMPONENT*

$$U = q + 1 - e^{-\lambda_s T_P}$$

The following values must be > 0 in the RDB:

- fault exposure time (time between demands),
- failure rate,

OR

- failure per demand.

(4) *STAND-BY MONITORED COMPONENT*

$$U = q + \frac{\lambda_s T_R}{1 + \lambda_s T_R}$$

Monitored during standby, repaired upon failure.

The following values must be > 0 in the RDB:

- repair time,
- failure rate.

(5) *ON-LINE MONITORED COMPONENT*

$$U = \frac{\lambda_o T_R}{1 + \lambda_o T_R}$$

The following values must be > 0 in the RDB:

- repair time,
- failure rate.

(6) *STAND-BY (MONITORED)/ OPER. (NON-REP.) COMPONENT*

Monitored during standby, not repairable during operation.

$$U = U(\text{type 4}) + U(\text{Type 2})$$

The following values must be > 0 in the RDB:

- repair time,
- failure rate,
- mission time.

(7) *STAND-BY (TEST)/ OPER. (MONITORED) COMPONENT*

$$U = U(\text{type 1}) + U(\text{Type 5})$$

Tested during standby, monitored with repair during operation.

The following values must be > 0 in the RDB:

- repair time,
- failure rate,
- test interval.

(8) *STAND-BY (TEST)/ OPER (NON-REPAIR) COMPONENT*

$$U = U(\text{type 1}) + U(\text{Type 2})$$

Tested during standby, not repairable during operation

The following values must be > 0 in the RDB:

- mission time,
- failure rate,
- test interval.

(9) *CONSTANT UNAVAILABILITY = FAIL PER DEMAND*

$$U = q$$

Failure per demand

The following values must be > 0 in the RDB:

- failure per demand.

NOTE: This data field is only accessible after entering **<F9>** in the component RDB database.

6.5. COMPONENT ATTRIBUTES

Component attributes are properties, such as room in the plant, which can be linked to a variety of components.

APPENDIX I. FAULT TREE GRAPHICS

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, Fig. I.1 will be displayed. The editing commands are shown in the left column, while the rest of the screen is the drawing surface. The editing commands shown in upper-case letters have additional pop-up menus associated with them. The cursor is used to position pop-up menus, draw lines, place drawing symbols, and select menu options.

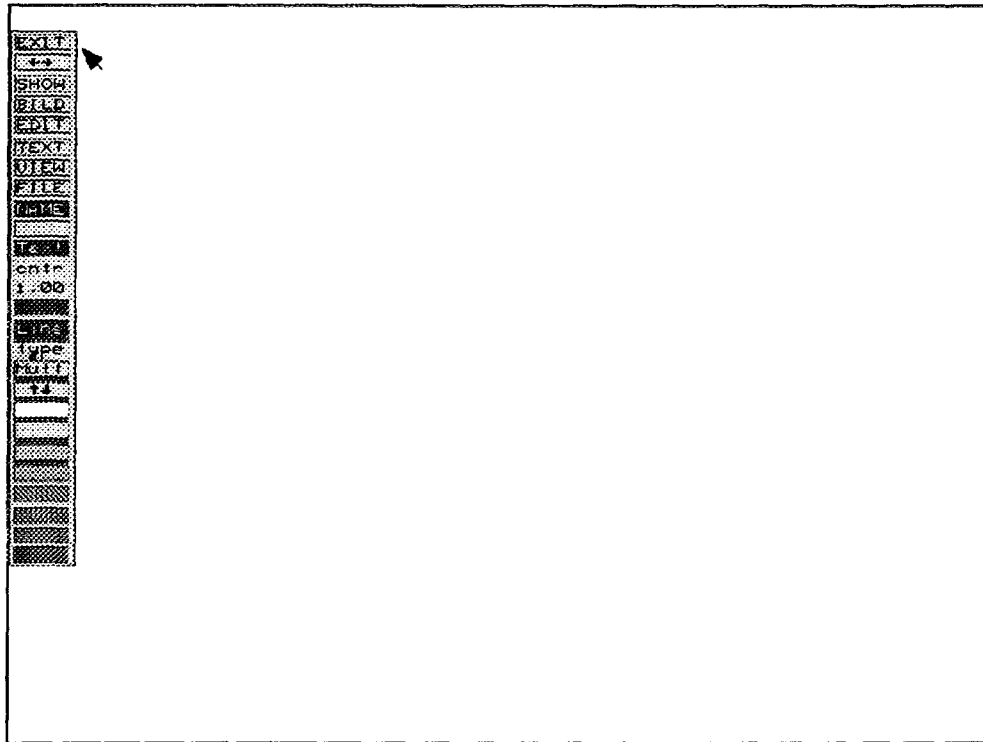


FIG. I.1. Fault tree editor main menu options.

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.

I.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>.

I.2. MOVE

The move command, which is represented by \longleftrightarrow , 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.

I.3. SHOW

This command clears the screen and re-displays the currently defined diagram.

I.4. BILD

This command allows you to generate drawing symbols. When you invoke this command, an additional pop-up menu is displayed (Fig. I.2). This submenu contains all the constructs needed to create fault tree models. These constructs are presented below. Indications on how the transfer of graphic fault trees to the fault trees in text format as handled by FTED (fault tree editor, Section 4.1.2) is performed are given in brackets.

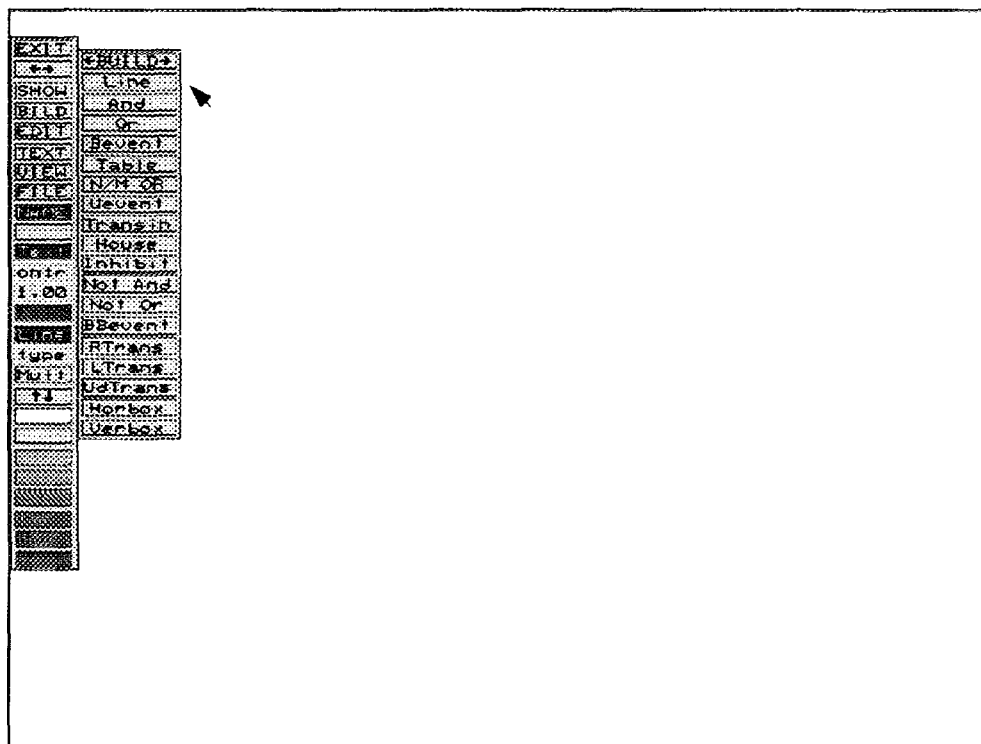


FIG. I.2. BILD pop-up menu options.

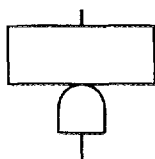
←BUILD→

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 re-displayed at the new location.

Line —————

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 into 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 I.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).

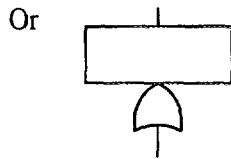
And



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 I.16), another And symbol will

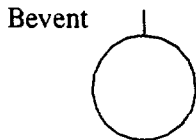
appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate And symbol generation.

(Transfer to FTED: AND gate)



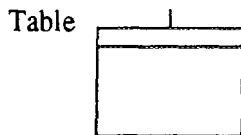
Generates the "Or" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section I.16), another Or symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate Or symbol generation.

(Transfer to FTED: OR gate)



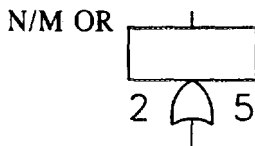
Generates the "Bevent" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section I.16), another Bevent symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate Bevent symbol generation.

(Transfer to FTED: Basic event)



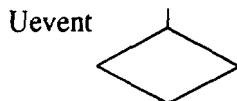
Generates the "Table" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section I.16), another Table symbol will appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate Table symbol generation.

(Transfer to FTED: Basic events)



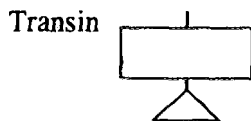
Generates the "N/M OR" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. The prompt **Enter N (out of) M values** will appear at the bottom of the screen. Enter the required values (e.g. 2 5) and press <Enter>. If the multipick option is turned on (see Section I.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.

(Transfer to FTED: N/M gate)



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 I.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.

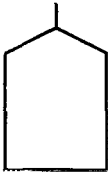
(Transfer to FTED: Basic event)



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 I.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.

(Transfer to FTED: Transfer gate, see Section 6.1.)

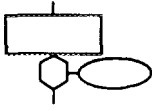
House



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 I.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.

(Transfer to FTED: Basic event)

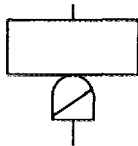
Inhibit



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 I.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.

(Transfer to FTED: Converted to an AND gate with two inputs)

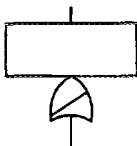
Not And



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 I.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.

(Transfer to FTED: Transferred as a NAND gate, but not accepted for analysis)

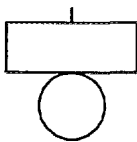
Not Or



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 I.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.

(Transfer to FTED: Transferred as a NOR gate, but not accepted for analysis)

BBevent



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 I.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.

(Transfer to FTED: Basic event)

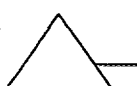
RTrans



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 I.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.

(Transfer to FTED: Ignored)

LTrans

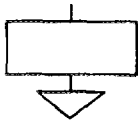


Generates the "LTrans" symbol. Move the symbol to the desired screen location and press the left mouse button or the <Enter> key. If the multipick option is turned on (see Section I.16), another LTrans symbol will

appear automatically. You can position this symbol to the desired location or press the right mouse button to terminate LTrans symbol generation.

(Transfer to FTED: Ignored)

UdTrans



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 I.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.

(Transfer to FTED: Basic event)

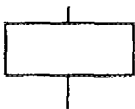
Horbox



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 I.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.

(Transfer to FTED: Ignored)

Verbox



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 I.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.

(Transfer to FTED: Ignored)

I.5. EDIT

This option allows you to modify fault tree diagrams. In addition to 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 (Fig. I.3) 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.

I.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 Fig.I.4. 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 change color, then the selected box was not large enough to include any shapes. If the multipick option is turned on (see Section I.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.

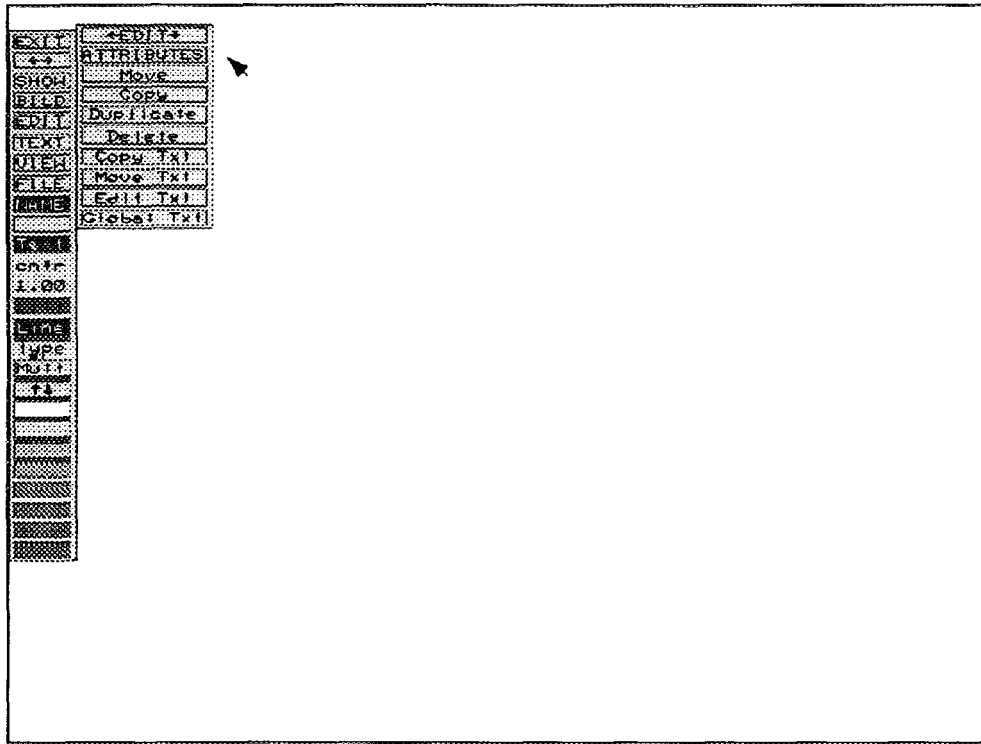


FIG. I.3. Edit pop-up menu.

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 $\uparrow \downarrow$ (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 I.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 I.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 $\uparrow\downarrow$ (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 I.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 next 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 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 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 I.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 I. 1.11 for a complete discussion on setting the justification). If the multipick option is turned on (see Section I.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 (Fig. I.5). 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 I.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.

