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PAYLOAD CREW TRAINING COMPLEX SIMULATION ENGINEER'S HANDBOOK

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16. ABSTRACT

The Simulation Engineer's Handbook is a guide for new engineers assigned to Experiment Simulation and a reference for engineers previously assigned. The experiment simulation process, development of experiment simulator requirements, development of experiment simulator hardware and software, and the verification of experiment simulators are discussed. The training required for experiment simulation is extensive and is only referenced in the handbook.

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FOREWORD

The role of the Simulation Engineer in Payload Crew Training Center operations is one of the most challenging jobs within the space field. He or she must become, at once, a multi-discipline and multi-task oriented person gaining experience in computer hardware and software, simulation techniques, scientific experiments, engineering operations, and management. This handbook is written to guide the uninitiated Simulation Engineers and is dedicated to the Simulation Engineers who worked the first Spacelab Mission.

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PAYLOAD CREW TRAINING COMPLEX SIMULATION ENGINEER'S HANDBOOK

I. INTRODUCTION

The Spacelab missions, Astro missions, Space Station, and subsequent missions are designed to carry experiments into outer space to conduct scientific investigations. Prior to launch, the crew must be trained to operate and monitor science, astrophysics, medical, and commercial experiments using mockups and experiment simulators (hardware/software devices) which simulate experiment Command Data Management System (CDMS) operations to a training-level fidelity.

The Simulation Engineer's assignment is to develop experiment simulators for use by training personnel in the Payload Crew Training Complex (PCTC). This assignment covers a spectrum of tasks which includes: monitoring or developing experiment simulator model requirements; technical coordination for software development; acceptance of simulator design; preparation of data bases; verification and acceptance of the simulator; and operating the simulator. Details of these tasks and the support provided to perform the tasks are covered in this document.

The Simulation Engineer is both a technical and operational oriented engineer who has been assigned to the PCTC Simulator Development Team. Work assignments in the simulator area and technical supervision will be the responsibility of the Experiment Simulation Lead Engineer.

II. DESCRIPTION OF SIMULATION ENGINEER'S TASK

The Simulation Engineer's tasks are grouped in four major categories: developing experiment simulator modeling requirements; developing hardware/software for the experiment simulator; verification and acceptance of the experiment simulator software; and operating the simulator. A summary of each task is given in this section. The details of each task are covered in Sections III through VII.

A typical Experiment Simulator Development Life Cycle is shown in Figure 1. The Simulation Engineer's participation in the experiment development is indicated by the symbol MSFC. As can be seen, development of the Experiment Simulator Modeling Requirements (ESMR) is the initial task in the development cycle and it is important to note that the modeling requirements are the keystone of a successful experiment simulator. The time required to correct discrepancies in requirements is magnified as the experiment simulator reaches each succeeding step in the development cycle; thus, the Simulation Engineer should concentrate efforts to develop a complete and correct ESMR.

The Simulation Engineer's role in hardware/software development is to act as a consultant in interpreting and clarifying the requirements and in reviewing the design flows. When the hardware/software simulator design is completed, the Simulation Engineer accepts the simulator design and initiates the verification/acceptance phase.

Verification takes place at the completion of the hardware/software development phase and is performed using a set of verification test procedures. If the hardware/software is found to be at an acceptable level of operation, the Simulation Engineer initiates the acceptance phase. When the hardware/software passes the acceptance reviews [Simulator Acceptance Review (SAR) and Simulator Training Acceptance Review (STAR)], the experiment simulator is presumed to be operational.

The Simulation Engineer's activities will then continue into the operational phase in the role of a training consultant. This role is not precisely defined as to participation, consequently, the Simulation Engineer will be expected to respond to training requests when called upon.

On Spacelab 1, a number of experiment simulators were built to support the European Space Agency (ESA) experiments. The development life cycle flow for these experiment simulators is different from the flow of Figure 1, especially from the point of verification to training. These differences are unique to Spacelab 1 and other European supported missions and will not be discussed herein.

There are also a number of Mission Peculiar Equipment (MPE) simulators which have been developed to support the CDMS training. These MPE simulators are NASA Branching Distributor (NBD), ESA Junction Box (EJB), Horizon Sensor (HRZ), Video (VID), Video Tape Recorder (VTR), Orbital Flight Data (OFD), Magnetic Field (AMAG), Payload Thermal Control (PTC), European Standard ECAS (ESE), and Environmental (ENV). All of these simulators were developed in-house using civil service personnel or ESA personnel.

III. EXPERIMENT SIMULATOR MODEL REQUIREMENTS (ESMR)

The ESMR is a set of functional requirements which are the basis for all experiment simulator development. An ESMR may be developed by civil service personnel or by a contractor. Reference 1 contains detailed procedures for ESMR development when done in-house. However, in the past, MSFC has had a contract for support in developing experiment ESMRs. When the ESMR is developed by a contractor, the Simulation Engineer will have direct communication with the ESMR developer and may, also, communicate with the Principal Investigator (PI) through the Program Office to assist in getting clarification or additional requirements.

The Simulation Engineer's role in ESMR development, in this instance, is to make contact with the contractor to determine the person responsible for the ESMR for the assigned experiment. The Simulation Engineer and the ESMR developer will then review the program schedule and plan how to deliver the ESMR on time. All problems in meeting the schedule should be identified and referred to the Experiment Simulator Lead Engineer. A flow of ESMR development is shown in Figure 2.

The Simulation Engineer should review the ESMR as it is being written to facilitate the signoff at delivery. It may be necessary for the Simulation Engineer to clarify the experiment operations to the ESMR developer and, if necessary, the Simulation Engineer may request the Program Office to have the PI or flight software contractor meet with the ESMR developer. The Simulation Engineer should be the key person in arranging PI or flight software contractor meetings and should attend all meetings between the PI, flight software contractor, and ESMR contractor. The Simulation Engineer is also responsible for coordinating with the mockup designers to obtain Control and Display (C&D) panel requirements.

ESMR signoff will be required of the ESMR contractor, the PI, the Experiment Simulation Lead Engineer, and the PCTC manager. Once the document is signed, it becomes a baseline version and will be subject to configuration control requirements. The signed ESMR will then be given to the Software (S/W) contractor and to the Hardware (H/W) developers (MSFC) for building the Experiment Simulator.

There will normally be changes to the experiment flight hardware after the ESMR has been baselined which the Simulation Engineer will be informed of by an approved Engineering Change Request (ECR). The Experiment Simulation Lead Engineer and the Simulation Engineer will need to assess the ECR change as to whether the change significantly affects the experiment simulator fidelity. A decision will then be made as to a change in experiment simulator design based on where the simulator is in the development cycle and the impact on requirements and S/W design resources.

Other changes to the baselined ESMR may be identified by the PI, the Simulation Engineer, the Requirements Engineer, or the S/W designers. The impact of these changes will also be assessed by the Experiment Simulation Lead Engineer and the Simulation Engineer and a decision will be made as to whether resources are available to incorporate the changes.

