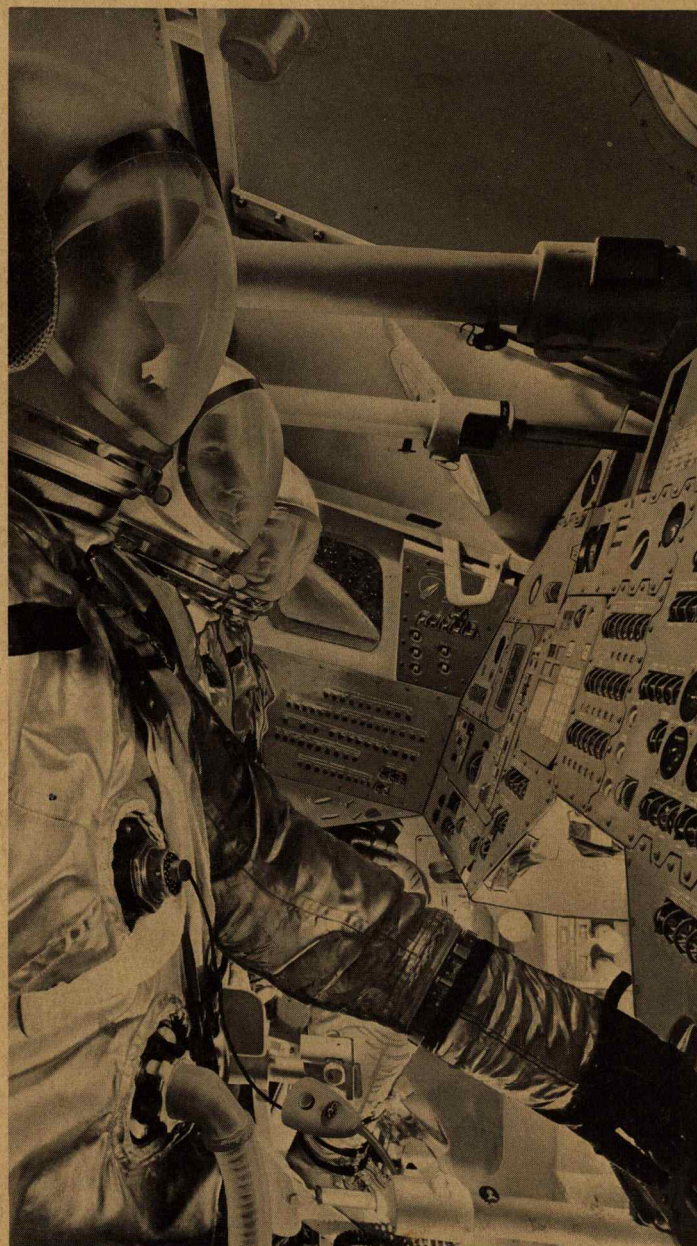


Preliminary

APOLLO MISSION SIMULATOR INSTRUCTOR HANDBOOK

VOLUME II — OPERATION &
UTILIZATION



Prepared by:

APOLLO SITE ACTIVATION AND LOGISTICS



NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

SM-6T-2-02

PRELIMINARY

APOLLO MISSION SIMULATOR

INSTRUCTOR HANDBOOK

(INITIAL DELIVERED CONFIGURATION)

VOLUME II: OPERATION AND UTILIZATION

Contract NAS9-150
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Prepared by North American Aviation, Inc.
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DESCRIPTIVE TERMS: Consists of three volumes, this being Volume 2. This volume is comprised of three sections. Section one provides operating instruction for the Apollo Mission Simulator including instructions for Simulator Equipment Operation, Simulator Systems Checklists, and Simulator Complex Checklists. Section two describes Simulator Computer Programs including Vehicle Programs, Vehicle System Programs, Simulator Effects Programs, and Simulator Control Programs. The third section explains training applications of the simulator and instructor handbook and describes the Flight Crew Training Syllabus (for AMS), Types of Flight Crew Training, Part Task Training, Mission Task Training, Typical Mission Training, and Specific Mission Training.

ABSTRACT

This handbook is Volume 2 of a preliminary edition of the Apollo Mission Simulator Instructor Handbook to be used by NASA instructors in operating the simulator for training purposes. This volume provides instructor oriented procedures for using the simulator (and the AMS Instructor Handbook) in accomplishing flight crew training with the simulator.

APOLLO MISSION SIMULATOR INSTRUCTOR HANDBOOK

FOREWORD

Paragraph 10.10 of Exhibit I to Contract NAS9-150 specifies that NAA will provide training procedures and handbooks for the NASA-conducted training associated with training equipment provided by NAA. This book is Volume II of a three-volume Instructor Handbook for the initial delivered configuration of the Apollo Mission Simulator in compliance with the exhibit. Compatibility of contents with the simulator equipment is to be accomplished by hardware verification during acceptance demonstration at the subcontractor's facility. Prior to such verification, the accuracy and validity of the handbook contents are unconfirmed. Under these circumstances, it must be understood that where the AMS is not as described, and/or will not provide the simulation required by the handbook contents, the handbook is to be adjudged in error. Under no circumstances shall any of the handbook contents be interpreted as design requirements data.

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VOLUME II

INTRODUCTION

The purpose of this handbook is to provide detailed instructions for using the Apollo Mission Simulator (AMS) to train flight crew personnel. The handbook is comprised of three volumes. Volume I (Description) describes the AMS and the systems and missions simulated. This volume (Volume II - Operation and Utilization) provides instructions for operating the simulator, instructor data on computer programs, and a recommended syllabus of training sessions for accomplishing training sessions with the AMS. Volume III (Scripting Materials) contains the material for making up a complete instructor-operator data package for each training session in the syllabus. Volume III is loose-leaf bound to permit removal of materials for copying.

Volume II is divided into three sections. Section 1 (AMS Operation) provides the instructor-operator with the simulator operating procedures required to accomplish the training sessions outlined in the syllabus provided in section 3. Wherever possible, procedures are presented in checklist form.

Section 2 (Program Data) provides the instructor-operator with the computer program data required to effectively operate the simulator. Contents describes the simulation characteristics and purposes of the various operational programs, and describes those prepared magnetic tapes and punch card decks that are used to accomplish or modify operational programs.

Section 3 (AMS Utilization) describes the recommended syllabus of training and provides instructions on how the Apollo Operations Handbook (SM2A-03, 1 July 1965) is used to fly the nominal training mission.

APOLLO MISSION SIMULATOR INSTRUCTOR HANDBOOK

SECTION 1

AMS OPERATION

1.1 PURPOSE AND SCOPE.

It is the purpose of this section of the Apollo Mission Simulator Instructor Handbook to provide the instructor-operator with those simulator operating procedures required to accomplish the training sessions in the syllabus in section 3. Instructions will include descriptive text, step-by-step procedures, illustrations, and tables, as needed, to explain required instructor-operator activity. When simulator peculiar variables exist, appropriate tabular and/or graphic data covering the range of such variables is included. When simulator variables are identified in spacecraft quantities, the manner of transposing such spacecraft data into the simulator is described.

NOTE

At the time this preliminary edition of Volume II goes to press, much of the data required to prepare the tables mentioned above is unavailable. Those additional tables for which data becomes available before Volume III is published will be provided as appendices to Volume III.

Three types of procedural information are provided. The first of these is text and figures as required to explain how specific tasks are performed on individual equipment units. The second type of procedure is systems checklists. These checklists are step-by-step outlines for the preparation, use, and shut-down of each simulator system. The third type of procedure is simulator complex checklists. These checklists are integrated composites of the unit procedures and system checklists, and are used to prepare, use, and shut down the trainer complex.

Table 1-1 identifies all of the procedures and checklists included in this section of this manual. The table illustrates the relationship between the unit procedures and the system checklists, and identifies the procedures-checklists of which each complex checklist is comprised.

1.2 EQUIPMENT OPERATION.

This portion of the operations section provides text, figures, and tables to explain the operation of individual equipment units of the AMS. However, many of these units do not require explanation above and beyond the description provided in section 1 of Volume I, the computer program section of this volume, and/or tabular data provided in Volume III. These items will not be supported with written operating instructions at the unit level. Their step-by-step operation will be identified in outline form, however, as it occurs in the system and complex checklists.

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Table 1-1. AMS Operating Procedure and Checklist Summary

Unit Procedure	System Checklist	Simulator Complex Checklists							
		1. 4. 1 Mission Simulation Prep/Op	1. 4. 2 Launch Simulation Prep/Op	1. 4. 2. 2 Abort Simulation Prep/Op	1. 4. 3 Orbital Simulation Prep/Op	1. 4. 4 Entry Simulation Prep/Op	1. 4. 5 Simulation Complete		
Visual Display System		X			X				
1. 2. 1	Film Cassette Loading								
Simulated Command Module		X			X				
1. 2. 2	Check-Fill Potable Water Tank								
1. 2. 3	Check-Empty Waste Stor- age System								
1. 2. 4	Vertical Insertion and Retraction								
Computer Complex		X	X	X	X	X			
1. 2. 5	1. 3. 1							Computer Readiness for Loading	
	1. 3. 2							Magnetic Tape Program Loading	
	1. 3. 3							Card Reader Program Loading	
	1. 2. 8							Typewriter Operation	
								1. 3. 4	Typewriter Program Loading
								1. 3. 5	Manual Program Loading
	1. 3. 6							Securing Computer Complex	
X Simulator System Required ☒ Unit Procedure Optional									

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Table 1-1. AMS Operating Procedure and Checklist Summary (Cont)

Unit Procedure	System Checklist	Simulator Complex Checklists					
		1. 4. 1 Mission Simulation Prep/Op	1. 4. 2 Launch Simulation Prep/Op	1. 4. 2. 2 Abort Simulation Prep/Op	1. 4. 3 Orbital Simulation Prep/Op	1. 4. 4 Entry Simulation Prep/Op	1. 4. 5 Simulation Complete
X-Y Plotter (30 X 30)		☒	☒	☒	☒	☒	
	1. 3. 7 Plotter Readiness and Setup (X-Y, 30 X 30)						
X-Y Plotter (11 X 17)		☒	☒	☒	☒	☒	
	1. 3. 8 Plotter Readiness and Setup (X-Y, 11 X 17)						
X-T Recorders		☒	☒	☒	☒	☒	
	1. 3. 9 Recorder Readiness and Setup (X-T)						
Telemetry Console		☒	☒	☒	☒	☒	X*
1. 2. 9 TM Console Fault Patching							
	1. 3. 11 TM Console Readiness and Setup						
	1. 3. 12 Securing the TM Console						
Instructor-Operator Station		X	X	X	X	X	
1. 2. 10 Communica- tions Control System Operation	1. 3. 13 Computer and Simulator Status						
	1. 3. 10 Communica- tion Control Setup						
X Simulator System Required ☒ Unit Procedure Optional * System Checklist if Used							

...continued

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Table 1-1. AMS Operating Procedure and Checklist Summary (Cont)

Unit Procedure	System Checklist	Simulator Complex Checklists					
		1.4.1 Mission Simulation Prep/Op	1.4.2 Launch Simulation Prep/Op	1.4.2.2 Abort Simulation Prep/Op	1.4.3 Orbital Simulation Prep/Op	1.4.4 Entry Simulation Prep/Op	1.4.5 Simulation Complete
1.2.11 True Trainee Environment Operation	1.3.14 Closed Circuit TV Setup	☒	☒	☒	☒	☒	
	1.3.15 Recorder and Plotter Status	☒	☒	☒	☒	☒	
	1.3.10 Voice Interference Operation	☒			☒	☒	X*
	1.3.16 True Trainee Environment and Waste Management Status	X	X	X	X	X	X
	1.3.17 G&N and Visuals Readiness	X			X		X
1.2.12 Up-Data Link Operation	1.3.18 Malfunction Insertion and Status	☒	☒	X	☒	☒	
	1.3.19 Up-Data Link Status	X	☒		X	☒	
	1.3.20 Time Sync and Initialization	X	X	X	X	X	
	1.3.21 Secure True Trainee Environment System						X
	1.3.22 Secure Recorders and Plotters Panel						X*
	1.3.23 Secure G&N and Visual System						X
X Simulator System Required ☒ Unit Procedure Optional * System Checklist if Used							

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1.2.1 FILM CASSETTE LOADING.

Insertion of the proper film cassette(s), as determined by the desired mission training exercise, is required prior to each exercise. The instructor selects the desired film cassettes for each of the two turrets in each MEP. Table 1-2 contains a list of each cassette available with the initial delivered configuration of the AMS and its normal assigned turret location. The desired film cassettes are obtained from the maintenance storage area. Power must be removed from the related MEP and optical assembly before installing or removing cassettes.

Visual power to the window and G&N optics is removed by operating push-button switches located in visual peripheral cabinet 61. Their operation is indicated by backlighting at the power cabinet and by the indicators located on IOS panel 1, visual systems status. The MAINTENANCE IN PROGRESS and VISUAL SYSTEM lights on IOS panel 47, simulator status, will also be illuminated as a result of the operation of the POWER OFF switches in cabinet 61.

The maintenance doors located at the top and bottom of each MEP afford access to the two turrets. Fork trucks or ladders are required to reach the maintenance doors. Precautionary safety measures must be taken with the simulated telescope MEP because of the extreme height involved. The film cassette can only be installed or removed when it is positioned beneath the loading and adjustment opening. Figure 1-1 illustrates a typical turret assembly. If the desired cassette to be removed is not in this location or if this location is not the desired location for the cassette to be installed, the turret must be indexed manually (that is, the turret must be manually rotated until the desired film cassette is beneath the opening). The instructor must then return to cabinet 61, re-establish power for this particular optical assembly, and place the optical assembly on manual control at its associated peripheral cabinet. (Refer to table 1-1, section 1 of Volume I.) By operating the turret index drive servos, the desired cassette or space may be positioned beneath the loading and adjustment opening by manual control. The old cassette may now be removed by sliding it towards the opening. A new cassette is installed by placing the cassette into the guides in front of the viewing surface and sliding it in until latched in place (figure 1-1). The turret access door is then replaced, the optical assembly is placed under computer control at its peripheral cabinet, and power is restored at the main power control panel, cabinet 61. Upon completion of removal or installation of all cassettes in the manner described above, the instructor returns to the IOS and verifies that the status indicators on IOS panels 1 and 47 are extinguished and all optical assemblies are under computer control.

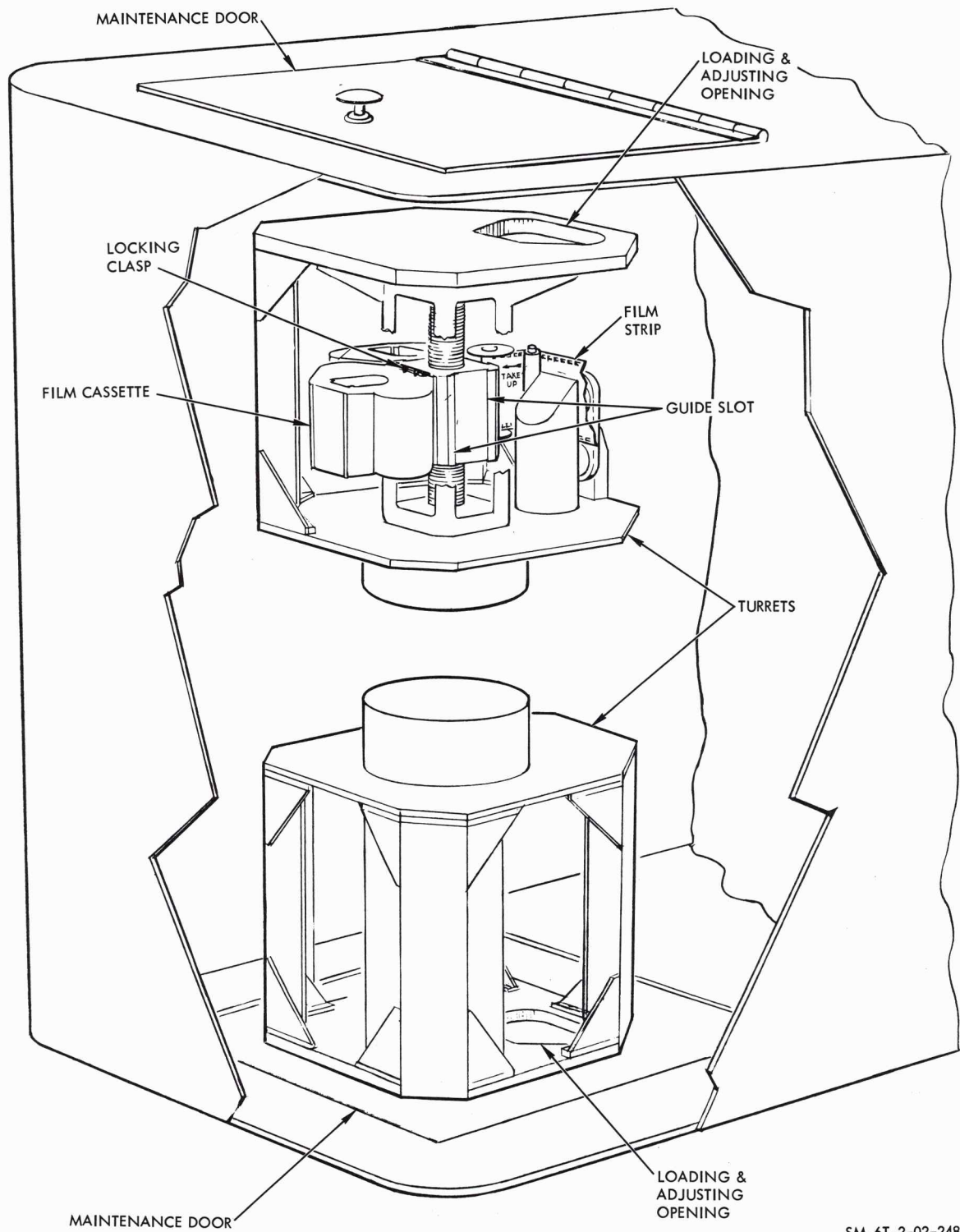
1.2.2 CHECK AND FILL POTABLE WATER TANK.

Prior to each exercise that is expected to embrace mission proportions, the instructor is required to ascertain that there is sufficient potable water within the simulated spacecraft. In the AMS, potable water is supplied to simulate the actual spacecraft waste and potable water system and provide life systems support. The water is required for drinking and food reconstitution.

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Table 1-2. AMS Film Cassettes

Turret No. 1	Turret No. 2	Altitudes	Film Presentation
Cassette 1a		Earth 100 to 215	Coverage: 1000 n mi, Scale: 8.7 n mi/MM. Constant scale rectilinear grid
Additional Capabilities Beyond IDC			
Cassette 1a	Cassette (TBD)	Earth 100 to 1000	Variscale 8.7-40.7 n mi/MM. Rectilinear grid. Coverage: 1000 to 3750 n mi
		Earth 215 to 464	Constant scale rectilinear grid. Coverage: 2150 n mi, Scale: 18.9 n mi/MM
Cassette (TBD)		Earth 464 to 1000	Constant scale rectilinear grid. Coverage: 4640 n mi, Scale: 40.7 n mi/MM
	Cassette 2b	Trajectory from 1400 n mi above earth to 383 n mi above moon	Variscale spherical view of earth and moon
Cassette 2b		Trajectory from 1000 to 1400 n mi above earth	Constant scale frame view of earth with 5 MM area of solid cloud surrounding the earth scene
Cassette 1b		Trajectory from 1400 n mi above earth to 383 n mi above moon	Variscale spherical view of moon and earth
	Cassette (TBD)	Moon 273 to 126	Constant scale rectilinear grid. Coverage: 1270 n mi, Scale: 11.2 n mi/MM
Cassette 2a		Moon 126 to 58	Constant scale rectilinear grid. Coverage: 590 n mi, Scale: 5.23 n mi/MM
		Moon 58 to 27	Constant scale rectilinear grid. Coverage: 273 n mi, Scale: 2.4 n mi/MM



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Figure 1-1. MEP Film Cassette Location

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A 42-gallon tank located beneath the SCM contains the reservoir for the potable water system. This quantity is sufficient for missions of the longest expected duration with proper water system management. Attached to the tank (figure 1-2) is a level gage that provides an indication of the quantity of water within the tank. (The water tank is pressurized to approximately 20 psig. The air supply is closed at the regulator valve and actuate relief valve to reduce pressure within the tank to facilitate filling.) By attaching a standard flexible hose to the fill and drain quick-disconnect valve and attaching the hose to any water connection supplied by the facility, the instructor can fill the tank to the desired level by observing the level gage. At the completion of training, the tank is drained by hose connection from the fill and drain quick-disconnect valve to the building plumbing facilities. Draining is required to prevent stagnation and assure trainees with a fresh water supply for each mission.