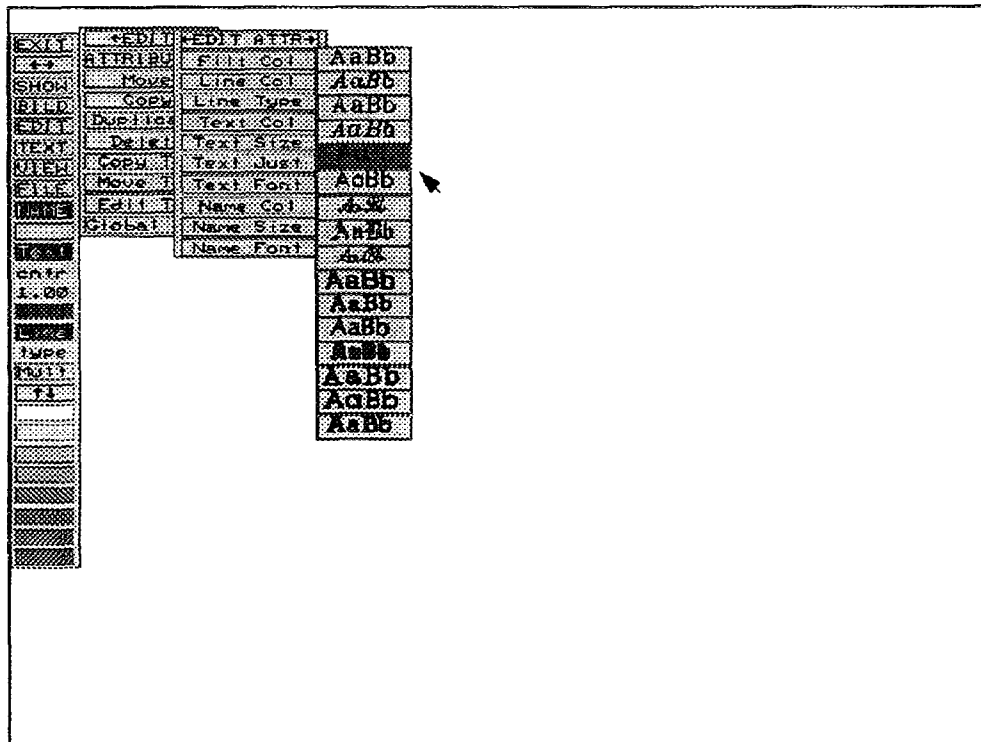


FIG. I.5. Font selection screen.

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 $\uparrow \downarrow$ (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 I.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 the purpose of writing shape names, 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 shape 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 I.16), you will be prompted to **Pick next shapes to be modified**. At this point you can select more

shapes, or press the right mouse button to terminate the process. This new name 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 (Fig. I.5). 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 shape 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 I.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.

I.5.2. Move. This editing option allows you to move a portion 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 I.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.

I.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 I.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.

I.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 I.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.

I.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 I.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.

I.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 I.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.

I.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 I.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.

I.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 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 I.16). At this point you can select additional text to modify or press the right mouse button to terminate the process.

I.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.

I.6. TEXT

The TEXT command allows you to create titles, labels, descriptions, and names for your fault tree diagram. When you invoke this option, Fig. I.6 will be displayed. Each of the text submenu options is described in the following paragraphs.

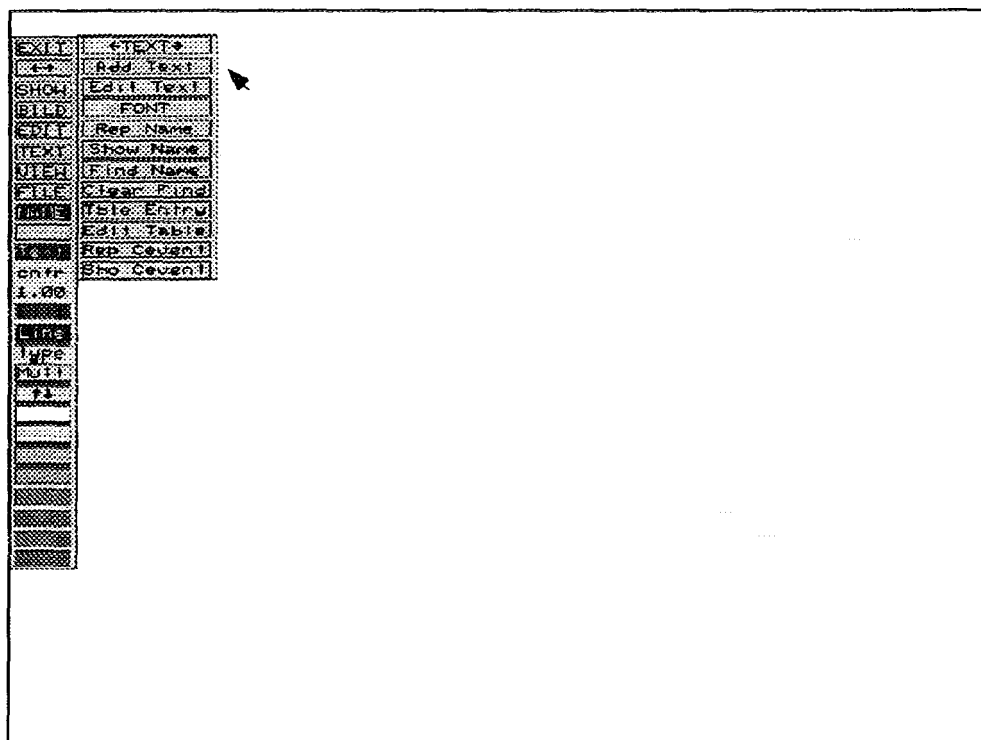


FIG. I.6. TEXT main menu.

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.

I.6.1. Add 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 I.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.

I.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 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>. If the multipick option is turned on (see Section I.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.

I.6.3. FONT. This text suboption allows you to change the FONT type of the text. When you invoke this option, Fig. I.7 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.

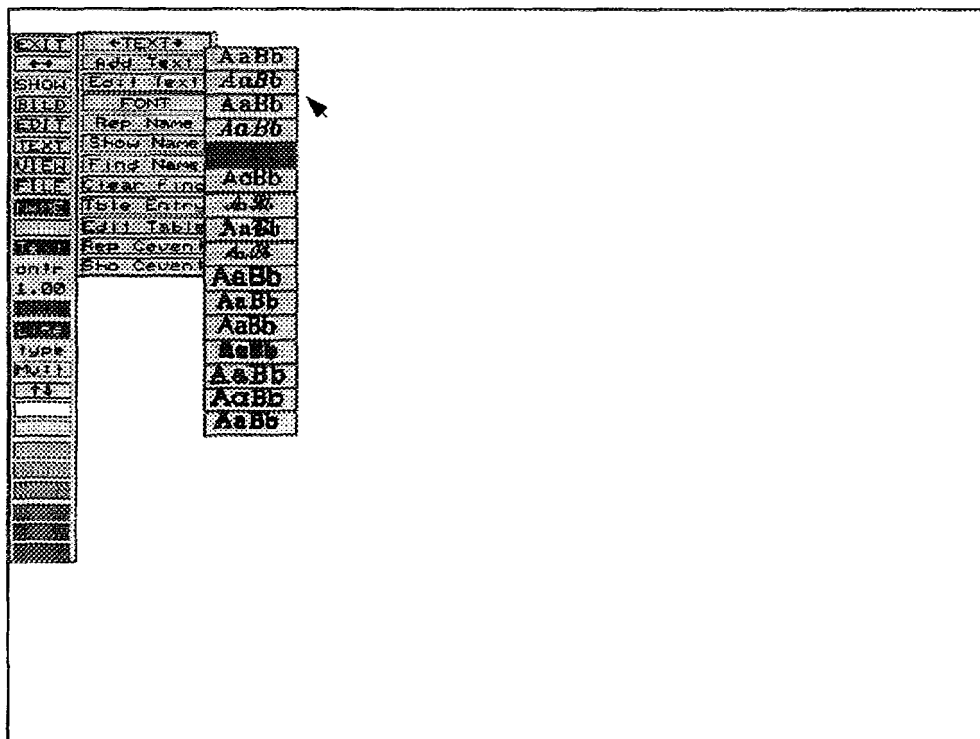


FIG. I.7. FONT selection menu.

I.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 I.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.

I.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 I.16), the cross hair returns and you may select another shape or press the right mouse button to terminate the process.

I.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.

I.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.

I.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.

I.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.

I.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**.

I.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**.

I.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, Fig. I.8 will be displayed.

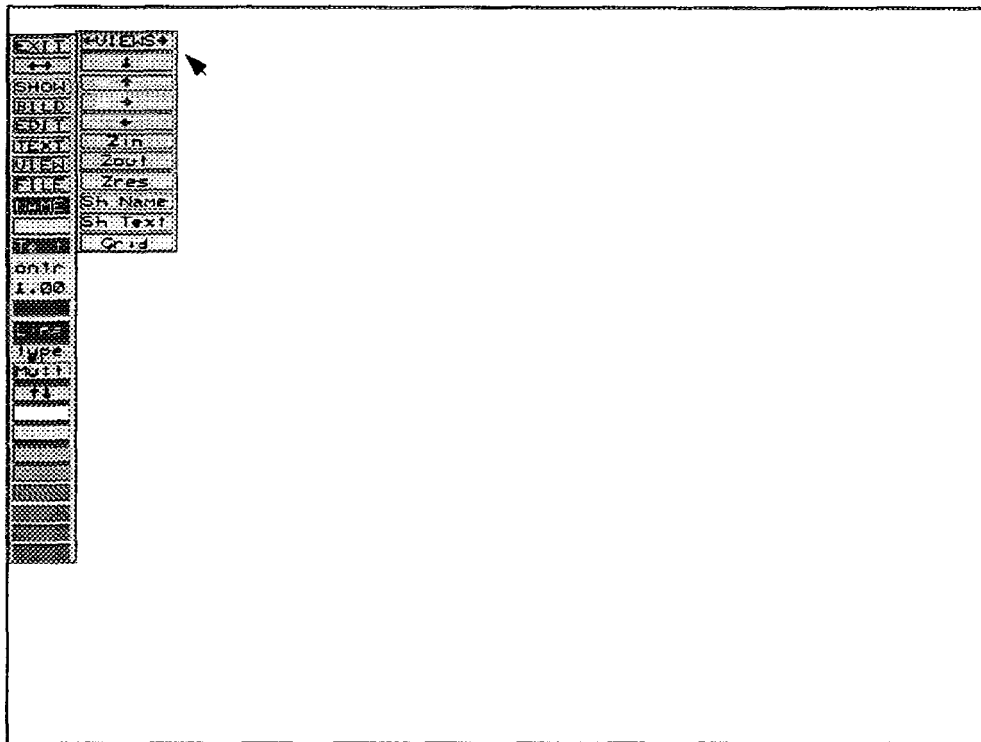


FIG. 1.8. VIEW main menu.

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:

- Down Arrow ↓: The down arrow command allows the user to move the drawing in a downward direction. When selected the user is asked to pick the new bottom edge of the screen. The distance from the bottom of the screen and the new point picked is how far the drawing will move.
- Up Arrow ↑: The up arrow command allows the user to move the drawing in an upward direction. When selected the user is asked to pick the new top edge of the screen. The distance from the top of the screen and the new point picked is how far the drawing will move.
- Right Arrow →: The right arrow command permits the user to move the drawing in the right direction. It functions in the same manner as the two commands above.
- Left Arrow ←: The left arrow command permits the user to move the drawing in the left direction. It functions in the same manner as the three commands above.
- 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.

I.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, Fig. I.9 will be displayed. Each FILE option is discussed in the following paragraphs.

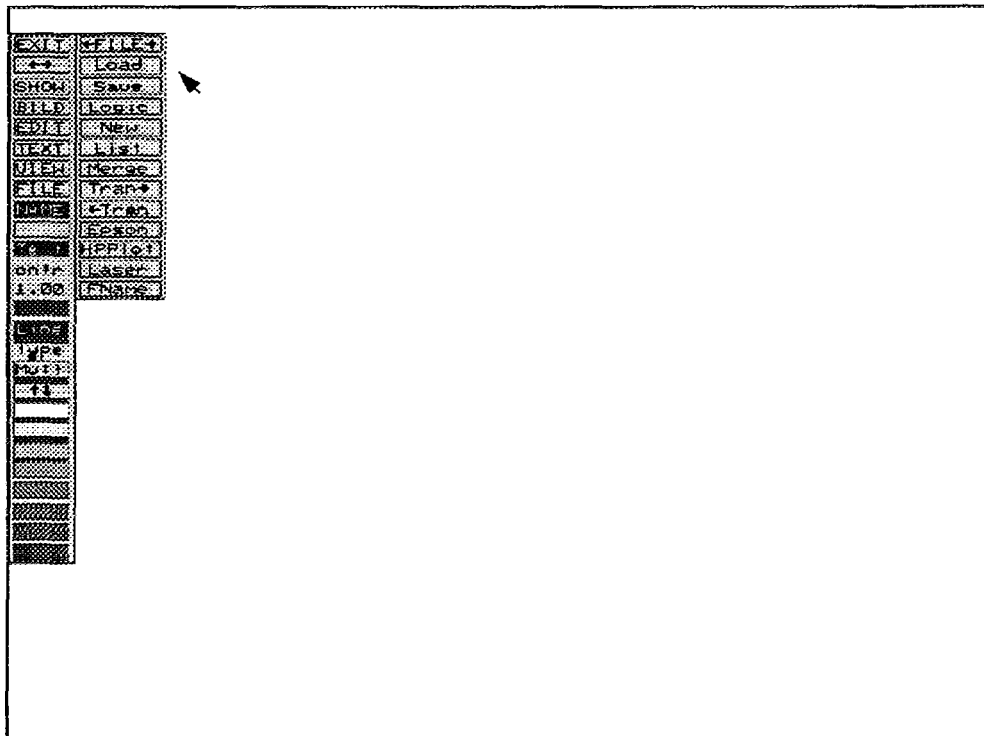


FIG. 1.9. FILE main menu.

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.

I.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.

I.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.

I.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.

I.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 Fig. I.1.

I.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.

I.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.

I.8.7. Tran→. This FILE suboption allows you to view the drawing defined in the file given in the transfer name.

I.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.

I.8.9. Epson. This option formats the diagram for an Epson printer and sends it to the local Epson printer.

I.8.10. HPPlot. This option prepares the intermediate file xxx.HPP for the HP Plotter option in the utilities option of the FEP menu (see Appendix IV. for details).

I.8.11. Laser. This option formats the diagrams for a laser printer and sends it to the local laser printer to be printed.

I.8.12. 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.

I.9. NAME

This option allows you to change the defaults for the name symbols. When you invoke this option, Fig. I.10 will be displayed. Each option is described below.

