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CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES

FINAL REPORT

30 JULY 1976 MDC W0018

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GLOSSARY

Batch	PPP control mode which uses punch card inputs to control the program operations.
CDC	Control Data Corporation
Criterion Data	Stored parameter values which are used to measure the response of the vehicle and crew.
CRT	Cathode Ray Tube
C/S	Crew Station
CUE	A reference identifier initiated by the PPP user to facilitate data retrieval and review at a specified time during a run.
Data Base	The collection of data that is internally accessible by the PPP and on which the PPP operates. Segments of the PPP data base are identified as: (1) Hollerith Statements Data, (2) Numerical and Criterion Data, (3) Format Descriptors, (4) Reference Procedures, and (5) Stored Run Data.
Difference Procedure	A combination of the following data: Hold Configuration Difference, Switch Configuration Difference, Sequence Difference, Summary Procedures Difference and Detailed Difference Listing.
FDF	Flight Data File
Format	The arrangement and general makeup of a data output display as seen by the PPP user.
Format Descriptor	A complete set of user oriented, PPP recognizable, instructions that define a display format in its entirety.
FMT	Format
Fname	File Name
GDP	Generalized Documentation Processor
GET	Ground Elapsed Time
GMT	Greenwich Mean Time
Hollerith	Computer representation of alphanumeric characters.
IBM	International Business Machine
I.D.	Identification Number
Interactive	PPP control mode which uses either CDC 211 or CDC 243 interactive terminal inputs to control the program operations.
MET	Mission Elapsed Time
Mini-Phase	A small segment or portion of a mission phase.
Non Real-Time	PPP program mode when processing PPP Initialization data, stored SPS data, and PPP post-run data.

Parametric Data Analysis	Data presented by the PPP to provide a measure of crew response.
Performance Data	That data which is the "delayed" result of crew action (e.g., vehicle attitude, airspeed, and sink rate).
PPP	Procedures and Performance Program
PPP User	The PPP user is identified as a Procedures Developer during a procedures generation type run and as an SPS Instructor during a training exercise.
Procedures	Collection of C/S activity and mission event Hollerith statements in a specified format (e.g., detailed procedures, checklists, cue cards, and summary procedures).
Procedures Data	That data which is the "immediate" result of crew action (e.g., switch settings, keyboard entries, and control deflections).
Real-Time	PPP program mode when processing data from an SPS actual or simulated transfer.
Reference Data	Procedures Data from a previous SPS run used as the nominal time history reference for difference comparisons.
Run	SPS real-time operation (actual or simulated).
Run Data	Data which is stored by the PPP and represents procedures data and performance data from an SPS run. These data are adequate for the construction of all PPP formats.
SPS	Shuttle Procedures Simulator
SPS Actual Transfer	SPS program is active and generating the data transferred to the PPP.
SPS Simulated Transfer	A magnetic tape containing data recorded from an actual SPS transfer supplies the data transfer to the PPP.
SRT	Simulation Run Time. Time starts when the SPS run is initiated and ends when the SPS run is terminated.
SVDS	Space Vehicle Dynamics Simulation
Training Data	Data which tracks the training instructors PPP operations and tracks the SPS utilization.
Tutorial Display	A display that contains information to instruct or "tutor" the user in the operation of the PPP.

ABSTRACT

The Continuation of Advanced Crew Procedures Development Techniques (CACPDT) Study has resulted in the development of an operational computer program, the Procedures and Performance Program (PPP) which operates in conjunction with the Phase I Shuttle Procedures Simulator to provide a procedures recording and crew/vehicle performance monitoring capability. This report provides a summary of the work performed on the subject contract. A technical synopsis of each task resulting in the development of the Procedures and Performance Program is provided. Conclusions and recommendations for action leading to the improvements in production of crew procedures development and crew training support are included.

The PPP provides real-time CRT displays (alphanumeric and graphical) and post-run hardcopy output of procedures, difference procedures (actual versus reference), performance data, parametric analysis data, and training script/training status data. During post-run, the program is designed to support evaluation through the reconstruction of displays to any point in time. A permanent record of the simulation exercise can be obtained via hardcopy output of the display data and via transfer to the Generalized Documentation Processor (GDP). Reference procedures data may be transferred from the GDP to the PPP. Interface is provided with the all digital trajectory program, the Space Vehicle Dynamics Simulator (SVDS) to support initial procedures timeline development.

Section 1

INTRODUCTION

This report presents the final results of the Continuation of Advanced Crew Procedures Development Techniques Study conducted for the Johnson Space Center of the National Aeronautics and Space Administration under Contract NAS9-14780. The study has been performed by the McDonnell Douglas Technical Services Company, Inc., Houston Astronautics Division.

A synopsis of the tasks performed and technical accomplishments is presented in Section 2. Conclusions and recommendations are discussed in Section 3. An annotated bibliography of the study documentation is presented in Section 4.

Section 2

TECHNICAL SYNOPSIS

The purpose of this contracted research and development study has been to provide a computerized means of documenting Shuttle flight crew procedures based on crew action in the Shuttle Procedures Simulator (SPS), and to provide an interactive tool which supports Shuttle Crew Training. This contract is the third in a series of contracts which have resulted in the successful development of the Procedures and Performance Program (PPP) to satisfy these objectives.

The initial study contract, NAS9-13660 (Crew Procedures Development Techniques Study), established the system hardware and software requirements for the total operational capability of the PPP. Detailed design, implementation, and verification activities during this contract were directed towards achieving a system suitable for demonstrating the feasibility of automating the process of crew procedures development and crew training. This objective was satisfied during the contract period of performance.

Following the successful demonstration of the concept, a second study contract, NAS9-14354 (Advanced Crew Procedures Development Techniques Study), was performed which provided (1) implementation of the remaining requirements, (2) modification and maintenance of the PPP relative to the continuing design activities of the SPS, and (3) integration of the Generalized Document Processor (GDP) Terminal and the CDC 243 Interactive Graphics Terminal. Demonstration, user training, and operational utilization of the PPP system in concert with the SPS was achieved during the contract period of performance.

This, the third study contract, NAS9-14780 (Continuation of Advanced Crew Procedures Development Techniques Study), provided for the modification and expansion of the PPP capabilities in concert with the SPS, and support for the integration of the PPP with the Shuttle Mission Simulator (SMS). The modification activities were to include upgrading the PPP design to accommodate the computer complex which drives the SPS, maintain compatibility with the SPS for newly implemented Shuttle mission phases, and integration of the PPP with a non real-time trajectory generation program. Design studies and expanded capabilities were to be implemented in the area of crew station configuration determination, CDC 243 graphical displays, Hazeltine 4000G terminal interface, and advanced training techniques.

The integration of the PPP with the SMS is to be the responsibility of the SMS contractor. Support to that contractor was to be provided via this study effort in the area of consulting as to the PPP system, capabilities of the hardware devices, software interfaces, support software routines, and program structure changes.

Documentation included the determination of the PPP effectiveness, studies supporting the modification of the PPP, recommendation to the SMS contractor for PPP implementation, PPP Data Base maintenance and updates to the PPP Users Guide, the PPP User Training Plan, and all PPP software documentation.

These activities have been successfully completed during the contract performance period. The remaining subsections describe the capabilities of the operational PPP system, and summarize the accomplishments of the tasks performed during the study.

2.1 PPP CAPABILITIES DESCRIPTION

The Procedures and Performance Program (PPP) capabilities provide real-time CRT outputs and post-run hardcopy outputs of various data associated with SPS operations. These outputs provide valuable information to simulation, training, and procedures development personnel. The following highlights information available and possible usage for each group.

Using the PPP, simulation personnel can verify crew station control inputs and corresponding hardware and software output responses. Alphanumeric procedures data generated by the PPP, provide a record of crew station input/output discrete interaction. These data are time tagged and, therefore, provide an indication of the reaction time between input and output. Alphanumeric and graphical performance data generated by the PPP, provide a record of the simulated vehicle dynamic characteristics. These data, also time tagged, when combined with the procedures data, represent vital documentation for SPS hardware and software verification. The recording and subsequent hardcopy output of PPP generated data also provide maintenance personnel firm documentation of simulator problems. Problems during simulator operations can be easily duplicated without guessing what prior operations occurred. Finally, the PPP recording of simulator operations provide documentation on SPS utilization.

Training personnel can utilize the PPP in many different ways. Prior to each training exercise, the instructor can verify the proper initial SPS crew station configuration. During an exercise, crew operations and vehicle responses are monitored and, if desired, may be compared against an established reference. The reference procedures data provide a check on how closely the crew is following the established operating procedures and the performance evaluation data provide an indication of whether the run is within pre-established criterion for various vehicle parameters. PPP data are available which indicate the crews responsiveness to vehicle malfunction indications. This real-time data gives the training personnel the ability to closely control training sessions, thus allowing early termination of sessions which do not appear constructive. The post-run output provides documentation for crew debriefings and subsequent reviews of a training exercise. Here again, recording simulator operation provides documentation on SPS utilization and also of crew training activities.

Procedures development personnel can utilize the PPP for procedural techniques development and procedures development. Procedures development personnel can generate summary procedures timelines thru utilization of the PPP/SVDS trajectory program interfaces. Using an abbreviated timeline the procedures developer operates the SPS and then uses the performance data to check and verify the response to new techniques. The PPP recorded procedures data then provide the initial procedures documentation. Subsequent runs may be made to refine the newly developed procedures with the updated procedures immediately documented. Magnetic tape output of the procedures data also provide for direct transfer to the Generalized Documentation Processor (GDP). The GDP then provides the capability to finalize the procedures for Flight Data File (FDF) documentation. Another item worth noting is the consistency of FDF document nomenclature; since all nomenclature is generated from one source, the PPP Data Base. The PPP has the CALCOMP hardcopy capability which provides hardcopy of the graphical displays.

2.2 PPP SYSTEM DESCRIPTION

The PPP is a digital computer program and associated hardware system designed to operate in conjunction with the SPS in a real-time mode. During real-time, the PPP accepts actual SPS data transfers or simulated transfers where a magnetic tape represents the SPS data; then monitors, processes, and stores this SPS run data. The system also operates in a non real-time mode for PPP initialization, data reconstruction, and post-run processing. PPP user control is through the interactive control and display stations (either the CDC 211 or CDC 243 terminal) or batch inputs via punch cards. Monitor capability is provided on the CDC 211 or CDC 243 CRT and on hardcopy outputs. The PPP provides for data transfer from the SVDS to PPP for summary timeline procedures development. The PPP also provides for data transfer to the GDP and for procedures data transfer from the GDP via magnetic tape. The PPP Flight Display Unit contains a Norden CRT, Norden Keyboard, and a rotary switch which allows the PPP user to monitor the SPS crew station CRT's, direct a display to the left crew station CRT, or call up any SPS flight display independent of the SPS crew station selection. A function keybox provides six switches to key various PPP functions. Presently only two of the keys are operational. One, the CUE key inserts the time when the CUE key is depressed into the PPP real-time data stream to facilitate returning to a specific data point. The other, the FREEZE key is used to terminate the real-time CDC 211 or CDC 243 CRT display update.

Figure 2-1 presents a functional description of the PPP system and its interfaces with the SPS, GDP, and SVDS systems.

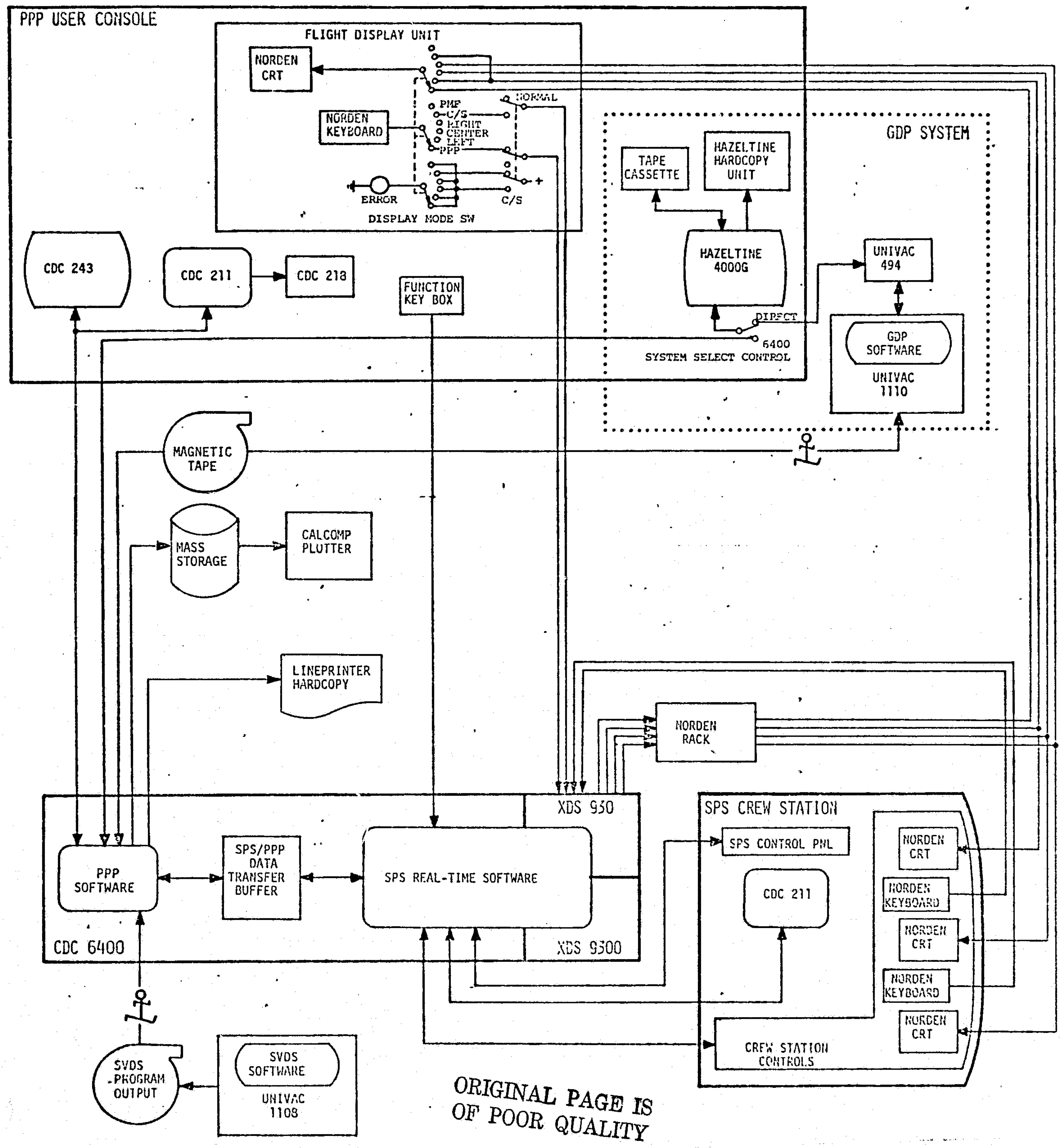
2.3 TASK DESCRIPTION/ACCOMPLISHMENTS

The following subsections present a technical summary of each task performed during the contract period of performance. Included is a brief summary of the objectives and significant technical accomplishments of each task.

2.3.1 Data Processing and Requirements Studies

The purpose of these activities was the performance of the necessary studies leading to the development of requirements to modify and expand the PPP capabilities in concert with the SPS and PPP users requirements. Specific studies addressed included (1) optimization of the PPP computer core and time utilization, (2) selection and integration of a non real-time digital trajectory program with the PPP, and (3) analysis and determination of the effectiveness

Figure 2-1 PPP/SPS/GDP/SVDS Functional Diagram



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of the PPP. The following summarizes the studies performed and the results obtained.

