AUTOMATED DOCUMENTATION GENERATOR
for
ADVANCED PROTEIN CRYSTAL GROWTH
(5-33192)

Final Technical Report for Period
03 March 1993 through 10 March 1994

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16.Abstract

To achieve an environment less dependent on the flow of paper, automated techniques of data storage and retrieval must be utilized. This software system, "Automated Payload Experiment Tool", seeks to provide a knowledge-based, hypertext environment for the development of NASA documentation. Once developed, the final system should be able to guide a Principal Investigator through the documentation process in a more timely and efficient manner, while supplying more accurate information to the NASA payload developer.

The current system is designed for the development of the Science Requirements Document (SRD), the Experiment Requirements Document (ERD), the Project Plan, and the Safety Requirements Document.

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PREFACE

This technical report was prepared by the staff of the Research Institute, The University of Alabama in Huntsville. The purpose of this report is to provide documentation of the work performed and results obtained under delivery order 72 of Marshall Space Flight Center (MSFC) Contract No. NAS8- 38609. Mr. Gary A. Maddux was Principal Investigator for this 12 month level of effort. Ms. Anna Provancha served as co-PI. Mr. David Jex of the Microgravity Experiment Projects Office provided technical coordination.

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official NASA position, policy, or decision unless so designated by other official documentation.

I have reviewed this report, dated 3/7/94 and the report contains no classified information.

Anna Provancha
Principal Investigator

Approval:

Gary A. Maddux
Research Institute

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1.0 INTRODUCTION

The System Management and Production Laboratory at the Research Institute, the University of Alabama in Huntsville (UAH), was tasked by the Microgravity Experiment Projects (MEP) Office of the Payload Projects Office (PPO) at Marshall Space Flight Center (MSFC) to conduct research in the current methods of written documentation control and retrieval. The goals of this research were to determine the logical interrelationships within selected NASA documentation, and to expand on a previously developed prototype system to deliver a distributable, electronic knowledge-based system. This computer application would then be used to provide a "paperless" interface between the appropriate parties for the required NASA documents.

2.0 BACKGROUND AND OBJECTIVES

The Microgravity Experiment Projects (MEP) Office of the Payload Projects Office (PPO) at MSFC is currently responsible for collecting and coordinating experiment/facility specifications and requirements between NASA and various colleges, universities, research centers, and other public- and private-sector organizations that are selected or are requesting to fly their respective microgravity experiments on designated flights. This coordination involves the communication of flight hardware requirements and the preparation and review of all documentation between NASA and the research groups. To reduce difficulties encountered by these customers of NASA, an effort was undertaken to research, analyze, and evaluate the current procedures involved in the information gathering activities.

The MEP Office identified a need to develop an Automated Payload Experiment Tool (APET) which would lead experiment developers through the development planning process, obtain necessary information, establish an electronic data exchange avenue and allow easy manipulation/reformatting of the collected information. In order to fulfill this need, the University of Alabama in Huntsville (UAH) was tasked to design and develop the APET software package to meet the increasing demands to lighten the burden of documentation preparation and maintenance for NASA and its customers.

The objective of this task was to expand on the results of the Automated Payload Experiment Tool (APET) Feasibility Study (previously performed by UAH) and provide procedures and software for the generation of experiment requirements and flight hardware requirements. The software would assist the scientist or engineer in generating the appropriate documentation used to develop and perform flight qualified experiments for the manned microgravity environment.

3.0 CURRENT ENVIRONMENT

The current environment of manual data gathering and information dissemination is excessively reliant on paper as the primary medium of transfer. This reliance on a static media adds exponentially to the complexity of a process that by its nature is elaborate. Changes to a document stored on an information media that requires physical manipulation are costly and burdensome. With no method in place to ensure that changes are incorporated throughout follow-on documents, (other

than manual verification), modifications to science, engineering, safety, and other documents are more susceptible to human error than necessary.

The design, development and preparation of an experiment to fly in space are time consuming tasks demanding a great deal of technical and disciplinary knowledge. Reducing the time required to prepare an experiment and its supporting documentation is of vital interest to the Microgravity Science Applications Division (MSAD). Methods of developing and utilizing state of the art information technologies are of prime concern in simplifying the critical Principal Investigator (PI)/Payload Element Developer (PED) interface.

4.0 ACTIVITIES

4.1 Form and Documentation Evaluation

UAH collected, analyzed, organized, and evaluated a number of forms and documents used in the current flight hardware development process. Documents were analyzed as to their content, and also evaluated regarding their relationships both within the same document and within other documents. The findings of this research were incorporated in the design of the computer software and its accompanying knowledge base.

4.2 Design Considerations

The objective of APET is to provide an easy to use tool to the Principal Investigator team. To ensure ease of use, few computer hardware requirements are necessary to operate the APET software package.

4.2.1 Hardware

APET is designed to run on any IBM-PC compatible personal computer. There have been five modules developed, four of which have been distributed. Each module's requirements depend on its level of complexity. These five modules are the SRD, the SRD/ERD, the Project Plan, the Science Requirements Envelope Document, and the Safety Requirements Document. All five packages will run on a 386 machine. However, while it is possible to use the SRD/ERD system on a 386 PC, it is recommended that the APET user install the software on a 486 PC or higher. The graphical displays, multiple screen windows, and the complexity of the system cause noticeable slowdowns on any machine less than the 486.

The software requires that the PC be equipped with a hard disk drive. For proper execution, the hard drive (or some partition of it) must be named C:. The SRD/ERD version of APET will require approximately 14M (megabytes) of space on the hard drive for the system, plus another 1M on the hard drive for the data files created by the user. However, for optimal performance, the hard drive should have a total of at least 17M free upon installation of the software. The Project Plan, the Science Requirements Envelope Document, and the Safety Requirements Document will each require from 1M - 3M of hard disk space.

For ease of use, the PC should be equipped with a mouse. This, however, is not mandatory. APET utilizes hypertext technology as the user interface. Hypertext software systems allow for the retrieval of related information at the point and click of a mouse or, if a mouse is not used, at the touch of one or two keystrokes. For information on a highlighted topic, the user should move the mouse to that word and click. A window will be opened, overlaying the current screen. Once the information is reviewed, the user can press the space bar and close the window, returning the user to the previous screen.

4.2.2 Software

One of the primary objectives in developing the APET was to reduce the confusion of the documentation process. This guiding principle was instrumental in the design of the software as well. All APET software packages use a standardized format for the user interface. Screen design, menu selection, method of data entry, and user messages take the same form throughout the APET packages.

In developing the questions and knowledge base for the APET, it was assumed that all necessary instructions for successful completion of PI requirements were contained in the hardcopy documents. Therefore, to formulate user prompts, questions, explanations, etc., the questions and background information were taken directly from the applicable document. Definitions were taken from pertinent entries within the applicable document. When conflicting definitions were found to exist, the most logical definition was used in that software section.

4.3 Software Packages

4.3.1 Science Requirements Document

According to the Microgravity Science Applications Division (MSAD) Management Plan, "The Science Requirements Document (SRD) is the basic document which levies the science requirements on the hardware. As such, the document must first provide adequate justification for conducting the experiment in space and then delineate and justify the individual science requirements. The science requirements include the observational and environmental data requirements necessary to meet the science objectives".

The SRD is the first documentation requirement to be met by the Principal Investigator. It was also the logical beginning for the APET software. The SRD section of APET consists of a query of 52 questions concerning the description of the experiment, the limitations of non-space testing, and the potential benefits from the space environment. The answers to these questions are narrative in form (unlike other parts of APET, which are more fill-in-the-blank or choose from a list). User prompts for these questions were taken directly from the MSAD Management Plan. The user has the option of answering these questions sequentially or randomly (see Appendix A). An option also exists to answer only the unaddressed questions, so that at any time the user can see how many questions remain. There are a number of options available to the user to make the documentation process more

efficient. For example, during the question/answer session, the user has the option of viewing/editing related answers on selected questions. This adds to the consistency of the material, and provides an easier data retrieval method for the user. For a full description of the SRD software package, see the SRD/ERD User Guide (Appendix A).

4.3.2 Experiment Requirements Document

The Experiment Requirements Document (ERD) is used by the payload element developer and/or the principal investigator to define experiment requirements to be accommodated by the Space Transportation System (STS) for a given mission. The ERD is the logical follow-on document to the SRD. While the SRD justifies the need for a space environment and generally describes experiment requirements, the ERD expands on these generalities and requires specific experiment specifications.

Because of the more exacting nature of the ERD, the user faces more demands to respond to questions with exact numbers rather than narrative descriptions. Therefore, the ERD user prompts will often ask for a number or word to be selected from a limited list of appropriate answers, or supply a short (one or two word) answer to the software query. Because of the more demanding requirements of the ERD, the software has a much deeper level of complexity. Questions with a limited number of answers or questions that require logical (YES/NO) responses can be checked against previous answers to ensure that conflicting or mutually exclusive responses are not accepted. This built-in "expertise" adds much to the integrity of the user supplied data, and thus makes the information contained in the ERD more consistent and useful.

The ERD section of APET is a great deal larger than the SRD. There are twelve sections of the ERD, several of which taken separately would be as large as the SRD in its entirety. However, based on the requirements of the experiment, complete sections of the ERD can be eliminated. The ERD is also more technically complex than the SRD, containing far more terminology, acronyms, etc. than the other APET modules. Therefore, the use of hypertext definitions, examples, graphics and hypertext reference sections are more widely used in the ERD.

The most critical of the ERD sections is the first, which deals with the experiment's functional objectives. Each experiment contains one or more functional objectives, which in turn are composed of one or more steps. Follow-on sections in the ERD refer back to and are based on the answers given in ERD Section One. The APET software helps the user by requiring that Section One be completed before these follow-on sections, and also aids by ensuring that if a functional objective is deleted, that the follow-on sections that refer to that deleted functional objective will also be deleted. Again, this adds to the consistency of the material, and provides an easier documentation method for the user. A full description of the ERD software package is contained in the SRD/ERD User Guide (Appendix A).

4.3.3 Project Plan

The Project Plan is the basic planning document that describes the overall plan for proceeding with the project. Project Plans are unique to each project and the format and level of detail vary with the size, complexity, sensitivity and other characteristics of the project. The Project Plan will cover the project to completion, including operational and data analysis periods. The Microgravity Science and Applications Division (MSAD) requires that a MSAD Project Plan be submitted and approved prior to making a major commitment of resources to an MSAD project. MSAD Project Plans are to be prepared in final draft form for the Requirements Definition Review.

Plans will be prepared and submitted for all flight experiments. Project Plans will be reissued, modified, or amended for reflights depending on the complexity of the task. A plan's preparation is the responsibility of the designated Project Manager at the responsible NASA center. The Project Manager will sign the MSAD Project Plan as the preparer; the Project Scientist and the Principal Investigator will sign as concurring. The MSAD Project Plan will be signed off at the NASA center prior to submission to Headquarters by the appropriate center's authorities. When the Program Scientist and Program Manager sign to register their concurrence, the MSAD Project Plan will be submitted to the MSAD Director for approval.

The Project Manager is responsible for updating a MSAD Project Plan when significant changes occur (such as changes in scope, organization, or roles and responsibilities). This does not apply to resources, schedules or manpower, which are updated through normal budgeting and project monitoring activities. The Project Manager will establish a change control process for maintaining the MSAD Project Plan and other project documentation.

The Project Plan component of APET is similar to the SRD component, in that it is comprised primarily of text responses to a series of predefined questions. There are a number of options available to the user to make the documentation process more efficient. For a full description of the Project Plan software package, see the Project Plan User's Guide (Appendix B).

4.3.4 Science Requirements Envelope Document

The Science Requirements Envelope Document provides an envelope or volume of science requirements for a type of experimentation which is intended to encompass the science requirements generated by individual experiments of that type. The primary purpose of the document is to provide science requirements against which hardware can be conceptualized such that later, when specific PIs are chosen, their individual requirements will fall within the requirements originally stated in the Science Requirements Envelope Document.

The Science Requirements Envelope Document is very similar to the SRD. The primary difference is not the questions, but in the user responses, where a range of values is given for a capacity rather than a discreet measurement for an experiment. To complete the Science Requirements Envelope Document, questions were taken directly from the MSAD Management Plan. For a detailed description of the Science Requirements Envelope Document, see Appendix C.

4.3.5 Safety Requirements Document

The purpose of the Safety Requirements Document is to delineate the activities and documentation requirements leading to safety certification of instruments, facilities, Mission-Peculiar Equipment (MPE), and Instrument Ground Support Equipment (IGSE) that constitute a National Space Transportation System (NSTS) Payload or payload complement for which the Payload Project Office (PPO) has management and integration responsibility. The Safety Requirements Document designates the safety-related activities and documentation required of individual Payload Element Developers (PEDs). This document is applicable to all MSFC PPO managed STS attached payload missions and to all of the PEDs for those missions. STS attached payloads include Spacelab dedicated missions, middeck payloads, and partial-payload missions. A partial-payload mission is a flight that is not a Spacelab-dedicated (unique) mission and is shared with other payloads. Such missions are also referred to as mixed cargo missions. Partial payloads are defined as those payloads that do not require a Spacelab module or the Spacelab igloo.

As with the previous APET components, completion of the Safety Requirements Document involves answering a series of predefined questions. The answers to these questions may be given in the form of short narratives, or as choices from lists of possible answers. For ease of data storage and retrieval, the answers are stored in a directory according to the phase of the review in which the questions are associated (i.e. Phase 0, Phase 1, etc.). For a detailed description of the Safety Requirements Document, see Appendix D.

5.0 PRELIMINARY RESULTS OF SOFTWARE DISTRIBUTION

To solicit inputs about the APET software package, presentations and demonstrations were conducted for selected PIs at Marshall Space Flight Center, Huntsville, AL, Lewis Research Center in Cleveland, OH, and at NASA headquarters in Washington, D.C., where instruction manuals and system software were distributed. The primary emphasis was on the validation of the SRD package, and limited emphasis was on the ERD package. Emphasis was placed on the SRD because it is the first document to be completed by the PI and is due 12 - 36 months before the ERD. In addition, two packages for the generation of the Project Plan were distributed. Currently, no packages addressing the Science Requirements Envelope Document or the Safety Requirements Document have been dispensed.

The preliminary results of these distributions have been favorable. The first SRD software package was distributed on diskette only, with no supporting documentation. Even so, the user was able to generate an acceptable SRD with minimal instruction from the UAH APET development staff. Two more SRD packages have since been evaluated by potential users, and while both found the software to be useful, both were primarily Macintosh users and opted not to produce the SRD using the APET software. After evaluation of the Project Plan, it was determined that the schedule examples found in the Development Approach section (Section 4.4.3) currently displayed in the package were inadequate. After working with selected Project Managers, a better understanding of scheduling requirements and development was obtained. This understanding resulted in an updated Project Plan containing improved schedule examples. Comments from these and other early users of

the system have found it user-friendly, and an aid in meeting the documentation requirements. Users have been complimentary about the ease of data retrieval.

Although the ERD component of APET has been distributed, none of the early PI participants have completed any ERD sections. Likewise, the software distribution addressing the Project Plan has not yielded any conclusive results. Recipients of the software have been impressed with the work NASA and MSFC have put into this effort, and all have agreed that the research completed is a valuable and needed first step in automating the documentation process.

6.0 LIMITATIONS OF DELIVERED SOFTWARE

The most valuable comments made about the APET software are not the compliments, but the criticisms. Without the customer inputs of what is still required in the system, it would be difficult to determine the improvements necessary to make it a valuable tool for the PI. The following paragraphs represent the most common suggestions on improving the APET tool.

The APET software was designed to run on any IBM-compatible personal computer (PC) using the DOS operating system. This requirement thus restricts users of the Macintosh line of computers and their associated operating system. The determination to build for the PC and not the Macintosh was made primarily because little application software exists for the Macintosh that offers the same support that Knowledge Pro offerers for the PC. However, because the NASA PI community's alliances seem to be evenly split between PC and Macintosh, it is a reoccurring suggestion that the Macintosh be supported. Efforts to convert the existing PC code to a form that can be executed on the Macintosh are currently being investigated. In an attempt to find a successful conversion package, the software package SoftPC by Insignia® Solutions was evaluated. SoftPC is a Macintosh application which enables the Macintosh to emulate a high specification IBM PC/AT compatible computer. This, however, proved not to be a viable solution because the amount of random access memory (RAM) required to support certain portions of the APET software package could possibly exceed the amount of RAM available on most Macintosh computers causing the system to fail.

The second common suggestion is that the APET editor be improved to include a spell checker function. This was realized to be a shortcoming of Knowledge Pro from the outset of the software development project. The exclusion of a spell checker function is primarily attributable to the lack of random access memory of the current generation of personal computers. RAM is required for both APET, Knowledge Pro, and the Knowledge Pro editor. The addition of an internal spell checker would increase the requirements of RAM to the point of system failure. The proposed solution for the lack of a spell checker is to include an external spell checker that can be called by APET. In order to add this feature, a spell checker software package that is inexpensive and free to distribute must be found. Attempts have been made to furnish an acceptable spell checker, however no suitable package has of yet been found. At this point, the conversion of APET to a Windows operating environment my be the best alternative for overcoming this obstacle.

Most other suggestions about the APET software are not necessarily criticisms of the package but of the documentation process. For instance, PIs preparing to fill out the SRD commented that many of the questions asked did not pertain to the objective of the SRD. In those cases, it was explained

that all questions came from the MSAD Management Plan. However, there has been enough commentary generated to justify that this is a valid concern within the PI community. The SRD should be examined for what information is needed to meet its objective, and eliminate any irrelevant questions that may exist.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The APET package has been developed and distributed to PIs required to submit SRDs and ERDs to justify/define their experiments. Additionally, software has been developed and is currently being distributed/evaluated to fulfill the documentation requirements for Project Plans and Science Requirements Envelope Documents. Initial software efforts have begun on the Safety Requirements Document, with the prototype design being developed. Based on the preliminary comments of the PIs who have taken part in the distribution of the APET software, APET fills a need to automate the documentation process. However, more work needs to be done to enhance the APET system.

There should be a Macintosh version of APET available. There are a number of PIs who wish to use the software, but are unhappy with the PC-only restriction. The editor of the APET software should also be enhanced to include additional features, such as a spell checker. This recommendation may be delayed, however, until machines with a greater RAM are available on the market.

It is also recommended that the findings of this research be used to examine the documentation requirements placed on the PI. There are instructions in the NASA-supplied hardcopy documentation that are vague and have little or no relationship to the true objective of the master document. These instructions also offer little information as to the amount of detail required to adequately answer the question. These questions cause problems for the PI, and add unneeded complexity to the overall task.

Once a number of SRDs have been created using APET, it is suggested that the software be modified to include examples of what is expected from the PI. This could further be developed to provide the PI a model that could be copied into his answer, then customized to his individual response.

Further work should be conducted to complete the Safety Requirements Document's Material Usage Listing. This will be of great benefit to the PI, who is unlikely to be aware of the dynamic nature of the hazardous materials database. This work, along with the completed validation/ distribution of the Project Plan and the Science Requirements Envelope Document, will provide a solid baseline from which NASA can move from a paper environment to an electronic environment.

APPENDIX A

SRD/ERD User Guide

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Automated Payload Experiment Tool

User Manual

Science Requirements Document
and the
Experiment Requirements Document

Prepared by:

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Prepared for:

National Aeronautics and Space Administration
Microgravity Science and Applications Division
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1.0 INTRODUCTION

So you want to fly an experiment on the Shuttle.

Well, to begin the process, we must get a little information about your experiment and its requirements.

If you have flown with us in the past, you may remember a substantial amount of paper documentation was required. This application, the Automated Payload Experiment Tool, is designed to alleviate much of the burden of the document preparation and maintenance process. This system can currently be used to prepare two support documents, the Science Requirements Document (SRD), which defines the science objectives, and the Experiment Requirements Document (ERD), which defines the experiment design/build requirements. The version that you have is for the creation of both documents.

2.0 DISCUSSION

2.1 Background

The Microgravity Experiment Projects (MEP) Office of the Payload Projects Office (PPO) at the Marshall Space Flight Center (MSFC) is currently responsible for collecting and coordinating experiment/facility specifications and requirements between NASA and various colleges, universities, research centers, and other public- and private-sector organizations that are selected or are requesting to fly their respective microgravity experiments on designated flights. This coordination involves the communication of flight hardware requirements and the preparation and review of all documentation between NASA and the research groups. To reduce difficulties encountered by these customers of NASA, an effort was undertaken to research, analyze, and evaluate the current procedures involved in the information gathering activities.

The MEP Office identified a need to develop an Automated Payload Experiment Tool (APET) which would lead experiment developers through the development planning process, obtain necessary information, establish an electronic data exchange avenue and allow easy manipulation/reformatting of the collected information. In order to fulfill this need, the University of Alabama in Huntsville (UAH) was tasked to design and develop the APET software package to meet the increasing demands to lighten the burden of documentation preparation and maintenance for NASA and its customers.

2.2 System Requirements

The objective of APET is to provide an easy to use tool to the Principal Investigator (PI) team. To ensure ease of use, few computer hardware requirements are necessary to operate the APET software package.

APET is designed to run on any IBM-PC compatible personal computer. While it is possible to use the system on a 386 PC, it is recommended that the APET user install the software on a 486 PC or higher. The graphical displays, multiple screen windows, and the complexity of the system cause noticeable slowdowns on any machine less than the 486.

The software requires that the PC be equipped with a hard disk drive. For proper execution, the hard drive (or some partition of it) must be named C:. The SRD/ERD version of APET will require approximately 14M (megabytes) of space on the hard drive for the system, plus another 1M on the hard drive for the data files created by the user. However, for optimal performance, the hard drive should have a total of at least 17M free upon installation of the software.

For ease of use, the PC should be equipped with a mouse. This, however, is not mandatory. APET utilizes the hypertext technology, which offers a point-and-click user interface. Instead of a mouse, the user does have the option of pressing selected function keys to achieve the same effect.

2.3 Installation

The APET software package is provided on four high density diskettes. The files stored on these diskettes have been compressed; therefore, it is required that the user follow several simple steps to ensure correct installation.

1) Insert the diskette marked as "APET SRD/ERD DISK 1" in the drive designated as A:. If the A: drive on your system is not the correct size, then use the DOS ASSIGN command to redesignate the drives appropriately. (For example, if you have 3 1/2" disks but your 3 1/2" drive is B:, then at the DOS prompt type **ASSIGN A: B:**.)

2) From this drive (A:) type:

INSTALL.

This will activate the installation routine. A series of instructions and informational text will be presented. Each screen will advise what is transpiring in the installation procedure. The installation routine will create a subdirectory on the C: drive called GARDEN. Once created, the files contained on the installation disks will be copied to the directory **C:\GARDEN**. Most of these files have been compressed to conserve disk space. An uncompress routine will be invoked to return these files to their normal (and usable) condition. As the installation routine is completed for each disk, the user will be advised to insert the next diskette. To cancel the installation at any time, press the CTRL (control) C keys.

3) Upon successful installation of the APET program files, the message **INSTALLATION ROUTINE COMPLETE** will be displayed. The APET application, running under the direction of Knowledge Pro software, will be entered and you will be

presented the opening menu. All subsequent sessions using the APET software may be initiated by going to the C:\GARDEN subdirectory and typing **FLY**.

2.4 Getting Started

This application uses hypertext technology. Hypertext software systems allow for the retrieval of related information at the point and click of a mouse or, if a mouse is not used, at the touch of one or two keystrokes. For information on a highlighted topic, just move the mouse to that word and click. A window will be opened, overlaying the current window. In the new window, the information will immediately be displayed. Once this support information has been reviewed, press SPACE (or ESC) once to close the window and return to your original screen. If you are not using a mouse, please use the **F3** and **F4** function keys (marked Select and View) as indicated at the bottom of the screen. (see Figure 1). The **F3** key allows you to select the different hypertext topics. Once the desired topic is selected (i.e. highlighted), the **F4** key calls the background information for view.

Multiple page displays are indicated by the **Page 1 of 2** message at the lower right of the screen. To navigate through multiple screen displays, please use the **Page Up** and **Page Down** keys to scroll either forward or backward through the pages.

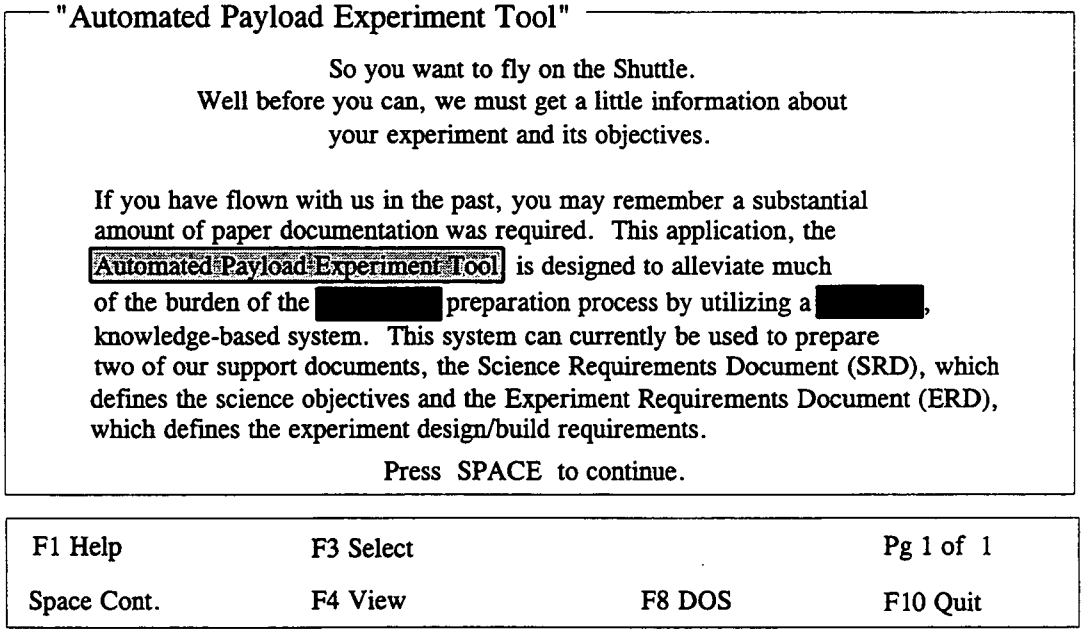

Figure 1
Sample Screen Layout Using Hypertext

For help at anytime throughout the APET application, press the F1 key. This will retrieve location sensitive help information, and may be called from the system or system-called edit screens. This will be the method by which assistance information will be retrieved throughout this application.

APET has been designed as a menu-driven software package. This means that any function required of the user can be activated via a menu option. This includes exiting the system. It is strongly recommended that the user always "back out" of the application by using the appropriate menu options, i.e. "Return to Previous Menu". An option does exist to exit from any point in the application by selecting **F10**. It is not recommended that this be used from inside a question/answer section of the application. The **F10** command causes an immediate exit from the program, without checking to ensure that open files have been properly saved. Therefore, the user may experience data loss if the application is exited in this manner.

After the installation and initial use of the APET software, future sessions will be initiated by going to the **C:\GARDEN** subdirectory and typing **FLY**. This will activate the software and present the opening menu. (see Figure 2).

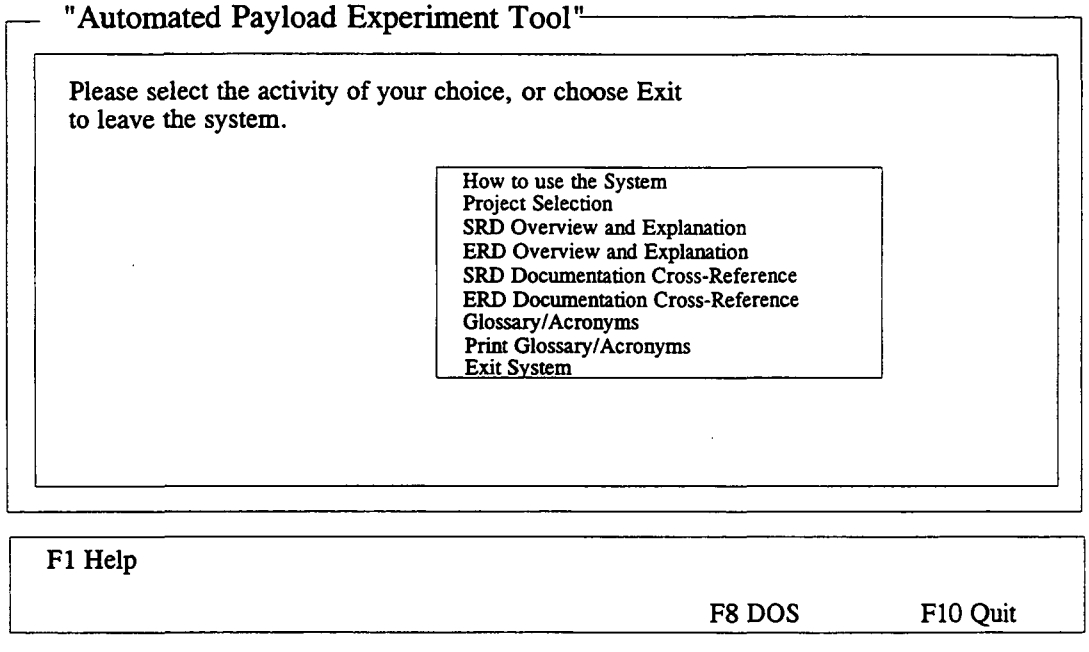

Figure 2
Opening APET Main Menu

Due to the hypertext capabilities of the APET software, a large amount of RAM (random access memory) is required. Because of the heavy RAM demand, proper execution of the software requires no other software package be running simultaneously with the APET software. Whenever the available RAM becomes too little for the application, an "Insufficient Memory" message will be shown at the bottom right of the screen. To alleviate this situation, simply get out of APET and reboot the system. This will usually free up all available RAM and ensure proper execution. (see Helpful Hints for further instruction.)

3.0 USING THE APET SYSTEM

3.1 How to Use the System

Because the use of a hypertext tool may be a new experience, a brief on-line tutorial is provided with APET. To use this tool, please choose option one on the opening menu entitled "How to Use the System". To select this option, point with the mouse to the phrase and click. If not using a mouse, use the arrow keys to highlight the option and press RETURN. You can tell when an option has been selected because it (the phrase or word) will be highlighted differently from all other options. As the mouse is moved to other options, each in turn will be highlighted.

Once the "How to Use the System" option has been selected, a different screen will be presented with a brief overview of hypertext and the methods of selecting topics. (This overview is much the same as appears in Section 2.4 of this user's guide.) Practice selecting topics and moving from one screen to another using either the mouse or the appropriate keyboard function keys.

3.2 Project Selection

The APET software package will accommodate one or more experiments for the user. However, each experiment must be identified by a short (8 characters or less) name, which must conform to the naming convention used by the DOS computer operating system. Briefly, these rules state that a DOS name cannot be over 8 characters in length, and must contain a combination of either letters, numbers, or the underscore (_) character. Any other special keys, including the SPACE, are prohibited. The rationale behind this naming convention is to allow storage of data files for each experiment in a subdirectory for that specific experiment. For example, if a user is working on two experiments, identified as THINFILM and HIPROTEN, then there would be a subdirectory for each. The configuration of these files would be as follows:

Root Directory	Application Directory	Experiment Directory
C:\	GARDEN\	THINFILM
		HIPROTEN

Therefore, all data files containing answers for the APET questions for the experiment THINFILM would appear in the subdirectory THINFILM. If additional experiments are required, the user would identify the new experiment and an additional subdirectory would be added.

Figure 3 shows the menu for selecting, adding, or deleting an experiment project. In the example, the experiment AADSF_L has been previously defined by the user. If the user wants to work on this experiment, he simply points and clicks on this selection. (This would be the case in a majority of the cases, since most Principal Investigators will have only one active experiment at any given point). However, if another experiment is required, the user

would click on "ENTER A NEW PROJECT". The user would be prompted to identify the new experiment, and would immediately be passed into the APET system, where information regarding that experiment would be addressed.

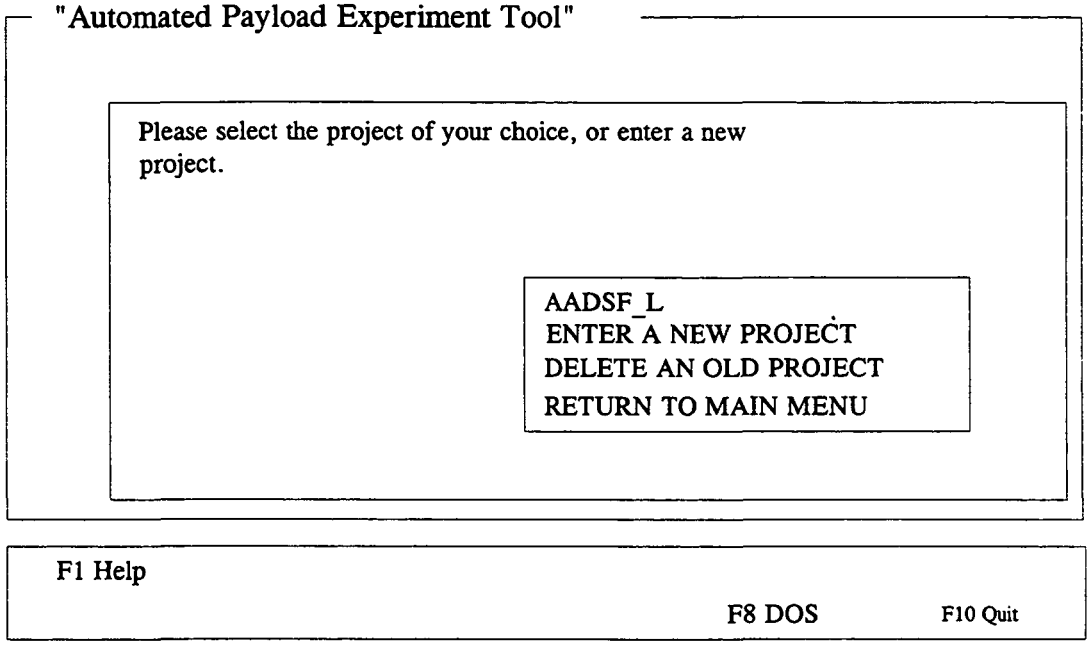

Figure 3
Project Selection/Identification Menu

If a user wishes to delete an experiment, along with all its associated data files, he may do so by selecting the "DELETE AN OLD PROJECT" option from the menu. However, there is no recoverable procedure to undelete a project. Therefore, the user is strongly advised to use this procedure with caution.

3.3 SRD Overview and Explanation

The third selection from the APET Main Menu is the "SRD Overview and Explanation". This option should be selected when the user wishes to see an overview of the SRD document, along with brief explanations of the information to be covered in each section/subsection of the document. For an additional overview of the topics to be addressed in the SRD, see Appendix A of this document.

3.4 ERD Overview and Explanation

The fourth selection from the APET Main Menu is the "ERD Overview and Explanation". This option should be selected when the user wishes to see an overview of the ERD, along with brief explanations of the information to be covered in each section/subsection of the document. For an overview of the topics to be addressed in the ERD, see Appendix B of this document.

3.5 SRD Documentation Cross-Reference

The fifth selection from the APET Main Menu is the "SRD Documentation Cross-Reference". Selection of this option allows the user to more fully understand the interrelationships between the Science Requirements Document (SRD) and the other documentation required by NASA. The SRD has sections that reference information contained in other sections of the SRD as well as other documents. Only the highlighted topics are further referenced.

3.6 ERD Documentation Cross-Reference

The sixth selection from the APET Main Menu is the "ERD Documentation Cross-Reference". Selection of this option allows the user to more fully understand the interrelationships between the Experiment Requirements Document (ERD) and the other documentation required by NASA. The ERD has sections that reference information contained in other sections of the ERD as well as other documents. Only the highlighted topics are further referenced.

3.7 Glossary/Acronyms

A number of NASA specific terms, definitions, and acronyms will appear as support material throughout the documentation process. One of the primary advantages of using a hypertext-based tool is to allow for easy and immediate retrieval of these terms.

Option number seven from the APET Main Menu allows the user to retrieve a listing of these terms, and presents them in a form analogous to a glossary in a book. To view a definition, highlight the desired term and click. A term can be highlighted by using the mouse to move the cursor to that word, or by using the **F3** key for selection. To view the definition, the user should either click the mouse or press the **F4** key. The definition of that word/term will be presented. Should the definition contain a term that requires further description, highlight that word and click. The new definition will overlay the previous definition. This method can be repeated as long as further definitions exist and the memory capacity of the machine is not exceeded.

Please note that the glossary consists of multiple pages. Remember to navigate through the multi-page displays by using either the **Page Up/Page Down** function keys.

3.8 Print Glossary/Acronyms

Option number eight from the APET Main Menu activates a routine for the printing of the glossary/acronym list, as discussed in Section 3.7. Because the output of this selection will be a multi-page document, the use of this option will be rare.

3.9 Filling Out the SRD

To fill out the SRD, the user must first select "Project Selection" from the APET Main Menu. Then the Project Selection/Identification Menu (Figure 3) will be presented for the user to identify either a new project or select an existing project. Once the selection/identification has been made, the SRD/ERD Activity Menu (Figure 4) will be presented. Please note that the selected project is shown on the upper right corner of the screen. Please be sure that the project shown is the one you wish to work.

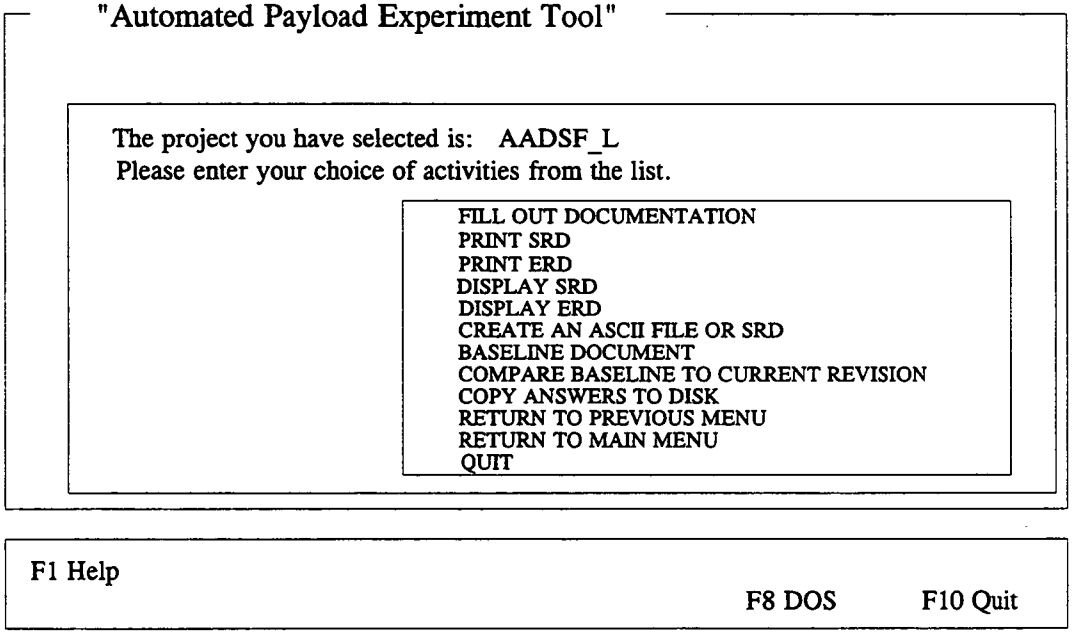

Figure 4
SRD/ERD Activity Menu

The SRD/ERD Activity Menu presents eleven options for the user. The most significant of these is the first: "FILL OUT DOCUMENTATION". The selection of this option will present the Fill Out SRD/ERD Documentation Menu (Figure 5). This menu offers the user three options: "ENTER PROJECT INITIALIZATION INFORMATION", "COMPLETE SCIENCE REQUIREMENTS DOCUMENT (SRD)", and "COMPLETE EXPERIMENT REQUIREMENTS DOCUMENT (ERD)".

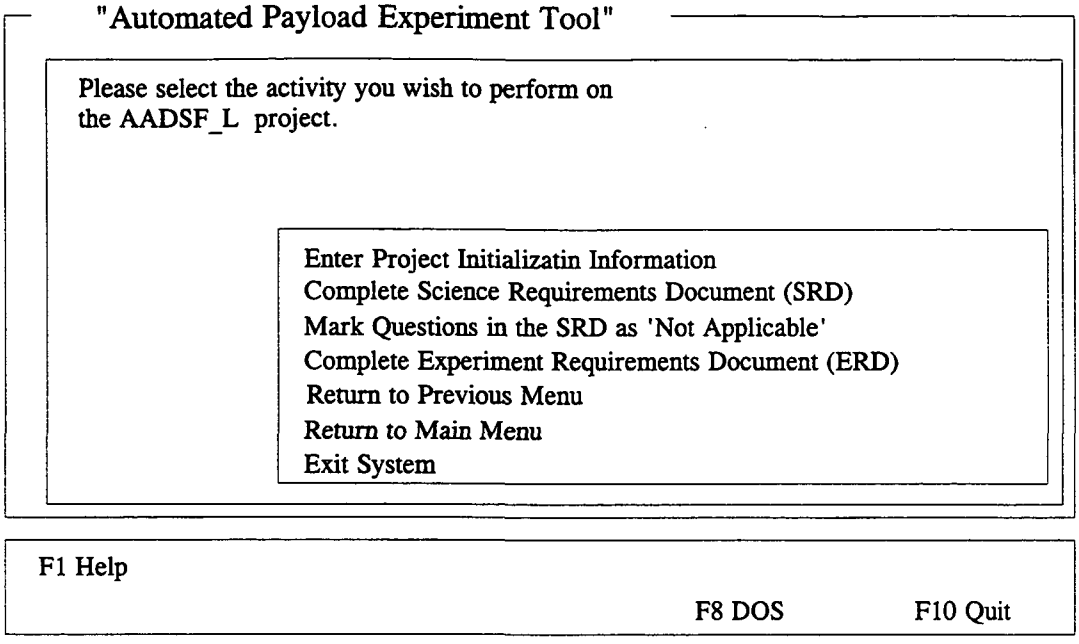

Figure 5
Fill Out SRD/ERD Documentation Menu

3.10 Entering Project Initialization Information

Under most circumstances, the first information entered by the user into the APET system is the project initialization information. To enter this information, select option one from the Fill Out SRD/ERD Documentation Menu. This information is used to identify certain aspects of the experiment, and will be used throughout the documentation process. Entries include the PI name, organization, address, city, state, zip, phone, and experiment title. This information will be provided in the form of type written responses to user prompts. For example, the user will be asked:

Please enter your first and last names, i.e. Dr. John Doe.

The user should respond with a one line response. (If there is a limitation on the length of this one line response, the screen display will provide an instruction, such as "Please limit your response to 16 characters.") This will be the format of user entries throughout the APET application. When the user is prompted to make an entry, the response should be on one line. When the user responds with a RETURN, the answer is stored and the next question, if one exists, is asked. Once all questions for that segment have been answered, the answers are written to a data file.

In the "Project Initialization Information" subsection, the only variation in the user prompt/one line response routine is with the experiment title. Because experiment titles can be several lines, the user is given a prompt and immediately sent to the APET editor. This

editor is a small version of a word processor, with many of the functions of a common word processing package. The commands used in the APET editor are similar to those in the software package WORDSTAR. To see the commands available, press the F1 function key from inside the editor. A separate window will be opened and will overlay the current screen. From there, page down until the function you wish to perform is shown. The one-to-two keystroke command to accomplish the task will be shown. (Note: The symbol (^) represents the CONTROL key., i.e. ^KQ means to hold the CONTROL key down while pressing the letter K, then press the letter Q.) When the user is finished entering the answer into the editor, he may exit by pressing the ESC (escape) key. A message will then appear on the screen that tells the user what file name is being saved. Respond with a RETURN to accept this name and save the answer, or an ESC to cancel the answer.

Important: Do not change the file name when the APET software asks if the name is acceptable. Future sessions that allow the user to change, delete, print, or display the SRD answers require that these file names be used. Changing the file name will make the file either inaccessible or inappropriate. Therefore, always accept the file name as given.

3.11 Complete Science Requirements Document

To complete the Science Requirements Document, there are usually between 50 - 60 questions that must be answered. These answers will be in the form of short narratives, consisting of one or more paragraphs of text. Each question or user prompt will invoke the APET editor and give the user sufficient space to write as much (or little) as required. (For an outline of the topics to be addressed, see Appendix A.) A sample question from the SRD is shown in Figure 6.

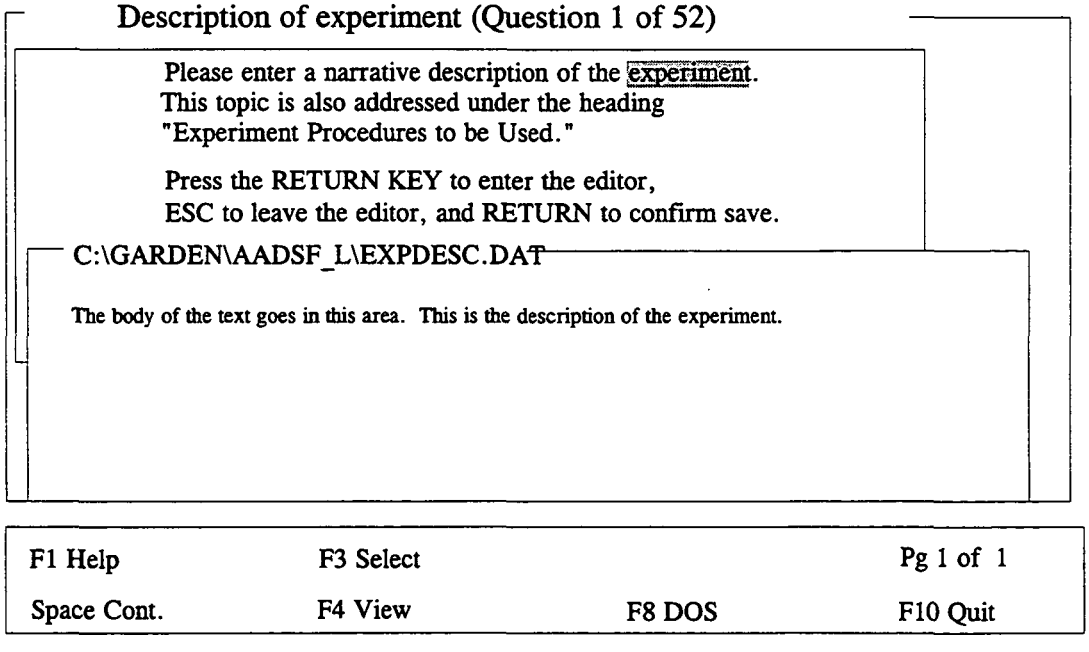

Figure 6
Sample SRD Question Screen

The Complete SRD session begins by asking the user if he has begun to fill out the SRD previously. A 'NO' response causes the questions to be asked in sequence. A 'YES' response results in the question topics to be displayed in a list. If questions are to be answered from a list, a list will appear as a window that overlays the question screen. The user is expected to point-and-click on the appropriate topic. (If not using a mouse, use the arrow keys to select and press RETURN.) The user should click on the appropriate answer with the left-side mouse button.