A special class of changes which must be considered by the Simulation Engineer are Configuration Data Table (CDT) and data base updates. These updates are easily accommodated and are normally incorporated at the first opportune time in the development cycle.

The overriding criteria in the development of experiment simulator requirements and the assessment of changes to the requirements is the need for crew experiment interaction and the associated level of training fidelity needed in the experiment simulator. If the level of fidelity cannot be achieved with the available resources, the Experiment Simulator Lead Engineer should notify the training personnel.

IV. EXPERIMENT SIMULATOR HARDWARE/SOFTWARE DEVELOPMENT

Upon receipt of a signed ESMR, the mockup personnel (MSFC) will build the control display panels necessary to support the Experiment Simulator. The Simulation Engineer's role in hardware development is to be the consultant to the mockup personnel for experiment hardware requirements and to the Host Computer personnel for the experiment hardware/software interface.

The Simulation Engineer's role in software development is to contact the software support contractor to determine the name of the person(s) assigned to develop the software for the experiment. The software programmer will then be given a copy of the signed ESMR and the Simulation Engineer will review the program schedule with the programmer and they will plan the software activities. Any problems in meeting the schedule should be identified and referred to the Experiment Simulator Project Engineer. A flow of experiment simulator hardware/software development is shown in Figure 3.

The software development task should include reviews of the design flow diagrams by the programmer, ESMR developer, and Simulation Engineer. These reviews will help uncover requirement discrepancies as well as programming errors.

After the simulator design is approved by the Simulation Engineer, the software contractor will code the simulator model.

The incorporation of changes to the baselined requirements has a direct impact on software design; therefore, the software designers should be included in the assessment of changes to requirements. The approval of changes to requirements normally results in a redistribution of programming resources and a reassignment of priorities. Consequently, as a rule, changes to baselined requirements should be minimized.

Experiment simulator software may be developed in-house using civil service personnel. When this alternative is used, the assigned personnel should use References 1 and 2 as a guide. Tables 1 and 2 outline the methodology and milestones associated with experiment simulator software development for in-house personnel.

V. EXPERIMENT VERIFICATION AND ACCEPTANCE

The Simulation Engineer's involvement in simulator development will be at a maximum during the experiment verification and acceptance phase. Figures 4, 5, and 6 show the tasks associated with verification, SAR, and STAR.

Prior to verification, the Simulation Engineer must make sure that the experiment simulator files are prepared. The Simulation Engineer will, in most instances, be personally responsible for file preparation as MSFC has no support contract for this effort. There are a number of files and data bases which the Simulation Engineer must become familiar with. Figure 7 is a pictorial representation of the files and data bases required to run the simulator. The end product of this phase of activity should be an ECOS Session File, SDC Display(s), Cross Reference Command File, OCT Format File, and an Experiment Simulator Data Base.

The Simulation Engineer can begin file preparation activities by reviewing the ESMR and software design documents. The Simulation Engineer then builds the appropriate files using the MMU Program [3], TL PREP Program [4], ECOS Mission Data Base and Test ID File [5], and SDC Display [6]. The programmer builds the DDS display format using the Display Background generator [7], the Experiment Simulator Data Base using the File Create Program [8], and finally, the Simulation Engineer can build the Environmental Data Base [9], and the Cross Reference File using the text editor, and then, last, the ECOS Session Data Base [5] is built.

After all files are prepared, the Simulation Engineer is ready for experiment verification. The purpose of experiment verification is to assure that the experiment simulator will actually perform as specified by the ESMR. To verify that all requirements are satisfied, it is necessary to establish some pattern of checking such as proposed in this section. The Simulation Engineer may want to devise another scheme of checking which is permissable if it satisfactorily covers verification of the requirements.

A schematic of a typical experiment simulator is shown in Figure 8. The three modes of verifying simulator operations are to use the Data Display System (DDS) terminal in the mockup, and the LSI terminal or the Simulation Director's Console (SDC) terminal in the Simulation Director's room. Approximately 80 percent of verification will take place using the DDS terminal and about 10 percent each will take place using the LSI and SDC terminals.

Table 3 indicates the functional areas which must be verified. Areas 2 to 6 are based on an understanding of the ESMR, ECOS, and ECAS and constitute the major part of the verification procedures. An outline for Acceptance Test Procedures (ATP) is shown in Figure 9. A sample of acceptance test procedures (ATP) are included in Figures 10 and 11. The Simulation Engineer may want to call upon the ESMR person who is working requirements for the assigned experiment to assist in developing the ATP. The Simulation Engineer will then schedule a verification time with the ESMR Developer and the software contractor. An outline of the acceptance team responsibilities is given in Table 4.

After verification, an experiment simulator is subjected to two major reviews, SAR and STAR. The SAR is conducted at the end of the verification phase to validate the experiment simulator requirements with the PI as shown in Figure 5. The Simulation Engineer will schedule the SAR with ESMR Developer/software contractor/PI. Table 5 is an outline of the steps which the Simulation Engineer must take to conduct the SAR. All discrepancies identified during the SAR will be corrected by ESMR Developer/software contractor prior to the STAR.

The final review for the simulator is the STAR which will determine the fidelity of the simulator relative to the training procedures. The STAR development cycle is shown in Figure 6. The Simulation Director will schedule the STAR and will request the Simulation Engineer's participation. When the simulator passes the STAR, it is operational and ready for use by training personnel.

One general comment should be made: during the experiment simulator development life cycle, a number of discrepancies to requirements, software, and hardware may be found. These discrepancies to experiment simulator requirements, software and hardware will be handled using the PAR process of Reference 10. If a flight software discrepancy is uncovered, the PCTC Alert Notice (PAN) form will be used.

VI. EXPERIMENT SIMULATOR OPERATIONS

The Simulation Engineer becomes, with the exception of the programmer, the person most knowledgable of the experiment simulator operations and, thus, will be consulted for expertise and advice relative to assigned experiments. Most of the operations experience will be gained prior to and during the SAR and most of the consulting will take place subsequent to the SAR.

This section of the handbook will address only those simulator operations which are more or less general to all experiments. Unique experiment simulator operations must be learned from the experiment simulator programmer and Host Software Manager.

One operation common to all experiment simulators is start up/shutdown procedure. This procedure has been simplified considerably and a sample of the start up/shutdown procedure can be obtained from the Host Software Manager.

There are a number of commands which can be issued at the SDC console such as loading a program manually, accelerating time, and changing environmental parameters. The Host Software Manager should be consulted for a list of these commands.

There are a number of other more general commands such as bringing up both DDU's in the mockup and changing the GMT time. The Host Software Manager should also be consulted for these commands.

Finally, there is also a set of ECOS commands which the Simulation Engineer should be familiar with. Most of these are covered in the ECOS design manual reference and will be covered during the ECOS training session.

In addition to becoming familiar with the operational simulator commands, the Simulation Engineer must learn how to run all the MPE models listed in Section II. A training session with hands-on training and a thorough review of the MPR User's Guides [11] is the recommended way of accomplishing this.