2.3.1.1 Core Utilization and Timing

The CACPDT Statement of Work (SOW) provides for a study of PPP core utilization and timing. The study was especially important in light of the upcoming requirements for the PPP which would require an increase in core utilization above the level at the start of the contract, and because of the increasing size of the operational user simulations. Although core utilization was a continuing concern in the PPP development process, a detailed study of possible core reduction schemes was necessary to satisfy the upcoming requirements.

CACPDT Design Note No. 15 (PPP Core Utilization Studies) documents the results of the study performed. Five candidate recommendations were defined to reduce the PPP core utilization. These recommendations are summarized as follows:

(1) LOADER Core - Allow core allocation for the LOADER to co-reside (over-write) blank common during the loading process.

(2) SYSTEM Code - Remove unused code and error checking code from SYSTEM software routines used by the PPP. Duplicate SYSTEM routines would have to be provided in PPP software library. Technique should be applied to production deck of PPP only.

(3) Assembly Language Coding - PPP utility routines could be coded in CDC 6400 assembly language (COMPASS). Optimization of the program registers can be realized by an efficient programmer, thereby saving a little core (doing a better job than the FORTRAN compiler).

(4) Existing Code Optimization - Clean up and recode sections of the PPP software.

(5) Overlaying - Restructive software by additional overlaying of the Graphics Formatter and Training Data Formatter modules to reduce maximum core requirement.

Further details of the candidate techniques are discussed in Design Note No. 15. The results of implementing these recommendations are discussed in Section 2.3.2.3

of this report.

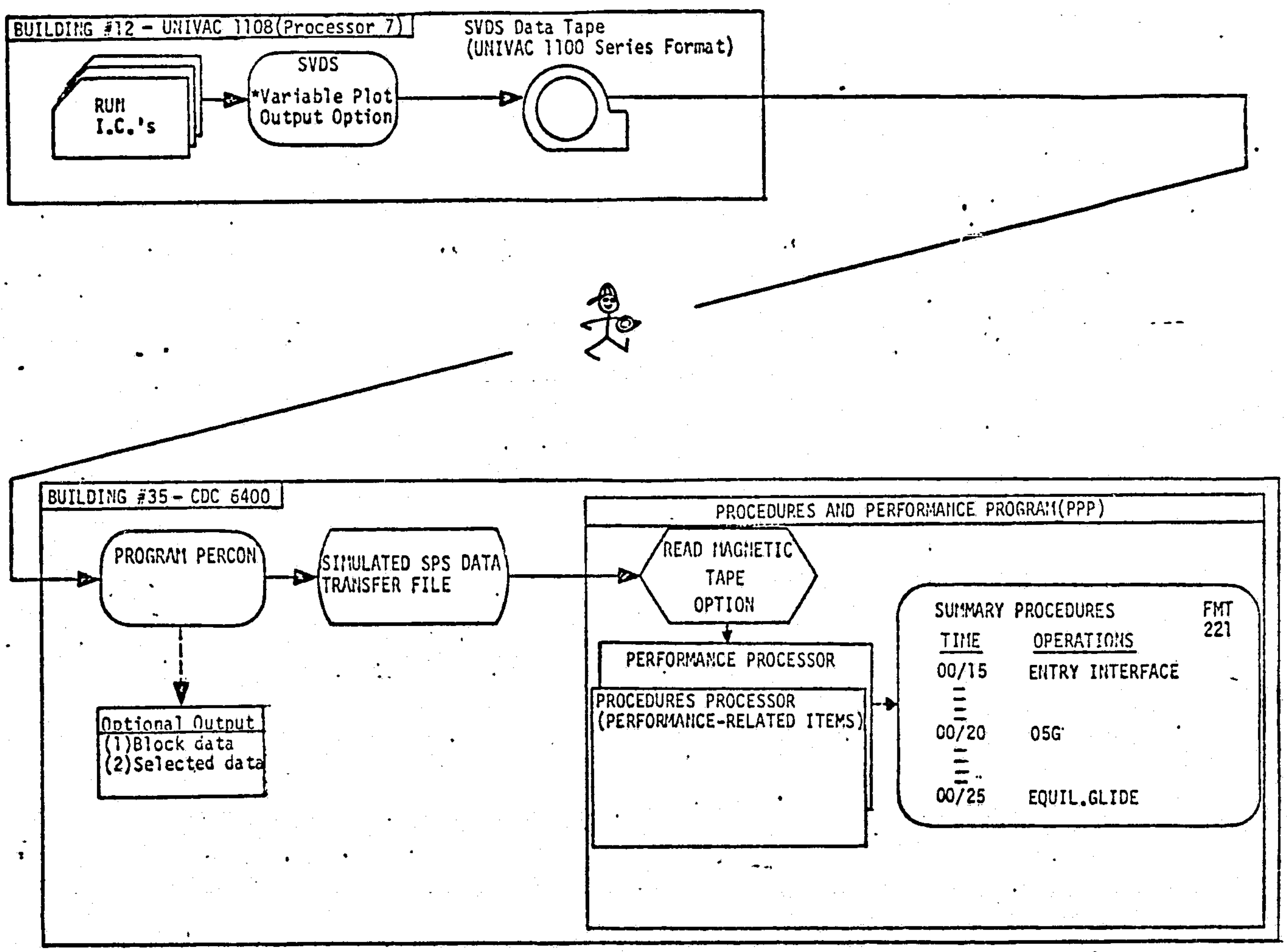
In addition to the major study of PPP core reduction techniques, an exercise was performed to explore the core required to perform certain recurring software operations in alternate ways. Sample test cases were developed and data gathered to compare alternate software implementation techniques. Results of this exercise are documented in PPP Working Paper No. 49 (Study of Software Alternatives for Reduction of Required PPP Core).

2.3.1.2 PPP/Trajectory Generation Program Interface

The CACPDT Contract Statement of Work (Section 2.0) defined the task of interfacing a non real-time trajectory program with the PPP. The purpose of this task was to provide a capability to generate summary procedures timeline data for any desired trajectory profile that could be used for subsequent simulation activities. A study was conducted in response to this task which discussed candidate methods of trajectory program implementation, the data transfer requirements, the PPP real-time procedures recording requirements, and the PPP post-run procedures merge requirements. CACPDT Design Note No. 14 (PPP/Non Real-Time Trajectory Program Interface Requirements and Capabilities) documents the detailed results of this study.

A feasibility study was made which considered the BANDITO and the SVDS non real-time trajectory programs. It was adjudged that the integration task of either program with the PPP would be too enormous and time-consuming. An alternate method was decided on which would provide the PPP with trajectory data via the SVDS variable plot tape output option. The SVDS trajectory program would be provided with PPP-selected initial conditions according to the desired mission phase. The variable plot output option would subsequently write user selected performance parameters at a prescribed frequency to a Univac coded tape. Upon receipt of the SVDS trajectory tape, a PPP conversion program would be executed which will (1) convert the Univac coded trajectory data to a recognizable CDC 6400 data file, and (2) commutate the CDC 6400 coded data file to a file identical in format to a simulated SPS data transfer and recognizable by the PPP. The generated performance data transfer file would be accessible by the PPP through the simulated real-time option. A unique summary procedures timeline could then be generated by the PPP performance and procedures processors. The final SVDS/PPP interface design is presented in Figure 2-2.

Figure 2-2 SVDS/PPP Interface Design



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2.3.1.3 PPP Effectiveness Study

The intent of the PPP Effectiveness Study was to determine manpower time savings and the improvements in job performance gained thru PPP automated techniques. The results of this study are documented in CACPDT Design Note No. 17 (PPP Effectiveness Study). The documentation presents a synopsis of the PPP capabilities and identification of potential users and associated applications, PPP effectiveness, and PPP applications to other simulation/training facilities. An appendix containing a detailed description of each PPP capability is provided.

PPP real-time and post-run output capabilities were identified to supply useful data to various Shuttle program disciplines. The first potential user identified was the flight operations discipline. In this area, PPP data could support systems analysis, mission analysis, procedures development, flight planning, and training activities. Other potential users identified include Engineering and Development (E&D), Data Systems and Analysis (DSA), and simulator support disciplines. In these areas, PPP data could support systems analysis, mission analysis, and simulator checkout and verification.

Figure 2-3 presents a detail matrix relating PPP capabilities to two different potential users needs. The first grouping indicates user needs for the flight operations and flight procedures development process. The matrix shows the PPP capabilities applicable to supporting user needs for each task identified. In general, total PPP capabilities are utilized during simulation activities. Other tasks are supported by the data output gathered during these simulation activities. Similar applications exist for the E&D (data outputs were supplied for the E&D Systems Management 1 & 2 Simulations) and DSA disciplines, but a detailed identification was not performed during this analysis. The second grouping identifies user needs for the simulator support discipline, and also indicates the different PPP capabilities supporting each task.

It was determined that PPP output capabilities could provide a useful and effective tool when applied to the user needs and tasks previously discussed. Proper use of this tool could save users time in completing their tasks and supply a combination of data that will improve total job performance. Time savings are a direct result of automated techniques applied to time consuming

Figure 2-3 Application of PPP to User Needs

	PROCEDURES AND PERFORMANCE PROGRAM CAPABILITIES																					
		PERFORMANCE DATA		PARAMETRIC DATA ANALYSIS		DIFFERENCE PROCEDURES						TRAINING DATA						GDP TRANSFER		SVDS TRANSFER		
	PROCEDURES	ALPHANUMERIC DISPLAYS	GRAPHICAL DISPLAYS	ALPHANUMERIC DISPLAYS	GRAPHICAL DISPLAYS	INITIAL CONFIG STATUS CHECK	HOLD DIFFERENCES	SWITCH CONFIG DIFFERENCES	SEQUENCE DIFFERENCES	SUMMARY PROC DIFFERENCES	DETAILED DIFF LISTING	TRAINING SCRIPT	CREW TRAINING STATUS	NON CREW STATUS	SYSTEM UTILIZATION	RECONSTRUCTION CAPABILITY	CUE INSERTION (PPP FUNCTION KEYS)	GDP TO PPP	PPP TO GDP	SVDS TO PPP	SVDS REF CONSTRUCTION*	PPP FLIGHT DISPLAY UNIT
FLIGHT PROCEDURES DEVELOPMENT TASKS																						
CREW OPERATIONAL REQUIREMENTS																						
• HARDWARE/SOFTWARE/MISSION REQUIREMENTS	•	•	•	•	•														•			
• DOCUMENT/DESIGN REVIEW	•	•	•	•	•														•			
• PANEL MEETINGS	•	•	•	•	•														•			
• ENGINEERING SIMULATIONS	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
• CREW ACTIVITY TIMELINES	•	•	•	•	•																	
FLIGHT PROCEDURES/TECHNIQUES DEVELOPMENT																						
• FLIGHT TECHNIQUES PANEL INTERFACE	•	•	•	•	•																	
• PART TASK SIMULATIONS	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
• ANALYTICAL STUDIES	•	•	•	•	•														•			
• CREW ACTIVITY TIMELINES UPDATES	•	•	•	•	•														•			
DETAILED PROCEDURES DEVELOPMENT/VALIDATION																						
• BASELINE VEHICLE DESIGN	•	•	•	•	•														•	•		
• FLIGHT TRAJECTORY DESIGN	•	•	•	•	•														•	•	•	
• PART-TASK SIMULATIONS	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
• PROCEDURES CONSTRAINTS/RATIONALE	•	•	•	•	•													•	•			
• DETAILED PROCEDURES	•	•	•	•	•													•	•			
• TRAINING CHECKLISTS	•	•	•	•	•							•	•					•	•			
• FLIGHT PROCEDURES HANDBOOK	•	•	•	•	•													•	•			
FDF DEVELOPMENT/VALIDATION																						
• PRELIMINARY FDF																						
• PART-TASK SIMULATIONS	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
• CONDITIONAL VALIDATION	•	•	•	•	•													•	•			
• BASIC FDF																		•	•			
• CPB CONTROL	•	•	•	•	•													•	•			
• FLIGHT SIMULATIONS	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
• BASIC EDITION VALIDATION	•	•	•	•	•													•	•			
• FINAL FDF																						
• INTEGRATED SIMULATIONS	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
• FLIGHT READINGS VALIDATION	•	•	•	•	•													•	•			
CREW TRAINING/FLIGHT OPERATIONS SUPPORT																						
• BRIEFINGS/PART-TASK/FAMILIARIZATION	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•
• BASIC/FLIGHT RELATED	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•
• INTEGRATED	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•
• REAL TIME SUPPORT	•	•	•	•	•														•			
• DEBRIEFINGS	•	•	•	•	•														•			
SIMULATOR SUPPORT OPERATIONS — PRE-FLIGHT SUPPORT																						
PREFLIGHT CHECKOUT AND TESTING																						
• INITIAL STATUS CHECK	← VISUAL INSPECTION ONLY -- NO COMPUTER CONTROL →																					
• POWER-UP SEQUENCE	← ACTIVATION OF SIMULATOR SYSTEMS -- NO COMPUTER CONTROL →																					
• CONFIGURE FOR CHECKOUT						•								•				•	•	•		
• STATIC AND DYNAMIC CHECKOUT	•	•	•	•	•		•	•	•	•	•			•	•	•	•	•	•	•		•
NOTIFICATION OF AVAILABILITY AND STATUS	← VERBAL COMMUNICATION BETWEEN SIMULATOR OPERATOR AND USER →																					
CONFIGURE FOR UNIQUELY PLANNED EXERCISE						•						•		•	•			•	•	•		
ASSIST IN FINAL PREPARATION																						
SIMULATOR SUPPORT OPERATIONS — OPERATIONAL ASSISTANCE																						
INFLIGHT OPERATIONS																						
• MONITOR DISPLAYS AND EQUIPMENT	•	•	•	•	•		•									•	•					•
• ASSIST IN PLANNED TRAINING EXERCISE	•	•	•	•		•	•	•														
POST-FLIGHT OPERATIONS																						
• COORDINATE RECONFIGURATION ACTIVITIES						•						•						•	•			
• FLIGHT CLOSE-OUT ACTIVITIES	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•					
IMMEDIATE CORRECTIVE ACTION																						
• TOP LEVEL TROUBLE SHOOTING	•	•	•	•	•		•	•	•	•	•					•						
• COLLECT DATA TO ANALYZE FAILURE	•	•	•	•	•		•	•	•	•	•					•						
• ASSESS IMPACT IN TRAINING SESSION	•	•	•	•	•		•	•	•	•	•					•						
• COORDINATE IMMEDIATE CORRECTIVE ACTION	← HARDWARE OR SOFTWARE MODIFICATION TO CORRECT FAILURE →																					
LONG RANGE FAULT ISOLATION																						
• DEFINE DATA MONITORING REQMTS FOR USERS	•	•	•	•	•											•						•
• ACQUIRE DATA FROM LATER REQMTS	•	•	•	•	•											•						•
• ANALYZE DATA TO DETERMINE SOLUTION	•	•	•	•	•																	
• COORDINATE CORRECTIVE ACTION	← HARDWARE OR SOFTWARE MODIFICATION TO CORRECT FAILURE →																					
• VERIFY SIMULATION	•	•	•	•	•	•	•	•	•	•	•	•				•	•	•				•

* This capability has not been implemented.

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tasks such as crew station configuration/verification, procedures documentation, performance data analysis, and training status documentation. The improvements in job performance result from properly identified and well formatted data outputs and from time savings which reduce required manpower.

The effectiveness of PPP capabilities is summarized in Figure 2-4. The figure presents a list of PPP capabilities, specifies that capability's function and provisions, indicates any previous methods employed, and then identifies the effectiveness of the capability. The list only provides the effectiveness on an individual capability basis and thus does not provide a total picture of overall PPP effectiveness. Coupling various capabilities further increases PPP effectiveness. This can readily be seen in the case of procedures development, crew training, and simulator support activities.