For the initial SRD session, the user would respond with a NO and proceed to the questions. These questions will be asked in the same sequence as is shown in the outline. After each response, the user will be asked if he wants to continue to the next question. This gives the user a chance to end the session when desired, rather than advancing through all the remaining questions. The title of each question screen will include the number of the question (i.e., Number 1 of 52). This allows the user to see where he is in the process and act accordingly.

If the user responds with a 'YES', which means there has been a previous session, the following question will appear:

Do you wish to change only one item, resume at a point
and continue sequentially through the remainder of the
SRD, or complete all topics previously unanswered?

This allows the user one of three options. 1) He may select the one answer that needs changing, go directly to that answer and change it, then record that answer to disk. 2) He can select the topic where he would like to resume his activities, answer that question, record the answer, and go to the next question in sequence. This gives the user the capability of selecting the 20th question, and proceed sequentially through the remaining 32 questions. 3) The user can complete all questions that have not yet been answered. This option will invoke a command to look at what answers (files) do not exist, and build a list of these topics. The user then selects the topic to answer, answers the question, records the answer, and goes to the next question of his choice. With each recorded answer, that topic is removed from the list.

3.12 Mark Questions in the SRD as 'Not Applicable'

The SRD questions used in APET are taken directly from the Microgravity Science and Applications Division (MSAD) Management Plan. However, the PI and his NASA project manager may determine that some of these questions do not pertain or are not necessary for the completion of the SRD. In order to simplify the SRD preparation process, the ability to mark multiple questions as 'Not Applicable' has been provided. This option would probably be chosen as one of the first actions taken in preparing the SRD.

Upon selecting this option from the menu, the user will be requested to choose the topics to mark as "Not Applicable" by one of the below two methods. This choice depends on whether a mouse is being used. For mouse users, topics will be selected by clicking the RIGHT side mouse button on each topic to be marked. When the list is complete, click the LEFT side mouse button. To navigate through the multiple page listing, click on the **Page 1 of 4** message at the bottom of the list.

Non-mouse users are instructed to use the arrow keys to move to the topic to be selected, then use the INSERT key to select it. To move from one page to another, use the **Page Up/Page Down** keys. When the list is complete, press the RETURN key.

All topics selected will be given the answer 'Not Applicable'. However, any questions that have been previously answered will not be changed, and a warning message to that effect will appear on the screen. This safeguards against the user accidentally destroying a valid answer by choosing this option. If an answer is required to be changed to 'Not Applicable', then the user must select the topic from the 'Change One Item' option (see Section 3.11).

3.13 Printing the SRD

The user has three methods available to generate output from the APET software. These include printing the document, displaying the document, and creating an ASCII file of the document. The APET application was designed to be flexible enough to go to a variety of printers. As with most output, the best results will be with the use of a laser printer. If a laser printer is not available, the use of a dot-matrix printer will also be acceptable. A variety, although not nearly exhaustive, of dot-matrix printers have been tested with the APET software, and all have performed well.

If the document has previously been baselined (discussed later in Section 3.21), then a menu will appear giving the user the option of printing the document from the baselined version, the current revision, or neither version. If the neither option is chosen, then it is assumed that the user does not want the document printed, and the program will automatically return to the previous menu. If the baseline option is chosen, then the document will be printed from the file which is in the project baseline subdirectory. If the current revision option is chosen, then the document will be printed from the version of the document which the user is currently revising. If the document has not been baselined, then the document will be printed from the current version.

The printing of the SRD will generate the document in its entirety. An initial page eject will normally (depending on printer type) advance a blank sheet of paper before the cover sheet is printed. This will be followed by a second page advance, then page one of the document will be printed, followed by two, three, etc. through the end of the document. Because there are often graphics, tables, etc. that must be inserted within the textual document, no table of contents is printed. Because of the limitation of graphics support, it is suggested that all externally generated graphic illustrations, tables, etc. be provided in an appendix, with appropriate references throughout the document.

While the print procedure is active, a message will appear in the lower left of the screen. No other activities may take place while the document is printing. In case the printer runs out of paper, an error message will appear. Reload paper in the printer and press the SPACE key to continue.

3.14 Displaying the SRD

The second method of generating output using APET is to display sections of the SRD to the screen. The SRD is divided into seven major sections, with each divided into one or more subsections (see Appendix A). The user has the capability of selecting a section and seeing the identical output as would appear if the document was printed. Displaying the SRD is recommended to quickly review answers, especially during the development phase of document preparation.

If the document has previously been baselined (discussed later in Section 3.21), then a menu will appear giving the user the option of displaying the document from the baselined version, the current revision, or neither version. If the neither option is chosen, then it is assumed that the user does not want the document displayed, and the program will automatically return to the previous menu. If the baseline option is chosen, then the document will be displayed from the file which is in the project baseline subdirectory. If the current revision option is chosen, then the document will be displayed from the version of the document which the user is currently revising. If the document has not been baselined, then the document will be displayed from the current version.

Most SRD sections will require multiple page displays. Please note that to view the equivalent of an entire printed page, there will be at least three and usually four screen displays. Use the Page Up/Page Down method to move up or down in the document. Once a page is adequately reviewed, press the SPACE key to retrieve the next page in sequence. To abandon a display at any time, press the F10 key.

3.15 Create an ASCII File of SRD

The APET software does not have the ability to generate or insert graphics, charts, etc. that were created in some other application. This is primarily due to the memory size limitations of the computer. However, to alleviate this limitation, APET does have the ability to generate an ASCII file of its **SRD** output. After choosing this option, the user need only type in the full file name (includes drive, file name, and extension). The file will then be created as a replica of the printed output.

The benefit of creating an ASCII text file of the SRD is in providing the user with the capability of enhancing the final printing by inserting graphics, photos, tables, equations, or other difficult to create figures. In addition, different fonts, font sizes, and special effects can be used to dress up the final printed output.

3.16 Filling Out the ERD

To fill out the ERD, the user must first select "Project Selection" from the APET Main Menu. Upon this action, the Project Selection/Identification Menu (Figure 3) will be presented for the user to identify either a new project or select an existing project. Once the selection/identification has been made, the SRD/ERD Activity Menu (Figure 4) will be presented. Please note that the selected project is shown on the upper right corner of the screen. Please be sure that the project shown is the one you wish to work.

The SRD/ERD Activity Menu presents eleven options for the user. The most significant of these is the first: "FILL OUT DOCUMENTATION". The selection of this option will present the Fill Out SRD/ERD Documentation Menu (Figure 5). This menu offers the user three options: "ENTER PROJECT INITIALIZATION INFORMATION", "COMPLETE SCIENCE REQUIREMENTS DOCUMENT (SRD)" and "COMPLETE EXPERIMENT REQUIREMENTS DOCUMENT (ERD)". Select "COMPLETE EXPERIMENT REQUIREMENTS DOCUMENT (ERD)" if the project initialization information has already been entered. If this information has not already been entered, select it before generating the ERD.

3.17 Complete Experiment Requirements Document

To complete the Experiment Requirements Document, the user must answer a series of questions about the experiment. The questions are grouped into topics, a list of which is presented to the user. The user is asked to select the topic which is to be displayed. The chosen topic will be displayed along with the subtopics covered within that section. The user is prompted as to whether or not he wishes to begin or continue filling out the questions in that section. (For an outline of the topics to be addressed, see Appendix B.) If the user chooses to fill out the section, he will be prompted to select one of the subheadings. Upon subheading selection, a brief description of the topic will be given, along with any necessary instructions for answering the question.

If the question invokes the editor, the answers should be given in the form of short narratives, consisting of one or more paragraphs of text. Sufficient space will be given to write as much (or little) as required. If an answer requires a numeric response, enter the number just as you wish it to appear. A sample of this procedure is shown in Figures 7 through 11.

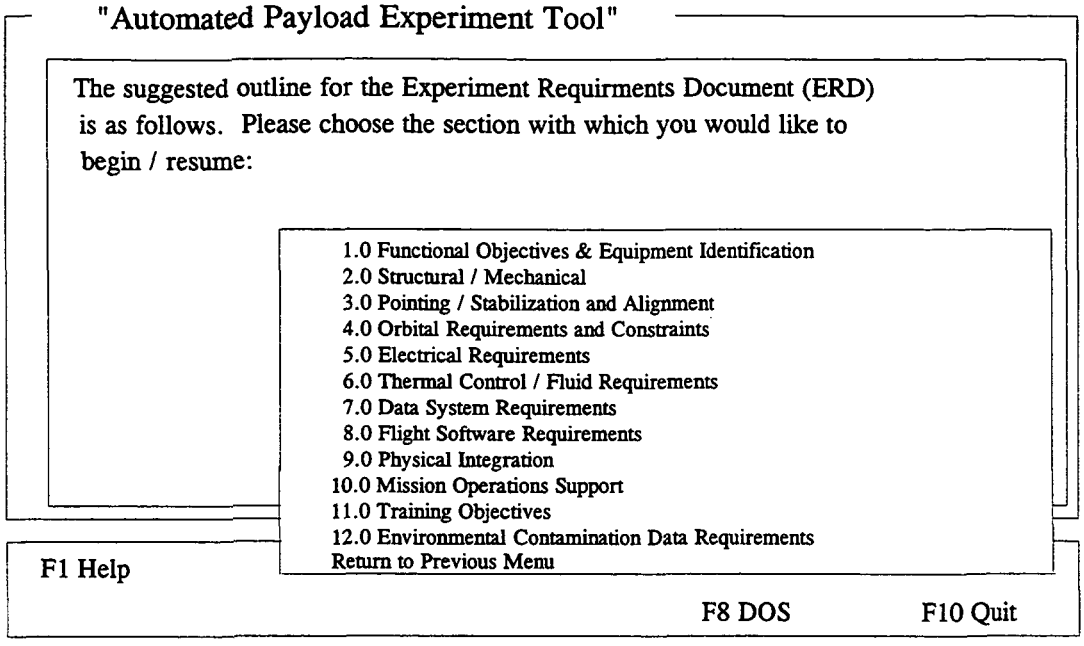

Figure 7
ERD List of Sections

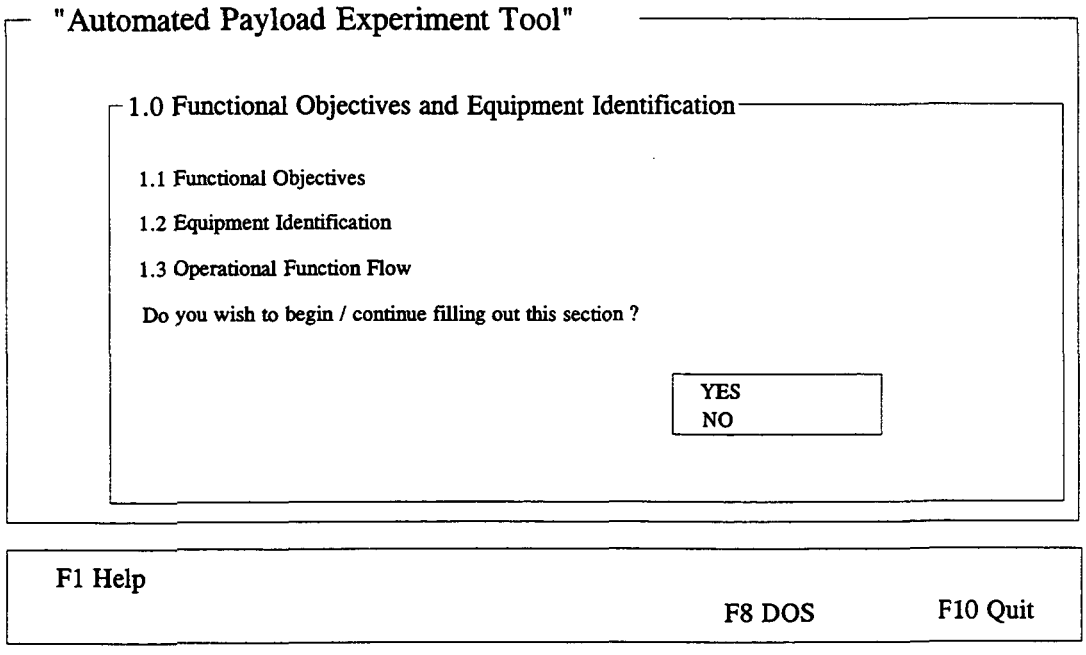

Figure 8
ERD Section Selection

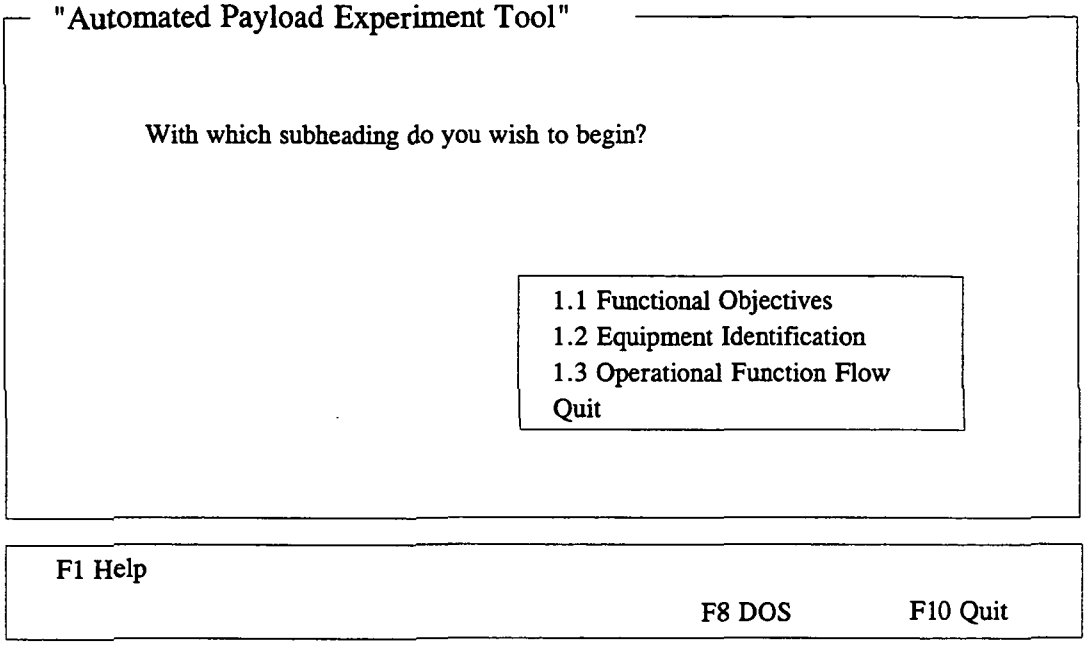

Figure 9
ERD Subtopic Selection

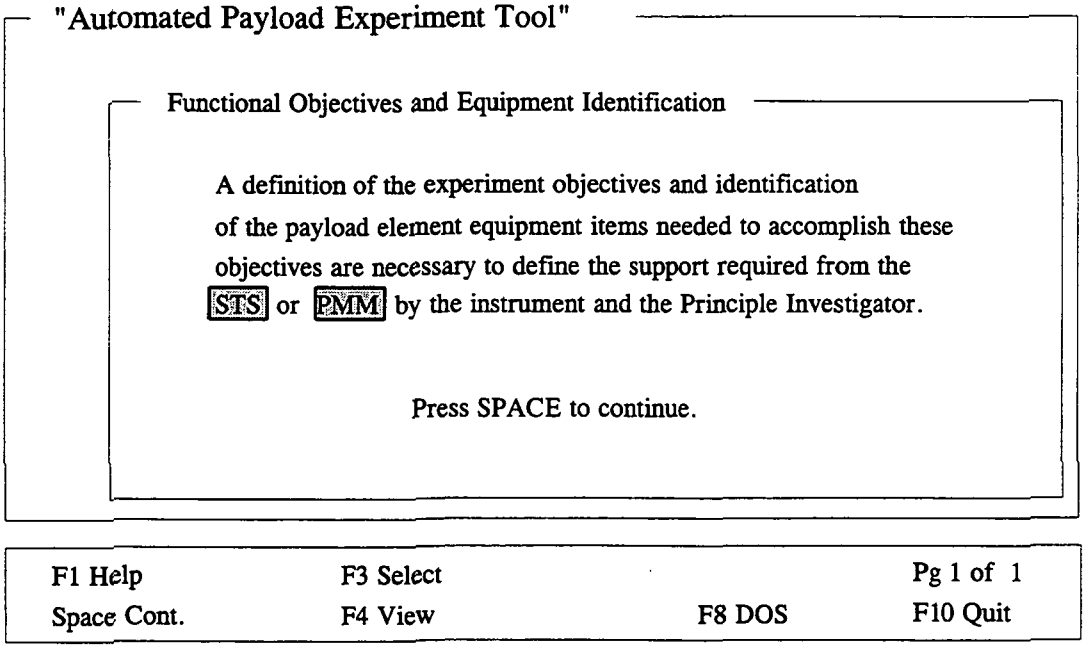

Figure 10
ERD Topic Narrative

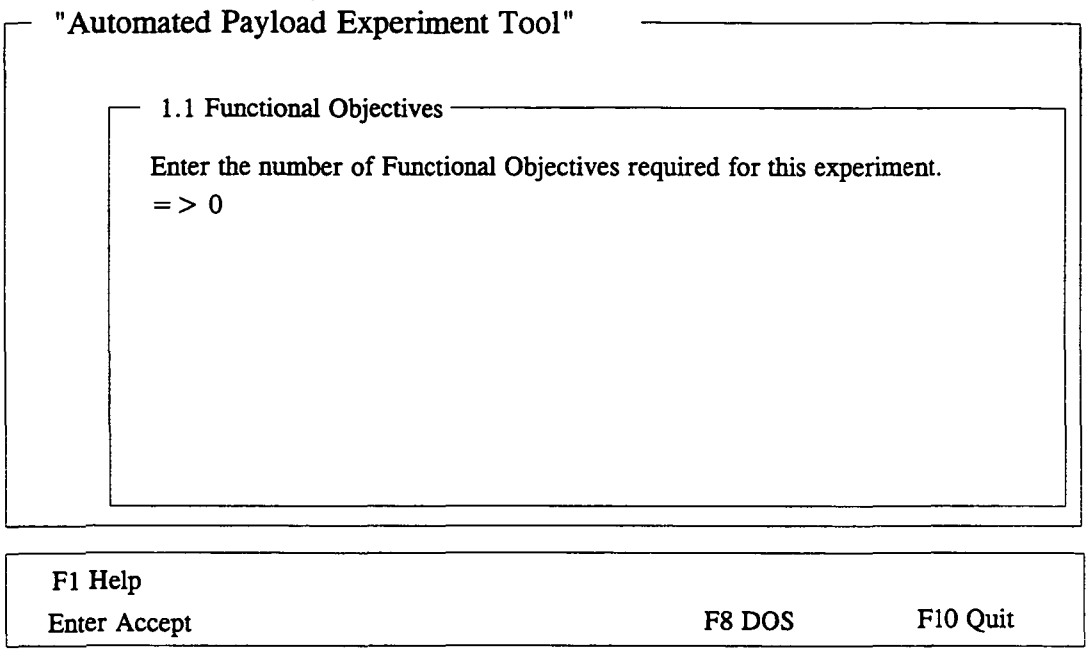

Figure 11
Sample ERD Question

Upon selection of a topic, if the questions within that chosen topic have already been answered, the user will be prompted with a message saying that the section has already been completed. The user then has the options of ADDING, EDITING, or DELETING answers, or RETURNING to the previous menu. The user should select an option and follow the instructions accordingly. If the chosen topic does not have any related subtopics, and the user wishes to complete that section, the program will give instructions for answering that question, and the APET editor will be invoked as needed.

Some of the topics have accompanying illustration(s) in order to give the user a better understanding of what information is needed. If you wish to view the illustration, simply click on, or select, the appropriate phrase. This will cause the screen to momentarily go blank, and the illustration will then be presented. After you have viewed the illustration, simply press SPACE and the program will return you to your original screen.

3.18 Determine Current ERD Required Sections

The APET software package has been included with a feature to allow the user to determine which ERD sections, tables, or figures are required based on the answers supplied at the time this option is selected. This allows the user to determine at any given time which requirements of the ERD have not yet been satisfied. APET does this by looking at selected answers already input by the user, and determining if these answers logically imply that an additional section is required. For example, if the user has identified that crew involvement is required, then the user will be asked if this crew requires training to conduct the experiment. If training is required, and that section has not been addressed, then 'Section 11.0 Training Objectives' is added to the requirements list.

This feature of APET also generates a listing of those figures that are required to be prepared off-line. These requirements are also based on answers input in previous sessions. Since there is no method of logically checking to see if the user has met these requirements, the off-line documents referenced may or may not have been completed by the user.

It is important to note that this option will provide dynamic results. If answers have been added or changed since the last session, then the user may see a different list if it can be logically determined that additional sections are now required. This provides the user with a valuable tool in meeting the ERD requirements.

3.19 Printing the ERD

The user has two methods available to generate output from the APET software in regard to the ERD. These include printing the document, and displaying the document. The APET application was designed to be flexible enough to go to a variety of printers. As with most output, the best results will be with the use of a laser printer. If a laser printer is not available, the use of a dot-matrix printer will also be acceptable. A variety, although not nearly exhaustive, of dot-matrix printers have been tested with the APET software, and all have performed well.

If the document has previously been baselined (discussed later in Section 3.21), then a menu will appear giving the user the option of printing the document from the baselined version, the current revision, or neither version. If the neither option is chosen, then it is assumed that the user does not want the document printed, and the program will automatically return to the previous menu. If the baseline option is chosen, then the document will be printed from the file which is in the project baseline subdirectory. If the current revision option is chosen, then the document will be printed from the version of the document which the user is currently revising. If the document has not been baselined, then the document will be printed from the current version.

The printing of the ERD must be accomplished by printing either selected sections or tables of the document. An initial page eject will normally (depending on printer type) advance a blank sheet of paper before the first sheet is printed. This will be followed by a second page advance, then page one of the document will be printed, followed by two, three, etc. through the end of the section.

When a table/chart is created it is listed as a separate item, to print one, simply select the name of the table/chart and it will be printed. Because there are often graphics, and more complicated tables, etc. that must be inserted within the textual document, no table of contents is printed. Because of the limitation of graphics support, it is suggested that all externally generated graphic illustrations, tables, etc. be provided in an appendix, with appropriate references throughout the document.

While the print procedure is active, a message will appear in the lower left of the screen. No other activities may take place while the document is printing. In case the printer runs out of paper, an error message will appear. Reload paper in the printer and press the SPACE key to continue.

3.20 Displaying the ERD

The second method of generating ERD output using APET is to display sections of the ERD to the screen. The ERD is divided into twelve major sections, some of which may be divided into more subsections (see Appendix B). The user has the capability of selecting a section and seeing the identical output as would appear if the document was printed. Displaying the ERD is recommended to quickly review answers, especially during the development phase of document preparation.

If the document has previously been baselined (discussed later in Section 3.21), then a menu will appear giving the user the option of displaying the document from the baselined version, the current revision, or neither version. If the neither option is chosen, then it is assumed that the user does not want the document displayed, and the program will automatically return to the previous menu. If the baseline option is chosen, then the document will be displayed from the file which is in the project baseline subdirectory. If the current revision option is chosen, then the document will be displayed from the version of the document which the user is currently revising. If the document has not been baselined, then the document will be displayed from the current version.

Most ERD sections will require multiple page displays. Please note that to view the equivalent of an entire printed page, there will be at least three and usually four screen displays. Use the point-and-click (or Page Up/Page Down) method to move up or down in the document. Once a page is adequately reviewed, press the SPACE key to retrieve the next page in sequence. Displays will continue until all output has been presented.

3.21 Baselining a Document

At some point in the documentation procedure, the SRD/ERD will be considered complete and released to external offices, agencies, organizations, etc. When this occurs, that version of the document is considered the baseline, and should be easily identified as such.

To aid in the process of maintaining separate versions of the SRD and ERD, an option exists to baseline the current version of the document. (see Figure 12) The selection of this option will cause a replica of the current version's answers (or data files) to be copied to a new subdirectory for that experiment. This new subdirectory will be called **BASELINE**. From that point, all additional editing will transpire on a new version of the answers, while the baselined version of the answers will remain intact. The generation of output will require the user to identify which version (baseline or current revision) he wishes to access.

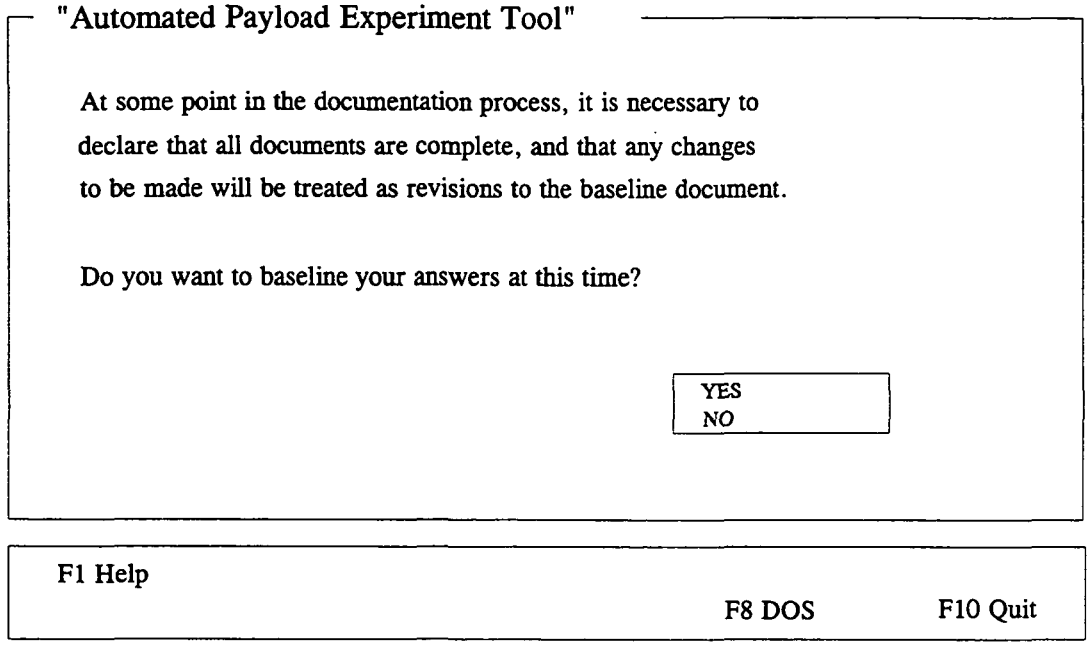

Figure 12
Baseline Menu

3.22 Comparing a Baseline to the Current Revision

Once the document has been baselined (see Section 3.21), the user may wish to compare this baseline with the current revision. APET provides a mechanism to accomplish this task. By selecting the option "Compare Baseline to Current Revision", a DOS routine will be invoked to compare all identical data files from the current revision to the baseline document. This comparison generates a file that can then be displayed or printed, so that a quick review will show which answers have been modified since the original baseline date.

3.23 Copying Answers to Disk

The final output option provided by APET is the creation of files that contain all data generated by the software. This can be used as either a backup mechanism during the creation of the files, or as a means of submission of the final document instead of a hard copy/printed document. By submitting the answers on diskette, the receiving party can have direct access to the answers in the same manner as would the sender. These files are not formatted as an ASCII file, and should not be confused with the final report output, which can be created using the "Create an ASCII File of SRD" (discussed in Section 3.15).

The user will have the option of selecting either the baseline document or the current revision. After this selection, the user is asked to select the drive to receive the backup (either A:,B:,C:, or D:). A DOS copy command will then be invoked to copy all files to the selected drive.

4.0 HELPFUL HINTS

1) Avoid the use of the F10 key to exit from within the APET application. It is a better practice to "back out" of the APET system through the use of the menus. By doing so, the user ensures that all answers are properly recorded to the disk drive. Use of the F10 key from within the APET application will allow the user to exit but will not automatically save information generated during the session.

2) APET does not support the insertion of externally generated graphics, tables, equations, or other non-text material. To alleviate this problem without the added labor of using a secondary word processor, it is suggested that any such material be included in an Appendix, and referenced in the text generated in APET.

3) To insert an externally generated text file into the text area in the APET editor, use the command ^KR from within the editor. This is one of a variety of commands that can be used from the APET word processor. To see all available commands, press the F1 key from inside the editor and page through the instruction set.

4) The APET editor uses a word wrap routine that automatically wraps the line to the next line (a common word processing feature). It also maintains vertical alignment along the left margin. If you use indented paragraphs, please be sure that the line after the indented line begins in the column you desire. To do this, use the backspace key to move the first word in the line to the column desired. The recommended solution to this problem is not to indent paragraphs, but instead insert a blank line between each paragraph.

5) If your computer system is configured to automatically load WINDOWS or some other application package, it may be necessary to alter the AUTOEXEC.BAT file (located in the boot drive). Instructions for changing the automatic load of an application will vary by computer. One of the easier methods is to edit the AUTOEXEC.BAT file and remove the line that calls the package. For example, WINDOWS is called by the command WIN. By preventing these packages from loading, a significant amount of RAM is freed and allowed for use by APET.

APPENDIX A

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- 1.2 Scientific Knowledge to be Gained
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APPENDIX C

APET Editor Commands

MOVING THE CURSOR:

^D	Left One Character
^S	Right One Character
^A	Left One Word
^F	Right One Word
^I	Tab
^E	Up One Line
^X	Down One Line
^W	Scroll Up
^Z	Scroll Down
^R	Page Up
^C	Page Down
^QS	Beginning of a Line
^QD	End of a Line
^QE	Beginning of a Page
^QX	End of a Page
^QR	Beginning of a File
^QC	End of the File
^QB	Beginning of Marked Block
^QK	End of Marked Block

DELETING AND INSERTING TEXT:

^G	Delete Character Under Cursor
^H	Delete Character Left of Cursor
^T	Delete Next Word
^Y	Delete a Line
^QY	Delete to the End of a Line
^KY	Delete a Marked Block
^V	Insert On/Off
^N	Insert a Line

BLOCK COMMANDS:

^KS	Save This File
^KB	Mark Beginning of Block
^KK	Mark End of Block
^KH	Hide / Display Block
^KC	Copy a Block
^KV	Move a Block
^KY	Delete a Block
^KR	Read a Block from a File
^KW	Write a Block to a File
^KP	Print a Block or File

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FORMATTING COMMANDS:

^B	Reformat Paragraph
^OR	Set Right Margin
^QI	Toggle Auto indent Mode
^QW	Toggle Word Wrap

FIND AND REPLACE COMMANDS:

^QA	Find and Replace a String
^QF	Find an Occurrence of a String
^L	Find the Next Occurrence

For assistance in using this software,
or to offer suggestions or comments,
please contact the following:

Mr. Gary Maddux
Ms. Anna Provancha
Mr. David Chattam

at (205) 895-6343,
or write

Systems Management and Production Laboratory
Research Institute
RI E-47
The University of Alabama in Huntsville
Huntsville, AL 35899

APPENDIX B

Project Plan User Guide

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Automated Payload Experiment Tool

User Manual

Project Plan

Prepared by:

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Prepared for:

National Aeronautics and Space Administration
Microgravity Science and Applications Division
Marshall Space Flight Center, AL 35812

November, 1992

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1.0 INTRODUCTION

So you want to fly an experiment on the Shuttle.

Well, to begin the process, we must get a little information about your experiment and its requirements.

If you have flown with us in the past, you may remember a substantial amount of paper documentation was required. This application, the Automated Payload Experiment Tool, is designed to alleviate much of the burden of the document preparation and maintenance process. This system can currently be used to prepare three support documents: the Science Requirements Document (SRD), which defines the science objectives, the Experiment Requirements Document (ERD), which defines the experiment design/build requirements and the Project Plan. The version that you have is for the creation of the Project Plan only.

2.0 DISCUSSION

2.1 Background

The Microgravity Experiment Projects (MEP) Office of the Payload Projects Office (PPO) at the Marshall Space Flight Center (MSFC) is currently responsible for collecting and coordinating experiment/facility specifications and requirements between NASA and various colleges, universities, research centers, and other public- and private-sector organizations that are selected or are requesting to fly their respective microgravity experiments on designated flights. This coordination involves the communication of flight hardware requirements and the preparation and review of all documentation between NASA and the research groups. To reduce difficulties encountered by these customers of NASA, an effort was undertaken to research, analyze, and evaluate the current procedures involved in the information gathering activities.

The MEP Office identified a need to develop an Automated Payload Experiment Tool (APET) which would lead experiment developers through the development planning process, obtain necessary information, establish an electronic data exchange avenue and allow easy manipulation/reformatting of the collected information. In order to fulfill this need, the University of Alabama in Huntsville (UAH) was tasked to design and develop the APET software package to meet the increasing demands to lighten the burden of documentation preparation and maintenance for NASA and its customers.

2.2 System Requirements

The objective of APET is to provide an easy to use tool to the Principal Investigator (PI) team. To ensure ease of use, few computer hardware requirements are necessary to operate the APET software package.

APET is designed to run on any IBM-PC compatible personal computer. It is recommended that the APET user install the software on a 286 PC or higher. The multiple screen windows, and the complexity of the system cause noticeable slowdowns on any machine less than the 286.

The software requires that the PC be equipped with a hard disk drive. For proper execution, the hard drive (or some partition of it) must be named C:. The Project Plan version of APET will require approximately 2M (megabytes) of space on the hard drive for the system, plus another 1M on the hard drive for the data files created by the user. However, for optimal performance, the hard drive should have a total of at least 4M free upon installation of the software.

For ease of use, the PC should be equipped with a mouse. This, however, is not mandatory. APET utilizes the hypertext technology, which offers a point-and-click user interface. Instead of a mouse, the user does have the option of pressing selected function keys to achieve the same effect.

2.3 Installation

The APET software package is provided on one 3 1/2" high density diskette. The files stored on this diskette have been compressed; therefore, it is required that the user follow several simple steps to ensure correct installation.

1) Insert the 3 1/2 " diskette in the drive designated as A:. If the A: drive on your system is not the correct size, then use the DOS ASSIGN command to redesignate the drives appropriately. (For example, if you have 3 1/2" disks but your 3 1/2" drive is B:, then at the DOS prompt type **ASSIGN A: B:**.)

2) From this drive (A:) type:

PINSTALL.

This will activate the installation routine. A series of instructions and informational text will be presented. Each screen will advise what is transpiring in the installation procedure. The installation routine will create a subdirectory on the C: drive called GARDEN. Once created, the files contained on the installation disks will be copied to the directory **C:\GARDEN**. Most of these files have been compressed to conserve disk space. An uncompress routine will be invoked to return these files to their normal (and usable) condition. To cancel the installation at any time, press the CTRL (control) C keys.

3) Upon successful installation of the APET program files, the message **INSTALLATION ROUTINE COMPLETE** will be displayed. The APET application, running under the direction of Knowledge Pro software, will be entered and you will be presented the opening menu. All subsequent sessions using the APET software may be initiated by going to the C:\GARDEN subdirectory and typing **PLAN**.

2.4 Getting Started

This application uses hypertext technology. Hypertext software systems allow for the retrieval of related information at the point and click of a mouse or, if a mouse is not used, at the touch of one or two keystrokes. For information on a highlighted topic, just move the mouse to that word and click. A window will be opened, overlaying the current window. In the new window, the information will immediately be displayed. Once this support information has been reviewed, press SPACE (or ESC) once to close the window and return to your original screen. If you are not using a mouse, please use the **F3** and **F4** function keys (marked Select and View) as indicated at the bottom of the screen. (see Figure 1). The **F3** key allows you to select the different hypertext topics. Once the desired topic is selected (i.e. highlighted), the **F4** key calls the background information for view.

Multiple page displays are indicated by the **Pg 1 of 2** message at the lower right of the screen. To navigate through multiple screen displays, please use the **Page Up** and **Page Down** keys to scroll either forward or backward through the pages.

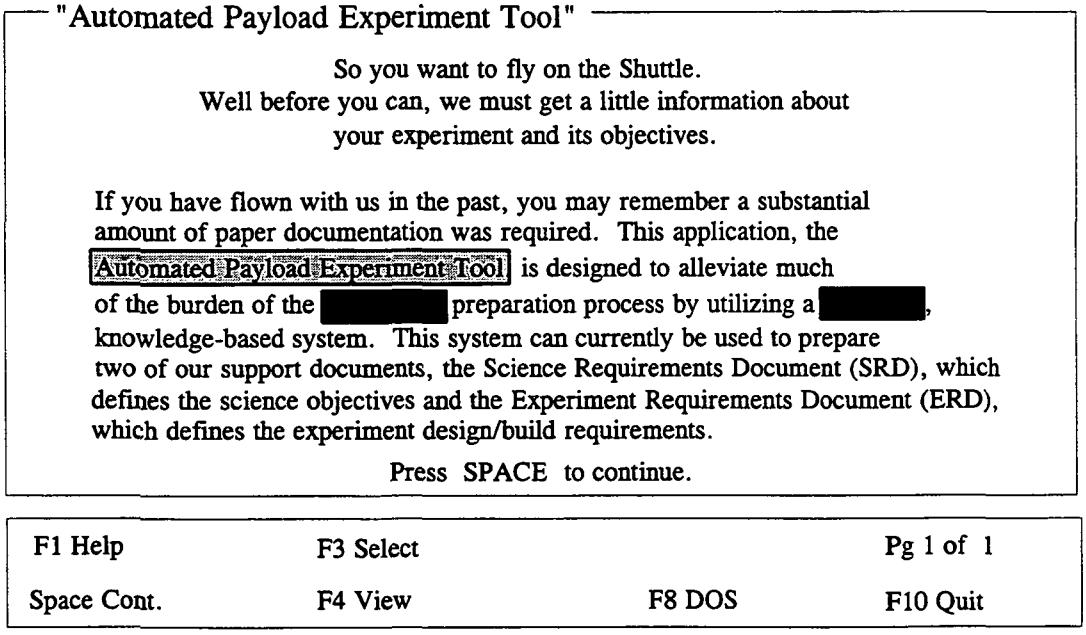

Figure 1
Sample Screen Layout Using Hypertext

For help at anytime throughout the APET application, press the **F1** key. This will retrieve location sensitive help information, and may be called from the system or system-called edit screens. This will be the method by which assistance information will be retrieved throughout this application.

APET has been designed as a menu-driven software package. This means that any function required of the user can be activated via a menu option. This includes exiting the system. It is strongly recommended that the user always "back out" of the application by using the appropriate menu options, i.e. "Return to Previous Menu". An option does exist to exit from any point in the application by selecting **F10**. It is not recommended that this be used from inside a question/answer section of the application. The **F10** command causes an immediate exit from the program, without checking to ensure that open files have been properly saved. Therefore, the user may experience data loss if the application is exited in this manner.

After the installation and initial use of the APET software, future sessions will be initiated by going to the **C:\GARDEN** subdirectory and typing **PLAN**. This will activate the software and present the opening menu. (see Figure 2).

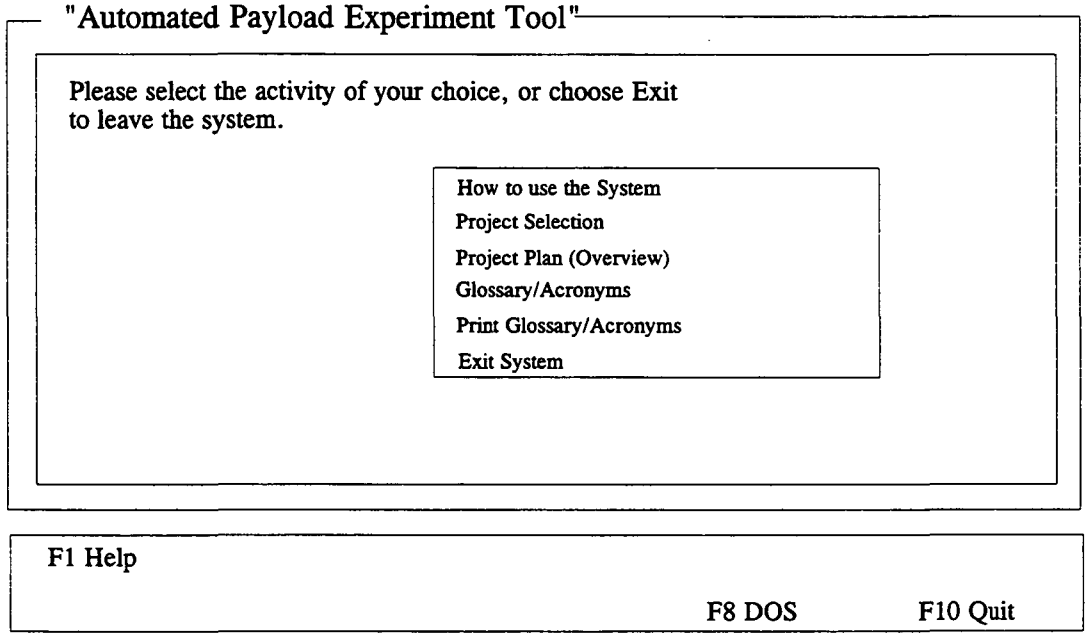

Figure 2
Opening APET Main Menu

Due to the hypertext capabilities of the APET software, a large amount of RAM (random access memory) is required. Because of the heavy RAM demand, proper execution of the software requires no other software package be running simultaneously with the APET software. Whenever the available RAM becomes too little for the application, an "Insufficient Memory" message will be shown at the bottom right of the screen. To alleviate this situation, simply get out of APET and reboot the system. This will usually free up all available RAM and ensure proper execution. (see Helpful Hints for further instruction.)

3.0 USING THE APET SYSTEM

3.1 How to Use the System

Because the use of a hypertext tool may be a new experience, a brief on-line tutorial is provided with APET. To use this tool, please choose option one on the opening menu entitled "How to Use the System". To select this option, point with the mouse to the phrase and click. If not using a mouse, use the arrow keys to highlight the option and press RETURN. You can tell when an option has been selected because it (the phrase or word) will be highlighted differently from all other options. As the mouse is moved to other options, each in turn will be highlighted.

Once the "How to Use the System" option has been selected, a different screen will be presented with a brief overview of hypertext and the methods of selecting topics. (This overview is much the same as appears in Section 2.4 of this users guide.) Practice selecting topics and moving from one screen to another using either the mouse or the appropriate keyboard function keys.

3.2 Project Selection

The APET software package will accommodate one or more experiments for the user. However, each experiment must be identified by a short (8 characters or less) name, which must conform to the naming convention used by the DOS computer operating system. Briefly, these rules state that a DOS name cannot be over 8 characters in length, and must contain a combination of either letters, numbers, or the underscore (_) character. Any other special keys, including the SPACE, are prohibited. The rationale behind this naming convention is to allow storage of data files for each experiment in a subdirectory for that specific experiment. For example, if a user is working on two experiments, identified as THINFILM and HIPROTEN, then there would be a subdirectory for each. The configuration of these files would be as follows:

Root Directory	Application Directory	Experiment Directory
C:\	GARDEN\	THINFILM
		HIPROTEN

Therefore, all data files containing answers for the APET questions for the experiment THINFILM would appear in the subdirectory THINFILM. If additional experiments are required, the user would identify the new experiment and an additional subdirectory would be added.

Figure 3 shows the menu for selecting, adding, or deleting an experiment project. In the example, the experiment AADSF_L has been previously defined by the user. If the user wants to work on this experiment, he simply points and clicks on this selection. (This would be the case in a majority of the cases, since most Principal Investigators will have only one active experiment at any given point). However, if another experiment is required, the user would click on "ENTER A NEW PROJECT". The user would be prompted to identify the new experiment, and would immediately be passed into the APET system, where information regarding that experiment would be addressed.

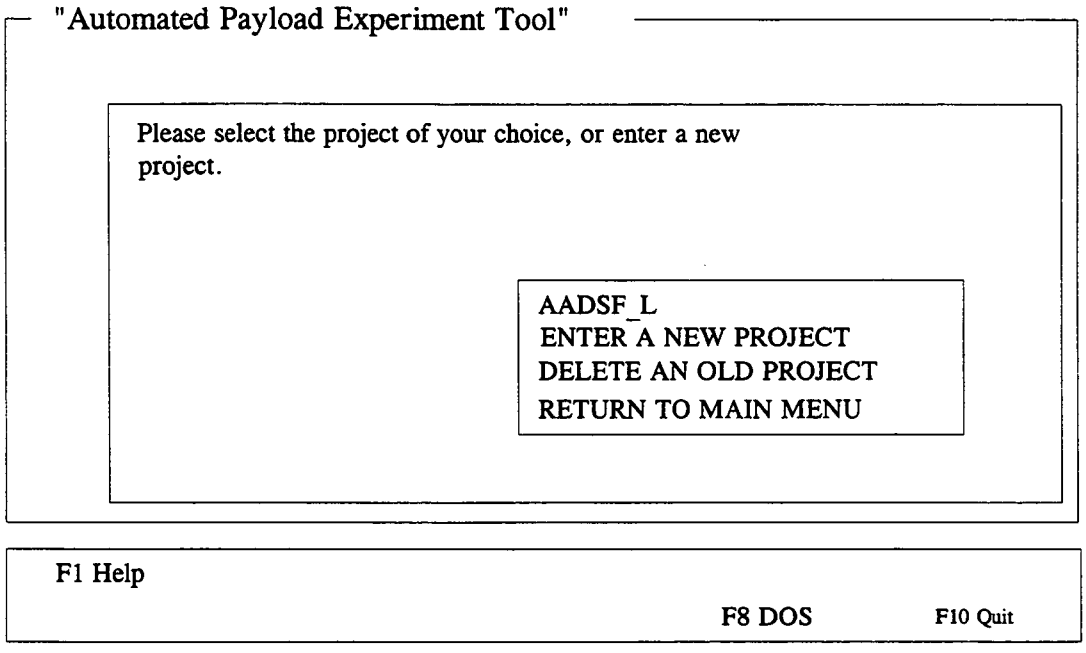

Figure 3
Project Selection/Identification Menu

If a user wishes to delete an experiment, along with all its associated data files, he may do so by selecting the "DELETE AN OLD PROJECT" option from the menu. However, there is no recoverable procedure to undelete a project. Therefore, the user is strongly advised to use this procedure with caution.