VII. TRAINING

Simulation Engineers are generally assigned to the Experiment Simulator Team at random times which makes a formal training program unfeasible. The approach to training selected is a combination of assigned reading (Engineer's Handbook and reference documents), individual discussion sessions using the outline of training requirements, Table 6, and on-the-job training. The Simulation Lead Engineer and the Simulation Engineer will be responsible for developing a viable training schedule for the Simulation Engineer which will fit into the overall simulator development schedule. Simulation training will be the responsibility of the Experiment Simulator Lead Engineer; however, actual training sessions may be assigned to any of the other simulation engineers or to the Host/Software/Configuration Engineer.

ECOS operational training is a special type which is conducted by the PCTC personnel. The Simulation Engineer will be scheduled to attend the PCTC ECOS Training Sessions, if possible; however, the Simulation Engineer can gain a degree of ECOS operational proficiency by using the outline and other notes in Tables 7 and 8 and the diagram in Figure 12 along with the ECOS documents to self-learn.

A Training Manual [12] has been developed for use in training Simulation Engineers. It is recommended that the Simulation Engineer use this as a basis for establishing a training program for Simulation Engineers, Software Developers, or ESMR Developers.

TABLE 1. EXPERIMENT SIMULATOR DEVELOPMENT METHODOLOGY

I. ANALYSIS PHASE

   A. Preliminary Document Review
   B. Meetings with Requirements Engineer
   C. Preparation of Structured Analysis
      1. Bubble Charts
      2. Data Dictionary
   D. Analysis Walkthroughs
   E. Documentation of Requirements Feedback
   F. Documentation of Analysis

II. DESIGN PHASE

   A. Preparation of Module Hierarchy
   B. Interface Analysis and Design
   C. Walkthrough of Hierarchy and Interface Design
   D. Preparation of Structured Flowcharts
   E. Preparation of File Description
   F. Design Walkthrough
   G. Performance Estimate
   H. Documentation of Design
   I. Presentation and Review of Design

III. IMPLEMENTATION PHASE

   A. Preparation of Implementation Plan
   B. Coding of Modules
   C. Code Walkthroughs
   D. Preparation of Directed Graphs for Module Testing
   E. Preparation of Test Data
   F. Module Testing (Test Harness)
   G. Preparation of Data Files

IV. INTEGRATED TESTING PHASE

   A. Preparation of Display Skeleton
   B. Preparation of Integrated Test Files
   C. Preparation of Test Data and Test Plan
   D. Integrated Testing (CDB and ECOS)
   E. Software Acceptance Test Support

TABLE 2. SIMULATION ENGINEER'S TYPICAL MILESTONES

I. REQUIREMENTS ANALYSIS

A. Review ESMR
B. Draw DFD's
C. X-Ref ESMR
D. Document
E. Hold Reqs Anal Review

II. DESIGN

A. Draw Hierarchy Charts
B. Review Library Routines
C. Develop Routines

1. Initialization
2. Run
3. Freeze
4. Stop
5. Hardware
6. ECAS
7. DEP
8. C&D

III. BUILD FILES

A. Simulator DB
B. Experiment Simulator Files

IV. TEST

A. ETS
B. HOST

TABLE 3 ACCEPTANCE TEST PROCEDURES (ATP) FUNCTIONAL AREAS

	Functional Area		S/W	Terminal
1.	MODE Control (I, F, R, H, S)		OCT	SDC
2.	ECOS Data Base (CDT)		ECOS	DDS-SDC DB Preparation
3.	Instrument Model (Manual Commands)			
	a. H/W Model	(Nominal and Off-nominal Commands)	ECOS (OCT)	DDS-(SDC)
	b. C&D Model			
	c. DEP Model			
4.	Exercise ECOS T/L Service (Nominal, Off-Nominal)		ECOS	DDS
5.	Exercise ECAS W/HDWR Model (Display, Item, Type)		ECOS	DDS
6.	Accelerated Time-HDWR/ ECAS Models		ECOS	DDS (SDC)

TABLE 4. ACCEPTANCE TEAM SIMULATOR VERIFICATION/SAR

I. PREPARATION TASKS/RESPONSIBILITIES

A. Test Procedures Development - Simulation Engineer/ESSEX
B. Experiment Simulator Ready - Simulation Engineer/BCS

II. VERIFICATION TESTING TASKS/RESPONSIBILITIES

A. Team Position Assignments - Simulation Engineer
B. Test Conductance - Simulation Engineer
   30 Pages/Day Pacing
   Note discrepancies on test procedures
   Record discrepancy time, video tape change times
C. Computer Problems - Host/System Engineer

III. DEBRIEF

Discussion Lead - Simulation Engineer
   Record approved DR's
   Assign actions to ESSEX/BCS to close discrepancies

IV. ENDING TASKS

A. Delog/Distribute Event Recorder Tape - Simulation Engineer
B. Reverification - Simulation Engineer

TABLE 5. SAR PREPARATION/CONDUCT/POST

I. NOTIFICATION OF PARTICIPANTS

A. Memo/Agency/DOC.

B. Scheduling the Computer

II. AGENDA

A. Briefing/Introduction

1. Purpose
2. SIM Requirements ESMR (Date) Data Base - CDT
3. Role of Participants
4. Summary of Test Proc.
5. PAR Process
6. Reacceptance

B. Hands-On Testing

1. Test Procedure Sheets
2. Informal Testing

C. Debrief

Review of PARs

III. SAR MINUTES/DOCUMENTATION

TABLE 6. SIMULATION ENGINEER TRAINING REQUIREMENTS

I. PCTC FAMILIARIZATION

- Layout
- Equipment
- Personnel
- Operations

II. HOST/SYSTEM FAMILIARIZATION

- PDP 11/70 Terminal
- Hardware System
- Software System
  - Operator Control Task (OCT)
  - Experiment Computer Operating System (ECOS)
  - Common Data Buffer (CDB)

III. DOCUMENTATION FAMILIARIZATION

- Reference Documents (Simulation Engineer's Handbook)

IV. EXPERIMENT SIMULATOR

- Hardware Model
- DEP Model
- C&D Panel Model
- ECAS Model
- Data Bases
- External Files
- Configuration

V. FILE PREPARATION

- Mass Memory Unit (MMU)
- ECOS Timeline (TL)
- Simulator Director Console (SDC) Display
- Background Display
- OCT Format
- Cross Reference Command
- Experiment Logic
- Test ID
- ECOS Mission
- Environmental

VI. DATA BASE PREPARATION

- ECOS Session Data Base - ECOS Session Program
- Experiment Simulator Data Base - Create Program

VII. EXPERIMENT SIMULATOR MODELING REQUIREMENTS (ESMR)

- Source Documents
- Development
- Review
- Changes

TABLE 6. (CONTINUED)

VIII. EXPERIMENT SIMULATOR S/W DEVELOPMENT

- Requirements Analysis
- Design
- Reviews
- Stand-Alone Testing
- Integrated Testing

IX. EXPERIMENT SIMULATOR VERIFICATION AND ACCEPTANCE

- Verification - Test Procedure Development
- Simulator Acceptance Review (SAR)
- Simulator Training Acceptance Review (STAR)