Considering procedures development, the obvious PPP aid is the procedures recording capability. This capability ensures recording of all crew station procedural operations on a user defined format. This output alone reduces the required typing support, subsequent review time, and correction cycle. By coupling procedures recording with difference procedures, performance data, and performance evaluation data (all time tagged), the iterative process of desk analysis work and simulator reverification of developed procedures is shortened. These same PPP capabilities support new techniques evaluation. In this case, real-time PPP outputs provide extensive on-the-spot evaluations; and post-run outputs provide the initial properly formatted procedures and the data necessary to reduce the iterative processes.

The study continues with an analysis of the system effectiveness considering the coupling of other capabilities and their application to the previously introduced disciplines. The study concluded that an increase in job performance and cost saving would be realized to the Shuttle program if the techniques developed were applied properly. For further discussions, the reader is directed to the study report documented in CACPDT Design Note No. 17.

2.3.1.4 Advanced Training Techniques

The purpose of this study was to determine if the PPP can be modified to provide a more efficient use of SPS training capability by application of advanced

Figure 2-4 Effectiveness of PPP Capabilities

CAPABILITY	FUNCTION AND PROVISIONS	PREVIOUS METHODS	EFFECTIVENESS
Procedures Data	Automated recording and display of real-time simulation procedural operations and mission events.		
	• Real-time recording and verification of potential procedures checklist.	• Manual tracking, recording, and markups of existing procedures.	• Precise well formatted documentation that eliminates manual errors. • Precise documentation for trouble-shooting simulator failures.
	• Procedures recorded using standard nomenclature from common data base.	• Tedious review of all procedures documentation.	• Eliminates nomenclature errors and saves many man-hours.
	• User definable formats provide flexability to construct new or revised documentation to fit users needs.	• Not applicable.	• System handles new or revised formats without software changes.
Performance Data	Display of simulator performance data.		
	• User definable formats allow grouping of systems or mission related parameters on one display page (graphical or alphanumeric).	• Search of onboard displays with a limited parameter hardcopied during real-time.	• Improves data access for analysis purposes.
	• Post-run selection of only the required data.	• Post-run search of large volume of hardcopy outputs including unwanted data.	• Reduces volume of unnecessary hardcopy data outputs.
PARAMETRIC DATA ANALYSIS	Display of simulator performance data with automatic calculations of deviations from established criterion.		
	• User definable formats allow grouping of related critical parameters on one display page.	• Search of onboard displays with limited parameters hardcopied during real-time.	• Improves data access for analysis purposes.
	• Post-run selection of only the required data.	• Post-run search of large volume of hardcopy outputs including unwanted data.	• Reduces volume of unnecessary hardcopy data outputs.
	• Rapid recognition of out-of-tolerance conditions from display of calculated deviations.	• Recognition of out-of-tolerance conditions depend on user knowledge of limits and available cue card aids.	• Reduces chance of unproductive simulation runs and negative training.
	• Snapshot calculations of desired parameters at mission critical times.	• Search of onboard displays at the mission critical times.	• Ensures access of critical data.
	• Graphics provides unlimited number of traces providing the parameters past trends and including criterion plots. Scaling, labeling, parameter, and run identification automatically output with all data.	• Limited traces of X-Y plotter and time variant strip chart recorder outputs. Scaling, labeling, parameter, and run identification recorded manually.	• Improves data access for analysis purposes. • Eliminates manual identification of data. • Run identification reduces chance of data loss or mix up.
Difference Procedures Data	Automatic comparison of present run procedures and simulator status against an established reference during real-time and post-run.		
	• Rapid and accurate verification of initial crew station status (only out of configuration devices displayed).	• Switch by switch visual verification of total crew station configuration.	• Man-hours and errors reduced in establishing initial crew station configuration.
	• Tracking of crew station configuration during simulation holds.	• None other than manual verification if the initial hold configuration is known.	• Reduces errors resulting from configuration changes during simulation holds.
	• Rapid check of crew station configuration at random user specified times.	• None.	• Ensures simulation exercise is proceeding per the established reference.
	• Rapid check of crew station configuration at preestablished (critical), user specified times.	• None.	• Ensures simulation exercise is proceeding per the established reference.
	• Rapid check of procedural sequences during critical mission phases.	• Manual monitoring of crew procedures against checklist in real-time.	• Immediate notification of erroneous operations reduces negative training. Saves man-hours by reducing reruns of an exercise.
	• Provides a listing of all detected differences.	• None.	• Ensures discussion and debriefing of all problem areas. • Reduce man-hours finding and researching problem areas.
Training Data	Automatic recording of simulator operators inputs (script) and simulator activities (status).		
	• Records operators control inputs to the simulator and PPP.	• Not applicable.	• Provides for verification of proper execution of exercise training script.
	• Records and accumulates exercises executed for crew training, noncrew activities, and total simulator/PPP utilization.	• Manual recording and accumulation including post-mission guessing.	• Increases accuracy of records and reduces man-hours required to assemble the data. • Formatted output can be used directly for required documents.
Data Reconstruction	Access for past-time procedures and performance data.		
	• CRT outputs during simulation holds.	• None.	• Aids in discussions of reviews of questional portions of an exercise.
	• CRT outputs post-run for subsequent review and debriefing.	• Hardcopy outputs.	• Immediate access to data reducing wasted man-hours waiting for debriefing data. • CRT review can reduce the required hardcopy outputs.
Cue Insertion	Allows user to automatically record times, during simulation real-time, to be used for subsequent data access.		
	• Time tags problem areas or desirable discussion areas of any simulation without requiring a simulation hold (reconstruction and cue table provide access at a later time).	• Manual recording of problem areas and subsequent search through hardcopy outputs for desired data or going to simulation hold.	• Quick and simple identification of questionable areas for later discussion. • Reduce simulation holds for minor problems.
GDP/PPP Data Transfer	Provides for direct PPP/GDP data transfers via magnetic tape.		
	• Transfer of all PPP simulation data to GDP.	• Manual transfer of simulation data monitored.	• Reduces man-hours required to format data for formal documentation.
	• Transfer of GDP procedures data to PPP.	• Not applicable.	• Provides FDF reference procedures.
SVDS Data Transfer	Generates Shuttle trajectory, performance data file for any mission phase.		
	• Provide initial procedures timeline definition including trajectory data.	• Not applicable.	• Reduces manual operations.
Flight Display Unit	Provides simulator operator easy access to crew station flight displays.		
	• Allows tracking of CRT data displayed to crewmen.	• Not applicable.	• Addition data check on crews flight display selection and response to the displayed data.

training techniques. This study was to address such techniques as (1) transfer of training, (2) adaptive training programs, (3) automated training capability, and (4) individualized training programs.

This task was initially delayed from the original PPP schedule because higher priority tasks, specifically the core utilization and timing study, had to be accomplished in order to allow continued SPS/PPP operations. The task was finally deleted completely by the NASA Technical Monitor because of a reorganization within the Crew Training and Procedures Division. Under the reorganization, the training function was allotted to an entirely different branch, whose sole purpose was to define the crew training methods to be used on the Shuttle program.

The time and manpower originally scheduled for the advanced training techniques study was rescheduled to allow for the teaching of formal courses on the PPP software and operations. Section 2.3.4 presents the results and further rationale for this redirection of effort.

2.3.1.5 PPP Recommendations for SMS

The purpose of this study was to provide engineering support to the SMS contractor to facilitate PPP integration with the SMS. A review was to be performed of the SMS user interface terminal hardware to provide recommendation regarding PPP terminal hardware and/or software modifications to alleviate apparent incompatibilities. Also, a review of the SMS computer complex characteristics was to be performed to provide recommendation regarding PPP software modification to alleviate apparent software incompatibilities.

The manhours allocated for this study task were redirected by the NASA Technical Monitor during the performance of the study contract. The effort was directed towards the preparation of the PPP Requirements Document which defines in detail the PPP capabilities to be implemented on the SMS-Fixed Base, SMS-Motion Base, and Phase II SPS Complexes. The rationale and results of this redirection are discussed in Section 2.3.4 of this document.

2.3.2 Computer Program Development

The purpose of these tasks was to translate the PPP computer program requirements into detailed software which was consistent with the baseline hardware system, computer system software, and existing PPP applications software. The scope of the tasks included requirements traceability and functional definition for the top-level design of the PPP, detailed software design (math flows), coding, and checkout.

2.3.2.1 Maintain Compatibility with SPS

The PPP has maintained compatibility with the SPS for newly implemented Shuttle mission phases. The PPP was interfaced with the Ascent 1 and Ascent 2 simulations during this contract period. A performance data transfer was provided in the Ascent/PPP interface. PPP performance parameter displays were developed to account for the new mission phase data. The computer time requirements of the Ascent simulation necessitated a sharply reduced PPP compute time. As a consequence core and timing reduction activities were conducted on the PPP real-time routines to ensure complete and timely monitoring of all procedures and performance data. A new SPS keyboard signal linkage was implemented which the PPP monitored and verified as sufficient to retain all SPS keyboard inputs. The PPP verification of complete SPS keyboard inputs via the procedures data transfer was of particular importance in lieu of the reduced PPP compute time. The PPP Procedures Processor was updated as necessary to account for the addition, deletion, and relocation of pertinent input and output discrete channel assignments in the SPS data transfer. During this contract, the PPP staff participated in the requirements definition and preliminary design reviews for the SPS Orbit Maneuvering Simulation. This simulation is currently postponed until the Rendezvous Requirements are more firmly established.

2.3.2.2 PPP/SVDS Interface Capability

CACPDT Design Note No. 14 (PPP/Non Real-Time Trajectory Program Interface Requirements and Capabilities), concluded that the most feasible and proficient method of providing trajectory data to the PPP was through the variable plot tape option of the Space Vehicle Dynamics Simulation (SVDS) Program. The resultant trajectory data tape generated by the SVDS program was then to be interpreted and commutated into a PPP input data file in the form of a simulated SPS data transfer. This performance data conversion process was implemented through a PPP utility program, PERCON.

The initial task included the generation of two SVDS working decks, JMENT1 and JMASC1, that would output on separate tapes PPP prescribed trajectory data for both Entry and Ascent mission phases, respectively. These decks were setup to run on the Univac 1108 in Building 12 at the JSC. Modifications to the SVDS program and to each simulation I.C. file were necessary to generate the PPP selected trajectory data, and to output the data in a prescribed format at a selected frequency. All SVDS generated data were output to tape in Univac 1108 display code.

The second task was the development of a PPP data conversion program that would convert the SVDS generated trajectory data in Univac 1100 series display code to a simulated, real-time SPS data transfer file of CDC 6400 type real data for PPP input. The PPP conversion program, PERCON, was executed on the CDC 6400 in Building 35 at the JSC. The PPP performance data conversion program is essentially composed of two data processing segments. The first data processing segment of the program, implemented through Program PERCON and Subroutine CONVERT, is responsible for converting and transferring the tape records, formatted in Univac 1100 series display code, to an intermediate data file composed of 105 word records, type real in CDC internal binary form. All Univac to CDC display code conversion is performed in Subroutine CONVERT. The second data processing segment of the program is implemented through Subroutine P3DATA and Subroutine PINTER. Subroutine P3DATA commutates the intermediate file data into a simulated, real-time SPS data transfer file. Subroutine PINTER performs the necessary interpolation of the medium frequency performance data prior to the final commutation. The PPP performance data conversion program also provides the user both block and select-parameter time history printout options. The simulated, SPS real-time data transfer file generated by the PPP performance data conversion program provides a run data source for the PPP real-time run option for simulated SPS transfer via magnetic tape.

2.3.2.3 Program Modifications for Core and Timing

Implementation of the candidate core reduction techniques recommended in CACPDT Design Note No. 15 (PPP Core Utilization Study) was performed with two of the proposed schemes resulting in sizable reductions realized by the PPP. These schemes are discussed below.

The first was to find a way to eliminate the need to request more field length on the job card than was needed to execute to account for the LOADER. It was discovered that the LOADER is allowed to extend over a blank common area if one exists. Since the PPP used only labeled common, it was decided to change some labeled common to blank common. This change, while not affecting the core needed by the PPP to execute, allowed the requested field length to be only the amount required to execute.

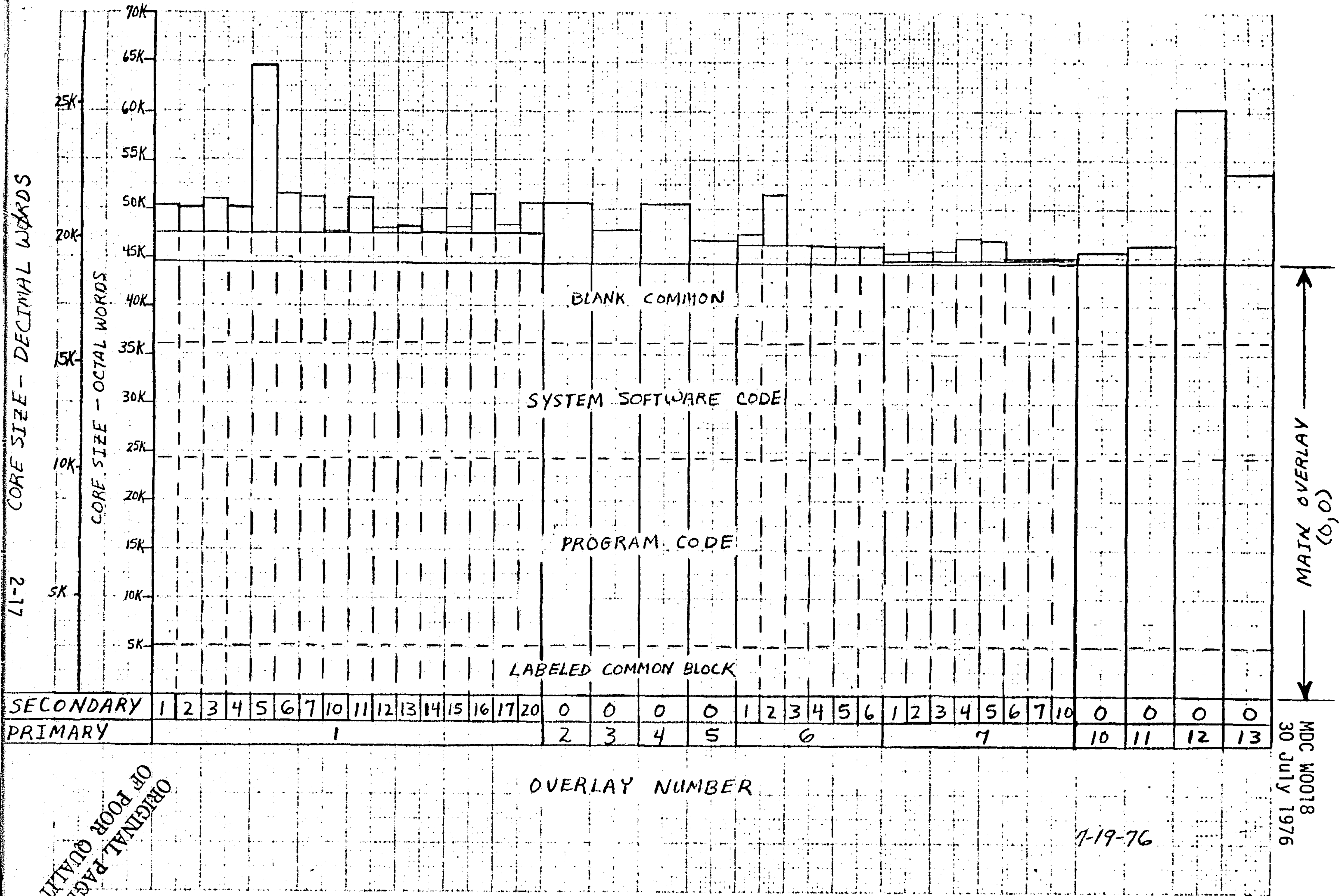
The second major core reduction was realized by a major recoding of the Procedures Processor and the Performance Processor software of the 0,0 overlay. New techniques learned through experience, combined with the elimination of duplicate code, allowed the processor code to be reduced by about 2200_8 words of core. The new techniques utilized a series of mask words to control the processing of the discrete data words. A standardized set of code was developed which provides a series of code words to control the processing of the discrete data. Removal of the SPS keyboard logic from the processor area (0,0 overlay) to the Procedures Formatter (2,0 overlay) also contributed significantly to the core reduction.