3.3 Project Plan Overview

The third selection from the APET Main Menu is the "Project Plan Overview". This option should be selected when the user wishes to see an overview of the Project Plan document, along with brief explanations of the information to be covered in each section/subsection of the document. For an additional overview of the topics to be addressed in the Project Plan, see Appendix A of this document.

3.4 Glossary/Acronyms

A number of NASA specific terms, definitions, and acronyms will appear as support material throughout the documentation process. One of the primary advantages of using a hypertext-based tool is to allow for easy and immediate retrieval of these terms.

Option number four from the APET Main Menu allows the user to retrieve a listing of these terms, and presents them in a form analogous to a glossary in a book. To view a definition, highlight the desired term and click. A term can be highlighted by using the mouse to move the cursor to that word, or by using the **F3** key for selection. To view the definition, the user should either click the mouse or press the **F4** key. The definition of that word/term will be presented. Should the definition contain a term that requires further description, highlight that word and click. The new definition will overlay the previous definition. This method can be repeated as long as further definitions exist and the memory capacity of the machine is not exceeded.

Please note that the glossary consists of multiple pages. Remember to navigate through the multi-page displays by using either the **Page Up/Page Down** function keys.

3.5 Print Glossary/Acronyms

Option number five from the APET Main Menu activates a routine for the printing of the glossary/acronym list, as discussed in Section 3.4. Because the output of this selection will be a multi-page document, the use of this option will be rare.

3.6 Filling Out the Project Plan

To fill out the Project Plan, the user must first select "Project Selection" from the APET Main Menu. Then the Project Selection/Identification Menu (Figure 3) will be presented for the user to identify either a new project or select an existing project. Once the selection/identification has been made, the Project Plan Activity Menu (Figure 4) will be presented. Please note that the selected project is shown on the upper right corner of the screen. Please be sure that the project shown is the one you wish to work.

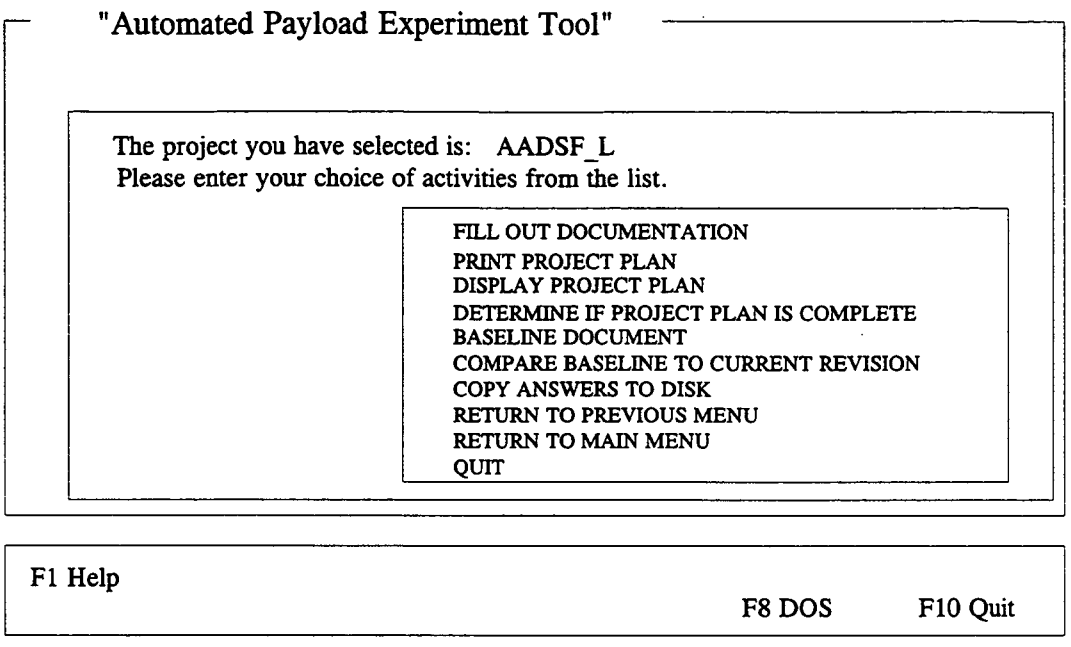

Figure 4
Project Plan Activity Menu

The Project Plan Activity Menu presents ten options for the user. The most significant of these is the first: "FILL OUT DOCUMENTATION". The selection of this option will present the Fill Out Project Plan Documentation Menu (Figure 5). This menu offers the user two options: "ENTER PROJECT INITIALIZATION INFORMATION", and "COMPLETE PROJECT PLAN."

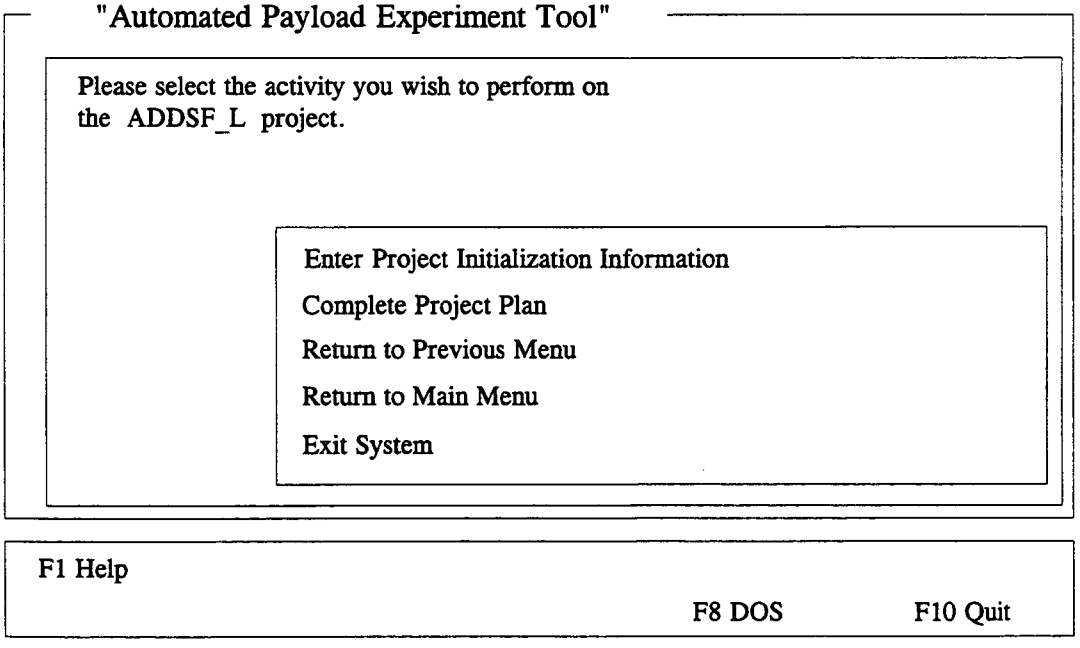

Figure 5
Fill Out Project Plan Documentation Menu

3.7 Entering Project Initialization Information

Under most circumstances, the first information entered by the user into the APET system is the project initialization information. To enter this information, select option one from the Fill Out Project Plan Documentation Menu. This information is used to identify certain aspects of the experiment, and will be used throughout the documentation process. Entries include the PI name, organization, address, city, state, zip, phone, and experiment title. This information will be provided in the form of type written responses to user prompts. For example, the user will be asked:

Please enter your first and last names, i.e. Dr. John Doe.

The user should respond with a one line response. (If there is a limitation on the length of this one line response, the screen display will provide an instruction, such as "Please limit your response to 16 characters.") This will be the format of user entries throughout the APET application. When the user is prompted to make an entry, the response should be on one line. When the user responds with a RETURN, the answer is stored and the next question, if one exists, is asked. Once all questions for that segment have been answered, the answers are written to a data file.

In the "Project Initialization Information" subsection, the only variation in the user prompt/one line response routine is with the experiment title. Because experiment titles can be several lines, the user is given a prompt and immediately sent to the APET editor. This editor is a small version of a word processor, with many of the functions of a common word processing package. The commands used in the APET editor are similar to those in the software package WORDSTAR. To see the commands available, press the **F1** function key from inside the editor. A separate window will be opened and will overlay the current screen. From there, page down until the function you wish to perform is shown. The one-to-two keystroke command to accomplish the task will be shown. (Note: The symbol (^) represents the CONTROL key, i.e. ^KQ means to hold the CONTROL key down while pressing the letter K, then press the letter Q.) When the user is finished entering the answer into the editor, he may exit by pressing the ESC (escape) key. A message will then appear on the screen that tells the user what file name is being saved. Respond with a RETURN to accept this name and save the answer, or an ESC to cancel the answer.

Important: Do not change the file name when the APET software asks if the name is acceptable. Future sessions that allow the user to change, delete, print, or display the Project Plan answers require that these file names be used. Changing the file name will make the file either inaccessible or inappropriate. Therefore, always accept the file name as given.

3.8 Complete Project Plan

To complete the Project Plan Document, the user must answer a series of questions about the experiment. (For an outline of the topics to be addressed, see Appendix A.) A sample question from the Project Plan is shown in Figure 6.

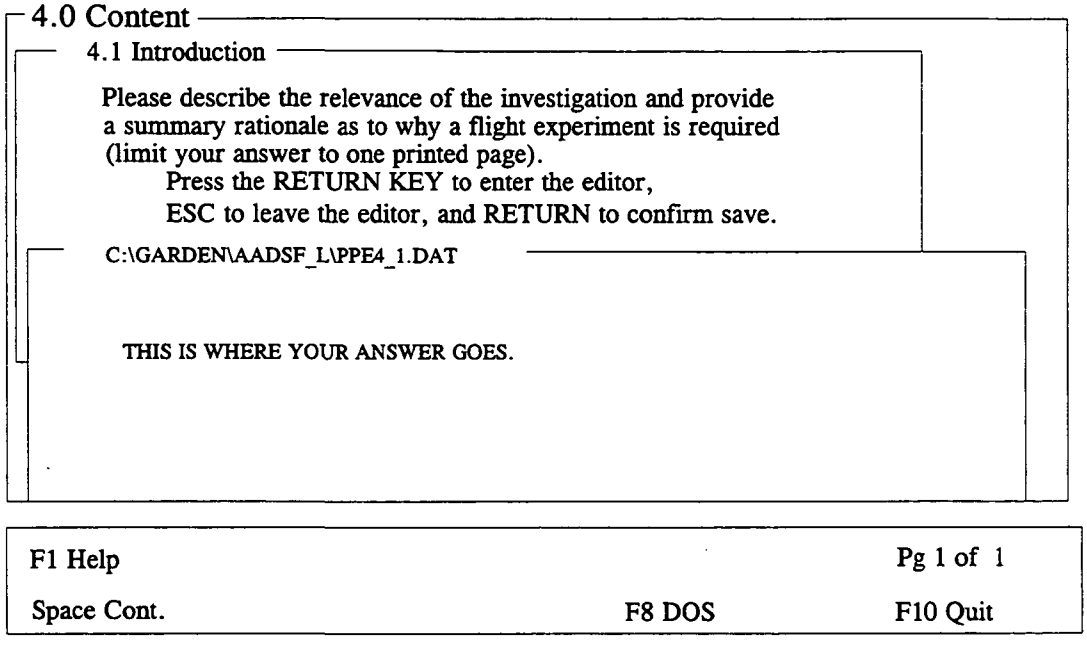

Figure 6
Sample Project Plan Question Screen

The questions are grouped into topics, a list of which is presented to the user. The user is asked to select the topic which is to be addressed. The chosen topic will be displayed, along with either its accompanying question or the subtopics covered within that section. If the user chooses to fill out one of the subsections, he will be prompted to select from a list. Upon subheading selection, a brief prompt, along with any necessary instructions for answering the question will be displayed.

Each question in the Project Plan will invoke the editor. Answers should be given in the form of short narratives, consisting of one or more paragraphs of text. Sufficient space will be given to write as much (or as little) as required. A sample of this procedure is shown in Figures 7 through 10.

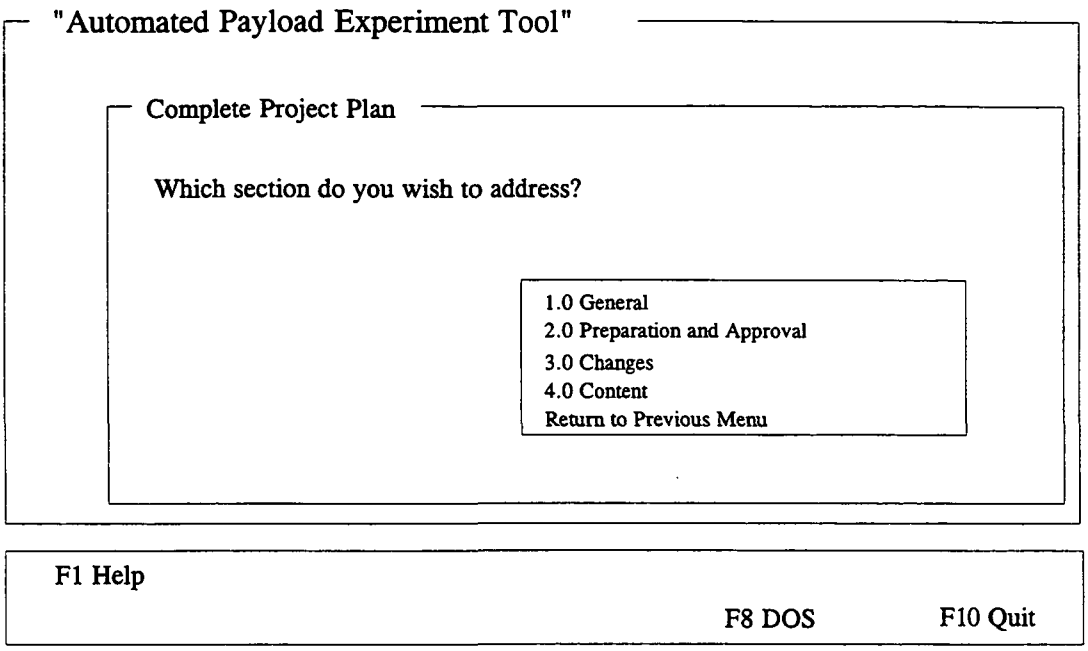

Figure 7
Project Plan List of Sections

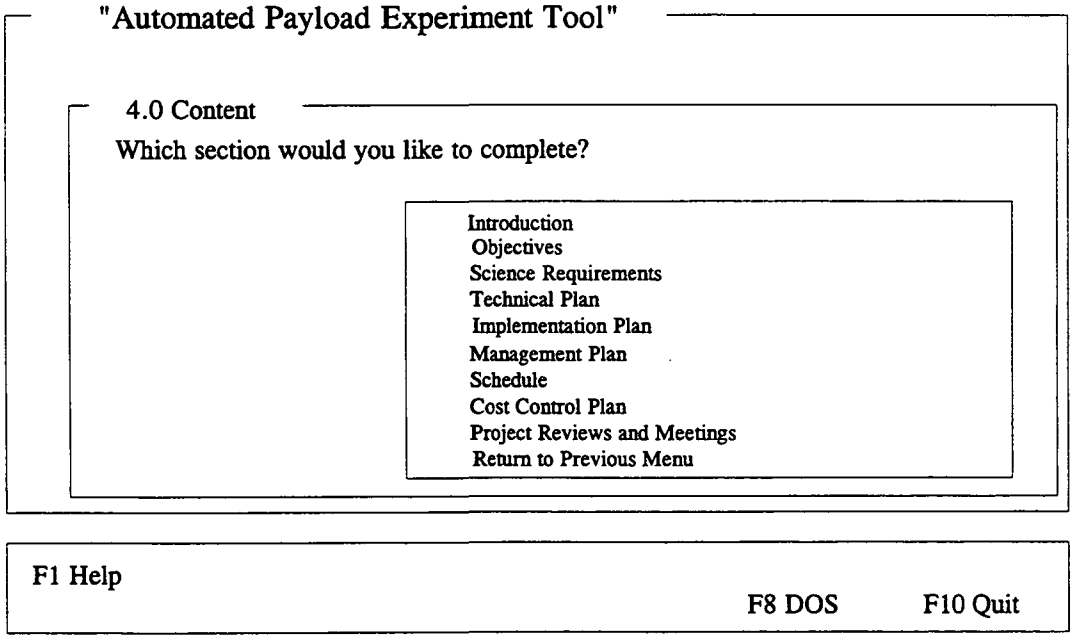

Figure 8
Project Plan Section Selection

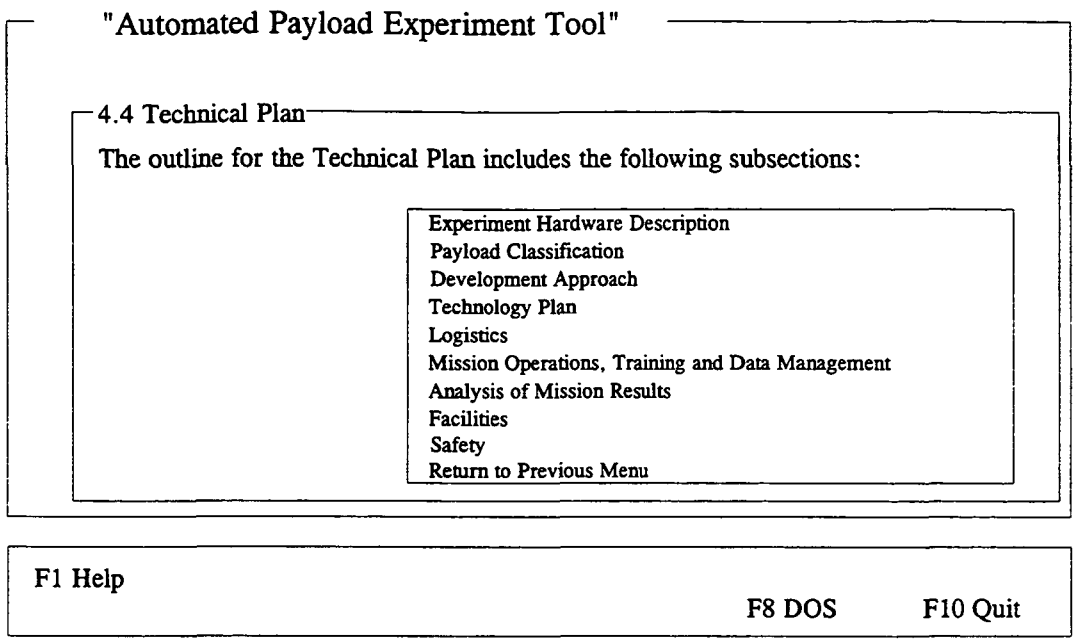

Figure 9
Project Plan Subtopic Selection

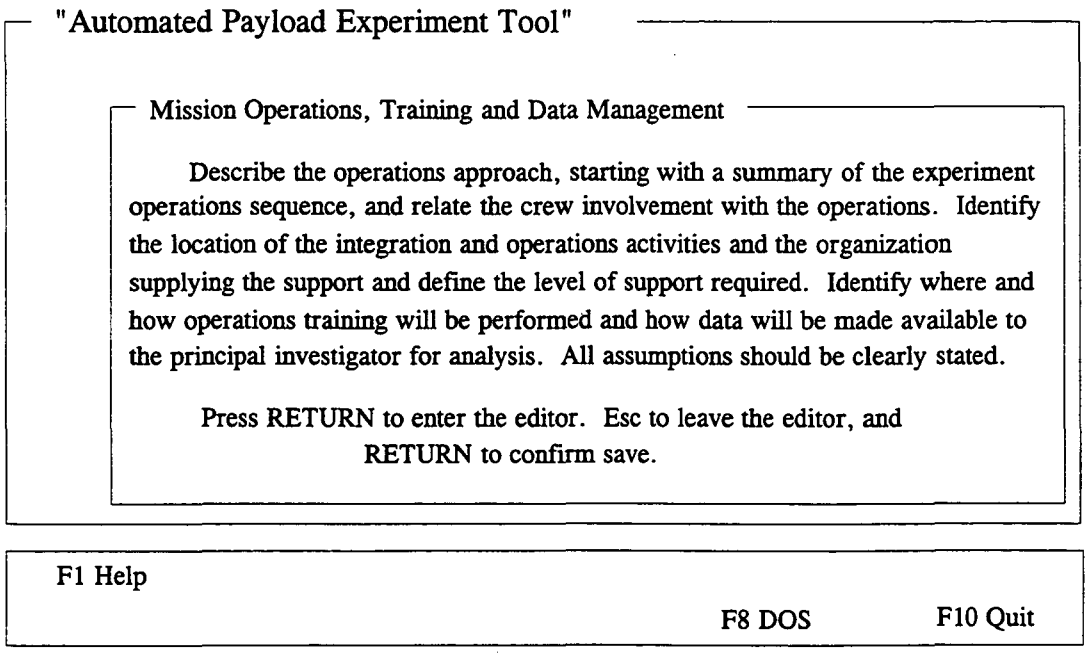

Figure 10
Project Plan Topic Narrative

Some of the topics have accompanying illustration(s) in order to give the user a better understanding of what information is needed. If you wish to view the illustration, simply click on, or select, the appropriate phrase. This will cause the screen to momentarily go blank, and the illustration will then be presented. After you have viewed the illustration, press SPACE and the program will return you to your original screen.

3.9 Printing the Project Plan

The user has two methods available to generate output from the APET software. These include printing the document, or displaying the document to the screen. The APET application was designed to be flexible enough to go to a variety of printers. As with most output, the best results will be with the use of a laser printer. If a laser printer is not available, the use of a dot-matrix printer will also be acceptable. A variety, although not nearly exhaustive, of dot-matrix printers have been tested with the APET software, and all have performed well.

If the document has previously been baselined (discussed later in Section 3.12), then a menu will appear giving the user the option of printing the document from the baselined version, the current revision, or neither version. If the neither option is chosen, then it is assumed that the user does not want the document printed, and the program will automatically return to the previous menu. If the baseline option is chosen, then the document will be printed from the file which is in the project baseline subdirectory. If the current revision option is chosen, then the document will be printed from the version of the document which the user is currently revising. If the document has not been baselined, then the document will be printed from the current version.

The printing of the Project Plan can be accomplished in either of two methods. First, the user may choose the section to be printed. This is recommended for a document that is in the development process. Once the entire Project Plan has been completed, the user can generate the document in its entirety. An initial page eject will normally (depending on printer type) advance a blank sheet of paper before the cover sheet is printed. This will be followed by a second page advance, then page one of the document will be printed, followed by two, three, etc. through the end of the document. Because there are often graphics, tables, etc. that must be inserted within the textual document, no table of contents is printed. Because of the limitation of graphics support, it is suggested that all externally generated graphic illustrations, tables, etc. be provided in an appendix, with appropriate references throughout the document.

While the print procedure is active, a message will appear in the lower left of the screen. No other activities may take place while the document is printing. In case the printer runs out of paper, an error message will appear. Reload paper in the printer and press the SPACE key to continue.

3.10 Displaying the Project Plan

The second method of generating output using APET is to display sections of the Project Plan to the screen. The Project Plan is divided into four major sections, with each divided into subsections as necessary (see Appendix A). The user has the capability of selecting a section and seeing the identical output as would appear if the document was printed. Displaying the Project Plan is recommended to quickly review answers, especially during the development phase of document preparation.

If the document has previously been baselined (discussed later in Section 3.12), then a menu will appear giving the user the option of displaying the document from the baselined version, the current revision, or neither version. If the neither option is chosen, then it is assumed that the user does not want the document displayed, and the program will automatically return to the previous menu. If the baseline option is chosen, then the document will be displayed from the file which is in the project baseline subdirectory. If the current revision option is chosen, then the document will be displayed from the version of the document which the user is currently revising. If the document has not been baselined, then the document will be displayed from the current version.

Most Project Plan sections will require multiple page displays. Please note that to view the equivalent of an entire printed page, there will be at least three and usually four screen displays. Use the Page Up/Page Down method to move up or down in the document. Once a page is adequately reviewed, press the SPACE key to retrieve the next page in sequence. To abandon a display at any time, press the **F10** key.

3.11 Determining if the Project Plan is Complete

To aid in the logical completion of the Project Plan, APET provides the user with the ability of "Determining if the Project Plan is Complete". By selecting this option, the user activates a routine that checks for the existence of the data files created as answers to the Project Plan questions. The missing data files are analyzed to determine which sections have not been answered, and a listing is displayed to the screen.

3.12 Baselining a Document

At some point in the documentation procedure, the Project Plan will be considered complete and released to external offices, agencies, organizations, etc. When this occurs, that version of the document is considered the baseline, and should be easily identified as such.

To aid in the process of maintaining separate versions of the Project Plan, an option exists to baseline the current version of the document. (see Figure 11) The selection of this option will cause a replica of the current version's answers (or data files) to be copied to a new subdirectory for that experiment. This new subdirectory will be called **BASELINE**. From that point, all additional editing will transpire on a new version of the answers, while the baselined version of the answers will remain intact. The generation of output will require the user to identify which version (baseline or current revision) he wishes to access.

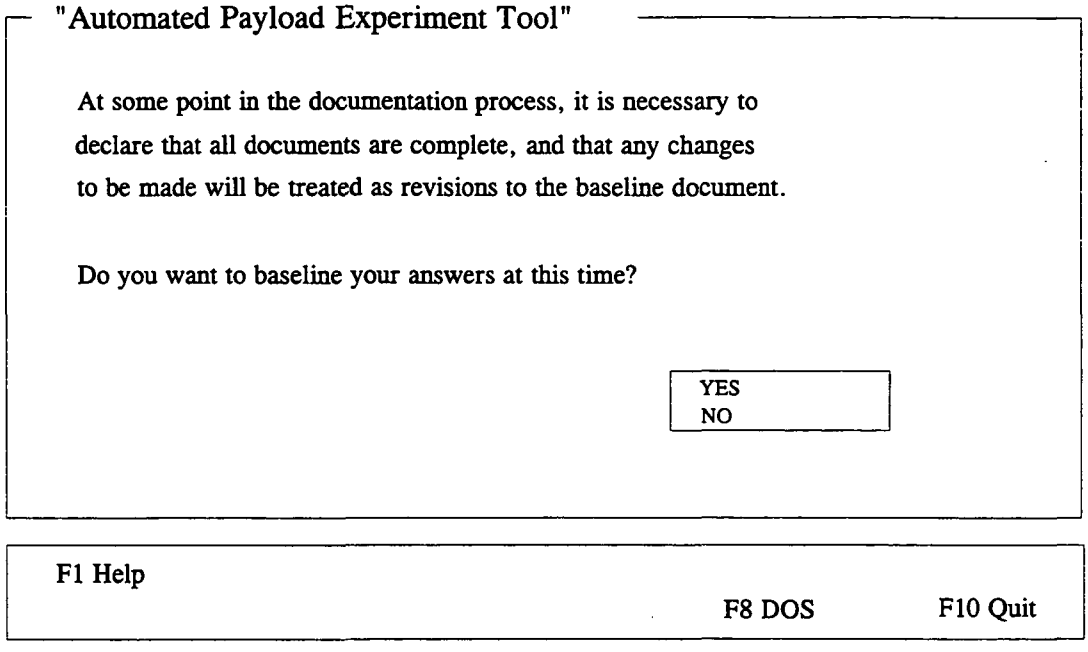

Figure 11
Baseline Menu

3.13 Comparing a Baseline to the Current Revision

Once the document has been baselined (see Section 3.12), the user may wish to compare this baseline with the current revision. APET provides a mechanism to accomplish this task. By selecting the option "Compare Baseline to Current Revision", a DOS routine will be invoked to compare all identical data files from the current revision to the baseline document. This comparison generates a file that can then be displayed or printed, so that a quick review will show which answers have been modified since the original baseline date.

3.14 Copying Answers to Disk

The final output option provided by APET is the creation of files that contain all data generated by the software. This can be used as either a backup mechanism during the creation of the files, or as a means of submission of the final document instead of a hard copy/printed document. By submitting the answers on diskette, the receiving party can have direct access to the answers in the same manner as would the sender. These files are not formatted, and should not be confused with the final report output.

The user will have the option of selecting either the baseline document or the current revision. After this selection, the user is asked to select the drive to receive the backup (either A:,B:,C:, or D:). A DOS copy command will then be invoked to copy all files to the selected drive.

4.0 HELPFUL HINTS

1) Avoid the use of the F10 key to exit from within the APET application. It is a better practice to "back out" of the APET system through the use of the menus. By doing so, the user ensures that all answers are properly recorded to the disk drive. Use of the F10 key from within the APET application will allow the user to exit but will not automatically save information generated during the session.

2) APET does not support the insertion of externally generated graphics, tables, equations, or other non-text material. To alleviate this problem without the added labor of using a secondary word processor, it is suggested that any such material be included in an Appendix, and referenced in the text generated in APET.

3) To insert an externally generated text file into the text area in the APET editor, use the command ^KR from within the editor. This is one of a variety of commands that can be used from the APET word processor. To see all available commands, press the F1 key from inside the editor and page through the instruction set.

4) The APET editor uses a word wrap routine that automatically wraps the line to the next line (a common word processing feature). It also maintains vertical alignment along the left margin. If you use indented paragraphs, please be sure that the line after the indented line begins in the column you desire. To do this, use the backspace key to move the first word in the line to the column desired. The recommended solution to this problem is not to indent paragraphs, but instead insert a blank line between each paragraph.

5) If your computer system is configured to automatically load WINDOWS or some other application package, it may be necessary to alter the AUTOEXEC.BAT file (located in the boot drive). Instructions for changing the automatic load of an application will vary by computer. One of the easier methods is to edit the AUTOEXEC.BAT file and remove the line that calls the package. For example, WINDOWS is called by the command WIN. By preventing these packages from loading, a significant amount of RAM is freed and allowed for use by APET.

APPENDIX A

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3.0 CHANGES

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- 4.3 Science Requirements
- 4.4 Technical Plan
  - 4.4.1 Experiment Hardware Description
  - 4.4.2 Payload Classification
  - 4.4.3 Development Approach
  - 4.4.4 Technology Plan
  - 4.4.5 Logistics
  - 4.4.6 Mission Operations, Training and Data Management
  - 4.4.7 Analysis of Mission Results
  - 4.4.8 Facilities
  - 4.4.9 Safety
- 4.5 Implementation Plan
  - 4.5.1 Implementation Approach
  - 4.5.2 Summary Work Breakdown Structure
  - 4.5.3 Documentation
- 4.6 Management Plan
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  - 4.9.1 Internal Reviews
  - 4.9.2 External Reviews
  - 4.9.3 Design and Readiness Reviews

APPENDIX B

APET Editor Commands

MOVING THE CURSOR:

^D	Left One Character
^S	Right One Character
^A	Left One Word
^F	Right One Word
^I	Tab
^E	Up One Line
^X	Down One Line
^W	Scroll Up
^Z	Scroll Down
^R	Page Up
^C	Page Down
^QS	Beginning of a Line
^QD	End of a Line
^QE	Beginning of a Page
^QX	End of a Page
^QR	Beginning of a File
^QC	End of the File
^QB	Beginning of Marked Block
^QK	End of Marked Block

DELETING AND INSERTING TEXT:

^G	Delete Character Under Cursor
^H	Delete Character Left of Cursor
^T	Delete Next Word
^Y	Delete a Line
^QY	Delete to the End of a Line
^KY	Delete a Marked Block
^V	Insert On/Off
^N	Insert a Line

BLOCK COMMANDS:

^KS	Save This File
^KB	Mark Beginning of Block
^KK	Mark End of Block
^KH	Hide / Display Block
^KC	Copy a Block
^KV	Move a Block
^KY	Delete a Block
^KR	Read a Block from a File
^KW	Write a Block to a File
^KP	Print a Block or File

PRECEDING PAGE BLANK NOT FILMED

FORMATTING COMMANDS:

^B	Reformat Paragraph
^OR	Set Right Margin
^QI	Toggle Auto indent Mode
^QW	Toggle Word Wrap

FIND AND REPLACE COMMANDS:

^QA	Find and Replace a String
^QF	Find an Occurrence of a String
^L	Find the Next Occurrence

For assistance in using this software,
or to offer suggestions or comments,
please contact the following:

Mr. Gary Maddux
Ms. Anna Provancha
Mr. David Chattam

at (205) 895-6343,
or write

Systems Management and Production Laboratory
Research Institute
RI E-47
The University of Alabama in Huntsville
Huntsville, AL 35899

APPENDIX C

Science Requirements Envelope Document User Guide

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Automated Payload Experiment Tool

User Manual

Science Requirements Envelope Document

Prepared by:

Research Institute
The University of Alabama in Huntsville
Huntsville, AL 35899

Prepared for:

National Aeronautics and Space Administration
Microgravity Science and Applications Division
Marshall Space Flight Center, AL 35812

January, 1992

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1.0 INTRODUCTION

So you want to fly an experiment on the Shuttle.

Well, to begin the process, we must get a little information about your experiment and its requirements.

If you have flown with us in the past, you may remember a substantial amount of paper documentation was required. This application, the Automated Payload Experiment Tool, is designed to alleviate much of the burden of the document preparation and maintenance process. This system can currently be used to prepare four support documents, the Science Requirements Document (SRD), which defines the science objectives, and the Experiment Requirements Document (ERD), which defines the experiment design/build requirements, the Project Plan, which is the basic planning document that describes the overall plan for proceeding with the project, and the Science Requirements Envelope Document. The version that you have is for the creation of the Science Requirements Envelope Document only.

2.0 DISCUSSION

2.1 Background

The Microgravity Experiment Projects (MEP) Office of the Payload Projects Office (PPO) at the Marshall Space Flight Center (MSFC) is currently responsible for collecting and coordinating experiment/facility specifications and requirements between NASA and various colleges, universities, research centers, and other public- and private-sector organizations that are selected or are requesting to fly their respective microgravity experiments on designated flights. This coordination involves the communication of flight hardware requirements and the preparation and review of all documentation between NASA and the research groups. To reduce difficulties encountered by these customers of NASA, an effort was undertaken to research, analyze, and evaluate the current procedures involved in the information gathering activities.

The MEP Office identified a need to develop an Automated Payload Experiment Tool (APET) which would lead experiment developers through the development planning process, obtain necessary information, establish an electronic data exchange avenue and allow easy manipulation/reformatting of the collected information. In order to fulfill this need, the University of Alabama in Huntsville (UAH) was tasked to design and develop the APET software package to meet the increasing demands to lighten the burden of documentation preparation and maintenance for NASA and its customers.

2.2 System Requirements

The objective of APET is to provide an easy to use tool to the Principal Investigator (PI) team. To ensure ease of use, few computer hardware requirements are necessary to operate the APET software package.

APET is designed to run on any IBM-PC compatible personal computer. It is recommended that the APET user install the software on a 286 PC or higher. The multiple screen windows, and the complexity of the system cause noticeable slowdowns on any machine less than the 286.

The software requires that the PC be equipped with a hard disk drive. For proper execution, the hard drive (or some partition of it) must be named C:. The SRD version of APET will require approximately 1M (megabytes) of space on the hard drive for the system, plus another 1M on the hard drive for the data files created by the user. However, for optimal performance, the hard drive should have a total of at least 3M free upon installation of the software.

For ease of use, the PC should be equipped with a mouse. This, however, is not mandatory. APET utilizes the hypertext technology, which offers a point-and-click user interface. Instead of a mouse, the user does have the option of pressing selected function keys to achieve the same effect.

2.3 Installation

The APET software package is provided on one 3 1/2" diskette. The files stored on this diskette have been compressed; therefore, it is required that the user follow several simple steps to ensure correct installation.

1) Insert the 3 1/2 " diskette in the drive designated as A:. If the A: drive on your system is not the correct size, then use the DOS ASSIGN command to redesignate the drives appropriately. (For example, if you have 3 1/2" disks but your 3 1/2" drive is B:, then at the DOS prompt type **ASSIGN A: B:**.)

2) From this drive (A:) type:

VINSTALL.

This will activate the installation routine. A series of instructions and informational text will be presented. Each screen will advise what is transpiring in the installation procedure. The installation routine will create a subdirectory on the C: drive called GARDEN. Once created, the files contained on the installation disks will be copied to the directory **C:\GARDEN**. Most of these files have been compressed to conserve disk space. An uncompress routine will be invoked to return these files to their normal (and usable) condition. To cancel the installation at any time, press the CTRL (control) C keys.

3) Upon successful installation of the APET program files, the message **INSTALLATION ROUTINE COMPLETE** will be displayed. The APET application, running under the direction of Knowledge Pro software, will be entered and you will be presented the opening menu. All subsequent sessions using the APET software may be initiated by going to the C:\GARDEN subdirectory and typing **ENVELOPE**.

2.4 Getting Started

This application uses hypertext technology. Hypertext software systems allow for the retrieval of related information at the point and click of a mouse or, if a mouse is not used, at the touch of one or two keystrokes. For information on a highlighted topic, just move the mouse to that word and click. A window will be opened, overlaying the current window. In the new window, the information will immediately be displayed. Once this support information has been reviewed, press SPACE (or ESC) once to close the window and return to your original screen. If you are not using a mouse, please use the **F3** and **F4** function keys (marked Select and View) as indicated at the bottom of the screen. (see Figure 1). The **F3** key allows you to select the different hypertext topics. Once the desired topic is selected (i.e. highlighted), the **F4** key calls the background information for view.

Multiple page displays are indicated by the **Pg 1 of 2** message at the lower right of the screen. To navigate through multiple screen displays, please use the **Page Up** and **Page Down** keys to scroll either forward or backward through the pages.

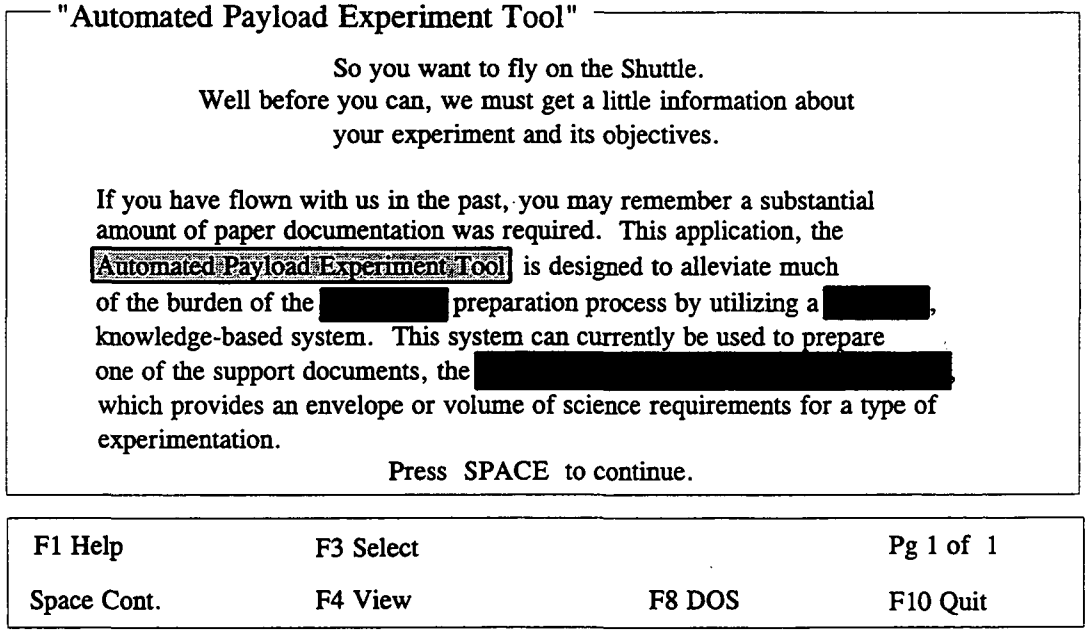

Figure 1
Sample Screen Layout Using Hypertext

For help at anytime throughout the APET application, press the **F1** key. This will retrieve location sensitive help information, and may be called from the system or system-called edit screens. This will be the method by which assistance information will be retrieved throughout this application.

APET has been designed as a menu-driven software package. This means that any function required of the user can be activated via a menu option. This includes exiting the system. It is strongly recommended that the user always "back out" of the application by using the appropriate menu options, i.e. "Return to Previous Menu". An option does exist to exit from any point in the application by selecting **F10**. It is not recommended that this be used from inside a question/answer section of the application. The **F10** command causes an immediate exit from the program, without checking to ensure that open files have been properly saved. Therefore, the user may experience data loss if the application is exited in this manner.

After the installation and initial use of the APET software, future sessions will be initiated by going to the **C:\GARDEN** subdirectory and typing **ENVELOPE**. This will activate the software and present the opening menu. (see Figure 2).

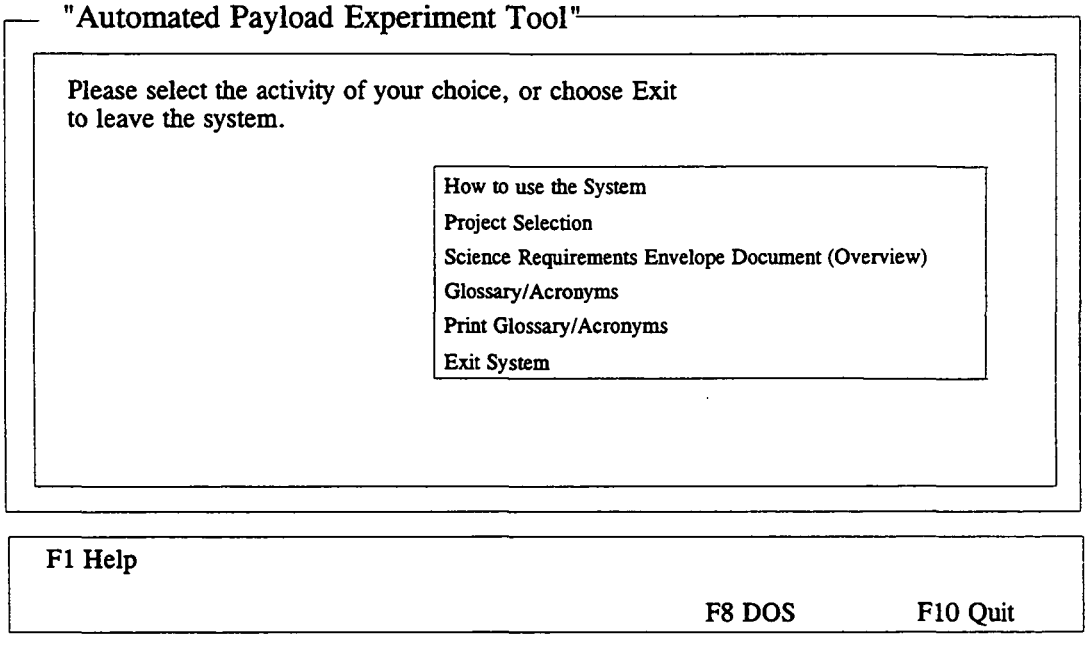

Figure 2
Opening APET Main Menu

Due to the hypertext capabilities of the APET software, a large amount of RAM (random access memory) is required. Because of the heavy RAM demand, proper execution of the software requires no other software package be running simultaneously with the APET software. Whenever the available RAM becomes too little for the application, an "Insufficient Memory" message will be shown at the bottom right of the screen. To alleviate this situation, simply get out of APET and reboot the system. This will usually free up all available RAM and ensure proper execution. (see Helpful Hints for further instruction.)

3.0 USING THE APET SYSTEM

3.1 How to Use the System

Because the use of a hypertext tool may be a new experience, a brief on-line tutorial is provided with APET. To use this tool, please choose option one on the opening menu entitled "How to Use the System". To select this option, point with the mouse to the phrase and click. If not using a mouse, use the arrow keys to highlight the option and press RETURN. You can tell when an option has been selected because it (the phrase or word) will be highlighted differently from all other options. As the mouse is moved to other options, each in turn will be highlighted.

Once the "How to Use the System" option has been selected, a different screen will be presented with a brief overview of hypertext and the methods of selecting topics. (This overview is much the same as appears in Section 2.4 of this users guide.) Practice selecting topics and moving from one screen to another using either the mouse or the appropriate keyboard function keys.

3.2 Project Selection

The APET software package will accommodate one or more experiments for the user. However, each experiment must be identified by a short (8 characters or less) name, which must conform to the naming convention used by the DOS computer operating system. Briefly, these rules state that a DOS name cannot be over 8 characters in length, and must contain a combination of either letters, numbers, or the underscore (_) character. Any other special keys, including the SPACE, are prohibited. The rationale behind this naming convention is to allow storage of data files for each experiment in a subdirectory for that specific experiment. For example, if a user is working on two experiments, identified as THINFILM and HIPROTEN, then there would be a subdirectory for each. The configuration of these files would be as follows:

Root Directory	Application Directory	Experiment Directory
C:\	GARDEN\	THINFILM
		HIPROTEN

Therefore, all data files containing answers for the APET questions for the experiment THINFILM would appear in the subdirectory THINFILM. If additional experiments are required, the user would identify the new experiment and an additional subdirectory would be added.

Figure 3 shows the menu for selecting, adding, or deleting an experiment project. In the example, the experiment AADSF_L has been previously defined by the user. If the user wants to work on this experiment, he simply points and clicks on this selection. (This would be the case in a majority of the cases, since most Principal Investigators will have only one active experiment at any given point). However, if another experiment is required, the user would click on "ENTER A NEW PROJECT". The user would be prompted to identify the new experiment, and would immediately be passed into the APET system, where information regarding that experiment would be addressed.