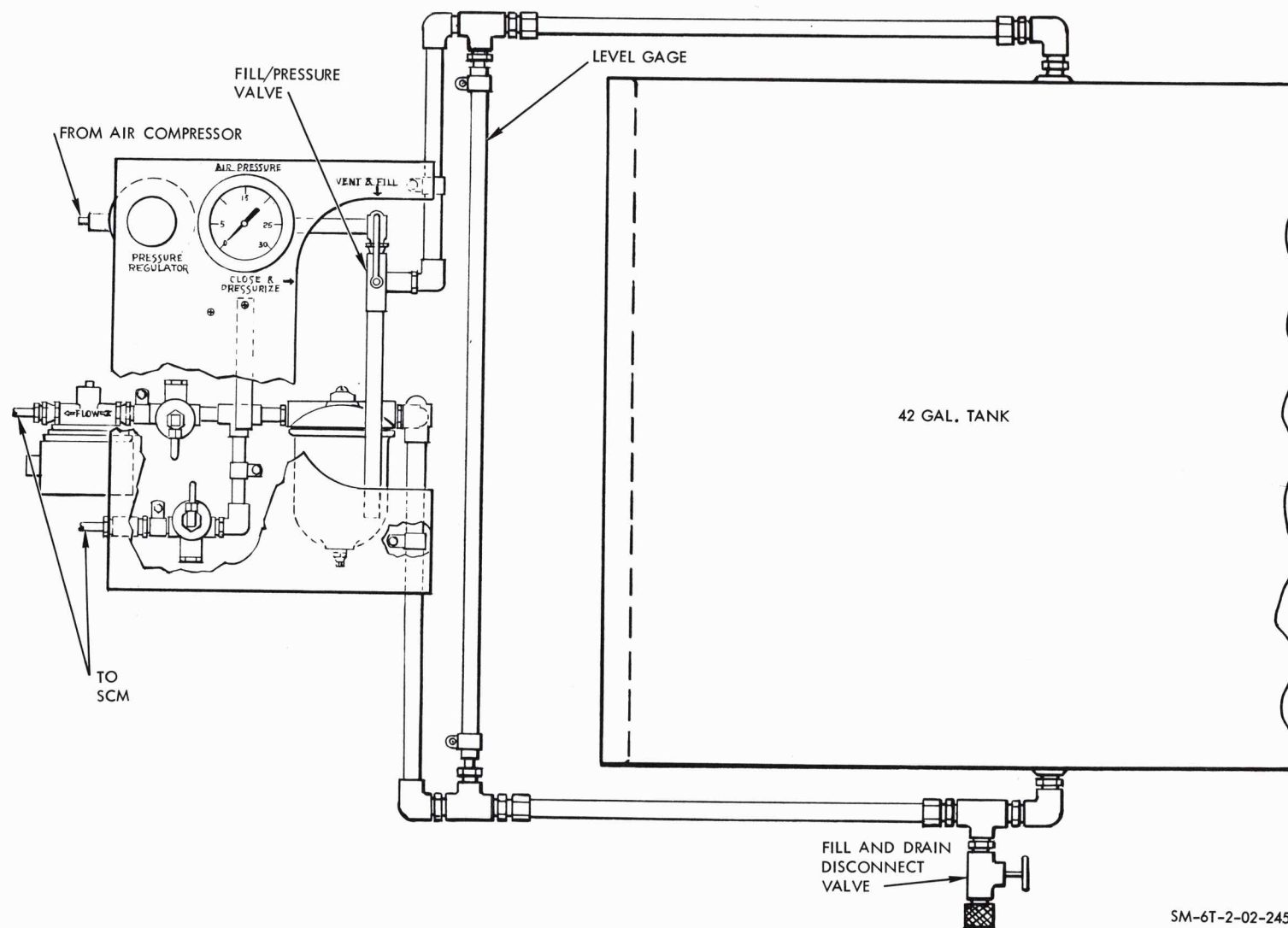
After the tank has been filled, the pressure relief valve must be closed before pressure is supplied to the system. The pressure regulator is adjusted until the pressure gage indicates 20 psig. The instructor must then operate the potable and waste water valves within the SCM to bleed any air that may have accumulated in the lines between the tank and valves until a smooth even flow of water, without cavitation, results.

1.2.3 CHECK AND EMPTY WASTE STORAGE SYSTEM.

During extended training exercises, the instructor may be required to eliminate waste material accumulated by the AMS waste management system. Liquid waste material accumulates in the main storage tank located in the support base beneath the access hatch. Bulk material is stored in the portion of the waste storage compartment in the SCM which extends below to the support base. This compartment is beneath the lower right-hand equipment bay. After removal, proper disposal is to be ensured by the instructor. Figure 1-3 illustrates component locations.

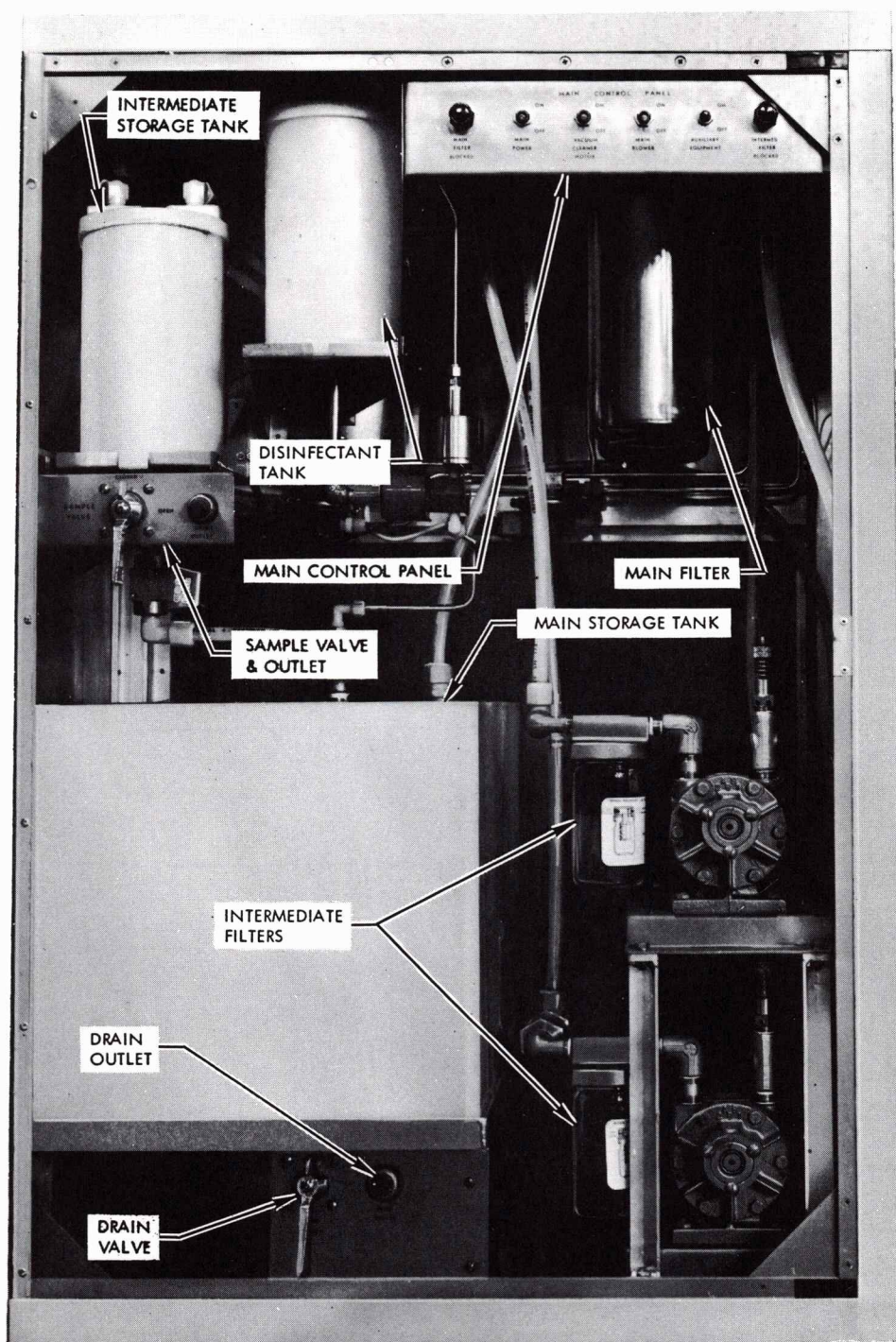
Urine samples can be taken from a two-quart intermediate translucent polyethylene tank through a drain line controlled by a sample valve and/or the urine may be drained into the main storage tank. The main storage tank is also translucent polyethylene with a 15-gallon capacity. Levels of both containers can be viewed through windows on the door of the waste management support assembly.

The main storage tank contains a plug valve and a drain line for drainage purposes. A flexible hose and hose adapter is inserted into the drain outlet connection so that urine will drain into a portable container used for disposal. Rotation of the drain valve 90 degrees counterclockwise will open and drain the tank.



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Figure 1-2. Potable Water System Component Location



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Figure 1-3. Waste Management Component Location

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A disinfectant (two-quart) storage tank of translucent polyethylene is used to hold disinfectant that is combined with the urine in the main storage tank. The tank is filled by either removing the top panel of the assembly by rotating four quick-release fasteners and removing the plug from the top of the tank or by inserting a soft flexible tube around the tank, up the rear side, and into the filling port at the top of the tank.

The following procedure enables proper waste management shutdown after usage. The control panel for the system is also illustrated in figure 1-3.

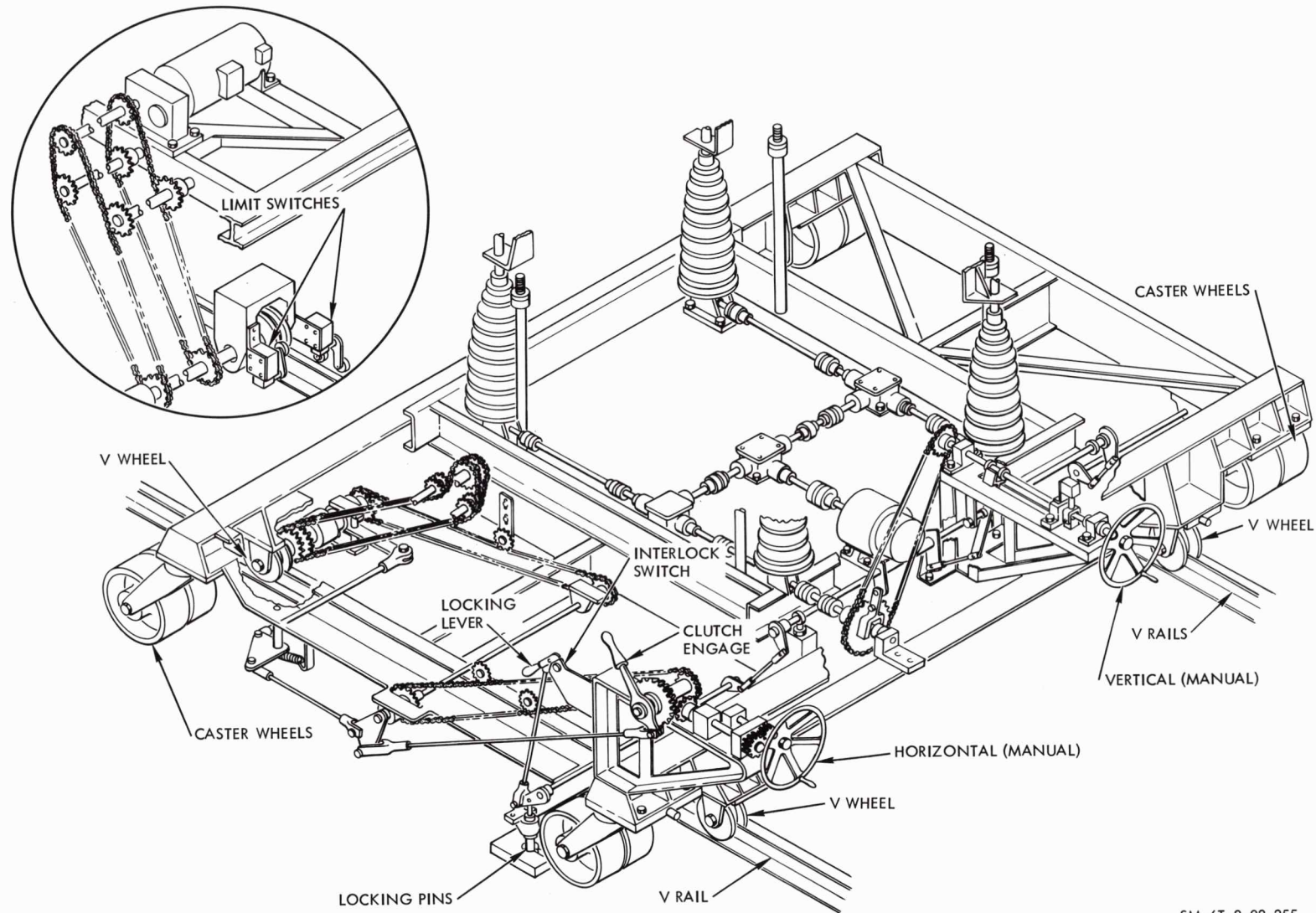
- a. Place VACUUM CLEANER MOTOR and MAIN BLOWER switch-breakers to OFF.
- b. Place SCM URINE DUMP switches (two) to DUMP.
- c. Attach flexible hose to drain outlet quick-disconnect valve and drain into portable container.
- d. Place SCM URINE DUMP switches (two) to OFF.
- e. Set MAIN BLOWER switch-breaker to ON.
- f. Fill urinal in SCM with one quart of disinfectant.
- g. Place SCM URINE DUMP switches (two) to DUMP.
- h. Place MAIN BLOWER switch-breaker to OFF.
- i. Drain disinfectant tank by alternately opening and closing SCM URINE DUMP switches every 20 seconds until tank is empty.
- j. Repeat step c.

1.2.4 VERTICAL INSERTION AND RETRACTION.

The SCM is capable of motion in the horizontal and vertical direction. Horizontal movement is on one of two sets of wheels: four, ten-inch double-caster wheels or four, six-inch diameter V-grooved wheels. The caster wheels facilitate unlimited motion of the SCM. The grooved wheels provide powered motion on raised guide rails. The rails allow accurate positioning of the SCM within the visual equipment.

The end of the track most distant from the visual equipment is inclined to allow the castered wheels to be lifted clear of the floor when the grooved drive wheels climb the incline. Forward motion on the rails is now provided by the motor-driven grooved wheels at a preset speed until a limit switch, located at a predetermined position, is actuated. This limit switch energizes the motor deaccelerator, slowing the SCM to zero speed within a prescribed distance. Fixed stops with limit switches affixed to each stop are located on the end of the tracks for additional safety features.

Figure 1-4 illustrates the locations of the rails, limit switches, stops, and controls required to drive the SCM horizontally. In addition to the power controls, hand cranks (as illustrated in the figure) are provided to manually position the SCM along the angle rails.



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Figure 1-4. Vertical and Horizontal Insertion Mechanism

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At the completion of horizontal motion, the locking lever is installed on the support base to prevent undesirable movement. This lever also drops two locating pins into striker plates mounted on the track base. The pins actuate limit switches which de-energize the horizontal drive circuits and energize the vertical drive circuits. Figure 1-5 illustrates controls used by the instructor during horizontal and vertical insertion. Vertical motion can either be motor driven or manually powered through a hand crank. Limit switches and stops are provided to stop vertical motion. Pressure strip switches are mounted around the top of the SCM and about the periphery of the support base. Pressure on this safety strip will stop powered SCM vertical motion to prevent equipment or personal injury caused by objects between the movable SCM and the stationary tunnel structure above and the skirt frame below.

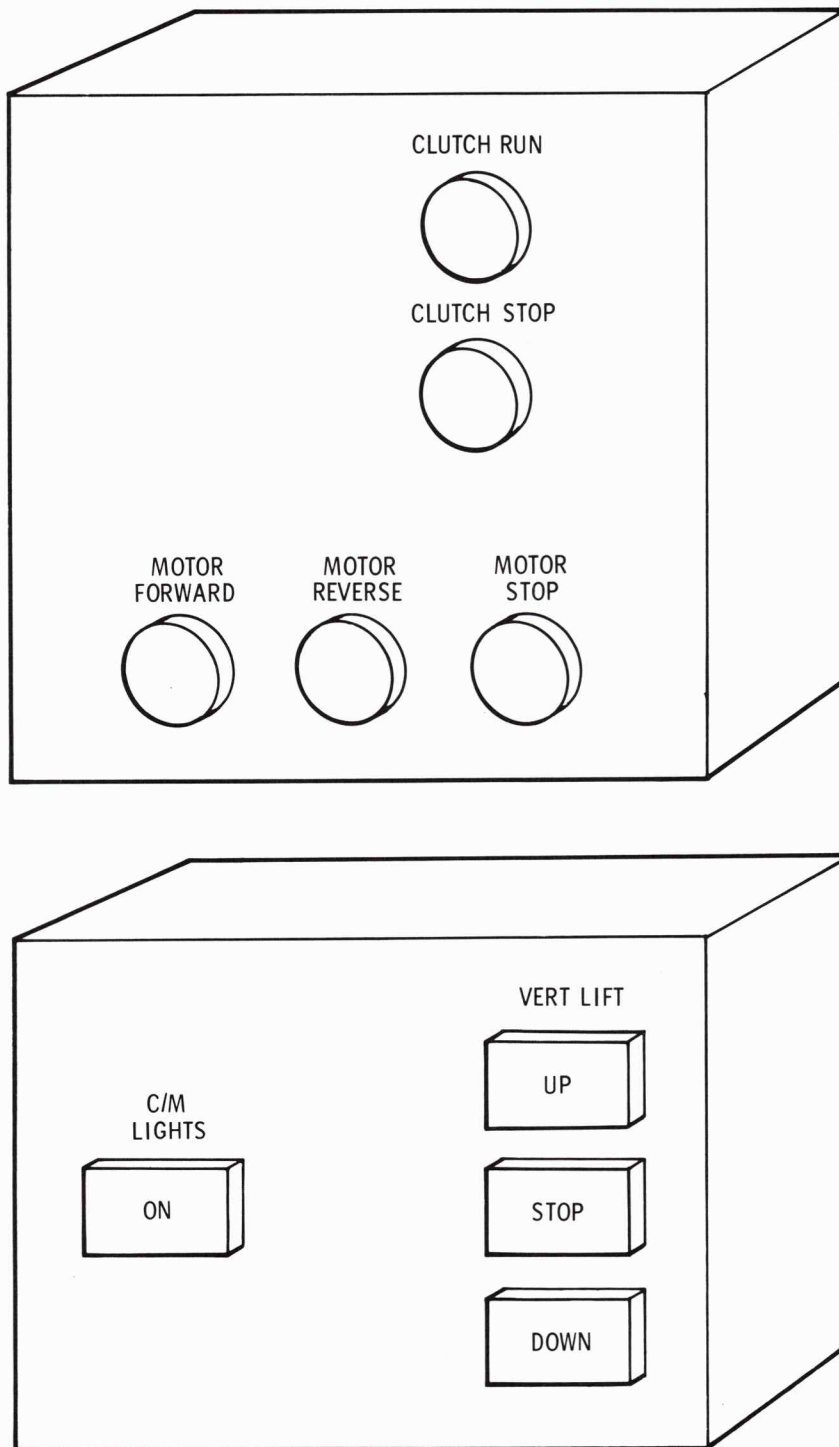
1.2.5 LOAD-UNLOAD MAGNETIC TAPE UNITS.