X. EXPERIMENT SIMULATOR OPERATION

- DDS (Mockup, SDC, POCC)
- SDC

XI. MISSION PECULIAR MODELS (MPE)

- NASA Branching Distributor (NBD)
- ESA Junction Box (EJB)
- Horizon Sensor (HRZ)
- Video Monitor (VID)
- Video Tape Recorder (VTR)
- Orbital Flight Data (OFD)
- Magnetic Field Image (AMAG)
- Payload Thermal Control (PTC)
- European Standard ECAS (ESE)
- Environmental (ENV)

TABLE 7. ECOS OPERATIONAL TRAINING REQUIREMENTS

FUNCTIONAL AREA	SUPPORT MODEL
I. BASIC KEYBOARD/SYSTEM LINES	CDT/RAU/HW/ECAS
Initiator Keys - DISPLAY, ENTER, ITEM, ETC.	
SPL Format	
SPL Errors	
Hidden Page Advisory	
Line 20 - Format, Clearing, Recording	
Timeline Status	
II. COMMAND KEY USAGE	
ISS	DEP
ISM	CDT/RAU/HW
WRI	ECAS
CAN	
TER	
MON Type	
REM	
TLH	
TLC	
TLL	
RUN	
MMU	
Syntax	
Contex	
III. MEMORY MANAGEMENT OPERATIONS	
Display (MEM)	Multiple ECAS's
Page Allocation/Deallocation	
Task Management/Priority Levels/Status	
Error Conditions - Line 20	
IV. EXCEPTION MONITORING	CDT/RAU/HW
Limit Changes (AI & DI)	
Out of Limit Error Generation	
N Count Change	
Interlock Time Change	
Reset Conditions	
V. CDT DATA	CDT/RAU/HW
RAU OP/NOP	
Display SID on SPL	
Output Data on Exp't Display	
Non-CDT Displayed Data	
Line 20 Errors	

TABLE 7. (Concluded)

FUNCTIONAL AREA	SUPPORT MODEL
VI. DEP SERVICES	DEP/ECAS
Protocol-Data Solicit/Initialize Link	CDT/RAU
SID OP/NOP - RAU OP/NOP	
SI/SO Channel Traffic	
Request Message	
Transmit Message	
Load DEP	
Line 20 Errors	
VII. DISPLAYS GENERAL	CDT/RAU
General Format - Color	
Call-Up	
Missing Data/CDT/Appended Field	
EXPERIMENT FAULT SUMMARY (EFS)	
System Convention	
ECOS Versus ECAS Pages	ECAS/HW
Special Cases - TLM/TMN	
VIII. TIMELINE SERVICES	
Loading Masters and Subordinates T/L	MMU
Counting MT/L & ST/L	EXP'T
Pending Holds, Conditions for Canceling	DEP
Error Conditions - Line 20	ECAS/DEP
System Contention (Buffers all filled)	
IX. TIMELINE MAINTENANCE	
Display Output	MMU
All Item Entries	
System Contention	
2nd DDS	
POCC/MDM	POCC/MDM
Timeline in Count	
XMON Task	
MDM Buffer	
Line 19 and 20 Messages	
X. TIMELINE MONITOR	
Display Output	
All Item Entries	
System Contention	
2nd DDS	
POCC/MDM	
XTLM Task	
Line 19 and 20 Messages	

TABLE 8. ECOS PAGES

PAGE ID	PAGE NAME
MEM	Memory Page
NBD	NASA Branching Distributor
PLS	Payload Status Page
DPM	
EFS	Experiment Fault Summary
PTC	Payload Thermal Control
TLM	Timeline Maintenance
TMN	Timeline Monitor
EJB	European Junction Box

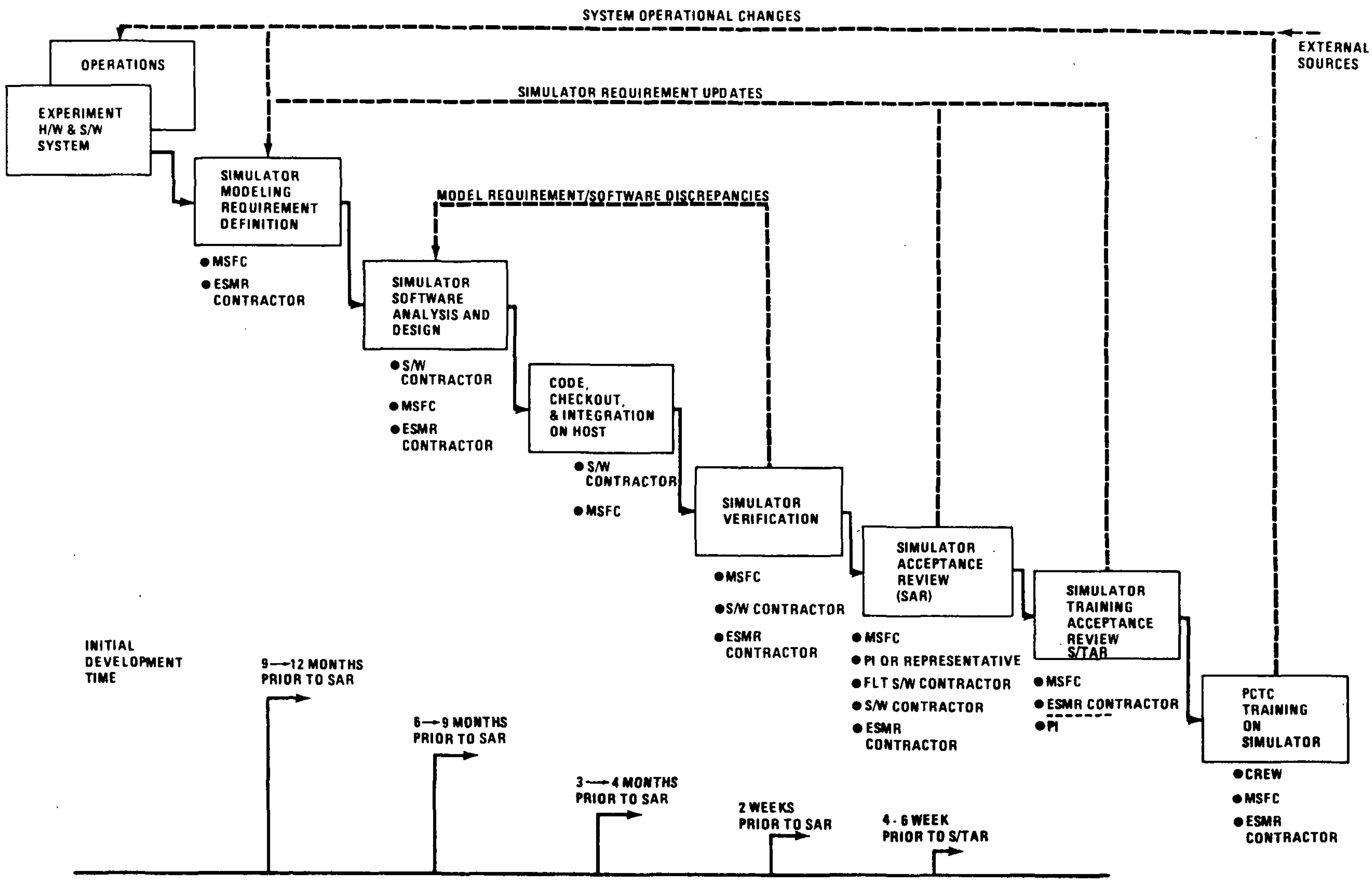

Figure 1. Experiment Simulator Development Life Cycle.