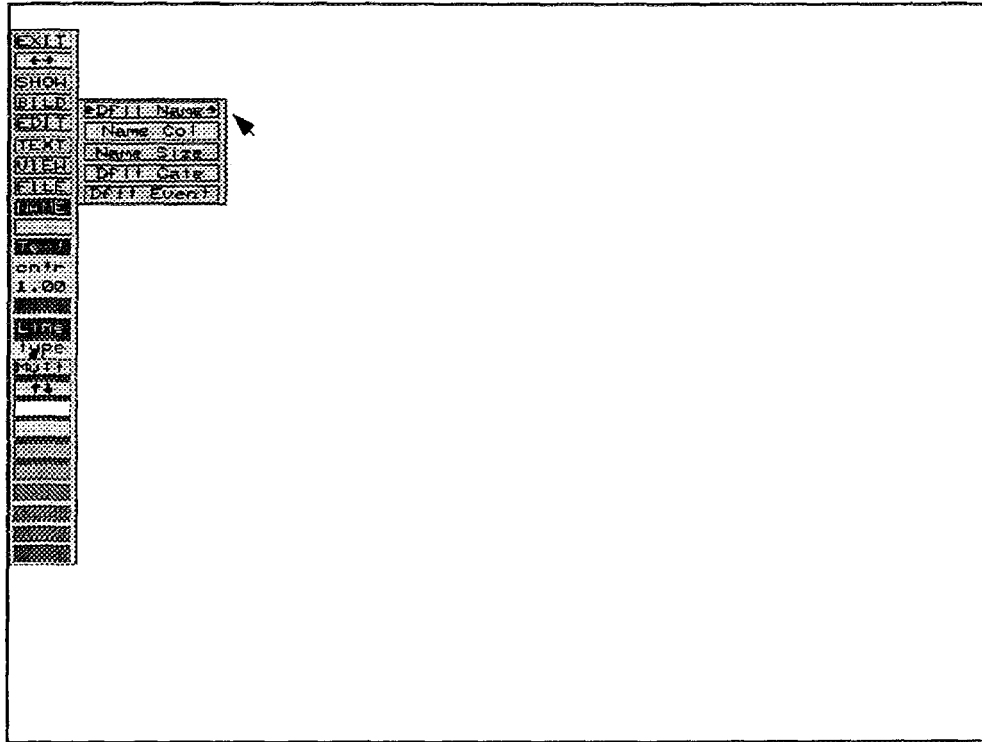


FIG. I.10. NAME menu options.

- **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>**.

I.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).

I.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 rht (right). Press the left mouse button or <Enter> key again, and the box will change from rht 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.

I.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.

I.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.

I.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.

I.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.

I.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 (snl) is turned on, the user must return to the menu and select "AND" again after each placement.

I.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.

APPENDIX II. EVENT TREE GRAPHICS

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, Fig. II.1 is displayed. The editing commands are shown in the left column, while the rest of the 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.

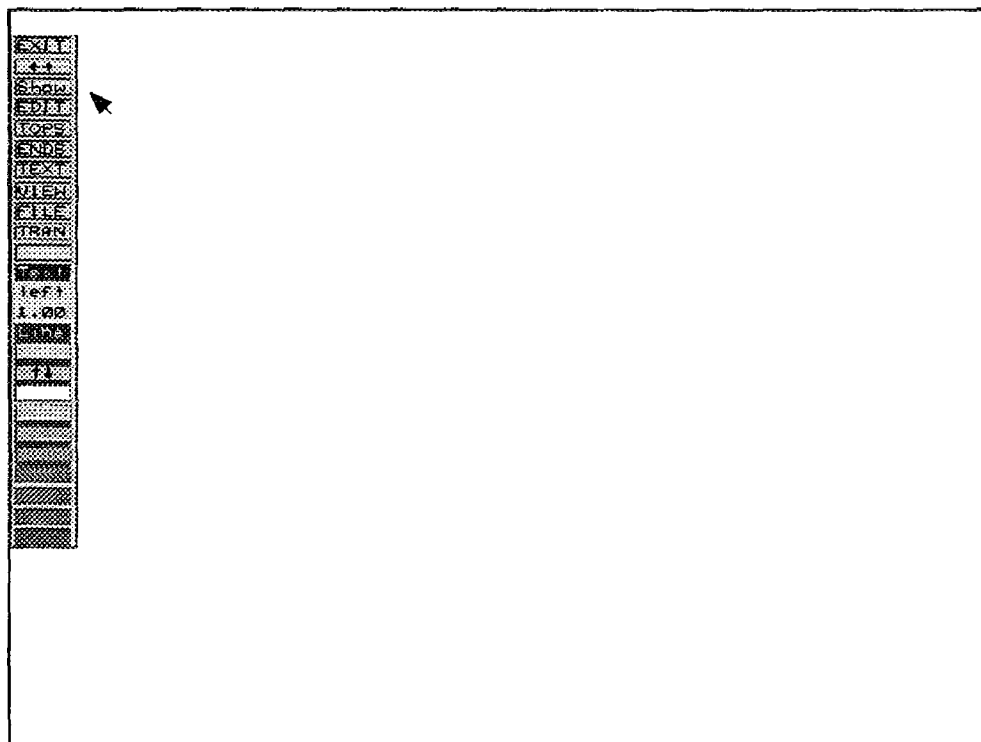


FIG. II.1. Event tree editor main menu options.

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.

II.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>.

II.2. Move (\longleftrightarrow)

The move command, which is represented by \longleftrightarrow , 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 $\langle \text{Enter} \rangle$. The menu will be displayed at the new location.

II.3. Show

This command clears the screen and re-displays the currently defined diagram.

II.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 (Fig. II.2). As shown, five options are available: EDIT, Add, Del, Copy and Pass.

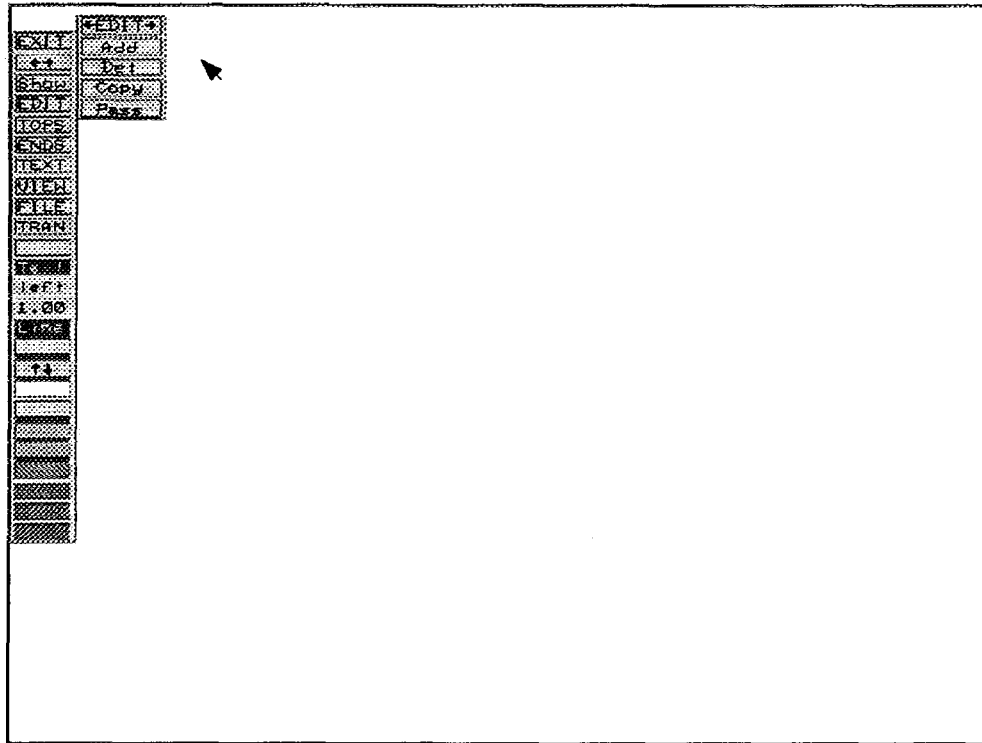


FIG. II.2. Event tree EDIT pop-up menu.

II.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.

II.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 to 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.

II.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.

II.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 you use, 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.

II.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.

II.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? [Y]** 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. In either case, 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.

II.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 II.3). As shown, the following options are available: TOPS, Add, Del, Edit and Name?.

II.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.

II.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.

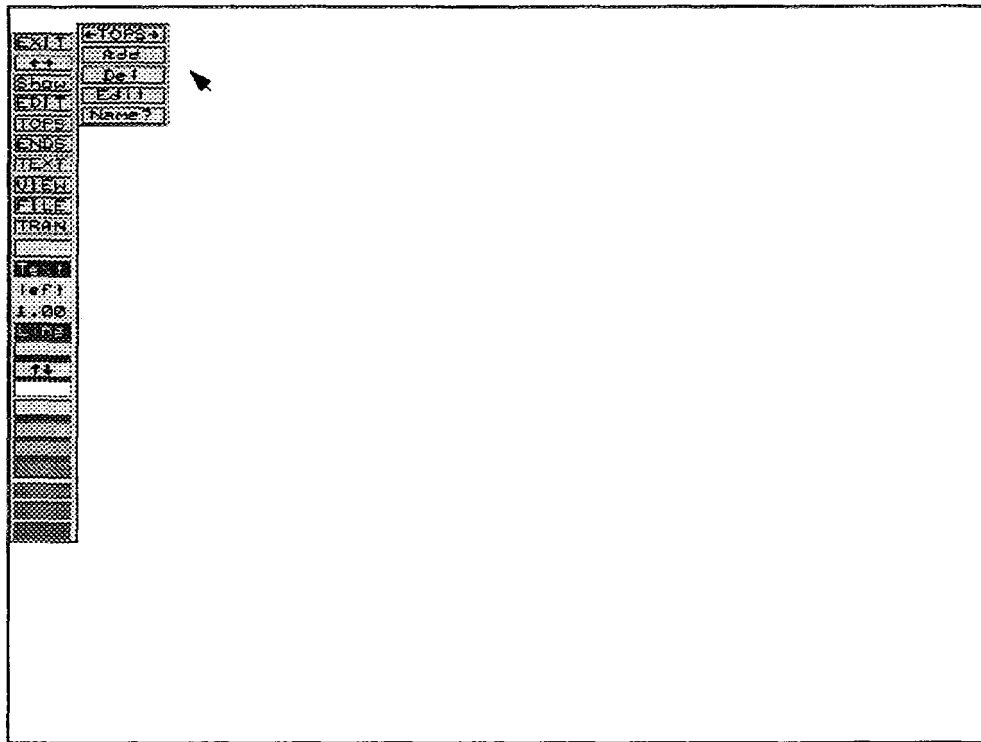


FIG. II.3. TOPS pop-up menu.

II.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.

II.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.

II.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.

II.6. ENDS

At the end of each sequence is a unique number and some textual information. 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. 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 (Fig. II.4). As shown, the following options are available: ENDS, End States, Edit Header and Place Header.

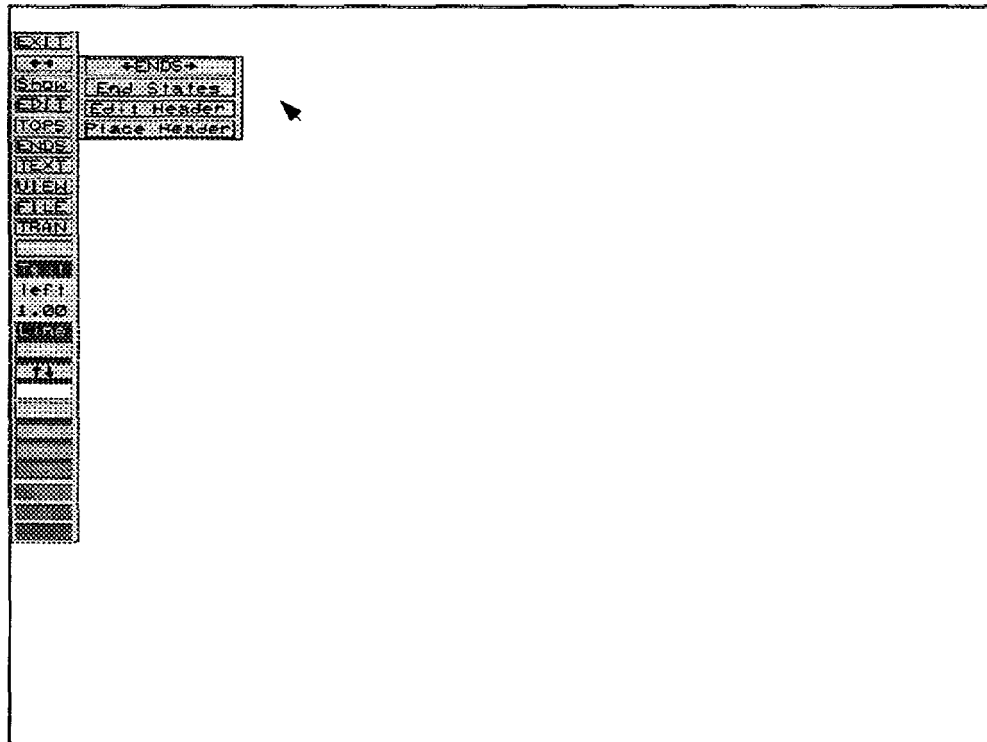


FIG. II.4. ENDS pop-up menu.

II.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.

II.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 the content of the user-defined fields 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.

The two remaining fields are toggle switches. The toggles allow you to specify whether or not to display the item. In this option one can modify only the toggle switch belonging to the field content. The other one can be modified using the Edit Header option (see II.6.3).

FEP provides four columns of information for the user to add additional information about each sequence in an event tree. FEP offers that the first column be the sequence name, the second be the end state, the third and the fourth is user defined. The column names and positions may be changed by the user.

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.

II.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, 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. Also the toggle switches preceding each field can be modified using this option. Depending on the status of the toggle switch (Y/N) the given field will be displayed or not.

II.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.

II.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 (Fig. II.5). As shown, seven options are available: TEXT, FONT, Write, Move, Copy, Erase, and EDIT.

II.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.

II.7.2. FONT. This option allows you to select the font type for the text. When you select this option an additional pop-up menu will be displayed (Fig. II.6). 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 using this option. No existing text will be changed to this new font type. To change existing text, select the TEXT option, the EDIT suboption, and invoke the FONT command. You may then mark existing text to be changed to the default font.

II.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.

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.

II.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.

II.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.

II.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 (Fig. II.7).

II.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.

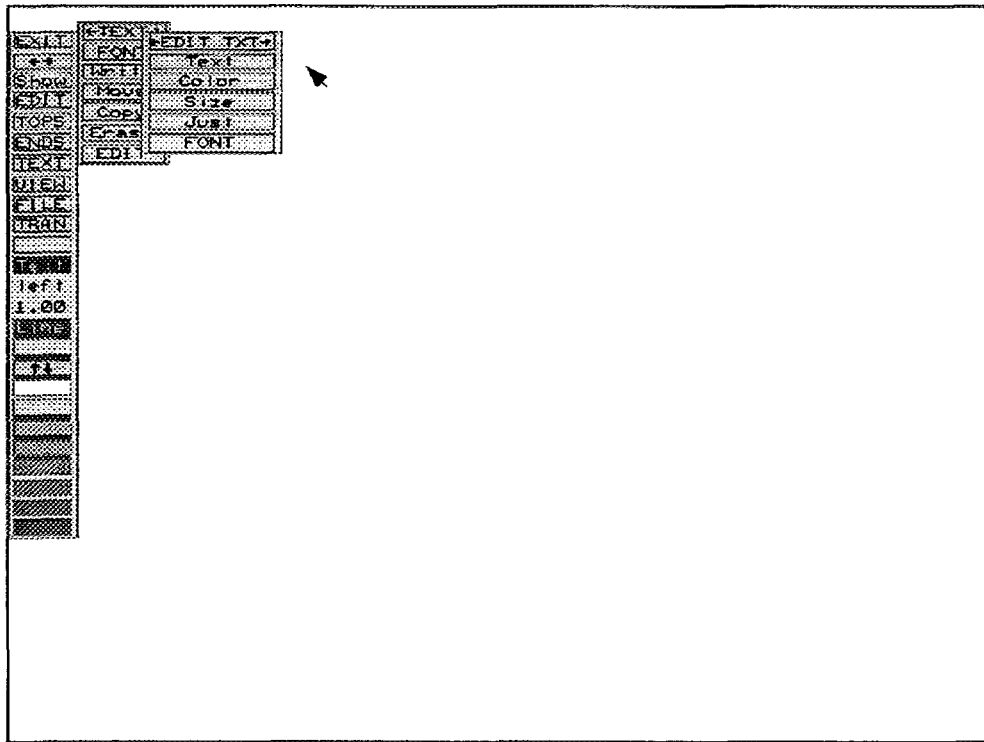


FIG. II.7. EDIT pop-up menu.