The magnetic tape units (MTU) are used in the AMS system as input-output devices for the computers. A complete list of the programs available is provided in section 2 of this volume of the handbook. Each unit is connected to the computers through a direct memory access channel, a word-forming buffer, and interface logic. Magnetic tape data is used to load the memory for the master program. Boost data and ephemeris information is also stored on magnetic tape for loading under executive control or boost program control.

1.2.5.1 Tape Spool Installation.

To manually load tape spools on the MTU, the instructor selects the desired spool from the library file and an empty takeup reel. The type of spool to be used (that is, read or read-write) must be established before installing tape spools in the MTU. Figure 1-6 illustrates those components essential to proper installation of tape spools on the MTU. The following step procedure is to be used for reel mounting:

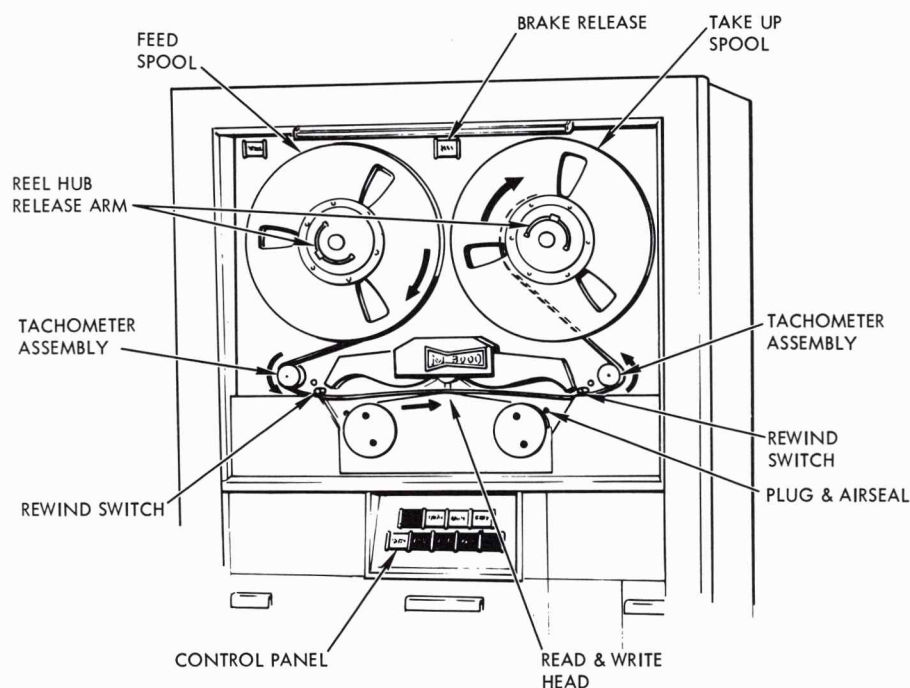
- a. Slide glass front door down to gain access to reel turntables.
- b. Depress POWER ON switch at MTU control panel to apply power to unit.
- c. Lift reel hub release arm on left turntable.
- d. Place tape spool on hub. If tape is to be used for writing, ascertain that write ring on spool is away from instructor when spool is mounted on turntable hub.
- e. Lower reel hub release arm to secure spool on turntable.
- f. Place empty takeup spool on right turntable in same manner.
- g. Depress BRAKE RELEASE switch-light located between turntables.
- h. Manually pull approximately six feet of tape off spool in clockwise direction.



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Figure 1-5. Vertical and Horizontal Insertion Controls

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Figure 1-6. MTU Tape Loading Deck

- i. Position tape around left tachometer assembly and under left rewind switch arm.
- j. Place tape over digital write and read head.
- k. Position tape past head assembly, under right rewind switch arm, over and around right tachometer assembly.
- l. Depress BRAKE RELEASE switch-light to release turntable.
- m. Wind tape manually on takeup spool to secure tape until LOAD POINT silver marker appears past right plug and air seal assembly.
- n. Release BRAKE RELEASE switch-light.
- o. Lift and close sliding glass front door.
- p. Depress LOAD-REWIND switch on control panel and observe tape feed into both columns and stop at beginning of tape.
- q. Observe that STOP light on manual control panel illuminates.
- r. Depress REMOTE switch on control panel to transfer control of MTU to computer.

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1.2.5.2 Computer Loading by MTU.

To input program data into the computer memory from the MTU requires the use of a special program previously loaded into the computer via the paper tape reader. This monitor program enables the MTU to input programs or program data into memory under control of the typewriter. The procedure for this operation is as follows:

- a. Select either HI or LO DENSITY mode at MTU control panel as specified on spool canister.
- b. Verify that monitor program has been inserted into computer and that computer is in halt condition.
- c. Depress MASTER CLEAR pushbutton at computer control panel.
- d. Manually set starting address of monitor program into computer panel PROGRAM REGISTER.
- e. Depress START pushbutton at computer control panel.
- f. Observe typewriter unlock and that word SELECT is typed out.
- g. Verify computer is in input-output hold condition.
- h. Select mnemonic code of desired operational program on tape to be loaded by typing this code on typewriter.
- i. Depress typewriter CARRIAGE RETURN to transfer data from tape.
- j. Observe that word READY is typed out on typewriter and that computer is in halt condition.
- k. Depress MASTER CLEAR pushbutton at computer control panel.
- l. Select additional program data transfer by repeating procedures from step d.

1.2.5.3 Tape Spool Removal.

To manually remove the tape spools from the MTU after data transfer is complete, the following procedure is used.

- a. Depress LOCAL switch at MTU control panel.
- b. Depress LOAD-REWIND switch and observe tape rewind to beginning of tape and stop.
- c. Lower sliding glass front door.
- d. Depress and hold BRAKE RELEASE switch-light between two turntables.
- e. Manually wind left tape spool counterclockwise until all tape is on spool.
- f. Release BRAKE RELEASE switch-light.
- g. Lower reel hub release arm on left turntable.
- h. Remove tape spool, place in canister, and store.

1.2.6 LOAD-UNLOAD CARD READER.

The card reader, which is physically and functionally described in section 1 of Volume I, will be used by the instructor in presimulation operation. It may also be utilized for program variations during extended freeze periods of AMS operation. The procedure listed is applicable in both cases and also include operational readiness checks of the card reader.

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1.2.6.1 Loading Punch Card Data.

To load the punch card data, proceed with the following steps:

- a. Depress POWER ON switch and observe that NOT READY light illuminates.
- b. Depress VALIDITY ON switch and observe that switch illuminates.
- c. Place card deck in read hopper, face down, column one first.
- d. At card reader manual control panel, lift cover on lower panel to gain access to LOCAL-RUN switch.
- e. Place LOCAL-RUN switch to LOCAL.
- f. Observe card feed from hopper through read heads to stacker until hopper is emptied.
- g. Note that FEED CHECK light illuminates.
- h. Remove cards from stacker.
- i. Place LOCAL-RUN switch to RUN.
- j. Close cover over LOCAL-RUN switch.
- k. Depress RESET switch and observe that FEED CHECK light extinguishes.
- l. Place desired deck of cards into card reader hopper, face down, column one first.
- m. Depress START switch and observe that NOT READY light extinguishes and READY light illuminates.

NOTE

Card feed will occur under computer control. When the last card has been fed, the reader stops in a not ready condition with that indicator illuminated. If additional cards are to be fed, the following steps are used.

- n. Observe that NOT READY light illuminates and READY light extinguishes.
- o. Depress and hold END OF FILE switch until all cards have been cleared through read station into stacker.
- p. Repeat steps j, k, and l.

NOTE

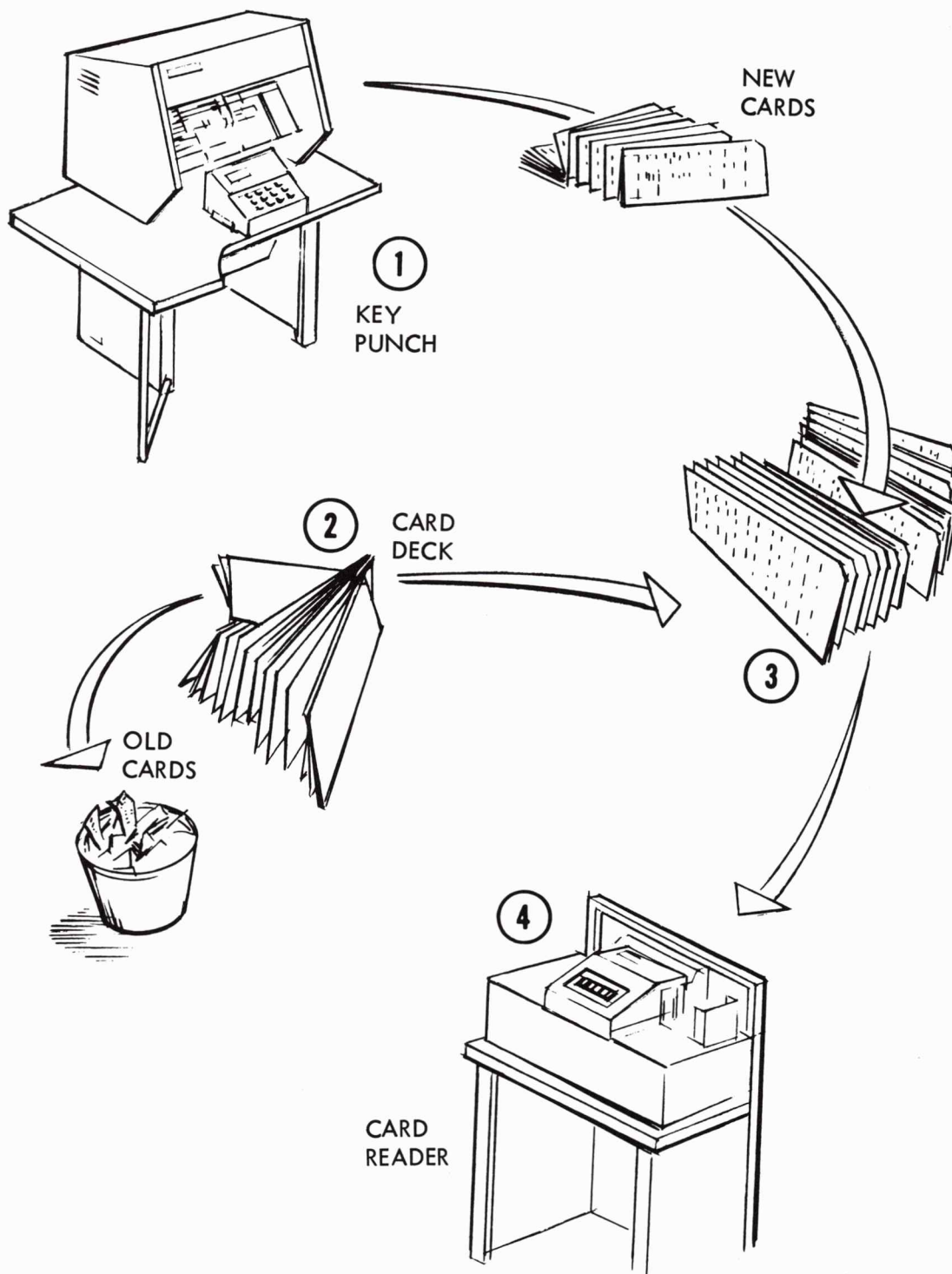
The reader will also stop in a not ready condition when the stacker becomes full. This requires that the instructor remove the cards from the stacker and repeat steps j, k, and l.

1.2.6.2 Preparing Program Changes.

The method of program variation using the card reader is illustrated in figure 1-7. The instructor should obtain a computer printout of the affected program or otherwise be familiar with the program card deck. The procedure involved in this method is as follows:

- a. Prepare card(s) with new information in same format as old card(s).
- b. Remove old card(s) from card deck and file or dispose.

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Figure 1-7. Card Change Functional Flow

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- c. Set new card(s) in place of old card(s).
- d. Re-insert program into computer.

1.2.7 PAPER TAPE PROGRAM LOADING.

The Digitronics paper tape reader, supplied as standard equipment with the DDP computers, is used to input load programs into the computer memory. This equipment is physically and functionally described in section 1 of Volume I. The following procedure is required to program load using paper tape.

- a. At computer control panel, place TYPE ON LINE-OFF LINE switch to ON LINE.
- b. At computer control panel, place PUNCH ON-OFF switch to OFF.
- c. At computer control panel, place READER ON LINE-OFF LINE switch to ON LINE.
- d. At computer control panel, place PUNCH ON LINE-OFF LINE switch to OFF LINE.
- e. At computer control panel, place READER CONTIN-PULSED switch to CONTIN.
- f. Place tape reader POWER ON switch up.
- g. Depress MASTER CLEAR pushbutton at computer control panel. Pushbutton illuminates; registers reset.
- h. Rotate ready load switch on tape reader to load position (CW).
- i. Insert tape into tape reader.
- j. Place PROGRAM REGISTER to _____. Register indicates value.
- k. At computer control panel, depress FILL pushbutton. Pushbutton illuminates.
- l. Observe paper tape feed and halt at completion of loading.
- m. Depress MASTER CLEAR pushbutton. Pushbutton illuminates.

1.2.8 TYPEWRITER OPERATION.

The IBM Selectric typewriter, described in section 1 of Volume I and located at the desk between the IOS and TM consoles, is used as an on-line input-output device. As such, it provides the instructor with communication capability with the AMS computers while the simulator is being used operationally. On-line input to the computers via the typewriter can only be accomplished either prior to exercise initialization or during a freeze condition of the AMS. On-line outputs via the typewriter can be accomplished under computer control in either freeze or nonfreeze. The computers use the IOS typewriter as an auxiliary printer to notify the instructor of the existence of conditions which require instructor action. For instance, notification that the on-line diagnostic routine has located an error, notifying the instructor that a new data recording tape reel must be mounted, or that a specific operational program tape reel is required for the training problem.

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1.2.8.1 Input-Output.

The instructor uses the typewriter to input program changes or data output requests. Data output requests are accomplished by interrogating the contents of any memory location in any of the computers. The procedure to accomplish data requests is provided as follows:

- a. At IOS trainer control panel 45, depress FREEZE switch-light.
- b. Observe that switch-light illuminates.
- c. At typewriter, depress CARRIAGE RETURN key.
- d. Observe that word READY is typed out on typewriter.
- e. Type desired memory location and octal character code requesting core readout on typewriter.
- f. Depress typewriter CARRIAGE RETURN key.
- g. Observe that desired data is typed out on typewriter.
- h. Depress typewriter BACKSPACE key.
- i. Depress RUN switch-light at IOS panel 45 and observe simulation resumption.

1.2.8.2 Initiation.

At the start of each simulation, the instructor must insert the date and time of day (GMT) into the computer via the typewriter. This is accomplished through the following steps:

- a. Depress typewriter CARRIAGE RETURN key.
- b. Observe that word READY is typed out on typewriter.
- c. Type octal characters representative of GMT on typewriter.
- d. Depress CARRIAGE RETURN key.
- e. Observe GMT up-date on CTE timer displays at IOS panels.
- f. Depress typewriter BACKSPACE key.

1.2.8.3 Recorder and Plotter Inputs

Assigning parameters to the X/T and X/Y recorders is accomplished by means of the IOS typewriter. In order to assign a parameter to a recorder, the following information must be entered:

- The particular computer memory in which the parameter is stored.
- The absolute core location.
- The scale factor.
- The recorder channel where the parameter is to be displayed.

A computer printout called the "memory map" provides the gross and absolute parameter core location. Another printout called the "symbol dictionary" provides the scale factor. These printouts list all parameters in terms of program symbols. The Simulation Output Tables located in Section 5 of Volume III of this handbook are used to identify these symbols except in the case where the Session Data Sheets provide such data for a particular training session. In this case the recommended parameters have been identified; however, reference to the printouts is still necessary for memory location and scale factor.

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The selection of a particular recorder and channel on which the parameter will be displayed rests with the instructor(s). Table 1-2A contains the code to be inserted when selection of a recorder and channel has been made. The following is the procedure for the assignment of the recorder channels:

- a. Prepare list of parameters to be recorded.
- b. From Simulation Output Tables, list program symbols associated with chosen parameters. (If Session Data Sheets are to be used, this information is already available.)
- c. From "memory map", record computer memory in which parameters are located (i.e., computer memory A, B, or C, or extended memory of computer C).
- d. Also from the memory map, record absolute core locations of parameters.
- e. From symbol dictionary, record scale factor for each parameter. This term will be in form of + or - followed by two decimal integers.
- f. Determine and record recorder and channel on which each parameter is to be recorded (i.e., X/T #1 Channel 1; X/Y (11" X 17") Pen #1, etc.).
- g. At IOS Simulator Control Panel 45, depress FREEZE switch-light.
- h. Observe illumination of switch-light.
- i. Using IOS typewriter, type in letter "X".
- j. Observe for carriage return and following message typed out: "Begin to ENTER X/Y - X/T INPUTS".
- k. From the prepared list type in "+" if parameter is located in computer memory A, B, or C and "-" if the parameter is in the extended 8K memory of computer C.
 1. Type in 5 octal integers representing absolute core location. (In some cases it may be necessary to add leading zeros for proper representation.)
- m. Type in "/" (slash) following core location.
- n. Type in scale factor taken from prepared list.
- o. Type in "/" (slash) following scale factor.
- p. From Table 1-2A obtain channel code location associated with recorder channels and type in (i.e., 01, 23, etc.).
- q. If above procedure has been correctly implemented, typewriter will initiate carriage return signifying readiness for receiving next recorder selection. Repeat steps k through p to complete recorder assignment.

NOTE

It is not necessary that all recorders be assigned a parameter.

- r. Type in _____ to signal computer that all desired recorders have been assigned and transmission is complete.
- s. Prior to beginning training session, verify procedures have been completed that are called out in paragraphs 1.3.7, 1.3.8, and 1.3.9 of Section 1, Volume II of this handbook.

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Table 1-2A. Recorder/Plotter Code Identification

<u>Recorder & Channel</u>	<u>Channel Code Location</u>
<u>X/T #1</u>	
Channel 1	01
Channel 2	02
Channel 3	03
Channel 4	04
Channel 5	05
Channel 6	06
Channel 7	07
Channel 8	08
<u>X/Y (11" X 17")</u>	
Pen #1	09
Arm #1	10
Pen #2	11
Arm #2	12
<u>X/T #2</u>	
Channel 1	13
Channel 2	14
Channel 3	15
Channel 4	16
Channel 5	17
Channel 6	18
Channel 7	19
Channel 8	20
<u>X/Y (30" X 30")</u>	
Pen #1	21
Arm #1	22
Pen #2	23
Arm #2	24
<u>X/T #3</u>	
Channel 1	25
Channel 2	26
Channel 3	27
Channel 4	28
Channel 5	29
Channel 6	30
Channel 7	31
Channel 8	32

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1.2.9 TM CONSOLE FAULT PATCHING

The faulting of down telemetry signals is accomplished at the telemetry console by either computer or manual control. The fault controls of the TM console are described in section 1 of Volume I. Fault controls are provided to enable the TM console operator to vary the presentation of telemetry parameters at the flight controller consoles. Operation of the fault controls does not effect system simulation data manifested to either the flight crew in the SCM or the instructor-operators at the IOS.