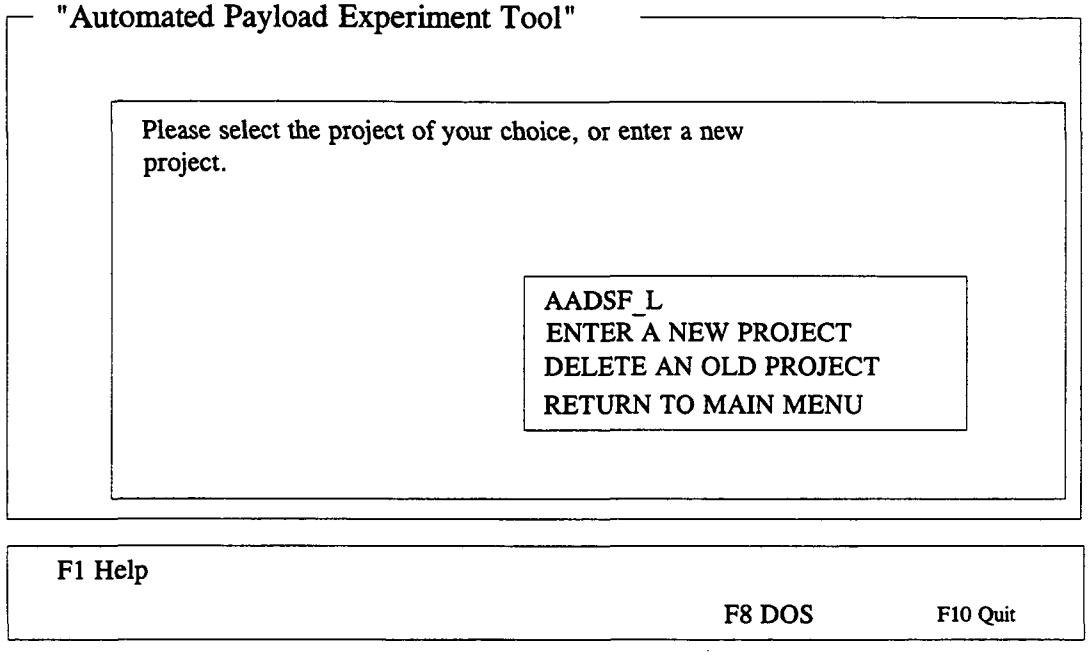

Figure 3
Project Selection/Identification Menu

If a user wishes to delete an experiment, along with all its associated data files, he may do so by selecting the "DELETE AN OLD PROJECT" option from the menu. However, there is no recoverable procedure to undelete a project. Therefore, the user is strongly advised to use this procedure with caution.

3.3 Science Requirement Envelope Document Overview

The third selection from the APET Main Menu is the "Science Requirement Envelope Document Overview". This option should be selected when the user wishes to see an overview of the Science Requirement Envelope Document, along with brief explanations of the information to be covered in each section/subsection of the document. For an additional overview of the topics to be addressed in the Science Requirement Envelope Document, see Appendix A of this document.

3.4 Glossary/Acronyms

A number of NASA specific terms, definitions, and acronyms will appear as support material throughout the documentation process. One of the primary advantages of using a hypertext-based tool is to allow for easy and immediate retrieval of these terms.

Option number five from the APET Main Menu allows the user to retrieve a listing of these terms, and presents them in a form analogous to a glossary in a book. To view a definition, highlight the desired term and click. A term can be highlighted by using the mouse to move the cursor to that word, or by using the **F3** key for selection. To view the definition, the user should either click the mouse or press the **F4** key. The definition of that word/term will be presented. Should the definition contain a term that requires further description, highlight that word and click. The new definition will overlay the previous definition. This method can be repeated as long as further definitions exist and the memory capacity of the machine is not exceeded.

Please note that the glossary consists of multiple pages. Remember to navigate through the multi-page displays by using either the **Page Up/Page Down** function keys.

3.5 Print Glossary/Acronyms

Option number six from the APET Main Menu activates a routine for the printing of the glossary/acronym list, as discussed in Section 3.5. Because the output of this selection will be a multi-page document, the use of this option will be rare.

3.6 Filling Out the Science Requirements Envelope Document

To fill out the Science Requirements Envelope Document, the user must first select "Project Selection" from the APET Main Menu. Then the Project Selection/Identification Menu (Figure 3) will be presented for the user to identify either a new project or select an existing project. Once the selection/identification has been made, the Science Requirement Envelope Document Activity Menu (Figure 4) will be presented. Please note that the selected project is shown on the upper right corner of the screen. Please be sure that the project shown is the one you wish to work.

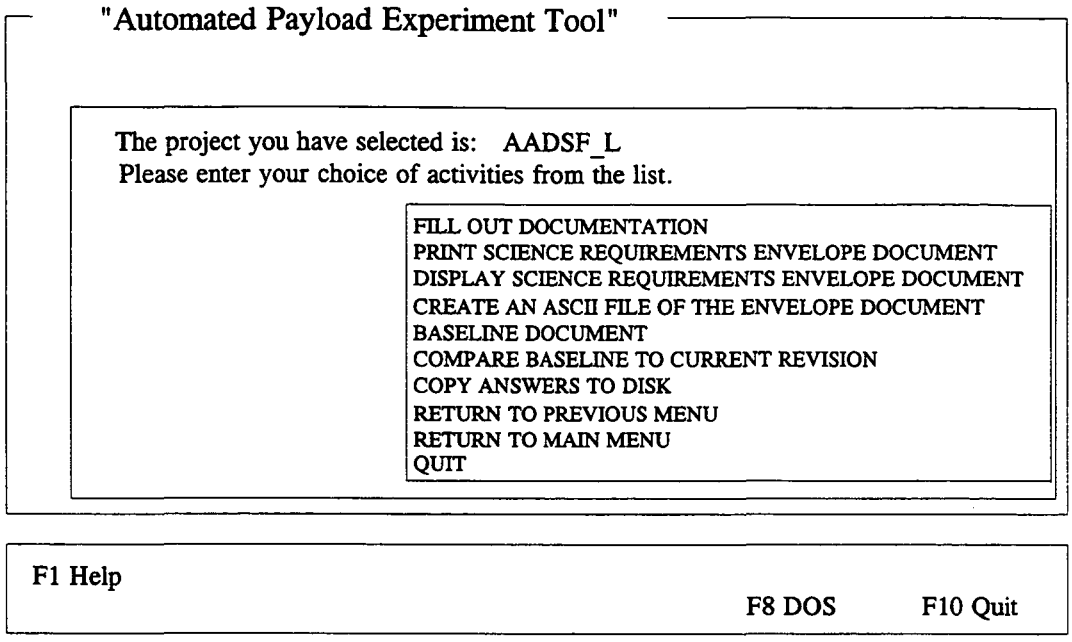

Figure 4
Science Requirements Envelope Activity Menu

The Science Requirements Envelope Document Activity Menu presents ten options for the user. The most significant of these is the first: "FILL OUT DOCUMENTATION". The selection of this option will present the Fill Out Science Requirements Envelope Documentation Menu (Figure 5). This menu offers the user three new options: "ENTER PROJECT INITIALIZATION INFORMATION", "COMPLETE SCIENCE REQUIREMENTS ENVELOPE", and "MARK QUESTIONS IN THE SCIENCE REQUIREMENTS ENVELOPE AS 'NOT APPLICABLE'".

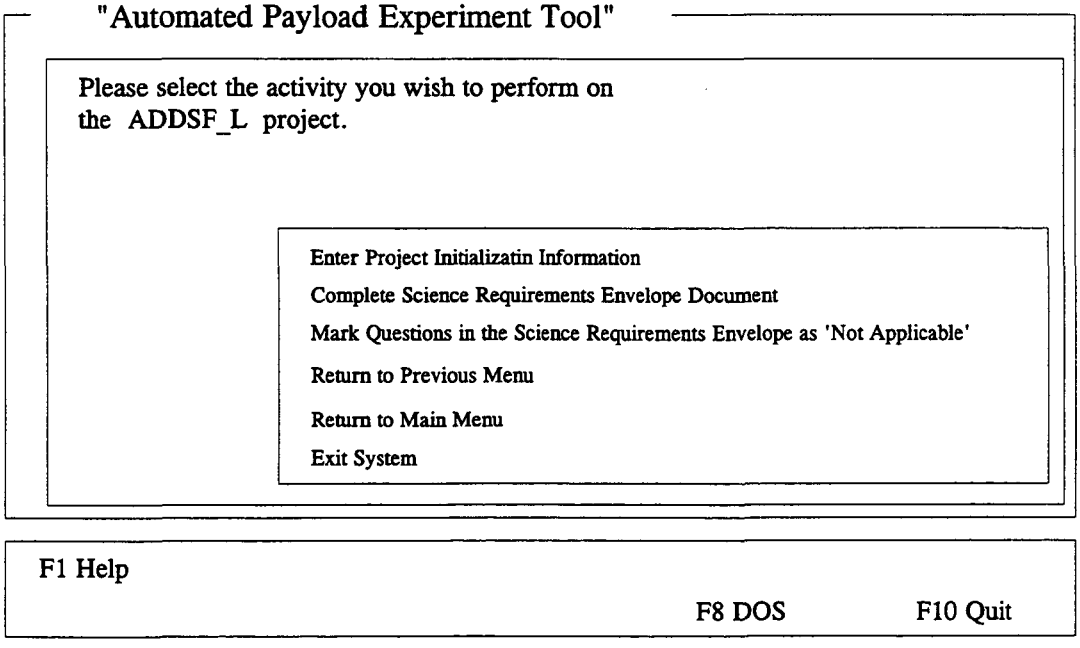

Figure 5
Fill Out Science Requirements Envelope Documentation Menu

3.7 Entering Project Initialization Information

Under most circumstances, the first information entered by the user into the APET system is the project initialization information. To enter this information, select option one from the Fill Out Science Requirements Envelope Documentation Menu. This information is used to identify certain aspects of the experiment, and will be used throughout the documentation process. Entries include the PI name, organization, address, city, state, zip, phone, and experiment title. This information will be provided in the form of type written responses to user prompts. For example, the user will be asked:

Please enter your first and last names, i.e. Dr. John Doe.

The user should respond with a one line response. (If there is a limitation on the length of this one line response, the screen display will provide an instruction, such as "Please limit your response to 16 characters.") This will be the format of user entries throughout the APET application. When the user is prompted to make an entry, the response should be on one line. When the user responds with a RETURN, the answer is stored and the next question, if one exists, is asked. Once all questions for that segment have been answered, the answers are written to a data file.

In the "Project Initialization Information" subsection, the only variation in the user prompt/one line response routine is with the experiment title. Because experiment titles can be several lines, the user is given a prompt and immediately sent to the APET editor. This editor is a small version of a word processor, with many of the functions of a common word processing package. The commands used in the APET editor are similar to those in the software package WORDSTAR. To see the commands available, press the **F1** function key from inside the editor. A separate window will be opened and will overlay the current screen. From there, page down until the function you wish to perform is shown. The one-to-two keystroke command to accomplish the task will be shown. (Note: The symbol (^) represents the CONTROL key, i.e. ^KQ means to hold the CONTROL key down while pressing the letter K, then press the letter Q.) When the user is finished entering the answer into the editor, he may exit by pressing the ESC (escape) key. A message will then appear on the screen that tells the user what file name is being saved. Respond with a RETURN to accept this name and save the answer, or an ESC to cancel the answer.

Important: Do not change the file name when the APET software asks if the name is acceptable. Future sessions that allow the user to change, delete, print, or display the SRD answers require that these file names be used. Changing the file name will make the file either inaccessible or inappropriate. Therefore, always accept the file name as given.

3.8 Complete Science Requirements Envelope Document

To complete the Science Requirements Envelope Document, there are between 30 - 40 questions that must be answered. These answers will be in the form of short narratives, consisting of one or more paragraphs of text. Each question or user prompt will invoke the APET editor and give the user sufficient space to write as much (or little) as required. A sample question from the Science Requirements Envelope Document is shown in Figures 6.

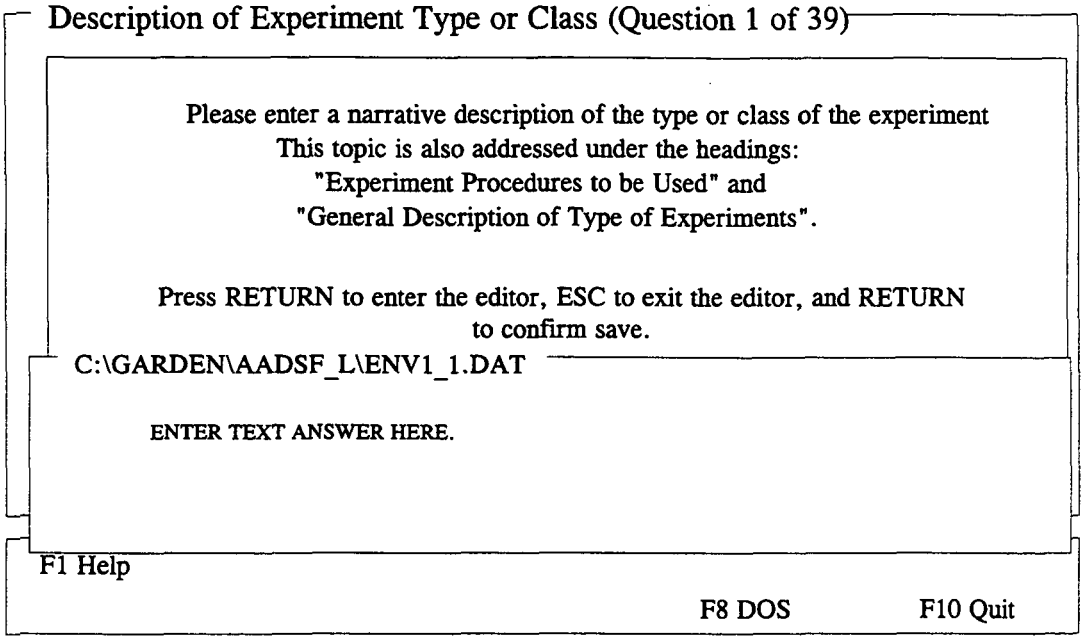

Figure 6
Science Requirements Envelope Document
Sample Question

The Complete Science Requirements Envelope Document session begins by asking the user if he has begun to fill out the Science Requirements Envelope Document previously. A 'NO' response causes the questions to be asked in sequence. A 'YES' response results in the question topics to be displayed in a list. If questions are to be answered from a list, a list will appear as a window that overlays the question screen. The user is expected to point-and-click on the appropriate topic. (If not using a mouse, use the arrow keys to select and press RETURN.) The user should click on the appropriate answer with the left-side mouse button.

For the initial Science Requirements Envelope Document session, the user would respond with a NO and proceed to the questions. These questions will be asked in the same sequence as is shown in the outline. After each response, the user will be asked if he wants to continue to the next question. This gives the user a chance to end the session when desired, rather than advancing through all the remaining questions. The title of each question screen will include the number of the question (i.e., Number 1 of 39). This allows the user to see where he is in the process and respond accordingly.

If the user responds with a 'YES', which means there has been a previous session, the following question will appear:

Do you wish to change only one item, resume at a point
and continue sequentially through the remainder of the
SRD, or complete all topics previously unanswered?

This allows the user one of three options. 1) He may select the one answer that needs changing, go directly to that answer and change it, then record that answer to disk. 2) He can select the topic where he would like to resume his activities, answer that question, record the answer, and go to the next question in sequence. This gives the user the capability of selecting the 20th question, and proceed sequentially through the remaining 19 questions. 3) The user can complete all questions that have not yet been answered. This option will invoke a command to look at what answers (files) do not exist, and build a list of these topics. The user then selects the topic to answer, answers the question, records the answer, and goes to the next question of his choice. With each recorded answer, that topic is removed from the list.

3.9 Mark Questions in the Science Requirements Envelope as 'Not Applicable'

The Science Requirements Envelope Document questions used in APET are taken directly from the Microgravity Science and Applications Division (MSAD) Management Plan. However, the PI and his NASA project manager may determine that some of these questions do not pertain or are not necessary for the completion of the Science Requirements Envelope Document. In order to simplify the Science Requirements Envelope Document preparation process, the ability to mark multiple questions as 'Not Applicable' has been provided. This option would probably be chosen as one of the first actions taken in preparing the Science Requirements Envelope Document.

Upon selecting this option from the menu, the user will be requested to choose the topics to mark as ''Not Applicable'' by one of the two methods. This choice depends on whether a mouse is being used. For mouse users, topics will be selected by clicking the RIGHT side mouse button on each topic to be marked. When the list is complete, click the LEFT side mouse button. To navigate through the multiple page listing, click on the **Pg 1 of 4** message at the bottom of the list.

Non-mouse users are instructed to use the arrow keys to move to the topic to be selected, then use the **Insert** key to select it. To move from one page to another, use the **Page Up/Page Down** keys. When the list is complete, press the RETURN key.

All topics selected will be given the answer 'Not Applicable'. However, any questions that have been previously answered will not be changed, and a warning message to that effect will appear on the screen. This safeguards against the user accidentally destroying a valid answer by choosing this option. If an answer is required to be changed to 'Not Applicable', then the user must select the topic from the 'Change One Item' option (see Section 3.8).

3.10 Printing the Science Requirements Envelope Document

The user has three methods available to generate output from the APET software. These include printing the document, displaying the document, and creating an ASCII file of the document. The APET application was designed to be flexible enough to go to a variety of printers. As with most output, the best results will be with the use of a laser printer. If a laser printer is not available, the use of a dot-matrix printer will also be acceptable. A variety, although not nearly exhaustive, of dot-matrix printers have been tested with the APET software, and all have performed well.

If the document has previously been baselined (discussed later in Section 3.13), then a menu will appear giving the user the option of printing the document from the baselined version, the current revision, or neither version. If the neither option is chosen, then it is assumed that the user does not want the document printed, and the program will automatically return to the previous menu. If the baseline option is chosen, then the document will be printed from the file which is in the project baseline subdirectory. If the current revision option is chosen, then the document will be printed from the version of the document which the user is currently revising. If the document has not been baselined, then the document will be printed from the current version.

The printing of the Science Requirements Envelope Document will generate the document in its entirety. An initial page eject will normally (depending on printer type) advance a blank sheet of paper before the cover sheet is printed. This will be followed by a second page advance, then page one of the document will be printed, followed by two, three, etc. through the end of the document. Because there are often graphics, tables, etc. that must be inserted within the textual document, no table of contents is printed. Because of the limitation of graphics support, it is suggested that all externally generated graphic illustrations, tables, etc. be provided in an appendix, with appropriate references throughout the document.

While the print procedure is active, a message will appear in the lower left of the screen. No other activities may take place while the document is printing. In case the printer runs out of paper, an error message will appear. Reload paper in the printer and press the SPACE key to continue.

3.11 Displaying the Science Requirements Envelope Document

The second method of generating output using APET is to display sections of the Science Requirements Envelope Document to the screen. The Science Requirements Envelope Document is divided into seven major sections, with each divided into one or more subsections (see Appendix A). The user has the capability of selecting a section and seeing the identical output as would appear if the document was printed. Displaying the Science Requirements Envelope Document is recommended to quickly review answers, especially during the development phase of document preparation.

If the document has previously been baselined (discussed later in Section 3.13), then a menu will appear giving the user the option of displaying the document from the baselined version, the current revision, or neither version. If the neither option is chosen, then it is assumed that the user does not want the document displayed, and the program will automatically return to the previous menu. If the baseline option is chosen, then the document will be displayed from the file which is in the project baseline subdirectory. If the current revision option is chosen, then the document will be displayed from the version of the document which the user is currently revising. If the document has not been baselined, then the document will be displayed from the current version.

Most Science Requirements Envelope Document sections will require multiple page displays. Please note that to view the equivalent of an entire printed page, there will be at least three and usually four screen displays. Use the Page Up/Page Down method to move up or down in the document. Once a page is adequately reviewed, press the SPACE key to retrieve the next page in sequence. To abandon a display at any time, press the **F10** key.

3.12 Create an ASCII File of Science Requirements Envelope Document

The APET software does not have the ability to generate or insert graphics, charts, etc. that were created in some other application. This is primarily due to the memory size limitations of the computer. However, to alleviate this limitation, APET does have the ability to generate an ASCII file of its Science Requirements Envelope Document output. After choosing this option, the user need only type in the full file name (includes drive, file name, and extension). The file will then be created as a replica of the printed output.

The benefit of creating an ASCII text file of the Science Requirements Envelope Document is in providing the user with the capability of enhancing the final printing by inserting graphics, photos, tables, equations, or other difficult to create figures. In addition, different fonts, font sizes, and special effects can be used to dress up the final printed output.

3.13 Baselining a Document

At some point in the documentation procedure, the Science Requirements Envelope Document will be considered complete and released to external offices, agencies, organizations, etc. When this occurs, that version of the document is considered the baseline, and should be easily identified as such.

To aid in the process of maintaining separate versions of the Science Requirements Envelope Document, an option exists to baseline the current version of the document. (see Figure 7). The selection of this option will cause a replica of the current version's answers (or data files) to be copied to a new subdirectory for that experiment. This new subdirectory will be called **BASELINE**. From that point, all additional editing will transpire on a new version of the answers, while the baselined version of the answers will remain intact. The generation of output will require the user to identify which version (baseline or current revision) he wishes to access.

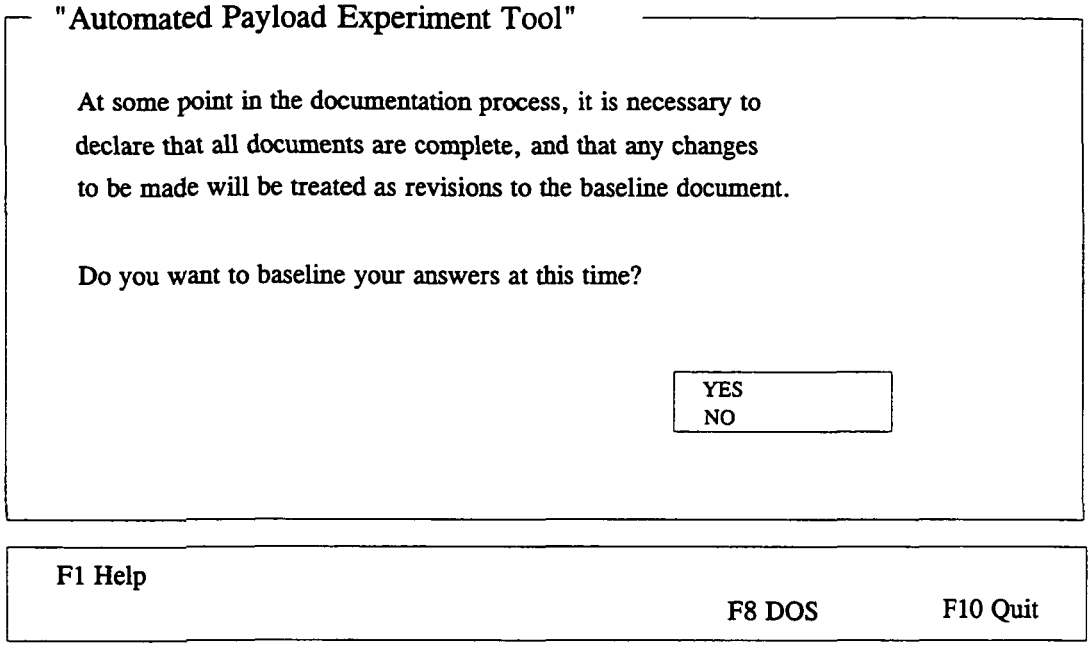

Figure 7
Baseline Menu

3.14 Comparing a Baseline to the Current Revision

Once the document has been baselined (see Section 3.14), the user may wish to compare this baseline with the current revision. APET provides a mechanism to accomplish this task. By selecting the option "Compare Baseline to Current Revision", a DOS routine will be invoked to compare all identical data files from the current revision to the baseline document. This comparison generates a file that can then be displayed or printed, so that a quick review will show which answers have been modified since the original baseline date.

3.15 Copying Answers to Disk

The final output option provided by APET is the creation of files that contain all data generated by the software. This can be used as either a backup mechanism during the creation of the files, or as a means of submission of the final document instead of a hard copy/printed document. By submitting the answers on diskette, the receiving party can have direct access to the answers in the same manner as would the sender. These files are not formatted as an ASCII file, and should not be confused with the final report output, which can be created using the "Create an ASCII File of SRD" (discussed in Section 3.13).

The user will have the option of selecting either the baseline document or the current revision. After this selection, the user is asked to select the drive to receive the backup (either A:,B:,C:, or D:). A DOS copy command will then be invoked to copy all files to the selected drive.

4.0 HELPFUL HINTS

1) Avoid the use of the F10 key to exit from within the APET application. It is a better practice to "back out" of the APET system through the use of the menus. By doing so, the user ensures that all answers are properly recorded to the disk drive. Use of the F10 key from within the APET application will allow the user to exit but will not automatically save information generated during the session.

2) APET does not support the insertion of externally generated graphics, tables, equations, or other non-text material. To alleviate this problem without the added labor of using a secondary word processor, it is suggested that any such material be included in an Appendix, and referenced in the text generated in APET.

3) To insert an externally generated text file into the text area in the APET editor, use the command ^KR from within the editor. This is one of a variety of commands that can be used from the APET word processor. To see all available commands, press the F1 key from inside the editor and page through the instruction set.

4) The APET editor uses a word wrap routine that automatically wraps the line to the next line (a common word processing feature). It also maintains vertical alignment along the left margin. If you use indented paragraphs, please be sure that the line after the indented line begins in the column you desire. To do this, use the backspace key to move the first word in the line to the column desired. The recommended solution to this problem is not to indent paragraphs, but instead insert a blank line between each paragraph.

5) If your computer system is configured to automatically load WINDOWS or some other application package, it may be necessary to alter the AUTOEXEC.BAT file (located in the boot drive). Instructions for changing the automatic load of an application will vary by computer. One of the easier methods is to edit the AUTOEXEC.BAT file and remove the line that calls the package. For example, WINDOWS is called by the command WIN. By preventing these packages from loading, a significant amount of RAM is freed and allowed for use by APET.

APPENDIX A

Science Requirements Envelope Document
Topic Outline

1.0 INTRODUCTION/SUMMARY
- 1.1 Description of Experiment Type or Class
- 1.2 Scientific Knowledge to be Gained From This Type of Experimentation
- 1.3 Value of Knowledge of This Type of Experiment to Scientific Field
- 1.4 Necessity for Space Environment to Experiment Type

2.0 BACKGROUND
- 2.1 Scientific Field to which Experiment Type Belongs
- 2.2 Current Application for Research in the Field
- 2.3 Brief Historical Account of Prior Research in the Field
- 2.4 Current Research
- 2.5 Relationship of Proposed Experiment Type to Experiment Field
- 2.6 Anticipated Advance in State of the Art for This Type of Experimentation

3.0 JUSTIFICATION FOR CONDUCTING THE EXPERIMENT IN SPACE
- 3.1 Limitations of Ground-Based Testing
- 3.2 Limitations of Drop Towers
- 3.3 Limitations of Testing in Aircraft
- 3.4 Need for Accommodations in the Shuttle
- 3.5 Limitations of Mathematical Modeling
- 3.6 Limitations of Other Modeling Approaches

4.0 DESCRIPTION OF EXPERIMENT TYPES
- 4.1 General Description of Type of Experiments
- 4.2 Types of Experiment Procedures to be Used
- 4.3 Types of Measurements and Ranges of Values Required

5.0 SCIENCE REQUIREMENTS ENVELOPE
- 5.1 General Description of Experiment Sample Requirements
- 5.2 Range of Atmospheric Requirements
  - 5.2.1 Pressure
  - 5.2.2 Gas Composition
  - 5.2.3 Humidity
  - 5.2.4 Vacuum
- 5.3 Temperature Control and Measurement
- 5.4 Vibration Control and Measurement
- 5.5 Test Matrices

5.6 Imaging Requirements Envelope
5.6.1 Photography
5.6.2 Radiography
5.6.3 Television
5.6.4 Resolution
5.6.5 Frame Rate

5.7 Electromagnetic Limitations

5.8 Astronaut Involvement
5.8.1 Extravehicular Activity
5.8.2 Activation of Experiment

5.9 Data Requirements

5.10 Telepresence and Telerobotics
5.10.1 Telepresence
5.10.2 Telerobotics

6.0 OTHER REQUIREMENTS
6.1 Research Equipment
6.1.1 Preflight
6.1.2 Post flight

6.2 Apparatus Design Assistance

6.3 Consultation

6.4 Grants and Contracts
6.4.1 Grants
6.4.2 Contracts

6.5 Services
6.5.1 Film Developing
6.5.2 Software Development

APPENDIX B

APET Editor Commands

MOVING THE CURSOR:

^D	Left One Character
^S	Right One Character
^A	Left One Word
^F	Right One Word
^I	Tab
^E	Up One Line
^X	Down One Line
^W	Scroll Up
^Z	Scroll Down
^R	Page Up
^C	Page Down
^QS	Beginning of a Line
^QD	End of a Line
^QE	Beginning of a Page
^QX	End of a Page
^QR	Beginning of a File
^QC	End of the File
^QB	Beginning of Marked Block
^QK	End of Marked Block

DELETING AND INSERTING TEXT:

^G	Delete Character Under Cursor
^H	Delete Character Left of Cursor
^T	Delete Next Word
^Y	Delete a Line
^QY	Delete to the End of a Line
^KY	Delete a Marked Block
^V	Insert On/Off
^N	Insert a Line

BLOCK COMMANDS:

^KS	Save This File
^KB	Mark Beginning of Block
^KK	Mark End of Block
^KH	Hide / Display Block
^KC	Copy a Block
^KV	Move a Block
^KY	Delete a Block
^KR	Read a Block from a File
^KW	Write a Block to a File
^KP	Print a Block or File

FORMATTING COMMANDS:

^B	Reformat Paragraph
^OR	Set Right Margin
^QI	Toggle Auto indent Mode
^QW	Toggle Word Wrap

FIND AND REPLACE COMMANDS:

^QA	Find and Replace a String
^QF	Find an Occurrence of a String
^L	Find the Next Occurrence

For assistance in using this software,
or to offer suggestions or comments,
please contact the following:

Mr. Gary Maddux
Ms. Anna Provancha
Mr. David Chattam

at (205) 895-6343,
or write

Systems Management and Production Laboratory
Research Institute
RI E-47
The University of Alabama in Huntsville
Huntsville, AL 35899

APPENDIX D

Safety Requirements Document Software Listing

```
(*SAF12MEN.KB      This is the activity menu to allow the          *)
(*                user to select an activity to perform on        *)
(*                        an existing project.                    *)

no_edit_key ().
no_debug ().
do_gloss = 1.
yn is [YES,NO].
eof = number_to_char (26).

curdir is read_line ('CURDIR.DAT').
orig_curdir = ?curdir.
close (concat('C:\GARDEN\',?CURDIR,'\BASELINE.DAT')).
curdir is string_replace (?curdir,' ','',8).

menu_option is ['FILL OUT DOCUMENTATION',
  'PRINT PED SAFETY COMPLIANCE DATA PACKAGE',
  'DISPLAY PED SAFETY COMPLIANCE DATA PACKAGE',
  'BASELINE PED SAFETY COMPLIANCE DATA PACKAGE',
  'COMPARE BASELINE TO CURRENT REVISION',
  'COPY ANSWERS TO DISK',
  'RETURN TO PREVIOUS MENU',
  'RETURN TO MAIN MENU',QUIT].

window ('Safety Compliance Data Package',blue,white,white,3,3,76,17).
menu_choice = ' '.

while ?menu_choice <> QUIT
  then do (nasamenu).

topic nasamenu.

  ask (['#e #n#n#s    The project you have selected is:  ',?curdir,'#d #n

  Please enter your choice of activities from the list.'],menu_choice,
        ?menu_option).

if ?menu_choice = 'FILL OUT DOCUMENTATION'
  then new_kb ('SAFJA012.HKB').

if ?menu_choice = 'RETURN TO PREVIOUS MENU'
  then new_kb ('SAF12PRO.HKB').

if ?menu_choice = 'RETURN TO MAIN MENU'
  then new_kb ('SAF12.CKB').

if ?menu_choice = 'PRINT PED SAFETY COMPLIANCE DATA PACKAGE'
  then
    new_kb ('SAF12PRN.HKB').

if ?menu_choice = 'DISPLAY PED SAFETY COMPLIANCE DATA PACKAGE'
  then
    new_kb ('SAF12DIS.HKB').

if ?menu_choice = 'BASELINE PED SAFETY COMPLIANCE DATA PACKAGE'
  then do (baseline_rtn).

if ?menu_choice = 'COPY ANSWERS TO DISK'
  then do (copyfiles).
```

```
if ?menu_choice = 'COMPARE BASELINE TO CURRENT REVISION'
  then do (compare_rtn).

if ?menu_choice = QUIT
  then stop ().

topic 'copyfiles'.

  drive_destination = [].
  base_dir = [].

  ask ('

  Do you want to copy your answers to a different drive?',wantcopy,?yn).

  if ?wantcopy = YES
    then
      base_dir = []
      and
      curbase is read_line (concat('C:\GARDEN\',?CURDIR,'\BASELINE.DAT'))
      and
      close (concat('C:\GARDEN\',?CURDIR,'\BASELINE.DAT'))
      and
      if ?curbase <> ?eof
        then
          base_choice = ['BASELINE','CURRENT REVISION','NEITHER']
          and
          ask ('#e

    Do you wish to copy files from the baseline or
    the current revision?',base_dir,?base_choice)
          and
          if ?base_dir = BASELINE
            then
              curdir = concat (?curdir,'\BASELINE')
              and
              curdir = string_replace(?curdir,' ','',8)
              and
              new_file ('C:\GARDEN\CURDIR.DAT')
              and
              write ('C:\GARDEN\CURDIR.DAT',?curdir).

  if ?wantcopy = YES
    then drivelist is [A:,B:,C:,D:,NONE]
  and
    if ?base_dir <> NEITHER
      then
        ask
      ('#e
      Please choose the drive to which you wish to copy the files: ',
      drive_destination,?drivelist).

  if ?wantcopy = YES and ?drive_destination <> NONE and ?base_dir <> NEITHER
    then
      copy_command = concat ('COPY C:\GARDEN\',?curdir,'\*.DAT ',?DRIVE_DESTINAT
    and
      say ('
      Please insert diskette now if you are copying to a floppy drive.

                  Please press #fyellow SPACE#d when ready.     ')
```

```
    and
      move_cursor (1,10)
    and
      dos (?copy_command,restore)
    and
    say ('#e

              Answers have been copied to drive #s',?drive_destination,' #n #n


              Please press #fyellow SPACE#d to exit.    ').

  if ?base_dir = BASELINE
    then
      curdir = ?orig_curdir
      and
      curdir = string_replace(?curdir,' ','',8)
      and
      new_file ('C:\GARDEN\CURDIR.DAT')
      and
      write ('C:\GARDEN\CURDIR.DAT',?curdir).

    do (nasamenu).

end. (* copyfiles *)

topic 'baseline_rtn'.
today = date ().
month = element(?today,1).
day = element(?today,2).
year = element(?today,3).
today = concat(?month,'/',?day,'/',?year).
  ask ('#e

  At some point in the documentation process, it is necessary to
  declare that all documents are complete, and that any changes
  to be made will be treated as revisions to the baseline document.

  Do you want to baseline your answers at this time?',baseline,?yn).

  curbase = ?eof.
  overwrite = YES.
  if ?baseline = YES
    then
      curbase is read_line (concat('C:\GARDEN\',?CURDIR,'\BASELINE.DAT'))
      and
      close (concat('C:\GARDEN\',?CURDIR,'\BASELINE.DAT'))
      and
      if ?curbase <> ?eof
        then
          ask
      ('#e

      You have already baselined this experiment in the past.  Do you
      want to take all revisions and overwrite your previous baseline
      to create a new baseline? ',overwrite,?yn).

  if ?curbase = ?eof and ?baseline = YES
    then
```

```
    window (,white,red,yellow,1,14,32,6)
  and
 say ('#e
This selection will invoke
a DOS command, which will
cause your screen to blank
out momentarily.  Do not
be alarmed.  Press #fyellow SPACE#d now. ')
  and
    md_command = concat ('MD C:\GARDEN\',?curdir,'\BASELINE')
  and
    dos (?md_command,restore)
  and
    copy_command = concat
     ('COPY C:\GARDEN\',?CURDIR,'\*.DAT C:\GARDEN\',?CURDIR,'\BASELINE\*.*')
  and
    dos (?copy_command,restore)
  and
    write (concat('C:\GARDEN\',?CURDIR,'\BASELINE.DAT'),?today)
  and
    close_window ()
  and
    say ('#e

      Baseline document has been created.  All changes to this
      document will be stored in the revision.  A new baseline
      must be created to incorporate any revisions into the
      final document.


                  Please press #fyellow SPACE#d to exit.    ').

 if ?curbase <> ?eof and ?baseline = YES and ?overwrite = YES
  then
    xcopy_command = concat
     ('XCOPY C:\GARDEN\',?CURDIR,'\*.DAT C:\GARDEN\',?CURDIR,
     '\BASELINE\*.* /D:',?CURBASE)
  and
    window (,white,red,yellow,1,14,32,6)
  and
 say ('#e
This selection will invoke
a DOS command, which will
cause your screen to blank
out momentarily.  Do not
be alarmed.  Press #fyellow SPACE#d now. ')
  and
    dos (?xcopy_command,restore)
  and
    new_file (concat('C:\GARDEN\',?CURDIR,'\BASELINE.DAT'))
  and
    write    (concat('C:\GARDEN\',?CURDIR,'\BASELINE.DAT'),?today)
  and
    close_window ()
  and
    say ('#e

      All revisions have been incorporated in the baseline
      document.  Addition changes to this document will be
      stored in a new revision.  A new baseline must be
```

```
        created to incorporate any new revisions into the
        final document.


                        Please press #fyellow SPACE#d to exit.    ').

    do (nasamenu).

end. (* baseline_rtn *)

topic 'compare_rtn'.
  close (concat('C:\GARDEN\',?CURDIR,'\BASELINE.DAT')).
  curbase is read_line (concat('C:\GARDEN\',?CURDIR,'\BASELINE.DAT'))
  and
  close (concat('C:\GARDEN\',?CURDIR,'\BASELINE.DAT'))
  and
  if ?curbase = ?eof
  then
    say
      ('#e

      You have not yet baselined this experiment;  therefore,
      no comparison is necessary.


                      Press #fyellow SPACE#d to continue')

    and
    new_kb ('SAF12MEN.HKB').

  comp_choices = ['RUN COMPARISON PROGRAM','DISPLAY COMPARISONS',
                  'PRINT COMPARISONS','RETURN TO PREVIOUS MENU'].

  ask ('#e

    Do you wish to run the comparison program to generate a new
    listing of differences between the baseline and revision,
    print or display the results of the most recent comparison,
    or exit this menu?',comp_ans,?comp_choices).

  if ?comp_ans = 'RETURN TO PREVIOUS MENU'
    then new_kb ('SAF12MEN.HKB').

  if ?comp_ans = 'RUN COMPARISON PROGRAM'
    then
      do (comp_pgm).

topic 'comp_pgm'.
  comp_command = concat
     ('FC /a C:\GARDEN\',?CURDIR,'\*.DAT C:\GARDEN\',?CURDIR,
     '\BASELINE\*.* > C:\GARDEN\',?CURDIR,'\DIFFER.DAT').
  dos (?comp_command,restore).
  close (concat('C:\GARDEN\',?CURDIR,'\DIFFER.DAT')).

  say ('#e

        Files have been compared.  Please use the display or
        print options to view the results of the comparison.

                      Press #fyellow SPACE#d to continue.').
```

```
end.   (* comp_pgm *)

  if ?comp_ans = 'DISPLAY COMPARISONS'
    then
      comp_file = read (concat(C:\GARDEN\,?CURDIR,'\DIFFER.DAT'))
      and
      say (?comp_file).

  if ?comp_ans = 'PRINT COMPARISONS'
    then
      comp_file = read (concat(C:\GARDEN\,?CURDIR,'\DIFFER.DAT'))
      and
      print (#p,?comp_file,#p).

  do (nasamenu).

end. (* compare_rtn *)

end.   (* nasamenu *)
```

```
(*SAF12.KB       This is the opening screen for a knowledge-        *)
(*                 based system to aid in the development of        *)
(*                NASA documentation for pre-flight planning        *)
(*                              and control.                        *)

yn = [YES,NO].
no_edit_key ().
no_debug ().
action = '  '.
nasaloop = 1.
glossary_load = 0.
column = 3.
row = 3.

while ?action <> 'Exit System'
  then do (mainmenu).

topic 'mainmenu'.

choices = ['How to use the System',
           'Project Selection',
           'PPO Payload Safety Implementation Approach Overview',
           'Glossary/Acronyms',
           'Print Glossary/Acronyms',
           'Exit System'].

window (,white,red,yellow,5,5,75,16).
  set_number_of_values (action,1).

  ask ('#e
  Please select the activity of your choice, or choose Exit
  to leave the system.',action,?choices).

close_window ().

if ?action = 'How to use the System'
  then new_kb ('SAF12INT.HKB').

if ?action = 'Project Selection'
  then new_kb ('SAF12PRO.HKB').

if ?action = 'PPO Payload Safety Implementation Approach Overview'
  then
    new_kb ('SAF12OVR.HKB').

if ?action = 'Glossary/Acronyms'
  then
  glossary_load = (?glossary_load + 1)
  and
  do (glossary).

if ?action = 'Exit System'
  then exit ().

if ?action = 'Print Glossary/Acronyms'
  then
    ask ('#e

        The printing of the glossary/acronym list can require
        a significant amount of time (5 - 10 minutes depending
```

```
        on your system).  Are you sure you want to print the
        glossary at this time?',printok,?yn)
    and
      if ?printok = NO
        then new_kb ('safety.CKB')
      else
    window (,white,red,yellow,1,16,27,4)
    and
    WRITE ('con:',
'  GLOSSARY is being
  printed.

  Please stand by.          ')
    and
    glossary_print is read ('NASATERM.DAT',,'//KSC')
    and
    glossary_print is string_replace(?glossary_print,'//','        ')
    and
    glossary_print is string_replace(?glossary_print,'/end','')
    and
    print (?glossary_print)
    and
    glossary_print is read ('NASATERM.DAT','//KSC')
    and
    glossary_print is string_replace(?glossary_print,'//','        ')
    and
    glossary_print is string_replace(?glossary_print,'/end','')
    and
    print (?glossary_print)
    and
    close_window ().
(* ************************************************************** *)
topic glossary.
  window ('LISTING OF NASA GLOSSARY AND ACRONYMS',blue,white,white,1,1,80,20).


if ?glossary_load = 1
  then
  window (,white,red,yellow,1,16,27,4)
  and
  WRITE ('con:',
'  A slight delay will
  occur while the
  glossary is loaded.
  Please stand by.          ')
  and
  glossary_text is read ('NASAINDX.DAT')
  and
  close_window ()
  and
  close ('NASATERM.DAT').

  say (?glossary_text).

  close_window ().

end. (* glossary *)

topic mark (find_string).
  column = ?column + 1.
```

```
  row     = ?row + 1.
  text is read ('nasaterm.dat',concat('//',?find_string),'/end').
  window (?find_string,blue,white,white,?column,?row,72,).
  say (?text).
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (* mark *)

end. (* mainmenu *)
```

```
(*SAF12INT.KB        This is an introductory screen for the              *)
(*                 NASA Automated Payload Element Tool.                 *)
(*                It is used to give the novice user a                  *)
(*              brief tour of the functions of the system.              *)


yn is [YES,NO].
column = 3.
row = 3.
no_edit_key ().
no_debug ().

tried = 0.


do (so_you_want_to_fly).

new_kb ('SAF12.HKB').

topic so_you_want_to_fly.
  say ('

              #bmagenta So you want to fly an experiment on the Shuttle.#d


     If you have flown with us in the past, you may remember a substantial
     amount of paper documentation was required.  This application,
     the #mAutomated Payload Experiment Tool#m (APET), is designed to
     alleviate much of the burden of the #mexperiment#m document prepar-
     ation and maintenance process.  The APET system can be used to
     prepare several of our support documents, including the Science
     Requirements Document (#mSRD#m), which defines the science objectives,
     the Experiment Requirements Document (#mERD#m), which defines the
     experiment''s design/build requirements, and the PED Safety Compliance
     Data Package, which this specific package addresses.

                              Press #fyellow SPACE#D to continue.').
if ?tried = 0
  then
       column = ?column + 1
       and
       row = ?row + 1
       and
       window (' ',white,red,white,7,5,66,14)
       and

       say ('#e

     This application uses #mhypertext#m technology.  For more
     information on a highlighted topic, just move the mouse
     to that word and click.  The information will immediately
     be displayed.  If you are not using a mouse, please use
     the function keys as indicated at the bottom of the screen.

     For multiple page definitions, please use the #fyellow Page Up#d
     and #fyellow Page Down#d keys to scroll back and forth through
     the pages.  Multiple page displays are indicated by the
     #fyellow Page x of x #d message at the lower right of the screen.
```

```
    For help at anytime throughout the application, select
    the #fyellow F1#d key.  This will retrieve location sensitive
    help information, and may be called from the system
    or system-called edit screens.

    This will be the method by which support documentation
    will be retrieved throughout this application.

                    Press #fyellow SPACE#D to continue.')
  and
    close_window ()
  and
    tried = 1
  and
    column = ?column - 1
  and
    row = ?row - 1
  and
    do (so_you_want_to_fly).


topic mark (find_string).
  column = ?column + 1.
  row    = ?row + 1.
  text is read ('nasaterm.dat',concat('//',?find_string),'/end').
  window (?find_string,blue,white,white,?column,?row,72,).
  say (?text).
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (* mark *)


end. (* so_you_want_to_fly *)
```

```
(*SAF12PRO.KB     This is the project menu to allow the              *)
(*                 user to define a new project or select           *)
(*                an existing project.  It then calls               *)
(*                     the  appropriate submenu.                    *)

no_edit_key ().
no_debug ().
do_gloss = 1.
yn is [YES,NO].
projlist is ' '.
do (firstpass).

if ?project_want = 'RETURN TO MAIN MENU'
  then new_kb ('SAF12.CKB').

topic 'firstpass'.
  eof = number_to_char (26).
  projtest is read_line ('PROJLIST.DAT').
  if ?projtest = ?eof
    then
     do (new_project)
    else
     projlist is read ('PROJLIST.DAT')
    and
     do (old_project).


topic 'new_project'.

window (,white,red,yellow,5,5,75,16).
read_response ('#e
     Please enter an identifier for your project.  This identifier
     should be eight (8) characters or less.  #n ',newproject).

newproject = string_copy (?newproject,1,8).
newproject = string_replace(?newproject,' ','',8).

IF ?NEWPROJECT <> [ ] AND ?NEWPROJECT <> ' ' AND ?NEWPROJECT <> ''
  then
    projlist gets ?newproject
    and
    new_file ('PROJLIST.DAT')
    and
    write ('PROJLIST.DAT',#o,?projlist)
    and
    close ('PROJLIST.DAT')
    and
    project_want = ?newproject
    and
    cur_dir = string_replace(?project_want,' ','',10)
    and
    new_file ('CURDIR.DAT')
    and
    write ('CURDIR.DAT',?cur_dir)
    and
    close ('CURDIR.DAT')
    and
    DOSCOMMAND = CONCAT('MD ',?NEWPROJECT)
    and
    dos (?DOSCOMMAND,restore)
```

```
  else
    say ('#e

     Sorry, the identifier for your project must be a valid DOS
     name, i.e., eight (8) characters or less.

               Please press #fyellow SPACE#d and begin again. ')

     and
     new_kb ('SAF12PRO.HKB').
close_window ().

end. (* new_project *)

topic 'old_project'.

  window (,white, red, yellow, 5,5,75,16).
  choose_project = ?projlist.
  choose_project gets 'ENTER A NEW PROJECT'.
  choose_project gets 'DELETE AN OLD PROJECT'.
  choose_project gets 'RETURN TO MAIN MENU'.
  ask ('#e
  Please select the project of your choice, or enter a new
  project.',project_want,?choose_project).

if ?project_want = ' ' or ?project_want = [ ] or ?project_want = ''
  then do (new_project).

if ?project_want = 'DELETE AN OLD PROJECT'
  then do (kill_project).

if ?project_want = 'RETURN TO MAIN MENU'
    then new_kb ('SAF12.CKB').

  if ?project_want = 'ENTER A NEW PROJECT'
    then do (new_project)
  else
    cur_dir = string_replace(?project_want,' ','',10)
    and
    new_file ('CURDIR.DAT')
    and
    write ('CURDIR.DAT',?cur_dir)
    and
    close ('CURDIR.DAT').

close_window ().

end. (* old_project *)

end. (* firstpass *)

new_kb ('SAF12MEN.HKB').

topic 'kill_project'.
  close ('projlist.dat').
  deletename = ' '.
  window (,white,red,yellow,5,5,75,16).
  ask ('#e

   You have chosen to delete a project.  This will erase all data
```

```
files for the project from your hard drive, plus will remove
the project from the list of available projects.  This deletion
is permanent and cannot be undone;  therefore, use this option
with CAUTION.

Do you wish to proceed with the project deletion?          ',
deleteok,?yn).

if ?deleteok = YES
  then
  read_response ('#e
  Please enter the project identifier exactly as it appears in
  the project selection list.  This identifier should be eight
  (8) characters or less.  #n',killproj).

oldlist is string_to_list (?projlist).

if ?deleteok = YES
  then
    deletename is intersect(?killproj,?oldlist).

deletefnl = NO.

if ?deleteok = YES
  then
    if ?deletename <> ' ' and ?deletename <> '' and ?deletename <> [ ]
      then
        ask (['#e
    This is your FINAL WARNING.
    #s
    Do you want to delete the project: ',?deletename,'?'],deletefnl,?yn)
      else
        say ('#e

     This project was not found.  Please be sure to type
     project title as it appears on the list, i.e. using
     appropriate upper- and lower-case letters.

               Press #fyellow SPACE#d to continue.').

if ?deletefnl = YES
  then
  oldlist is remove (?oldlist,?deletename)
  and
  new_file ('PROJLIST.DAT')
  and
  write ('PROJLIST.DAT',?oldlist)
  and
  close ('PROJLIST.DAT')
  and
  doscommand = concat ('ERASE C:\GARDEN\',?deletename,'\*.*')
  and
  dos (?doscommand,restore)
  and
  doscommand = concat ('RD ',?deletename)
  and
  dos (?doscommand,restore).
close_window ().
new_kb ('SAF12PRO.HKB').
```

```
end. (* kill_project *)
(* ********************************************************************** *)
end.  (* nasamenu *)
```

```
(*SAF12OVR.KB  This is the Overview of JA-012 PPO Payload Safety Implementtion
  Approach document that provides the PED with the informtion used to develope
  the Safety Compliance Data Package.                                        *)

eof = number_to_char (26).
column = 3.
row = 3.

window ('PPO Payload Safety Implementation Approach Overview',blue,white,
  white,?column,?row,77,16).
say ('#e


   This overview limits the access to the referenced documents, however,
   the referenced documents are provided in the section used for filling
   out the Safety Compliance Data Package.



                    Press #fyellow SPACE#d to continue.').

do (Safety_Compliance_Data_Package).

topic mark (find_string).
  row = ?row + 1.
  column = ?column + 1.
  text is read ('NASATERM.DAT', concat ('//', ?find_string), '/end').
  window (?find_string, blue, white, white, ?column, ?row, 72,12).
  say (?text).
  close_window ().
  row = ?row - 1.
  column = ?column - 1.
end. (*topic mark*)

topic 'Safety_Compliance_Data_Package'.
  firstchoice = ''.
  listfirst = ['1.0  PURPOSE',
               '2.0  SCOPE',
               '3.0  GENERAL',
               '4.0  APPLICABLE DOCUMENTS',
               '5.0  IMPLEMENTATION APPROACH',
               '6.0  SAFETY DATA REQUIREMENTS FOR NEW MISSIONS',
               '7.0  SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS',
               'QUIT'].
  while ?firstchoice <> 'QUIT'
    then
      ask ('#e

      The JA-012 PPO Payload Safety Implementation Approach Document
      provides information to the PEDs about their responisbilities
      for documenting the tasks required to evaluate the design and
      operation of the payload element.  This documentation is recorded
      in the PED Safety Compliance Data Package.

      JA-012 covers these areas:  ',firstchoice,?listfirst)
      and
      if ?firstchoice = 'QUIT'
        then
          new_kb ('SAF12.HKB')
```

```
    else
      if ?firstchoice = '1.0  PURPOSE'
        then
          do ('1.0  PURPOSE')
    else
      if ?firstchoice = '2.0  SCOPE'
        then
          do ('2.0  SCOPE')
    else
      if ?firstchoice = '3.0  GENERAL'
        then
          do ('3.0  GENERAL')
    else
      if ?firstchoice = '4.0  APPLICABLE DOCUMENTS'
        then
          do ('4.0  APPLICABLE DOCUMENTS')
    else
      if ?firstchoice = '5.0  IMPLEMENTATION APPROACH'
        then
          do ('5.0  IMPLEMENTATION APPROACH')
    else
      if ?firstchoice = '6.0  SAFETY DATA REQUIREMENTS FOR NEW MISSIONS'
        then
          do ('6.0  SAFETY DATA REQUIREMENTS FOR NEW MISSIONS')
    else
      if ?firstchoice =
            '7.0  SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS'
        then
          do ('7.0  SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS').


topic '1.0  PURPOSE'.
  column = ?column + 1.
  row = ?row + 1.
  window ('1.0  PURPOSE',blue,white,white,?column,?row,74,18).
  say ('
  The purpose of this document is to delineate the activities and
  documentation requirements leading to safety certification of
  instruments, facilities, Mission-Peculiar Equipment (MPE), and
  Instrument Ground Support Equipment (IGSE) that constitute a
  National Space Transportation System (NSTS) payload or payload
  complement for which the #mPPO#m has management and integration
  responsibility. These requirements and activities are commensurate
  with and issued to implement:
  NHB 1700.7,"Safety Policy and Requirements for Payloads Using the NSTS";
  KHB 1700.7,"NSTS Ground Safety Handbook"; and
  NSTS 13830,"Implementation Procedure for NSTS Payload Systems Safety
              Requirements."

  *Documentation references apply to current issue and/or revision and
  all approved changes of the referenced document.

                    Press #fyellow SPACE#d to continue.').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*1.  PURPOSE*)

topic '2.0  SCOPE'.
  column = ?column + 1.
```

```
  row = ?row + 1.
  window ('2.0  SCOPE',blue,white,white,?column,?row,74,19).
  say ('
    This document designates the safety-related activities and
  documentation required of individual #mPED#ms. The Payload Mission
  Manager (PMM) activities are outlined and discussed only to the
  extent necessary for clarification of the overall systems safety
  program activities.

    This document is applicable to all Marshall Space Flight Center
  (MSFC) #mPPO#m managed #mSTS#m attached payload missions and to all of the
  PEDs for those missions. STS attached payloads include Spacelab
  dedicated missions, middeck payloads, and partial-payload missions.
  A partial-payload mission is a flight that is not a Spacelab-dedicated
  (unique) mission and is shared with other payloads. Such missions are
  also referred to as mixed cargo missions.

    Partial payloads are defined as those payloads that do not require
  a Spacelab module or the Spacelab igloo.

                      Press #fyellow SPACE#d to continue.').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*2.  SCOPE*)

topic '3.0  GENERAL'.
  column = ?column + 1.
  row = ?row + 1.
  window ('3.0  GENERAL',blue,white,white,?column,?row,74,18).
  say ('
   There are two distinct aspects of the payload systems safety program.

   These are:
   1.  The Individual Payload Element. Certifying that each item of
       payload equipment, including ground support equipment (GSE), is
       safe for flight/ground operations.

   2.  The Integrated Payload. Certifying that the payload elements,
       when combined into an integrated payload (IPL), including GSE,
       are safe for flight and ground operations.

   The analysis/data and documentation submittal cycles designated
 herein are required to accomplish this certification process.
 All activities required for payload element equipment and operations
 safety certification are the responsibility of the #mPED#m. All PEDs are
 required to certify the safety of their individual payload elements to
 the #mPMM#m.
   The PMM is responsible for certifying the safety of the #mIPL#m to the #mSTS#
 Operators [Johnson Space Center (JSC) and Kennedy Space Center (KSC)].

   A series of progressive reviews, scaled to the maturity of the
 hardware, are scheduled during the Payload Element/Mission Development
 activity. These are necessary to ensure that the final delivered payload
 elements are safe and acceptable for ground processing and flight.

   It is the PED''s responsibility to evaluate the design and operation of
 the payload element; identify, document, and control potential hazards;
 and verify the hazard controls of the payload element. These tasks are
 documented in a #mPED#m Safety Compliance Data Package and are reviewed by
```

```
 the #mPMM#m to ensure overall payload safety. The PED''s safety data submit-
 tals are incorporated into Integrated Payload Safety Compliance Data
 which are reviewed as part of the PMM #mIPL#m reviews, updated as a result
 of the reviews, and used for the safety reviews with the #mNSTS#m operators.

                    Press #fyellow SPACE#d to continue.').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*3.  GENERAL*)

topic '4.0  APPLICABLE DOCUMENTS'.
  column = ?column + 1.
  row = ?row + 1.
  window ('4.  APPLICABLE DOCUMENTS',blue,white,white,?column,?row,74,17).
  say ('  No revision letters/numbers are designated since all references are
  to the latest revision of the document including all approved changes.

   NHB 1700.7       Safety Policy and Requirements for Payloads Using
                    the Space Transportation System (STS)

   KHB 1700.7       Space Transportation System Payload Ground
                    Safety Handbook

   NSTS 18798       Interpretations of STS Payload Safety Requirements
                    (Which contains JSC Letter TA-87-079, "Resumption
                    of Payload Safety Activity," a mandatory
                    requirements letter)

   JA-447           Mission  Requirements on Facilities/Instruments/
                    Experiments for Space Transportation Systems
                    (STS) Attached Payloads (MROFIE)

   JA-061           Payload Mission Manager Interface and Safety
                    Verification Requirements for Instruments, Facilities,
                    MPE, and ECE on STS Spacelab Payload Missions

   JA-081           Payload Mission Manager Interface and Safety
                    Verification Requirements for Instruments, Facilities,
                    MPE, and ECE on STS Partial Payload Missions

   JA-276           Payload Mission Manager Interface and Safety
                    Verification Requirements for Instruments, Facilities,
                    MPE, and ECE on STS Orbiter Middeck Payload Missions

   NSTS 13830       Implementation Procedure for NSTS Payloads System
                    Safety Requirements


   JSC 11123        STS Payload Safety Guidelines Handbook
                    (Guidelines Only)

   KHB 1860.1       KSC Radiation Protection Handbook

   KHB 1860.2       KSC Non-lonizing Radiation Protection Program

   JA-418           Payload Flight Equipment Requirements for Safety
                    Critical Structures

   MSFC-PROC-1301   Guidelines for the Implementation of Required
```