The resulting core utilization for the PPP software at the end of PPP software development on this contract is summarized in Figure 2-5.

2.3.2.4 SPS Computer Complex Modification Impact

During this contract period, a computer complex selection study was performed and plans formulated to modify the SPS computer complex configuration in support of the Phase II SPS simulation requirements. These studies were being performed by the Flight Simulation Division, the SPS development personnel. In support of this study effort, an analysis was performed to determine software conversion requirements for the PPP to operate in conjunction with the candidate computer complex configuration under consideration. The PPP software conversion was analyzed considering two configurations: (1) selection of an SPS computer complex that required maximum conversion of the PPP software, and (2) selection of an SPS computer complex that requires minimum conversion of the PPP software. Replacement of the CDC 6400 computer system with a new third generation computer similar to the Univac 1110 represents the maximum conversion. A configuration retaining the CDC 6400 with the addition of mini-computers (i.e., INTERDATA 832's) for the simulation software was considered for the minimum conversion case.

Figure 2-5 PPP Software Sizing Data



For the maximum conversion case, the analysis indicated that approximately 4500 manhours would be required to convert the PPP software. For this analysis, such factors as the FORTRAN compiler, word size of the FORTRAN variable, word size and structure of the data words, data file management techniques, and machine dependent functions and capabilities were considered to have significant impact on the conversion requirements. Although it was assumed that some conversion requirements would be required in all PPP software routines, the major conversion requirements were assumed to be as follows:

- NASA Program Library Utilization
    - Real-time overlay
    - Real-time software processing techniques (frame job and software interrupt concept)
    - Real-time data transfer
- Display Terminal Interface and Software
    - CDC 211
    - CDC 243
    - Hazeltine 4000G
- CDC System Routine Utilization
    - SHIFT, and Mask Functions
    - Random Access Mass Storage Files
    - Sequential Mass Storage Files
- PPP Software
    - Compass routines, RESPOND, TIMEX
    - PPP Data Base Structure
    - PPP Input/Output Techniques (FASTBUF)
    - PPP Code Word Structure

In the minimum conversion case, the analysis indicated approximately 500 manhours would be required for conversion of the PPP software. In this analysis, the conversion requirements were assumed to be the data transfer from the mini-computer system to the CDC 6400. No program conversion of the PPP software would be required.

No further activities were performed relative to the new SPS computer complex on this contract. It was learned that the SPS Phase II computer complex was defined as the CDC 6400 with multi(5) mini-computers (INTERDATA 832's). Thus, minimum conversion of the PPP software will be required. The new complex is planned for activation approximately August 1977 and software conversion will be the responsibility of the Data Systems and Analysis Division.

2.3.2.5 Data Base Update Capability

During the process of developing portions of the PPP under the previous contract (NAS9-14354), a restructuring and redesign of the PPP data base occurred. An offline support program (Program PGPFIL) was developed to provide the capability to update the PPP data base contents. During this contract, requirements were defined (see Section 2.3.3.2) which provides a series of tutorial displays as an integral part of the Initialization module for assisting the user in the operations and updating of the PPP data base.

Software development, coding, and checkout of the implementation of these requirements were accomplished during this contract period of performance. The data base update capability provides the user the capability to update Hollerith statements and selected common block locations using the CDC 211 or card inputs. The capability is implemented as an integral part of the PPP software.

2.3.2.6 Hazeltine 4000G Applications

The PPP/GDP interface provides the capability to transfer PPP data format outputs to the GDP system and GDP procedures data to the PPP system. PPP transfers to the GDP allow the user to finalize the data for documentation and storage purposes. GDP procedures data transfers to the PPP are used as reference data. During the previous study contract (NAS9-14354) the capability was developed to provide the PPP/GDP interface via magnetic tape. An offline interpretative software program, GDPPGP, was developed which provided the GDP to PPP data transfer. The PPP to GDP transfer was accomplished via tape transfer of a PPP data file representing the PPP display contents.

During this contract period, the interpretative software program, GDPPGP, was incorporated as an integral part of the PPP applications software. The task was performed in anticipation of the capability to provide a direct data transfer via the GDP and PPP systems. Concurrent with this activity, the CDC systems analysts supporting the Building 35 facility were implementing the INTERCOM software package to provide communication between the CDC 6400 computer system and the Hazeltine 4000G terminal.

Development and checkout of an operational direct transfer of data between the PPP and GDP system was constrained by delays in getting an operational INTERCOM package. When the INTERCOM package was finally available, the CACPDT study effort had already been directed to address the higher priority tasks as discussed in Section 2.3.4. However, a minimal amount of time was spent towards studying and developing an operational interface between the GDP and PPP systems. Functional flow of operations were developed and exercised to provide the GDP/PPP direct transfer capabilities. Figure 2-6 presents the functional flow of the operations for the PPP to GDP direct data transfer capability. Figure 2-7 presents a functional flow of operations for the GDP to PPP direct data transfer capability.

2.3.2.7 CDC 243 Graphical Applications

A series of graphical display applications studies were to be performed as part of the contract effort. Techniques were to be studied and implemented to efficiently utilize the capabilities provided by the CDC 243 interactive graphics terminal unit. The initial application of the CDC 243 was to provide dynamic displays of crew and vehicle performance data. It was desirable to investigate application of the CDC 243 for use in the area of construction of Shuttle onboard CRT formats and onboard CRT data in a post-run mode, and to investigate application of the CDC 243 for the prime interface device for the PPP.

Efforts to study the CDC 243 Graphical Applications were significantly impacted by a channel reject problem associated with the PPP use of the CDC 243. This problem was first identified on the previous contract (24 June 1975) and at that time, occurred on an infrequent basis. Since then the problem has begun to occur on a more frequent basis. The problem became so bad during this contract period that it would occur everytime the PPP attempted to utilize the CDC 243.

Several unsuccessful attempts were made by the resident CDC analysts to resolve this problem. Manhours were spent on the CACPDT contract to assist in isolating the channel reject problem. The major concern was that PPP applications were

Figure 2-6 PPP to GDP Transfer Via Hazeltine 4000G

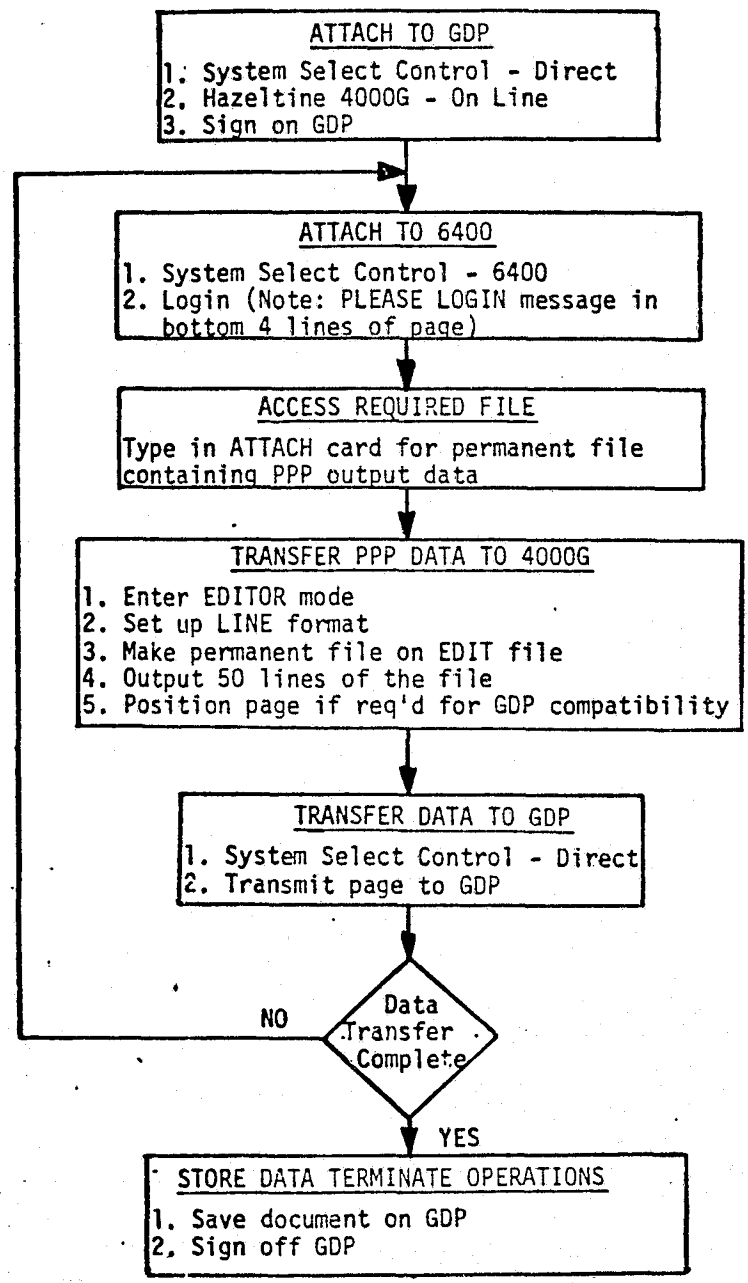
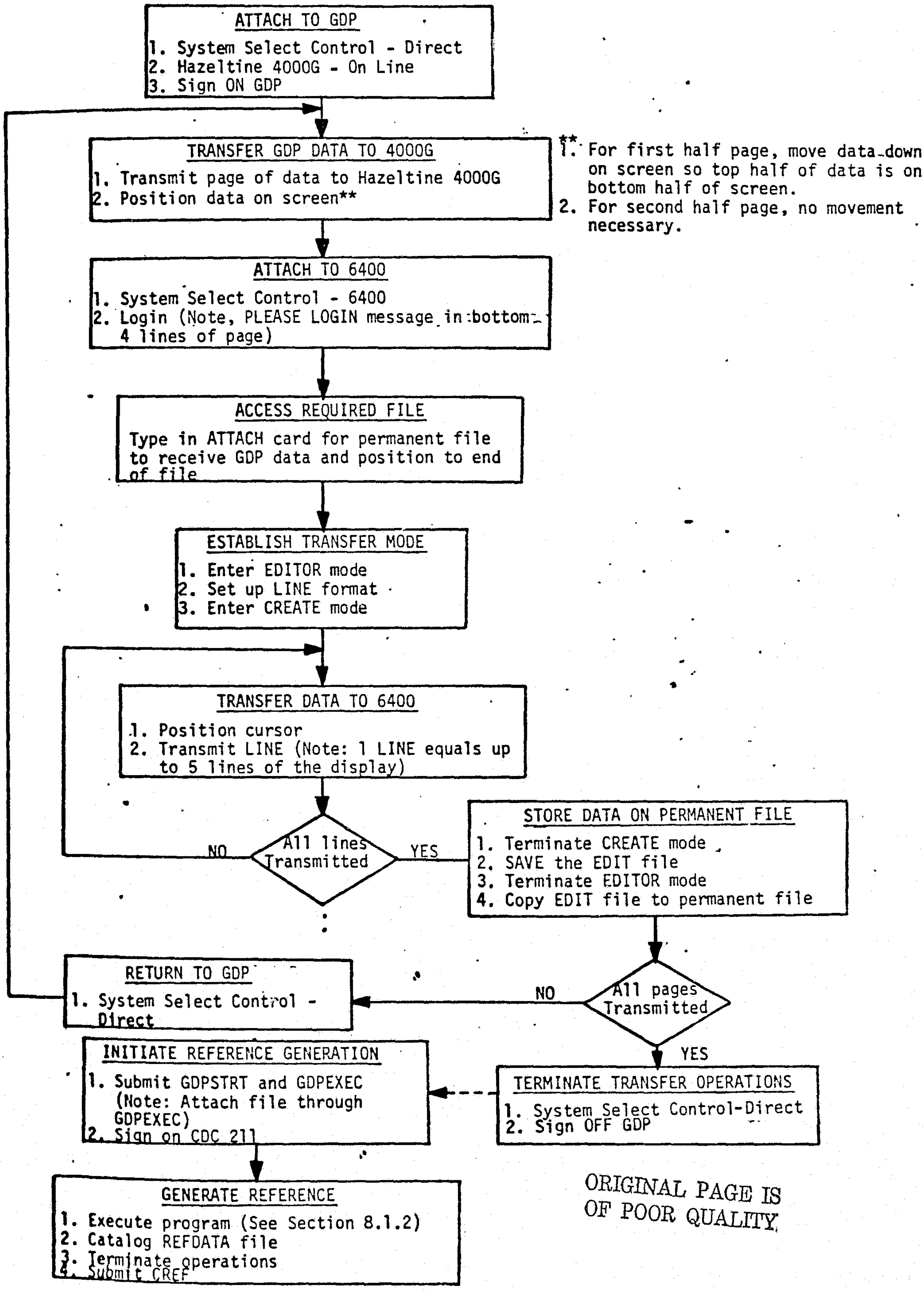


Figure 2-7 GDP to PPP Transfer Via Hazeltine 4000G



the only time channel rejects would occur. In order to assist in checkout of this problem, a test deck (non PPP) was developed which recreated the problem. This test deck was small, easy to utilize, and could be executed while other jobs were operating. The deck was used locally by the CDC analysts to analyze the problem. The deck was sent to Minneapolis to see if the problem could be recreated and corrected at the facilities there. No support was received from the Minneapolis facility because the CDC 243 system was not within the current product line maintained by Minneapolis. The test deck was then forwarded to Albuquerque to attempt to recreate the problem there. The program would not run on the Albuquerque facility due to system imcompatibilities.