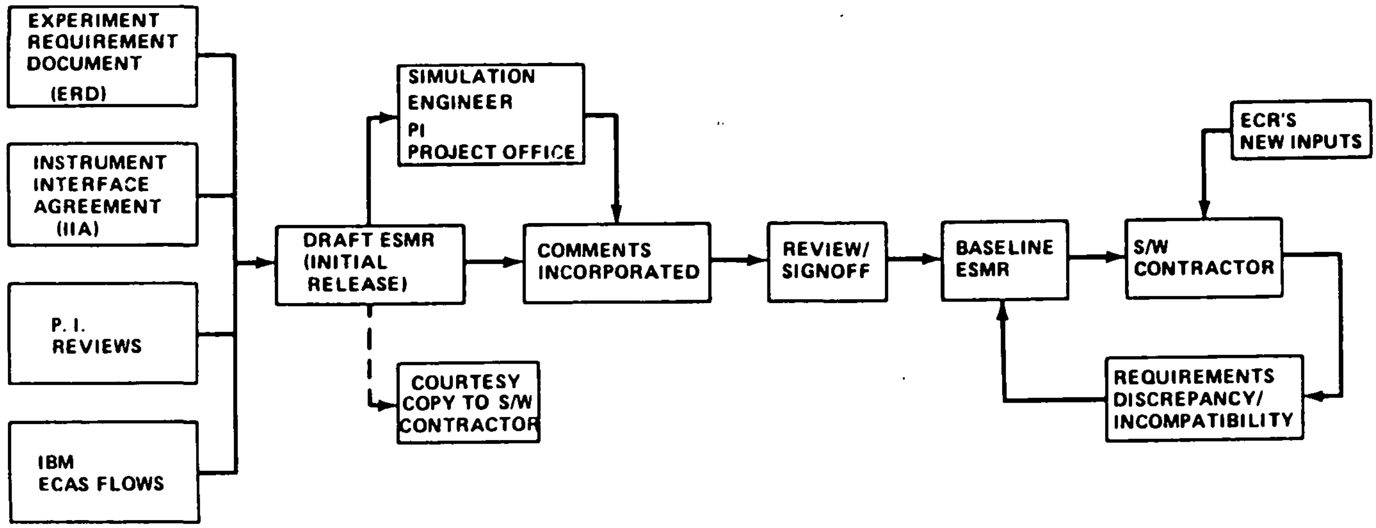

Figure 2. ESMR Development Cycle.

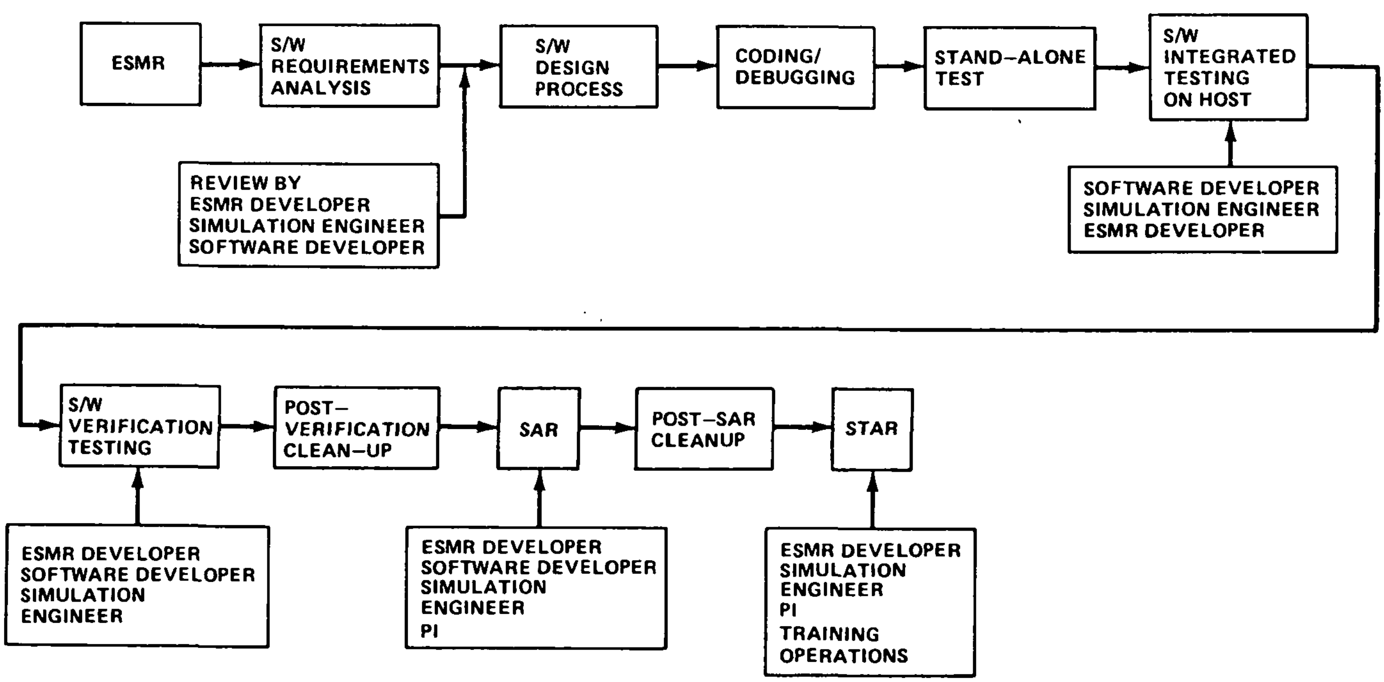

Figure 3. Experiment Simulation HDW/SW Development.