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

II.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.

II.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

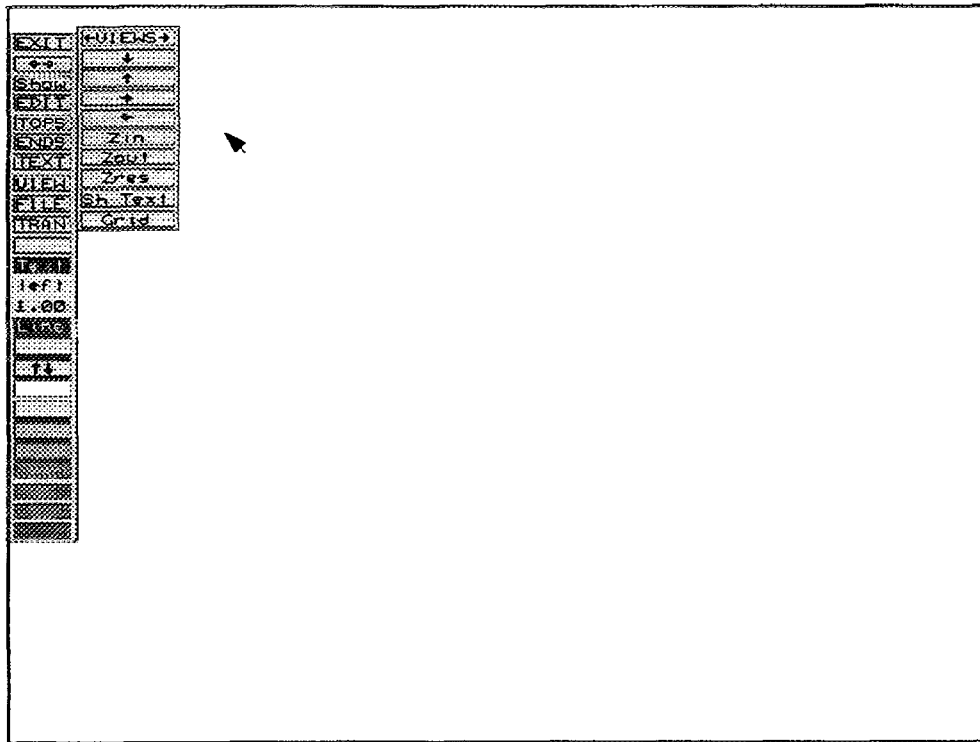


FIG. II.9. VIEW pop-up menu.

- Down Arrow ↓: The down arrow command allows the user to move the drawing in a downward direction. When selected the user is asked to pick the new bottom edge of the screen. The distance from the bottom of the screen and the new point picked is how far the drawing will move.
- Up Arrow ↑: The up arrow command allows the user to move the drawing in an upward direction. When selected the user is asked to pick the new top edge of the screen. The distance from the top of the screen and the new point picked is how far the drawing will move.
- Right Arrow →: The right arrow command permits the user to move the drawing in the right direction. It functions in the same manner as the two commands above.
- Left Arrow ←: The left arrow command permits the user to move the drawing in the left direction. It functions in the same manner as the three commands above.
- 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.
- 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.

II.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 (Fig. II.10). Each of these pop-up commands is discussed in the following paragraphs.

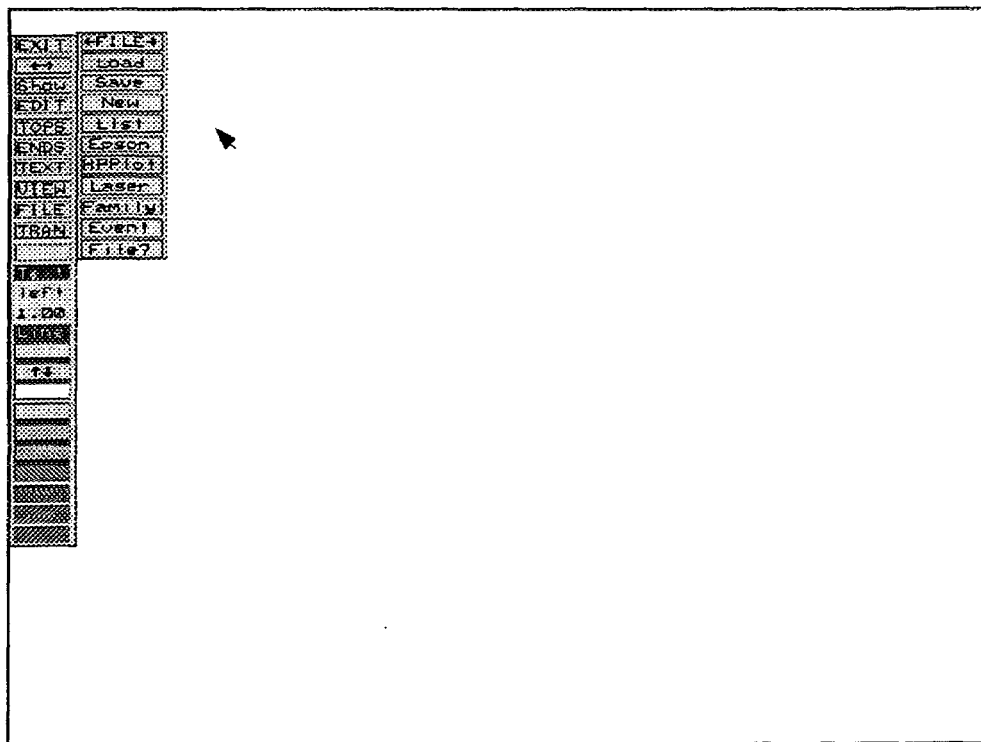


FIG. II.10. FILE pop-up menu.

II.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.

II.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.

II.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 FEP.

II.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.

II.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.

II.9.6. Epson. This option formats the current diagram for an Epson printer and sends it to the attached local Epson printer.

II.9.7. HPPlot. This option prepares the xxx.HPP file for the HP Plotter option in the Utilities option of the FEP menu (see. APPENDIX IV. for more details).

II.9.8. Laser. This option formats the current diagram for a laser printer and sends it to the local laser printer to be printed.

II.9.9. 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.

II.9.10. 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.

II.9.11. 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.

II.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 (Fig. II.11). Each pop-up option is discussed in the following paragraphs.

II.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**

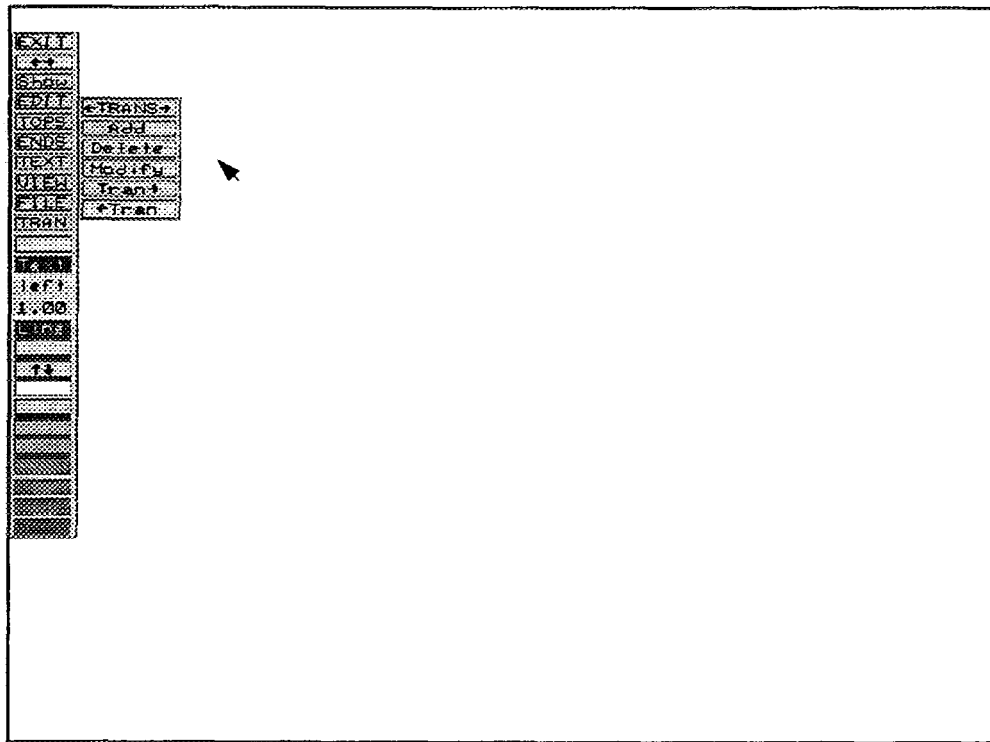


FIG. II.11. TRAN pop-up menu.

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.

II.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.

II.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.

II.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.

II.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.

II.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 II.7).

II.12. cntr/left/right

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 right) box and press the left mouse button. You will see the box change from cntr to right (right). Press the left mouse button again and the box will change from right 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.

II.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 the purpose of 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, here 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 II.7).

II.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.

II.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.

APPENDIX III. PIPING AND INSTRUMENTATION DIAGRAM GRAPHICS

After invoking this Editor, the screen will clear and Fig. III.1 will be displayed. 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.

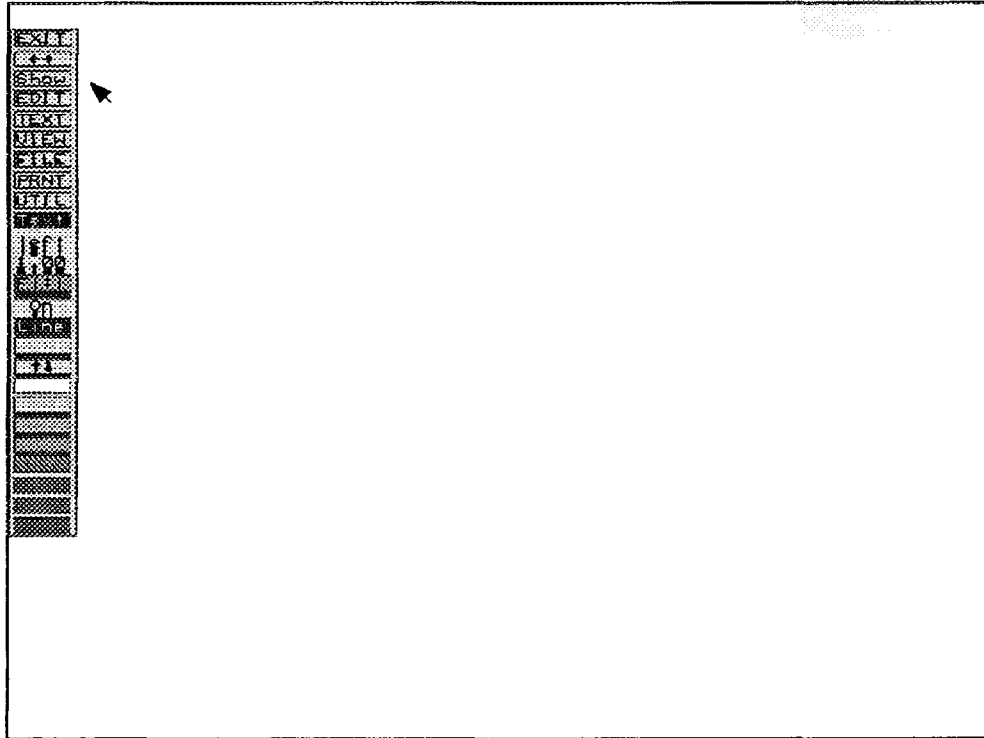


FIG. III.1. P&ID main menu options.

III.1. EXIT

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

III.2. Move (\longleftrightarrow)

The "tear off" or "move" command, which is represented by \longleftrightarrow , 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.

III.3. Show

This command clears the screen and re-displays the currently defined diagram.

III.4. EDIT

This command allows you to make changes to the diagram. When you invoke this option, an additional pop-up menu is displayed (Fig. III.2). Each of these editing commands is described in the following paragraphs.

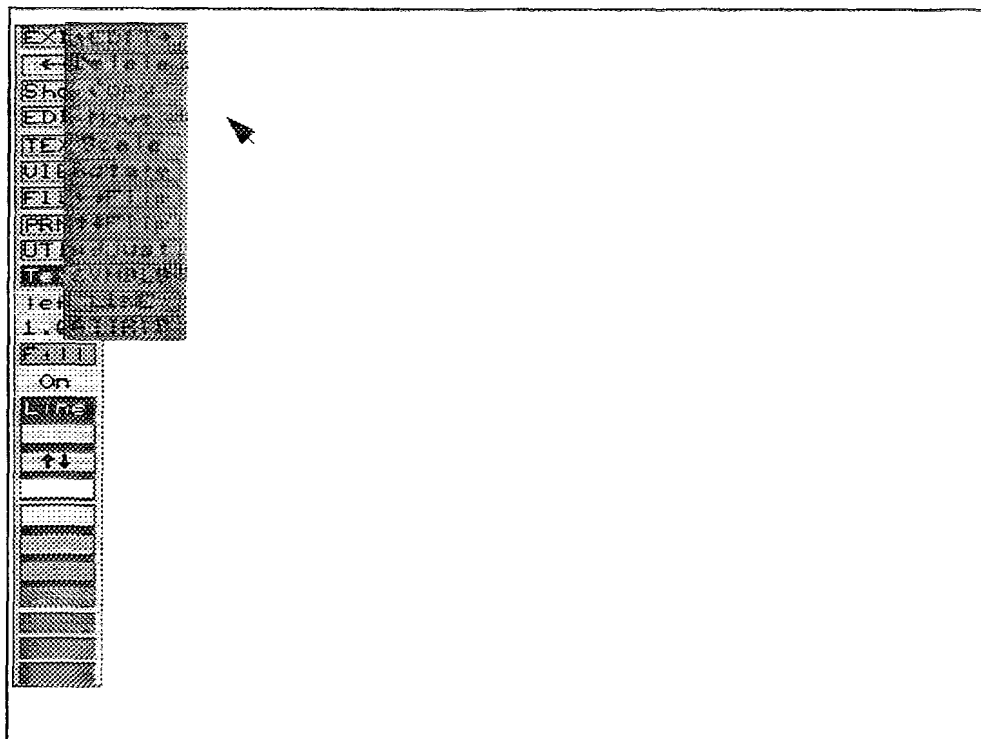


FIG. III.2. EDIT commands.