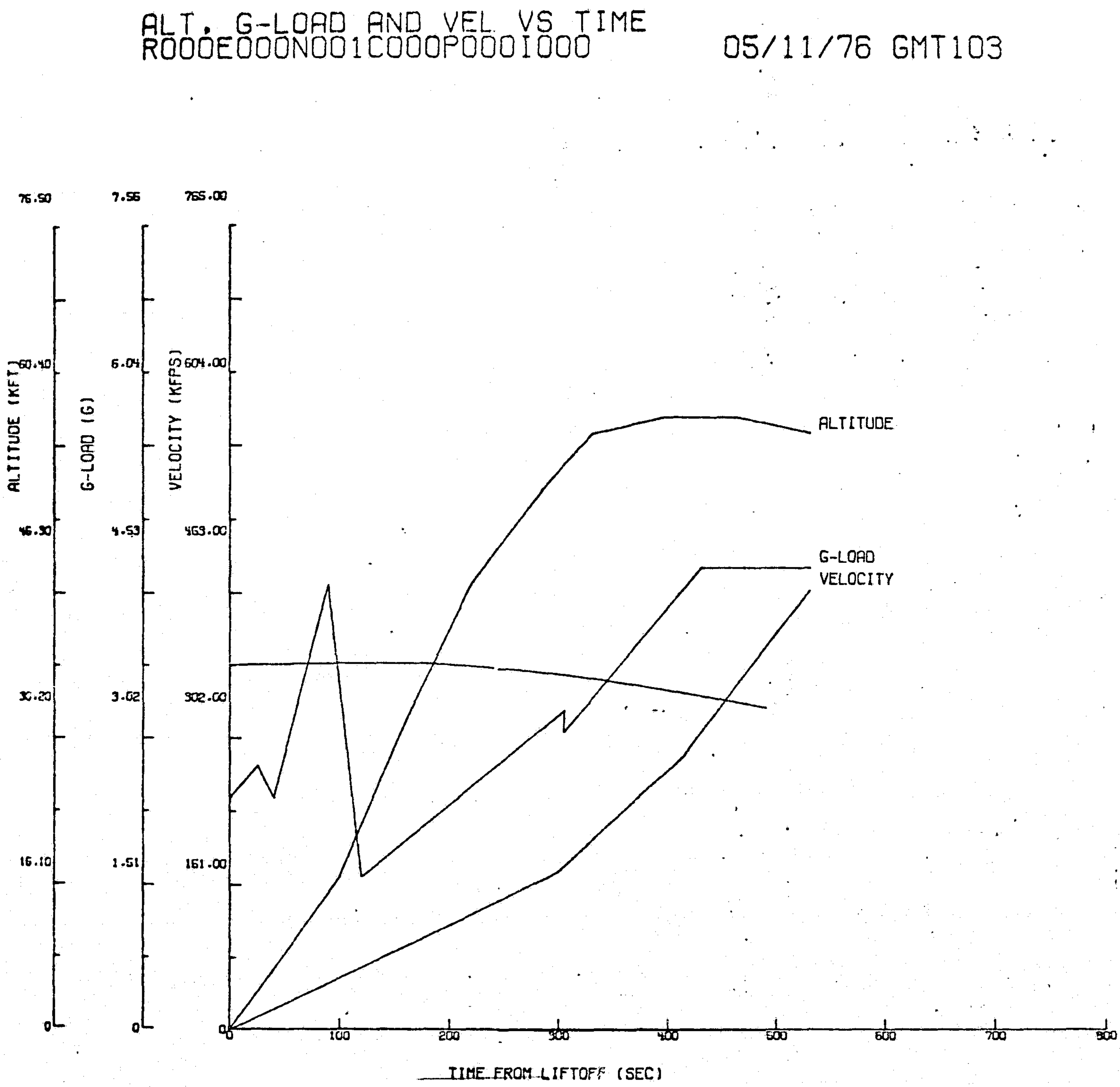
It seems JSC is the only facility with the particular equipment and system in use. Therefore, the availability for outside help is removed leaving the CDC analysts here to solve the problem. The problem remains unsolved as of the publication of this report. No work has progressed to isolate the problem because of assignment of the CDC analyst to higher priority system problems.

2.3.2.8 Graphics Hardcopy Capability

The PPP utilizes the CDC 243 Graphical Display Unit as a tool for providing dynamic plots of performance data during a simulation exercise. The CDC 243, however, does not have a hardcopy capability. Thus, on offline digital programs, P3PLOTR was developed to provide hardcopy of the CDC 243 graphical plots. The P3PLOTR program is able to duplicate exactly what was or could have been seen on the CDC 243 unit and provides the hardcopy output via the CALCOMP Plotting System. Figure 2-8 presents a sample output generated by P3PLOTR.

P3PLOTR processes user requests and reproduces plots from a given PPP run. P3PLOTR accomplishes this by using the same graphical format descriptors as the PPP which results in exact duplication of the graphical plot. The input data for P3PLOTR is generated by the PPP run. At the end of a run, the required files (PPPCALC and PERDATA) are made permanent by the user for future use P3PLOTR. The PPPCALC file contains the information describing the user hardcopy request, and PERDATA contains the actual performance data to be plotted. After a PPP run, the support program P3PLOTR is run which attaches these files and provides the desired hardcopy output.

Figure 2-8 Sample Output of Program P3PLOTR



2.3.3 PPP Support and User Data

The purpose of these activities was the development of the data necessary to support the design, development, and operation of the digital computer program, PPP. The scope of the tasks included monitoring the SPS development activities, establishment of PPP user requirements, maintenance and update of the PPP data base (new switch labels and display formats), maintenance of the PPP user guide, definition and execution of the PPP checkcases, and revision of the PPP user training plan.

2.3.3.1 Maintain Compatibility with SPS

This activity was a continual effort, during this contract, to maintain PPP operations and data outputs consistent with the SPS design. The task also supported the definition of PPP requirements stated in the SPS Development Plan and the performance data transfer required from the SPS Ascent simulation.

Included in the activities was the review of SIMCOM/NASA mod packages to identify the PPP software and data base (Hollerith statement labels) updates required to maintain the program consistent with the mod package changes. One specific change required an update to the PPP/SPS operational procedures. Figure 2-9 presents the updated version of these procedures. Subsequent to SPS mod package implementation, the activities required a checkout of PPP software and data base changes. This checkout also provided verification of the SPS mod implementation. The mod package review was terminated with the software and data base reflecting a 1 May 1976 SPS configuration.

Another activity was the definition of PPP requirements incorporated into the SPS Development Plan. This included the statement of the capabilities required for future SPS development and the definition of the PPP user console layout and configuration after the SPS forward crew station is mated with the support room (blue goose). Figure 2-10 shows that user console configuration.

Finally, the activity included the definition of the SPS Ascent simulation performance data transfer required for PPP operation with the simulation. The list was documented in Working Paper No. 47 (SPS Ascent Simulation Data Transfer) and subsequently informally transmitted to the NASA for finalization. The list is shown in Figure 2-11. The items identified by an asterisk in the table,

Figure 2-9 PPP/SPS Operational Procedures

		PPP OPERATIONS	SPS OPERATIONS		
INITIAL	SETUP	Submit PPPEX Execute Deck Depress CDC 243 POWER ON if lt off Depress CDC 243 ON LINE if lt off Depress CDC 243 RUN if lt off Verify Flight Display Unit CRT power on	Submit XXXXX Execute Deck (XXXXX=Simulation) @Depress RESET pb if blue ID lt off @Depress PGP ON pb if blue ID lt off @Depress 930 ON pb if blue ID lt off @Depress 9300 ON pb if blue ID lt off	INITIAL	SETUP
SYS OPS	ATTACH JOB	ACTIVE AND NOT BUSY (211 CRT display) Δ (SEND key on 211) MACΔ 0Δ H,IΔ (Select a PPPEX** from display) 2.DIR,PPPEX**Δ (** assigned by system) $JΔ 2Δ Δ (Wait until "EX" on display) Δ PΔ 0,2Ø,1Δ [0,2Ø,5]	ACTIVE AND NOT BUSY (211 CRT display) Δ (SEND key on 211) NASAΔ 0Δ H,IΔ (Select a XXXXX** from display) 1.DIR,XXXXX**Δ (** assigned by system) $JΔ 1Δ Δ (Wait until RM ERROR 354 ON LFN ALPHA on display) Δ PΔ 0,2Ø,5Δ	ATTACH JOB	SYS OPS
PPP OPERATIONS	INITIALIZATION	I,1Δ I,XΔ (X=desired reference) I,ACCEPTΔ I,2Δ I,M=XXXΔ (XXX=desired mission phase) I,X=YYYΔ (Input desired record ID) I,ACCEPTΔ	Line Skip (key on 211 keyboard) XXΔ (XX=desired reset no.) Then monitor CDC 211 CRT for the following: WAITING FOR 930 TO RECEIVE DATA Input the following on the left C/S keyboard 3330 ENTER ENTER (Initial Execution Only) ENTER (Reset Only) Then monitor CDC 211 CRT for the following: SPS WAITING FOR PGP INITIALIZATION	INITIALIZATION	SPS OPERATIONS
PPP OPERATIONS	INITIALIZATION SEQ. REQD	I,9Δ (Real-time run option) I,4Δ [1,1Δ] I,ACCEPTΔ I,DISPLAY=2,4,1Δ I,CLEARΔ I,RUN RTΔ	SPS WAITING FOR PGP READY SPS READY TO RUN R.T. (CYCLE SW TO RUN) @Depress COMPUTER OPERATE (verify blue)	INITIALIZATION SEQ REQD	SPS OPERATIONS
PPP OPERATIONS	REAL TIME	During first CDC 243 activities Depress LP CAPT if lt off		SIM ACTIV	SPS OPERATIONS
PPP OPERATIONS	SEQ REQ	I,END RTΔ		SEQ REQ	SPS OPERATIONS
PPP OPERATIONS	POST RUN REQD	I,DISPLAY=7,1,1Δ I,ACCEPTΔ I,2Δ I,ACCEPTΔ	@Depress RESET (verify blue) then	RESET	SPS OPERATIONS
PPP OPERATIONS	RESET OR TERM	9Δ then I,TERMINATEΔ	Depress ACTIVATE DISCRETE SW $DΔ ABORTΔ	OR TERM	SPS OPERATIONS
SYS OPS	TERM	$$Δ If required with "NO MORE CONTROL CARDS" displayed input as described in Section 6 X,PURGE,frame,PW=MACM,Δ GOΔ X,REWIND,TAPEOUT.Δ GOΔ X,CATALOG,frame,ID=MAC,XR=MACM.Δ GOΔ $$Δ 2Δ TΔ ACTIVE AND NOT BUSY (211 CRT)	$$Δ $$Δ 1Δ TΔ Δ ACTIVE AND NOT BUSY (211 CRT)	TERM	SYS OPS

NOTES: [ ] entry for simulated SPS run fname = file name Ø = Zero @ = On SPS Control & Display Panel

Figure 2-10 Future PPP User Console Layout and Configuration

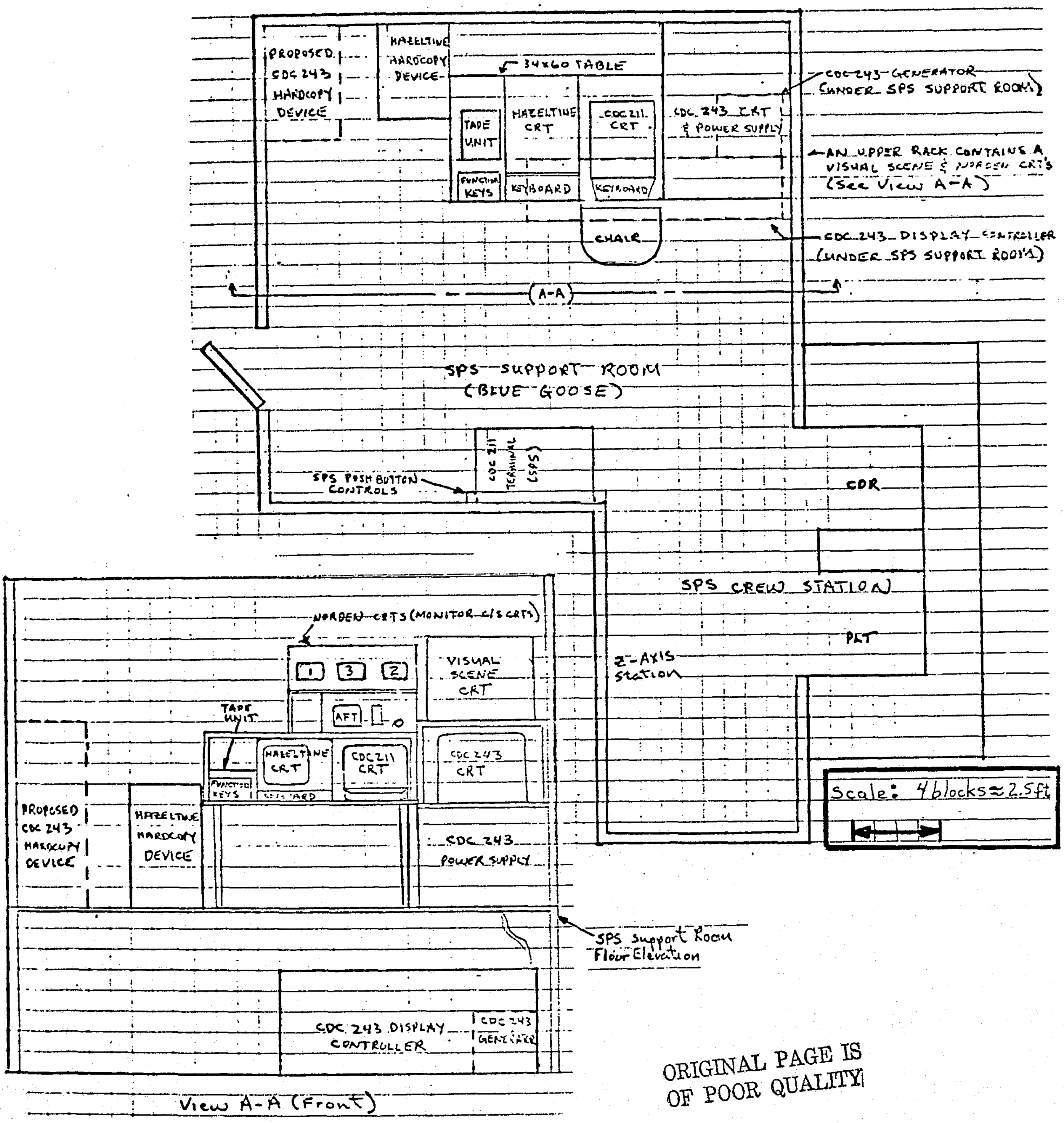


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Figure 2-11 Ascent Performance Data Transfer