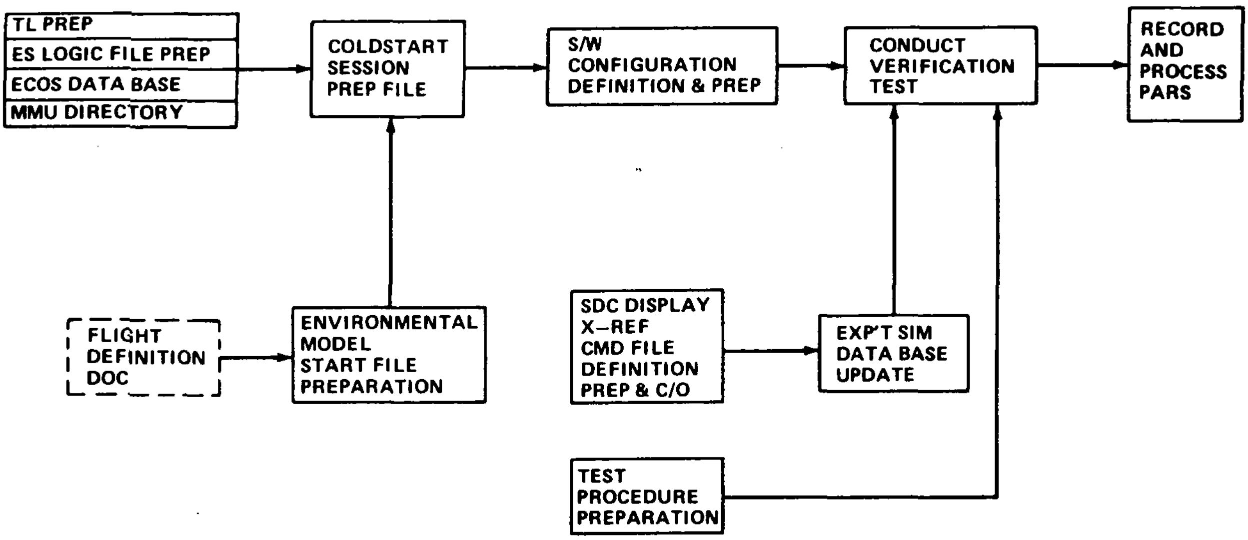

Figure 4. PCTC Verification Test S/W Preparation Tasks.

Figure 5. PCTC SAR S/W Preparation Tasks.

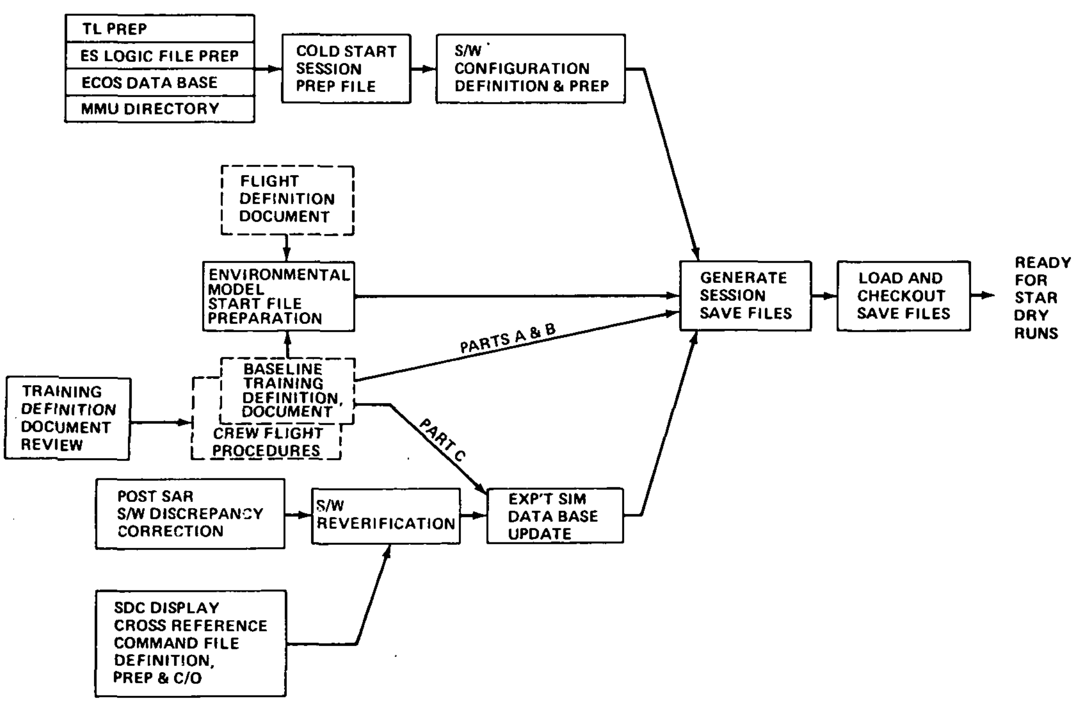

Figure 6. PCTC STAR S/W Preparation Tasks.