III.4.1. \leftarrow EDIT \rightarrow . 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 \leftarrow EDIT \rightarrow 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.

III.4.2. Delete. This option allows you to delete a specified portion of the displayed 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. It is important to note that only those items that are completely within the boundaries of the box will be deleted, except the lines. To delete lines the box must only intersect with the lines. Upon pressing <Enter>, a menu will appear in the center of the screen and you will be prompted to **Select type of deletion - CANCEL to terminate**. This menu allows you to selectively delete classes of items within the box. They are: lines, text, symbols, or all. For example selecting "Lines" will delete all lines within or intersecting with, the box. All other items are left alone. Selecting "All" will delete all items. The cancel button (i.e., the right mouse button or the <Esc> key) will terminate the operation.

After the operation is complete the prompt **Pick next region to be deleted** is given. A new box may be drawn around any items to be deleted or the delete command may be exited by pressing the right mouse button.

III.4.3. Copy. This option allows you to copy the selected portion of the diagram to a new location on the screen. When you invoke this option you will be prompted to **Pick region to be copied - cancel to quit**. You select the region by marking the opposite corners of the region to be copied. Position the cross hair at the area you wish to copy and press the left mouse button. A small dot appears. Drag the cursor across the desired region until the box totally surrounds the desired region. Press the left mouse button. The message **Pick reference point - 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 and press the left mouse button. Next, you will be prompted to **Pick placement point - cancel to reselect** will be displayed again. Use the mouse to move the box to the exact position where you want the selected region to appear. When you are satisfied with the new position, press the left mouse button. The selected region will be copied to the new location. After completion of the copy, the prompt **Pick reference point - cancel to reselect** will return. At this point you may select another location to copy the region, or press the right mouse button or <Esc> key to terminate the process.

III.4.4. Move. This option allows you to move the selected portion of the diagram to a new location on the screen. When you invoke this option, you will be prompted to **Pick region to be moved - cancel to quit**. Select the region by marking the opposite corners of the region to be moved. Position the cross hair at the area you wish to move and press the left mouse button. A small dot appears. Drag the cursor across the desired region until the box totally surrounds the desired region. Press the left mouse button. The message **Pick reference point - 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 moved to and press the left mouse button. Next, you will be prompted to **Pick placement point - cancel to reselect** will be displayed again. Use the mouse to move the box to the exact position where you want the selected region to appear. When you are satisfied with the new position, press the left mouse button. The selected region will be copied to the new location. After completion of the move, the prompt **Pick reference point - cancel to reselect** will return. At this point, you may select another location to move the region, or press the right mouse button or <Esc> key to terminate the process.

III.4.5. Scale. This option allows you to select items within the drawing and change their size. When you invoke this option, you will be prompted to **Box Symbols to scale**. You select the symbols to scale by marking the opposite corners of the region to be scaled. Position the cross hair at the area you wish to scale and press the left mouse button. A small dot appears. Drag the cursor across the desired region until the box totally surrounds the desired region. Press the left mouse button. You will be prompted to **Select edge/corner to expand - corners give even scale**. Position the cursor at the desired corner/edge and press the left mouse button. The prompt **Place edge** will be displayed. Position the cursor at the desired edge and press the left mouse button. Move the mouse to enlarge/reduce the scaling factor. The scaling factor is displayed at the bottom left corner of the screen and is updated as you move the mouse. When the desired scaling factor is reached, press the left mouse button or <Enter>. The symbol will be displayed in its new size. The prompt **Select edge/corner to expand - corners give even scale** will be displayed again. At this point, you may select a new region to scale or press the right mouse button to terminate the process.

Using scale, you can draw an entire diagram, label it, and then scale it to the size of the output page. Items may be scaled in any direction, to any size.

III.4.6. Rotate. This option allows you to rotate or spin any symbol or line. Rotate has two forms of use. The first (default) form rotates the item(s) about the center. The second rotates the item(s) about a user specified point. To select the method of rotation see Section III.9. When you invoke this option, you will be prompted to **Pick Symbol to rotate**. You select the symbols to rotate by marking the opposite corners of the region to be rotated. Position the cross hair at the symbol you wish to rotate and press the left mouse button. A small dot appears. Drag the cursor across the desired symbol until the box totally surrounds the desired symbol. Press the left mouse button. If the second method is selected, you will be prompted to **Pick center of rotation (point to remain unchanged)**. Position the cross hair at the desired position, and press the left mouse button. A small window appears containing the following options:

CANCEL	Terminates the current process and returns you to the Pick next Symbol to rotate prompt.
--------	---

OK	Accepts the current rotation value displayed in the window.
Angle	Allows you to input the rotation value. You may enter a value from 0 to 360. This value will become the default value.
Left Window	This symbol (which looks like an analog clock without numbers) can also be used to change the rotation value. Position the cursor in the box at the approximate angle you wish to rotate the symbol and press the left mouse button. The amount of the rotation is displayed in the Angle window. When satisfied with the rotation value, position the cursor on the OK window and press the left mouse button. The selected symbol will be rotated, to the specified angle.

NOTE: Text is rotated by entering the exact amount in the Angle window. Orientation is always horizontal.

When complete, the prompt **Pick next Symbol to rotate** will reappear. At this point, you may select another symbol to rotate or press the right mouse button to terminate the rotate option.

III.4.7. ←Flip→ and ↑Flip↓. This option allows you to invert a symbol. For example, a given symbol may be defined in a particular drawing as having one input and one output. The input is on the left side of the symbol and the output on the right. This defines the flow or direction of the symbol as left to right. However, the logic or drawing may dictate that the flow is going in a right to left direction. Connecting the symbols in this manner may yield incorrect logic in the drawing. Therefore, the symbol may be flipped to invert the direction of flow through the symbols. The "←Flip→" command inverts a symbol horizontally; the "↑Flip↓" command inverts a symbol vertically.

When you invoke either flip symbol you will be prompted to **Box Symbols to flip**. You select the symbol to flip by marking the opposite corners of the symbol to be flipped. Position the cross hair at the area you wish to flip and press the left mouse button. A small dot appears. Drag the cursor across the desired region until the box totally surrounds the desired symbol. Press the left mouse button. The symbol will be flipped in the specified direction and the prompt **Box next symbol to flip** will be displayed. At this point you may continue to flip symbols or press the right mouse button to terminate the process.

III.4.8. Adjust. This command allows you to line up symbols. After a rotation or scale a symbol may no longer be lined up according to its snap point. To adjust a symbol or symbols, select the command and box the symbols in the same fashion as the Flip command.

III.4.9. Symls. The "SYMBLS" command is used to select the proper symbol and place it in your drawing. When you invoke this command, the symbols submenu is displayed (Fig. III.3). As shown, this submenu contains a graphic representation of each symbol in the current symbol file. If the current file is incorrect or the required symbol needs to be created refer to Section III.15. for information on how to modify the symbol file. The symbol submenu is capable of displaying only six symbols at one time. However, there may be many more symbols contained within the current symbol file. It is possible to view each symbol in the file by selecting one of the arrows ("←" or "→") in the upper left, and upper right corners of the symbol menu. This will page or scroll through the entire list of symbols. It is also possible to select a page of symbols directly without scrolling through one page at a time. The symbol submenu provides a status bar that displays the currently selected page. The status bar is divided into segments, which presents six symbols at a time. To display a specific page, you select a specific segment. This function is only useful when you know which page contains the desired symbol.

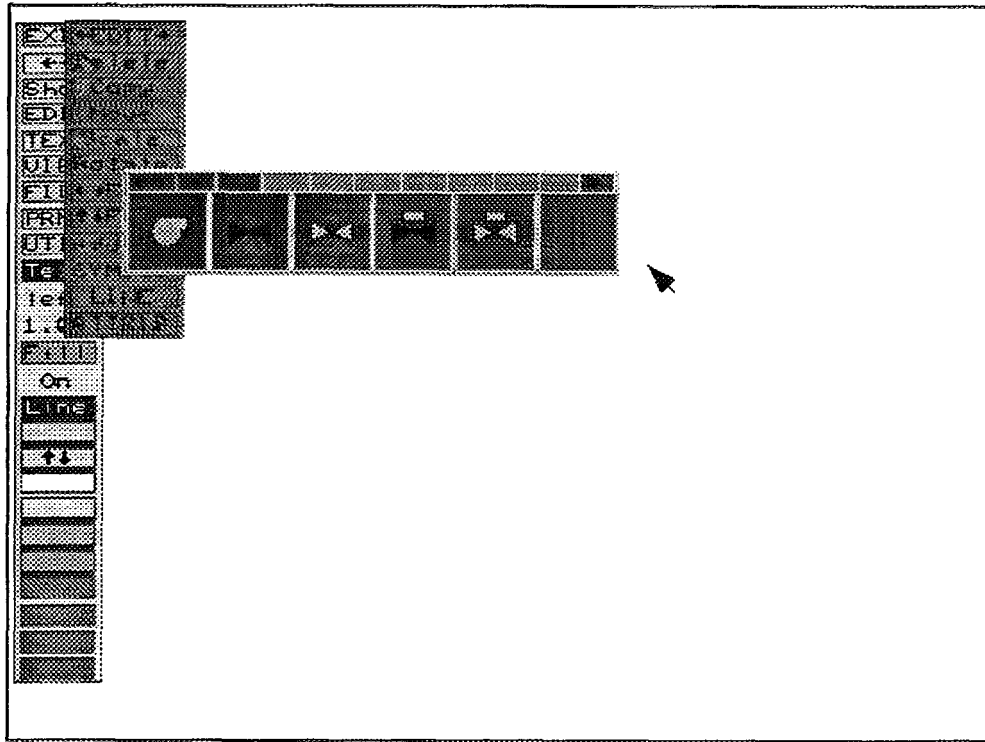


FIG. III.3. Symbols menu.

When the symbol that is to be placed into the drawing is displayed in the menu, place the cursor in the appropriate box and select it. The cursor now takes on the shape of the selected symbol and may be moved to any place on the screen. When the cursor is over the location of the desired placement point, select it. This will place the symbol down in the drawing. You may continue placing the same symbol into the drawing each time a placement point is selected. To get a new symbol, press the right mouse button (cancel) and select a new symbol from the symbol menu. To exit the symbol command, press the right mouse button again. Press the right mouse button again to remove the symbol submenu from the screen.

III.4.10. Line. Lines are symbols that are used to link other symbols together, such as a pipe connecting two valves. When the "Line" command is selected in the edit menu, a submenu called the "Line" menu is displayed (see Fig. III.4). You may then pick the desired line type to be used from this menu. When this is done the prompt **Enter points in order of direction of flow** is given. Position the cursor at the desired start point and press the left mouse button. A small dot appears and you are asked to **Enter next point**. Drag the cursor to the desired location and length and press the left mouse button. An additional line may be added to the first by simply selecting one additional point. To start a new line, press the cancel button and the original prompt **Enter points in order of direction of flow** appears. To pick a new line type or to exit the line command, press the cancel button again. When this is done, the line menu remains on the screen.

The Line menu contains a command called "Ortho", for orthogonal line function. This command is a toggle that switches the ortho function on or off (Y or N). The line function will automatically connect the symbols together (output to input if defined). The orthogonal line function will draw lines in at only right angles; thus, if a symbols output does not line up with the next symbols input a line adjustment is automatically made. If ortho is off, then a diagonal line is drawn instead.

With the orthogonal line function, if you try to connect two symbols in which the flow is incorrect a message is given which states that the flow may be incorrect and asks you to verify.

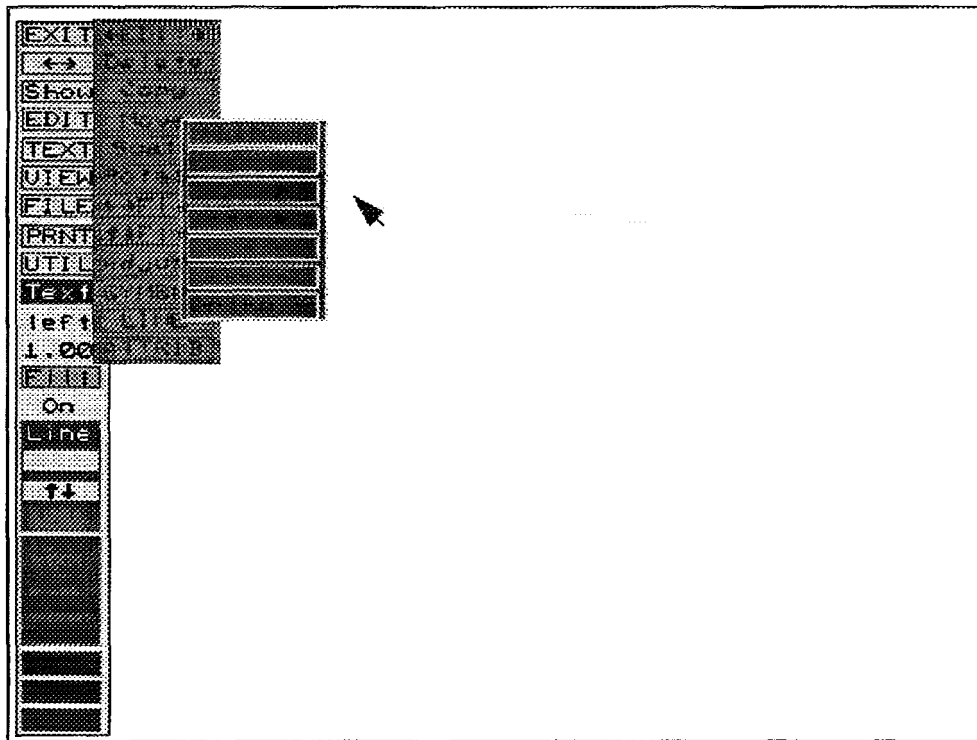


FIG. III.4. Lines menu.

III.4.11. ATTRIB. This command allows you to make changes to symbols that have already been placed in a drawing. When you invoke this command, another submenu (Fig. III.5) will be displayed.