Materials Control Procedures

SPAH SLP/2104 Spacelab Payload Accommodation Handbook

ICD 2-1 M001 Orbiter Middeck/Payload Standard Interfaces Control Document

ICD 2-1-19001 Shuttle Orbiter/Cargo Standard Interfaces (Attachment 1 to NSTS 07700, Volume XIV)

NOTE: The Level I payload flight safety requirements document, NHB 1700.7, is currently undergoing revision. JSC Letter TA-87-079 outlines mandatory additional requirements that must be implemented by the PED, pending release of the revised Level I document. These include certain unique safety data submittal requirements beyond those defined here in Section 6.0, SAFETY DATA REQUIREMENTS FOR NEW MISSIONS. Particular attention should be given to Paragraph c and Enclosure 2 of TA-87-079 relative to data submittals.

```
                    Press #fyellow SPACE#d to continue.').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*4.  APPLICABLE DOCUMENTS*)

topic '5.0  IMPLEMENTATION APPROACH'.
  column = ?column + 1.
  row = ?row + 1.
  window ('5.0  IMPLEMENTATION APPROACH',blue,white,white,?column,?row,74,17).
  say ('
```

The objective of the Safety Program is to protect flight and ground personnel, the #mSTS#m, Spacelab, #mGSE#m, the general public, public-private property, and the environment from payload-related hazards. As defined in #mNHB 1700.7#m, a hazard is "the presence of a potential risk situation caused by an unsafe act or condition."

Simply put, safety assurance consists of the following three steps:

1. Hazard Identification - This is the result of a "Hazard Analysis" in which the Payload flight and ground support equipment, along with its attendant flight and ground operations, are analyzed to determine potential hazards.

2. Hazard Control - The method in the design by which the hazard is controlled and/or eliminated. In certain cases this may be accomplished by operating procedures.

3. Hazard Control Verification - Demonstration by test, and/or analysis, and/or inspection that the hazard control method performs to specifications and does, indeed, control and/or eliminate the hazard.

The data/information from these steps are documented in "Hazard Reports" and supporting data which are required submissions at appropriate Payload/Program Reviews. These reviews are:

*The #mPED#m Payload Element Reviews and the #mPMM#m Integrated Payload (IPL) Reviews which are described in Section 4.0 of #mJA-447#m.

*The Phase 0, I, II, and III Safety Reviews conducted with the #mNSTS#m Operators which are described in Section 5.0 of #mNSTS 13830#m. The PMM assesses/incorporates the PED safety data given at the PED reviews into an overall Integrated Payload Safety Compliance Data Package which the PMM presents to the NSTS Safety Panels. The PED is encouraged (and in most cases will be required) to participate in these Safety Panel reviews.

The relationship of the PED and #mIPL#m reviews to the #mPED#m design, safety implementation and verification activities is shown in #mFigure 5-1 Phase 0#m. The indicated flight and ground safety data is described in more detail in Section 6.0 SAFETY DATA REQUIREMENTS FOR NEW MISSIONS and also in Section 7.0 SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS, and its flow in relation to program milestones is depicted in Figure 6-1. These safety data must be in sufficient detail to describe the equipment and its operation and to define the potential hazards and the proposed or implemented hazard control methods. A hazards analysis is required on all flight/ground hardware, operations, and software, as applicable. These data also form the basis for the Phase 0, I, II, III integrated safety reviews required by the #mNSTS#m Operators.

In some cases, depending upon payload design maturity, Phase 0 and Phase I may be combined into a single review, at the discretion of the #mPMM#m. The integrated payload safety reviews conducted for the #mNSTS#m Operators are generally scheduled 10 weeks after the PMM''s integrated payload reviews. Ensuring the safety of the payload is the primary objective of the reviews. The safety compliance data packages consist of the Hazard Reports (HRs) with their supporting data and the other mandatory data such as the equipment descriptions and operations and the hazardous subsystem descriptions. The Payload Safety Compliance Data Packages are vital in transmitting to the reviewers an understanding of the equipment, of the hazards involved, of the validity of the approach to hazards control, and verification that the controls have been implemented and proven effective.

As shown in #mFigure 5-1 Phase 0#m, the initial safety assessment is of the conceptual design of the flight/ground hardware. This is Phase 0 safety data which is generated for the #mPED#m Preliminary Requirements Review (PRR) and then combined with the other payload element safety data in an integrated payload safety data package for review at the #mIPL#m Requirements Review (RR). After resolution of discrepancies it will be taken, if required, by the #mPMM#m to the #mNSTS#m safety review panels for a Phase 0 review.

Both ground and flight safety hazards analyses, at the preliminary design level, are required for the Phase I ground and flight safety data package due at #mPED#m #mPDR#m. Also due at PED PDR is a preliminary version of the PED Verification Plan which includes descriptions of the activities and the plan for verifying the hazard controls. The applicable data are summarized in the #mHR#ms which are assessed by the #mPMM#m, combined into an #mIPL#m Safety Compliance Data Pack at the IPL PDR, and then presented to the #mNSTS#m Safety Panels at the Phase I review.

The next safety data iteration is at the final design level. This is the Critical Design Review (CDR) and is a review of the design to

which the flight and ground hardware/software is to be manufactured. Thus, the finalization of the hardware description and operation, the hazard controls, and the verifiction methods to be implemented in verifying those controls are in the #mPED#m CDR data package. The PED Safety Compliance Data is assessed and combined by the PMM into an #mIPL#m Safety Compliance Data Package which is baselined following the IPL CDR, with the signature of each of the PEDs required. Once baselined, the data/documents come under control of the Payload Mission Manager (PMM) Configuration Control Board (CCB) and any subsequent changes are formally controlled. It is the responsibility of the PED to ensure that his data remains current and accurate.

Data/documentation changes resulting from mandatory modifications, closeouts, or other review actions are incorporated into the safety data package by the submission of an Engineering Change Request (ECR) by the #mPED#m and approval of the ECR by the #mPMM#m chaired #mCCB#m.

(Note: Change request preparation and processing is described in Appendix F of #mJA-447#m, MROFIE).

After #mIPL#m #mCDR#m, the PMM delivers the baselined #mIPL#m Safety Complia Data Package to the NSTS Phase II Safety Review Panels for the Phase II safety reviews. Actions and open items arising from the Phase II panel review are then addressed and suitable actions are assigned for resolution. The PED remains responsible for the safety of his Payload Element (PE). He must demonstrate satisfactory completion of hazard control verification and must be responsive to any safety mandated action, with respect to his equipment, arising from the successive reviews.

The purpose of the Phase III safety review is to obtain Safety Panel approval of the completed safety analysis and of the safety certification data. The #mPED#m must submit data before the PED Integration Readiness Review (PED IRR), which confirms the satisfactory completion of all hazard control verification items and of all open safety items. These data are submitted by the PED in the form of requested changes as #mECR#ms to the PED''s section of the baselined #mIPL#m Safety Compliance Data Package. The #mPMM#m will assess these data for technical adequacy, completeness, and compliance of the flight and ground hardware/software with the applicable #mNSTS#m safety requirements.

Upon his approval of the #mECR#ms, the #mPMM#m will make the appropriate changes in the #mIPL#m Safety Compliance Data Package then he will initiate and maintain the Payload Flight Safety Verification Tracking Log to formally document and status the payload verification work that was not completed at the time of preparation of the Phase III data package. The PMM will then present the data contained in the safety analyses and the Verification Log to the Safety Panels. He will place special emphasis on all changes made since the Phase II review, on the status of any open actions, and in particular he will address satisfactory completion of all open hazard control verifications. He will also present his required final assessment of the as-built payload/#mGSE#m

against the applicable safety requirements.

A delta Phase III Flight Safety Review will be conducted for all payloads at Launch minus 2 months (L-2 mo). No change in #mPED#m hardware/ software/operations is permitted following the original Phase III review unless the intended change is formally approved by the #mPMM#m before its incorporation. Should the proposed change be planned before on-line operations at #mKSC#m, PMM approval is sought through formal submission by the PED of an #mECR#m to the PMM Configuration Control Board.

Once on-line activities are underway at KSC, changes to hardware/ software/operations may become necessary because of problems arising in the physical integration, test, and checkout of the Payload Element. Changes necessitated by these on-line activities become part of the KSC problem reports/closeouts in the appropriate KSC procedures, and the submission of an ECR is not required. However, these changes will be reviewed and assessed for safety impacts by the PMM in preparation for the delta Phase III Flight Safety Review. Also, the PED will participate in the closing of all applicable problem reports.

Safety certification will be given only after the satisfactory completion of all of the required verification activity.

Early identification of potential flight and ground hazards is necessary to ensure that controls are implemented in the design and that the proper hazard control verification is incorporated in the PED Verification Plan (defined in Appendix B of #mJA-447#m). Based on results of #mPED#m, #mIPL#m, and #mNSTS#m safety reviews, additional safety verificati data may be required during the course of the hardware program. The complexity of some instruments/experiments, coupled with their associated failure severity, requires significant insight into the systems/operations used to control catastrophic hazards. A Failure Mode and Effects Analysis (FMEA) serves as a useful tool for evaluating and assessing the independence of required redundant hazard controls for complex systems requiring two-failure tolerance (fail-safe, fail-safe systems).

The #mPED#m should assess his experiment hardware/software/operations and identify potential hazards that, based upon his judgement, require an #mFMEA#m to clearly demonstrate the required hazard control redundancy. The final FMEA "minimum" requirement will be based upon #mPMM#m assessment of the safety compliance data package with its Hazard Reports. Additional FMEAs may be required by the PMM to show redundancy of hazard controls for catastrophic hazards. The PED safety compliance data are an integral part of the #mIPL#m safety data, with the individual Payload Element reports being integrated as sections into the overall IPL Safety Compliance Data Package, which is baselined at IPL #mCDR#m. In addition to the PED safety compliance data, the IPL Safety Compliance Data Package contains #mMPE#m and IPL safety assessments.

During the course of resolving hazards associated with earlier payload missions, several hazards were identified as common to most payload elements. These hazards have been designated as "generic" hazards (see Appendix B) and can be used by the #mPED#m as guidelines if they are applicable to his equipment. The use of generic hazard reports

is not mandatory; however, the PED is required to identify all hazards, establish and verify controls, and document the results of hazard analyses. The results can be documented on unique reports. The use of generic hazard reports is encouraged since they provide appropriate documentation and identify suitable controls and their verifications.

If the generic hazard reports are used, the PED should carefully evaluate whether the controls and verifications are applicable and adequate for his specific situation and modify the information accordingly. The generic hazard reports and information on backup data required are presented in Appendix B. The generic reports include both flight and ground hazards.

To further assist the #mPED#m in developing hazard reports, examples of some unique hazard reports (that is, hazards unique to the payload element) have been included in Appendix C. These reports show the type and depth of information required, including the hazard controls. The actual control approach will be determined by the PED. These examples are provided as information only and should not be considered a compendium of all hazards associated with a payload.

```
                Press #fyellow SPACE#d to continue.').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*5.  IMPLEMENTATION APPROACH*)

topic '6.0  SAFETY DATA REQUIREMENTS FOR NEW MISSIONS'.
  column = ?column + 1.
  row = ?row + 1.
  window ('6.0  SAFETY DATA REQUIREMENTS FOR NEW MISSIONS',blue,white,white,
  ?column,?row,74,16).
  say ('
     Minimum requirements for the content of flight and ground safety
    compliance data packages have been established and documented in
    #mNSTS 13830#m, the implementing procedure for #mNHB 1700.7#m and #mKHB 1700.
    Safety data required from the #mPED#m is depicted in the Payload Safety
    Compliance Documentation Flow of #mFigure 6-1#m, with corresponding
    submittal time requirements given in #mTable 6-1#m. Specific details of
    the data shown are given in this section.

      In developing the safety data in compliance with implementation
    requirements, it is necessary that each hazard report stand alone
    (i.e., all information/data necessary to fully explain/describe the
    hazard causes and controls must be incorporated into or attached to
    the hazard report).   Reference to other documents may not be used in
    lieu of presenting the necessary information and supporting data.


      Reference to known standards (i.e., #mMSFC-SPEC-522#m, #mMIL-B-5087#m,
    #mNHB 8060.1#m, etc .) is acceptable, however, in the hazard control
    statements.  Safety data will ultimately be reviewed by #mNSTS#m design
    and safety organizations who do not have access to the payload
    element design review packages. This necessitates that hazard reports
    must stand alone and be supported with sufficient information,
    including simplified drawings, sketches, and schematics.   This allows
    for assessment of the hazard, cause, controls, specific verification
```

methods, and status of hazard control verification. The degree of supporting information required is based on the payload element design complexity, the maturity of the payload element development, and the safety review phase.

This section of the program provides information and instructions for the PED to follow to develop both the Flight Safety Compliance Data Package, the Ground Safety Compliace Data, and the PMM Activities for each Phase 0, Phase I, Phase II, Phase III and Delta Phase III.

```
                    Press #fyellow SPACE#d to continue.').

    topic 'Table 6-1'.
      column = ?column + 1.
      row = ?row + 1.
      window ('Table 6-1',blue,white,white,?column,?row,72,18).
  say ('   PED SAFETY COMPLIANCE DATA PACKAGE SUBMITTAL REQUIREMENTS

  PED DATA PACKAGE          SUBMITTAL              UPDATED PACKAGE
                            REQUIREMENT             per RIDs/DNs

  ____________________________________________________________________
  FLIGHT SAFETY DATA
     Phase 0                PED PRR  -30 days      PED PRR  +30 days
     Phase I                PED PDR  -30 days      PED PDR  +30 days
     Phase II               PED CDR  -30 days      PED CDR  +30 days
     Phase III              PED IRR  -30 days
     Delta Phase III        Launch   - 2 months

  GROUND SAFETY DATA
     Phase 0                PED PRR  -30 days      PED PRR  +30 days
     Phase I                PED PDR  -30 days      PED PDR  +30 days
     Phase II               PED CDR  -30 days      PED CDR  +30 days
     Phase III              PED IRR  -90 days
                  Press #fyellow SPACE#d to continue. ').
      column = ?column - 1.
      row = ?row - 1.
      close_window ().
    end. (*Table 6-1*)

  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*6.  SAFETY DATA REQUIREMENTS FOR NEW MISSIONS*)

topic '7.0  SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS'.
  column = ?column + 1.
  row = ?row + 1.
  window ('7.0  SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS',blue,
  white,white,?column,?row,74,16).
  say ('#e
```

Standard Elements are those elements that have successfully completed the #mNSTS#m payload safety review process. Standard elements are:

Previously flown hardware that is to be reflown or Ground Support Equipment which has completed the safety review process.

Series hardware (hardware in a series that is identical in design to hardware previously flown, or qualified ground hardware).

Special data submittal requirements have been developed for payloads using standard elements to eliminate unnecessary duplication of safety activities. The data flow from Payload Element #mPED#m to Integrated Payload #mPMM#m to #mNSTS#m Phased Safety reviews remains the same as that depicted in #mFigure 5-1#m and #mFigure 6-1#m.

This section defines the specific safety assurance data requirements for standard elements in both the Safety Compliance Data Package and the PMM Activities.

```
                    Press #fyellow SPACE#d to continue.').
    column = ?column - 1.
    row = ?row - 1.
    close_window ().
end. (*7.  SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS*)

(*created 1/24/94*)
```

```
(*SAFJA012.KB  This is the beginning of the Safety Compliance Data Package*)
eof = number_to_char (26).
column = 3.
row = 3.
do (Safety_Compliance_Data_Package).

topic mark (find_string).
  row = ?row + 1.
  column = ?column + 1.
  text is read ('NASATERM.DAT', concat ('//', ?find_string), '/end').
  window (?find_string, blue, white, white, ?column, ?row, 72,12).
  say (?text).
  close_window ().
  row = ?row - 1.
  column = ?column - 1.
end. (*topic mark*)

topic 'Safety_Compliance_Data_Package'.
  firstchoice = ''.
  listfirst = ['1.0  PURPOSE',
               '2.0  SCOPE',
               '3.0  GENERAL',
               '4.0  APPLICABLE DOCUMENTS',
               '5.0  IMPLEMENTATION APPROACH',
               '6.0  SAFETY DATA REQUIREMENTS FOR NEW MISSIONS',
               '7.0  SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS',
               'QUIT'].
  window ('PPO Payload Safety Implementation Approach',blue,white,white,
    ?column,?row,76,17).
  while ?firstchoice <> 'QUIT'
    then
      ask ('#e

      The JA-012 PPO Payload Safety Implementation Approach Document
      provides information to the PEDs about their responisbilities
      for documenting the tasks required to evaluate the design and
      operation of the payload element.  This documentation is recorded
      in the PED Safety Compliance Data Package.

      JA-012 covers these areas:  ',firstchoice,?listfirst)
      and
      if ?firstchoice = 'QUIT'
        then
          new_kb ('SAF12MEN.HKB')
      else
        if ?firstchoice = '1.0  PURPOSE'
          then
            do ('1.0  PURPOSE')
      else
        if ?firstchoice = '2.0  SCOPE'
          then
            do ('2.0  SCOPE')
      else
        if ?firstchoice = '3.0  GENERAL'
          then
            do ('3.0  GENERAL')
      else
        if ?firstchoice = '4.0  APPLICABLE DOCUMENTS'
          then
            do ('4.0  APPLICABLE DOCUMENTS')
```

```
    else
      if ?firstchoice = '5.0  IMPLEMENTATION APPROACH'
        then
          do ('5.0  IMPLEMENTATION APPROACH')
    else
      if ?firstchoice = '6.0  SAFETY DATA REQUIREMENTS FOR NEW MISSIONS'
        then
          do ('6.0  SAFETY DATA REQUIREMENTS FOR NEW MISSIONS')
    else
      if ?firstchoice =
              '7.0  SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS'
        then
          do ('7.0  SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS').


topic '1.0  PURPOSE'.
  column = ?column + 1.
  row = ?row + 1.
  window ('1.0  PURPOSE',blue,white,white,?column,?row,74,18).
  say ('
  The purpose of this document is to delineate the activities and
  documentation requirements leading to safety certification of
  instruments, facilities, Mission-Peculiar Equipment (MPE), and
  Instrument Ground Support Equipment (IGSE) that constitute a
  National Space Transportation System (NSTS) payload or payload
  complement for which the #mPPO#m has management and integration
  responsibility. These requirements and activities are commensurate
  with and issued to implement:
  NHB 1700.7,"Safety Policy and Requirements for Payloads Using the NSTS";
  KHB 1700.7,"NSTS Ground Safety Handbook"; and
  NSTS 13830,"Implementation Procedure for NSTS Payload Systems Safety
              Requirements."

  *Documentation references apply to current issue and/or revision and
  all approved changes of the referenced document.

                    Press #fyellow SPACE#d to continue.').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*1.  PURPOSE*)

topic '2.0  SCOPE'.
  column = ?column + 1.
  row = ?row + 1.
  window ('2.0  SCOPE',blue,white,white,?column,?row,74,19).
  say ('
    This document designates the safety-related activities and
  documentation required of individual #mPED#ms. The Payload Mission
  Manager (PMM) activities are outlined and discussed only to the
  extent necessary for clarification of the overall systems safety
  program activities.

    This document is applicable to all Marshall Space Flight Center
  (MSFC) #mPPO#m managed #mSTS#m attached payload missions and to all of the
  PEDs for those missions. STS attached payloads include Spacelab
  dedicated missions, middeck payloads, and partial-payload missions.
  A partial-payload mission is a flight that is not a Spacelab-dedicated
  (unique) mission and is shared with other payloads. Such missions are
  also referred to as mixed cargo missions.
```

```
    Partial payloads are defined as those payloads that do not require
  a Spacelab module or the Spacelab igloo.

                    Press #fyellow SPACE#d to continue.').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*2.  SCOPE*)

topic '3.0  GENERAL'.
  column = ?column + 1.
  row = ?row + 1.
  window ('3.0  GENERAL',blue,white,white,?column,?row,74,18).
  say ('
   There are two distinct aspects of the payload systems safety program.

   These are:
   1.  The Individual Payload Element. Certifying that each item of
       payload equipment, including ground support equipment (GSE), is
       safe for flight/ground operations.

   2.  The Integrated Payload. Certifying that the payload elements,
       when combined into an integrated payload (IPL), including GSE,
       are safe for flight and ground operations.

   The analysis/data and documentation submittal cycles designated
 herein are required to accomplish this certification process.
 All activities required for payload element equipment and operations
 safety certification are the responsibility of the #mPED#m. All PEDs are
 required to certify the safety of their individual payload elements to
 the #mPMM#m.
   The PMM is responsible for certifying the safety of the #mIPL#m to the #mSTS#
 Operators [Johnson Space Center (JSC) and Kennedy Space Center (KSC)].

   A series of progressive reviews, scaled to the maturity of the
 hardware, are scheduled during the Payload Element/Mission Development
 activity. These are necessary to ensure that the final delivered payload
 elements are safe and acceptable for ground processing and flight.

   It is the PED''s responsibility to evaluate the design and operation of
 the payload element; identify, document, and control potential hazards;
 and verify the hazard controls of the payload element. These tasks are
 documented in a #mPED#m Safety Compliance Data Package and are reviewed by
 the #mPMM#m to ensure overall payload safety. The PED''s safety data submit-
 tals are incorporated into Integrated Payload Safety Compliance Data
 which are reviewed as part of the PMM #mIPL#m reviews, updated as a result
 of the reviews, and used for the safety reviews with the #mNSTS#m operators.

                    Press #fyellow SPACE#d to continue.').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*3.  GENERAL*)

topic '4.0  APPLICABLE DOCUMENTS'.
  column = ?column + 1.
  row = ?row + 1.
  window ('4.  APPLICABLE DOCUMENTS',blue,white,white,?column,?row,74,17).
  say ('  No revision letters/numbers are designated since all references are
```

to the latest revision of the document including all approved changes.

NHB 1700.7	Safety Policy and Requirements for Payloads Using the Space Transportation System (STS)
KHB 1700.7	Space Transportation System Payload Ground Safety Handbook
NSTS 18798	Interpretations of STS Payload Safety Requirements (Which contains JSC Letter TA-87-079, "Resumption of Payload Safety Activity," a mandatory requirements letter)
JA-447	Mission Requirements on Facilities/Instruments/ Experiments for Space Transportation Systems (STS) Attached Payloads (MROFIE)
JA-061	Payload Mission Manager Interface and Safety Verification Requirements for Instruments, Facilities, MPE, and ECE on STS Spacelab Payload Missions
JA-081	Payload Mission Manager Interface and Safety Verification Requirements for Instruments, Facilities, MPE, and ECE on STS Partial Payload Missions
JA-276	Payload Mission Manager Interface and Safety Verification Requirements for Instruments, Facilities, MPE, and ECE on STS Orbiter Middeck Payload Missions
NSTS 13830	Implementation Procedure for NSTS Payloads System Safety Requirements
JSC 11123	STS Payload Safety Guidelines Handbook (Guidelines Only)
KHB 1860.1	KSC Radiation Protection Handbook
KHB 1860.2	KSC Non-lonizing Radiation Protection Program
JA-418	Payload Flight Equipment Requirements for Safety Critical Structures
MSFC-PROC-1301	Guidelines for the Implementation of Required Materials Control Procedures
SPAH SLP/2104	Spacelab Payload Accommodation Handbook
ICD 2-1 M001	Orbiter Middeck/Payload Standard Interfaces Control Document
ICD 2-1-19001	Shuttle Orbiter/Cargo Standard Interfaces (Attachment 1 to NSTS 07700, Volume XIV)

NOTE: The Level I payload flight safety requirements document, NHB 1700.7, is currently undergoing revision. JSC Letter TA-87-079 outlines mandatory additional requirements that must be implemented by the PED, pending release of the revised Level I document. These include certain unique safety data submittal requirements beyond

```
   those defined here in Section 6.0, SAFETY DATA REQUIREMENTS FOR NEW
   MISSIONS. Particular attention should be given to Paragraph c and
   Enclosure 2 of TA-87-079 relative to data submittals.


                    Press #fyellow SPACE#d to continue.').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*4.  APPLICABLE DOCUMENTS*)

topic '5.0  IMPLEMENTATION APPROACH'.
  new_kb ('SEC5SUB.HKB').
end. (*5.  IMPLEMENTATION APPROACH*)

topic '6.0  SAFETY DATA REQUIREMENTS FOR NEW MISSIONS'.
  column = ?column + 1.
  row = ?row + 1.
  window ('6.0  SAFETY DATA REQUIREMENTS FOR NEW MISSIONS',blue,white,white,
  ?column,?row,74,17).
  say ('
     Minimum requirements for the content of flight and ground safety
   compliance data packages have been established and documented in
   #mNSTS 13830#m, the implementing procedure for #mNHB 1700.7#m and #mKHB 1700.
   Safety data required from the #mPED#m is depicted in the Payload Safety
   Compliance Documentation Flow of #mFigure 6-1#m, with corresponding
   submittal time requirements given in #mTable 6-1#m. Specific details of
   the data shown are given in this section.

     In developing the safety data in compliance with implementation
   requirements, it is necessary that each hazard report stand alone
   (i.e., all information/data necessary to fully explain/describe the
   hazard causes and controls must be incorporated into or attached to
   the hazard report).   Reference to other documents may not be used in
   lieu of presenting the necessary information and supporting data.



     Reference to known standards (i.e., #mMSFC-SPEC-522#m, #mMIL-B-5087#m,
   #mNHB 8060.1#m, etc .) is acceptable, however, in the hazard control
   statements.  Safety data will ultimately be reviewed by #mNSTS#m design
   and safety organizations who do not have access to the payload
   element design review packages. This necessitates that hazard reports
   must stand alone and be supported with sufficient information,
   including simplified drawings, sketches, and schematics.   This allows
   for assessment of the hazard, cause, controls, specific verification
   methods, and status of hazard control verification. The degree of
   supporting information required is based on the payload element design
   complexity, the maturity of the payload element development, and the
   safety review phase.

                    Press #fyellow SPACE#d to continue.').

  (*This calls a subprogram that displays all of section 6.0.*)

    topic 'Table 6-1'.
      column = ?column + 1.
      row = ?row + 1.
      window ('Table 6-1',blue,white,white,?column,?row,72,18).
  say ('   PED SAFETY COMPLIANCE DATA PACKAGE SUBMITTAL REQUIREMENTS
```

```
  PED DATA PACKAGE          SUBMITTAL              UPDATED PACKAGE
                            REQUIREMENT             per RIDs/DNs
  ------------------------------------------------------------------
  FLIGHT SAFETY DATA
     Phase 0                PED PRR  -30 days      PED PRR  +30 days
     Phase I                PED PDR  -30 days      PED PDR  +30 days
     Phase II               PED CDR  -30 days      PED CDR  +30 days
     Phase III              PED IRR  -30 days
     Delta Phase III        Launch   - 2 months

  GROUND SAFETY DATA
     Phase 0                PED PRR  -30 days      PED PRR  +30 days
     Phase I                PED PDR  -30 days      PED PDR  +30 days
     Phase II               PED CDR  -30 days      PED CDR  +30 days
     Phase III              PED IRR  -90 days
                    Press #fyellow SPACE#d to continue. ').
      column = ?column - 1.
      row = ?row - 1.
      close_window ().
    end. (*Table 6-1*)

  new_kb ('SEC6SUB.HKB').

  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*6.  SAFETY DATA REQUIREMENTS FOR NEW MISSIONS*)

topic '7.0  SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS'.
  column = ?column + 1.
  row = ?row + 1.
  window ('7.0  SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS',blue,
  white,white,?column,?row,74,16).
  say ('#e
   Standard Elements are those elements that have successfully completed
   the #mNSTS#m payload safety review process. Standard elements are:

       Previously flown hardware that is to be reflown or Ground Support
       Equipment which has completed the safety review process.

       Series hardware (hardware in a series that is identical in design
       to hardware previously flown, or qualified ground hardware).

   Special data submittal requirements have been developed for payloads
   using standard elements to eliminate unnecessary duplication of
   safety activities. The data flow from Payload Element #mPED#m to
   Integrated Payload #mPMM#m to #mNSTS#m Phased Safety reviews remains the
   same as that depicted in #mFigure 5-1#m and #mFigure 6-1#m.

                    Press #fyellow SPACE#d to continue.')
      and
      do (sectionseven).

   topic 'sectionseven'.
     list7 = ['7.1   SAFETY COMPLIANCE DATA REQUIREMENTS',
              '7.2   PMM ACTIVITIES',
              'QUIT'].
     choice7 = ''.
     while ?choice7 <> 'QUIT'
```

```
     then
       ask ('

These sections define the specific safety assurance data requirements
for standard elements.  Please select the section you wish to continue
with.',choice7,?list7)
       and
       if ?choice7 = 'QUIT'
         then
           column = ?column - 1
           and
           row = ?row - 1
           and
           close_window()
       else
         if ?choice7 = '7.1   SAFETY COMPLIANCE DATA REQUIREMENTS'
           then
             do ('7.1   SAFETY COMPLIANCE DATA REQUIREMENTS')
       else
         if ?choice7 = '7.2   PMM ACTIVITIES'
           then
             do ('7.2   PMM ACTIVITIES').

topic '7.1   SAFETY COMPLIANCE DATA REQUIREMENTS'.
  column = ?column + 1.
  row = ?row + 1.
  window ('7.1  SAFETY COMPLIANCE DATA REQUIREMENTS',blue,white,white,
    ?column,?row,73,16).
  say ('
 A payload may be composed of a combination of new payload elements
 and standard elements. In this event, the safety data for new payload
 elements will be provided in accordance with section 6.0 SAFETY DATA
 REQUIREMENTS FOR NEW MISSIONS.

 The following data for standard elements shall be included in the #MPED#M
 Safety Compliance Data Package:

   1) Baseline Safety Compliance Data Package previously approved for
   flight or ground use/operation and closures of Safety Panel action
   items. The package should be updated to clearly delineate
   information which is not applicable to the new payload.  This data
   shall be submitted as a part of the review data package at the
   first PED milestone review.


   2) An assessment of the safety verification methods identified on
   the hazard reports contained in the baseline Safety Compliance Data
   Package. All the safety verification methods that are modified or
   that must be reverified shall be clearly identified.

   3) Descriptions of changes (if applicable) made to the design or
   operational procedures of the standard element. Changes to the
   ground operations scenario should also be provided. For reflown
   hardware, a description of all maintenance and/or refurbishment
   to be accomplished should also be included.

   4) Hazard reports, including supporting data as necessary, to
   address changes affecting the standard element and its interfaces.
   These hazard reports shall be prepared to the level of detail
   required by the review being conducted.
```

5) Assessment statement regarding safety deficiencies encountered during previous usages of the standard elements. The #mPED#m shall evaluate all failures and anomalies encountered during previous use of the standard elements on the #mNSTS#m, ensure that those failures and anomalies affecting safety have been corrected, and identify the corrective action(s) taken.

6) Assessment of the standard element for limited-life items (reflown hardware or reused #mGSE#m only) in terms of remaining time /cycles left before exceeding design life time/cycles.

The data shall be updated as necessary for each of the phased reviews. At the Phase III review, the data should show that the verification/ reverification process has been completed and that all hazard controls /verifications are closed.

(Note: The Phase III Safety Compliance Data Package shall contain a signed Certificate of Safety Compliance.)

```
                    Press #fyellow SPACE#d to continue.').

    column = ?column - 1.
    row = ?row - 1.
    close_window ().
  end. (*7.1   SAFETY COMPLIANCE DATA REQUIREMENTS*)

  topic '7.2   PMM ACTIVITIES'.
    column = ?column + 1.
    row = ?row + 1.
    window ('7.2  PMM ACTIVITIES',blue,white,white,?column,?row,73,15).
    say ('

        Review of #mPED#m flight and ground safety data, subsequent
        incorporation of these data into the #mIPL#m Safety Compliance
        Data Package, and review of the IPL safety data by the #mNSTS#m
        Safety Panels at #mJSC#m and #mKSC#m proceed as in new missions.


                          Press #fyellow SPACE#d to continue.').
    column = ?column - 1.
    row = ?row - 1.
    close_window ().
  end. (*7.2 PMM ACTIVITIES*)
  end. (*sectionseven*)
end. (*7.  SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS*)

(*created 6/30/92 - 7/1/92*)
(*edited 12/13/93 - *)
```

```
 (*SEC5SUB.KB  This is the program called from SAFJA012.KB to display section
    5.0 IMPLEMENTATION APPROACH, due to the number of graphics and referenced
    documents this section must be a stand alone section to conserve memory.*)

eof = number_to_char (26).
column = 3.
row = 3.
do ('5.0  IMPLEMENTATION APPROACH').
new_kb ('SAFJA012.HKB').

topic mark (find_string).
  row = ?row + 1.
  column = ?column + 1.
  text is read ('NASATERM.DAT', concat ('//', ?find_string), '/end').
  window (?find_string, blue, white, white, ?column, ?row, 72,12).
  say (?text).
  close_window ().
  row = ?row - 1.
  column = ?column - 1.
end. (*topic mark*)

topic '5.0  IMPLEMENTATION APPROACH'.
  window ('SAFETY COMPLIANCE DATA PACKAGE',blue,white,white,?column,?row,76,18).
  column = ?column + 1.
  row = ?row + 1.
  window ('5.0  IMPLEMENTATION APPROACH',blue,white,white,?column,?row,74,17).
  say ('
    The objective of the Safety Program is to protect flight and ground
  personnel, the #mSTS#m, Spacelab, #mGSE#m, the general public, public-private
  property, and the environment from payload-related hazards. As defined
  in #mNHB 1700.7#m, a hazard is "the presence of a potential risk situation
  caused by an unsafe act or condition."

    Simply put, safety assurance consists of the following three steps:

    1. Hazard Identification - This is the result of a "Hazard Analysis"
       in which the Payload flight and ground support equipment,
       along with its attendant flight and ground operations, are
       analyzed to determine potential hazards.

    2. Hazard Control - The method in the design by which the
       hazard is controlled and/or eliminated. In certain cases this
       may be accomplished by operating procedures.

    3. Hazard Control Verification - Demonstration by test, and/or
       analysis, and/or inspection that the hazard control method
       performs to specifications and does, indeed, control and/or
       eliminate the hazard.

    The data/information from these steps are documented in "Hazard
  Reports" and supporting data which are required submissions at
  appropriate Payload/Program Reviews. These reviews are:

    *The #mPED#m Payload Element Reviews and the #mPMM#m Integrated Payload
    (IPL) Reviews which are described in #mSection 4.0#m of #mJA-447#m.

    *The Phase 0, I, II, and III Safety Reviews conducted with the #mNSTS#m
    Operators which are described in #mSection 5.0#m of #mNSTS 13830#m. The PMM
    assesses/incorporates the PED safety data given at the PED reviews
    into an overall Integrated Payload Safety Compliance Data Package
```

which the PMM presents to the NSTS Safety Panels. The PED is encouraged (and in most cases will be required) to participate in these Safety Panel reviews.