....text continued on page 1-21

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The TM console operator can fault any 20 of the 320 analog channels or any 16 of the 312 bilevel channels of the AMS. The analog and bilevel channels are identified in the simulation output tables to be found in section 5 of Volume III of this handbook.

Faulting of selected TM channels is accomplished by means of a patch panel located in the upper left portion of cabinet 30 (figure 1-8). This panel is removed by loosening a thumbscrew in the left center of the patch panel front face to unlatch it, and then pulling the handle down and out. The handle pivots in a downward quarter-circle which lifts the panel patch contacts clear of the connecting pins prior to the panel being pulled out. The panel slides outward on guide slots which prevent misalignment during removal and installation of the panel.

Normally, the TM channels identified on the patch panel are bottle-plugged to allow the signal through to the TM console monitors and the flight controller monitors. To fault a particular parameter, the TM instructor must refer to the Telemetry Channel list located in the simulation output table. The table includes the type of parameter (analog, digital bit, digital word), its channel assignment, and the related pin connection. With this information, the TM console operator can locate the desired channel at the patch panel and remove the bottle plug located there. With a patch cord, the TM console operator connects the channel number to one of the 20 analog or 16 bilevel (depending on the type of parameter) fault channels located at the bottom of the patch panel bay. This procedure is repeated for all TM parameters that are to be faulted until the limit of 20 and 16 channels are exhausted. The patch panel is then replaced and secured in cabinet 30.

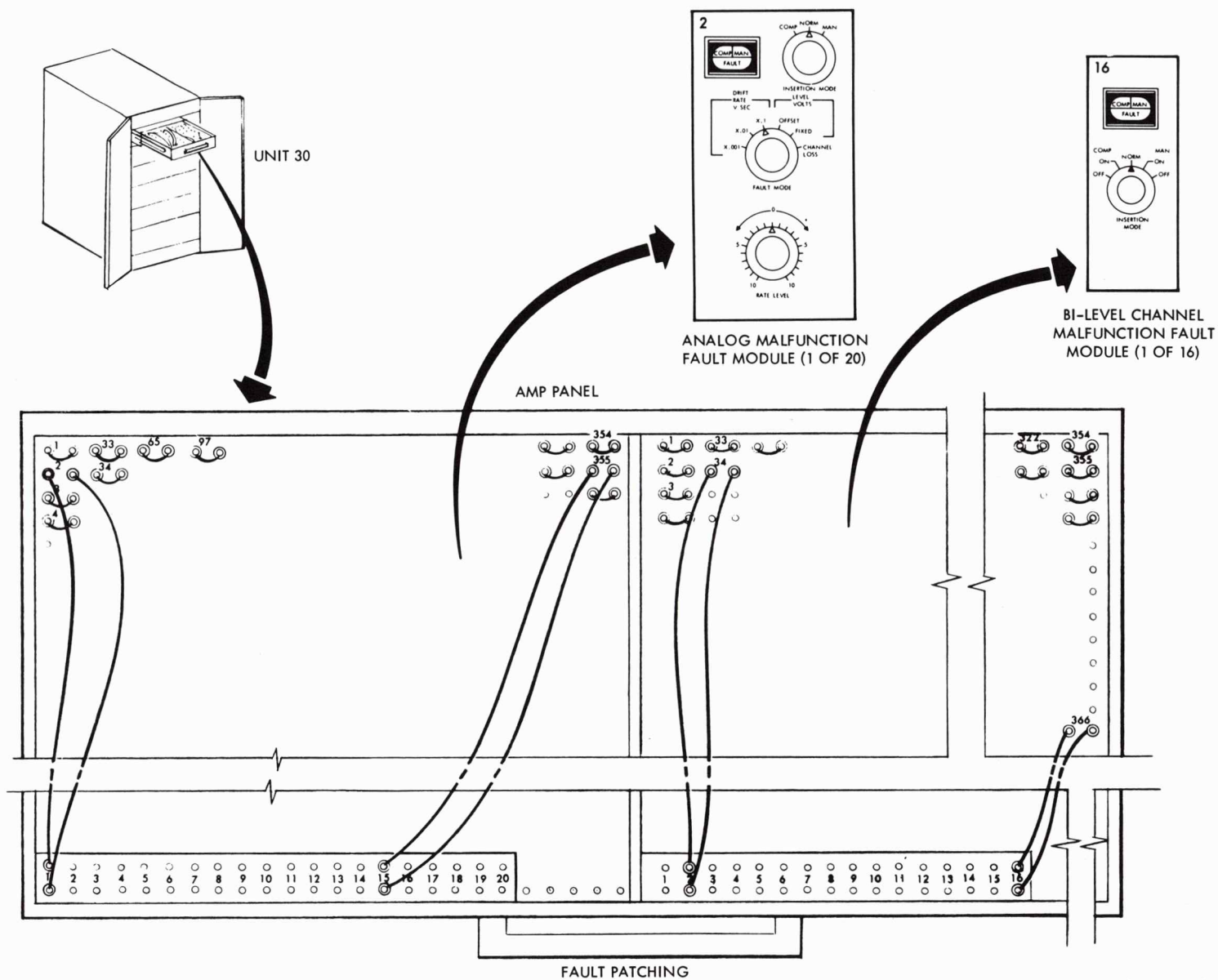
The TM console operator can then use the fault modules to accomplish the particular type of fault required for the parameter assigned to each module, or he can allow the parameter to be transmitted unaffected by the fault controls. Faulting can be done manually or by computer control.

NOTE

The TM instructor should be cognizant of all malfunctions affecting system TM parameters that have been inserted at the IOS. This can be accomplished by monitoring the MIU display when operating fault control modules to assure that previously malfunctioned system TM parameters are not being inadvertently faulted.

1.2.10 COMMUNICATIONS CONTROL SYSTEM OPERATION.

The console communications system (CCS) interfaces with flight crew simulator communications systems and other systems, as required. The CCS consists of eleven independent loops and shares nine other loops with MSCC for integrated operations. These loops are two local conference loops (command



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Figure 1-8. TM Fault Patching Functional Flow

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module instructor loop, and computer loop), five intersite conference loops (simulator conference loop, simulation tracking and trajectory loop, flight crew simulator-conference loop, and telemetry loops 1 and 2), three astronaut loops (AL 1, 2, and 3), and four monitor loops (flight director, prime MSFN, launch vehicle-test conductor, and spacecraft operations). Each CCS loop is defined in table 1-3.

Table 1-3. AMS Console Communications Loops

Local Conference Loops
<p>Local conference loops provide signaling, as required; two-way (talk-listen) communications; and monitoring capabilities at all stations in the loop.</p> <ul style="list-style-type: none"> • <u>Command Module Instructor Loop (CMIL)</u>. The CMIL provides conference communications between the console instructor-operators. • <u>Computer Loop (CL)</u>. The CL provides two-way communications between the instructor console and support position for the purpose of maintaining AMS equipment.
Intersite Conference Loops
<p>Intersite conference loops are identical to local conference loops with additional facilities to provide connection with MSCC internal loops.</p> <ul style="list-style-type: none"> • <u>Simulator Conference Loop (SCL)</u>. The SCL provides conference communications between AMS instructor-operator and the simulation control area (SCA) during integrated training. • <u>Simulation Tracking and Trajectory Loop (ST and TC)</u>. The ST and TC provides conference communications between AMS instructor-operator and SCA personnel. • <u>Flight Crew Simulator Computer Loop (FCS-CL)</u>. The FCS-CL provides conference capability for coordinating AMS and MSCC computer operations. • <u>Telemetry Loops 1 (TM 1) and 2 (TM 2)</u>. The TM loops provide conference communications between MSCC and AMS telemetry fault operators.

. . . continued

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Table 1-3. AMS Console Communications Loops (Cont)

Command Module Simulated Voice Communications Loops
<p>The C/M simulated voice communications loops are identical to local conference loops except that signaling circuits will not be provided and voice signals are appropriately muted for simulation of half-duplex communications between flight crew and ground. C/M voice loops can be patched to include the MSCC.</p> <ul style="list-style-type: none"> • <u>Very High Frequency-1 (VHF-1)</u>. The VHF-1 loop simulates the RF voice transmission between the C/M flight crews and the MSFN stations. • <u>Very High Frequency-2 (VHF-2)</u>. The VHF-2 loop will simulate the RF voice transmission between the C/M flight crew and the LEM flight crew. • <u>High Frequency (HF)</u>. Same function as VHF-1. • <u>S-Band</u>. The S-band loop will simulate the duplex voice transmission between the C/M flight crews and MSFN stations. • <u>Command Module Intercom</u>. The C/M intercom loop will simulate the command module intercommunications and the ground to spacecraft hardwire communications for prelaunch.
Astronaut Loops
<p>The astronaut loops are identical to the local conference loops with no signaling capability. The three astronaut loops (AL1, AL2, AL3) provide communications with each individual astronaut and the instructor-operator at the IOS. These loops do not simulate a portion of the Apollo spacecraft communications system.</p>
Monitor Loops
<p>The monitor loops provides monitoring capability of MSCC and MSFN stations by AMS instructor-operators.</p> <ul style="list-style-type: none"> • <u>Flight Director (FD)</u>. The FD loop provides AMS personnel with a capability to monitor the flight director. • <u>Prime MSFN</u>. The prime MSFN loop provides the AMS instructor-operator with a capability to monitor the entire MSFN range.

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Table 1-3. AMS Console Communications Loops (Cont)

- Launch Vehicle Test Conductor Monitor (LV-TC). The LV-TC loop provides the AMS instructor-operator with a capability to monitor the launch vehicle test conductor.
- Spacecraft Operations (SC-OP). The SC-OP loop provides the AMS instructor-operator with a capability to monitor the simulated activities of the blockhouse spacecraft test conductor personnel.

Control over and access to these loops is accomplished through the use of two panels: the keyset panel and the trainer communications control panel. The function of each control is described and illustrated in section 1 of Volume I. Table 1-4 illustrates, in matrix form, the connections available at each position through the use of the keyset. This section delineates requirements for operating the CCS in both the integrated and nonintegrated modes.

1.2.10.1 Nonintegrated Mode Communication.

During nonintegrated operations, the instructor-operator simulates the function of the MSFN and supporting organizations. Therefore, the integrated conference loops previously mentioned will not be required. Only the local loops, astronaut loops and the simulated S/C voice systems will be used. Operation is initiated by connecting individual headsets to the jack plugs at each position. The AUDIO SELECT switch at the trainer communications control panel is placed to the CCS position and the VOLUME control is set as desired. For training purposes, S/C voice communications are simulated by the instructor-operator acting as ground support personnel. This is accomplished by appropriate manipulation of the keyset panel in simulating ground messages on the correct spacecraft communication subsystems. For utility purposes, the astronaut loops or any of the local conference loops may be selected at the operator's discretion for coordinating conversation with either the flight crew or support personnel.

1.2.10.2 Integrated Mode Communication.

During integrated operations, the AMS operator interfaces with other simulator-training devices and support personnel. In this mode, control of the training operations is the responsibility of the simulation supervisor (flight director), and the instructor-operator no longer simulates ground voice inputs. Since the instructor must still remain cognizant of all operations, utilization of the intersite and monitor loops becomes mandatory. Access to these loops (intersite and monitor) is acquired through the keyset located at the trainer setup and control station (IOS panel 88). Incoming signals on intersite conference loops are signified by the station buzzer sounding and the appropriate talk-listen key flashing. Depressing the key causes the buzzer to stop and changes the illumination from flashing to steady. Initially depressing a talk-listen key

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Table 1-4. AMS Circuits

Loops	Position								
	Command Instructor Astronaut	Navigation Instructor	Systems Management Instructor	Trainer Setup and Control Instructor	No. 1 Telemetry Instructor	No. 2 Telemetry Instructor	Viewing Station	Digital Computer	Equipment Area
VHF 1	X	X	X						
VHF 1 (mon)	X	X	X		X	X	X		
VHF 2	X	X	X						
VHF 2 (mon)	X	X	X		X	X	X		
HF	X	X	X						
HF (mon)	X	X	X		X	X	X		
S-BAND	X	X	X						
S-BAND (mon)	X	X	X		X	X	X		
INTERCOM	X	X	X						
INTERCOM. (mon)	X	X	X		X	X	X		
AL 1	X	X	X	X					
AL 1 (mon)	X	X	X	X	X	X			
AL 2	X	X	X	X					
AL 2 (mon)	X	X	X	X	X	X			
AL 3	X	X	X	X					
AL 3 (mon)	X	X	X	X	X	X			
(ML) Maintenance Loop	X	X	X	X	X	X		X	X
(ML) (mon)	X	X	X	X	X	X		X	
(CL) Computer Loop	X	X	X	X	X	X		X	X
(CL) (mon)	X	X	X	X				X	
(CMIL) Command Module Instructor Loop	X	X	X	X	X	X		X	X
(CMIL) (mon)	X	X	X	X	X	X	X	X	
(SC) Simulator Conf. Loop	X	X	X	X	X	X		X	
(SC) (mon)	X	X	X	X	X	X	X	X	
(ST&T) Simulation Tracking and Trajectory Loop				X	X	X			
(ST&T) (mon)				X	X	X			
(FCS-CL) Flight Crew Simulator Computer Loop				X				X	
(FCS-CL) (mon)				X				X	
(TM 1) Telemetry Loop					X	X			
(TM 1) (mon)				X	X	X			
(TM 2) Telemetry Loop					X	X			
(TM 2) (mon)				X	X	X			
(FD) Flight Director (mon)				X			X		
(PRIME MSFN) (mon)				X	X	X	X		
(LV-TC) L/V Test Conductor (mon)				X	X	X			
(SCOP) Spacecraft Operations (mon)				X	X	X	X		
(BC/O) Buzzer Cutoff	X	X	X	X	X	X			
MULTI-ACCESS	X	X	X	X	X	X			
(RLS) Release	X	X	X	X	X	X			
HOLD				X	X	X			
RING	X	X	X	X	X	X			
Total Keys	28	28	28	29	29	29	10	10	3

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causes all keys associated with the loop to flash until another key on the loop is depressed. In this manner, the instructor-operator can signal others on his loop and is aware when they have responded to his outgoing signal. If his outgoing signal is not acknowledged, the instructor-operator may use the RING key. This key activates the buzzer at the called station. The talk keys are normally interlocked so that only one key can be operated at one time. An alternative is provided by the MULTI ACCESS key, which allows up to three talk keys to be used simultaneously. Any number of monitor keys may be engaged at any one time. To discontinue conversation on any one line, the instructor may select another talk-listen key or he may depress the RLS (release) key, which unlatches all keys on that particular keyset panel.

Push-to-talk capability is provided at all stations. This is controlled from switches provided in the headset cords, switches on the hand set, or in certain cases, foot switches wired in parallel with the headset switch. A HOLD key is provided at IOS panel 88 to enable hold of any talk-listen key circuit. The buzzer, which signifies an incoming signal in conjunction with the flashing key illumination, may be terminated by the use of the BC/O (buzzer cutoff) key. This also changes the flashing key to a steady illumination.

1.2.11 TRUE TRAINEE ENVIRONMENT OPERATION.

The indicators on IOS panel 2 reflect the actual environmental conditions existing in the flight crew spacesuits and the simulated command module cabin. These indicators display temperature, pressure, and suit air flow. The simulator environmental system (to be distinguished from the simulated ECS) controls these various inputs with instructor inputs for suit pressure control.

The simulator environmental system provides the SCM with a temperature-controllable cabin at standard atmosphere, and temperature and pressure-controllable spacesuits. During the training exercise, these factors are exercised (within safe limits) under computer control. However, the trainee (or instructor) may desire to dispense with the authenticity of pressure and temperature conditions for the sake of comfort and convenience. In these cases, the instructor may utilize the override controls on the true trainee environment panel. Other situations warranting the use of the suit pressure override control may result from simulated malfunctions. In the AMS, the condition of cabin depressurization (for example, meteorite strike) is simulated by means of a rapid change from the shirtsleeve environment of a few inches of water pressure to full pressure. This condition may cause crew discomfort after repeated or prolonged occurrence. The instructor may use the override control to either remove or somewhat lessen the full-pressure condition of the suits.

1.2.12 UP-DATA LINK OPERATION.

The up-data link (UDL) panel, IOS panel 5, enables the instructor to simulate the transmission of data originating at various ground stations. The panel allows the instructor (operating independently of the SCATS-IMCC) to select the appropriate system and transmit the required type of messages to the simulated onboard UDL. Nonintegrated operation is initiated by setting the split-screen mode switch for NON INT.

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In the nonintegrated mode, four switch-lights are enabled (REAL TIME COMMANDS, GUIDANCE AND NAVIGATION, CENTRAL TIMING EQUIPMENT, and DATA DISPLAY). These switch-lights are interlocked to prevent the selection of more than one system. The KEYBOARD CLEAR switch-light unlatches the selected system and resets the panel, thereby, allowing selection of another system.

The first step of UDL operation is to select the desired system and to format the proper message. System address is then accomplished by depressing the appropriate key (G&N, CTE, or RTC). The message format is signified by successively depressing the NOUN, VERB, PLUS, MINUS, and the 0-9 keys on the decimal keyboard. The message is transmitted to the computer through the use of the ENTER key after proper formatting. Inadvertent errors, occurring through keyboard use, can be rectified through the use of the NON-INTEGRATED CLEAR switch-light.

The fourth switch enabled by the mode selector switch is not associated with system selection. This is the DATA DISPLAY switch-light. This select pushbutton enables the instructor to insert the identification of the star or landmark the trainee is observing with the simulated SCT or SXT. The procedure is as described with the identification of the star-landmark coded in the noun, verb, and digit combinations. The instructor also uses this switch to provide data to the simulated AGC during alignment and navigation procedures. Another use is instructor simulation of the functions of the ground support personnel providing the up-dating information normally supplied by MSFN through this panel.

1.2.13 MALFUNCTION INSERTION UNIT.

Procedures for malfunction insertion are grouped under three topic subjects: (1) manual malfunction insertion, (2) preprogramed malfunction insertion, and (3) time-dependent malfunction insertion. The operation of the malfunction insertion unit (MIU), in relation to each of these categories, is also described in general terms. For a functional description of the MIU, refer to the section 1 of Volume I.

1.2.13.1 Manual Malfunction Insertion.

The following discussion of operating procedures entails use of controls and displays described in section 1 of Volume I. Operation of the MIU involves two basic manipulations: malfunction insertion and malfunction clear. Status indications exist only to the extent of notifying the instructor-operator that a specific malfunction has or has not been entered into the computer program. This indication may be printed out on the line printer prior to the start of a mission exercise or displayed on the MIU display panel during a mission exercise. In the case of a time-dependent malfunction, an impending indication of the malfunction occurs at the display panel at a preset time prior to activation.

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In many cases a given simulated malfunction requires the programming of more than one malfunction code. Where such is the case, each malfunction code is inserted and entered in the same manner as separate malfunctions.

Malfunction Insertion.

The instructor-operator must follow the outlined procedure for use of the MIU control panel. The system is designed to prevent errors and notify the instructor-operator when an error in procedure has occurred. To insert a malfunction into the computer program, the instructor selects an indicator display on the display panel. This is done by depressing any one of the nine DISPLAY switches. The tenth display (No. 10) is reserved for display of preprogrammed time-dependent malfunctions. This action causes the selected DISPLAY switch to illuminate on the control panel, as well as the CONTROL PANEL-IN-USE light on all panels. The malfunctions are coded alphanumerically. The system to be malfunctioned is identified by the letter portion and is selected by depressing the desired SYSTEM switch, which is also backlighted. Three successive depressions of the octal digits on the KEYBOARD identify and select the particular system malfunction. The selected digits are displayed in the VERIFY register as they are keyed. The selection of the third digit initiates a logic communication between the MIU and the computer, which results in one of three possibilities.