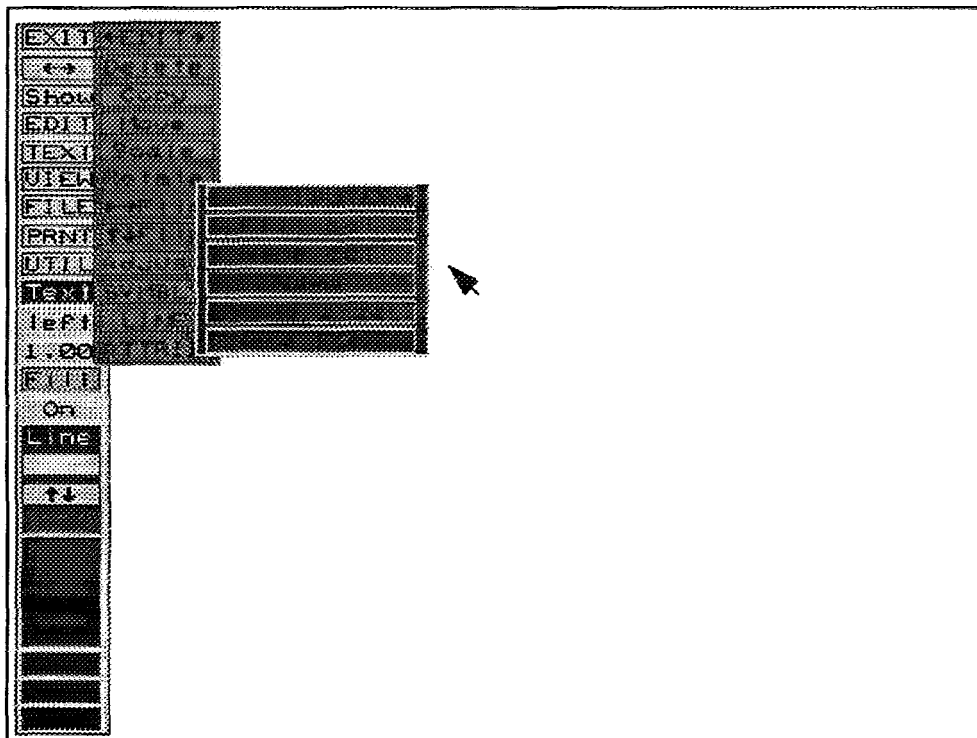


FIG. III.5. Symbol attributes submenu.

As shown, the following options are available:

- Fill col** This command allows you to change the fill color for specific symbols. 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. (Remember, activate the color bar (↑ ↓) to display additional color selections.) The prompt **Box the symbols to be changed** will be displayed. To box the symbols, you mark the opposite corners of the symbols to be changed. Position the cross hair at the area you wish to change and press the left mouse button. A small dot appears. Drag the cursor across the desired symbols until the box totally surrounds the desired region. Press the left mouse button. The symbol will change to the specified fill color and the prompt **Box the symbols to be changed** will be displayed. At this point, you may select additional symbols to change or press the right mouse button to terminate the process. Remember, this does not change the default fill color. This command allows you to change the color of existing symbols only.
- Name col** Same as Fill Col above, except you are changing the color of the name.
- Name** This command allows you to change the name of a specified symbol. When you invoke this option, you will be prompted to **Box the symbols to be changed**. To box the symbol, you mark the opposite corners of the symbol to be changed. Position the cross hair at the area you wish to change and press the left mouse button. A small dot appears. Drag the cursor across the desired symbol until the box totally surrounds the desired region. Press the left mouse button. You will be prompted to **Enter new symbol name:**. Type in the new symbol name from the keyboard and press <Enter>. Symbol names must be unique and can be up to 16 characters long. Once the new name has been entered the screen is updated to reflect the change. The prompt **Box next symbols to be changed** will be displayed. At this point, you may continue to box symbols and change names, or press the right mouse button to terminate the process.
- Name size** This command allows you to change the size the name is displayed or printed in. When you invoke this option you will be prompted to **Enter new 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. Negative numbers are not valid. Enter the desired text size and press <Enter>. You will be prompted to **Box the symbols to be changed**. To box the symbol, you mark the opposite corners of the symbol to be changed. Position the cross hair at the area you wish to change and press the left mouse button. A small dot appears. Drag the cursor across the desired symbol until the box totally surrounds the desired region. Press the left mouse button. The change will be applied to the drawing and the prompt **Box next symbols to be changed** will be displayed. At this point, you may continue the process, or press the right mouse button to terminate the process.
- Name FONT** This command allows you to change the font for a specified name. When you invoke this option, the font submenu will be displayed. Select the font by positioning the cursor over the desired font on the submenu and pressing the left mouse button. You will be prompted to **Box the symbols to be changed**. To box the symbols, you mark the opposite corners of the symbols to be changed. Position the cross hair at the area you wish to change and press the left mouse button. A small dot appears. Drag the cursor across the desired symbol until the box totally surrounds the desired region. Press the left mouse button. The drawing will be updated to reflect the change and you will be returned to the **Box symbols to be**

changed prompt. You can continue this process, or press the right mouse button to terminate this process.

III.5. TEXT

This option allows you to add or manipulate the text in your drawing. When you invoke this option, Fig. III.6 will be displayed. Each text command is discussed in the following paragraphs.

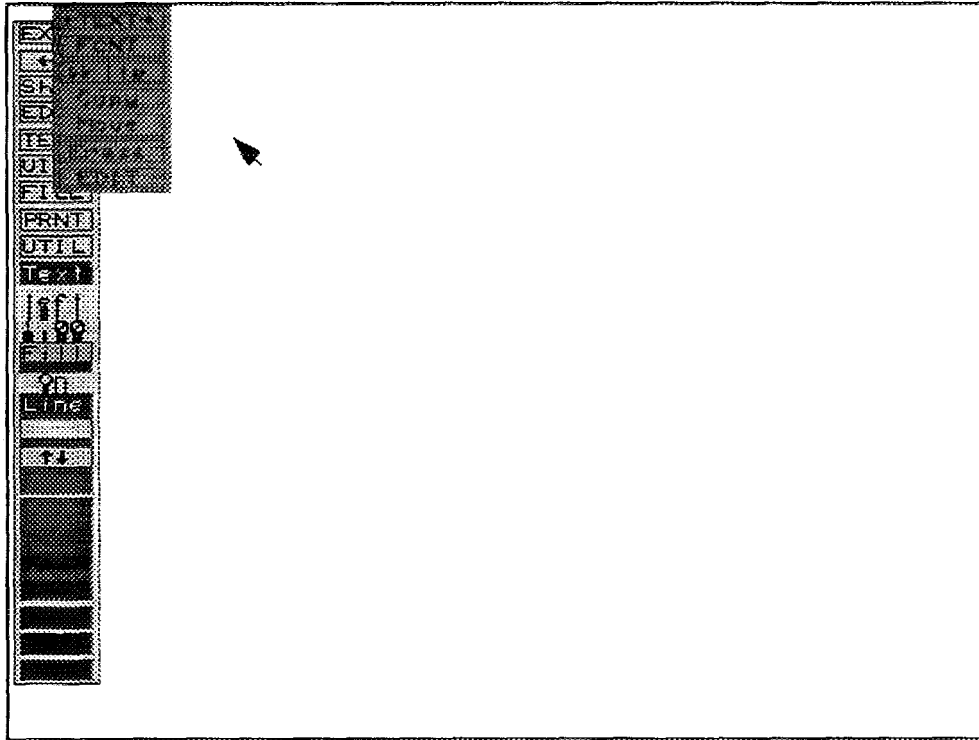


FIG. III.6. Text menu.

III.5.1. ←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 on the screen and press the left mouse button. The menu will be moved to the new location.

III.5.2. Font. The font command allows you to select the default font for the text. Selection is done in the same manner as explained above in the Edit - Name Font section.

III.5.3. Write. The "WRITE" command allows you to place text at any location on the screen. When you invoke this command you will be prompted to **Pick text placement location**. Position the cross hair on the screen where you want the new text to be placed and press the left mouse button. A window will appear in the upper left corner of the screen. You may enter up to 10 lines of text with 60 characters each. Enter the desired text and when complete press the <Esc> key. The following is a description of the keys that can be used in the window editor:

<↑, ↓, →, ←>: Moves the direction indicated within the window.

<Enter>: Positions the cursor at the beginning of the next line.

<Backspace>: Moves all the characters, from the cursor to the line's end, to the left one space.

- : Deletes the character at the cursor position, then moves all the characters to the line's end left one space.
- <End> : Positions the cursor at the line's end.
- <Ins> : Turns on the insert mode.
- <Esc> : Exits the window editor.

III.5.4. Copy. Allows you to copy any text and place it at any location in the diagram. When you invoke this option you will be prompted to **Pick region to be copied - cancel to quit**. Position the cross hair at the text you want to copy and press the left mouse button. A small dot appears. Drag the mouse until the box completely surrounds the text to be copied. Press the left mouse button. Next, you will be prompted to **Pick reference point - cancel to quit**. The reference point is used to give you some indication of the position of the text being moved relative to the box. Position the cursor at the desired point and press the left mouse button. You will be prompted to **Pick placement point - cancel to reselect**. Position the cursor at the desired placement point and press the left mouse button. The selected text will be displayed at the new placement point. (The text still remains at its original location). The prompt **Pick placement point - cancel to reselect** will return. At this point, you may select another placement point to copy the selected text, or press the right mouse button to terminate the process.

III.5.5. Move. This command operates the same as the COPY command, except the selected text is moved rather than copied.

III.5.6. Erase. This command allows you to delete selected text. When you invoke this option you will be prompted to **Pick region to be deleted**. To select the text to be deleted you mark the opposite ends of the text. Position the cross hair at the text to be deleted and press the left mouse button. A small dot appears. Drag the cursor across the text until the box completely surrounds the text to be deleted. Press the left mouse button. The text will be deleted and the prompt **Pick next region to be deleted** will be displayed. At this point you may select more text to delete or press the right mouse button to terminate the process. **NOTE:** If the text was not deleted, the box was not large enough.

III.5.7. Edit. This command allows you to alter existing text by changing the size, color, context, and justification. When you invoke this option, the Edit submenu will be displayed (Fig. III.7).

The following options are available:

- ←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.
- Text This option allows you to edit any text displayed on the screen. When you invoke this option, you will be prompted to **Pick the text to be changed**. To select the text to be changed you mark the opposite ends of the text. Position the cross hair at the text to be changed and press the left mouse button. A small dot appears. Drag the cursor across the text until the box completely surrounds the text to be changed. Press the left mouse button. A window appears displaying the selected text. Change the text as desired and press <Esc> when complete. The cursor movements used in this window are described in Section III.5.3, the WRITE command.

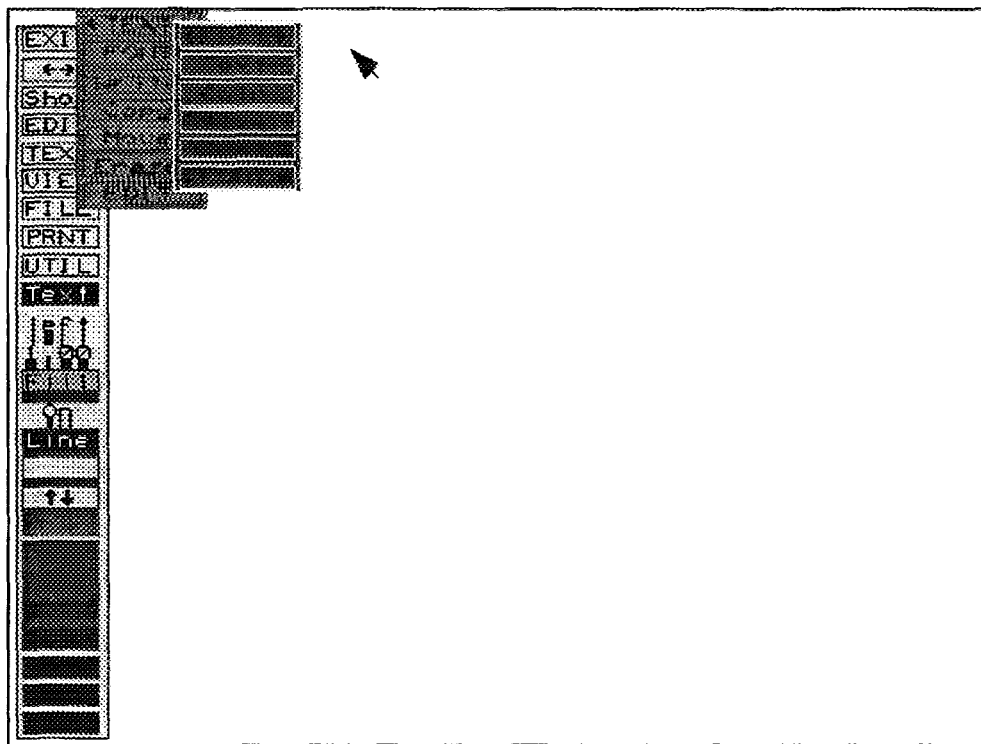


FIG. III. 7. Text edit submenu.

- Colr** This command allows you to change the color of the specified text. When you invoke this option you will be prompted to **Pick a new color from the color bar**. Select the desired color and press the left mouse button. Next, you will be prompted to **Pick the text to be changed**. To select the text to be changed you mark the opposite ends of the text. Position the cross hair at the text to be changed and press the left mouse button. A small dot appears. Drag the cursor across the text until the box completely surrounds the text to be changed. Press the left mouse button. The selected text will change to the new color and the prompt **Pick the text to be changed** will be displayed. At this point, you may select more text to change to the new color, or press the right mouse button to terminate the process.
- Size** This command allows you to change the size of the specified text. When you invoke this option you will be prompted to **Enter new text size >**. Enter the desired text size (1 - 66) and press the left mouse button. Next, you will be prompted to **Pick the text to be changed**. To select the text to be changed you mark the opposite ends of the text. Position the cross hair at the text to be changed and press the left mouse button. A small dot appears. Drag the cursor across the text until the box completely surrounds the text to be changed. Press the left mouse button. The selected text will change to the size and the prompt **Pick text to be changed - Press cancel to quit** will be displayed. At this point you may select more text to change to the new size or press the right mouse button to terminate the process.
- NOTE:** Remember, if the text does not change your box was not large enough.
- Just** This command allows you to justify selected portions of the text in your diagram. When you invoke this command, the prompt **Enter text justification - ('L'= Left, 'R'= Right, 'C'= Center)** will be displayed. Enter the type of justification (L, R, or C). Next, you will be prompted to **Pick the text to be changed**. To select the text to be justified you mark the opposite ends of the text. Position the cross hair at the text to be justified and press the left mouse button. A small dot appears. Drag the cursor across the text until the box completely surrounds the text to be justified. Press the left mouse

button. The selected text will be justified and the prompt **Pick text to be changed - Press cancel to quit** will be displayed. At this point you may select more text to justify, or press the right mouse button to terminate the process.