INDEX NO.	PARAMETER NAME	DESCRIPTION	UNITS	INDEX NO.	PARAMETER NAME	DESCRIPTION	UNITS
1	TIME	SIMULATOR RUN TIME	SEC	54	MTZ	THRUST MOMENT Z-AXIS	FT-LB
2	CR	CROSS RANGE	FT	55	MBXA	AERO BODY MOMENT X-AXIS	FT-LB
3	DR	DOWN RANGE	FT	56	MBYA	AERO BODY MOMENT Y-AXIS	FT-LB
4	R	RANGE *	NM	57	MBZA	AERO BODY MOMENT Z-AXIS	FT-LB
5	H	ALTITUDE	FT	58	MBX	BODY MOMENT Y-AXIS	FT-LB
6	HDOT	ALTITUDE RATE	FPS	59	MBY	BODY MOMENT Y-AXIS	FT-LB
7	VR	RELATIVE VELOCITY	FPS	60	MBZ	BODY MOMENT Z-AXIS	FT-LB
8	QBAR	DYNAMIC PRESSURE	LBS/FT^2	61	X	VEHICLE POSITION VECTOR X-AXIS	FT
9	GLMAG	LOAD FACTOR TOTAL	G	62	Y	VEHICLE POSITION VECTOR Y-AXIS	FT
10	GLX	LOAD FACTOR X-AXIS	G	63	Z	VEHICLE POSITION VECTOR Z-AXIS	FT
11	GLY	LOAD FACTOR Y-AXIS	G	64	ALPHA	PITCH ANGLE OF ATTACK	DEG
12	GLZ	LOAD FACTOR Z-AXIS	G	65	BETA	YAW ANGLE OF ATTACK (SIDE SLIP)	DEG
13	FTMAG	THRUST MAGNITUDE *	LBS	66	GAMMA	FLIGHT PATH ANGLE	DEG
14	FBAMAG	AERO BODY FORCE MAGNITUDE *	LBS	67	THETA	LOCAL VERTICAL PITCH ANGLE *	DEG
15	FBMAG	BODY FORCE MAGNITUDE *	LBS	68	PHI	ROLL ANGLE *	DEG
16	OMEGA	BODY RATE MAGNITUDE *	DEG/SEC	69	BANK	BANK ANGLE *	DEG
17	OMEGAD	BODY ACCELERATION MAGNITUDE *	DEG/SEC^2	70	DZ	OUT-OF-PLANE DISPLACEMENT	NM
18	RI	POSITION VECTOR MAGNITUDE	FT	71	DZDOT	OUT-OF-PLANE VELOCITY	FPS
19	VI	VELOCITY VECTOR MAGNITUDE	FPS	72		THROTTLE SETTING %	-
20	AI	ACCELERATION VECTOR MAGNITUDE	FPS^2	73	VWT	VEHICLE WEIGHT *	LBS
21	FTX	THRUST X-AXIS	LBS	74	VM	VEHICLE MASS	SLUGS
22	FTY	THRUST Y-AXIS	LBS	75		ET FUEL REMAINING	LBS
23	FTZ	THRUST Z-AXIS	LBS	76	DNI	DAY/NIGHT INDICATOR *	-
24	FBXA	AERO BODY FORCE X-AXIS	LBS	77	AZ	AZIMUTH *	DEG
25	FBYA	AERO BODY FORCE Y-AXIS	LBS	78	AI	ORBITAL INCLINATION *	DEG
26	FBZA	AERO BODY FORCE Z-AXIS	LBS	79	OGA	OUTER GIMBLE ANGLE	DEG
27	FBX	BODY FORCE X-AXIS *	LBS	80	IGA	INNER GIMBLE ANGLE	DEG
28	FBY	BODY FORCE Y-AXIS *	LBS	81	MGA	MIDDLE GIMBLE ANGLE	DEG
29	FBZ	BODY FORCE Z-AXIS *	LBS	82	OGAD	OUTER GIMBLE ANGLE RATE *	DEG/SEC
30	OMEGX	BODY RATE X-AXIS *	DEG/SEC	83	IGAD	INNER GIMBLE ANGLE RATE *	DEG/SEC
31	OMEGY	BODY RATE Y-AXIS *	DEG/SEC	84	MGAD	MIDDLE GIMBLE ANGLE RATE *	DEG/SEC
32	OMEGZ	BODY RATE Z-AXIS *	DEG/SEC	85	HA	VEHICLE APOGEE ALTITUDE *	FT
33	QALPHA	PRODUCT OF ANG ATT AND DYN PRESS *	DEG LBS/FT^2	86	HP	VEHICLE PERIGEE ALTITUDE *	FT
34	QBETA	PRODUCT OF SIDE-SLIP AND DYN PRESS *	DEG LBS/FT^2	87	VWIND	WIND VELOCITY MAGNITUDE *	FPS
35	OMEGXD	BODY ACCELERATION X-AXIS	DEG/SEC^2	88	VWINDX	WIND VELOCITY X-AXIS *	FPS
36	OMEGYD	BODY ACCELERATION Y-AXIS	DEG/SEC^2	89	VWINDY	WIND VELOCITY Y-AXIS *	FPS
37	OMEGZD	BODY ACCELERATION Z-AXIS	DEG/SEC^2	90	VWINDZ	WIND VELOCITY Z-AXIS *	FPS
38	XD	VEHICLE VELOCITY VECTOR X	FPS	91	CGX	CENTER OF GRAVITY X-AXIS	FT
39	YD	VEHICLE VELOCITY VECTOR Y	FPS	92	CGY	CENTER OF GRAVITY Y-AXIS	FT
40	ZD	VEHICLE VELOCITY VECTOR Z	FPS	93	CGZ	CENTER OF GRAVITY Z-AXIS	FT
41	XDD	VEHICLE ACCELERATION VECTOR X	FPS^2	94	STDN1	GROUND STATION 1 CONTACT IDENT *	-
42	YDD	VEHICLE ACCELERATION VECTOR Y	FPS^2	95	STDN2	GROUND STATION 2 CONTACT IDENT *	-
43	ZDD	VEHICLE ACCELERATION VECTOR Z	FPS^2	96	STDN3	GROUND STATION 3 CONTACT IDENT *	-
44		NONE		97	CL	COEFFICIENT OF LIFT *	-
45		NONE		98	CD	COEFFICIENT OF DRAG *	-
46	MACHNO	MACH NUMBER	-	99		NONE	
47	LAT	LATITUDE	DEG	100		GUIDANCE MODE FLAG (MODES TBD) *	-
48	LONG	LONGITUDE	DEG	101		STATUS WORD (TBD) *	-
49	MTMAG	THRUST MOMENT MAGNITUDE *	FT-LB	102		NONE	
50	MBAMAG	AERO BODY MOMENT MAGNITUDE *	FT-LB	103	TGO	TIME-TO-GO (MECO) *	SEC
51	MBMAG	BODY MOMENT MAGNITUDE *	FT-LB	104	VGO	VELOCITY-TO-GO (MECO) *	FPS
52	MTX	THRUST MOMENT X-AXIS	FT-LB	105		NONE	
53	MTY	THRUST MOMENT Y-AXIS	FT-LB				

* NOT AVAILABLE IN SPS ASCENT-1 SIMULATION

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indicate parameters which are not available from the simulation but are available from SVDS data transfers.

2.3.3.2 PPP Data Base

The purpose of this activity was to maintain the PPP user definable data base, including Hollerith Statements File (Hollerith labels, difference test data, error messages, and training statistics data), common block data and format descriptors, compatible with the required program outputs.

Included in the activities were updates to the Hollerith statements labels consistent with the October and November 1975 SPS crew station updates, training statistics data in support of SM2 flight crew simulations, and difference procedures test data in support of checkcase 3 execution. A final update was made to the total data base Hollerith statements, common block, and format descriptors to reflect the 1 May 1976 SPS configuration prior to termination of the PPP development activities.

The task also included the redefinition of the PPP data base update capability. The activities started with the establishment of the requirements for the user interface and operations. These requirements were documented in Working Paper No. 45 (PPP Data Base Update Capability Requirements). Included in the document was the display tree structure within the initialization loop, the user operations, and the tutorial displays. Figure 2-12 presents the display tree structure and tutorial displays developed following the implementation of these capabilities into the system, a detailed checkout was performed to verify the operational capabilities.

2.3.3.3 PPP Operational Support

PPP operational support was provided to the Engineering Simulations Branch during the SPS Systems Management 2 (SM2) simulation. The support included developing an output data format consistent with a format specified in the SM2 pre-simulation report. The format developed was then verified with the Engineering Simulations Branch personnel. Simulation support was provided during fifteen exercises, normally an hour to an hour and one half in duration, with the prime flight crews participating. Figure 2-13 presents an actual hardcopy data output of the crew chronological history format (FMT621) which tracked the

Figure 2-12 PPP Data Base Update Display Tree

```
DATA BASE INPUT                                   ACTUAL
R3J0E3G0N0J1C0J0P0J0C1C0J BATCH 06/17/76 FMT131
 CODE          OPERATION
   1        COMMON BLOCK UPDATE
   2        DATA BASE UPDATE
 FINISH     UPDATES COMPLETE
```

1

```
COMMON BLOCK UPDATE                               ACTUAL
RJ0JEJ0G0N0J0ICJJ0P0J0I0GJ BATCH 06/17/76 FMT132-1
 CODE
D=XXX,Y   DISPLAY COMMON LOCATION DATA TYPE XXX
          (SPECIFY Y FOR SWG,SWT AND SQT
           GROUP/TEST NUMBER)
          XXX
          BIT BIAS TIME
          STF STORAGE FREQUENCY
          SWG SWITCH GROUP      ( Y=1 TO 15 )
          SWT SWITCH TEST       ( Y=1 TO 10 )
          SQT SEQUENCE TEST     ( Y=1 TO 10 )

INPUT FINISH WHEN ALL OPERATIONS ARE COMPLETE
```

```
                                                  ACTUAL
                                                  132-2
LOCATION    DATA        DESCRIPTION
  101       900.        GET BIAS
  102       900.        GHT BIAS
  103       900.        MET BIAS
  104       0.          SRT BIAS

C=XXXX,D CHANGE LOCATION XXXX WITH DATA D
INPUT + OR + TO SCAN OTHER COMMON BLOCK DATA
INPUT FINISH WHEN ALL OPERATIONS ARE COMPLETE
```

```
                                                  ACTUAL
                                                  132-3
LOCATION    DATA        DESCRIPTION
  70        5.          STORAGE FREQUENCY

C=XXXX,D CHANGE LOCATION XXXX WITH DATA D
INPUT + OR + TO SCAN OTHER COMMON BLOCK DATA
INPUT FINISH WHEN ALL OPERATIONS ARE COMPLETE
```

```
                                                  ACTUAL
                                                  132-4 1
LOCATION    DATA          DESCRIPTION
                        SWITCH GROUP                    1
  361       499
  362       505
  363       517
  364       529
  365       535
  366       541
  367       547
  368       565
  369       571
  370       0
C=XXXX,D CHANGE LOCATION XXXX WITH DATA D
INPUT + OR + TO SCAN OTHER COMMON BLOCK DATA
INPUT FINISH WHEN ALL OPERATIONS ARE COMPLETE
```

```
                                                  ACTUAL
                                                  132-5 1
LOCATION    DATA          DESCRIPTION
                        PRE-ESTABLISHED TIME            1
  770       9247
  771          5
  772       9851
  773          0
  774          0
  775          0
  776          0
  777          0
  778          0
  779          0
C=XXXX,D CHANGE LOCATION XXXX WITH DATA D
INPUT + OR + TO SCAN OTHER COMMON BLOCK DATA
INPUT FINISH WHEN ALL OPERATIONS ARE COMPLETE
```

```
                                                  ACTUAL
                                                  132-6 1
LOCATION    DATA          DESCRIPTION
                        SEQUENCE GROUP                  1
  561       9241
  562          5
  563       9841
  564          0
  565          0
  566          0
  567          0
  568          0
  569          0
  570          0
C=XXXX,D CHANGE LOCATION XXXX WITH DATA D
INPUT + OR + TO SCAN OTHER COMMON BLOCK DATA
INPUT FINISH WHEN ALL OPERATIONS ARE COMPLETE
```

2

```
HOLLERITH LABEL UPDATE                            ACTUAL
R0J0E0G0N0J1CJ0P0C1J0J BATCH 06/17/76 FMT133
  RECORD LINE
            1    5    1    1    2    2    3
                      0    5    0    5    0

R=XXXX          DISPLAY RECORD XXXX AND NEXT 4
C=XXXX,Y,Z,D*   CHANGE RECORDXXXX ON LINE Y(1 OR 2)
                AT COLUMN Z WITH DATA D(END WITH *)
INPUT +,+,+ OR + TO SCAN DATA
INPUT FINISH WHEN OPERATIONS ARE COMPLETE
```

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Figure 2-13 Crew Chronological History (SM2 Data)

~~CHRONOLOGICAL HISTORY ACTUAL~~

P000E102N001C000P000I000 BATCH 12/30/75 FMT621- 1

DATE	CREWMEN		EXERCISE	DESCRIPTION	TIME	
12/04/75	REE	C	200	**NO DESCRIPTION AVAIL	0/59	15
~~12/04/75~~	~~JRL~~	~~P~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~0/59~~	
11/25/75	GPC	C	200	**NO DESCRIPTION AVAIL	0/59	14
~~11/25/75~~	~~JRL~~	~~C~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~1/37~~	
11/25/75	REE	P	200	**NO DESCRIPTION AVAIL	1/37	13
~~11/21/75~~	~~GPC~~	~~C~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~0/52~~	12
11/20/75	REE	C	200	**NO DESCRIPTION AVAIL	1/14	11
~~11/20/75~~	~~JRL~~	~~P~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~1/14~~	
11/20/75	GPC	C	200	**NO DESCRIPTION AVAIL	1/00	10
~~11/20/75~~	~~RHT~~	~~P~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~1/00~~	
11/18/75	RHT	C	200	**NO DESCRIPTION AVAIL	1/14	9
~~11/18/75~~	~~GPC~~	~~P~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~1/14~~	
11/18/75	REE	C	200	**NO DESCRIPTION AVAIL	1/20	8
~~11/18/75~~	~~JRL~~	~~P~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~1/20~~	
11/14/75	GPC	C	200	**NO DESCRIPTION AVAIL	1/14	7
~~11/14/75~~	~~RHT~~	~~P~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~1/14~~	

CHRONOLOGICAL HISTORY ACTUAL

~~P000E0G0N001C000P000I000 BATCH 11/30/75 FMT621- 2~~

DATE	CREWMEN		EXERCISE	DESCRIPTION	TIME	
11/13/75	REE	C	200	**NO DESCRIPTION AVAIL	1/27	6
~~11/13/75~~	~~RHT~~	~~P~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~1/27~~	
~~11/12/75~~	~~GPC~~	~~C~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~0/01~~	5
11/12/75	REE	P	200	**NO DESCRIPTION AVAIL	0/01	
~~11/12/75~~	~~GPC~~	~~C~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~0/10~~	
11/12/75	REE	P	200	**NO DESCRIPTION AVAIL	0/10	
~~10/30/75~~	~~JRL~~	~~C~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~1/36~~	4
10/24/75	KJB	C	200	**NO DESCRIPTION AVAIL	1/30	
~~10/24/75~~	~~RHT~~	~~P~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~1/30~~	
10/24/75	RHT	C	200	**NO DESCRIPTION AVAIL	1/24	2
~~10/24/75~~	~~GPC~~	~~C~~	~~200~~	~~**NO DESCRIPTION AVAIL~~	~~1/24~~	1

simulation exercise activities. The data format hardcopies were subsequently passed on to the Engineering Simulations Branch personnel.

2.3.3.4 PPP Checkcase Execution

All PPP checkcases developed under the Advanced Crew Procedures Development Techniques (ACPDT) Contract were executed during this contract. As reported in the ACPDT Final Report, the re-execution of the checkcases was progressing concurrent with the preparation of that report; but the completion of the task actually occurred during this follow-on contract. This execution was to verify modifications made to correct minor problems noted during the initial execution. Results were documented in Working Paper No. 46 (Checkcase Execution Results).

Final checkout of PPP operations was performed as a part of the termination of PPP development activities. Because of limited time, only selected portions of the PPP checkcases and random exercises consistent with the actual PPP usage were executed. Minor problems were encountered during these exercises, but all problem areas were corrected.

2.3.3.5 PPP User Training and Demonstrations

An initial PPP training plan was developed during the ACPDT Contract. During this contract, the plan was used in training Mike Hollars of the Flight Activities Branch. After completing all five exercises, a review was made and a revised plan was generated. This revised plan was documented and formally transmitted to the NASA in CACPDT Design Note No. 16 (PPP Revised Training Plan). The contents of the design note are intended for use as a formal handout for subsequent training sessions. Following the generation of the final training plan, various short sessions were provided to interested personnel. The first sessions were one hour demonstrations given to T. A. Guillory, Orbit and Rendezvous Planning Section Chief and T. W. Holloway, Flight Activities Branch Chief, on 15 and 20 April 1976, respectively. Other demonstrations were given to (1) Ken Mansfield, Art Nolting, Willard Steele, and Darrell Boyd of the Simulation Development Branch, (2) Jake Smith, Dennis Dahms, and Tom Kaiser of the Training Development and Integration Branch, (3) Leo Reitan, Bob Myers, Leon Payne, and Ben Fulbright of the Flight Training Branch, and (4) John Weyener, Ben Ferguson, Bill Anderson, and Francisco Torres of the Flight Activities Branch.

2.3.4 Termination of PPP Development Activities

At the request of the Director of Flight Operations, the Principal Investigator and Technical Monitor prepared an indepth review presentation of the PPP. Brief contract history, cost analysis, program capabilities review, and actual versus anticipated benefits of the study were summarized in the presentation. The presentation was made on 21 April 1976 by Mr. Tom Holloway, Chief of the Flight Activities Branch. As a result of the presentation, the activities of this contract were redirected.