- If the instructor procedures were improper and/or the selected malfunction code invalid, the INSTRUCTION INVALID light illuminates. In this instance, all controls are inhibited with the exception of the CONTROL PANEL RESET switch. This switch must be utilized to clear the control panel, turn off all indications, and allow renewed utilization of the control panel.
- If the instruction is valid, but the malfunction has been previously entered into the program, the appropriate DISPLAY STATUS and ENT (entered) lights illuminate on the display panel and the magnaline indicator is driven to the selected code.
- If the instruction is valid and the malfunction is not already in the program, the appropriate DISPLAY STATUS number and the IMP (impending) lights on the display panel illuminate. The magnaline display indicates the selected code and all control panel lights extinguish.

In the second possibility, the only alternative available to the instructor is the clear function (to be described later). In the third possibility, the instructor may elect several actions. He has selected a malfunction but this malfunction is not yet active, that is, entered into the computer programs. He may choose to select further malfunctions (up to nine) in the manner described or he may activate a selected malfunction.

To activate a selected malfunction (or group of malfunctions), the instructor depresses the appropriate DISPLAY switch. This causes the same switch to illuminate on all control panels, as well as the CONTROL PANEL-IN-USE light. By depressing the MALFUNCTION ENTER switch, the

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malfunction is activated, the ENT (entered) light illuminates, the IMP (impending) light and all control panel lights extinguish. Successively depressing appropriate DISPLAY switches, followed by depressing MALFUNCTION ENTER switch, activates all selected displayed malfunctions.

Malfunction Clear.

All active malfunctions within the computer program may be cleared by depressing the MASTER CLEAR ALL SYSTEMS switch. This switch has a lock cover to prevent inadvertent use. This inhibits all control panels until the malfunctions have been cleared. This is indicated when the MASTER CLEAR ALL SYSTEMS indicator is extinguished. All display panel lights extinguish and all alphanumeric readouts become blank.

Individual malfunctions may be cleared from a system by selecting the malfunction through the procedure outlined for malfunction insertion. However, instead of activating the malfunction, the appropriate DISPLAY switch followed by the MALFUNCTION CLEAR switch is depressed. When the malfunction has been cleared, the display lights and control panel lights extinguish and the alphanumeric readout becomes blank.

The instructor-operator also has the option of clearing the MIU display only. He can do this by depressing the appropriate DISPLAY switch and then the DISPLAY CLEAR switch. This causes all lights associated with the selected MIU display panel to extinguish and the alphanumeric readout to become blank. However, this only clears the selected MIU display and in no way effects the malfunction which had been displayed.

1.2.13.2 Preprogramed Malfunction Insertion.

The use of this procedure is prescribed, prior to the initialization of a training exercise, if the number of malfunctions to be used is considerable. Small numbers of malfunctions should be manually inserted through the MIU as described.

A card deck of malfunctions is stored in the library of cards. These cards have been prepunched to include the information tabulated in table 1-5 in that format. New malfunctions, which require cards, must also be punched in this format. The individual cards for each malfunction are selected from the deck by the instructor. These selected cards form a subdeck to be used with a particular exercise or run. It is not necessary to sort or arrange the cards in any special order. The cards are placed in the card reader stacker and inserted into the computer using the procedure outlined in paragraph 1.2.6 of this section. The MIU program in the computer outputs a list of the malfunctions, inserted on the line printer. This list can be used by the instructor as ready reference during the performance of the exercise.

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Table 1-5. Preprogramed Malfunction Card Format

Column 1 and 2	- Blank
Column 3 and 4	- System code (two alphabetic characters)
Column 5 through 7	- 3-digit malfunction number
Column 8	- Blank
Column 9 through 80	- Malfunction description or blank

1.2.13.3 Time-Dependent Malfunction Insertion.

This type of malfunction carries a time tag in its format as indicated in table 1-6. Time-dependent malfunctions can only be inserted via the card reader, using the procedure defined in paragraph 1.2.6. They may be included in the preprogramed card deck described, or they may be inserted separately to facilitate organization of card decks and filing. Time-dependent malfunctions must be in order by time sequence (earliest to latest). The program outputs a list of time-dependent malfunctions on the line printer, if entered separately. Otherwise, they are included in the printout of preprogramed malfunctions along with their respective time of occurrence.

Table 1-6. Time-Dependent Malfunction Card Format

Column 1	- T
Column 2	- Blank
Column 3 and 4	- System code (two alphabetic characters)
Column 5 through 7	- 3-digit malfunction number
Column 8	- Blank
*Column 9 through 11	- Day of the year
Column 12	- Blank
Column 13 and 14	- Hour
Column 15	- Blank
Column 16 and 17	- Minute
Column 18	- Blank
*Column 19 and 20	- Second
Column 21	- Blank
Column 22 through 80	- Blank or malfunction description

*The information in columns 9 through 20 will indicate the time tag for the malfunction to be entered into the system. This time will be referenced to time from launch.

1.2.13.4 Computer Initiated Malfunctions.

In addition to the described instructor-operator initiated functions, the following computer functions are performed by the MIU. The computer sends an impending signal to the MIU logic, along with the displayed malfunction, 90 seconds prior to the time a time-dependent malfunction is to become active. This function is performed for predictable malfunctions only. The TIME DEP

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light flashes and the operator may perform such instructions upon the malfunction as previously described. When the malfunction becomes active, the TIME DEP light extinguishes, providing the operator did not initiate any instruction. The display is then cleared by the MIU logic.

1.3 SIMULATOR SYSTEMS CHECKLISTS.

Simulator system checklists are provided in the following paragraphs for each specific AMS system instructor procedure. The procedures outlined are for three specific purposes: (1) preparation of each system for use, (2) operation of each system during AMS operation, and (3) restoring each system to a safe and known baseline configuration in readiness for the next utilization.

In many instances, these procedures encompass the unit procedure previously presented and will reference these by paragraph number and/or particular step numbers where applicable. The paragraphs are not presented in any chronology and may be interchanged at the instructor's convenience, provided that any referenced procedure in a specific paragraph is performed.

1.3.1 COMPUTER READINESS FOR LOADING.

The procedure, as presented, is based upon the assumption that maintenance personnel have applied power to the computers, accomplished diagnostic checks, and otherwise have ascertained the operational readiness of the computer systems. Following this philosophy, the instructor completes the listed steps, which prepares the computers for operational program loading from either the MTU or the card reader.

- a. Verify operational readiness of computer systems with maintenance personnel.
- b. Verify that each SENSE switch on each computer control panel is placed to defined positions per program operational descriptions.
- c. Depress MASTER CLEAR pushbutton on each computer control panel.
- d. Place READER ON LINE-OFF LINE switch at computer control panels to ON LINE.
- e. Place READER CONTIN-PULSED switch at computer control panels to CONTIN.
- f. Place PUNCH ON-OFF switch at computer control panels to OFF.
- g. Place TYPE ON LINE-OFF LINE switch at computer control panels to ON LINE.
- h. Insert loading program (monitor) as per procedures of paragraph 1.2.7.
- i. Manually place PROGRAM REGISTER of master computer to location of first card word of loading program by using pushbutton switch-lights at the computer control panel.
- j. Depress FILL pushbutton at this control panel.
- k. Observe that HALT indicator illuminates to signify loading program is in memory.

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1.3.2 MAGNETIC TAPE PROGRAM LOADING.

The procedure for inputting program data into the computer memory is identified under the unit operations for the MTU. The instructor is referred to paragraph 1.2.5.

1.3.3 PUNCHED CARD PROGRAM LOADING.

This procedure is to be accomplished once the card reader has been set up and loaded as per paragraph 1.2.6 of this section. The instructor verifies the computer readiness for program loading and institutes the following steps.

- a. Verify that card reader power is on and NOT READY light is illuminated.
- b. At card reader, depress RESET switch-light.
- c. At card reader, depress START switch and observe that READY light illuminates and NOT READY light extinguishes.
- d. At computer control panel, depress MASTER CLEAR pushbutton.
- e. Place computer control READER ON LINE-OFF LINE switch to OFF LINE.
- f. Manually set PROGRAM REGISTER to location of first card word of load program.
- g. At computer control panel, depress START pushbutton.
- h. Monitor card feed at reader.
- i. Observe that NOT READY light illuminates when card hopper is exhausted or card stacker becomes full.
- j. If hopper is emptied, depress END OF FILE switch to run out remaining cards.
- k. Depress STOP switch at card reader.
- l. If stacker is full and cards are still in read hopper, depress STOP switch and remove cards from stacker.
- m. Depress RESET switch at card reader.
- n. Depress START switch at card reader and observe that NOT READY light extinguishes and the READY light illuminates.
- o. Continue operation until all program cards have been processed through card reader.

1.3.4 TYPEWRITER PROGRAM LOADING.

Paragraph 1.2.8 explains the various uses of the typewriter in preparing the simulator for operation. The procedure for typewriter program loading is listed. The typewriter presents codes to the computer in octal form and ignores all other formats. Only eight characters may be typed at one time. For this procedure, it is not necessary that a loader program be in the computer, since each word is to be inserted via the typewriter, directly. However, steps a through i of paragraph 1.3.1 must be completed.

- a. Verify that computer control READER ON LINE-OFF LINE switches are at OFF LINE.
- b. Manually set operation code (output control pulse, OCP) for typewriter into OP REGISTER by depressing appropriate pushbuttons on computer control panel.

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- c. Set Z REGISTER to typewriter keyboard code in same manner to enable keyboard.
- d. At computer control panel, depress EXECUTE pushbutton.
- e. Reset OP REGISTER and Z REGISTER by depressing respective RESET pushbuttons.
- f. Manually set PROGRAM REGISTER to location for first typewriter word by using pushbuttons.
- g. At computer control panel, depress FILL pushbutton.
- h. Type desired octal characters on typewriter keyboard.
- i. Depress CARRIAGE RETURN at keyboard to insert typed word.
- j. Repeat steps g and h until the entire program is loaded into computer.
- k. Depress BACKSPACE key and observe that I/O HOLD light illuminates at computer control panel.

1.3.5 MANUAL PROGRAM LOADING.

Programs can be manually loaded into computer memory from the computer control panel. This procedure requires each program word to be entered individually, one word at a time. For extensive programs, this procedure is obviously time consuming, but can be accomplished in the following manner:

- a. Depress MASTER CLEAR pushbutton at computer control panel.
- b. Set OP REGISTER to desired operation code (that is, STA command) by depressing desired indicator pushbuttons to form numerical code.
- c. Set Z REGISTER to address of first word to be entered in same manner.
- d. Set program data (word) into A REGISTER in same manner.
- e. Depress EXECUTE pushbutton at computer control panel.
- f. Observe that HALT indicator illuminates.
- g. Reset all registers by depressing associated RESET pushbutton.

The procedure outlined must be repeated for each program word until the entire program is loaded. At this time, the program may be executed per the defined program instructions.

1.3.6 SECURING COMPUTER COMPLEX.

These procedures to be defined later.

1.3.7 PLOTTER READINESS AND SETUP (30 X 30).

The EAI variplotter used as an X-Y plotter is operated under remote control of the computer system. The instructor is referred to section 1 of Volume I for a description of the X-Y plotter and the function of the local controls. Detailed here is the procedure required to set up this plotter prior to a training exercise.

- a. Place PEN UP-DOWN-REMOTE switches to REMOTE.
- b. Place PEN OPERATE-STANDBY-REMOTE switches to REMOTE.
- c. Place POWER switch on.

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- d. Place LIGHTS switch to ON.
- e. Place plotting paper over plotting surface.
- f. Place VACUUM switch to ON.
- g. Place PEN INTERCHANGE switch to AUTOMATIC.
- h. Adjust PEN & ARM PARALLAX controls to set initial positions of pens and arms.
- i. Place PAPER ADJUST controls for reference voltages in each servo.
- j. Adjust rotary selector pen and arm SCALE FACTOR switches to desired setting.
- k. Using VERNIER control, adjust scale factor.

1.3.8 PLOTTER READINESS AND SETUP (11 X 17).

The EAI variplotter, model 1110E, is used as the second X-Y plotter for the AMS. It also is described in section 1 of Volume I including its local controls. This plotter is remote-controlled by the computer system during training operations. Those operations, required of the instructor prior to an exercise, are outlined. The procedure enables the plotting of various simulated spacecraft and mission parameters.

- a. Place VAC PWR switch to OFF-ON to apply power.
- b. Place VARIABLE-FIXED switches on all four modules to FIXED.
- c. Place RANGE controls on all four modules to desired setting.
- d. Place SCALE-FACTOR controls for plotted parameters.

NOTE

The plug-in modules must be removed to gain access to the switch which allows a changeover from volts/inch to volts/cm.

- e. Place PEN-ARM switches to UP-STANDBY.
- f. Adjust X and Y ZERO controls to set desired center of plot.
- g. Place plotting paper over plotting surface.
- h. Place VAC PWR switch to ON-ON to apply vacuum to plotting surface.
- i. Place PEN INTCHG switch to AUTO.
- j. Place PEN-ARM switches to UP-OPERATE.

1.3.9 RECORDER READINESS AND SETUP (X-T).

The AMS is equipped with three Brush, Mark 200, X-T recorders with remote controls for operating the pen lift and marking systems. The instructor has the capability of selecting parameters and routing them to any of the recording equipment channels. This selection is made through the use of the typewriter and the procedures defined in paragraph 1.2.8 of this section. The recording equipment is physically and functionally described in section 1 of Volume I. It operates under the remote control of the computer system during a training exercise.

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1.3.9.1 Recorder Checkout.

The recorder is to be checked out prior to setup for operation in a training condition. This checkout procedure is outlined as follows:

- a. Verify that main power switch at amplifier level indicator panel is at OFF.
- b. Press CONTROL MODE LOCAL pushbutton on oscillograph control panel.
- c. Depress STOP pushbutton on same panel.
- d. Loosen locking knobs on SENSITIVITY controls at attenuation and control panel.
- e. Rotate SENSITIVITY controls fully clockwise.
- f. Depress ZERO pushbutton at attenuation and control panel.
- g. Depress red pushbuttons, located beneath light level panel behind pens, for polarity reversal.
- h. Verify black polarity reversal pushbuttons are released on all channels.
- i. Place main power switch to ON and observe that power switch indicator illuminates at light level panel.

NOTE

Allow 15 minutes for proper warmup before operation.

- j. Place SPEED $\div 100$ switch to up position on oscillograph control panel.
- k. Depress CHART SPEED MM/SEC 100 or 200 pushbutton.
- l. Observe that paper motion is at 1 or 2 millimeters per second.
- m. Loosen locking knobs on PEN POSITION controls at attenuation and control panel and center pens using bias control.
- n. Depress 25 LINE CAL. CHECK pushbutton and observe that pen deflects 25 lines.

NOTE

If proper calibration is not observed, refer to maintenance and calibration documents.

- o. Depress ZERO pushbutton to return pens to base line.
- p. Depress .05 VOLTS/LINE pushbutton for all channels.
- q. Depress and hold ATTEN. STEP IDENT. pushbutton and note that pen deflects 16 lines.

NOTE

If proper calibration is not observed, refer to maintenance and calibration documents.

- r. Release ATTEN. STEP IDENT. pushbutton and observe that pens return to base line.

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1.3.9.2 Recorder Setup.

After completing the procedure of paragraph 1.3.9.1 and verifying that calibration is satisfactory, the X-T recorder is ready for setup. Setup for operation requires the instructor to perform the following procedure:

- a. Select desired attenuation for each channel by depressing appropriate VOLTS-LINE pushbuttons at the attenuation and control panel.
- b. Select desired chart speed by depressing appropriate CHART SPEED MM/SEC pushbuttons at oscillograph control panel in conjunction with the SPEED $\div 100$ switch.
- c. Depress PAPER TAKE-UP pushbutton on oscillograph.
- d. Set TAKE-UP SPEED control to desired speed at oscillograph.
- e. Depress CONTROL MODE FULL REMOTE pushbutton at oscillograph control panel.

Minor maintenance, such as paper load or change, ink cartridge change and calibration and gain checks, procedures are supplied in other documents.

1.3.10 COMMUNICATIONS CONTROL SETUP.

1.3.10.1 Console Communications System Setup.

The procedure outlined in this paragraph pertains to setup and checkout of the communications configuration to be used during simulation. The operation of the CCS has been presented in paragraph 1.2.9. The CCS setup procedure is as follows:

- a. Place all trainer communication control panel switches to CCS.
- b. Insert headset cords into TALK-LISTEN plugs at trainer communication control panel.
- c. Adjust VOLUME control to nominal position.
- d. Depress the CMIL talk-listen key at each IOS keyset station.
- e. Verify continuity of communication over instructor loop.
- f. Depress CL talk-listen key at each IOS keyset station.
- g. Depress RING key at trainer control and set up positions (IOS panel 88).
- h. Observe that CL key flashing illumination changes to steady.
- i. Verify continuity of communications over computer loop.
- j. Depress ML talk-listen key at each instructor keyset station.
- k. Depress RING key at IOS panel 88.
- l. Observe that ML key illumination changes from flashing to steady.
- m. Verify continuity of communications over maintenance loop.
- n. At IOS panel 88, depress CMIL talk-listen key and following monitor keys: AL 1, AL 2, AL 3, TM 1 and TM 2.
- o. At command, navigation and system management instructor positions (IOS panels 26, 46, and 70), depress CMIL and CM INTERCOM monitor keys.
- p. At these same panels, select appropriate talk-listen key that is required to simulate spacecraft voice communications as per procedures in section 3 of Volume III, Crew Procedures.

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1.3.10.2 Instructor Simulation of MSFN.

Further operation of the CCS is dictated by compliance with the Crew Procedures of Volume III. The instructor may vary his individual communications loops during the performance of the training problem to monitor individual crewmember conversations or complete individual crewmember communication loops in the instructor-trainee faculty (that is, astronaut loops, backup loops, or other monitor loops).

In conjunction with the simulation of spacecraft voice communications, the instructor may operate the noise and garble controls on the communications interference panel (IOS panel 86) to simulate the effects of spacecraft misorientation or improper communications configuration management. This requires the instructor to be aware of simulated spacecraft position and orientation, and the location of the ground stations in order to perform the following steps:

- a. Vary VHF-AM NOISE and GARBLE controls at IOS panel 86 if voice communications configuration indicates trainee use of VHF.
- b. Vary S-BAND NOISE and GARBLE controls at IOS panel 86 if voice communications configuration indicates trainee use of S-BAND modes.
- c. Monitor effect of previous steps on astronaut management of spacecraft orientation controls and communications configuration.

1.3.11 TM CONSOLE READINESS AND SETUP.

Operations involved in setting up the TM console require the TM instructor-operator to coordinate with both the IOS instructor-operator and MSFN personnel. Interface between the TM console, the IOS, and various stations in MSCC is provided via the console communications system (CCS). Procedures and loops available in the CCS are the subject of paragraphs 1.2.10 and 1.3.10. The CCS interface between the TM console, the IOS, and MSCC should be set up and manned prior to initiation of TM console readiness and setup procedures.

Other preparations required before TM console readiness and setup include TM channel faulting as specified for the simulation being prepared. The procedure for TM console fault patching is provided in paragraph 1.2.9. In addition, the TM console operator should have a list of both the TM faults to be initiated at the TM console and the simulated malfunctions to be initiated at the IOS.

1.3.11.1 TM Console Readiness Check.

The procedure establishing a readiness for use condition at the TM console areas is as follows:

- a. Prepare CCS as defined in paragraph 1.2.10.
- b. Verify, with IOS instructor, correlation of TO FROM LAUNCH TIME and MISSION TIME displays with those at IOS.
- c. Depress all LAMP TEST pushbuttons on TM console and verify that lamp illuminates.