FONT This command allows you to change the font of the specified text. When you invoke this option, the font submenu will be displayed. Select the font by positioning the cursor over the desired font and pressing the left mouse button. Next, you will be prompted to **Pick the text to be changed**. To select the text to be changed you mark the opposite ends of the text. Position the cross hair at the text to be changed and press the left mouse button. A small dot appears. Drag the cursor across the text until the box completely surrounds the text to be changed. Press the left mouse button. The selected text will change to the new font and the prompt **Pick text to be changed - Press cancel to quit** will be displayed. At this point you may select more text to change or press the right mouse button to terminate the process.

NOTE: Remember, if the text does not change your box was not large enough.

III.6. 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, restore the drawing to its original size, or restore to the view previous to the last view change. When you select this option, Fig. III.8 will be displayed.

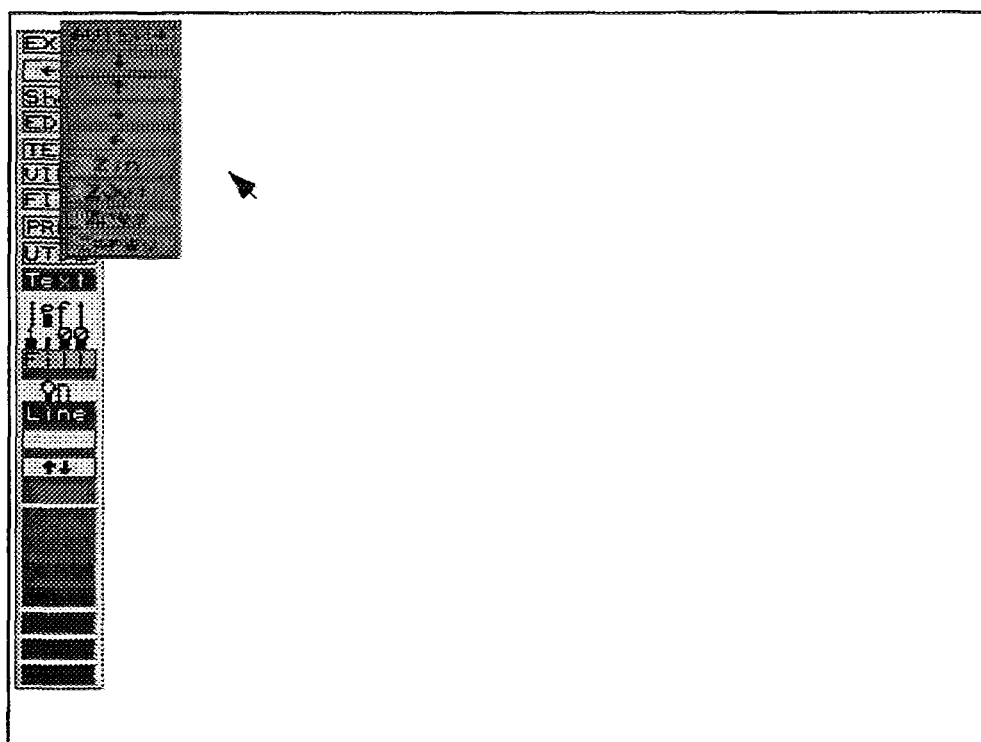


FIG. III.8. View menu.

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 of 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:

- Down Arrow ↓: The down arrow command allows the user to move the drawing in a downward direction. When selected the user is asked to pick the new bottom edge of the screen. The distance from the bottom of the screen and the new point picked is how far the drawing will move.
- Up Arrow ↑: The up arrow command allows the user to move the drawing in an upward direction. When selected the user is asked to pick the new top edge of the screen. The distance from the top of the screen and the new point picked is how far the drawing will move.
- Right Arrow →: The right arrow command permits the user to move the drawing in the right direction. It functions in the same manner as the two commands above.
- Left Arrow ←: The left arrow command permits the user to move the drawing in the left direction. It functions in the same manner as the three commands above.
- 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. 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 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. To restore the display to its original size, invoke the Zres option.
- Zoom Restore: This option restores any display created by Zin (zoom in) 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>.
- Zoom Previous: This option restores the display to the view previous to the last view change.

III.7 FILE

This option allows you to load and save drawings and to perform various file manipulations. When you invoke this option, Fig. III.9 will be displayed. Each command 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 desired location on the screen and press the left mouse button. In addition, you can remove the FILE options box by positioning the cursor on any command in the FILE menu and pressing the right mouse button or pressing the <Esc> key.

III.7.1. Save. This option 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 *current file name*.PID** >. To accept the default name press <Enter>, or you may enter a new file name. A file name consists of up to eight characters. A three character extension of .PID will be supplied by the system. If the default file name already exists (i.e., you have saved your diagram previously), the message **File already exists! Replace file? <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>.

III.7.8. SName. This command allows you to use a different symbol table with the editor. Because the name of the symbol table is stored with the drawing, each drawing can use a different set of symbols. When you invoke this option, the message **Symbol table name or <cr> for [default file.stb]**. Press <Enter> to accept the default file name or enter a new file name and press <Enter> .

III.7.9. File?. This command displays the file name of the file currently loaded on the screen.

III.8. PRINT

This option includes several printing options. When you invoke this command, Fig. III.10 will be displayed. As shown, the print options include:

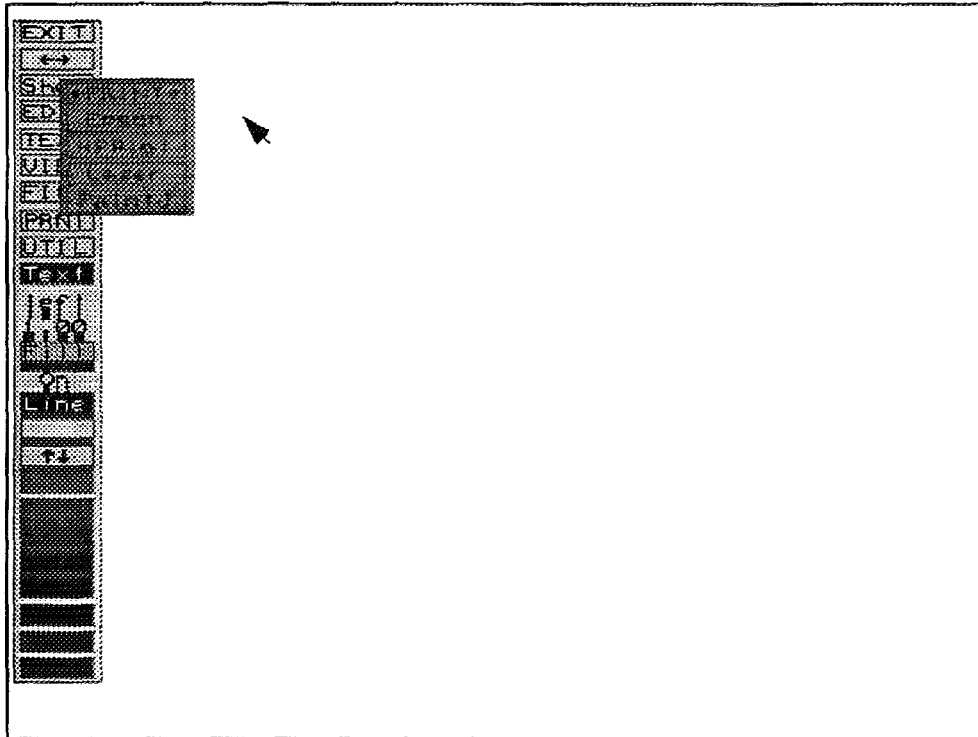


FIG. III.10. Print menu.

- Epson** This option sends the current file to the Epson printer. When you invoke this option, the screen will clear, the drawing will be redrawn without menus, and the Epson printer will begin to print.
- HPPlot** This option prepares the intermediate file xxx.HPP for the HP Plotter option in the Utilities option of the FEP menu (see Appendix IV. for details).
- Laser** This option sends the current file to the laser printer. When you invoke this option, the screen will clear, the drawing will be redrawn without menus, and the Laser printer will begin to print.
- PaintJ** This option sends the current file to the HP Paint Jet printer. When you invoke this option, the screen will clear, the drawing will be redrawn without menus, and the PaintJet printer will begin to print.

III.9. UTIL

The Utility option allows you to specify program defaults used when working with and displaying the drawings. When you invoke this command, Fig. III.11 will be displayed.

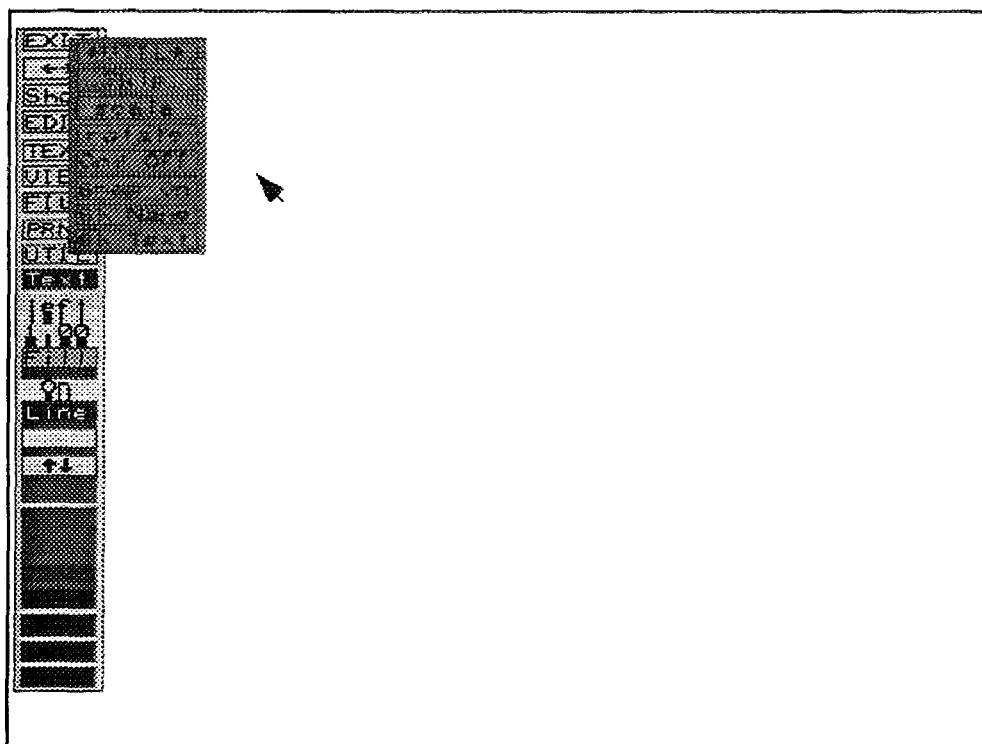


FIG. III.11. Utility menu.

As shown, the following options are available:

- | | |
|----------------|---|
| Skip | The Skip function allows you to specify how much of a skip or jump factor to use when moving the cursor. This is used to fine tune the spacing used for the placement of symbols. For example, the first two symbols in the default symbol table are a motor driven pump and a valve. The pump has an input defined at left center of the symbol and an output at upper-center right. The valve has an input defined at left center. To connect the symbols together without a jag in the line one of the symbols must be adjusted up or down. This may prove to be difficult if the skip value is too large. A modification can be made to specify how much to jump in the x and y directions at movement. |
| Scale | Each symbol in the symbol table is defined in a normalized grid from -1 to 1 in the x and y directions. By default each symbol when placed onto the drawing area is scaled by a factor of 2 (twice the normal size). This value may be changed with this command to fit your needs. Values may range from 0.1 to 99. |
| Rotate | Rotation within the Edit menu is done in two ways: about the center of each object and about a user selected point. This option allows you to specify which method to use. |
| Grd Off | The grid command enables you to turn on or off the grid. |
| Snap On | The P&ID cursor movement snaps according to the skip value defined with the skip function. This command will allow you to disable the skip/jump inherent to the cursor. |

- Sh Name** This command toggles the symbol names on and off. If the symbol names are off when a hard copy of the drawing is made, the symbol names will not be printed.
- Sh Text** This command gives you the ability to show all text on the screen, or to hide all text from the screen.

III.10. Text

This option allows you to set a default color for the text in your diagrams. 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).

III.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 right (right). Press the left mouse button or <Enter> key again, and the box will change from right 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.

III.12. Text Size

This option allows you to set a default text size for your diagrams. The default value is 0.5. Text size ranges from 0.001 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 large enough when printed on 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.

III.13. Fill

This option allows you to select a color for your 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 color selections available.) The Fill box will change to the newly selected color. All drawing symbols created in your diagram will be displayed in this selected color. If you modify an existing drawing, these symbol colors won't change. To change the color of existing symbols you must invoke the ATTRIBUTES suboption from the EDIT option.

III.14. On/Off

This option is a toggle to fill or not fill symbols when placed on the drawing. When set to On, the symbol is filled with the set color; if set to off, no fill is used.

III.15. 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 diagram will be this selected color. Again, if you are modifying an existing drawing the lines won't change to this color.

III.16. Symbol Generator

The symbol compiler is invoked from the FEP main menu by selecting the Utility Option, then selecting the "Symbol Generator" option. The symbol compiler is used when a change has been made to an existing symbol file or a new symbol file has been created. When the symbol generator is invoked a new screen appears and prompts for the file name of the file to be compiled. The file name entered must be an ASCII file, formatted in a specific manner that will be explained later. The file provided with the P&ID software package is named SMBLFILE.GEN. When this file name is entered at the prompt the system responds with the message, **Compiling....Please Wait**. The compile time will vary depending upon the length of the file and the complexity of the symbols being compiled. When completed the success of the compilation is displayed at the bottom of the screen. All compiled files are given the ASCII file name entered by the user. However, the extension ".STB" is added to distinguish between the two files. Each time the ASCII symbol file is edited it must be recompiled in order for the changes to be incorporated into a P&ID. It is important to note that once a symbol in a symbol file has been changed and the file has been compiled, each copy of that symbol in each drawing using the changed symbol file name will be updated to reflect the change. To avoid global changes like this, simply copy and rename the file before making any changes. This will preserve the original symbol file and avoid changes being made to earlier drawings.

III.16.1. Editing a Symbol File. Editing the symbol file becomes necessary whenever a symbol needs to be changed, added, or deleted. It is important to remember that only the ASCII symbol file may be edited. An example of such a file is the file named SMBLFILE.GEN that is provided as part of the P&ID software package. Editing a symbol file is accomplished by using any text editor. A symbol when completed may not have any X or Y value less than -1.0 or greater than 1.0. There are three essential items required to create a correct symbol: unique symbol numbers, graphic entities, and inputs and outputs. An explanation of each follows.

III.16.1.1. Symbol Numbers. Each symbol must have a unique number. Symbols do not have to be numbered in consecutive order. However, they must be in ascending (sorted) order from the top of the file to the bottom. The symbol number must be the first line of a symbol. Following the symbol number, a semicolon and a brief description of the symbol may be entered. A correct example is:

symbol 1 ;box.