The relationship of the PED and #mIPL#m reviews to the #mPED#m design, safety implementation and verification activities is shown in #mFigure 5-1#m. The indicated flight and ground safety data is described in more detail in Section 6.0 SAFETY DATA REQUIREMENTS FOR NEW MISSIONS and also in Section 7.0 SAFETY DATA REQUIREMENTS FOR STANDARD ELEMENT MISSIONS, and its flow in relation to program milestones is depicted in #mFigure 6-1#m. These safety data must be in sufficient detail to describe the equipment and its operation and to define the potential hazards and the proposed or implemented hazard control methods. A hazards analysis is required on all flight/ground hardware, operations, and software, as applicable. These data also form the basis for the Phase 0, I, II, III integrated safety reviews required by the #mNSTS#m Operators.

In some cases, depending upon payload design maturity, Phase 0 and Phase I may be combined into a single review, at the discretion of the #mPMM#m. The integrated payload safety reviews conducted for the #mNSTS#m Operators are generally scheduled 10 weeks after the PMM''s integrated payload reviews. Ensuring the safety of the payload is the primary objective of the reviews. The safety compliance data packages consist of the Hazard Reports (HRs) with their supporting data and the other mandatory data such as the equipment descriptions and operations and the hazardous subsystem descriptions. The Payload Safety Compliance Data Packages are vital in transmitting to the reviewers an understanding of the equipment, of the hazards involved, of the validity of the approach to hazards control, and verification that the controls have been implemented and proven effective.

As shown in #mFigure 5-1#m, the initial safety assessment is of the conceptual design of the flight/ground hardware. This is Phase 0 safety data which is generated for the #mPED#m Preliminary Requirements Review (PRR) and then combined with the other payload element safety data in an integrated payload safety data package for review at the #mIPL#m Requirements Review (RR). After resolution of discrepancies it will be taken, if required, by the #mPMM#m to the #mNSTS#m safety review panels for a Phase 0 review.

Both ground and flight safety hazards analyses, at the preliminary design level, are required for the Phase I ground and flight safety data package due at #mPED#m #mPDR#m. Also due at PED PDR is a preliminary version of the PED Verification Plan which includes descriptions of the activities and the plan for verifying the hazard controls. The applicable data are summarized in the #mHR#ms which are assessed by the #mPMM#m, combined into an #mIPL#m Safety Compliance Data Pack at the IPL PDR, and then presented to the #mNSTS#m Safety Panels at the Phase I review.

The next safety data iteration is at the final design level. This is the Critical Design Review (CDR) and is a review of the design to which the flight and ground hardware/software is to be manufactured. Thus, the finalization of the hardware description and operation, the hazard controls, and the verifiction methods to be implemented in verifying those controls are in the #mPED#m CDR data package. The PED Safety Compliance Data is assessed and combined by the PMM into an

#mIPL#m Safety Compliance Data Package which is baselined following the IPL CDR, with the signature of each of the PEDs required. Once baselined, the data/documents come under control of the Payload Mission Manager (PMM) Configuration Control Board (CCB) and any subsequent changes are formally controlled. It is the responsibility of the PED to ensure that his data remains current and accurate.

Data/documentation changes resulting from mandatory modifications, closeouts, or other review actions are incorporated into the safety data package by the submission of an Engineering Change Request (ECR) by the #mPED#m and approval of the ECR by the #mPMM#m chaired #mCCB#m.

(Note: Change request preparation and processing is described in #mAppendix F#m of #mJA-447#m, MROFIE).

After #mIPL#m #mCDR#m, the PMM delivers the baselined #mIPL#m Safety Complia Data Package to the NSTS Phase II Safety Review Panels for the Phase II safety reviews. Actions and open items arising from the Phase II panel review are then addressed and suitable actions are assigned for resolution. The PED remains responsible for the safety of his Payload Element (PE). He must demonstrate satisfactory completion of hazard control verification and must be responsive to any safety mandated action, with respect to his equipment, arising from the successive reviews.

The purpose of the Phase III safety review is to obtain Safety Panel approval of the completed safety analysis and of the safety certification data. The #mPED#m must submit data before the PED Integration Readiness Review (PED IRR), which confirms the satisfactory completion of all hazard control verification items and of all open safety items. These data are submitted by the PED in the form of requested changes as #mECR#ms to the PED''s section of the baselined #mIPL#m Safety Compliance Data Package. The #mPMM#m will assess these data for technical adequacy, completeness, and compliance of the flight and ground hardware/software with the applicable #mNSTS#m safety requirements.

Upon his approval of the #mECR#ms, the #mPMM#m will make the appropriate changes in the #mIPL#m Safety Compliance Data Package then he will initiate and maintain the Payload Flight Safety Verification Tracking Log to formally document and status the payload verification work that was not completed at the time of preparation of the Phase III data package. The PMM will then present the data contained in the safety analyses and the Verification Log to the Safety Panels. He will place special emphasis on all changes made since the Phase II review, on the status of any open actions, and in particular he will address satisfactory completion of all open hazard control verifications. He will also present his required final assessment of the as-built payload/#mGSE#m against the applicable safety requirements.

A delta Phase III Flight Safety Review will be conducted for all

payloads at Launch minus 2 months (L-2 mo). No change in #mPED#m hardware/ software/operations is permitted following the original Phase III review unless the intended change is formally approved by the #mPMM#m before its incorporation. Should the proposed change be planned before on-line operations at #mKSC#m, PMM approval is sought through formal submission by the PED of an #mECR#m to the PMM Configuration Control Board.

Once on-line activities are underway at KSC, changes to hardware/ software/operations may become necessary because of problems arising in the physical integration, test, and checkout of the Payload Element. Changes necessitated by these on-line activities become part of the KSC problem reports/closeouts in the appropriate KSC procedures, and the submission of an ECR is not required. However, these changes will be reviewed and assessed for safety impacts by the PMM in preparation for the delta Phase III Flight Safety Review. Also, the PED will participate in the closing of all applicable problem reports.

Safety certification will be given only after the satisfactory completion of all of the required verification activity.

Early identification of potential flight and ground hazards is necessary to ensure that controls are implemented in the design and that the proper hazard control verification is incorporated in the PED Verification Plan (defined in #mAppendix B of JA-447#m). Based on results of #mPED#m, #mIPL#m, and #mNSTS#m safety reviews, additional safety verificati data may be required during the course of the hardware program. The complexity of some instruments/experiments, coupled with their associated failure severity, requires significant insight into the systems/operations used to control catastrophic hazards. A Failure Mode and Effects Analysis (FMEA) serves as a useful tool for evaluating and assessing the independence of required redundant hazard controls for complex systems requiring two-failure tolerance (fail-safe, fail-safe systems).

The #mPED#m should assess his experiment hardware/software/operations and identify potential hazards that, based upon his judgement, require an #mFMEA#m to clearly demonstrate the required hazard control redundancy. The final FMEA "minimum" requirement will be based upon #mPMM#m assessment of the safety compliance data package with its Hazard Reports. Additional FMEAs may be required by the PMM to show redundancy of hazard controls for catastrophic hazards. The PED safety compliance data are an integral part of the #mIPL#m safety data, with the individual Payload Element reports being integrated as sections into the overall IPL Safety Compliance Data Package, which is baselined at IPL #mCDR#m. In addition to the PED safety compliance data, the IPL Safety Compliance Data Package contains #mMPE#m and IPL safety assessments.

During the course of resolving hazards associated with earlier payload missions, several hazards were identified as common to most payload elements. These hazards have been designated as "generic" hazards (see #mAppendix B#m) and can be used by the #mPED#m as guidelines if they are applicable to his equipment. The use of generic hazard reports is not mandatory; however, the PED is required to identify all hazards, establish and verify controls, and document the results of hazard analyses. The results can be documented on unique reports. The use of generic hazard reports is encouraged since they provide appropriate documentation and identify suitable controls and their verifications.

If the generic hazard reports are used, the PED should carefully evaluate whether the controls and verifications are applicable and adequate for his specific situation and modify the information accordingly. The generic hazard reports and information on backup data required are presented in Appendix B. The generic reports include both flight and ground hazards.

To further assist the #mPED#m in developing hazard reports, examples of some unique hazard reports (that is, hazards unique to the payload element) have been included in #mAppendix C#m. These reports show the type and depth of information required, including the hazard controls. The actual control approach will be determined by the PED. These examples are provided as information only and should not be considered a compendium of all hazards associated with a payload.

```
                        Press #fyellow SPACE#d to continue.').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*5.  IMPLEMENTATION APPROACH*)

topic 'Figure 5-1'.
  window (,white,red,yellow,1,16,29,4)
  and
  say ('  The screen will go blank
  for a few seconds while
  the files are being loaded.
  Press #fyellow SPACE#d to continue.')
  and
  collect ()
  and
  dos ('SAFE_REV.EXE',restore)
  and
  close_window().
end. (*figure 5-1*)

topic 'Figure 6-1'.
  (*This section needs to be redone.  The figure has been divided into 6
  seperate parts to be displayed seperately, however, 1 & 2 = Phase 0
  3 & 4 = Phase I, 5 = Phase II, Phase III is not shown, and Delta Phase = 6.
  This coding blinks a screen in between graphics which will be very confusing
  and unpleasant to the user.*)
  dos ('PAYSAFE1.EXE',restore).
  dos ('PAYSAFE2.EXE',restore).
  dos ('PAYSAFE3.EXE',restore).
  dos ('PAYSAFE4.EXE',restore).
  dos ('PAYSAFE5.EXE',restore).
  dos ('PAYSAFE6.EXE',restore).
end. (*Figure 6-1*)

topic 'Appendix B'.
  window ('Appendix B',blue,white,white,?column,?row,74,18).
  say ('#e                          GENERIC HAZARD REPORTS
```

During the safety review process by MSFC on numerous payloads (including Spacelab and partial payloads), it has become apparent that there are several types of hazards that are applicable to most payload elements and use essentially the same hazard controls. These hazards and controls have been incorporated on payload hazard reports and have been designated as "generic." The generic hazard reports can be used by the PED in the development of safety data, if they are applicable.

In performing the hazard analyses, the PED should identify all hazards and causes, develop controls, and perform the verification necessary for safety certification. If a particular generic hazard report is applicable, the PED is free to use the form; however, the submitted report should be tailored to specific needs. All other hazards must be identified on unique hazard reports. Both unique and generic hazard reports are to be submitted in the PED safety data package.

To assiste the PED in the safety data development, seven generic flight hazard reports (designated G-1 through G-7) and three generic ground hazard reports (designated KG-1 through KG-3) are provided in the appendix. These hazard reports have been interspersed with notes to the PED to provide information or clarification of data to support the report.

The examples from the appendix are provided through Hypertext links in Section 6.0 SAFETY DATA REQUIREMENTS FOR NEW MISSIONS.

Press #fyellow SPACE#d to continue. ').

```
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*Appendix B*)

topic 'Appendix C'.
  column = ?column + 1.
  row = ?row + 1.
  window ('Appendix C',blue,white,white,?column,?row,74,16).
  say ('#e                              UNIQUE HAZARD REPORTS
```

During the performance of the payload element (including experiments) hazards analyses, it is highly probable that hazards that do not fall into the category covered by generic hazard reports will be identified. These hazards are generally peculiar to a particular instrument/ experiment, or the hazard contols very significantly from the other payload elements. These hazards are identified and documented as unique hazard reports and should be designated with a unique report number.

A tabulation of several hazard titles has been developed and is presented as an aid to the PED in developing the safety data. These titles are proveded in #mTable C-1#m for flight hazards and #mTable C-2#m for ground hazards.

To further assist the PED in understanding the type of backup information required for safety data, tow examples of unique flight hazard reports have been provided in a Phase III configuration. These hazard reports relate to pyrotechnic release devices and a high-presence gas system. The backup information is typical of the data required for hazard report closure.

There is one unique flight hazard report that must be submitted for each item of payload equipment, if applicable. This report deals with the loss of the payload cooling medium (Freon, water, rack air, cabin air, etc.) and is titled "Loss of Cooling." This is not categorized as a generic hazard because of the wide range of control and verification options which make such an inclusion impratical.

The category itself can be "critical" for some designs and "catastrophic" for others, depending upon the hazard potential. Controls can range from no special controls, if cooling loss can be verified not to be a hazard, to a redundant set of automatic power cutoff equiment for a design with catastrophic hazard potential.

```
                          Press #fyellow SPACE#d to continue. ').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*Appendix C*)

topic 'Table C-1'.
  column = ?column + 1.
  row = ?row + 1.
  window ('TABLE C-1',blue,white,white,?column,?row,72,16).
  say ('

               EXAMPLES OF UNIQUE FLIGHT HAZARD TITLES

               This section lists titles in both areas.
               Please select the most appropriate one.

                #mORBITER MIDDECK OR SPACELAB MODULE#m


                      #mORBITER PAYLOAD BAY#m


                     Press #fyellow SPACE#d to continue.').


  topic 'ORBITER MIDDECK OR SPACELAB MODULE'.
    say ('#e
          Exposure of Crew to Broken Glass or Frangible Materials
```

```
Release of Toxic or Noxious Gas into Habitable Atmosphere

Containment of Flammable Fluids

Frangmentation or Failure of Rotating Equipment

Explosion/Rupture of Batteries

Contamination Because of Battery Electrolyte Leakage

Electrical Shock from Biomedical Instrumentation System

Improperly Stowed Equipment

Untethered Experiment Apparatus

Hazardous Touch Temperatures

Exposure of Crew to Pathogenic Micro-Organisms

Containment of Stowed Energy; e.g., Springs

Explosion/Rupture of Pressure Systems

Contamination Because of Release of Mercury

Failure of Vacuum Venting Results in Loss of Orbiter/Module Atmosphere

Use of Toxic Materials

Eye Injury As A Result of Exposure to Laser or Other High-Intensity
Light (Nonionizing Radiation)

Overtemperature/Fire Resulting from Runaway Furnaces or Heaters

Loss of Cooling

Impediment for Emergency Egress of the Crew From the Module

Inability to Restow/Relatch Experiment Equipment during Emergency
Evacuation

Use of Radioactive Materials

Containment of Toxic Experiment Samples
Press #fyellow SPACE#d to continue. ').

end. (*ORBITER MIDDECK OR SPACELAB MODULE*)

topic 'ORBITER PAYLOAD BAY'.
  say ('#e
Battery - Explosive Rupture/Leakage

Collision Caused by Unsecured Hardware (e.g., Covers)

Explosion/Implosion of Experiment Container

Use of Radioactive Materials

Explosion/Rupture of Pressure Systems (Including Heat Pipes)
```

Collision Because of Experiment Pointing System Failure

Cryogen Storage Tank Overpressurization

Collision Because of Experiment Restraint Latch Failure

Collision Among Payload Elements During RMS Operations

Fire/Damage Becasue of High-Energy Laser; also Crew Exposure

Premature Deployment of Mast (or other Deployable Elements)

Premature Actuation of Pyrotechnic or other Release Devices

Inability to Restow Deployable Payloads

Inability to Clear Payload Bay Doors

Release of Mercury into the Payload Bay

Loose Equipment Jams Payload Bay Door Closure Mechanism

Eye Damage Because of Improper Positioning of Reflecting Lasers

Contamination Resulting from Release of Corrosive Materials

Contact or recontact with the Orbiter or Deployed Payload Equipment

```
                        Press #fyellow SPACE#d to continue. ').
  end. (*ORBITER PAYLOAD BAY*)

  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*Table C-1*)

topic 'Table C-2'.
  column = ?column + 1.
  row = ?row + 1.
  window ('TABLE C-2',blue,white,white,?column,?row,72,16).
  say ('#e
                EXAMPLES OF UNIQUE GROUND HAZARD TITLES

                    Use of Radioactive Materials

              Release of Toxic Gases during Ground Operations

     Use of Laser/High-Intensity Light that could Casue Eye Damage

                 Oxygen Displacement in Confined Areas

              Containment and Handling of Cryogenic Fluids

  Use of Spark (Ignition) Sources in Equipment Adjacent to Orbiter or
                          Propellant Systems
```

Explosion/Rupture of Batteries

Containment of Mercury

Handling/Operations using Biological Specimens

Use of Flammable Fluids during Ground Operations

Premature Actuation of Pyrotechnic Devices

Exposure of Ground Crew to Rotating Devices

```
                    Press #fyellow SPACE#d to continue. ').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*Table C-2*)

topic 'Section 4.0'.
  new_kb ('SEC4MROFE.HKB').
end. (*Section 4.0*)

topic 'Appendix B of JA-447'.
  column = ?column + 1.
  row = ?row + 1.
  window ('Appendix B of JA-447',blue,white,white,?column,?row,73,17).
  say ('#e                    DATA REQUIREMENT DESCRIPTIONS
              PAYLOAD ELEMENT DEVELOPER (PED) PREPARED

  Contained in this appendix are descriptions and instructions for prep-
  aration of the data required from the Payload Element Developer(PED).
  Following is the data requirements list for those documents to be
  prepared by the PED.  Instructions for preparing the documents follow
  this list (however, they are not proveded in this software due to
  limited computer storage space).

  NUMBER          TITLE                        DEFINED (Page)

  EX-R-01B    EXPERIMENT REQUIREMENTS       Instructions (B1/0)
              DOCUMENT (ERD)              (UAH software available)

  EX-D-01B    PAYLOAD ELEMENT MASS          Instructions (B2/0)
              PROPERTIES STATUS REPORT

  NUMBER          TITLE                        DEFINED (Page)

  EX-D-02B    ASSEMBLY AND INSTALLATION     Instructions (B3/0)
              (A&I) DRAWINGS

  EX-D-03B    INTERFACE SCHEMATICS          Instructions (B4/0)

  EX-D-04B    MATERIALS USAGE LIST          Instructions (B5/0)

  EX-D-05B    MATERIALS USAGE AGREEMENT     Instructions (B6/0)

  EX-V-01B    INSTRUMENT/FACILITY/MPE/      Instructions (B7/0)
              ECE VERIFICATION PLAN
```

```
  EX-V-02B    VERIFICATION ANALYASIS          Instructions (B8/0)
              REPORT
  NUMBER                TITLE                      DEFINED (Page)

  EX-V-03B    VERIFICATION TEST REPORT        Instructions (B9/0)

  EX-S-01B    SAFETY COMPLIANCE DATA          Instructions (B10/0)
              PACKAGE                        (UAH software available)

  EX-S-02B    SAFETY-CRITICAL STRUCTURES      Instructions (B11/0)
              DATA PACKAGE

  EX-D-06B    POINTING CONTROL DYNAMICS       Instructions (B12/0)
              DATA REQUIREMENTS DOCUMENT

  EX-F-01B    ONBOARD FLIGHT PROCEDURES       Instructions (B13/0)

                      Press #fyellow SPACE#d to continue. ').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*Appendix B of JA-447*)

topic 'Appendix F'.
  processlist = ['F.1 BACKGROUND AND INTRODUCTION',
                 'F.2 ENGINEERING CHANGE REQUEST PREPARATION',
                 'F.3 CHANGE REQUEST PROCESSING',
                 'QUIT'].
  process = ''.
  column = ?column + 1.
  row = ?row + 1.
  window ('Appendix F of JA-447',blue,white,white,?column,?row,72,16).
  while ?process <> 'QUIT'
    then
      ask ('#e

               CHANGE REQUEST PREPARATION AND PROCESSING

          Please select the section you wish to continue with.',process,
      ?processlist)
      and
      if ?process = 'F.1 BACKGROUND AND INTRODUCTION'
        then
          do ('F.1 BACKGROUND AND INTRODUCTION')
      else
        if ?process = 'F.2 ENGINEERING CHANGE REQUEST PREPARATION'
          then
            do ('F.2 ENGINEERING CHANGE REQUEST PREPARATION')
      else
        if ?process = 'F.3 CHANGE REQUEST PROCESSING'
          then
            do ('F.3 CHANGE REQUEST PROCESSING').


  topic 'F.1 BACKGROUND AND INTRODUCTION'.
    column = ?column + 1.
    row = ?row + 1.
    window ('Background and Introduction',blue,white,white,?column,?row,70,15).
    say ('#e
```

During the development of a payload element, changes will occur to the hardware or its use that require coordination with the Payload Mission Manager (PMM). Generally, these changes are those affecting payload interfaces with the carrier/mission-peculiar equipment (MPE), flight and ground safety, and flight and ground operations. During the design phase, these changes are addressed in the appropriate documentation for each design review. However, after baselining of program documentation at the PMM Level II Configuration Control Board or one of the Level III Control Boards (Engineering and Flight Operations), changes to the affected documentation will be considered only after submittal of an Engineering Change Request (ECR) form.

It should be noted that changes to documentation that cause a change to the Level II Control documents should not be incorporated until the Level II change is approved. This formal control provides a basis for performing analyses or trades at the integrated payload level to ensure that provisions for the changes are feasible and compatible. The Spacelab Payload Accommodation Handbook (SPAH), is considered a baselined Level II document even though it is not controlled by the PMM. Therefore, all PED nonstandard interfaces to the Spacelab, as defined by the SPAH, will also require an ECR. The words "This is a SPAH Deviation" should be placed at the bottom of block 16. Waivers or deviations, if any, which are against a requirements document other than SPAH should also use the ECR form.

An ECR should discuss all affected documentation and include supporting rationale sufficient to allow a total evaluation of change impacts. For example, changes to the safety data package required by an ECR to the PED IIA should be addressed as part of the affected documentation. Also, operational changes (e.g., FOs) which result if the ECR is approved should be described in some detail.

In summary, ECRs should:
Identify all affected documentation and delineate changes required

Define sufficient supporting rationale/information to allow a total evaluation of the proposed change''s impact

Include updated hazard reports with associated descriptive material

Provide sufficient information to revise O&IAs (DILs, procedures, FOs, etc.) where not presently baselined

Highlight where proposed change constitutes a deviation to the SPAH or other mission manager levied requirement

```
                    Press #fyellow SPACE#d to continue.').
 column = ?column - 1.
```

```
 row = ?row - 1.
 close_window ().
end.(*F.1 BACKGROUND AND INTRODUCTION*)

topic 'F.2 ENGINEERING CHANGE REQUEST PREPARATION'.
  column = ?column + 1.
  row = ?row + 1.
  window ('Engineering Change Request Preparation',blue,white,white,?column,
    ?row,70,15).
  say ('#e

The Engineering Change Request (ECR) form #mFigure F-1#m is a standard
MSFC form used for requesting and approving changes.  The instruc-
tions for completing the ECR form are found in #mFigure F-2#m. The PED
shall use this form. The instructions for preparing the form are
modified as follows:

   Space Number                                  Modification
      2              Omit
      5              PMM Name
   6 and 7           Omit
     10              Enter required approval date.
     11              Enter name of your project.
     12              Enter a list of your elements and any
                     interfacing elements affected by the change.
   Space Number                                  Modification
     13          Omit
     16          For nonstandard interfaces to Spacelab, add:
                 "This is a SPAH deviation."
     17          Do not include costs.
     20          Not required by PMM: however, the PED may use
     21          Enter payload element developer authorized
                 signature.

The use of this form does not preclude technical or programmatic
discussions; however, it is the basis for establishing a new
baseline from which to proceed in either hardware or software
development or mission integration.

                     Press #fyellow SPACE#d to continue.').
 column = ?column - 1.
 row = ?row - 1.
 close_window ().
end. (*F.2  ENGINEERING CHANGE REQUEST PREPARATION*)

topic 'F.3 CHANGE REQUEST PROCESSING'.
  column = ?column + 1.
  row = ?row + 1.
  window ('Change Request Processing',blue,white,white,?column,?row,70,14).
  say ('#e

 Upon receipt of the ECR, the PMM integration team will evaluate
 the change for possible impact on other payload elements and/or
 the allocation of available resources. Based on this evaluation,
 the change may be dispositioned immediately or identification of
 analyses, trades, and coordination with other PEDs will be done
 to allow disposition. If the "Need Date" cannot be met, the PMM
 will notify the PED to assist in developing a workaround. The
 disposition of the change request, if other than approved, will
 be coordinated with the PED, and the ECR will document the results
```

```
   of that coordination.

                    Press #fyellow SPACE#d to continue. ').
   column = ?column - 1.
   row = ?row - 1.
   close_window ().
  end. (*F.3  CHANGE REQUEST PROCESSING*)

  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*Appendix F of JA-447*)

topic 'Figure F-1'.
  row = ?row + 1.
  window ('Figure F-1 ECR Form',blue,white,white,3,?row,76,15).
  say ('#e
  1. NUMBER:    2. PCN:              MSFC           3. DATE:        4. PAGE
                        ENGINEERING CHANGE REQUEST                      1 OF
  ---------------------------------------------------------------------------
  5. TO:                6. THUR:                      7. FROM:
  ---------------------------------------------------------------------------
  8. TITLE OF CHANGE
  ---------------------------------------------------------------------------
  9. RECOMMENDED PRIORITY                        10. NEED DATE:
    ___Emergency  ___Urgent  ___Routine
  ---------------------------------------------------------------------------
  11. PROGRAM(S)/PROJECT(S) AFFECTED:

  ---------------------------------------------------------------------------
  12. END ITEM(S) AFFECTED BY NOMENCLATURE:

  ---------------------------------------------------------------------------
  13. RECOMMENDED EFFECTIVITY:

  ---------------------------------------------------------------------------
  14. BASELINE DOCUMENTATION AFFECTED (Specs, ICD, etc.):

  ---------------------------------------------------------------------------
  15. RELATED CHANGES (ECR,ECP,CR,etc.) BY NUMBER:

  ---------------------------------------------------------------------------
  16. JUSTIFICATION FOR CHANGE (Include effect if not incorporated):

  ---------------------------------------------------------------------------


  17. EFFECTS ON:
     ___Hardware  ___Software    ___Facility       ___Requirements Document
     ___Schedule (See Enclosure_____for impact)    ___Other (Specify)
     ___Cost(Estimated cost included in Enclosure_____)
  ---------------------------------------------------------------------------
  18. DESCRIPTION OF CHANGE (Include reference to enclosures):

  ---------------------------------------------------------------------------
  19. SIGNATURE OF ORIGINATOR:   DATE:   TELEPHONE NUMBER:  OFFICE SYMBOL:

  ---------------------------------------------------------------------------
  20.                              CONCURRENCE
```

```
  SIGNATURE & ORGANIZATION:    DATE:    SIGNATURE & ORGANIZATION:    DATE:
  ------------------------------------------------------------------------
  ------------------------------------------------------------------------



  21.                          TECHNICAL APPROVAL
  SIGNATURE & ORGANIZATION:    DATE:    SIGNATURE & ORGANIZATION:    DATE:
  ------------------------------------------------------------------------
  ------------------------------------------------------------------------
  ------------------------------------------------------------------------
  ------------------------------------------------------------------------



                      Press #fyellow SPACE#d to continue. ').
  row = ?row - 1.
  close_window ().
end. (*Figure F-1*)

topic 'Figure F-2'.
  row = ?row + 1.
  window ('Figure F-2 ECR Form Instructions',blue,white,white,4,?row,74,15).
  say ('#e

                  ENGINEERING CHANGE REQUEST

  GENERAL REQUIREMENTS - This ECR shall provide the information
  outlined in the ensuing item numbered entries in order that the
  request may be evaluated from the viewpoint of engineering,
  production, maintenance, cost, and supply by all effected parties.
  An entry must be made in each line or block.  "Not Applicable" (NA)
  or like terms may be used only after due consideration.  Enclosures
  should be used to provide comprehensive information (supplemented
  with necessary exhibits, sketches, and drawings) in sufficient detail
  to enable an understanding of the total impact of the change.  The
  item numbers are keyed to the ECR form.


  1. NUMBER - The originating organization shall assign the ECR number
     based on the following numbering system: a 4 digit prefix consist-
     ing of the letters assigned to the organization in the MSFC
     organization chart, followed by a dash and a 4 digit alphanumeric
     number for the sequence of ECR issued by that organization.

  2. PCN - Enter the Program Control Number (PCN) assigned to this change.
     This may be a new number or the number of a package against which the
     ECR is written.  The PCN shall be obtained from the applicable Program
     /Project Configuration Managment Office.

  3. DATE - Enter date form is prepared.

  4. PAGE - Enter Page 1 of 1, 1 of 2, etc. as appropriate.

  5. TO - Enter the title and mailing symbol of the Program/Projects
     /End Item Office to which the ECR will be routed.
```

6. THUR - Enter the title and mailing symbol of the organization focal point through which the ECR is to be routed. If not established enter "Not Applicable."

7. FROM - Enter the title and mailing symbol of the organization initiating the ECR.

8. TITLE - Enter a brief and concise title which reflects the intent of the ECR.

9. RECOMMENDED PRIORITY - Check appropriate priority in accordance with the following definitions:
   #mEmergency#m #mUrgent#m #mRoutine#m

10. NEED DATE - Enter date that change prepared by this ECR needs to be incorporated.

11. PROGRAM(S)/PROJECT(S) AFFECTED - Enter the Unique Project Number(s) from the Agency Wide Coding Structure and enter title(s) of program(s)/project(s) affected (e.g., ASTP, HEAO, Shuttle, etc.).

12. END ITEM(S) AFFECTED BY NOMENCLATURE - Enter nomenclature of all the end items affected by the change (e.g., S-IB Stage, Instrument Unit, Spacecraft, External Tank, etc.).

13. RECOMMENDED EFFECTIVITY - Enter recommended effectivity; e.g., vehicle effectivity, end item effectivity (by serial number), launch facility effectivity, etc.

14. BASELINE DOCUMENTATION AFFECTED - Enter number(s), including revision letter, of baseline documentation affected by this ECR; e.g., specification(s), interface control document(s), etc.

15. RELATED CHANGES - Enter the number(s) of any changes (ECPs, ECRs, CRs, etc.) related to this ECR.

16. JUSTIFICATION FOR CHANGE - Describe which requirements previously established will not be met and how this change will assure that provision, or on what the net cost reduction is based and how determined. The effect of not incorporating the change shall be described.

17. EFFECTS ON - Self explanatory, check the approprate blocks. As appropriate, include an enclose providing breakdown of costs and/or schedule impact.

18. DESCRIPTION OF CHANGE - Enter a clear statement explaining fully the technical problem which needs correcting or improving (i.e., "It is necessary to increase the capability of this unit in order to ....," or "The_____unit will not operate as planned until the following changes are made:..."). Include, as applicable, a description of the change impact on areas affected by each item checked in EFFECTS ON; e.g., safety, reliability, ground/flight

tapes, single point failures, weight, propulsion, critical components, mission operations, redlines, spares, test requirements, specifications, and criteria, etc. When the ECR affects safety, reliability, ordnance and/or critical components, the ECR shall include the applicable part of the FMEA and/or safety (hazards) analysis for the change.

19. ORIGINATOR - Enter the signature, date, telephone number and organization symbol of the ECR originator.

20. CONCURRENCE - Enter persons consulted or concurrences obtained. Person consulted: Indicate names of key persons consulted, within either the originating organization or other. Concurrences obtained: Obtain signature of any concurrences required by the originating organization. Any objections to proposed change should be so noted.

21. TECHNICAL APPROVAL - Enter signature of persons which must technically approve the ECR prior to transmittal to the applicable Program/Project/End Item Office for CCB processing.

Press #fyellow SPACE#d to continue. ').

```
topic 'Emergency'.
  column = ?column + 1.
  row = ?row + 1.
  window ('Emergency',blue,white,white,?column,?row,71,13).
  say ('#e
An emergency priority shall be assigned to a proposed
engineering change to correct a safety condition which could
result in fatal or serious injury to personnel or extensive
damage or destruction of equipment.  Such conditins usually will
require withdrawing the end item from service temporarily, or
suspension of the end item operation, or discontinuence of
further testing or development pending resolution of such conditions.
In addition, stray electromagnetic radiation or radio frequency
interference causing spurious command or control signals in
equipment, require emergency action where safety conditions
explained above are affected.
                    Press #fyellow SPACE#d to continue. ').

 column = ?column - 1.
 row = ?row - 1.
 close_window ().
end. (*emergency*)

topic 'Urgent'.
  column = ?column + 1.
  row = ?row + 1.
  window ('Urgent',blue,white,white,?column,?row,71,13).
  say ('#e  An urgent priortiy shall be assigned to a proposed
engineering change to correct a potentially hazardous
condition, the uncorrected existence of which could result
in injury to personnel or damage to equipment and reduce
the misssion effectiveness of the equipment.  Such conditions
compromise safety and embody risk within reasonable limits
```

```
  wherein affected equipment is continued in use, after the
  operator has been informed of the hazard and appropriate
  precautions have been defined and distributed to the user.
  This classification may also be used for those changes
  necessary to meet contractual requirements when lead time
  would necessitate slipping approved production, activation,
  or construction schedules.

  The urgent classification may also be used by the procuring
  activity for mission capability changes, when in its opinion,
  the nonincorporation of the changes at the earliest possible
  time would compromise the mission capability to a degree that
  would be unacceptable for contract production or mission launch
  schedules.  Changes associated with interface problems, resulting
  from compatibility changes made by the other contractors, shall
  be classified as urgent.



              Press #fyellow SPACE#d to continue. ').

   column = ?column - 1.
   row = ?row - 1.
   close_window ().
  end. (*urgent*)

  topic 'Routine'.
    column = ?column + 1.
    row = ?row + 1.
    window ('Routine',blue,white,white,?column,?row,71,13).
    say ('#e


  A routine priority shall be assigned to a proposed
  engineering change when emergency or urgent is not applicable.



                    Press #fyellow SPACE#d to continue. ').
   column = ?column - 1.
   row = ?row - 1.
   close_window ().
  end. (*routine*)

  row = ?row - 1.
  close_window ().
end. (*Figure F-2*)

topic 'Section 5.0'.
  load ('NSTS5.HKB').
  do ('Sect5.0').
  close ('NSTS5.HKB').
end. (*Section 5.0 of NSTS 13830*)

(*created 6/30/92 - 7/1/92*)
(*last edited 2/22/94*)
```

```
(*SEC6SUB.KB  This section covers all of the phases and allows the user to
  fill out the forms needed to make up the PED Safety Compliance Data Package
  including making changes to previous answers.                              *)

curdir is read_line ('CURDIR.DAT').
curdir = string_replace (?curdir,' ','',8).
eof = number_to_char (26).
column = 3.
row = 3.
haznum = 1.
yn = ['YES','NO'].

do (sec6).

topic 'SEC6'.
  window ('SAFETY COMPLIANCE DATA PACKAGE',blue,white,white,?column,?row,76,18).
  column = ?column + 1.
  row = ?row + 1.
  window ('6.0  SAFETY DATA REQUIREMENTS FOR NEW MISSION',blue,white,white,
     ?column,?row,74,17).

 listsix = ['6.1  FLIGHT SAFETY COMPLIANCE DATA',
            '6.2  GROUND SAFETY COMPLIANCE DATA',
            'QUIT'].

 sixstart = ''.

 while ?sixstart <> 'QUIT'
   then
     ask ('#e


   Please choose which section you wish to continue with.',sixstart,?listsix)
   and
   if ?sixstart = '6.1  FLIGHT SAFETY COMPLIANCE DATA'
     then
       do ('sixsub1')
   else
     if ?sixstart = '6.2  GROUND SAFETY COMPLIANCE DATA'
       then
         do ('sixsub2')
   else
     if ?sixstart = 'QUIT'
       then
         new_kb ('SAFJA012.HKB').

  topic 'sixsub1'.
    column = ?column + 1.
    row = ?row + 1.
    window ('6.1   FLIGHT SAFETY COMPLIANCE DATA',blue,white,white,?column,
           ?row,72,16).
    sub1list = ['6.1.1   Phase 0 Flight Safety Review',
                '6.1.2   Phase I Flight Safety Review',
                '6.1.3   Phase II Flight Safety Review',
                '6.1.4   Phase III Flight Safety Review',
                '6.1.5   Delta Phase III Flight Safety Review',
                'QUIT'].
    subone = ''.

    while ?subone <> 'QUIT'
```

```
 then
   ask('
Please choose the section you wish to continue with.#n',subone,?sub1list)
and
if ?subone = '6.1.1   Phase 0 Flight Safety Review'
  then
     do ('Phase 0 Flight Safety Review')
else
  if ?subone = '6.1.2   Phase I Flight Safety Review'
  then
     do ('Phase I Flight Safety Review')
else
  if ?subone = '6.1.3   Phase II Flight Safety Review'
  then
     do ('Phase II Flight Safety Review')
else
  if ?subone = '6.1.4   Phase III Flight Safety Review'
  then
     do('Phase III Flight Safety Review')
else
  if ?subone = '6.1.5   Delta Phase III Flight Safety Review'
  then
     do ('Delta Phase III Flight Safety Review')
else
  if ?subone = 'QUIT'
    then
      column = ?column - 1
      and
      row = ?row - 1
      and
      close_window().

topic 'Phase 0 Flight Safety Review'.
  column = ?column + 1.
  row = ?row + 1.
  window ('6.1.1   Phase 0 Flight Safety Review',blue,white,white,?column,
     ?row,71,15).
  phase0list = [
            '6.1.1.1   PED Phase 0 Flight Safety Compliance Data Package',
            '6.1.1.2   PMM Activities',
            'QUIT'].
  choice0 = ''.
  while ?choice0 <> 'QUIT'
    then
      ask ('#e

  Please choose which section you wish to continue with.',choice0,
  ?phase0list)
      and
      if ?choice0 =
          '6.1.1.1   PED Phase 0 Flight Safety Compliance Data Package'
        then
          do ('PED Phase 0 Flight Safety Compliance Data Package')
      else
        if ?choice0 = '6.1.1.2   PMM Activities'
          then
            do ('PMM Activities')
      else
        if ?choice0 = 'QUIT'
          then
```

```
              column = ?column - 1
              and
              row = ?row - 1
              and
              close_window ().

    topic 'PED Phase 0 Flight Safety Compliance Data Package'.
      column = ?column + 1.
      row = ?row + 1.
      window ('6.1.1.1   PED Phase 0 Flight Safety Compliance Data Package',
         blue,white,white,?column,?row,70,14).
      say ('

 The objectives of the Phase 0 Report are to conceptually describe
the payload element and its operation and to identify all potential
hazards.  This information is documented in the PED Phase 0 safety
compliance data and is included in the data package for review at
the PED PRR per Figure 6-1.

                    Press #fyellow SPACE#d to continue.')
      and
      do (phase0report).

      topic 'phase0report'.
        ans0 = ''.
        while ?ans0 <> 'NO'
          then
            ask ('
The PED shall include the following information in the Phase 0 data
package:
            Payload Element Overview,
            Safety Critical Subsystems Descriptions,
            Experiment Safety Package Cover Sheet (ESPCS),
            Phase 0 Hazard Reports,
            STS Payload Safety Requirements Applicability Matrix.

Would you like to begin filling out the documentation?',ans0,?yn)
             and
             if ?ans0 = 'YES'
               then
                 new_kb ('PH0FLDOC.HKB').
      end. (*phase0report*)

     column = ?column - 1.
     row = ?row - 1.
     close_window().
  end. (*6.1.1.1   PED Phase 0 Flight Safety Compliance Data Package*)

  topic 'PMM Activities'.
    column = ?column + 1.
    row = ?row + 1.
    window ('6.1.1.2   PMM Activities',blue,white,white,?column,?row,70,14).
    say ('
PED safety data are reviewed by the PMM for the PED PRR, and
recommended/required revisions are presented to the PED via Review
Item Discrepancies/Discrepancy Notices (RIDs/DNs) at the PED PRR.
The PED will incorporate the agreed-upon revisions in the PED
Phase 0 data in time to allow the revised report to be included in
the IPL Safety Compliance Data Package (see Table 6-1).  The IPL
Requirements Review (IPL RR) is typically held after the last PED
```

```
PRR or as required by the PMM to meet mission requirements.  The
Phase 0 flight safety review with the NSTS (JSC) will subsequently
be conducted by the PMM based on updated IPL RR safety data.

                    Press #fyellow SPACE#d to continue.').
      column = ?column - 1.
      row = ?row - 1.
      close_window().
    end. (*6.1.1.2    PMM Activities*)
  end. (*Phase 0 Flight Safety Review*)

  topic 'Phase I Flight Safety Review'.
    column = ?column + 1.
    row = ?row + 1.
    window ('6.1.2     Phase I Flight Safety Review',blue,white,white,
       ?column,?row,71,15).
    phaseIlist = [
              '6.1.2.1   PED Phase I Flight Safety Compliance Data Package',
              '6.1.2.2   PMM Activities',
              'QUIT'].
    choiceI = ''.
    while ?choiceI <> 'QUIT'
      then
        ask ('#e

    Please choose which section you wish to continue with.',choiceI,
    ?phaseIlist)
        and
        if ?choiceI =
            '6.1.2.1   PED Phase I Flight Safety Compliance Data Package'
          then
            do ('PED Phase I Flight Safety Compliance Data Package')
        else
          if ?choiceI = '6.1.2.2   PMM Activities'
            then
              do ('PMM Activities')
        else
          if ?choiceI = 'QUIT'
            then
              column = ?column - 1
              and
              row = ?row - 1
              and
              close_window ().

  topic 'PED Phase I Flight Safety Compliance Data Package'.
    column = ?column + 1.
    row = ?row + 1.
    window ('6.1.2.1   PED Phase I Flight Safety Compliance Data Package',
      blue,white,white,?column,?row,70,14).
    say ('

The objective of the Phase I data is to present a safety analysis
that reflects the preliminary payload element design. These data
are included in the data package for review at the PED Preliminary
Design Review (PED PDR), as shown in #mFigure 5-1#m and Figure 6-1.
The content will mature from the conceptual phase to include the
following information.

                    Press #fyellow SPACE#d to continue.')
```

```
      and
      do (phase1report).

      topic 'phase1report'.
        ans1 = ''.
        while ?ans1 <> 'NO'
          then
            ask('#e
The PED shall include the following information in the Phase I data
package:  Payload Element Description and Mission Scenario
          Safety Critical Subsystems Descriptions
          Experiment Safety Package Cover Sheet (ESPCS)
          NSTS Payload Safety Requirements Applicability Matrix
          Phase I Hazard Reports
          Failure Mode and Effects Analysis (FMEA)
          Ionizing Radiation Source Data Sheets

Would you like to begin filling out the documentation?',ans1,?yn)
            and
            if ?ans1 = 'YES'
              then
                new_kb ('PHIFLDOC.HKB').
    end. (*phase1report*)
    column = ?column - 1.
    row = ?row - 1.
    close_window ().
   end. (*6.1.2.1   PED Phase I Flight Safety Compliance Data Package*)

   topic 'PMM Activities'.
     column = ?column + 1.
     row = ?row + 1.
     window ('6.1.2.2   PMM Activities',blue,white,white,?column,?row,70,14).
     say ('
 PED safety data are reviewed by the PMM for the PED PDR, and
 recommended/required revisions are presented to the PED via
 RIDs/DNs at the PED PDR.  The PED will incorporate the agreed
 to revisions in the PED Phase I data in time to allow the
 PMM to include the revised report in the Phase I IPL Safety
 Compliance Data Package (see Table 6-1 Section ?). These changes
 should reflect action item closures for actions received during
 the IPL Phase 0 Safety Review. The updated safety data will be
 submitted to the PMM, who will generate IPL hazard reports,
 develop hazard controls, establish verification methods and
 update the IPL safety data.


 System level tests and analyses for verification of IPL hazard
 controls will be developed and entered in the Integrated System
 Verification Plan as a part of activities already planned or as
 newly defined activities. The PMM will assemble the inputs from
 all PEDs into the IPL Phase I Flight Safety Compliance Data
 Package and provide it to the NSTS Flight Safety Review Panel for
 the Phase I review.  Any additional requirements or actions items
 resulting from this review will be forwarded to the PED.


                  Press #fyellow SPACE#d to continue.').
     column = ?column - 1.
     row = ?row - 1.
```

```
    close_window ().
  end. (*6.1.2.2  PMM Activities*)
end. (*Phase I Flight Safety Review*)

topic 'Phase II Flight Safety Review'.
  column = ?column + 1.
  row = ?row + 1.
  window ('6.1.3   Phase II Flight Safety Review',blue,white,white,?column,
    ?row,72,15).
  phaseIIlist = [
            '6.1.3.1   PED Phase II Flight Safety Compliance Data Package',
            '6.1.3.2   PMM Activities',
            'QUIT'].
  choiceII = ''.
  while ?choiceII <> 'QUIT'
    then
      ask ('#e

  Please choose which section you wish to continue with.',choiceII,
  ?phaseIIlist)
      and
      if ?choiceII =
          '6.1.3.1   PED Phase II Flight Safety Compliance Data Package'
        then
          do ('PED Phase II Flight Safety Compliance Data Package')
      else
        if ?choiceII = '6.1.3.2   PMM Activities'
          then
            do ('PMM Activities')
      else
        if ?choiceII = 'QUIT'
          then
            column = ?column - 1
            and
            row = ?row - 1
            and
            close_window ().


  topic 'PED Phase II Flight Safety Compliance Data Package'.
    column = ?column + 1.
    row = ?row + 1.
    window ('6.1.3.1    PED Phase II Flight Safety Compliance Data Package',
      blue,white,white,?column,?row,71,14).
    say (['
The objective of the Phase II data is to present safety analyses
that reflect the payload element#39s final design.  These data include
definitive, finalized hazard controls, and the planned specific
verification methods to assure implementation and adequacy of hazard
controls. These data are included with the data package for review at
the PED Critical Design Review (PED CDR) as shown in #mFigure 5-1#m and
Figure 6-1. The data will mature from the preliminary phase to
include the following information.



                        Press #fyellow SPACE#d to continue.'])
    and
    do (phase2report).
```

```
      topic 'phase2report'.
        ans2 = ''.
        while ?ans2 <> 'NO'
          then
ask ('#e  The PED shall include the following information in the Phase II data
  package:    Payload Element Description,
              Safety Critical Subsystems Descriptions,
              Experiment Safety Package Cover Sheet (ESPCS),
              Phase II Hazard Reports, Failures/Accidents,
              Safety Requirements Applicability Matrix,
              Failure Mode and Effects Analysis (FMEA),
              Ionizing Radiation Source Data Sheets,
              Hazardous Radiation, Pyrotechnics.

  Would you like to begin filling out the documentation?#n#n',ans2,?yn)
               and
               if ?ans2 = 'YES'
                 then
                   new_kb ('PHIIFDOC.HKB').
      end. (*phase2report*)
      column = ?column - 1.
      row = ?row - 1.
      close_window ().
    end.(*6.1.3.1    PED Phase II Flight Safety Compliance Data Package*)

    topic 'PMM Activities'.
      column = ?column + 1.
      row = ?row + 1.
      window ('6.1.3.2   PMM Activities',blue,white,white,?column,?row,70,14).
      say ('
  The PMM will review each PED Safety Compliance Data Package and
  concur in the proposed hazard controls and safety verification
  methods.  This review will include any analysis, inspection, or
  test reports available that support the verification of hazard
  controls.  Recommended revisions to the data submitted for the
  PED CDR will be identified by the PMM.  The PED will incorporate
  the agreed-to revisions in the PED Phase II data in time to allow
  the revised report to be included in the Phase II IPL Safety
  Compliance Data Package (see Table 6-1). The PMM will update and
  finalize all integrated payload hazard reports and will integrate
  the Payload Element safety data into the Integrated Payload Flight
  Safety Compliance Data Package which he will submit to IPL CDR for
  review and baselining.
  This package (incorporating the updates, actions, and closeouts
  mandated by the review) will be baselined as a result of the IPL
  CDR with the signature of each PED required on the baselining
  document. The baselined integrated payload safety compliance data
  package is then forwarded by the PMM to the NSTS Flight Safety
  Review Panel for the Phase II review.   Action items or mandated
  changes identified during the Phase II review will be transmitted
  to the cognizant PED for incorporation and/or resolution.  The PED
  shall ensure that required documentation changes resulting from
  these actions are incorporated into the baselined safety data
  package by the submission of the appropriate ECRs to the PMM
  Configuration Control Board. (See #mJA-447, MROFIE, Appendix F#m).

                  Press #fyellow SPACE#d to continue.').
      column = ?column - 1.
      row = ?row - 1.
      close_window ().
```

```
  end. (*6.1.3.2   PMM Activities*)

  topic 'JA-447, MROFIE, Appendix F'.
    load ('AXFJA447.HKB').
    do ('APPF').
    close ('AXFJA447.HKB').
  end. (*JA-447, MROFIE, Appendix F*)

end. (*6.1.3      Phase II Flight Safety Review*)

topic 'Phase III Flight Safety Review'.
  column = ?column + 1.
  row = ?row + 1.
  window('6.1.4     Phase III Flight Safety Review',blue,white,white,
    ?column,?row,71,15).
  phaseIIIlist = [
           '6.1.4.1   PED Phase III Flight Safety Compliance Data Package',
           '6.1.4.2   PMM Activities',
           'QUIT'].

  choiceIII = ''.

  while ?choiceIII <> 'QUIT'
    then
      ask ('#e

  Please choose which section you wish to continue with.',choiceIII,
  ?phaseIIIlist)
      and
      if ?choiceIII =
          '6.1.4.1   PED Phase III Flight Safety Compliance Data Package'
        then
          do ('PED Phase III Flight Safety Compliance Data Package')
      else
        if ?choiceIII = '6.1.4.2   PMM Activities'
          then
            do ('PMM Activities')
      else
        if ?choiceIII = 'QUIT'
          then
            column = ?column - 1
            and
            row = ?row - 1
            and
            close_window ().

  topic 'PED Phase III Flight Safety Compliance Data Package'.
    column = ?column + 1.
    row = ?row + 1.
    window ('6.1.4.1   PED Phase III Flight Safety Compliance Data',blue,
      white,white,?column,?row,70,15).
    say ('
The principal PED safety activity leading to the PED Integration
Readiness Review (IRR) is the submittal of verification data to
the PMM to substantiate the closeout of all open hazard reports or
safety-related action items.


PED Phase III flight safety compliance data consists of data from
action and closeout items to ensure that the as-built equipment,
```

procedures and operations established as hazard controls have been fully verified to control the hazards and that all hazard control verifications have been satisfactorily completed. Modifications or changes to equipment or operations from the Phase II package will be documented and submitted as changes to the baselined safety data package.
Assessment of changes will be performed to identify any impact to safety and hazard reports will be revised to reflect safety changes. Hazard report closure statements (i.e., status of verification block on JSC Form 542B) must contain the following elements:

1) Statement(s) of fact concerning completion of applicable tests, analyses, or inspections.