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- d. Depress lamp test pushbutton on two SPRIL repeater indicators on communications subpanels and verify that lamp illuminates.
- e. Adjust CONSOLE and INDICATOR LIGHT INTENSITY controls as required for adequate illumination.
- f. Depress TELEMETRY PCM ON switch-light at status panel and observe that switch illuminates.
- g. Verify GO status of PCM units by observing PCM STATUS split-screen switch-light.
- h. Confer via CCS with MSFN as to which TV monitor presentation is desired and place CCTV TO IMCC SELECTOR CAMERA switch to corresponding position.
- i. Verify, with IOS instructor checklist that proper indications exist for communications subpanels.

1.3.11.2 TM Console Setup.

Following the readiness check procedure, the TM console instructor-operator prepares the console for the training situation. This involves selecting and inserting faults into the preselected channels through the analog, digital word, and bilevel fault modules at the TM console; and selecting those channels that the TM instructor initially chooses to monitor on his displays. This setup is accomplished by following the steps listed.

- a. With grease pencil or other soft-lead pencil, note channel number, parameter and characteristics of faulted channels on writing surface above each fault module.
- b. At ANALOG MALFUNCTION CONTROL panel, place INSERTION MODE switch to NORM on each of 20 fault modules.
- c. Select type of fault to be inserted into each channel controlled by 20 fault modules by operating FAULT MODE selector switch on each fault module.
- d. Adjust RATE LEVEL control on each fault module to required setting. If CHANNEL LOSS position had been selected in previous step, this control has no effect.
- e. At DIGITAL WORD MALFUNCTION panel, repeat step a.
- f. Place INSERTION MODE switch at this panel to NORM.
- g. At BI-LEVEL CHANNEL MALFUNCTION panel, repeat step a.
- h. Place INSERTION MODE switch to NORM.
- i. Operate digiswitches at ANALOG MONITOR panel to select desired parameters to be displayed on each meter.
- j. Operate digiswitches at BI-LEVEL CHANNEL MONITOR panel to select desired parameters to be displayed.

NOTE

Beneath each meter is a writing space for pertinent notations (channel data).

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This completes the setup procedure for the TM console. Note that the faults are set up but are not as yet inserted (that is, INSERTION MODE switch placed to NORM). During the training exercise, the TM instructor operates the insertion rotary switch and the insertion switch-light to activate the selected faults. If these faults are to be inserted under computer control (that is, INSERTION MODE switch placed to COMP), the TM instructor must verify that all fault control malfunctions have been either preprogramed into the AMS computer or inserted manually through the MIU by the AMS instructor at the IOS.

1.3.12 SECURING THE TM CONSOLE.

This procedure to be defined later.

1.3.13 COMPUTER AND SIMULATOR STATUS.

Prior to training operation of the AMS, a gross status check is performed by the instructor at the IOS. The overall status of the three computers and the peripheral equipment is indicated at the computer status panel, IOS 80. The indicators on this panel also serve to notify the instructor of the computer complex status during the training problem performance. The overall status of the entire AMS complex is provided at IOS panel 47, simulator status. This panel indicates, to the instructor, whether there is any trouble within the major subsystems. Only a gross indication is provided and if any indicator is illuminated, the instructor must check the associated panel on the IOS or peripheral cabinet to determine the nature of the problem. Therefore, the readiness checks required of the instructor are limited to the following:

- a. Verify that all indicators at simulator status panel are extinguished.
- b. Verify that none of the computers are in a halt condition at computer status panel (that is, HALT light extinguished).

1.3.14 CLOSED CIRCUIT TV SETUP.

The CCTV procedure in this paragraph is followed by each instructor-operator at the beginning of the training period. The camera image is prealigned and adjusted by maintenance personnel, using the appropriate scopes and metering equipment. The instructor is only required to set the uncovered and readily accessible controls. Each instructor station is provided with the controls necessary to operate that particular camera and monitor. Actions performed at one station do not effect the operation or presentation at either of the other two stations. To set up the CCTV system, the instructor(s) will accomplish the following:

- a. Place power switch at camera control module to ON.
- b. Observe that POWER light illuminates.
- c. Observe VIDEO LEVEL indicator for proper level reading.
- d. Adjust FOCUS, INTENSITY, and LINEARITY control on TV monitor chassis to desired setting.
- e. At camera control module, depress and hold MAGNIFIER pushbutton.
- f. Observe magnification of monitor image.
- g. Release MAGNIFIER pushbutton.
- h. Place AUTO-MANUAL switch to AUTO.

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1.3.15 RECORDER AND PLOTTER STATUS.

The following procedure defines the steps required by the instructor to operate the recorder and plotter panel during preparation, initialization, and simulation.

- a. At IOS panel 85, place VOICE RECORDER RECORDING on-off switch-light to on and observe that switch-light extinguishes.
- b. At IOS panel 85, depress VOICE RECORDER RECORDING CONT switch-light and observe that switch illuminates.
- c. Verify that VOICE RECORDER LAST CART indicator is extinguished.
- d. Depress each X-T RECORDERS switch-light.
- e. Observe that ON portion of split-screen switch-light illuminates.
- f. Depress each of four X-Y PLOTTERS PEN DOWN switch-lights and observe that switches illuminate.

1.3.16 TRUE TRAINEE ENVIRONMENT AND WASTE MANAGEMENT STATUS.

The waste management panel (IOS panel 3) is a repeater panel of simulated spacecraft controls. In conjunction with readiness, the instructor need only verify that all indicator lights on this panel are extinguished. However, the true trainee environment panel (IOS panel 2) contains instructor controls and displays used to monitor and assist the simulation effects. The instructor is referred to paragraph 1.2.11 for further information related to panel control operation. Setup and readiness checks involved require the instructor to accomplish the following:

- a. Verify that AIR FLOW LOW light is extinguished.
- b. Note indications of suit and cabin environmental conditions to verify normal operation of these systems.
- c. Place SUIT PRESSURE OVERRIDE control to NORM.
- d. Place REENTRY HEAT OVERRIDE control to NORM.
- e. Lift guard on AURAL SIMULATION ON-OFF switch and place switch to ON.
- f. Place AURAL SIMULATION OVERRIDE db control to NORM.
- g. Verify that SMOKE GENERATOR FLUID LOW light is extinguished.
- h. Place four switch-breakers at waste management control panel to ON.
- i. Verify that both FILTER BLOCKED indicators on this panel are extinguished.

1.3.17 G&N AND VISUAL READINESS.

The visual systems status panel (IOS panel 1) contains gross status indications of conditions existing within each of the visual system.

- a. Verify that all SERVO SYSTEM COMPUTER portions of split-screen indicators are illuminated and MANUAL portions are extinguished.
- b. Verify that all lamp supply and power supply fail indicators are extinguished.
- c. Verify that AIR COMPRESSOR SAFE portion of split-screen indicator is illuminated and FAIL portion is extinguished.

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NOTE

The air compressor is interlocked with all MEP arc lamps to shut down all lamps if the compressor fails or does not deliver the proper air pressure.

The G&N supplementary and navigation evaluation panels (IOS panels 16 through 23) required the following steps to be accomplished:

- a. Verify that NAVIGATION PARAMETERS (IOS panel 19) LONG and LAT split-screen indicators are illuminated.
- b. Adjust BRIGHTNESS and FOCUS controls for TELESCOPE-SEXTANT DISPLAY (IOS panel 20) to desired setting.
- c. Verify that proper REFERENCE FRAME light is illuminated on IOS panel 21.
- d. Depress ZERO pushbuttons on IOS panel 22 and verify that related digital display indicates zero.
- e. Place CRT MODE SELECTOR switch to SCT 60°.
- f. Place MARK HOLD RELEASE MAN-AUTO switch-light to AUTO and verify that proper switch illuminates.

1.3.18 MALFUNCTION INSERTION AND STATUS.

The procedure for presimulation preparation and insertion of malfunctions requires the instructor to be cognizant of session data, section 1 of Volume III. The data sheets contained therein, for each training exercise, list those malfunctions to be inserted. Working from these sheets and using the procedure defined in paragraph 1.2.13, the instructor will perform the following:

- a. Depress MASTER CLEAR ALL SYSTEMS switch-light at MIU control panel (IOS panels 28, 60, and 78).
- b. Observe that MASTER CLEAR ALL SYSTEMS switch-light extinguishes to signify all previous malfunctions have been cleared.
- c. Insert all malfunctions listed on data sheet into computers.
- d. Using computer printout, verify insertion of each malfunction on exercise data sheet.
- e. Note time of occurrence of any time-dependent malfunctions entered by this procedure or previously entered into computers.

NOTE

The master clear function will not clear inactive time-dependent malfunctions previously entered into computer programs (paragraph 1.2.13).

1.3.19 UP-DATA LINK STATUS.

The preparation of this panel for simulation use requires only that the instructor verify that the NON-INTEGRATED portion of the split-screen MODE switch-light is illuminated. For operation of this panel during simulation, the instructor is referred to paragraph 1.2.12 of this section.

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1.3.20 TIME SYNCHRONIZATION AND INITIALIZATION.

This paragraph delineates the procedures for initiating a simulation run. Most of the procedure is performed on IOS panel 45 (simulator control panel). The steps listed are those for normal initialization of a ready simulator at all initialization points other than those for prelaunch (S1 and S2). Program initialization points are the subject of paragraph 3.7 of Volume I of this handbook.

- a. At IOS panel 45, depress FREEZE switch-light.
- b. Observe that FREEZE light illuminates.
- c. At IOS panel 45, place INITIAL CONDITION CALL UP digiswitches to initial conditions corresponding to requirements for specific simulation run.
- d. Via typewriter, input GMT, day of month, and last day of current month (typewriter operation is provided in paragraph 1.2.8).
- e. Via typewriter, input MTU tape identifier for this exercise.
- f. Direct person(s) in SCM in setting of controls in accordance with appropriate initialization data sheet from section 2, Volume III of this handbook.
- g. At IOS panel 45, depress RESET switch-light.
- h. Observe that RESET light illuminates.
- i. Depress RUN switch-light at IOS panel 45.
- j. Observe that RUN light illuminates.
- k. Observe that RESET light extinguishes.
- l. Observe that FREEZE light extinguishes.
- m. Observe CTE clocks on IOS panels 35 and 64 update to GMT input.

NOTE

The CTE clocks will become active in coincidence with the next WWV one minute pulse after RUN is initiated.

The procedure for initializing at prelaunch or after a freeze, step ahead, reset, recycle and hold is very similar to those for normal initialization. All are itemized in table 1-7. The steps involved are listed at the left-hand side of the table. Numbers in column 1 are the sequence of steps for normal initialization per the procedure described. The numbers in column 2 are the sequence for prelaunch initialization. The numbers in columns 3, 4, 5, 6, and 7 are the sequences of events for the procedure identified in their respective headings.

1.3.21 SECURE TRUE TRAINEE ENVIRONMENT SYSTEM.

This procedure to be defined later.

1.3.22 SECURE RECORDERS AND PLOTTERS PANEL.

This procedure to be defined later.

1.3.23 SECURE G&N AND VISUAL SYSTEMS.

This procedure to be defined later.

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Table 1-7. Simulator Control Panel Procedures

Condition	1 Normal	2 Prelaunch	3 Freeze	4 Step Ahead	5 Reset	6 Recycle	7 Hold
Depress HOLD							1
HOLD light on						1	2
GO light out						2	3
Depress FREEZE	1	1	1		1		
FREEZE light on	2	2	2	3	2		
RUN light out			3	4	3	3	4
Set INIT COND	3	3		5	4		
Up-date CTE	4	4		6	5		
Select tape input	5	5		7	6		
Set SCM conditions	6	6					
Depress RESET	7				7		
RESET light on	8				8		
Depress RUN	9	9	4	9	10	6	5
RUN light on	10	10	5	10	11	7	6
RESET light out	11				9		
FREEZE light out	12		6	11	12		
CTE clocks running	13	14	7	12	13	12	10
Depress STEP AHEAD				1			
STEP AHEAD light on				2			
Depress GO		12				8	7
GO light on		13				9	8
Depress RECYCLE		7				4	
RECYCLE light on		8				5	
HOLD light out						10	9
RECYCLE light out		11				11	
STEP AHEAD light out				8			

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1.4 SIMULATOR COMPLEX CHECKLISTS.

Table 1-8 comprises a checklist for instructor-operator setup and operation of the AMS complex for complete mission simulations, that is, from pre-launch through orbital phase and retrofire and backdown to touchdown. All procedures included are with specific reference to unit procedures and/or systems checklists provided elsewhere in this section of the handbook. It is ultimately planned to add procedures for restoring the AMS to a known base line configuration when simulator operation is complete.

The checklist procedures provided in table 1-8 are the procedures for setup and operation for a complete three-orbital mission and inherently contain procedures for setting up the simulator for simulation of all partial missions. Table 1-1 provided earlier in this section illustrates how and which portions of the complete (mission) AMS complex checklist are used to prepare checklists for launch-boost, orbit, and entry part-mission simulations. Which AMS complex checklist each procedure applies to is noted in the procedure heading in the complete (mission) checklist. The special procedure for abort simulation is the subject of paragraph 1.4.2.2.

1.4.1 MISSION SIMULATION PREPARATION-OPERATION.

Preparation and operation of the AMS for purposes of simulating complete Apollo missions involves the accomplishment of all procedures in table 1-8 as explained in paragraph 1.4.

1.4.2 LAUNCH SIMULATION PREPARATION-OPERATION.

The checklists outlined in table 1-1 for launch simulation preparation-operation are for simulation of launch boosts that are not continued into the orbital phase. Such simulations fall into two groups: simulation of successful launch boost that is terminated at orbit injection and simulation of abortive launch boosts that are concluded with LES or SPS abort simulation. Because such simulations are relatively short and involve no visual simulation, many procedures in the complete (mission) checklists are omitted, for example, potable water system, waste management system, and visual system procedures.

1.4.2.1 Successful Launch-Boost Preparation-Operation.

The procedure for preparation and operation of the AMS for simulation of successful launch-boost is in accordance with those portions of table 1-8 outlined for this purpose in table 1-1.

1.4.2.2 Launch-Boost Abort Preparation-Operation.

The complex checklist for successful launch-boost simulation must be augmented with cause for abort and abort initiation instructions in order to be used for abort simulation.

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The single-boost tape provided for the initial delivered configuration of the AMS does not include any simulation of booster malperformance. This is not, however, prohibitive to effective simulation of crew and auto abort simulation for training purposes.

All instructor access to abort simulation is by means of the malfunction insertion unit. The malfunctions available for this purpose are listed as follows.

<u>Malfunction Title</u>	<u>MIU Code</u>
ABORT REQUEST LIGHT ON	CS 201
BOOSTER ENGINE #1 FAIL	CS 203
BOOSTER ENGINE #2 FAIL	CS 205
BOOSTER ENGINE #3 FAIL	CS 207
BOOSTER ENGINE #4 FAIL	CS 211
BOOSTER ENGINE #5 FAIL	CS 213
BOOSTER ENGINE #6 FAIL	CS 215
BOOSTER ENGINE #7 FAIL	CS 217
BOOSTER ENGINE #8 FAIL	CS 221
LV RATES EXCESSIVE	CS 223
LV GUIDANCE FAIL	CS 225
INSTRUCTOR INITIATED ABORT	CS 250

These malfunctions, with the exception of INSTRUCTOR INITIATED ABORT, only illuminate the respective lights within the SCM and do not cause an automatic abort to occur, as would happen in the actual spacecraft. Therefore, the instructor must augment the simulation. To do this, he may choose one of two alternatives after he has activated abort initiation malfunction indications: (1) the instructor may initiate an automatic abort (malfunction No. 250) to cause the simulation to appear realistic or (2) he may allow events that occur to be dependent upon crew actions (that is, apparent failure of the EDS automatic abort system). The following procedures are recommended for the operation of the MIU during the launch phase for purposes of effective abort simulation. In the procedures, specific malfunction codes are used as examples; however, others tabulated in the preceding list may be substituted for those used.

Alternative 1, Auto Abort.

- a. Depress MIU CONTROL PANEL RESET switch-light. Switch-light illuminates and extinguishes when MIU control panel clears.
- b. Depress DISPLAY 1 switch-light. Switch-light illuminates on MIU control and display panel; CONTROL PANEL IN USE light illuminates on all MIU control panels.
- c. Depress CS SYSTEM SELECT switch-light. Switch-light illuminates.
- d. Depress KEYBOARD digits 2, 0, and 3, in that order. Code 203 displayed in VERIFY register; IMP light illuminates; CS 203 code is displayed in DISPLAY 1 of MIU display panels; and control panel is reset.

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- e. Repeat steps a through d for malfunction codes CS 205 and CS 250 using DISPLAY 2 and DISPLAY 3.
- f. At desired time after lift-off, depress DISPLAY 1 switch-light on MIU control panel. Switch-light illuminates; CONTROL PANEL IN USE light illuminates on all MIU control panels.
- g. Depress MALF ENTER switch-light at MIU control panel. Switch illuminates; IMP light extinguishes; and ENT light illuminates.
- h. Observe crew reaction to booster engine failure indication.
- i. Reset MIU control panel.
- j. Repeat steps 6 and 7 for DISPLAY 2 and DISPLAY 3.
- k. Observe trainee response to abort initiation.
- l. Continue with abort crew procedures data.

Alternative 2, Crew Initiated Abort.

- a. Key malfunction codes CS 201, CS 203 and CS 205 in DISPLAY 1, 2, and 3, respectively. Malfunction codes are displayed on MIU display in respective display locations with each IMP light illuminated.
- b. At desired time after lift-off, depress DISPLAY 2 switch-light on MIU control panel. Switch-light illuminates; CONTROL PANEL IN USE light illuminates on all control panels.
- c. Depress MALF ENTER switch-light. Switch-light illuminates; display panel ENT light for DISPLAY 2 illuminates; and IMP light extinguishes.
- d. Observe crew reaction to booster engine failure indication.
- e. Reset MIU control panel.
- f. Depress DISPLAY 3 switch-light. Switch-light illuminates.
- g. Depress MALF ENTER switch-light. Switch-light illuminates; display panel ENT light for DISPLAY 3 illuminates; and IMP light extinguishes.
- h. Monitor crew response to abort situation.
- i. If crew does not initiate abort within prescribed time, depress DISPLAY 1 switch-light at MIU control panel. Switch-light illuminates; CONTROL PANEL IN USE light illuminates on all control panels.
- j. Depress MALF ENTER and verbally request crew to initiate abort. Switch-light illuminates; display panel ENT light illuminates; and IMP light extinguishes.
- k. Monitor crew reaction to ABORT indication and request.
- l. If crew does not initiate abort, terminate simulation.

1.4.3 ORBITAL SIMULATION PREPARATION-OPERATION.

The procedure for preparation and operation of the AMS for simulation of orbital situations is in accordance with those portions of table 1-8 outlined for this purpose in table 1-1. Preparation of the potable water and waste management system is optional on the basis of planned time duration for the simulation.

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1.4.4 ENTRY SIMULATION PREPARATION-OPERATION.

The procedure for preparation and operation of the AMS for simulation of entry subsequent to retrograde deboost is in accordance with those portions of table 1-8 outlined for this purpose in table 1-1. Such simulation is relatively short and involves no visual simulation. Many procedures in the complete (mission) complex checklists are omitted, for example, potable water system, waste management system, and visual system procedures.

1.4.5 SIMULATION COMPLETE.

These checklists will enable the instructor-operator to return the AMS to a known baseline configuration at the completion of training. At the present, baseline configuration is undefined.

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Table 1-8. Simulator Complex Checklist

VISUAL SYSTEMS CHECKLIST

SIMULATOR PREPARATION

FILM CASSETTE LOADING

This checklist is used to prepare the optical system with film required for the selected training exercise. Unit procedure is described in paragraph 1.2.1.