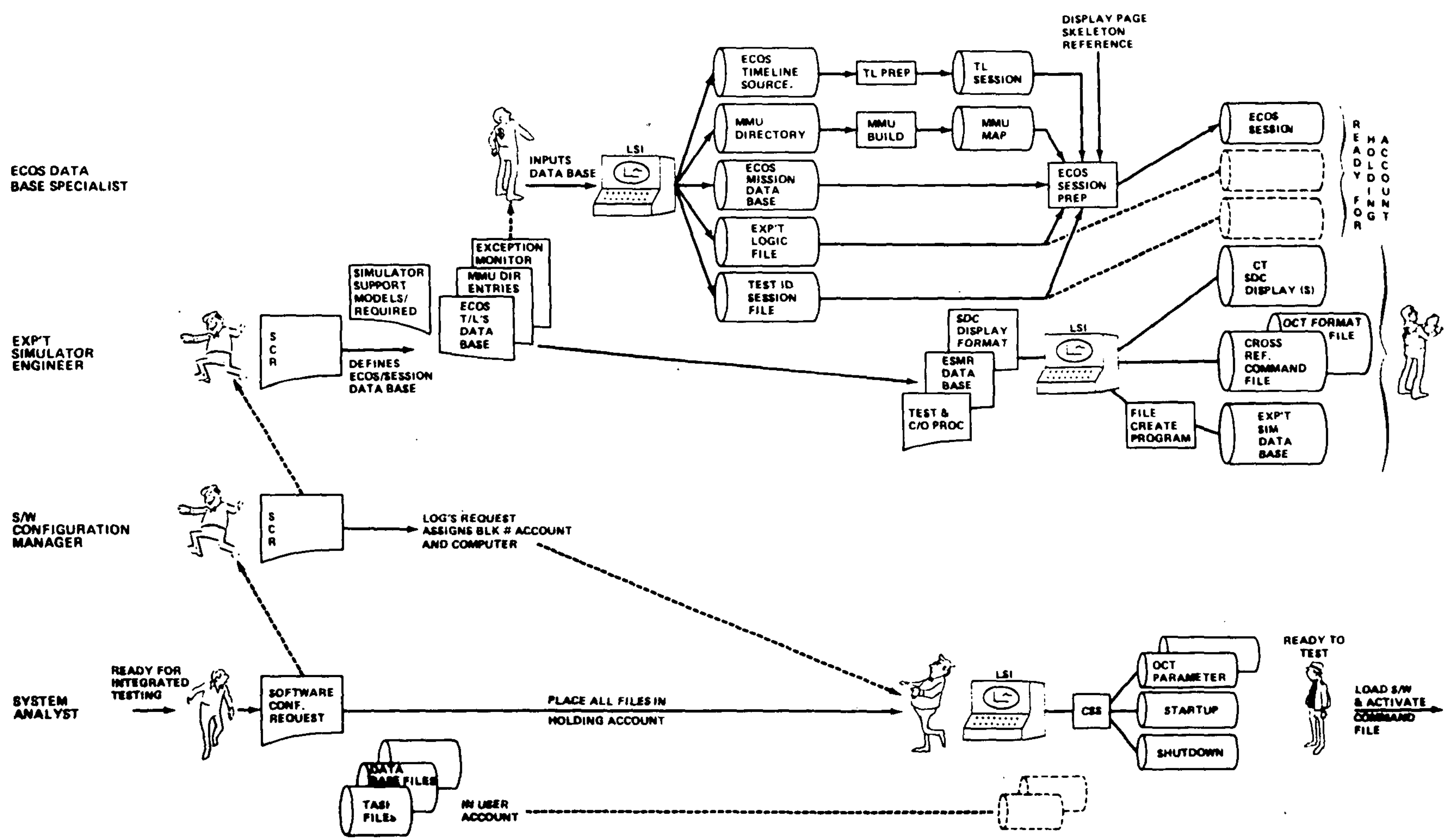

Figure 7. Experiment Simulator Configuration/Build Process for Initial Integrated Verification Test and Acceptance.

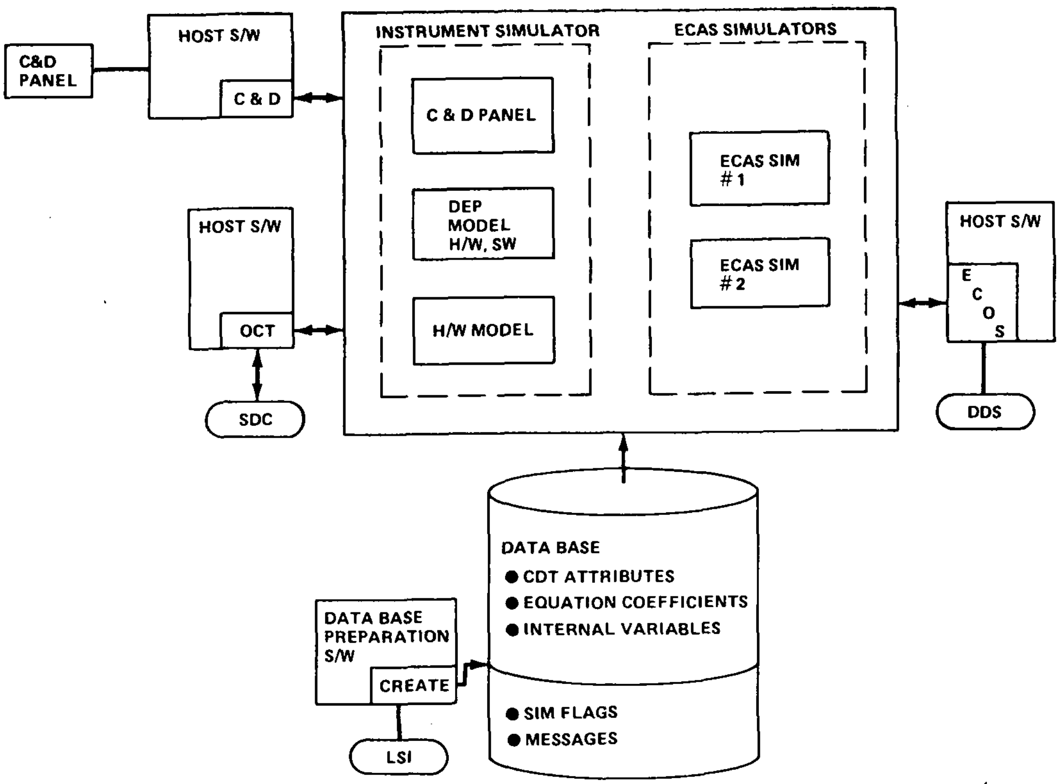

Figure 8. Experiment Simulator.

I. CDT VERIFICATION

A. DO'S	SID	
	PA	– Pulsed Level
B. DI'S	SID	– Allocated
	PA	– Allocated and Maintained (most models)
C. AI'S	SID	– Allocated and updated, Engineering Units
	PA	– Allocated, not maintained dynamically
D. SI, SO'S	SID	– Allocated, not maintained dynamically

II. COMMAND/FEEDBACK RESPONSE

A. INPUTS	CMD KEY–ISS, WRI, Etc.	
	ITEM ENTRY – (ECOS supported)	
	C & D PANEL – Switches	
B. OUTPUTS	SPL	AI, DI
	DISPLAY	AI, DI (ECOS supported)
	C & D – LIGHTS	

C. SDC FLAGS/MALFUNCTIONS/DISPLAY PAGE

III. ECOS FUNCTIONS

A. PAGE (ECOS supported) Evaluation
EXP'T Unique – Layout, GIE
PLS
PTC

B. Exception Monitor – Display Fields, Message Texts, NCOUNT, INTLK Time

C. RAU – OP/NOP, MMU – OP/NOP

IV. ECAS SIMULATION (IF REQUIRED)

A. Memory Management Functions
B. Command Response
C. Messages

V. TIMELINES

VI. OTHER

POCC SIM Terminal

Figure 9. Acceptance Test Procedures (ATP).

PCTC SIMULATOR ACCEPTANCE PROCEDURE

EXPERIMENT SAMPLE	ACCEPTANCE PHASE		DESCRIPTION	PAGE OF
ENGINEER	XID XTESTID	SDC MODE	GMT DT ( ) HOST A B S/W VERSION	DATE

SEQ #	DDS KB INPUT	DDS CMD	COMMAND CONTROL FUNCTIONS/DATA	EXPECTED RESPONSE	CODE	ACTUAL RESPONSE	(COMMENTS) FUNCTIONS AND ACTIVITIES VERIFIED	DR NUMBER
	CX-AR INPUT			SYS HDR LINE DISPLAYED GMT UPDATING	1		This is always a first step of procedure.	
	MSG RESET			MSG CLEARED	20		This is always second step of procedures.	
							CDT VERIFICATION:	
	DISP	3171	E	OFF	SPL		This is to display a variable (DO) by SID.	
	CMD	ISS						
	CMD	ISS	21-DO-0-ON E				This is a cmd using the physical address procedure.	
	CMD	ISS	3171E				This is a cmd using the SID procedure.	
	DISP	3211	E	000 I VOLT 000 000	SPL		This is a cmd to display a variable (AI) by SID.	
	CM						HDR VERIFICATION:	
	DISP	3171	E				Use the same cmds as for CDT verification except turn power on/off ~~and note responses.~~	
	CMD	ISS	3171 E					

CODE KEY: 1–21: LINE NO.
SPL: SCRATCH PAD LINE 1 OR 2
SDC: SIM. DIRECTOR CONSOLE
ADD: ADD ON AREA
XXX: PAGE ID
C & D: CONTROL PANEL
POCC: SIMULATED POCC

Figure 10. Verification Test Procedures.