III.16.1.2. Graphic Entities. Three types of entities may be used when creating a symbol: polylines, arcs, and lines. One or all types may be used in creating a symbol. The correct usage of each is briefly explained below.

Lines: Lines are used for drawing shapes that are not shaded or filled or they may be combined with arcs to create both filled and non-filled shapes. An example of how to draw an "L" shape using lines is shown below.

line 0.0, 1.0, 0.0, -1.0, 0.5, -1.0

Polylines: Polyline are best used for drawing polygon shapes. The first and last point of a polygon must be identical. An option provided with polylines enables polygons to be drawn filled or unfilled. To make a filled polygon, a "Y" is entered as the first parameter following the word polyline. This is followed by the x and y values for each point of the polygon shape. An example of how to draw a filled square shape using polyline is shown below.

polyline y, 0.0, 0.0, 1.0, 0.0, 1.0, 1.0, 0.0, 1.0, 0.0, 0.0

Arcs: Another graphic entity used for drawing symbols is arcs. Circles and ellipses may be generated also. Arcs may also be connected to lines to create polyline shapes with curves in them that can be filled. The first parameter of an arc is the fill option. Enter a "Y" or "N" to fill or not fill the shape. Remember, to fill a shape the first and last point must be identical. The second parameter is the x and y value for the center of the arc. The third parameter is the x radius and the y radius. The fourth parameter is the starting angle of the arc in degrees. The fifth and last parameter is the number of degrees to draw the arc. To draw a complete circle a value of 360.0 would be entered. An example of how to draw a "C" shape is shown below.

```
arc      n, 0.0, 0.0, 1.0, 1.0, 45.0 270.0
```

An example of how to connect arcs and lines together to make filled shapes is shown below. The shape is a "D".

```
line     0.0, 1.0, 0.0, -1.0
c
arc      y, 0.0, 0.0, 1.0, 1.0, 270.0, 180.0
```

III.16.1.3. Inputs and Outputs. Inputs and outputs are the points which connecting symbol lines use to make contact with a symbol. The line function in the P&ID will automatically detect if an input or output is present and connect the line to that point. This feature is useful for rapid development of a diagram.

Each symbol may have as many as 256 inputs and outputs. Each input and output must be written on a separate line in the ASCII symbol file. Some symbols may have no outputs. Still others may have neither inputs or outputs. When this occurs enter "nil" for the x and y value. Each symbol must have at least one input and one output defined even if it is defined as nil. Some correct input and output examples are listed below.

```
input     -1.0, 0.0
output    nil
input     nil
output     1.0, 0.0
output     0.0, 1.0
```

A completed symbol would look similar to the one listed below. This is a copy of the steam generator from SMBOLFILE.GEN.

```
symbol 25; steam generator
arc      n, 0.0, 0.0, 1.0, 1.09 53.0, 74.0
c
line     -0.6018, 0.7986, -0.6018, -0.1, -0.3009, -0.3009, -0.3009, -0.8993
c
arc      n, 0.0, -0.5, 0.5, 0.5, 233.0, 74.0
c
line     0.3009, -0.8993, 0.3009, -0.3009, 0.6018, -0.1, 0.6018, 0.7986
line     -0.6018, 0.7986, 0.6018, 0.7986
line     -0.6018, -0.1, 0.6018, -0.1
line     -0.3009, -0.3009, 0.3009, -0.3009
line     -0.3009, -0.8993, 0.3009, -0.8993
input    nil
output   nil
```

APPENDIX IV. PLOTTING AND PRINTING GRAPHICS

IV.1. PLOTTING GRAPHICS USING HP7475 PLOTTER

The **HP Plotter** option in the **Utilities** menu item of the FEP main menu allows you to plot graphics. When you invoke this option, Fig. IV.1 will be displayed. This screen shows all available plot files. The plot files xxx.HPP are produced using the **HPPLot** option in the fault tree, event tree or P&ID graphics editors.

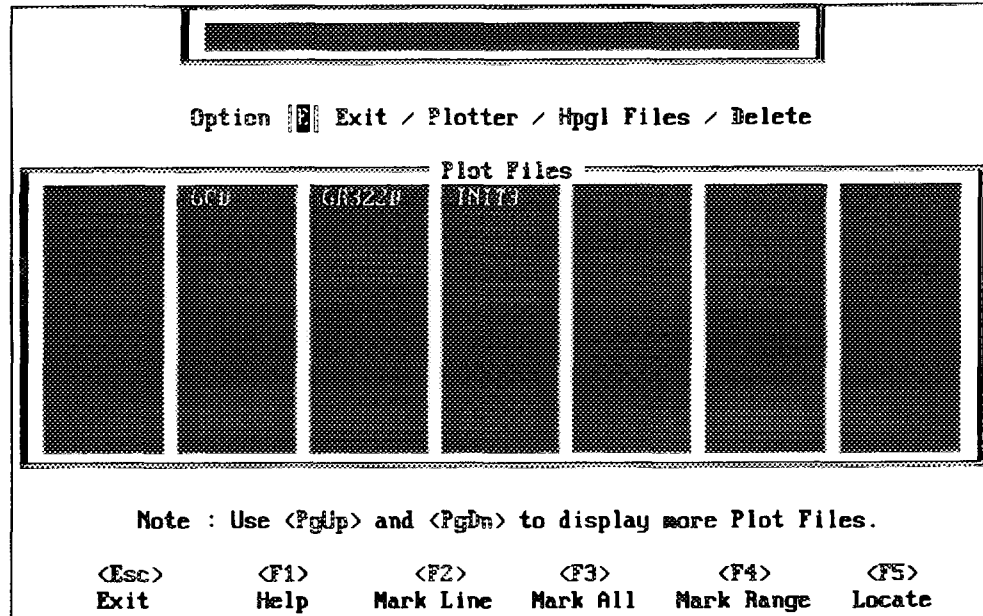


FIG. IV.1. HP plotter option display screen.

The following options are available:

Exit

Plotter - Sends the specified file(s) to the plotter.

Hpgl File - Generates an HPGL formatted file.

Delete - Deletes the specified file(s)

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

<Esc> - Returns you to the previous screen. Exits the option.

<F1> - Displays on-line help messages (not functional).

<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. You can specify a range of files highlighting the first file name and pressing <F4>. You will be

prompted **Range selected - highlight end of range...**, than highlight the last file name in the range and press **<F4>** again.

<F5> - Allows you to locate a specific file for further processing. When you invoke this function, You will be asked to 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.

IV.1.1. Plotter

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

IV.1.2. Hpgl Files

This option creates xxx.HPG files. A xxx.HPG file may be plotted using the DOS COPY command. Once the xxx.HPG file is created, exit PSAPACK and return to the PSA42\GRAPHICS subdirectory. At this point, you must type the following command:

Copy xxx.HPG port:

where *port:* is the port the plotter is connected to.

IV.2. PRINTING GRAPHICS USING HP LASERJET PRINTER

The **Rasterize** option allows you to rasterize fault tree, event tree and P&Id diagrams for printing. Obtaining a "laser printed" output of a diagram is done in two steps. First, you must select the drawings to rasterize. Once the drawings have been rasterized, you must exit PSAPACK and return to the PSA42\GRAPHICS subdirectory. At this point, you use the DOS COPY command to send the files to the laser printer. The command is as follows:

Copy /b *.RAS port:**, where *port:* is the port the laser printer is connected to. The **/b** switch tells the printer, that it has to print the file as a binary file.

When you select **Rasterize** option from the **Utility** option of the FEP menu, Fig. IV.2 will appear on the screen. Highlight the selection and press **<Enter>**. If you select **Fault Trees**, then Fig. IV.3 appears on the screen and you can start rasterizing the diagrams. If you select other file types (event trees or P&ID) a similar screen appears.

There are two options available for rasterizing the diagrams:

High Resolution Raster - 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).

IV.2.1. High Resolution Raster

This option rasterizes the selected fault tree to 300 dots per inch (dpi). The option provides you with the highest quality of printed 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 to follow the progress of rasterizing. When complete, a message will be displayed notifying that the raster image has been created.

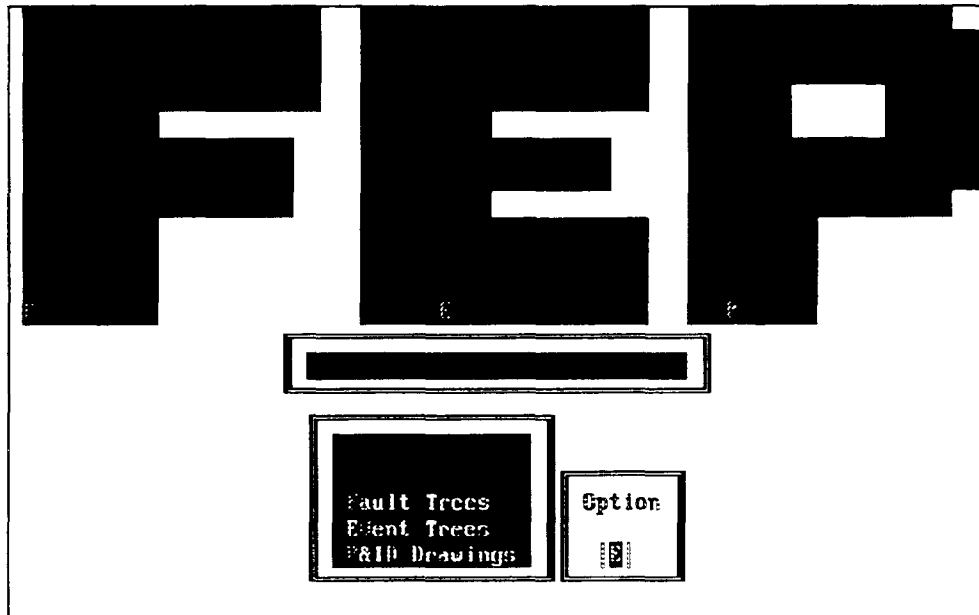


FIG. IV.2. Rasterize option display screen.

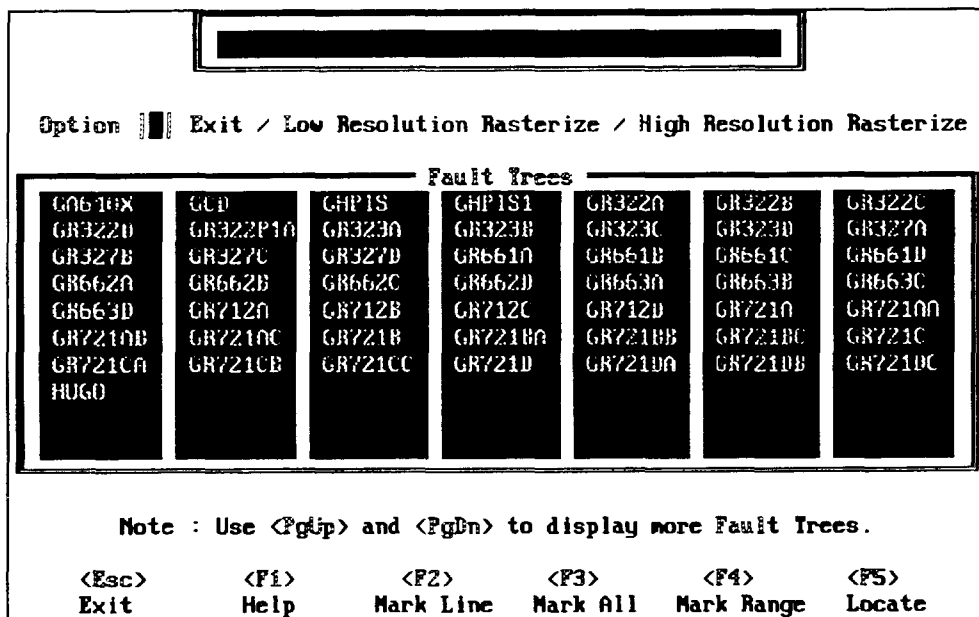


FIG. IV.3. Rasterize fault trees display screen.

IV.2.2. Low Resolution Raster

This option rasterizes the selected fault tree to 150 dpi. To invoke this option, enter a <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 to follow the progress of rasterizing. When complete, a message will be displayed notifying that the raster image has been created.

ABBREVIATIONS

AT	PC hardware standard (80286, 80386, 80486 ... processor)
ATT	attribute catalogue
BOOL	minimal cut sets generation module in PSAPACK (Level B)
BRFT	PSAPACK fault tree browse option (Level A)
CDFG	core damage frequency graphics module in PSAPACK (Level A)
CGA	PC graphic adapter and display standard
DB	database
DIRF	file directory option in PSAPACK (Level B)
DOS	disk operating system for PCs
ED	PSAPACK text editor module (Level B)
EGA	PC graphic adapter and display standard
ET	event tree
ETED	event tree editor module in PSAPACK (Level B)
FEP	graphical fault tree, event tree and P&ID editor in PSAPACK (Level B)
FT	fault tree
FTA	fault tree analyzer module in PSAPACK (Level B)
FTAP	fault tree analysis program
FTED	fault tree editor module in PSAPACK (Level B)
FTT	fault tree library
HKID	clear erased RDB components option in PSAPACK (Level B)
HRB	human reliability database
HRB	token of the human reliability database
HVAC	heating, ventilation and air conditioning
I&C	instrumentation and control
IAEARDDB	IAEA generic reliability database
ID	environment identifier
ID	change environment identifier module in PSAPACK (Level B)
ID	select environment identifier module in PSAPACK (Level A)
IEDB	initiating events database
IEV	initiating event library
IMPT	PSAPACK FTAP file import option (Level B)
KB	kilobyte
LPT1	PC parallel printer port No. 1
MB	megabyte
MCS	fault tree minimal cut sets library
MCS	minimal cut sets
MCS	token for event tree header labels
MCSLIB	fault tree minimal cut sets library
MOST	make the libraries for Level A option in PSAPACK (Level B)
P&ID	piping and instrumentation diagram
PLS	components out of service catalogue (Level A)
PLSLIB	plant status minimal cut sets library (Level A)
PSA42	PSAPACK main subdirectory
PSAG	PSAPACK PSA guidelines browse option (Level B)
PSAM	PSAPACK manual browse option (Levels A and B)
RAM	random access memory (for PCs)
RDB	reliability database
RDB	reliability database module in PSAPACK (Levels A and B)
SCP	supercomponent fault tree library
SCP	supercomponent token
SCPLIB	supercomponent minimal cut sets library
SEQ	event tree sequence library
SEQLIB	sequence minimal cut set library

SETS	fault tree analysis program
SWF	switch FALSE gate
SWF	switch FALSE token
SWT	switch TRUE gate
SWT	switch TRUE token
TMP	temporary component reliability database
TMP	token of the temporary component reliability database
TOP	top event token
TOPT	test interval optimization module (Level A, not implemented)
UGDB	user generic reliability database
VGA	PC graphic adapter and display standard
XT	PC hardware standard (8086 processor)