2) Completion date (month/year) of applicable tests, analyses, or inspections.

3) Summary statement or assessment including parametric data regarding results of the tests, analyses, or inspections (e.g., "Stress analysis results show positive margins of safety for all safety critical structures").

4) Identification of payload developer reports which contain test, analysis, or inspection results (i.e., title and number).

These data are submitted before the PED IRR to the PMM for review and incorporation into the individual PED#39s section of the baselined Integrated Payload Flight Safety Compliance Data Package (see #mFigure 5-1#m and Figure 6-1). A hazard report is not considered closed until all verification activities (analyses, tests, inspections) identified on the report have been satisfactorily completed and the results documented and approved by the PMM and the appropriate Safety Panels.

```
                    Press #fyellow SPACE#d to continue.')
      and
      do (phase3report).



      topic 'phase3report'.
        ans3 = ''.
        while ?ans3 <> 'NO'
          then
            ask ('#e
```

The PED shall include the following additional safety data submittals required specifically for review at the IRR:

```
            Open Safety Items List
            Pressure Vessel/System Log Book
            Failures/Accidents
            Certificate of Flight Safety Compliance

Would you like to begin filling out the documentation?#n',ans3,?yn)
            and
            if ?ans3 = 'YES'
              then
                new_kb ('PHIIIFDC.HKB').
      end.(*phase3report*)
```

```
    column = ?column - 1.
    row = ?row -1.
    close_window ().
  end. (*6.1.4.1. PED Phase III Flight Safety Compliance Data*)

  topic 'PMM Activities'.
    column = ?column + 1.
    row = ?row - 1.
    window ('6.1.4.2   PMM Activities',blue,white,white,?column,?row,70,14).
    say ('

The PMM will review and assess the PED Phase III submittal and
upgrade the Phase II data to a phase III status.  He will
initiate and maintain a Payload Flight Safety Verification
Tracking Log documenting the status of uncompleted (open) hazard
control verifications at the time of the Phase III review and
present these with his Certificate of NSTS Payload Safety
Compliance to the Flight Safety Review Panel for its approval.
This certificate provides certification from the PMM that the
as-built Integrated Payload is safe and complies with all NSTS
safety requirements.

                  Press #fyellow SPACE#d to continue.').
    column = ?column - 1.
    row = ?row - 1.
    close_window().
  end.(*6.1.4.2   PMM Activites*)
 end. (*6.1.4   Phase III Flight Safety Review*)

 topic 'Delta Phase III Flight Safety Review'.
   column = ?column + 1.
   row = ?row + 1.
   window ('6.1.5   Delta Phase III Flight Safety Review',blue,white,white,
     ?column,?row,71,15).
   delphaselist = [
      '6.1.5.1   PED Delta Phase III Flight Safety Compliance Data Package',
      '6.1.5.2   PMM Activities',
      'QUIT'].

   choicedelta = ''.

   while ?choicedelta <> 'QUIT'
     then
       ask ('#e

   Please choose which section you wish to continue with.',choicedelta,
   ?delphaselist)
       and
       if ?choicedelta =
     '6.1.5.1   PED Delta Phase III Flight Safety Compliance Data Package'
         then
           do ('Delta Phase III Flight Safety Compliance Data Package')
       else
         if ?choicedelta = '6.1.5.2   PMM Activities'
           then
             do ('PMM Activities')
       else
         if ?choicedelta = 'QUIT'
           then
             column = ?column - 1
```

```
              and
              row = ?row - 1
              and
              close_window ().

    topic 'Delta Phase III Flight Safety Compliance Data Package'.
      column = ?column + 1.
      row = ?row + 1.
      window ('6.1.5.1    PED Delta Phase III Flight Safety Compliance Data',
        blue,white,white,?column,?row,70,14).
      say ('

 The delta Phase III Safety Review will be conducted for all
 payloads at Launch - 2 mo. No change in PED hardware/software
 /operations is permitted following the original Phase III
 review unless the intended change is formally approved by the
 PMM before its incorporation. See section 5.0 of this document
 for definition of the requirements placed upon required/desired
 hardware/software/operations changes during this phase.

                Press #fyellow SPACE#d to continue.').
      column = ?column - 1.
      row = ?row - 1.
      close_window ().
    end. (*6.1.5.1    PED Delta Phase III Flight Safety Compliance Data*)

    topic 'PMM Activities'.
      column = ?column + 1.
      row = ?row + 1.
      window ('6.1.5.2   PMM Activities',blue,white,white,?column,?row,70,14).
      say ('

 The PMM will determine the impact to Integrated Payload Safety
 Compliance for all hardware/software/operations changes which
 occur subsequent to the Phase III safety review.  He will provide
 an assessment to the NSTS Safety Review Panel that these changes
 have not invalidated the flight safety compliance.  The closed-out
 Flight Safety Verification Tracking Log will be submitted at this
 review.

                      Press #fyellow SPACE#d to continue.').
      column = ?column - 1.
      row = ?row - 1.
      close_window ().
    end.(*6.1.5.2   PMM Activities*)
  end. (*6.1.5   Delta Phase III Flight Safety Review*)
end. (*sixsub1*)

topic 'sixsub2'.
  column = ?column + 1.
  row = ?row + 1.
  window ('6.2   GROUND SAFETY COMPLIANCE DATA',blue,white,white,?column,
    ?row,72,16).
  sub2list = ['6.2.1   Phase 0 Ground Safety Review',
              '6.2.2   Phase I Ground Safety Review',
              '6.2.3   Phase II Ground Safety Review',
              '6.2.4   Phase III Ground Safety Review',
              'QUIT'].
  subtwo = ''.
  while ?subtwo <> 'QUIT'
```

```
   then
    ask('
Ground safety data is developed to enable assessment of ground
equipment and operations during payload integration and prelaunch
activities and postflight operations. The data must consider
ground support and checkout equipment, flight equipment operations,
and hazardous processing including ground handling and equipment
installation.  The following are included in this data:',subtwo,?sub2list)
    and
    if ?subtwo = '6.2.1   Phase 0 Ground Safety Review'
      then
        do ('6.2.1   Phase 0 Ground Safety Review')
    else
      if ?subtwo = '6.2.2   Phase I Ground Safety Review'
        then
          do ('6.2.2   Phase I Ground Safety Review')
    else
      if ?subtwo = '6.2.3   Phase II Ground Safety Review'
        then
          do ('6.2.3   Phase II Ground Safety Review')
    else
      if ?subtwo = '6.2.4   Phase III Ground Safety Review'
        then
          do ('6.2.4   Phase III Ground Safety Review')
    else
      if ?subtwo = 'QUIT'
        then
          column = ?column - 1
          and
          row = ?row - 1
          and
          close_window().

 topic '6.2.1   Phase 0 Ground Safety Review'.
   column = ?column + 1.
   row = ?row + 1.
   window ('6.2.1   Phase 0 Ground Safety Review',blue,white,white,?column,
     ?row,71,15).
   gphaseIlist = [
      '6.2.1.1   PED Phase 0 Ground Safety Compliance Data Package',
      '6.2.1.2   PMM Activities',
      'QUIT'].

   gchoiceI = ''.

   while ?gchoiceI <> 'QUIT'
     then
       ask ('#e

   Please choose which section you wish to continue with.',gchoiceI,
   ?gphaseIlist)
       and
       if ?gchoiceI =
              '6.2.1.1   PED Phase 0 Ground Safety Compliance Data Package'
         then
           do ('PED Phase 0 Ground Safety Compliance Data Package')
       else
         if ?gchoiceI = '6.2.1.2   PMM Activities'
           then
             do ('PMM Activities')
```

```
        else
          if ?gchoiceI = 'QUIT'
            then
              column = ?column - 1
              and
              row = ?row - 1
              and
              close_window ().

    topic 'PED Phase 0 Ground Safety Compliance Data Package'.
      column = ?column + 1.
      row = ?row + 1.
      window ('6.2.1.1    PED Phase 0 Ground Safety Compliance Data Package',
         blue,white,white,?column,?row,70,14).
      say ('
 The objectives of the Phase 0 Ground Safety Data are to
conceptually describe payload element subsystems and GSE and to
identify potential hazards including hazards associated with
operating flight equipment during ground operations. To accomplish
these objectives, the PED shall include the following information
in his Phase 0 ground safety data package at the PED Preliminary
Requirements Review (PED PRR) as indicated in #mFigure 5-1#m and
Figure 6-1.


              Press #fyellow SPACE#d to continue.')
      and
      do (phase0pack).

      topic 'phase0pack'.
        ansg0 = ''.
        while ?ansg0 <> 'NO'
          then
            ask ('
The PED shall include the following information in the Phase 0 data
package:
             Payload Element Overview,
             Safety Critical Subsystems Descriptions,
             GSE Description,
             Phase 0 Ground Hazard Reports,
             Ground Operations Flow,

Would you like to begin filling out the documentation?',ansg0,?yn)
             and
             if ?ansg0 = 'YES'
               then
                 new_kb ('PH0GDOC.HKB').
      end. (*phase0pack*)
      column = ?column - 1.
      row = ?row - 1.
      close_window ().
    end. (*6.2.1.1    PED Phase 0 Ground Safety Compliance Data Package*)

    topic 'PMM Activities'.
      column = ?column + 1.
      row = ?row + 1.
      window ('6.2.1.2   PMM Activities',blue,white,white,?column,?row,70,14).
      say ('
```

```
  The PMM activities for the Phase 0 Ground Safety Review are
  essentially the same as those for the Phase 0 Flight Safety
  Review.



              Press #fyellow SPACE#d to continue.').
    column = ?column - 1.
    row = ?row - 1.
    close_window ().
  end. (*6.2.1.2   PMM Activities*)
end.(*6.2.1   Phase 0 Ground Safety Review*)

topic '6.2.2   Phase I Ground Safety Review'.
  column = ?column + 1.
  row = ?row + 1.
  window('6.2.2   Phase I Ground Safety Review',blue,white,white,?column,
    ?row,71,15).
  gphaseIIlist = [
     '6.2.2.1   PED Phase I Ground Safety Compliance Data Package',
     '6.2.2.2   PMM Activities',
     'QUIT'].

  gchoiceII = ''.

  while ?gchoiceII <> 'QUIT'
    then
      ask ('#e

  Please choose which section you wish to continue with.',gchoiceII,
  ?gphaseIIlist)
      and
      if ?gchoiceII =
            '6.2.2.1   PED Phase I Ground Safety Compliance Data Package'
        then
          do ('PED Phase I Ground Safety Compliance Data Package')
      else
        if ?gchoiceII = '6.2.2.2   PMM Activities'
          then
            do ('PMM Activities')
      else
        if ?gchoiceII = 'QUIT'
          then
            column = ?column - 1
            and
            row = ?row - 1
            and
            close_window ().

  topic 'PED Phase I Ground Safety Compliance Data Package'.
    column = ?column + 1.
    row = ?row + 1.
    window ('6.2.2.1   PED Phase I Ground Safety Compliance Data Package',
      blue,white,white,?column,?row,70,14).
    say ('
The objective of the Phase I Ground Safety data is to present a
preliminary analysis of potentially hazardous GSE and ground
operations involving both flight and ground equipment.  These
data are included in the data package for review at the PED PDR
(see #mFigure 5-1#m and Figure 6-1).  These ground safety data shall
```

```
contain the following list of information.·



                        Press #fyellow SPACE#d to continue.')
      and
      do (phaseIIIpack).

      topic 'phaseIIIpack'.
        ansgI = ''.
        while ?ansgI <> 'NO'
          then
            ask ('
The PED shall include the following information in the Phase I data
package:  Safety Critical Subsystem Description,
          Payload Element Description, GSE Description,
          List of Deliverable Items, Ground Flow Chart,
          Phase I Ground Hazard Reports, Ordnance Data,
          Ground Operations Scenario, Hazardous Radiation,
          Ionizing Source Data, Non-Ionizing Radiation.

Would you like to begin filling out the documentation?',ansgI,?yn)
            and
            if ?ansgI = 'YES'
              then
                new_kb ('PHIGDOC.HKB').
      end. (*phaseIIIpack*)
      column = ?column - 1.
      row = ?row - 1.
      close_window ().
    end. (*6.2.2.1   PED Phase I Ground Safety Compliance Data Package*)

    topic 'PMM Activities'.
      column = ?column + 1.
      row = ?row + 1.
      window ('6.2.2.2   PMM Activities',blue,white,white,?column,?row,70,14).
      say ('

  Activities related to the review of PED Phase I ground safety
  data and preparation of the IPL Phase I Report are similar to
  PMM flight safety activities for Phase I flight safety review.



                  Press #fyellow SPACE#d to continue.').
      column = ?column - 1.
      row = ?row - 1.
      close_window ().
    end. (*6.2.2.2   PMM Activities*)
  end. (*6.2.2   Phase I Ground Safety Review*)

  topic '6.2.3   Phase II Ground Safety Review'.
    column = ?column + 1.
    row = ?row + 1.
    window ('6.2.3   Phase II Ground Safety Review',blue,white,white,?column,
      ?row,71,15).
    gphaseIIIlist = [
       '6.2.3.1   PED Phase II Ground Safety Compliance Data Package',
```

```
      '6.2.3.2   PMM Activities',
      'QUIT'].

    gchoiceIII = ''.

    while ?gchoiceIII <> 'QUIT'
      then
        ask ('#e

    Please choose which section you wish to continue with.',gchoiceIII,
    ?gphaseIIIlist)
        and
        if ?gchoiceIII =
             '6.2.3.1   PED Phase II Ground Safety Compliance Data Package'
          then
            do ('PED Phase II Ground Safety Compliance Data Package')
        else
          if ?gchoiceIII = '6.2.3.2   PMM Activities'
            then
              do ('PMM Activities')
        else
          if ?gchoiceIII = 'QUIT'
            then
              column = ?column - 1
              and
              row = ?row - 1
              and
              close_window ().

    topic 'PED Phase II Ground Safety Compliance Data Package'.
      column = ?column + 1.
      row = ?row + 1.
      window('6.2.3.1   PED Phase II Ground Safety Compliance Data Package',
        blue,white,white,?column,?row,70,14).
      say ('

  The objective of the Phase II Ground Safety data is to present
  a safety analysis that reflects the GSE#39s final design and
  planned operations.   These data are delivered with the data
  package for review at the PED CDR (#mFigure 5-1#m and Figure 6-1).
  This ground safety data shall contain the following list.



                    Press #fyellow SPACE#d to continue.')
      and
      do (phaseIIpack).

      topic 'phaseIIpack'.
        ansgII = ''.
        while ?ansgII <> 'NO'
          then
            ask ('  The PED shall include the following information in the Pha
data package:      Safety-Critical Subsystem Description,
                   Payload Element Description,
                   GSE Descriptions, List of Deliverable Items,
                   Operating Procedures, Hazardous Radiation,
                   Phase II Ground Hazard Reports,
                   Failures/Accidents Reports, Ordnance Data,
```

```
                    Ionizing Source Data, Non-Ionizing Radiation,
                    Ground Operations Scenario.

Would you like to begin filling out the documentation?#n',ansgII,?yn)
              and
              if ?ansgII = 'YES'
                then
                  new_kb ('PHIIGDOC.HKB').
        end. (*phaseIIpack*)
        column = ?column - 1.
        row = ?row - 1.
        close_window ().
      end. (*6.2.3.1   PED Phase II Ground Safety Compliance Data Package*)

      topic 'PMM Activities'.
        column = ?column + 1.
        row = ?row + 1.
        window('6.2.3.2   PMM Activities',blue,white,white,?column,?row,70,14).
        say ('

      Activities of the PMM related to review, integration and
      baselining of the PED Phase II ground safety data are similar
      to the flight safety activities of the PMM for the Phase II
      flight safety review.




                        Press #fyellow SPACE#d to continue.').
        column = ?column - 1.
        row = ?row - 1.
        close_window ().
      end. (*6.2.3.2   PMM Activities*)
    end.(*6.2.3   Phase II Ground Safety Review*)

    topic '6.2.4   Phase III Ground Safety Review'.
      column = ?column + 1.
      row = ?row + 1.
      window ('6.2.4   Phase III Ground Safety Review',blue,white,white,
         ?column,?row,71,15).
      gphaseIIIIlist = [
         '6.2.4.1   PED Phase III Ground Safety Compliance Data Package',
         '6.2.4.2   PMM Activities',
         'QUIT'].

      gchoiceIIII = ''.

      while ?gchoiceIIII <> 'QUIT'
        then
          ask ('#e

      Please choose which section you wish to continue with.',gchoiceIIII,
      ?gphaseIIIIlist)
          and
          if ?gchoiceIIII =
               '6.2.4.1   PED Phase III Ground Safety Compliance Data Package'
            then
              do ('PED Phase III Ground Safety Compliance Data Package')
          else
```

```
      if ?gchoiceIIII = '6.2.4.2   PMM Activities'
        then
          do ('PMM Activities')
    else
      if ?gchoiceIIII = 'QUIT'
        then
          column = ?column - 1
          and
          row = ?row - 1
          and
          close_window ().


  topic 'PED Phase III Ground Safety Compliance Data Package'.
    column = ?column + 1.
    row = ?row + 1.
    window ('6.2.4.1   PED Phase III Ground Safety Compliance Data',blue,
      white,white,?column,?row,70,14).
    say (['
```

The principal PED safety activity leading to the PED IRR and is the submittal of verification data to the PMM to substantiate the closeout of all open hazard reports or safety-related action items.

PED Phase III ground safety compliance data consists of data from action and closeout items to ensure that the as-built equipment, procedures and operations established as hazard controls have been fully verified to control the hazards and that all hazard control verifications have been satisfactorily completed. Hardware/operations descriptions are updated to reflect modifications/changes which could impact safety. A finalized list of technical operating procedures with the hazardous procedures clearly identified is submitted. Copies of all procedures used to control ground hazards are to be submitted with the PED data package. Payload hazard reports are updated and supplemental data provided. Hazard report closure statements (i.e., status of verification block on JSC Form 542B) must contain the following elements:

Statement(s) of fact concerning completion of applicable tests, analyses, or inspections.

Completion date (month/year) of applicable tests, analyses, or inspections.

Summary statement or assessment including parametric data regarding results of the tests, analyses, or inspections (e.g., "Stress analysis results show positive margins of safety for all safety critical structures").

Identification of payload developer reports which contain test, analysis, or inspection results (i.e., title and number).

This data is submitted to the PMM by the PED via ECR before the PED IRR for review and incorporation into the individual PED#39s section of the baselined Integrated Payload Ground Safety Compliance Data Package. (See #mFigure 5-1#m and 6-1.)

```
              Press #fyellow SPACE#d to continue.'])
```

```
      and
      do (phaseIIIpack).

      topic 'phaseIIIpack'.
        ansgIII = ''.
        while ?ansgIII <> 'NO'
          then
            ask ('
The PED shall include the following information in the Phase III
data package:
                Open Safety Items List,
                Pressure Vessel/System Log Book,
                Failures/Accidents,
                Handling Equipment Certification,
                Certification of Ground Safety Compliance.

Would you like to begin filling out the documentation?#n',ansgIII,?yn)
            and
            if ?ansgIII = 'YES'
              then
                new_kb ('PHIIIGDC.HKB').
      end.(*phaseIIIpack*)
      column = ?column - 1.
      row = ?row - 1.
      close_window ().
    end. (*6.2.4.1   PED Phase III Ground Safety Compliance Data*)

    topic 'PMM Activities'.
      column = ?column + 1.
      row = ?row + 1.
      window ('6.2.4.2   PMM Activities',blue,white,white,?column,?row,70,15).
      say ('   The PMM will update the IPL Ground Safety Data Package includin
 updates to the individual PED sections utilizing latest reviewed
 and accepted PED safety data inputs and forward it to the NSTS
 Ground Safety Review Panel for the Phase III review. He will also
 review, approve, and forward hazardous operating procedures
 prepared by the PED.  The PMM will provide a Certificate of Safety
 Compliance to certify that the payload and the GSE fully comply
 with requirements of NHB 1700.7 and KHB 1700.7. The Phase III
 review must be accomplished before commencement of integration
 activities.  Upon successful completion of the Phase III review,
 ground processing will be authorized by the NSTS Ground Safety
 Panel. The certification statement will be forwarded to the PMM
 and launch site integration authority.

                  Press #fyellow SPACE#d to continue.').
      column = ?column - 1.
      row = ?row - 1.
      close_window ().
    end. (*6.2.4.2   PMM Activities*)
  end. (*6.2.4   Phase III Ground Safety Review*)
end. (*sixsub2*)

      topic 'Figure 5-1'.
        collect ().
        dos ('SAFE_REV_.EXE',restore).
      end. (*Figure 5-1*)

(*created 12/14/93*)
```

```
(*APPDB.KB  This is a subprogram to display the hazard reports found
  in appendix b of JA-012.                                          *)
column = 3.
row = 3.
do ('Appendix B').

topic 'Appendix B'.
  window ('SAFETY COMPLIANCE DATA PACKAGE',blue,white,white,?column,?row,76,
  18).
  report_option is ['GENERIC FLIGHT HAZARDS',
                    'GENERIC GROUND HAZARDS',
                    'QUIT'].
  report_choice = ' '.
  column = ?column + 1.
  row = ?row + 1.
  window ('Appendix B',blue,white,white,?column,?row,74,17).
  say ('
              Appendix B: GENERIC HAZARD REPORTS

   During the safety review process by MSFC on numerous payloads
   (including Spacelab and partial payloads), it has become apparent
   that there are several types of hazards that are applicable to
   most payload elements and use essentially the same hazard controls.
   These hazards and controls have been incorporated on payload
   hazard reports and have been designated as "generic."  The generic
   hazard reports can be used by the PED in the development of safety
   data, if they are applicable.

   In performing the hazard analyses, the PED should identify all
   hazards and causes, develop controls, and perform the verification
   necessary for safety certification.  If a particular generic hazard
   report is applicable, the PED is free to use the form; however, the
   submitted report should be tailored to specific needs.  All other
   hazards must be identified on unique hazard reports.  Both unique
   and generic hazard reports are to be submitted in the PED safety
   data package.


   To assiste the PED in the safety data development, seven generic
   flight hazard reports (designated G-1 through G-7) and three
   generic ground hazard reports (designated KG-1 through KG-3) are
   provided in the appendix.  These hazard reports have been inter-
   spersed with notes to the PED to provide information or clarifi-
   cation of data to support the report.

                    Press #fyellow SPACE#d to continue. ').

  while ?report_choice <> 'QUIT'
     then
       ask ('#e

        Which Hazard Reports do you wish to view?', report_choice,
        ?report_option)
       and
       if ?report_choice = 'GENERIC FLIGHT HAZARDS'
         then
            do (fligthaz)
       else
         if ?report_choice = 'GENERIC GROUND HAZARDS'
           then
```

```
        do (groundhaz)
  else
    if ?report_choice = 'QUIT'
      then
        new_kb ('PH0FLDOC.HKB').

topic 'fligthaz'.
  sub1option = ['ELECTRICAL',
                'HUMAN FACTORS',
                'MATERIALS',
                'STRUCTURES',
                'QUIT'].
  sub1choice = ''.
  column = ?column + 1.
  row = ?row + 1.
  window ('GENERIC FLIGHT HAZARDS',blue,white,white,?column,?row,73,16).
  while ?sub1choice <> 'QUIT'
    then
      ask ('#e

   Which Flight Hazard Report Subsystem do you wish to view?', sub1choice,
   ?sub1option)
      and
       if ?sub1choice = 'ELECTRICAL'
         then
           do ('ELECTRICAL')
       else
         if ?sub1choice = 'HUMAN FACTORS'
           then
             do ('HUMAN FACTORS')
       else
         if ?sub1choice = 'MATERIALS'
           then
             do ('MATERIALS')
       else
         if ?sub1choice = 'STRUCTURES'
           then
             do ('STRUCTURES')
       else
         if ?sub1choice = 'QUIT'
           then
              column = ?column - 1
              and
              row = ?row - 1
              and
              close_window ().

  topic 'ELECTRICAL'.
    typeElist = ['INJURY/ILLNESS',
                 'FIRE',
                 'RADIATION',
                 'QUIT'].
    typeans = ''.
    column = ?column + 1.
    row = ?row + 1.
    window ('ELECTRICAL',blue,white,white,?column,?row,74,16).
    while ?typeans <> 'QUIT'
      then
        ask ('
  Which Hazard Group would you like to view?',typeans,?typeElist)
```

```
          and
          if ?typeans = 'INJURY/ILLNESS'
            then
              do('INJURY/ILLNESS')
          else
            if ?typeans = 'FIRE'
              then
                do('FIRE')
          else
            if ?typeans =  'RADIATION'
              then
                do ('RADIATION')
          else
            if ?typeans = 'QUIT'
              then
                column = ?column - 1
                and
                row = ?row - 1
                and
                close_window ().

      topic 'INJURY/ILLNESS'.
        column = ?column + 1.
        row = ?row + 1.
        window ('INJURY/ILLNESS',blue,white,white,?column,?row,74,15).
        say ('                              PAYLOAD HAZARD REPORT           |NO. G
PAYLOAD:                                                    |PHASE
SUBSYSTEM: Electrical                                       |DATE 9-10-86
HAZARD GROUP: Injury/Illness
TITLE: Electrical Shock
-------------------------------------------------------------------------

APPLICABLE SAFETY REQUIREMENTS:                  |HAZARD CATEGORY
                                                 |  |Catastrophic
 NHB 1700.7A, paragraph 206, 213                 |X |Critical
-------------------------------------------------------------------------

DESCRIPTION OF HAZARD:
  Electrical shock to the flight crew could result from contact with
  voltages in excess of 30V.
HAZARD CAUSES:
  1. Defective components, wires, or insulation coupled with
     inadequate bonding/grounding results in shock potential.

   2. Exposed terminals or high voltage sources accessible to the
      crew during opertions.

HAZARD CONTROLS:
   1. Bonding and grounding will be (have been) accomplished in
      accordance with MIL-B-5087B.

   2. Bleed down circuitry will be (has been) provided for HV
      capacitors.  High voltage sources will be (are) inaccessible to
      the crew and interlocks will be (have been) provided to remove
      power when operations require access to areas of exposure.

                              NOTES TO PED:
```

1. Provide schematics of HV sources and interlocks, and identify voltage potential. If there is more than one area which would allow access to high voltage (e.g., exposed terminals or opening doors which could expose HV sources), attach a table which denotes voltage, areas of exposure (equipment), interlocks or controls, and switches for power removal.

2. Electric shock may be catastrophic. Each potential source must be evaluated for hazard classification and adequacy of controls.

SAFETY VERIFICATION METHODS:

1. Test of bonding/grounding per MIL-B-5087B - Class R for energized equipment and Class S for others.

2. Design review of equipment, inspection of as-built equipment, and test of interlocks.

STATUS OF VERIFICATION:

Phase I - (Provide a tentative schedule for completion of each inspection or test.)

Phase II - (Specify schedule for the completion of each verification test, analysis, or inspection.)

Phase III - (All safety verification should be complete. Briefly summaize the results of the completed tests, analyses, and/or inspections and provide verification completion dates.

Refer to particular test/analysis reports and verification completion dates by document number and title. All open verifications shall be identified.)

APPROVAL	PAYLOAD ORGANIZATION	STS
PHASE I		
PHASE II		
PHASE III		

```
                    Press #fyellow SPACE#d to continue. ').
      column = ?column - 1.
      row = ?row - 1.
      close_window ().
    end. (*injury/illness*)

    topic 'FIRE'.
      column = ?column + 1.
      row = ?row + 1.
      window ('FIRE',blue,white,white,?column,?row,74,15).
      say ('                          PAYLOAD HAZARD REPORT          |NO. G
PAYLOAD:                                                  |PHASE
SUBSYSTEM: Electrical                                     |DATE 9-10-86
HAZARD GROUP: Fire
TITLE: Ignition Sources
-------------------------------------------------------------------
APPLICABLE SAFETY REQUIREMENTS:                  |HAZARD CATEGORY
                                                 |X|Catastrophic
 NHB 1700.7A, paragraph 206, 209.3, 213, 219     | |Critical
-------------------------------------------------------------------
DESCRIPTION OF HAZARD:
   1. Overheating of electrical wiring results in ignition of flammable
```

materials.
2. Ignition of flammable atmospheres in the payload bay during Orbiter entry/landing and postlanding operations.

HAZARD CAUSES:

1. Wiring/fusing size improper to protect downstream wiring from overheating in the event of a short or partial short circuit.

2. Normal equipment operation provides a spark or other ignition source for flammable gases in the payload bay.

HAZARD CONTROLS:

1. Wiring/fusing (including the instrument) will be (has been) selected to protect down-stream wiring in accordance with MIL-HDBK-978A (NASA), Volume II, Section 18 (Except 18.3 and 18.4). [For Spacelab payloads the wiring/cabling will be (has been) designed in accordance with SLP 2104 para 7.4 to the first circuit protection device within the instrument and the instrument protected internally in accordance with NHB 5300.4 (3G) and MIL-HDBK-978A (NASA), Volume II, Section 18 (Except 18.3 and 18.4).]

NOTE TO PED:

Polyvinylchloride insulation should not be used.

2. Payload bay equipment will be de-energized during deorbit/ landing operations or potential ignition sources. (e.g., switches, relays, motors) will be (have been) hermetically sealed.

NOTES TO PED:

1. Attach a simplified electrical schematic showing the protective device rating (Amps) and wire size (AWG).

2. Hazard ##2 is only applicable to, and should only be included for elements in the payload bay - the PED should specify the applicable portion of hazard control ##2, (i.e., no power applied or hermetic sealing).

3. Potential ignition sources from high temperature devices (e.g., furnaces, heaters, etc.) should be documented on unique Paylod Hazard Reports.)

SAFETY VERIFICATION METHODS:

1. (a) Circuit analysis to verify wiring per MIL-HDBK-978A (NASA), Volume II, Section 18 (Except 18.3 and 18.4). Analysis of cable/ wiring to verify requirements of SLP 2104 para 7.4 (if applicable).
(b) Inspection of as-built hardware.

2. Crew procedure for equipment power down or design review and QA certification of sealed components.

STATUS OF VERIFICATION:

Phase I - (Provide a tentative schedule for completion of each

verification analysis and inspection.)
Phase II - (Specify schedule for the completion of each verification analysis, inspection, and certification.)
Phase III - (All Safety verification should be complete. Briefly summarize the results of the completed analyses, inspections, and QA certification and refer to particular analysis reports by document number and title. All open verifications shall be identified.)

APPROVAL	PAYLOAD ORGANIZATION	STS
PHASE I		
PHASE II		
PHASE III		

```
                Press #fyellow SPACE#d to continue. ').
        column = ?column - 1.
        row = ?row - 1.
        close_window().
      end. (*fire*)

      topic 'RADIATION'.
        column = ?column + 1.
        row = ?row + 1.
        window ('RADIATION',blue,white,white,?column,?row,74,15).
        say ('                              PAYLOAD HAZARD REPORT          |NO. G
PAYLOAD:                                                    |PHASE
SUBSYSTEM: Electrical                                       |DATE 9-10-86
HAZARD GROUP: Radiation
TITLE: Exposure of the STS electrical system or other payloads to EMI
```

APPLICABLE SAFETY REQUIREMENTS:	HAZARD CATEGORY	
		Catastrophic
NHB 1700.7, paragraph 206, 212.2	X	Critical

DESCRIPTION OF HAZARD:
Payload generated EMI in excess of allowable limits interferes with Orbiter and/or other payload operations.

HAZARD CAUSES:
Radiated or conducted EMI from payload elements caused by electrical switching and/or equipment operation.

HAZARD CONTROLS:
Payload equipment will be (has been) designed for compliance with MSFC-SPEC-521 or equivalent requirements. Equipment conducted and radiated emissions will (does) not exceed the levels specified in MSFC-SPEC-521.

SAFETY VERIFICATION METHODS:
Test for radiated and conducted emissions in accordance with MSFC-SPEC-521.
STATUS OF VERIFICATION:
Phase I - (Provide a tentative schedule for completion of the EMI tests.)

```
Phase II  - (Specify schedule for the completion of the EMI tests.)
Phase III - (All safety verification should be complete.  Briefly
            summarize the results of the completed tests and refer to
            particular test reports by document number and title.  All
            open verifications shall be identified.)
```

APPROVAL	PAYLOAD ORGANIZATION	STS
PHASE I		
PHASE II		
PHASE III		

```
                    Press #fyellow SPACE#d to continue. ').
          column = ?column - 1.
          row = ?row - 1.
          close_window().
        end. (*radiation*)
      end. (*electrical*)

      topic 'HUMAN FACTORS'.
          column = ?column + 1.
          row = ?row + 1.
          window ('HUMAN FACTORS',blue,white,white,?column,?row,74,16).
          say ('
                          PAYLOAD HAZARD REPORT                  |NO. G-4
PAYLOAD:                                                         |PHASE
SUBSYSTEM: Human Factors                                         |DATE 9-10-86
HAZARD GROUP: Injury/Illness
TITLE: Exposure of crew to sharp corners, edges or protrusions
```

APPLICABLE SAFETY REQUIREMENTS:		HAZARD CATEGORY
		Catastrophic
NASA-STD-3000, paragraphs 6.3.3 and 14.1.3	X	Critical

DESCRIPTION OF HAZARD:
Injury of personnel caused by contact with sharp edges, corners, or protrusions.

HAZARD CAUSES:
Hardware designed and/or manufactured with sharp edges, corners, or protrusions.

HAZARD CONTROLS:
Hardware will be (has been) designed to comply with the intent of NASA-STD-3000, Volume I, paragraph 6.3.3 (and paragraph 14.1.3 for payload bay equipment on EVA missions).

NOTE TO PED:

For planned EVA Missions, this hazard report should be identified as catastrophic.

SAFETY VERIFICATION METHODS:

1. Drawing review for inclusion of requirements to remove sharp corners and edges or to provide protective covers.

2. QA certification that as-built hardware conforms to the drawings.

STATUS OF VERIFICATION:
Phase I - (Provide a tentative schedule for completion of QA inspection.)
Phase II - (Specify schedule for the completion of QA inspection.)
Phase III - (All safety verification should be complete. Briefly summaize the results and actual dates of the completed inspections and refer to particular inspection certifications provided. All open verifications shall be identified.

APPROVAL	PAYLOAD ORGANIZATION	STS
PHASE I		
PHASE II		
PHASE III		

```
                        Press #fyellow SPACE#d to continue. ').
      column = ?column - 1.
      row = ?row - 1.
      close_window().
    end. (*human factors*)

    topic 'MATERIALS'.
      typeMlist = ['INJURY/ILLNESS',
                   'FIRE',
                   'QUIT'].
    typeMans = ''.
    column = ?column + 1.
    row = ?row + 1.
    window ('MATERIALS - GENERIC FLIGHT HAZARDS',blue,white,white,
      ?column,?row,74,15).
    while ?typeMans <> 'QUIT'
      then
        ask ('
  Which Hazard Group would you like to view?',typeMans,?typeMlist)
        and
        if ?typeMans = 'INJURY/ILLNESS'
          then
            do('INJURY/ILLNESS')
        else
          if ?typeMans = 'FIRE'
            then
              do('FIRE')
        else
          if ?typeMans = 'QUIT'
            then
              column = ?column - 1
              and
              row = ?row - 1
              and
              close_window ().

    topic 'INJURY/ILLNESS'.
```

```
        column = ?column + 1.
        row = ?row + 1.
        window ('INJURY/ILLNESS',blue,white,white,?column,?row,74,15).
        say ('                          PAYLOAD HAZARD REPORT          |NO. G
PAYLOAD:                                                    |PHASE
SUBSYSTEM: Materials                                        |DATE 9-10-86
HAZARD GROUP: Injury/Illness
TITLE: Toxic offgassing materials in habitable areas
-------------------------------------------------------------------------

APPLICABLE SAFETY REQUIREMENTS:                  |HAZARD CATEGORY
                                                 |X|Catastrophic
 NHB 1700.7, paragraph 209.3                     | |Critical
-------------------------------------------------------------------------

DESCRIPTION OF HAZARD:
  Toxic constituents of offgassing materials used in habitable areas
  cause temporary of permanent crew injury/illness.


HAZARD CAUSES:

  Use of materials which offgas toxic gases or other by-products.

                          NOTE TO PED:

  The use of toxic substances requiring containment should be
  documented in unique hazard reports.



HAZARD CONTROLS:
   1. Materials will be (have been) selected in accordance with
      MSFC-HDBK-527/JSC 09604.  A Materials Usage Agreement (MUA)
      will be (has been) submitted for materials having less than
      an "A" or "K" rating as defined in MSFC-HDBK-527/JSC 09604.

   2. Equipment/hardware will be (has been) built in conformance
      with approved materials lists.

   3. Payload assembly(s) will be (have been) offgas tested and
      test data will be (has been) submitted to MSFC in accordance
      with Test 16 of NHB 8060.1.


SAFETY VERIFICATION METHODS:
   1. Materials list will be (have been) submitted to MSFC Materials
      and Processes Laboratory for approval.

   2. QA certification that as-built configuration is in accordance
      with design drawings and parts lists.

   3. MSFC evaluation of offgassing test data.

STATUS OF VERIFICATION:
Phase I   - (Provide a tentative schedule for completion of each
```

verification test or data submittal.)
Phase II - (Specify schedule for the completion of each verification test or data submittal.)
Phase III - (All safety verification should be complete. Briefly summaize the results of the completed tests and data evaluations. Refer to particular test reports by document number and title. All open verifications shall be identified.)

APPROVAL	PAYLOAD ORGANIZATION	STS
PHASE I		
PHASE II		
PHASE III		

```
                    Press #fyellow SPACE#d to continue. ').
        column = ?column - 1.
        row = ?row - 1.
        close_window().
      end. (*injury/illness*)

      topic 'FIRE'.
        column = ?column + 1.
        row = ?row + 1.
        window ('FIRE',blue,white,white,?column,?row,74,15).
        say ('                          PAYLOAD HAZARD REPORT          |NO. G-
PAYLOAD:                                                    |PHASE
SUBSYSTEM: Materals                                         |DATE 9-10-86
HAZARD GROUP: Fire
TITLE: Use of flammable materials
```

APPLICABLE SAFETY REQUIREMENTS:		HAZARD CATEGORY
	X	Catastrophic
NHB 1700.7 paragraph 209.2		Critical

DESCRIPTION OF HAZARD:
Fire with heat and smoke causes injury/illness of crewmember, and possible equipment damage or malfunction.

HAZARD CAUSES:
The use of flammable materials in proximity to an ignition source could result in a fire or propagation of a fire.

NOTE TO PED:
The use of flammable liquids and gasses should be discussed in unique hazard reports.

HAZARD CONTROLS:
1. Non-metallic materials will meet (have met) the requirements of NHB 1700.7 and NHB 8060.1 as required. Materials will be (have been) selected in accordance with MSFC-HDBK-527/JSC 09604, Table 2. For each material having less than an "A" rating, a Materials Usage Agreement (MUA) will be (has been) submitted to the MSFC Materials and Processes Laboratory for approval.

SAFETY VERIFICATION METHODS:
1. Materials lists and MUAs will be (have been) submitted to

MSFC Materials and Processes Laboratory for approval.

2. QA certification that the as-built configuration is in accordance with design drawings and parts lists.

STATUS OF VERIFICATION:
Phase I - (Provide a tentative schedule for materials data submittals.)
Phase II - (Provide materials data submittal schedule.)
Phase III - (All Safety verification should be complete. Briefly summarize the results of the materials data evaluations and certifications. Refer to particular QA certifications. All open verifications shall be identified.)

APPROVAL	PAYLOAD ORGANIZATION	STS
PHASE I		
PHASE II		
PHASE III		

```
                    Press #fyellow SPACE#d to continue. ').
        column = ?column - 1.
        row = ?row - 1.
        close_window().
      end. (*fire*)
    end. (*Materials*)

    topic 'STRUCTURES'.
        column = ?column + 1.
        row = ?row + 1.
        window ('STRUCTURES',blue,white,white,?column,?row,74,16).
        say ('                          PAYLOAD HAZARD REPORT          |NO. G-
PAYLOAD:                                                  |PHASE
SUBSYSTEM: Structures                                     |DATE 9-10-86
HAZARD GROUP: Collision
TITLE: Structural failure due to launch, flight, and landing
       environments or stress corrosion cracking.
-------------------------------------------------------------------
APPLICABLE SAFETY REQUIREMENTS:                  |HAZARD CATEGORY
                                                 |X|Catastrophic
NHB 1700.7, paragraphs 208.1, 208.2, and 208.3   | |Critical
-------------------------------------------------------------------
```

DESCRIPTION OF HAZARD:
Failure of payload structural elements or attachment hardware results in unrestrained objects in the Spacelab module, Orbiter or Payload Bay which could impact Orbiter, Spacelab or other payloads.

HAZARD CAUSES:
1. Structural elements of payload equipment lack structural strength to withstand launch, landing, and emergency landing loads, on-orbit environments (including depressurization and repressurization), or fail because of pre-existing flaws.

2. The use of structural materials which are susceptible to stress corrosion cracking.

3. Structural elements improperly manufactured or manufactured using unacceptable materials.

HAZARD CONTROLS:

1. a. Safety critical structures design will be (has been) based on worse-case mission induced loads with no negative margins of safety. Metallic structures design will be based on factors of safety of 2.0 ultimate and 1.25 yeild on untested structure, or 1.4 ultimate and 1.1 yield on structures qualified by static load tests. Non-metallic (including composites) structure design will be (has been) based on a factor of safety of 1.4 and 2.0 ultimate, where the higher factor will be (has been) used in joint (discontinuity) areas. All design and tests will be in accordance with MSFC PPO document number JA-418.

   b. The design will be (has been) based on fracture control procedures for safety-critical structures in accordance with JA-418.

HAZARD CONTROLS: (continued)

   c. Positive locking for threaded fasteners in safety critical structures for module center aisle, SMIDEX, and pallet mounted equipment will be (has been) provided.

2. Materials will be (have been) selected in accordance with MSFC-SPEC-522, Table I, or a Materials Usage Agreement (MUA) will be (has been) submitted to the MSFC Materials and Processes Laboratory for approval.

3. Safety critical structures will be (have been) built in accordance with approved design drawings and parts lists.

SAFETY VERIFICATION METHODS:

1. a. Structural analysis to verify positive margins against specified factors of safety and static load test for safety factors < 2.0 ultimate.
   b. MSFC Fracture Control Board review and approval of fracture control plan and fracture mechanics analysis (including NDE).
   c. Inspection verifying positive locking devices are in place, or vibration testing showing no fastener back-off in accordance with MSFC-STD-561 criteria.

2. Approval of Metallic Materials List and MUAs by MSFC Materials and Processes Laboratory.

3. QA certification that as-built hardware is in accordance with design drawings and parts lists as approved for safety critical structures.

STATUS OF VERIFICATION:

Phase I - (Provide a tentative schedule for completion of each verification test, analysis, and/or inspection.)

Phase II - (Specify schedule for the completion of each verification test, analysis, or inspection.)
Phase III - (All safety verification should be complete. Briefly summaize the results of the completed tests, analyses, and/or inspections and refer to particular test/analysis reports by document number and title. Provide actual completion date or test(s). Based on stress analyses, provide a summary table which shows the minimum margins of safety for safety critical structures. All open verifications shall be identified.