The following summarizes the action taken to redirect the contract effort:

- Identify and come to a logical termination of all current PPP development activities,
- Perform an extensive documentation of the PPP capabilities and current system status,
- Transmit to the Data Systems and Analysis Division the requirements and existing PPP software programs for their implementation on the Shuttle Mission Simulator-Fixed Base, Shuttle Mission Simulator-Motion Base, and Shuttle Procedures Simulator-Phase II complexes, and
- Initiate activities on the contract to address higher priority tasks related to automating the crew procedures development process.

A schedule of activities was immediately prepared and the tasks promptly initiated to conform with the directives. The following sections summarize the activities performed to document and close-out the PPP development activities. These activities are completed with the publication of this report, and effort is now being directed towards higher priority tasks defined by the NASA. The work is being performed under supplemental agreement to the original Statement of Work for the contract.

2.3.4.1 PPP Requirements Document

The original requirements for the Procedures and Performance Program were developed under Contract NAS9-13600 (Crew Procedures Development Techniques). A comprehensive set of software and hardware requirements were prepared to define the eventual operational capability of the PPP. These requirements contained specification of the PPP capabilities in conjunction with the Shuttle Procedures Simulator - Phase I complex. Implementation of the requirements, demonstration of their feasibility, and revisions to the original specification were performed as part of Contract NAS9-13660, Contract NAS9-14354 (Advanced Crew Procedures Development Techniques), and this contract (NAS9-14780).

A new requirements document, however, has been prepared under this contract in response to the request for transmission of requirements to the Data Systems and Analysis Division for implementation of the PPP capabilities on other simulation simulator complexes. These requirements are documented in McDonnell Douglas Report MDC W0016 (Procedures and Performance Program Requirements Document). The document specifies the PPP capabilities as they are to be implemented on the Shuttle Mission Simulator-Fixed Base, Shuttle Mission Simulator-Motion Base, and Phase II Shuttle Procedures Simulator.

2.3.4.2 PPP Math Flow Charts

PPP math flow charts were developed to serve as the detailed design tool which translates the program requirements into detailed software implementation requirements. These math flow charts not only serve as a development aid, but upon termination of the PPP development activities they represent the most detailed documentation of the program with the exception of the computer listing.

McDonnell Douglas Report MDC W0015 (Procedures and Performance Program Math Flow Charts) documents the final version of the math flows and represents the PPP design at the termination of PPP development activities on the Continuation of Advanced Crew Procedures Development Techniques Study.

2.3.4.3 PPP Users Guide

McDonnell Douglas Report MDC W0017 (Procedures and Performance Program Users Guide) was prepared to describe the operations required to use the PPP and to describe the software implementation concepts and techniques. This document represents a revision and update to the PPP Users Guide published on the previous contract. The report is documented in two volumes: Volume I - Operations Description, and Volume II - Program Description.

The material presented in Volume I provides the PPP user general information on the PPP operational requirements including the PPP system hardware and software, and the integrated PPP/SPS system. Program activation and deck structure discussions are included which describe the initialization, run, and post-run operations. Operations required to activate and terminate the PPP and SPS for an actual or simulated SPS run, as shown in Figure 2-9, are described in detail. A detailed discussion is presented for the display structure, user command interface, and PPP operational phases. Display contents and available user commands are discussed in detail. Contents of the PPP data base, and procedures for accomplishing the PPP/GDP and PPP/SVDS data transfer are discussed. Five appendices are included which present and discuss (1) the PPP execute deck contents, (2) example format descriptors and resultant formats, (3) available PPP data output formats, (4) performance data parameters, and (5) contents of the Hollerith statements file of the PPP data base.

The material presented in Volume II discusses the (1) PPP design and program flow, (2) detailed PPP design concepts, (3) PPP support data including data base, data files and support programs, and (4) PPP unique implementation techniques. Four appendices are included which present and discuss (1) the SPS discrete data words, (2) SPS performance data transfer, (3) procedures data code words, and (4) alphanumeric format descriptor contents.

2.3.4.4 PPP Tapes, Listings and Card Decks

As a result of the termination of PPP development activities, the PPP tapes, listings and card decks in their final versions have been preserved for reference purposes. The PPP tapes are discussed in terms of file contents, tape type and number in a letter that was transmitted to NASA. All PPP support decks were repunched for storage. These card decks were processed for computer printer listings which were transmitted to NASA.

The PPP tapes have been stored in the CDC 6400 tape library in Building 35. The Card Decks have been forwarded to persons within the NASA Flight Simulation Division who have been designated to continue maintenance and development of the PPP. A duplicate copy of the card decks is stored with the project records for future reference.

2.3.4.5 PPP Training Session

A series of demonstrations were scheduled and given to inform persons within the Crew Training and Procedures Division and the Flight Simulation Division of the capabilities and status of the PPP. As a result of the demonstration to the Flight Simulation Division personnel, a series of software and program operations courses were requested and scheduled as part of the PPP Termination

Activities. The software course was to provide an explanation of the programming techniques, software design, support data/programs, software procedures, and special software related topics. The course length planned was 40 hours. Figure 2-14 summarizes the scope and details planned for the software course.

The operations course was planned for 20 hours and was to cover an explanation of the systems description, data output/reconstruction, difference procedures, data base/format construction, and GDP/PPP transfer. Figure 2-15 summarizes the scope and details planned for the operations course.

These courses are being given concurrent with the preparation and publication of this final report. The courses are progressing smoothly, as scheduled, and attendees seem to be receiving indoctrination into the program at the desired level of interest. Attendance in the classroom has included Frank Svejcar and Darrel Boyd from the Flight Simulation Division, and Ben Fulbright and William Chanis from the Flight Training Branch of Crew Training and Procedures Division. Copies of the handouts, vu-graphs, and the attendance record for the PPP Training Sessions are documented in PPP Working Paper No. 53 (PPP Training Session Attendance and Handouts).

2.4 SOFTWARE STATUS AND PROPOSED IMPROVEMENTS

Due to the premature termination of PPP development activities, the PPP was left in an operational, but incomplete, state. There are several PPP requirements which have not been satisfied and also several capabilities which, although not stated as a PPP requirement, the PPP staff has found, through experience, to be desirable. The following is a summary of the software status and of the proposed improvements for the PPP.

The major unsatisfied requirement is the reconstruction of difference procedures displays. The technique to satisfy this requirement was discussed with the resulting technique presented below.

- The file containing the difference procedures run data entries (PRODATA) will have been synchronized to the repeat time by the SYNCRO routine and the first two buffers of procedures run data read in. This function is currently operational in support of the display reconstruction for all other formatters.

Figure 2-14 PPP Software Course Synopsis

SESSION NO.	DATE	TOPIC OF DISCUSSION	INSTRUCTOR	LENGTH

1	12 JULY 1976	INTRODUCTION AND SOFTWARE OVERVIEW
		• Purpose and Scope
		• Design Features and Constraints
		• Module Identification
		• Program Flow
		• Subroutine Definition
		• Programming Techniques
		  • Common Block Descriptions
		  • Overlay Structure
		  • Input/Output Techniques
		  • Data Driven Software
		• Support Software Utilization
		  • CDC 6400 System Software
		  • Real Time Software
		  • Graphics Software Routines
		  • Machine Language Routines
			R. L. BENBOW	4 HOURS

2	13 JULY 1976	SOFTWARE DESIGN-CONTROL AND SUPPORT MODULES • Initialization Module • Sequence Control Module • Input/Output Module • Real Time Input/Output Module • Post Run Module • Support Subroutines and Functions Module • Error Detection/Top Level Displays	R. L. BENBOW	4 HOURS

3/4	14 JULY 1976 AND 15 JULY 1976	SOFTWARE DESIGN-DISPLAYS AND FORMATTER MODULES
		• Format Descriptors
		  • Alphanumeric
		  • Graphical
		• Procedures Formatter
		• Performance Formatter
		• Performance Evaluation Formatter
		• Difference Procedures Formatter
		• Training Data Formatter
			A. A. MANGIARACINA	4 HOURS EACH

5/6	16 JULY 1976 AND 19 JULY 1976	SOFTWARE DESIGN-DATA TRANSFER AND PROCESSOR MODULES • SPS/PPP Data Transfer • Real Time Interface Module • Procedures Processor Module • Difference Procedures Processor Module • Performance Data Processor Module • Performance Evaluation Processor Module	J. L. MCGAVERN	4 HOURS EACH

7	20 JULY	PPP SUPPORT DATA
		• PPP Data Base
		  • Design
		  • Update Procedures
		• PPP Data Files
		  • Design and Structure
		    • Prodata
		    • Perdata
		    • Refdata
		    • Etc.
			J. L. MCGAVERN	4 HOURS

8	21 JULY 1976	PPP SUPPORT PROGRAMS AND SOFTWARE LIBRARY • Support Programs and Interfaces • Tape Library • Check Cases	R. L. BENBOW	4 HOURS
9	22 JULY 1976	PPP SOFTWARE PROCEDURES • Loading • Updating • Execution • SVDS Interface • GDP/PPP Tape & Direct Interface • Hardcopy Capability	R. L. BENBOW	4 HOURS
10	23 JULY 1976	SPECIAL TOPICS AND SUMMARY • Reconstruction • PPP Software Documentation • Question & Answers • Review Highlights	R. L. BENBOW J. L. MCGAVERN	4 HOURS

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Figure 2-15 PPP Operations Course Synopsis

SESSION NO.	DATE	TOPIC OF DISCUSSION	INSTRUCTOR	LENGTH
1	26 JULY 1976	SYSTEMS DESCRIPTION AND USER INTERFACE • Review Loading/Updating/Execution • Hardware Interface • Program Activation • Display Tree Structure • Command Interface and Structure • PPP Initialization • Typical Formats (using all display selection commands) • PPP Post-Run • Training Script Data • Program Termination • Hands-On Machine	J. D. ARBET R. L. BENBOW	4 HOURS
2	27 JULY 1976	DATA OUTPUT AND RECONSTRUCTION • SPS Program Activation • Actual versus Simulated SPS Transfer Discussion • Procedures Data Display • Performance Output (alphanumeric and graphic) • Reconstruction • Training Status Data • Hands-On Machine	J. D. ARBET J. L. MCGAVERN	4 HOURS
3	28 JULY 1976	DIFFERENCE PROCEDURES OUTPUTS • Initial Crew Station Configuration • Switch Configuration Difference • Sequence Configuration Difference • Summary Procedures • Hold Difference • Summary Procedures Difference • Reference Data Display Output (reconstruction) • Hands-On Machine	J. D. ARBET J. L. MCGAVERN	4 HOURS
4	29 JULY 1976	PPP DATA BASE AND FORMAT CONSTRUCTION • Data Base Structure and Content Discussion • Data Base Update • Format Construction • RTOS and GRRTOS • STOR and GRSTOR • Hands-On Machine	J. D. ARBET A. A. MANGIARACINA	4 HOURS
5	30 JULY 1976	PPP/GDP TRANSFER AND CONCLUSION PPP to GDP • COPY=GDP • Termination Sequence (discuss RITIT and tape transfer) GDP to PPP • GDP STORE Tape (discuss tape transfer) • Submission of Tape and Program CRIS • GDPSTRT and GDPEXEC (tutorial operations) • CREF • Hands-On Machine Conclusion • Open Discussion of all topics	R. L. BENBOW J. D. ARBET A. A. MANGIARACINA J. L. MCGAVERN	4 HOURS

- The formatter should search through the procedures run data buffers until it finds the desired type of difference procedures entry, making input request for data when necessary.
- The formatter should then process the entry as in the run mode, making the display output.
- Upon user input requesting more data ("↑" command), the formatter should repeat the last two steps until the end of the run data is reached.

Another requirement which is not currently operational is the use of card inputs to completely execute a PPP job. This capability works in all places except for some problems in the first few initialization commands. Time did not allow for study of the problem, so no solution is currently available.

Due to a change in the procedural output code words, the Training Formatter and and the GDP/PPP transfer software will have to be modified to reflect the new structure of the onboard CRT keyboard entries.

The capability to request hardcopy of PPP displays is provided in initialization and post-run which defines the request data file to be used in providing the hardcopy output. However, the software to respond to the requests and generate the hardcopy has not been developed.

Two problems exist in the Procedures Formatter. One in which major event outputs are overwritten with later major events if they occur within the time defined for a line space of one another. The other results in loss of the procedural event output on the hardcopy of a display if a time tic occurs on a line prior to the output of the procedural event on that line.

Due to the synchronization of the reference data with procedures data by the difference procedures processor, the display of reference data by the Procedures Processor during run is adversely affected at times. The problem occurs when the processor changes the data which it is being displayed.

During the course of PPP development and operation, several desirable capabilities for the PPP were encountered. They are summarized below:

- Provide a major event at SPS initialization so that difference procedures can be displayed prior to an actual major event.

- Provide for the automatic selection, cataloging, and modification of permanent files internal to the PPP using routine PERMF (a reduced core, COMPASS, version is included in the PPP library but not accessed).
- Provide for the addition and/or deletion of the reference procedures data file in initialization and/or post-run internal to the PPP.
- Provide for the reconstruction of PPP displays for multiple resets in a single PPP run.
- Major events have to be defined for the ASCENT simulations so that difference procedures can be utilized.
- Provide display of the initial crew station configuration on a per-panel basis and also of the initial reference procedures configuration on a per-panel basis.
- Provide for the automated generation of the procedures processor mask words for procedures detection logic by the offline program PGPFILE. This would automatically provide the cards necessary to change the procedures processor when a crew station reconfiguration has occurred.

Section 3

CONCLUSIONS AND RECOMMENDATIONS

3.1 CONCLUSIONS

The PPP has been developed and documented in complete satisfaction of the Continuation of Advanced Crew Procedures Development Techniques contract requirements.

Demonstration of the feasibility of an automated procedures recording and evaluation digital program was accomplished under the Crew Procedures Development Techniques Study, Contract NAS9-13660. During the Advanced Crew Procedures Development Techniques Study, Contract NAS9-14354, the initial alphanumeric capabilities were expanded, a new user interface providing graphical capabilities was added, and the program began operational activities in support of the SPS Systems Management Simulation. The objectives of this Continuation of Advanced Crew Procedures Development Techniques Study, Contract NAS9-14780, were (1) to further modify and expand PPP capabilities in concert with the SPS, (2) support the integration of the PPP into the SMS, and (3) study PPP effectiveness, computer core, and time utilization. Successful completion of these objectives is demonstrated by the request of the Flight Operations Directorate (FOD), Crew Training and Procedures Division (CTPD) for PPP capabilities on the Phase II SPS, SMS-Fixed Base (SMS-FB), and SMS-Motion Base (SMS-MB) simulations. Transfer of the program to the Data Systems Analysis Directorate (DSAD), Flight Simulations Division (FSD) for maintenance and follow-on development on the Phase I SPS and Phase II SPS, SMS-FB, and SMS-MB implementation further demonstrates successful completion.

The development during the three PPP contracts and subsequent utilization during the last two indicates that a valuable support tool exists for simulation, procedures development and training personnel on the SPS. Implementation of PPP capabilities within the Phase II SPS and SMS complexes will provide the same valuable tool.

3.2 RECOMMENDATIONS

PPP output capabilities are an effective tool for simulator complex activities. Although it is an operational program, various modifications and improvements in it's design and operations have been identified. These modifications and improvements have been discussed in this Final Report and incorporated in the PPP requirements document. Their incorporation into the PPP Program should enhance the data outputs available.

It is recommended that the modifications and improvements be incorporated into the PPP for present use with the Phase I Shuttle Procedures Simulator Complex.

It is recommended that all capabilities as stated in the PPP Requirements Document be implemented on the Phase II Shuttle Procedures Simulator, Shuttle Mission Simulator - Fixed Base, and Shuttle Mission Simulator - Motion Base complexes.