This procedure is used for all complex checklists except launch, abort, and entry.

- | | |
|-------------------------|---------|
| a. MEP power | Off |
| b. Maintenance doors | Open |
| c. Film cassettes | Install |
| d. Maintenance doors | Closed |
| e. MEP power | On |
| f. VERIFY STATUS lights | Off |

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Table 1-8. Simulator Complex Checklist (Cont)

SIMULATED COMMAND MODULE CHECKLIST

SIMULATOR PREPARATION

POTABLE WATER SYSTEM

This checklist is used for replenishing the water supply within the simulated spacecraft. Unit procedure is described in paragraph 1.2.2.

This procedure is used for all complex checklists except launch and entry.

- | | |
|-------------------------------|----------------|
| a. Pressure regular valve | Closed |
| b. FILL-PRESSURE valve | FILL VENT |
| c. Fill hose disconnect valve | Attach |
| d. Fill tank-level gage | _____ gal. |
| e. Fill hose | Remove |
| f. FILL-PRESSURE valve | PRESSURE CLOSE |
| g. Pressure regulator 20 PSI | OPEN |
| h. Water supply valves | CYCLE |

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Table 1-8. Simulator Complex Checklist (Cont)

SIMULATED COMMAND MODULE CHECKLIST

SIMULATOR PREPARATION

CHECK AND EMPTY WASTE MANAGEMENT

This checklist is used to prepare the WMS for operation by removing waste matter and replenishing the disinfectant. Unit procedure is described in paragraph 1.2.3.

This procedure is used for all complex checklists except launch and entry.

- | | |
|--|-------------|
| a. MAIN POWER & AUXILIARY EQUIP breakers | ON |
| b. FILTER BLOCKED indicators (2) | Out |
| c. SCM URINE DUMP switches (2) | DUMP |
| d. Flexible hose to urine outlet | Attach |
| e. Urine valve 90° CW | Rotate |
| f. SCM URINE DUMP switches (2) | OFF |
| g. Fill urinal with disinfectant | 1 quart |
| h. Steps c and e | |
| i. Fill disinfectant tank | _____Quarts |
| j. VACUUM CLEANER MOTOR switch | ON |
| k. WMS storage compartment | Empty |

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Table 1-8. Simulator Complex Checklist (Cont)

SIMULATED COMMAND MODULE CHECKLIST

SIMULATOR PREPARATION

VERTICAL INSERTION AND RETRACTION

This checklist is used in positioning the SCM in the horizontal and vertical direction for operation. Unit procedure is described in paragraph 1.2.4.

This procedure is used for all complex checklists.

- | | |
|------------------------------------|---------------|
| a. SCM clear obstructions | Verify |
| b. C/M LIGHTS ON switch | Depress |
| c. Horizontal control panel | |
| 1. CLUTCH RUN switch | Depress |
| 2. Activate clutch | Position |
| 3. MOTOR FORWARD switch | Depress |
| 4. Deactivate clutch | Position |
| 5. CLUTCH STOP switch - after stop | Depress |
| 6. Lock lever | Down and Lock |
| d. Vertical control panel | |
| 1. UP switch | Depress |
| 2. STOP switch - after stop | Depress |

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Table 1-8. Simulator Complex Checklist (Cont)

COMPUTER SYSTEM CHECKLIST

SIMULATOR PREPARATION

COMPUTER LOADING BY MTU

This checklist is used to load program data into the computer via special programs previously loaded into the computer via the tape reader. This monitor program enables the MTU to input program data into memory under control of the typewriter. Unit procedure is described in paragraph 1.2.5.

This procedure is used for all complex checklists.

- | | |
|--|---------|
| a. DENSITY mode | Select |
| b. Monitor program inserted | Verify |
| c. Computer halt condition | Verify |
| d. MASTER CLEAR pushbutton | Depress |
| e. PROGRAM REGISTER _____ | Set |
| f. START pushbutton | Depress |
| g. Typewriter unlock - word SELECT typed | Observe |
| h. Computer input-output hold condition | Verify |
| i. CARRIAGE RETURN | Depress |
| j. Word READY - computer halt condition | Observe |
| k. MASTER CLEAR | Depress |

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Table 1-8. Simulator Complex Checklist (Cont)

TELEMETRY SYSTEM CHECKLIST

SIMULATOR PREPARATION

TM CONSOLE FAULT PATCHING

This checklist is used for inserting parameter faults into simulated spacecraft down telemetry channels. Unit procedure is described in paragraph 1.2.9.

This procedure can be used on all complex checklists.

- | | |
|---------------------------------------|---------|
| a. Patch panel | Remove |
| b. TM fault patch per paragraph 1.2.9 | |
| c. Patch panel | Replace |

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Table 1-8. Simulator Complex Checklist (Cont)

COMPUTER SYSTEM CHECKLIST

SIMULATOR PREPARATION

COMPUTER READINESS FOR LOADING

This checklist prepares the computers for operational program loading from either the MTU, paper tape or typewriter. Unit procedure is described in paragraph 1.3.1.

This procedure is used for all complex checklists.

- | | |
|----------------------------|-----------|
| a. Operational readiness | Verified |
| b. SENSE SWITCHES | Place |
| SENSE 1 _____ | |
| SENSE 2 _____ | |
| SENSE 3 _____ | |
| SENSE 4 _____ | |
| SENSE 5 _____ | |
| SENSE 6 _____ | |
| c. MASTER CLEAR pushbutton | Depress |
| d. Reader ON LINE-OFF LINE | ON LINE |
| e. Reader CONTIN-PULSED | CONTIN |
| f. PUNCH switch | OFF |
| g. TYPE switch | ON LINE |
| h. TAPE READER POWER | ON |
| i. LOAD switch | Rotate CW |
| j. Tape into tape reader | Insert |
| k. PROGRAM REGISTER _____ | Set |

...continued

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Table 1-8. Simulator Complex Checklist (Cont)

l. FILL pushbutton	Depress
m. Paper tape feed	Observe
n. HALT light	On
o. MASTER CLEAR pushbutton	Depress

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Table 1-8. Simulator Complex Checklist (Cont)

COMPUTER SYSTEM CHECKLIST

SIMULATOR PREPARATION

MAGNETIC TAPE PROGRAM LOADING

This checklist is used basically for loading the memory for the operational program from the MTU. Unit procedure is described in paragraph 1.3.2.

This procedure is used for all complex checklists.

- | | |
|---|----------------|
| a. Spool read or read-write | Select |
| b. POWER switch MTU | Depress |
| c. Glass door | Slide down |
| d. Reel hub release arm | Lift |
| e. Tape spool | Place |
| f. Reel hub release arm | Lower |
| g. Empty takeup spool | Place |
| h. BRAKE RELEASE | Depress-hold |
| i. Thread tape | |
| j. BRAKE RELEASE | Depress-hold |
| k. Wind tape manually on takeup spool | Secure |
| l. BRAKE RELEASE | Release |
| m. Glass door | Lift and close |
| n. LOCAL switch | Depress |
| o. LOCAL-REWIND switch - observe tape feed
stop at beginning of tape | Depress |

...continued

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Table 1-8. Simulator Complex Checklist (Cont)

p. STOP light	On
q. REMOTE switch	Depress
r. DENSITY MODE	Select
s. Monitor program	Loaded
t. MASTER CLEAR pushbutton	Depress
u. PROGRAM REGISTER _____	Set
v. PROGRAM REGISTER _____	Depress
w. SELECT on typewriter	Observe
x. I/O HOLD light	On
y. Choose _____	Type
z. CARRIAGE RETURN	Depress
aa. READY on typewriter	Observe
ab. HALT light	On
ac. MASTER CLEAR pushbutton	Depress
ad. Repeat steps u through ac if more data to be loaded.	

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Table 1-8. Simulator Complex Checklist (Cont)

COMPUTER SYSTEM CHECKLIST

SIMULATOR PREPARATION

PUNCHED CARD PROGRAM LOADING

This checklist is used for operation of the card reader to load program data into computer memory for training exercises. Unit procedure is described in paragraph 1.3.3.

This procedure is used for all complex checklists.

- | | |
|--------------------------------------|----------|
| a. POWER ON | Depress |
| b. NOT READY light | On |
| c. RESET switch | Depress |
| d. START switch | Depress |
| READY light on - NOT READY light off | |
| e. Card deck | Load |
| f. MASTER CLEAR pushbutton | Depress |
| g. READER switch | OFF LINE |
| h. PROGRAM REGISTER _____ | Set |
| i. START pushbutton | Depress |
| Card feed | |
| j. NOT READY light | Observe |
| 1. END OF FILE switch (hopper empty) | Depress |
| 2. STOP switch (stacker full) | Depress |

...continued

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Table 1-8. Simulator Complex Checklist (Cont)

- | | |
|-----------------------|---------|
| k. STOP switch | Depress |
| l. Cards from stacker | Remove |
| m. RESET switch | Depress |

If needed, repeat steps i through m.

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Table 1-8. Simulator Complex Checklist (Cont)

COMPUTER SYSTEM CHECKLIST

SIMULATOR PREPARATION

TYPEWRITER PROGRAM LOADING

This checklist is used for program loading from the typewriter presenting octal character to the computer for memory storage. Unit procedure is described in paragraph 1.3.4.

This procedure can be used for any complex checklists.

- | | |
|---|---------|
| a. Typewriter on line | Verify |
| b. OP REGISTER _____ | Set |
| c. Z REGISTER _____ | Set |
| d. EXECUTE pushbutton | Depress |
| e. OP and Z REGISTER RESET pushbutton | Depress |
| f. PROGRAM REGISTER _____ | Set |
| g. Computer FILL pushbutton | Depress |
| h. Octal characters on typewriter | Type |
| i. CARRIAGE RETURN key | Depress |
| j. Load complete program steps h and i. | Repeat |
| k. BACKSPACE key | Depress |

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Table 1-8. Simulator Complex Checklist (Cont)

COMPUTER SYSTEM CHECKLIST

SIMULATOR PREPARATION

MANUAL PROGRAM LOADING

This checklist is used for manual memory loading of the computer program words, one at a time. Unit procedure is described in paragraph 1.3.5.

This procedure can be used for any complex checklist.

- | | |
|--|---------|
| a. MASTER CLEAR pushbutton | Depress |
| b. OP REGISTER _____ | Set |
| c. Z REGISTER _____ | Set |
| d. A REGISTER _____ | Set |
| e. EXECUTE pushbutton | Depress |
| f. HALT light | On |
| g. MASTER CLEAR pushbutton | Depress |
| h. Subsequent words repeat from step b | |

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Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

RECORDER AND PLOTTER INPUTS

This checklist is used to assign selected parameter to the X/T and X/Y recorders. Unit procedure is described in paragraph 1.2.8.3.

This procedure is used for all complex checklists.

- | | |
|---|---------|
| a. FREEZE switch-light | Depress |
| b. "X" typewriter key | Depress |
| c. Carriage return | Verify |
| d. Output message | Verify |
| e. "+" or "-" typewriter key | Depress |
| f. Octal character on typewriter | Type |
| g. "/" (slash) typewriter key | Depress |
| h. "+" or "-" typewriter key | Depress |
| i. Two decimal integers | Type |
| j. "/" (slash) typewriter key | Depress |
| k. Two decimal integers | Type |
| l. Carriage return | Verify |
| m. Complete parameter assignments -
repeat steps e through i | Repeat |
| n. _____ typewriter key | Depress |
| o. Readiness and setup | Verify |

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Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

PLOTTER READINESS AND SETUP (30 X 30)

This checklist is used for setup of the plotter prior to a training exercise. Unit procedure is described in paragraph 1.3.7.

This procedure is used for all complex checklists.

- | | |
|--------------------------------------|--------|
| a. PEN UP-DOWN-REMOTE switch | REMOTE |
| b. PEN OPERATE-STANDBY-REMOTE switch | REMOTE |
| c. POWER switch | ON |
| d. LIGHTS switch | On |
| e. Load paper | |
| f. VACUUM switch | ON |
| g. PEN INTERCHANGE | AUTO |
| h. PEN & ARM PARALLAX control | Adjust |
| i. PEN & ARM SCALE FACTOR control | Adjust |
| j. VERNIER control | Adjust |
| k. PAPER ADJUST controls | Adjust |

APOLLO MISSION SIMULATOR INSTRUCTOR HANDBOOK

Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

PLOTTER READINESS AND SETUP (11 X 17)

This checklist is used for setup of the plotter for various simulated spacecraft and mission parameters. Unit procedure is described in paragraph 1.3.8.

This procedure is used for all complex checklists.

- | | |
|----------------------------|------------|
| a. VAC PWR switch | OFF-ON |
| b. VARIABLE-FIXED switches | FIXED |
| c. RANGE controls | Set |
| d. PEN-ARM switches | UP-STANDBY |
| e. ZERO controls | Adjust |
| f. Load paper | |
| g. VAC PWR switch | ON-ON |
| h. PEN INTCHG switch | AUTO |
| i. PEN-ARM switch | UP-OPERATE |
| j. SCALE FACTOR controls | Adjust |

APOLLO MISSION SIMULATOR INSTRUCTOR HANDBOOK

Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

RECORDER SETUP

This checklist is used for setting up the recorders prior to operation in a training exercise. Unit procedure is described in paragraph 1.3.9.

This procedure is used in all complex checklists.

- | | |
|--|---------|
| a. Power switch | ON |
| b. Selected VOLT-LINE pushbutton | Depress |
| c. Chart speed | Select |
| d. PAPER TAKE-UP pushbutton | Depress |
| e. TAKE-UP SPEED control | Adjust |
| f. CONTROL MODE FULL REMOTE pushbutton | Depress |

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Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

COMMUNICATIONS CONTROL SETUP

This checklist is used for setting up the communications configuration to be used during a simulation training exercise. Unit procedure is described in paragraph 1.3.10.

This procedure is used for all complex checklist.

a. AUDIO SELECT switches to CCS	Set
b. Headset cords	Connect
c. VOLUME control	Adjust
d. CMIL talk-listen keys	Depress
e. Continuity instructor loop	Verify
f. CL talk-listen keys	Depress
g. RING key (IOS 88)	Depress
h. CL key light	On
i. Continuity computer loop	Verify
j. ML talk-listen key	Depress
k. RING key (IOS 88)	Depress
l. ML key light	On
m. Continuity maintenance loop	Verify
n. CMIL talk-listen key (IOS 88)	Depress

...continued

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Table 1-8. Simulator Complex Checklist (Cont)

- | | |
|--|---------|
| o. Monitor keys AL-1 (IOS 88) | Depress |
| AL-2 | |
| AL-3 | |
| TM-1 | |
| TM-2 | |
| p. CMIL AND CM INTERCOM monitor keys | Depress |
| 1. Command (IOS 26) | |
| 2. Navigation (IOS 46) | |
| 3. System mangement instructor (IOS 70) | |
| q. Talk-listen keys per crew procedures | Depress |
| 1. Command (IOS 26) | |
| 2. Navigation (IOS 46) | |
| 3. System management instructor (IOS 70) | |

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Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

VOICE INTERFERENCE OPERATION

This checklist is used to allow the instructor to simulate effects of spacecraft misorientation or improper communications configuration management. Unit procedure is described in paragraph 1.3.10.

This procedure is used for orbital and entry complex checklists.

- | | |
|----------------------------------|--------|
| a. VHF-AM NOISE & GARBLE control | Adjust |
| b. S-BAND NOISE & GARBLE control | Adjust |

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Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

TM CONSOLE READINESS CHECK

This checklist is used for establishing a readiness for use condition at the console. Unit procedure is described in paragraph 1.3.11.

This procedure is used for all complex checklists.

- | | |
|---|---------|
| a. CCS as defined in paragraph 1.2.10 | |
| b. Correlation TO-FROM LAUNCH TIME AND MISSION TIME | Verify |
| c. LAMP TEST pushbutton | Depress |
| d. SPRIL LAMP TEST pushbutton | Depress |
| e. Light intensity controls | Adjust |
| f. TELEMETRY PCM ON switch | Depress |
| g. PCM STATUS switch-light | Observe |
| h. CCTV TO IMCC SELECTOR CAMERA switch | Set |
| i. Communications subpanel lights | Verify |

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Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

TM CONSOLE SETUP

This checklist is used for insertion of faults into preselected channels and selection of channels instructor chooses to monitor. Unit procedure is described in paragraph 1.3.11.

This procedure is used for all complex checklists.

- | | |
|--|--------|
| a. Analog fault INSERTION MODE switch | NORM |
| b. FAULT MODE rotary switch | OFFSET |
| c. RATE LEVEL control | Adjust |
| d. Digital word INSERTION MODE switch | NORM |
| e. Bilevel fault INSERTION MODE switch | NORM |
| f. CCTV to IMCC SELECT CAMERA switch | Set |

NOTE

Write faults above modules for reference.

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Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

COMPUTER AND SIMULATOR STATUS

This checklist is used for establishing readiness of the AMS through status indicator checks. Unit procedure is described in paragraph 1.3.13.

This procedure is used for all complex checklists.

- | | |
|------------------------|-----|
| a. STATUS lights (SSP) | Off |
| b. HALT lights (CSP) | Off |

APOLLO MISSION SIMULATOR INSTRUCTOR HANDBOOK

Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

CLOSED CIRCUIT TV SETUP

This checklist is used for setting the controls of the CCTV system at each instructor station prior to simulation run. Unit procedure is described in paragraph 1.3.14.

This procedure is used for all complex checklists.

- | | |
|--|------------------|
| a. POWER switch | ON |
| b. VIDEO LEVEL gage | Check |
| c. FOCUS, INTENSITY and LINEARITY controls | Adjust |
| d. MAGNIFIER pushbutton (CCM) | Depress and hold |
| e. Magnification on monitor | Observe |
| f. MAGNIFIER pushbutton | Release |
| g. AUTO-MANUAL switch | AUTO |

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Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

RECORDER AND PLOTTER STATUS

This checklist is used for defining steps needed in preparation, initialization and simulation. Unit procedure is described in paragraph 1.3.15.

This procedure is used for all complex checklists.

- | | |
|---|---------|
| a. VOICE RECORDER RECORDING ON-OFF switch-light | Out |
| b. VOICE RECORDER RECORDING CONT. switch-light | Depress |
| c. VOICE RECORDER LAST CART light | Off |
| d. X-T RECORDER switch-light | Depress |
| e. X-Y PLOTTERS PEN DOWN switch-light | Depress |

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Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

TRUE TRAINEE ENVIRONMENT

This checklist is used for setup and readiness checks of the instructor controls used to monitor and assist the simulation of system effects. Unit procedure is described in paragraph 1.3.16.

This procedure is used for all complex checklists.

- | | |
|--------------------------------------|--------|
| a. AIR FLOW LOW light | Off |
| b. Operation of SUIT and CABIN ECS | Verify |
| c. SUIT PRESSURE OVERRIDE control | NORM |
| d. REENTRY HEAT OVERRIDE control | NORM |
| e. AURAL SIMULATION ON-OFF switch | ON |
| f. AURAL SIMULATION OVERRIDE control | NORM |
| g. SMOKE GENERATOR FLUID LOW light | Off |

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Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

G&N AND VISUAL READINESS

This checklist is used to verify the readiness of the system and indicator operation. Unit procedure is described in paragraph 1.3.17.

This procedure is used for orbital complex checklist.

- | | |
|--|---------|
| a. SERVO SYSTEM COMPUTER light | On |
| b. Lamp and power fail light | Off |
| c. AIR COMPRESSOR SAFE light | On |
| d. NAVIGATION PARAMETERS LONG and
LAT light | On |
| e. BRIGHTNESS and FOCUS controls | Adjust |
| f. REFERENCE FRAME light | On |
| g. ZERO pushbutton | Depress |
| h. CRT MODE SELECTOR rotary switch | Set |
| i. MARK HOLD RELEASE MAN-AUTO switch-light | AUTO |

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Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

MALFUNCTION INSERTION AND STATUS

This checklist is used for inserting malfunctions into the training exercise. Unit procedure is described in paragraph 1.3.18.