APPROVAL	PAYLOAD ORGANIZATION	STS
PHASE I		
PHASE II		
PHASE III		

```
                        Press #fyellow SPACE#d to continue. ').
        column = ?column - 1.
        row = ?row - 1.
        close_window().
      end. (*structures*)
   end. (*fligthaz*)

   topic 'groundhaz'.
     sub2option = ['ELECTRICAL',
                   'STRUCTURES',
                   'PRESSURE',
                   'QUIT'].
     sub2choice = ''.
     column = ?column + 1.
     row = ?row + 1.
     window ('GENERIC GROUND HAZARDS',blue,white,white,?column,?row,73,16).
     while ?sub2choice <> 'QUIT'
       then
         ask ('#e

      Which Flight Hazard Report Subsystem do you wish to view?', sub2choice,
      ?sub2option)
         and
          if ?sub2choice = 'ELECTRICAL'
            then
              do ('ELECTRICAL')
          else
            if ?sub2choice = 'STRUCTURES'
              then
                do ('STRUCTURES')
          else
            if ?sub2choice = 'PRESSURE'
              then
                do ('PRESSURE')
          else
            if ?sub2choice = 'QUIT'
              then
```

```
                column = ?column - 1
                and
                row = ?row - 1
                and
                close_window ().

    topic 'ELECTRICAL'.
        column = ?column + 1.
        row = ?row + 1.
        window ('ELECTRICAL',blue,white,white,?column,?row,74,16).
    say ('
                        PAYLOAD HAZARD REPORT                    |NO. KG-1
PAYLOAD:                                                         |PHASE
SUBSYSTEM: Electrical                                            |DATE 9-16-86
HAZARD GROUP: Injury/Illness
TITLE: Electrical Shock
-----------------------------------------------------------------------

APPLICABLE SAFETY REQUIREMENTS:                  |HAZARD CATEGORY
                                                 |  |Catastrophic
 NHB 1700.7, paragraph 4.3.2                     |X |Critical
-----------------------------------------------------------------------

DESCRIPTION OF HAZARD:
   Electrical shock to ground operations personnel could result from
   contact with high voltage sources associated with Ground Support
   Equipment (GSE).

HAZARD CAUSES:
   1. High voltage sources accessible to the ground crew.

   2. Equipment inadequately bonded/grounded which allows exposed
      surfaces of equipment to have potential voltages above ground.

HAZARD CONTROLS:
   1. High voltages will be (are) inaccessible to the crew or interlocks
      will be (have been) provided to remove power.  Equipment will be
      (has been) designed to requirements of JA-077 and KHB 1700.7,
      paragraph 4.3.2.

   2. Equipment, including surfaces, will be (has been) grounded and
      the ground connected to facility ground.


SAFETY VERIFICATION METHODS:
   1. Design review, and test of interlocks.

   2. Design review and test.

STATUS OF VERIFICATION:
Phase I   - (Provide a tentative schedule for completion of each
            verification test.)
Phase II  - (Specify schedule for the completion of each verification
            test.)
Phase III - (All safety verification should be complete. Briefly
            summarize the results of the completed tests, provide actual
            date of test completion, and refer to particular test reports
            by document number and title.  All open verifications shall
            be identified.)
```

```
-----------------------------------------------------------------------

APPROVAL          |          PAYLOAD ORGANIZATION          |       STS
  PHASE I         |________________________________________|____________
  PHASE II        |________________________________________|____________
  PHASE III       |________________________________________|____________
                    Press #fyellow SPACE#d to continue. ').
        column = ?column - 1.
        row = ?row - 1.
        close_window().
      end. (*electrical*)

    topic 'STRUCTURES'.
        column = ?column + 1.
        row = ?row + 1.
        window ('STRUCTURES',blue,white,white,?column,?row,74,16).
    say ('
                        PAYLOAD HAZARD REPORT                |NO. KG-2
PAYLOAD:                                                     |PHASE
SUBSYSTEM: Structures                                        |DATE 9-16-86
HAZARD GROUP: Injury/Illness
TITLE: Injury due to structural failure or improper use of ground
       handling devices.
-----------------------------------------------------------------------

APPLICABLE SAFETY REQUIREMENTS:                      |HAZARD CATEGORY
                                                     |  |Catastrophic
 KHB 1700.7, paragraph 4.5.                          |X |Critical
-----------------------------------------------------------------------
```

DESCRIPTION OF HAZARD:

Failure or improper use of handling devices and slings cause injury to ground crew and/or equipment damage.

HAZARD CAUSES:

1. Inadequate design of handling devices and slings.

2. Degradation and/or structrual failure of equipment

3. Improper use of equipment or inadequate procedures.

HAZARD CONTROLS:

1. Handling devices and slings are (will be) designed, built, and tested to meet requirements of KHB 1700.7, paragraph 4.5. Design is (will be) based on safety factors 5.0 ultimate and 3.0 yield, and equipment has been (will be) proof-tested to 2 x rated load. Synthetic slings will be (have been) designed and tested to requirements of KHB 1700.7, Table 4-1. See #mattached table#m.

   NOTE TO PED:

   Provide line drawings of handling equipment and fill in the attached table.

2. Handling devices will be checked before each usage. Arrangements have been (will be) made for periodic inspection of equipment per KHB 1700.7.

3. Handling devices will be operated by using KSC approved handling procedures.

SAFETY VERIFICATION METHODS:

1. Stress/Design analysis.

2. QA certification of proof load test of handling equipment.

3. QA certification of inspections and re-proof tests.

4. Procedures to be submitted to MSFC. Procedures have been (will be) submitted to KSC with equipment. Procedure numbers have been (will be) identified on the hazard report (Phase III).

STATUS OF VERIFICATION:

Phase I - (Provide a tentative schedule for completion of proof-load testing, analysis, and inspection.)

Phase II - (Specify schedule for the completion of proof-load testing, analysis, and inspection.)

Phase III - (All safety verification should be complete. Briefly summarize the results of the completed tests, analyses, and/or inspections and provide actual date of test(s) completion. Refer to particular test/analysis reports by document number and title. All open verifications shall be identified.)

APPROVAL	PAYLOAD ORGANIZATION	STS
PHASE I		
PHASE II		
PHASE III		

Press #fyellow SPACE#d to continue. ').

```
topic 'attached table'.
  column = ?column + 1.
  row = ?row + 1.
  window ('SUPPORT DATA - PHR KG-2- GROUND HANDLING EQUIPMENT',
     blue,white,white,?column,?row,74,16).
  say ('
```

Designation Number	Item Name	Sling (1) M	Sling (1) S	Crit (2) Y	Crit (2) N	Rated Load (LBS)	Ultimate Load (LBS)	Proof Load (LBS)	Actual Load (LBS)	Verf. Status

NOTES: 1. Identify whether slings are metallic or synthetic by placing an "X" in the appropriate column. For synthetic slings include the type of sling material in the name column, and see Table 4-1 of KHB 1700.7 for the required safety factors and proof load test criteria.

```
        2. Denote whether the device has a critical weld by placing an
           "X" in the appropriate column.  If there are critical welds,
           other tests may be applicable (see KHB 1700.7, paragraph
           4.5.1.1 D).  A critcal weld is a weld which constitutes a
           single point or failure.  Where feasible, critical welds
           should be eliminated.

                    Press #fyellow SPACE#d to continue. ').
         column = ?column - 1.
         row = ?row - 1.
         close_window().
         end. (*attached table*)
         column = ?column - 1.
         row = ?row - 1.
         close_window().
       end. (*structures*)

     topic 'PRESSURE'.
         column = ?column + 1.
         row = ?row + 1.
         window ('PRESSURE',blue,white,white,?column,?row,74,16).
     say ('
                        PAYLOAD HAZARD REPORT                  |NO. KG-3
PAYLOAD:                                                       |PHASE
SUBSYSTEM: Pressure                                            |DATE 9-16-86
HAZARD GROUP: Explosion
TITLE: Pressure Systems
---------------------------------------------------------------------

APPLICABLE SAFETY REQUIREMENTS:                    |HAZARD CATEGORY
                                                   |X|Catastrophic
 KHB 1700.7, paragraph 4.3.3.                      | |Critical
---------------------------------------------------------------------

DESCRIPTION OF HAZARD:
   Injury to ground crew or damage to equipment resulting from
   failure of pressurized system elements or components during
   ground operations.

HAZARD CAUSES:
   1. Improper design of flight and ground pressure system elements
      and components resulting in structural failure, explosion, or
      rupture of components, lines, or fittings.

   2. Improper use of equipment or inadequate procedures.

HAZARD CONTROLS:
   1. a. Flight pressure systems will be (have been) designed to
         requirements of NHB 1700.7 Chapter 2.

                              NOTE TO PED:
      Reference the applicable unique flight hazard report here.

      b. Pressure vessels used in GSE will be (have been) designed
         to the ASME Boiler and Pressure Vessel Codes, Section VIII,
         Division I or Division II as applicable.

                              NOTE TO PED:
      Identify applicable division.
```

c. Pressure system components (except pressure vessels) will be (have been) designed to a burst pressure level of at least 4 times (safety factor 4.0 ultimate) the maximum operating pressure (MOP). See #mattached table#m.

d. Regulators, gages and pressure relief devices will be (have been) sized and provided to protect down stream equipment including flight hardware. (See KHB 1700.7 paragraph 4.3.3.1.3).

e. Pressure systems will be (have been) designed such that pressures cannot be trapped in any part of the system without bleed capability.

f. Pressure systems will be (have been) proof pressure tested to 1.5 X Maximum Operating Pressure.

2. System will be operated in accordance with approved precedures.

NOTE TO PED:
Attach a simplified pressure system schematic which specifies pressure relief device settings, flow rates, and denote the type of fluid. Provide the appropriate design information of each type of system component on the attached table.)

SAFETY VERIFICATION METHODS:

1. a. Verified through flight safety panel phased safety reviews.
   b. Stress analysis and qualification test as required.
   c. Stress analysis or certification of design criteria or purchased components.
   d. Design review and analysis.
   e. Design review.
   f. Proof pressure test to 1.5 X MOP of assembled equipment system.

2. Operating procedures will be (have been) submitted to MSFC.

NOTE TO PED:
Precedure numbers to be identified on the Phase III hazard report.

STATUS OF VERIFICATION:

Phase I - (Provide a tentative schedule for completion of each verification test and analysis.)

Phase II - (Specify schedule for the completion of each verification test and analysis.)

Phase III - (All safety verification should be complete. Briefly summarize the results of the completed tests, and analyses, provide actual date of test(s) completion, and refer to particular test and analysis reports and procedures by document number and title. Attach a summary of the Pressure Vessel/System Log Book. The Phase III log summary shall state: maximum operating pressue, proof pressure, burst pressure, number of cycles above threshold, number of cycles above maximum operating pressure, design cycle limit, maximum level of which vessel was pressurized, and date of proof test. All open verifications shall be identified.)

```
-----------------------------------------------------------------------

APPROVAL          |          PAYLOAD ORGANIZATION          |      STS
  PHASE I         |________________________________________|____________
  PHASE II        |________________________________________|____________
  PHASE III       |________________________________________|____________
                     Press #fyellow SPACE#d to continue. ').

          topic 'attached table'.
            column = ?column + 1.
            row = ?row + 1.
            window (
          'SUPPORT DATA - PAYLOAD HAZARD REPORT KG-3- PRESSUREIZED SYSTEMS',
               blue,white,white,?column,?row,74,16).
            say ('
```

COMPONENT NUMBER	COMPONENT NAME	DESIGN PRESSURE (PSI)	BURST PRESSURE (PSI)	SYSTEM WORKING PRESSURE (PSI)	COMPONENT PROOF PRESSURE (PSI)	VERF. STATUS

```
 DEFINITIONS:
   1. Design Pressure - The maximum design operating pressure of the
                        component.
   2. Burst Pressure -  The component design burst pressure.
   3. System Working Pressure - The working pressure as used in the
                                system.
   4. Component Proof Pressure - 1.5 maximum operating (working)
                                 pressure.

                  Press #fyellow SPACE#d to continue. ').
          column = ?column - 1.
          row = ?row - 1.
          close_window().
          end. (*attached table*)
          column = ?column - 1.
          row = ?row - 1.
          close_window().
        end. (*pressure*)
    end. (*groundhaz*)

end. (*Appendix B*)
```

```
(*APPDC.KB  This is a subprogram to display the unique hazard reports found
  in appendix c of JA-012.                                                *)
column = 3.
row = 3.
do ('Appendix C').
topic 'Appendix C'.
  window ('SAFETY COMPLIANCE DATA PACKAGE',blue,white,white,?column,?row,
    76,18).
  column = ?column + 1.
  row = ?row + 1.
  window ('Appendix C',blue,white,white,?column,?row,74,17).
  say ('#e
                      UNIQUE HAZARD REPORTS

   During the performance of the payload element (including experi-
   ments) hazards analyses, it is highly probable that hazards that
   do not fall into the category covered by generic hazard reports
   will be identified.  These hazards are generally peculiar to a
   particular instrument/experiment, or the hazard controls vary
   significantly from other payload elements.  These hazards are
   identified and documented as unique hazard reports and should be
   designated with a unique report number.

   A tabulation of several hazard titles has been developed and is
   presented as an aid to the PED in developing the safety data.
   These titles are provided in #mTable C-1#m for flight hazards and
   #mTable C-2#m for ground hazards.

   To further assist the PED in understanding the type of backup
   information required for safety data, two examples of unique
   flight hazard reports have been provided in a Phase III
   configuration.  These hazard reports relate to pyrotechnic
   release devices and a high-pressure gas system.  The backup
   information is typical of the data required for hazard report
   closure.

   There is one unique flight hazard report that must be submitted
   for each item of payload equipment, if applicable.  This report
   deals with the loss of the payload cooling medium (Freon, water,
   rack air, cabin air, etc.) and us titled "Loss of Cooling."  This
   is not categorized as a generic hazard because of the wide range
   of control and verification options which make such an inclusion
   impractical.  The category itself can be "critical" for some
   designs and "catastrophic" for others, depending upon the hazard
   potential.  Controls can range from no special controls, if
   cooling loss can be verified not to be a hazard, to a redundant
   set of automatic power cutoff equipment for a design with
   catastrophic hazard potential.

                    Press #fyellow SPACE#d to continue. ').


  sub1choice = ''.
  sub1option = ['PYROTECHNICS','PRESSURE SYSTEMS','QUIT'].
  column = ?column + 1.
  row = ?row + 1.
  window ('UNIQUE FLIGHT HAZARDS',blue,white,white,?column,?row,73,16).
  while ?sub1choice <> 'QUIT'
    then
      ask ('#e
```

```
  Which Unique Flight Hazard Report do you wish to view?', sub1choice,
  ?sub1option)
and
if ?sub1choice = 'PYROTECHNICS'
  then
    do ('PYROTECHNICS')
else
  if ?sub1choice = 'PRESSURE SYSTEMS'
    then
      do ('PRESSURE SYSTEMS')
else
  if ?sub1choice = 'QUIT'
    then
      new_kb ('PH0FLDOC.HKB').

topic 'Table C-1'.
  column = ?column + 1.
  row = ?row + 1.
  window ('TABLE C-1',blue,white,white,?column,?row,72,16).
  say ('#e

          EXAMPLES OF UNIQUE FLIGHT HAZARD TITLES

          This section lists titles in both areas.
          Please select the most appropriate one.

           #mORBITER MIDDECK OR SPACELAB MODULE#m


                  #mORBITER PAYLOAD BAY#m


                Press #fyellow SPACE#d to continue.').


  topic 'ORBITER MIDDECK OR SPACELAB MODULE'.
    say ('#e
    Exposure of Crew to Broken Glass or Frangible Materials

   Release of Toxic or Noxious Gas into Habitable Atmosphere

              Containment of Flammable Fluids

       Frangmentation or Failure of Rotating Equipment

              Explosion/Rupture of Batteries

     Contamination Because of Battery Electrolyte Leakage

   Electrical Shock from Biomedical Instrumentation System

              Improperly Stowed Equipment

            Untethered Experiment Apparatus

             Hazardous Touch Temperatures

      Exposure of Crew to Pathogenic Micro-Organisms
```

Containment of Stowed Energy; e.g., Springs

Explosion/Rupture of Pressure Systems

Contamination Because of Release of Mercury

Failure of Vacuum Venting Results in Loss of Orbiter/Module Atmosphere

Use of Toxic Materials

Eye Injury As A Result of Exposure to Laser or Other High-Intensity Light (Nonionizing Radiation)

Overtemperature/Fire Resulting from Runaway Furnaces or Heaters

Loss of Cooling

Impediment for Emergency Egress of the Crew From the Module

Inability to Restow/Relatch Experiment Equipment during Emergency Evacuation

Use of Radioactive Materials

Containment of Toxic Experiment Samples
Press #fyellow SPACE#d to continue. ').

end. (*ORBITER MIDDECK OR SPACELAB MODULE*)

topic 'ORBITER PAYLOAD BAY'.
say ('#e
Battery - Explosive Rupture/Leakage

Collision Caused by Unsecured Hardware (e.g., Covers)

Explosion/Implosion of Experiment Container

Use of Radioactive Materials

Explosion/Rupture of Pressure Systems (Including Heat Pipes)

Collision Because of Experiment Pointing System Failure

Cryogen Storage Tank Overpressurization

Collision Because of Experiment Restraint Latch Failure

Collision Among Payload Elements During RMS Operations

Fire/Damage Becasue of High-Energy Laser; also Crew Exposure

Premature Deployment of Mast (or other Deployable Elements)

Premature Actuation of Pyrotechnic or other Release Devices

Inability to Restow Deployable Payloads

Inability to Clear Payload Bay Doors

Release of Mercury into the Payload Bay

Loose Equipment Jams Payload Bay Door Closure Mechanism

Eye Damage Because of Improper Positioning of Reflecting Lasers

Contamination Resulting from Release of Corrosive Materials

Contact or recontact with the Orbiter or Deployed Payload Equipment

```
                    Press #fyellow SPACE#d to continue. ').
  end. (*ORBITER PAYLOAD BAY*)

  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*Table C-1*)

topic 'Table C-2'.
  column = ?column + 1.
  row = ?row + 1.
  window ('TABLE C-2',blue,white,white,?column,?row,72,16).
  say ('#e
          EXAMPLES OF UNIQUE GROUND HAZARD TITLES

                Use of Radioactive Materials

        Release of Toxic Gases during Ground Operations

Use of Laser/High-Intensity Light that could Casue Eye Damage

            Oxygen Displacement in Confined Areas

        Containment and Handling of Cryogenic Fluids

Use of Spark (Ignition) Sources in Equipment Adjacent to Orbiter or
                        Propellant Systems

              Explosion/Rupture of Batteries

                 Containment of Mercury

        Handling/Operations using Biological Specimens

       Use of Flammable Fluids during Ground Operations

          Premature Actuation of Pyrotechnic Devices

        Exposure of Ground Crew to Rotating Devices

                    Press #fyellow SPACE#d to continue. ').
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (*Table C-2*)
```

```
    topic 'PYROTECHNICS'.
      column = ?column + 1.
      row = ?row + 1.
      window ('PYROTECHNICS',blue,white,white,3,?row,74,16).
      say ('#e
```

PAYLOAD HAZARD REPORT	NO. ACT-1
PAYLOAD: Automated Celestial Telescope	PHASE III
SUBSYSTEM: Pyrotechnics	DATE 10-15-86
HAZARD GROUP: Collision	
TITLE: Inadvertent Actuation of Pyrotechnics	

APPLICABLE SAFETY REQUIREMENTS:	HAZARD CATEGORY	
	X	Catastrophic
NHB 1700.7, paragraph 210		Critical

DESCRIPTION OF HAZARD:

Inadvertent actuation (premature firing) of pyrotechnics causes release of experiment hardware in cargo bay.

HAZARD CAUSES:

Inadvertent actuation of pyrotechnics.

1. Operator error.
2. Multiple circuit failures.
3. EMI actuation.
4. Lightning (static electric discharge).
5. Use of non-approved initiators.
6. Bent pins in power and control circuit connectors.

HAZARD CONTROLS:

1. The design includes a minimum of three inhibits to pyrotechnic firing and requires that three switches be actuated sequentially to fire the pyrotechnic squibs for the primary system and three switches for the backup squibs. Two of these switches are lever lock positive actuation which use switch guards to preclude inadvertent operation. The control panel is provided with indicator lights on each relay to indicate that the relays are open (SAFE).

2. Power to the squibs is supplied through three series relays and the squibs are short circuited until the fire relay is actuated.

3. Pyrotechnic circuits are designed to MIL-STD-1512 requirements. Cables are schielded and there is a short circuit across the pyrotechnic NSI initiators until fire relay is actuated.

4. Control relays are enclosed in a metallic box and grounded. The experiment is enclosed by the payload bay doors.

5. The design uses approved NSI type intiators.

6.

SAFETY VERIFICATION METHODS:

1. Design Review. Test indicator lights during system level tests with Orbiter.

2. Design Review.

3. Separation system qualification test and acceptance test of

pyrotechnics circuitry for short across NSI initiators, and to verify shielding. Design review of shield attenuation.

4. Inspect enclosure of relays and verify grounding of box. Analysis to show pyrotechnics will not fire with lightning (static electric discharge).

5. Record serial number and acceptance test data on each NSI used for flight.

6. MSFC Procedure 924 dated June 13, 1983 will verify prior launch that there are no pin-to-pin shorts in the pyrotechnic lines that could result in short during launch. Bent pin analysis and test at KSC.

STATUS OF VERIFICATION:

1. CLOSED. See attached #m"Normal Pyrotechnic Operation"#m. Design review completed 7-1-86. System test satisfactory (11-5-86). See attached test summary.

2. CLOSED. See #mattached supporting data#m. Review completed 7-1-86.

3. CLOSED. See attached #m"Separation System Test Summary"#m.

4. CLOSED. Lightning static electric discharge analysis has been completed. See #mattached letter#m.

5. CLOSED. Serial number and acceptance test data on each NSI used for flight will be recorded when issued at KSC.

6. CLOSED. Bent pin analysis is in attached, TBE memorandum PMIC-INT-P341-007(84) dated January 11, 1985 and GIRD specifies MSFC procedure 924 for testing of pyrotechnic circuits for shorts.

APPROVAL	PAYLOAD ORGANIZATION	STS
PHASE I		
PHASE II		
PHASE III		

Press #fyellow SPACE#d to continue. ').

```
topic '"Normal Pyrotechnic Operation"'.
  column = ?column + 1.
  row = ?row + 1.
  window (,blue,white,white,?column,?row,74,16).
  say ('#e
         NORMAL PYROTECHNIC OPERATIONS
```

The design provides cross strapping of power supplies to the pyrotechnic controls in order to eliminate single point failures which could defeat the two-failure tolerance criteria for CTOL release. This design requires three distinct switch operations on the Deployment/Pointing Panel (Figure ACT-1-1) to fire either the primary squibs or the backup squibs. In order to fire the

primary pin pullers, the rotary separation switch (S1) on the Deployment Pointing Panel (DPP) depicted in Figure ACT-1-1, must be repositioned to "No.1 Primary", the Arm/Safe Switch (S2) positioned to "ARM", and then the Deploy/Safe Switch (S3) is positioned to the "Deploy" position. These three switch operations actuate three series relays which normally interrupt power to the squib. The third switch/relay operation also removes the normal short circuit across the squib. The short circuit normally across each squib is to preclude operation from EMI. After operation of the #1 primary squib, the #2 primary squib must be fired. This operation is accomplished by moving the rotary switch on the DPP from "#1 Primary" to "#2 Primary" and positioning the Arm/Safe and Deploy/Safe switches as discussed for firing "#1 Primary". Firing of the redundant pyrotechnic pin pullers is accomplished in the same manner as used to fire the primary 1 and 2 pin pullers except that the rotary switch is positioned to "#1 Redundant" and "#2 Redundant". Successful release of the ACT CTOL requires operation of a #1 pyrotechnic and a #2 pyrotechnic in any combination of primary and/or redundant pin pullers. Figure ACT-1-2 provides a schematic of the fusing circuit while Figure ACT-1-3 provides a simplified schematic of the pyrotechnic firing circuits.

Instrumentation has been incorporated to provide the operator with visual indication of firing accomplishment. Two indicators are provided on the control panel to indicate when the Primary or Redundant Arm switches and their corresponding relays have been actuated. These indicators, normally red and white barber pole, will swithc to gray when the system is armed. The control panel is also equipped with two indicators to show when the clamps have been operated (successful firing of a pin puller operates a clamp). Both indicators switch from barber pole to gray when the #1 and #2 clamps are released. When both clamps are released, the CTOL is free and can be separated. The relays and lights are depicted in Figure ACT-1-4 (Pyro Control).

```
                        Press #fyellow SPACE#d to continue. ').
    column = ?column - 1.
    row = ?row - 1.
    close_window().
end. (*"Normal Pyrotechnic Operation"*)

topic '"Separation System Test Summary"'.
  column = ?column + 1.
  row = ?row + 1.
  window (,blue,white,white,?column,?row,74,16).
  say ('#e
```

SEPARATION SYSTEM TEST SUMMARY

The test data, contained in the Test Procedure (Appendix A) in Tables II and IV of ACT-6-2421, is summarized below.

a. Pyro Pin Puller Test Results - The pneumatic release was nominal, with both pin pullers acting simultaneously. Separation was nominal, with no extraneous motion. Separation force was calculated to be 2.5 lb. This calculation involved the measured separation force of 12.5 lb and the measured system friction force of 10.0 lb.

b. Manual Pin Puller Release Test Results - The manual release was nominal. Extraction forces were 30.5 and 28.0 lb

respectively, for each manual release pin. Insertion forces into the keeper holes were 5.0 and 2.0 lb. The wing separation force was calculated to be 2.0 lb, with nominal separation motion. The reverse extraction sequence for the second phase of the manual test yielded extraction forces of 30.0 and 24.0 for the same pins. Insertion forces were 2.0 and 1.0 lb. Separation again was nominal, with a calculated separation force of 2.0 lb. The manual release indication limit switches on the support structure malfunctioned after the first manual release (see D-Log #4). Neither would open after resetting the support structure latches, which inspection revealed to be caused by bent limit switch actuator arms.

c. Pyro Pin Puller Release Summaries - The pyrotechnic release was nominal. A modification to the test specimen was necessary to complete the firing circuit installation. A key in one of the squib connectors was inadvertently left on and had to be removed. Squib firing was nominal, with no pyro shock effects or other anomalies seen either on the scene or in the films. Separation was non-nominal, in that the separation force was calculated to be 6.5 lb, 1.5 lb greater than allowed by the CEl Spec (see Appendix B, D-Log, Item 6). Separation motion was again nominal. Unofficial friction measurements indicated that the counter balance system friction had increased to 13.3 lb, 3.3 lb greater than that of the initial measurement. Independent conferences with Test Director and Separation Mechanics Representatives confirmed that the wing assembly was also meant to use 3.2 lb as the corrected separation force. The only damage to the test specimen due to testing was that the limit switch arms yielded. The pin pullers were damaged internally beyond repair, but they were non-flight items which are to be replaced with flight units.

Separation System Test Conclusions

The test program was satisfactory. All of the test objectives were tested and met the program requirements. Except for the release indication limit switches, there was no damage to the test specimen. The limit switch arms were bent to a workable configuration; this constituted an acceptable disposition of the problem. The DAS electronics performed flawlessly, firing all four squibs at the proper moment while providing safe operation. Separation motion conformed to the expectations of program. Release and separation forces measured met the CEl Spec requirements. If the separation motion provided by the RMS moves the CTOL in an initial direction parallel to the CTOL center axis as planned, then the test results indicate that CTOL separation at the CTOL support structure interface can be successfully accomplished for non-nominal configurations as weIt as the stowed configuration of the test.

Design Review/Bent Pin Analysis

A bent pin analysis has been performed and is in attached Supporting Data as Memorandum PMIC-P361-84-006 and in Technical Memorandum PMIC-INT-P341-007(84). This analysis shows that no single pin to pin short in the connectors within the electroexplosive system circuit will cause 50 microamperes of current to flow in the pyro circuits. The pyro circuit/power and control pins and wiring will be tested at KSC prior to launch as suggested in PMIC-INT-P341-007(84). Power will not be supplied to the experiment during launch. During flight, if one pedestal became loose during orbital operations the experiment would be

jettisoned since it cannot de-orbit with only one pedestal attached.

```
                    Press #fyellow SPACE#d to continue. ').
  column = ?column - 1.
  row = ?row - 1.
  close_window().
end. (*"Separation System Test Summary"*)

topic 'attached supporting data'.
  column = ?column + 1.
  row = ?row + 1.
  window (,blue,white,white,?column,?row,74,16).
  say ('#e
```

DESCRIPTION OF THE PYRO INHIBIT RELAY
PRE-LAUNCH VERIFICATION

A. Verification of the electrical short across the squib will be accomplished prior to installation of each squib by an ohmmeter check through the squib interface connector (see attached Pyro Control sketch).

B. Verification that the Enable, Arm and Fire Relays are in the inhibit positions will be done after squib continuity tests via ohmmeter test.

Test Condition/Results:

1. Primary arm relay (K25) de-energized and primary squib 1 fire relay energized - OHMMETER READS #126 2.0 kohms (verifies primary arm relay in inhibit position).

2. Primary arm relay (K25) and primary squib 1 firer elay (K23) de-energized (in inhibit position) - OHMMETER READS #126 58 kohms (verifies Primary Squib 1 fire relay in inhibit position).

3. Primary arm relay (K23) de-energized and primary squib 2 fire relay (K22) energized - OHMMETER READS #126 2.0 kohms (verifies primary arm relay (K24) is in inhibit position).

4. Primary arm relay (K25) and primary squib 2 fire relay (K22) de-energized - OHMMETER READS #126 58 kohms (verifies primary squib 2 fire relay in inhibit position).

5. Primary enable relay (K21) energized - OHMMETER READS #126 4.0 kohms.

6. Primary enable relay (K21) de-energized - OHMMETER READS open circuit (verifies primary pyro enable relay in inhibit position).

7. The redundant squib control relays status will be verified by repeating steps 1 through 6 above on the appropriate relays.

C. The above steps have been incorporated in MSFC Procedure 924. Per this procedure, the pyro control cables to the deploy pointing panel are disconnected prior to the start of this procedure and will remain disconnected during subsequent ground operations. After these cables are connected on-pad, the experiment is not powered; therefore, the pyro inhibit relays will not be activated until/unless experiment separation is activated on- orbit.

C-3.

```
                        Press #fyellow SPACE#d to continue. ').
        column = ?column - 1.
        row = ?row - 1.
        close_window().
      end. (*attached supporting data*)

      topic 'attached letter'.
        column = ?column + 1.
        row = ?row + 1.
        window (,blue,white,white,3,?row,74,16).
        say ('#e
          NOTE: THIS PAGE IS INCLUDED AS A REPRESENTATIVE SUMMARY
                STATEMENT FOR THE REPORT
CONCLUSIONS:
As previously stated in the analysis, the current pyrotechnic
qualification requirement employed at MSFC is to subject the
electrically operated pyrotechnic device to 1 A (dc) at 1 W for
5 min. The analysis shows that, under worst case conditions, the
RF energy will cause a current of 45 mA to flow in the NSl. This
level is well below the 1.0A value specified as no-fire for NSl.

Tests have been performed to determine the susceptibility of NSl
to RF energy. An NSI, with bare annealed copper wires on its inputs,
was subjected to 240 V/m at frequencies in the Ku-Band. Test
conductors were unable to fire the NSI at this level. We expect to
see only 10 V/m in the payload bay, therefore, we have a large margin
of safety.

Our analysis was performed assuming that no shielding is present on
pyrotechnic circuit wiring. In reality, the pyrotechnic circuit wiring
(see Attachment 1), utilizes a silver plated copper alloy shield which
is highly conductive and provides optimum attenuation. The shielding
effectiveness is limited only by the gaps in the coverage of the shield.
MIL-STD-1512, Tailored for STS, states that shielding shall provide a
minimum of 85 percent of optical coverage ratio, which the shielding
used provides.

In summary, our findings further support the conclusion that the
pyrotechnic circuitry should not be susceptible to RF energy.


                        Press #fyellow SPACE#d to continue. ').
        column = ?column - 1.
        row = ?row - 1.
        close_window().
      end. (*attached letter*)

      column = ?column - 1.
      row = ?row - 1.
      close_window().
    end. (*PYROTECHNICS*)

    topic 'PRESSURE SYSTEMS'.
      column = ?column + 1.
      row = ?row + 1.
      window ('PRESSURE SYSTEMS',blue,white,white,3,?row,74,16).
      say ('#e
```

SUBSYSTEM: Pressure Systems | DATE 9-15-86
HAZARD GROUP: Explosion
TITLE: Explosion of Pressurized System

APPLICABLE SAFETY REQUIREMENTS:	HAZARD CATEGORY
NHB 1700.7A paragraphs 208.4 and 208.5	X Catastrophic Critical

DESCRIPTION OF HAZARD:
The ACT contains pressure vessels, pressure regulators, lines and other components which are used to provide the experiment with two different mixtures of gases. Explosion or rupture of the vessels or other pressure system components could result in fragmentation damage in the Orbiter cargo bay resulting in serious damage to the Orbiter.

HAZARD CAUSES:
1. Pressure vessel rupture due to inadequate strength or material fatigue, the vessels will be filled with gas t a maximum pressure of 1800 psi at room temperature (20 deg C). In a continuous B = HOT CASE attitude, analyses show that the temperature could reach 55 deg C leading to a maximum pressure of 2000 psi.

2. Regulator, line or other component failure results in damage to the Orbiter.

3. Failure of the regulator results in over-pressure of the ACT.

HAZARD CONTROLS:
1. The pressure vessels have been designed and qualified to the requirements of MIL-STD-1522A.
   a. The aluminum pressure vessel design is based on Option A in MIL-STD-1522A. The vessels are designed to safety factors => 2.0 ultimate based on maximum design pressure (2000 psi.). Structural design criteria includes the burst pressure + flight and crew-induced loads.
   b. A fracture mechanics analysis has been performed to determine critical initial flaw propagation. The fracture mechanics analysis includes safe-life criteria.
   c. The vessel is designed to be leak tested before burst.
   d. The pressure vessel materials have been selected using non-stress corrosion susceptible materials per MSFC-SPEC-522A, Table I.
   e. Qualification tests per MIL-STD-1522A. Option A.

2. Pressure system lines and fittings have been designed to safety factors of 4.0 (ultimate) based on 2000 psi MEOP. Other system components (except vessels, lines, and fittings) have been designed to safety factors of 2.5 ultimate. The system has been proof pressure tested to 1.5 MEOP, and leak tested afterwards to 1.0 nominal operating pressure. Welds have been inspected using NDE techniques following system proof test.

3. The system is equipped with a pressure relief valve set to 550 psi which is 1.1 X the nominal operating pressure of 500 psi. The relief valve has been sized to accommodate full flow in the event of a regulator failure. Additionally, the ACT Detector is equipped with overpressure devices (the ACT Detector is discussed in

PHR ACT-D-2).

SAFETY VERIFICATION METHODS:

1. a. Stress analysis including design burst pressure and flight crew induced loads.
   b. A fracture control plan and a fracture mechanics analysis, including safe-life, have been submitted to MSFC for approval. Non-desctructive evaluation has been performed.
   c. Leak before burst failure analysis.
   d. Metallic materials list has been submitted to MSFC Materials and Processes Laboratory for approval.
   e. One vessel has been burst tested, and a second vessel cycled at 1.5 MEOP (3000 psi) for two times the predicted number of operating cycles (3000 psi for 5000 cycles). Both vessels ruptured at levels above the design burst pressure. The failure mode of both vessels was leak before burst (LBB).

2. Stress analyses were performed. Proof pressure test of the system was performed to 1.5 X MEOP with regulators and relief valves removed. After the regulators and relief valves were installed, the system was leak tested at 1.0 nominal operating pressure (500 psi). The welds in the system were inspected using NDE techniques following the system proof test.

3. Design Review of the pressure system, and flow sizing analysis and test of pressure relief valves.

STATUS OF VERIFICATION:

1. a. CLOSED - Design review completed March 18, 1985. See attached #m"Description of System"#m. Stress analysis, report number ACT-6-1211, was evaluated by MSFC in May 1985.
   b. CLOSED - The fracture control plan and fracture mechanics analysis (Report No. ACT-6-1213) was approved by the MSFC Fracture Control Board (FCB) in June 1985. QC certified inspection reports of NDE were submitted at the Acceptance Review in April 1986.
   c. CLOSED - Analysis (ACT-6-1212) completed March 1985. The vessels are leak before burst.
   d. CLOSED - Metallic Materials List of as-built harware approved March 1986 by MSFC Materials and Process Laboratory.
   e. CLOSED - The pressure vessel qualification tests were completed in November 1985 (see Test Report ACT-6-1275). A summary of the cycle testing is included in #mTable ACT-2-1#m. A summary of the pressure vessel log is presented in #mTable ACT-2-2#m.

2. CLOSED - The stress analysis (Report No. ACT-6-1211) was submitted and evaluated by MSFC in May 1985. Proof pressure tests (Report No. ACT-6-1305) were performed. Leak test (Report No. ACT-6-1321) was performed. QC certified NDE inspection report was submitted and approved by MSFC (Report No. ACT-6-1410).

3. CLOSED - Design Review was completed in March 1985. Flow Analysis of relief valve sizing (Report No. ACT-6-1241) completed March 1985. QC certification of relief valve testing (Report No. ACT-6-1289) provided at the Acceptance Review.

APPROVAL	PAYLOAD ORGANIZATION	STS

PHASE I
PHASE II
PHASE III

Press #fyellow SPACE#d to continue. ').

```
topic '"Description of System"'.
  column = ?column + 1.
  row = ?row + 1.
  window (,blue,white,white,?column,?row,74,16).
  say ('#e
```

DESCRIPTION OF SYSTEM

The gas system used in the ACT is schematically shown in Figure ACT-2-1. It consists of two gas systems labeled A and B which can be summarized as follows:

System	Mixture	Composition	Storage Volume (L)	Maximum Storage Pressure (psi)
A	N2 CO2	65:35	9400	2000
B	Xe He	75:25	14000	2000

The ACT detector system (discussed in Hazard Report (ACT-D-2) provides internal pressure relief valves to limit input pressures to 525 psi. Excess pressure gases are vented to space external to the Detector. The gases and all mixtures are controlled internally to the Detector.

The pressure supply system as depicted in Figure ACT-2-1 provides dual systems which are identical in design. Each pressure vessel is equipped with a manual shut off valve to enable installation. After installation, the system is proof pressure tested and the manual valves to the pre-charged bottles are opened and remain open until post flight operations. Down stream of the manual valve is a two-stage pressure regulator which regulates the output to 500 psi. The system is equipped with a pressure relief valve (sized for full flow in the event of regulator failure) which is set to actuate at 500 psi.

As depicted in Figure ACT-2-1, items 10 and 2 are high pressure manual ON/OFF valves. Items 20 and 23 are regulators which reduce the pressure to approximately 500 psia. Item 21 and 22 are relief pressure valves with a cracking pressure set at 550 psia. The high pressure vessels, the high pressure valves, the regulators and the relief valves are all external to the experiment detector system.

Press #fyellow SPACE#d to continue. ').

```
  column = ?column - 1.
  row = ?row - 1.
  close_window().
end. (*"Description of System"*)

topic 'Table ACT-2-1'.
  column = ?column + 1.
  row = ?row + 1.
  window (,blue,white,white,?column,?row,74,16).
  say ('#e
```

	QUALIFICATIONS
	MIN.

```
                OPERATE      PROOF     |CYCLE (1)   CYCLE (1)   BURST    BURST
                PRESSURE     PRESSURE  |           PRESSURE    REQTS   PRESSURE
-------------------------------------------------------------------------------
DEVELOPMENT      0-2000       3000     |    -          -        4000     5850
   MODEL
-------------------------------------------------------------------------------
QUALIFICATION    0-2000       3000     |   500        3000      4000     6200
   MODEL
-------------------------------------------------------------------------------
FLIGHT UNITS     0-2000       3000     |  N/A         N/A        N/A      N/A
-------------------------------------------------------------------------------
 NOTE: (1) Pressure cycling based on predicted 250 operating cycles.
                          Press #fyellow SPACE#d to continue. ').
        column = ?column - 1.
        row = ?row - 1.
        close_window().
      end. (*Table ACT-2-1*)

      topic 'Table ACT-2-2'.
        column = ?column + 1.
        row = ?row + 1.
        window (,blue,white,white,?column,?row,74,16).
        say ('#e                    Parameter
1. Maximum Operating Pressure (PSI)                          2000      2000

2. Proof Pressure (PSI)                                      3000      3000

3. Burst Pressure (Design) (PSI)                             4000      4000

4. Number of cycles above threshold                             0         0

5. Number of cycles above Maximum Operating Pressure            1         1

6. Design Cycle Limit                                         250       250

7. Maximum level to which the vessel was pressurized (PSI)   3020      3050

8. Date of proof test                                      12-3-85   12-6-85
                          Press #fyellow SPACE#d to continue. ').
        column = ?column - 1.
        row = ?row - 1.
        close_window().
      end. (*Table ACT-2-2*)

      column = ?column - 1.
      row = ?row - 1.
      close_window().
    end. (*PRESSURE SYSTEMS*)
end. (*Appendix C*)
```

```
(*                          MATRIX.KB
     THIS PROGRAM ALLOWS THE USER TO PRINT OUT THE STS PAYLOAD
     SAFETY REQUIREMENTS APPLICABILITY MATRIX (JSC FORM 1090)   *)

(* TURN OFF EDITOR AND DEBUGGER *)
no_edit_key ().
no_debug ().

(* SET INITIAL COLUMN AND ROW POSITION *)
column = 3.
row = 3.

(****************************** MAIN BODY ******************************)



menu_choice = ' '.
menu_option is ['PRINT MATRIX','DISPLAY INSTRUCTIONS','RETURN'].

window ('STS PAYLOAD SAFETY APPLICABILITY MATRIX',blue,white,white,
?column,?row,77,18).

while ?menu_choice <> 'RETURN'
 then
ask('
       The applicability matrix provides a systematic approach for
  identifying those #mNHB 1700.7#m requirements applicable to a particular
  payload element.  The purpose of the matrix is to provide objective
  evidence that the #mPED#m has considered every requirement of NHB 1700.7
  in assessing the safety of the proposed design.  The PED will initially
  submit the matrix at the Phase 0 Review and update the matrix for
  each future PED safety data submittal.

                Please choose one of the following:',menu_choice,?menu_option)
and
if ?menu_choice = 'DISPLAY INSTRUCTIONS'
   then do ('Instructions')
else
if ?menu_choice = 'PRINT MATRIX'
   then do ('Print Matrix')
else
  if ?menu_choice = 'RETURN'
   then
     column =   ?column - 1
     and
     row = ?row - 1
     and
     close_window().    (* MAIN WINDOW *)

(* TOPIC MARK *)
topic mark (find_string).
  column = ?column + 1.
  row    = ?row + 1.
  text is read ('nasaterm.dat',concat('//',?find_string),'/end').
  window (?find_string,blue,white,white,?column,?row,72,).
  say (?text).
  column = ?column - 1.
  row = ?row - 1.
  close_window ().
end. (* topic mark *)
```

```
(***************************** RELATED TOPICS ******************************)

  topic 'Print Matrix'.
    column = ?column + 1.
    row = ?row + 1.

    window ('PRINT MATRIX',blue,white,white,?column,?row,76,17).
    menu_choice2 = ' '.
    menu_option2 is ['PRINT MATRIX','RETURN'].

    while ?menu_choice2 <> 'RETURN'
      then
     ask ('          This selection invokes a DOS program which provides
     a printout of the STS Payload Safety Requirements Applicability
     Matrix.  The program is designed to print the matrix solely on a
     laser printer. If you do not have access to a laser printer, then
     a copy of the matrix has been included in the rear of the user#39s
     manual for you to copy at your discretion.

          Printing the matrix may take anywhere from a few seconds to a
     few minutes depending on the amount of internal memory that your
     printer has available.  Please do not be alarmed by the delay.

                     Please make your selection.',menu_choice2,?menu_option2)

     and
     if ?menu_choice2 = 'PRINT MATRIX'
     then
     row = ?row - 1
     and
     column =?column - 1
     and
     close_window()
     and
     collect ()
     and
     dos('MATRIX.EXE',restore).

     if ?menu_choice2 = 'RETURN'
     then
     column = ?column - 1
     and
     row = ?row - 1
     and
     close_window ().   (* PRINT MATRIX *)
  end. (* Print Matrix *)



  topic 'Instructions'.
    column = ?column + 1.
    row = ?row + 1.
    window ('FILLING OUT STS PAYLOAD SAFETY MATRIX',blue,white,white,?row,
    ?column,76,17).
    say('              STS PAYLOAD SAFETY REQUIREMENT APPLICIBILITY MATRIX
                                JSC FORM 1090

          This is an assessment of the applicability to the payload
    of the  technical requirements of #mNHB 1700.7#m.  The matrix is
```

```
  to be updated at each safety review.

  Blocks 1 - 4     Self-explanatory

  Block 5          #mPAYLOAD ELEMENT#m - Major payload element
                   subsystems are listed.  Typically, a subsystem
                   is a "black box" (a self contained housing) having
                   one or more functions, for example:  power supply
                   (microprocessor); power supply (microprocessor,
                   command generator, data storage); sensor assembly,
                   etc.

  Block 6          NHB 1700.7 REQUIREMENTS - Using the legend in
                   #mBlock 8#m as a guide, enter the appropriate
                   symbol in the matrix.

  Blocks 7 & 9     Self-explanatory


                        Press #fyellow SPACE#d to continue.').

  column = ?column - 1.
  row = ?row - 1.
  close_window().
end. (* Instructions *)

topic 'block 8'.
  column = ?column + 1.
  row = ?row + 1.
  window ('BLOCK 8 (LEGEND)',blue,white,white,?column,?row,75,16).
  say('
   The following symbols are used when filling out the STS Payload
   Safety Applicability Matrix:
                       ---  NOT APPLICABLE

                       /    APPLICABLE:
                            NO HAZARD IDENTIFIED

                       X    APPLICABLE:
                            HAZARD IDENTIFIED

                       #219   WAVIER DEVIATION
                            REQUIRED

                     Press #fyellow SPACE#d to continue.').


  column = ?column - 1.
  row = ?row - 1.
  close_window().
end. (* block 8 *)
```