It is recommended that PPP capabilities be utilized extensively to support simulator complex maintenance and verification, procedures development, and simulation training exercises.

Section 4

BIBLIOGRAPHY

Several difference documentation formats have been used to publish the progress and results of the Continuation of Advanced Crew Procedures Development Techniques Study. These documentation formats and a summary of their contents are as follows:

MDC Reports - These documents correspond to the line item reports specified in the Data Requirements List of the contract. Delivery of these reports to NASA represents satisfactory completion of a major milestone of the project schedule.

Design Notes - These documents present technical information resulting from the completion of specific tasks performed on the study. They include topics concerning program verification, program development, data processing, simulation results, hardware modification, user aids, advanced techniques, commercial applications, and application to other simulators.

Working Papers - These documents represent informal publication of work as it is in progress within the PPP technical staff. Draft material documenting the development of a PPP Module or subroutine, or documentation of technical data to be exchanged among the PPP staff is published in a working paper.

Miscellaneous - Several reports required by the contract do not logically fall into any of the above categories. These include computer listings and tapes and status reports of the contract.

A complete annotated bibliography of the documentation prepared under the Continuation of Advanced Crew Procedures Development Techniques Study is presented in Figure 4-1. Included in the figure is the report title, number, date of publication, list of authors, and synopsis of the contents of each of the documents written. The bibliography is subdivided according to the four format categories described above.

Figure 4-1

DOCUMENTATION BIBLIOGRAPHY FOR CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES STUDY (1 OF 10)

DOCUMENT - TITLE	DATE	AUTHOR	SYNOPSIS
MDC REPORTS			
MDC W0015 - PROCEDURES AND PERFORMANCE PROGRAM MATH FLOW CHARTS	25 JUNE 1976	R. L. BENBOW M. E. EVANS A. A. MANGIARACINA J. L. MCGAVERN M. C. SPANGLER I. C. TATUM	This report contains the math flow charts for the subroutines and programs contained in the Procedures and Performance Program. These math flow charts represent the status of the PPP as of the completion of the Continuation of the Advanced Crew Procedures Development Techniques Study. This document represents the most complete documentation, other than the computer listing, of the program as it existed at the time the Data Systems and Analysis Division assumed responsibility for the PPP implementation and maintenance.
MDC W0017 - PROCEDURES AND PERFORMANCE PROGRAM USERS GUIDE, VOLUME I, OPERATIONS DESCRIPTION	25 JUNE 1976	J. D. ARBET R. L. BENBOW A. A. MANGIARACINA	This report describes the operational aspects of utilizing the Procedures and Performance Program to obtain the desired procedures and performance data output in association with the Shuttle Procedures Simulator-Phase I complex. General information of the PPP system and a detailed information on the PPP operational requirements are presented. This document represents the operations description of the PPP at the end of the Continuation of the Advanced Crew Procedures Development Techniques Study and the time the Data Systems and Analysis Division assumed responsibility for the PPP implementation and maintenance.

Figure 4-1

DOCUMENTATION BIBLIOGRAPHY FOR CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES STUDY (2 OF 10)

DOCUMENT - TITLE	DATE	AUTHOR	SYNOPSIS
MDC W0017 - PROCEDURES AND PERFORMANCE PROGRAM USERS GUIDE, VOLUME II, PROGRAM DESCRIPTION'	25 JUNE 1976	R. L. BENBOW A. A. MANGIARACINA J. L. MCGAVERN	This report describes the software programming techniques and implementation of the Procedures and Performance Program in association with the Shuttle Procedures Simulator-Phase I complex. Included is a discussion of the PPP user interface, the SPS/PPP interface, the PPP top level design and data flow concept, and the PPP Applications software. This document represents the software description of the PPP at the end of the Continuation of the Advanced Crew Procedures Development Techniques Study and the time the Data Systems and Analysis Division assumed responsibility for the PPP implementation and maintenance.
MDC W0016 - PROCEDURES AND PERFORMANCE PROGRAM REQUIREMENTS DOCUMENT	2 JULY 1976	J. D. ARBET R. L. BENBOW A. A. MANGIARACINA	This report defines the hardware and computer program software requirements for the Procedures and Performance Program (PPP). These requirements define the capabilities as they are to be implemented on the Shuttle Mission Simulator-Fixed Base, the Shuttle Mission Simulator-Motion Base, and the Shuttle Procedures Simulator-Phase II complexes. These requirements have been developed and their feasibility demonstrated as a result of the Crew Procedures Development Techniques Study contracts with the Flight Operations Directorate. This document represent the requirements to be implemented by the Data Systems and Analysis Division to provide a PPP system capability in support of crew training and flight procedures development and verification.

Figure 4-1

DOCUMENTATION BIBLIOGRAPHY FOR CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES STUDY (3 OF 10)

DOCUMENT - TITLE	DATE	AUTHOR	SYNOPSIS
MDC W0018 - CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES STUDY FINAL REPORT	30 JULY 1976	J. D. ARBET R. L. BENBOW M. E. EVANS A. A. MANGIARACINA J. L. MCGAVERN M. C. SPANGLER I. C. TATUM	This report summarizes the work performed on the Continuation of Advanced Crew Procedures Development Techniques Study. A technical synopsis, abstract, conclusions, recommendations, and annotated bibliography are included. This report documents the activities performed relative to the Procedures and Performance Program Development.

Figure 4-1
DOCUMENTATION BIBLIOGRAPHY FOR CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES STUDY (4 OF 10)

DOCUMENT - TITLE	DATE	AUTHOR	SYNOPSIS
DESIGN NOTES			
CACPDT DN NO. 14 - PPP/NONREAL-TIME TRAJECTORY PROGRAM INTERFACE REQUIREMENTS AND CAPABILITIES	28 NOV. 1975	J. D. ARBET R. L. BENBOW J. L. MCGAVERN	This design note presents the requirements and capabilities for interfacing a trajectory program with the Procedures and Performance Program. The availability of this interface provide various new PPP capabilities. Processing of the trajectory data by the PPP generates a summary timeline related to that unique trajectory profile. This summary timeline then may be merged with existing PPP reference procedures to develop reference procedures related to the new trajectory. The design note includes a discussion of 1) the trajectory program selection process, 2) the data transfer requirements, 3) the PPP procedures recording process requirements, 4) the procedures merge requirements, and 5) the interface design philosophy.
CACPDT DN NO. 15 - PPP CORE UTILIZATION STUDY	15 JAN. 1976	R. L. BENBOW A. A. MANGIARACINA	This design note presents the results of an investigation made to identify candidate recommendations to reduce the Procedures and Performance Program core utilization. Several candidate schemes were recommended to be studied in detail for implementation as core reduction updates.
CACPDT DN NO. 16 - PPP REVISED TRAINING PLAN	19 MAR. 1976	J. D. ARBET R. L. BENBOW	This design note provides a revised Procedures and Performance Program Training Plan. The document contains an overview of the contents of each training session and a detailed outline to be used as the guideline for each session. This update incorporates PPP User Guide page references and restructures sessions two through five to use an actual real-time simulator environment.

Figure 4-1

DOCUMENTATION BIBLIOGRAPHY FOR CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES STUDY (5 OF 10)

DOCUMENT - TITLE	DATE	AUTHOR	SYNOPSIS
CACPDT DN NO. 17 - PPP EFFECTIVENESS STUDY	7 MAY 1976	J. D. ARBET R. L. BENBOW	This design note documents a study of the Procedures and Performance Program effectiveness. The intent of the study is to determine manpower time savings and the improvements in job performance gained through PPP automated techniques. The discussion presents a synopsis of PPP capabilities and identifies potential users and associated applications, PPP effectiveness, and PPP application to other simulation/training facilities. An appendix provides a detailed description of each PPP capability.

Figure 4-1
DOCUMENTATION BIBLIOGRAPHY FOR CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES STUDY (6 OF 10)

DOCUMENT - TITLE	DATE	AUTHOR	SYNOPSIS
WORKING PAPERS			
PPP WP NO. 41 - ACPDT PHASE I DETAILED TASK DESCRIPTION	19 SEPT. 76	R. L. BENBOW	This working paper presents the initial work plans for the Continuation of Advanced Crew Procedures Development Techniques Study (NAS-9-14780). Since no technical proposal was required to respond to the NASA Request for proposal (no exceptions to the statement of work existed), no specific technical work plans had been developed to date. A synopsis of the statement of work for the contract period and detailed task descriptions are included.
PPP WP NO. 44 - PPP/CDC 6400 TAPE CONTROL PROCEDURES	28 NOV. 76	A. A. MANGIARA-CINA	This working paper establishes the tape control procedures to create, update, and release program and data tapes utilized in the Procedures and Performance Program development.
PPP WP NO. 45 - PPP DATA BASE UPDATE CAPABILITY REQUIREMENTS	9 JAN. 76	J. D. ARBET	This working paper defines the requirements for re-establishing the PPP data base update capability during PPP initialization operations. The user operations and tutorial displays associated with this capability are discussed.
PPP WP NO. 46 - CHECKCASE EXECUTION RESULTS	23 JAN. 76	J. D. ARBET	This working paper documents the checkcase execution data output and provides discussion on various problems and considerations for each checkcase. The data output is limited to the training script data which provides a record of the operations exercised for each checkcase. Eight of the nine defined checkcase were executed and documented to verify PPP operations consistent with the requirements definition.

MDC W0018
30 July 1976

Figure 4-1

DOCUMENTATION BIBLIOGRAPHY FOR CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES STUDY (7 OF 10)

DOCUMENT - TITLE	DATE	AUTHOR	SYNOPSIS
PPP WP NO. 47 - SPS ASCENT SIMULATION DATA TRANSFER	23 FEB. 76	J. D. ARBET A. A. MANGIARA-CINA	This working paper defines the SPS Ascent simulation performance data transfer necessary to satisfy PPP data output requirements. Included are the groundrules for providing the performance data transfer and a detailed definition of each computation frame.
PPP WP NO. 48 - AIAA "MINI-SYMPOSIUM" PRESENTATION-CREW PROCEDURES/PERFORMANCE MONITORING SYSTEM: CONCEPT AND TECHNIQUES	3 MARCH 76	R. L. BENBOW	The Houston Section of the American Institute of Aeronautics and Astronautics (AIAA) sponsored a Technical Mini-Symposium on 2 March 1976. This working paper documents the subject abstract and paper presented by the author at the symposium.
PPP WP NO. 49 - STUDY OF SOFT-WARE ALTERNATIVES FOR REDUCTION OF REQUIRED PPP CORE	16 MARCH 76	I. C. TATUM	This working paper documents the results of a study conducted to explore the core requirement to perform certain recurring programming operations in alternate ways. The paper presents the sample code and data gathered for the different implementation techniques.
PPP WP NO. 50 - CALCOMP HARD-COPY REQUEST DISPLAYS AND FILE CONTENTS	22 MARCH 76	R. L. BENBOW	This working paper documents the user interface and hard-copy display request file contents that were programmed for the PPP CALCOMP hardcopy capability. Thru this capability the user defines the graphical hardcopy out-puts desired from the run. After all hardcopy requests have been made and the PPP run terminated, a support program convert the request and performance data into CALCOMP plots which represent those seen or that could have been seen on the CDC 243 Graphics terminal during a run.

Figure 4-1
DOCUMENTATION BIBLIOGRAPHY FOR CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES STUDY (8 OF 10)

DOCUMENT - TITLE	DATE	AUTHOR	SYNOPSIS
PPP WP NO. 51 - SVDS/PPP TRAJECTORY DATA INTERFACE (PROGRAM DESCRIPTION AND USAGE)	14 MAY 76	J. L. MCGAVERN	This working paper documents the final design and usage of the SVDS/PPP interface. Included is a discussion of the SVDS Program Modifications and Usage, and a discussion of the PPP performance data conversion program description and usage. Also included is a discussion of the PPP application.
PPP WP NO. 52 - DESCRIPTION AND USAGE OF CALCOMP HARDCOPY PROGRAM P3PLOTR	14 MAY 76	I. C. TATUM	This working paper presents a functional description, the control parameters, and example output of the PPP support program P3PLOTR. This program provides the capability to duplicate exactly what was or could have been on the CDC 243 Graphics Terminal and provide a hardcopy output via the CALCOMP Plotting System. Mathflows, FORTRAN source code listings, and program control cards are presented.
PPP WP NO. 53 - PPP TRAINING SESSION ATTENDANCE AND HANDOUTS	30 JULY 76	R. L. BENBOW J. D. ARBET A. A. MANGIARACINA J. L. MCGAVERN	This working paper documents the PPP Training Session Activities. Included is an attendance record of the NASA personnel who participated in the classroom and hands-on training sessions. Handouts from each classroom session are included in this working paper.

Figure 4-1

DOCUMENTATION BIBLIOGRAPHY FOR CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES STUDY (9 OF 10)

DOCUMENT - TITLE	DATE	AUTHOR	SYNOPSIS
MISCELLANEOUS			
CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES PROGRESS REPORTS - NUMBER 1 TO 11	MONTHLY	R. L. BENBOW	These reports summarize the progress of the work effort each month. A brief summary status of the technical work accomplished during each reporting period is discussed.
CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES FINANCIAL MANAGEMENT REPORT - NUMBER 1 TO 11	MONTHLY	D. ARMSTRONG	These reports summarize the cost performance for each month. NASA Form 533 summarizing the program cost items and a brief narrative analysis of the cost variances is included.
PPP COMPUTER TAPE LIBRARY SUMMARY	4 JUNE 76	R. L. BENBOW A. A. MANGIARA-CINA	This report transmits the Procedures and Performance Program Tapes to the NASA. The document describes the contents and structure of the computer tapes for the Procedures and Performance Program. The corresponding computer tapes are stored in the Building 35 Computer Tape Library. This report documents the status of the progress and data tapes as they exist at the completion of the Procedures and Performance Program development activities on the subject contract.

Figure 4-1
DOCUMENTATION BIBLIOGRAPHY FOR CONTINUATION OF ADVANCED CREW PROCEDURES DEVELOPMENT TECHNIQUES STUDY (10 OF 10)

DOCUMENT - TITLE	DATE	AUTHOR	SYNOPSIS
PPP AND SUPPORT PROGRAMS: CONTROL CARDS AND PROGRAM LISTINGS	2 JULY 76	R. L. BENBOW M. E. EVANS A. A. MANGIARA-CINA	This report transmits the Procedures and Performance Program Listings to the NASA. The document contains the PPP and support program control cards and listings. This report documents the status of the program as it exists at the completion of the Procedures and Performance Program development activities on the subject contract.
PPP PARAMETER DICTIONARY	2 JULY 76	R. L. BENBOW A. A. MANGIARA-CINA J. L. MCGAVERN	This is a computer listing which documents the common block parameters within the PPP. The name, dimension, common block location, and definition of each parameter within the PPP is presented.
SUMMARY OF NEW TECHNOLOGY REVIEW ACTIVITIES REPORT	30 JULY 76	R. L. BENBOW	This report provides information of the activities performed on the subject contract relating to the compliance with the New Technology Disclosure clause. This report documents the activities performed prior to the completion of the Procedures and Performance Program development activities on the subject contract.
PRESENTATION - DIRECTORATE OFFICE REVIEW OF THE PROCEDURES AND PERFORMANCE PROGRAM	APRIL 76	R. L. BENBOW D. W. LEWIS (NASA-CG5)	This presentation was prepared at the request of the Director of Flight Operations. Brief contract history, cost analysis, program capabilities review, and actual versus anticipated benefits of the study were summarized in the presentation. The presentation was made on 21 April 1976 by Mr. Tom Holloway, Chief of Flight Activities Branch.