PCTC SIMULATOR ACCEPTANCE PROCEDURE

EXPERIMENT SAMPLE	ACCEPTANCE PHASE		DESCRIPTION			PAGE OF
ENGINEER	XID XTESTID	SDC MODE	GMT	DT ( )	HOST A B S/W VERSION	DATE

SEQ #	DDS KB INPUT	DDS CMD	COMMAND CONTROL FUNCTIONS/DATA	EXPECTED RESPONSE	CODE	ACTUAL RESPONSE	(COMMENTS) FUNCTIONS AND ACTIVITIES VERIFIED	DR NUMBER
	CX-AR INPUT			SYS HDR LINE DISPLAYED GMT UPDATING	1		This is always a first step of procedure.	
	MSG RESET			MSG CLEARED	20		This is always second step of procedures.	
							CDT VERIFICATION:	
	DISP	3171	E	OFF	SPL		This is to display a variable (DO) by SID.	
	CMD	ISS						
	CMD	ISS	21-DO-0-ON E				This is a cmd using the physical address procedure.	
	CMD	ISS	3171E				This is a cmd using the SID procedure.	
	DISP	3211	E	000 I VOLT 000 000	SPL		This is a cmd to display a variable (AI) by SID.	
	CM						HDR VERIFICATION:	
	DISP	3171	E				Use the same cmds as for CDT verification except turn power on/off and note responses.	
	CMD	ISS	3171 E					

CODE KEY: 1–21: LINE NO.
SPL: SCRATCH PAD LINE 1 OR 2
SDC: SIM, DIRECTOR CONSOLE
ADD: ADD ON AREA

XXX: PAGE ID
C & D: CONTROL PANEL
POCC: SIMULATED POCC

Figure 11. Verification Test Procedures.

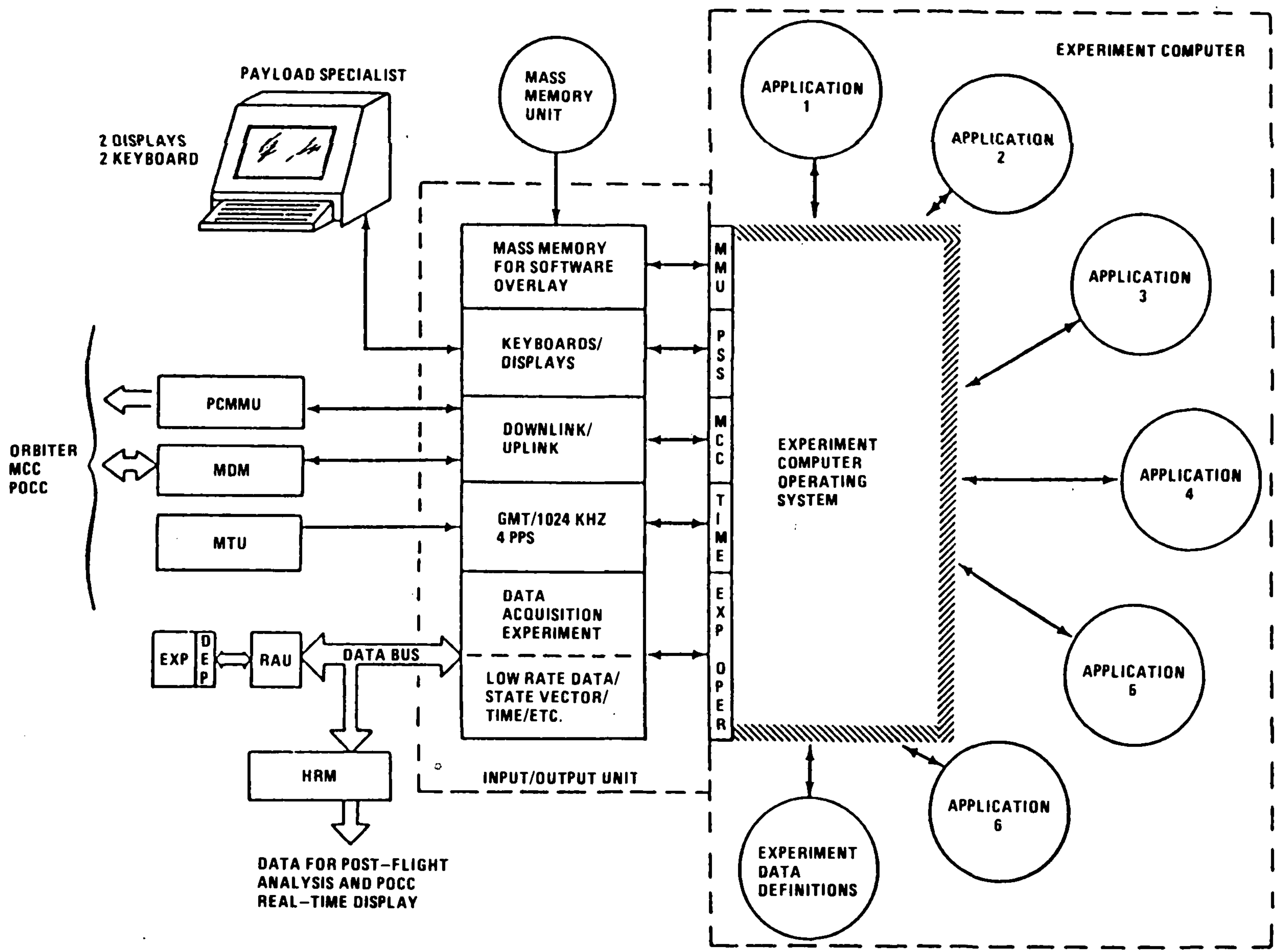

Figure 12. ECOS Interfaces.

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1. Experiment Simulator Modeling Requirements
2. Structured Programming
3. MMU Preparation User's Guide
4. ECOS Timeline Preparation User's Guide
5. ECOS Session Preparation User's Guide
6. SDC Display Preparation User's Guide
7. Display Background Generator User's Guide
8. The Create Program
9. PCTC Environmental User's Guide
10. PAR Process
11. MPE User's Guides
12. Simulation Engineer's Training Manual
13. ECOS Checkout User's Guide - Version 2.2
14. Operation Control Task - Version 2.0
15. PCTC ECOS Data Base Training Course
16. SIM Director's Console User's Guide
17. PCTC/ECOS S/W Design Document
18. ECIO Support Operations Manual for VAX and PDP
19. PS Training Host Simulator Design, Rev. C 8/80
20. PRB Debug Documentation
21. STAT Processing Prog Documentation, Rev. 1 9/81
22. PCTC Image Generation System 6/81
23. VT100 Band Rate Adjust
24. ECOS Offline Session Prep User's Guide
25. PCTC Host Simulator Design, Rev. C 7/81

26. PCTC Checkout Program User's Guide

27. PCTC C&D/Computer Interface Generic Test Model User's Guide

28. Software Configuration Management System

APPROVAL

PAYLOAD CREW TRAINING COMPLEX SIMULATION ENGINEER'S HANDBOOK

By Dr. David L. Shipman

The information in this report has been reviewed for technical content. Review of any information concerning Department of Defense or nuclear energy activities or programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

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