This procedure is used for all complex checklists.

- | | |
|--|---------|
| a. MASTER CLEAR ALL SYSTEMS switch-light | Depress |
| b. MASTER CLEAR ALL SYSTEMS switch-light | Off |
| c. Malfunctions per paragraph 1.2.13 | Insert |
| d. Malfunction printout-note time | Verify |

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Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

UP-DATA LINK STATUS

This checklist is used as a readiness check for nonintegrated operation of the up-data link panel. Unit procedure is described in paragraph 1.3.19.

This procedure is used for all complex checklists.

- | | |
|--------------------------|---------|
| a. UDL MODE switch-light | Depress |
| b. NON-INT light | On |

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Table 1-8. Simulator Complex Checklist (Cont)

INSTRUCTOR-OPERATOR STATION CHECKLIST

SIMULATOR PREPARATION

TIME SYNCHRONIZATION AND INITIALIZATION

This checklist is used for normal initialization of a ready simulator at all initialization points other than prelaunch S1 and S2. Unit procedure is described in paragraph 1.3.20.

This procedure is used for all complex checklists.

- | | |
|---|---------|
| a. INITIAL CONDITION CALL UP switch _____ | Set |
| b. FREEZE switch-light | Depress |
| c. GMT data | Type |
| Day _____
Hour _____
Minute _____
Last day of
current month _____ | |
| d. MTU tape identifier _____ | Type |
| e. RESET switch-light | Depress |
| f. RUN switch-light | Depress |
| g. RESET switch-light | Off |
| h. FREEZE switch-light | Off |
| i. MISSION TIME and TO-FROM LAUNCH CLOCKS running | Observe |

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SECTION 2

PROGRAM DATA

2.1 PURPOSE AND SCOPE.

This section of the handbook is to provide the AMS instructor-operator with enough computer program data to effectively operate the simulator without recourse to other AMS documentation. The AMS computer programs are divided into two functional groups: operational and diagnostic.

Operational programs are those programs used to accomplish simulation of Apollo spacecraft systems and missions. There are five types of operational programs: (1) vehicle dynamics, (2) vehicle systems, (3) simulation effects, (4) simulator control, and (5) interface (MSCC).

The diagnostic programs (routines) are used to determine status and condition of the simulator, test and/or monitor AMS equipment operation, and isolate simulation equipment failures. Diagnostic programs include off-line routines for simple readiness checks, checkout, and detailed error detection and troubleshooting. On-line routines are provided for operation of the simulator status displays on the IOS and for sampling of simulation characteristic during on-line simulator operation. The on-line routine related to the simulator status indicators is inherent in the normal operational program.

2.2 VEHICLE DYNAMICS PROGRAMS.

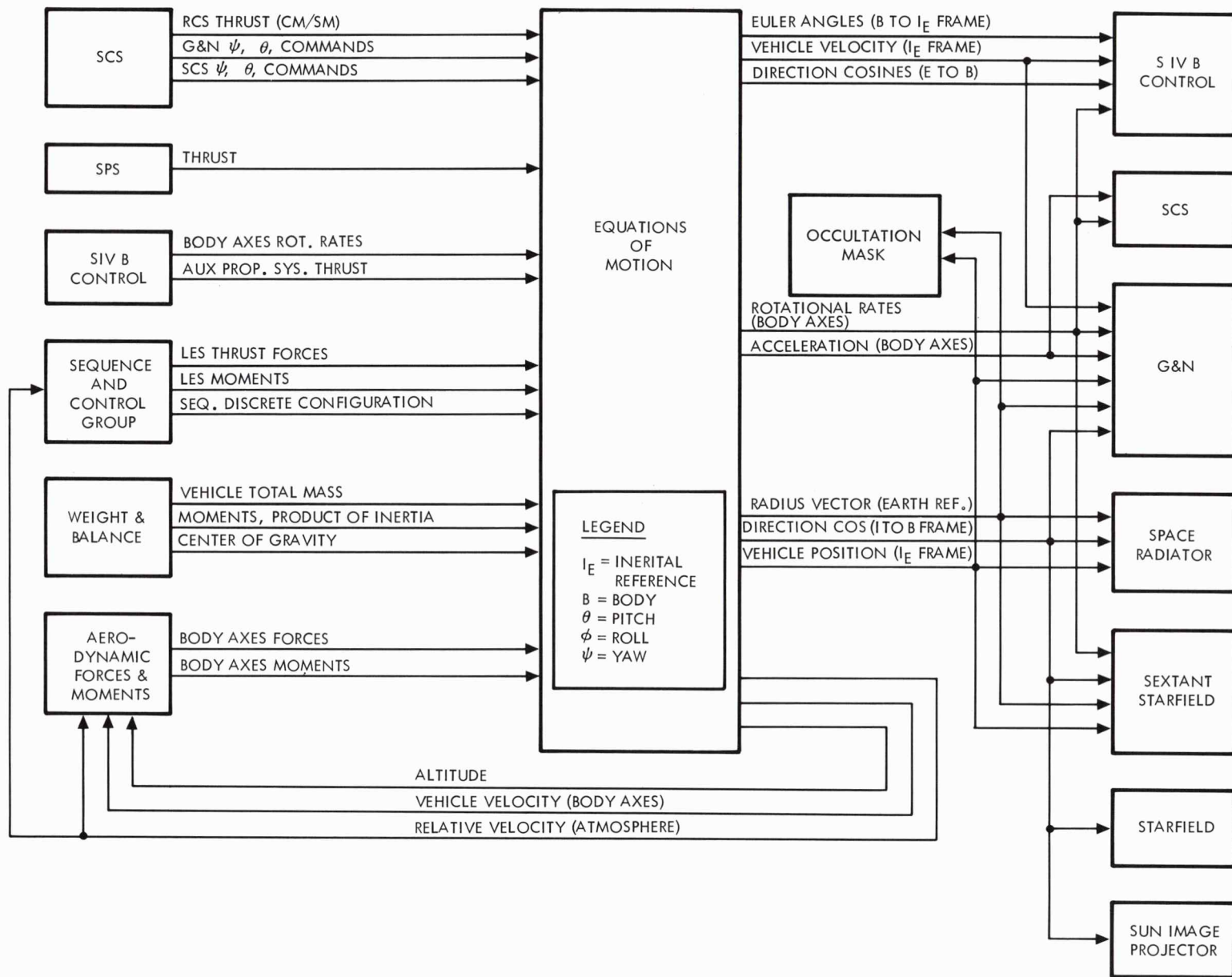
The vehicle dynamics programs are provided to simulate all dynamic aspects of the Apollo spacecraft and mission. Computations include the equations of motion, aerodynamics coefficients, weights and balances as a function of GMT elapse. The functional output of the computations include spacecraft geographic and celestial positions and attitude. These are manifested in the AMS visual systems and simulated spacecraft instruments. Computation of these characteristics are continually computed from simulated spacecraft thrusting systems inputs (SPS and RCS), elapsed time, and the operation of other spacecraft systems (where they affect weight and balance of the vehicle).

2.2.1 EQUATIONS OF MOTION.

The equations of motion compute translational movement along and rotational movement about the three spacecraft axes and the required conversion between the different inertial reference frames.

2.2.1.1 EOM Program Interface.

A block diagram of the interface between the equations of motion and other programs within the AMS computer is shown in figure 2-1. To compute



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Figure 2-1. Equations of Motion Interface Block Diagram

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simulated spacecraft attitude, position, and velocity vector, the equations consider the affect of RCS, SPS, S-IVB, LES and launch boost thrust inputs on the simulated spacecraft mass, inertia, and center of gravity.

Several output factors from the equations of motion (EOM) are fed back into the programs providing input to the EOM to continuously update the solution on the basis of continued thrusting. The factors routed back to inputting programs are altitude, vehicle velocity (body axis), and relative velocity to the aerodynamics forces and moments program, and altitude to the sequence and control group program. The functions of these interfaces are as follows:

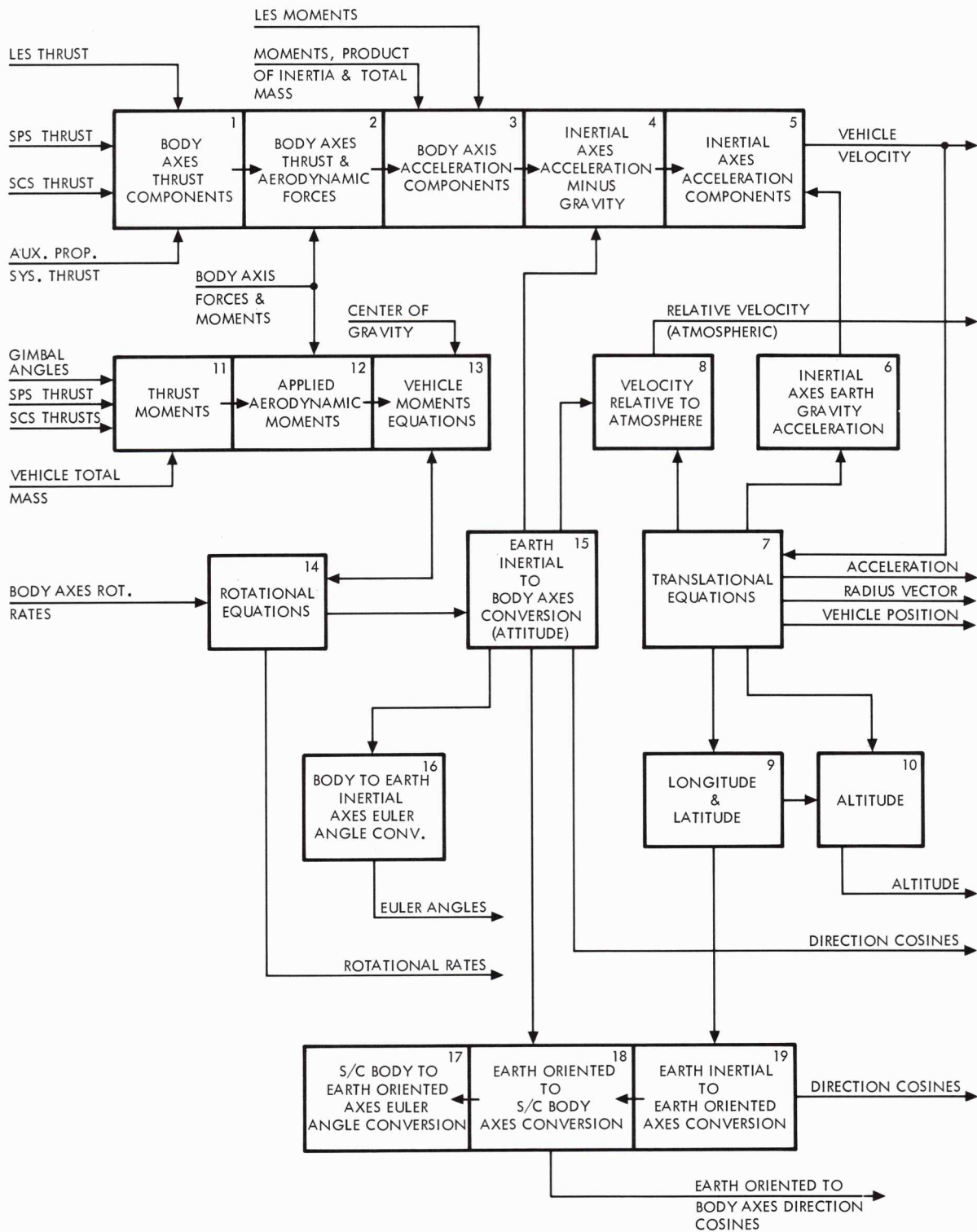
- The sequence control group program uses simulated S/C altitude to determine abort mode and for event initiation.
- Aerodynamic forces and moments program receive body axis vehicle velocity along with atmospheric (relative) velocity and altitude. These terms are used to compute atmospheric affect on vehicle attitude simulation. The resultant terms are then sent to the EOM in the form of aerodynamic force and moment vectors.
- The S-IVB control program receives vehicle attitude error in the form of Euler angles. Vehicle velocities, attitude direction cosines, and rotational rates are also sent to the S-IVB control block.
- The SCS and G&N simulations both receive rotational rates and acceleration with respect to the body axes from the EOM. These inputs simulate the gyros and accelerometers in the two systems. In addition, the G&N system receives earth radius vector, vehicle position and direction cosines for use in simulating vehicle location and attitude.
- The space radiators program also uses earth radius vector, vehicle position, and direction cosines from the EOM to determine cooling efficiency simulation.
- The same three EOM outputs plus body axes rotational rates are fed to various visual simulation blocks to control out-the-window and optics displays.

2.2.1.2 Computation of EOM.

A block diagram of the equations of motion is shown in figure 2-2. Each block represents one equation or more within the EOM.

Simulation of velocity, acceleration, and vehicle position is accomplished by blocks 1 through 10. The body axis thrust components block (block 1) uses thrust inputs from various S/C systems to compute the three body axis thrust vectors. Block 2 adds the affect of aerodynamic forces to the thrust vectors. In block 3, the effect of thrust on the vehicle mass is determined. In case of a simulated LES abort, this block will calculate the effect of LES thrusting on the command module. Blocks 4 and 5 convert the body axis accelerations from block 3 to inertial axis vectors, and integrate earth gravitational affect (block 6) into the output signals. These output signals represent vehicle velocity.

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Figure 2-2. Equations of Motion Block Diagram

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Vehicle velocity from block 5 is also fed to block 7. Here, the translational equations will integrate the vehicle velocity vectors to establish vehicle position, acceleration, and radius vector from the center-of-earth mass to the spacecraft. Vehicle velocity, in addition to being sent out of the EOM, is also sent through block 7 to block 8 where it is used to determine relative velocity.

Vehicle position, in addition to being sent out of the EOM, is fed into the longitude-latitude block (block 9). Radius vector is sent out of the EOM to the altitude block (block 10) where longitude-latitude position is combined with the radius vector to determine altitude above earth surface. This is necessary because the earth center of mass, upon which the radius vector is based, is not the same as the geographic center of the earth. Therefore, spacecraft altitude, with respect to earth surface, will vary as a function of longitude-latitude position.

Spacecraft attitude is simulated by blocks 11 through 19 in the EOM diagram of figure 2-2. Thrust moments (block 11) receive SPS gimbal angles and thrust along with various RCS jet fire commands from the SCS. The affect of these forces on total vehicle mass (from the weights and balances computations) is determined in the thrust moments block.

The affect of aerodynamic forces on spacecraft attitude is determined in block 12. This is done by adding the total aerodynamic moments in each body axis (input to the EOM from the aerodynamics simulation) to the total thrust moments in each axis.

The resultant simulation of spacecraft movement is sent to block 13, vehicle moments. There, this information is used to determine moments of inertia in each body axis. These moments of inertia are used, along with rotational rates from the S-IVB simulation, to determine vehicle rotational rates. These computations are accomplished in block 14, rotation equations. The end products of this block (rotational rates) are then time-integrated to provide spacecraft attitude.

Blocks 15, 16, 17, and 18 convert spacecraft attitude quaternions to equivalent angles in various inertial coordinate systems. The earth inertial to spacecraft inertial axes conversion block (block 19) receives longitude and latitude information to orient the Y_B -earth-inertial axis toward earth east at all times. The angular differences between the earth inertial and spacecraft inertial coordinate systems are then routed to block 18, spacecraft inertial to spacecraft body axes conversion. There, these conversion angles are used in further spacecraft attitude coordinate system conversions.

2.2.1.3 Simulated Coordinate Systems.

The coordinate systems used in the spacecraft computations and simulated in the AMS are the earth-inertial, earth-oriented spacecraft body and fixed body frames. These systems are briefly described below and are shown in figure 2-3.

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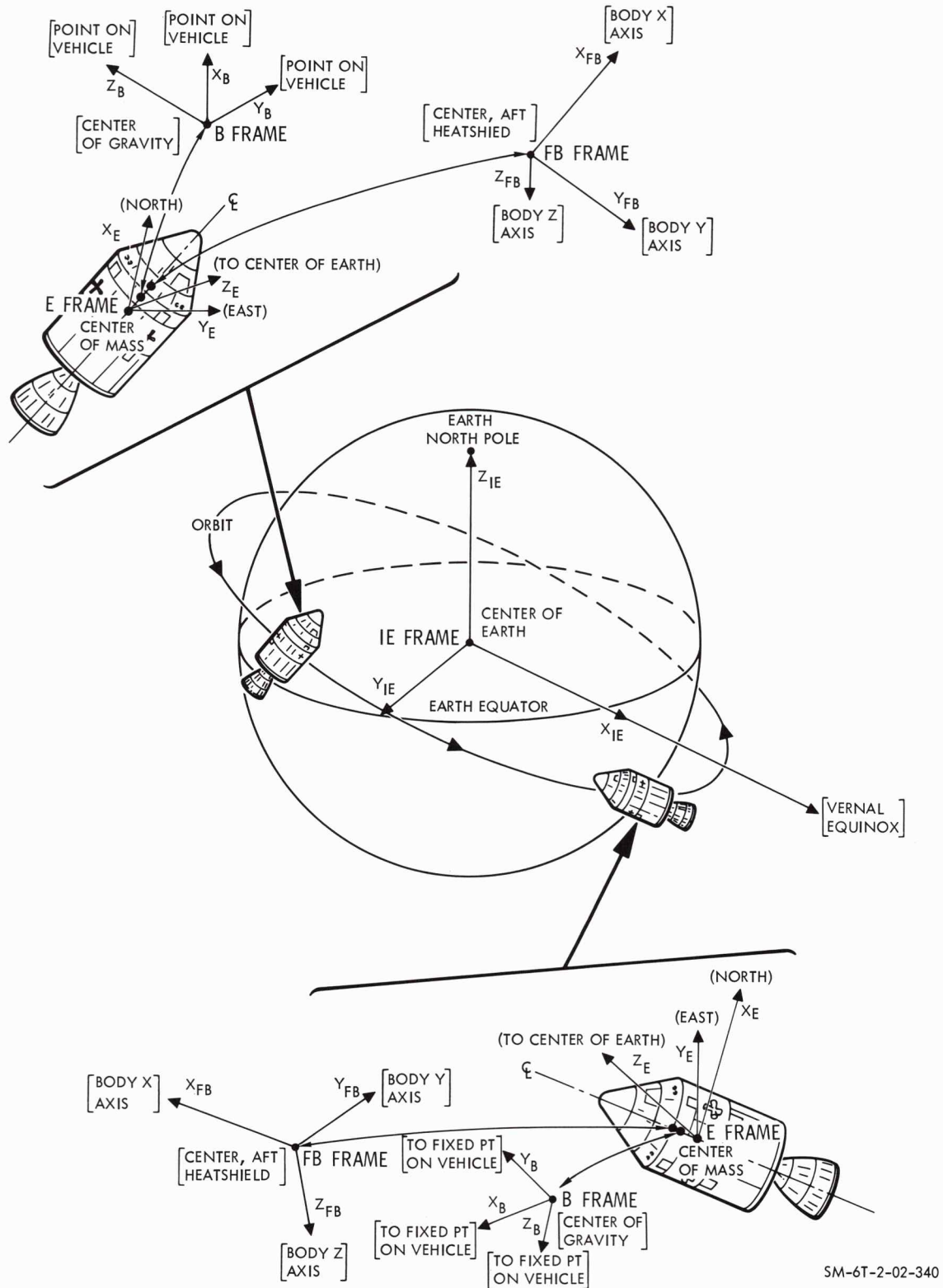


Figure 2-3. Simulated Coordinate Systems

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The earth-inertial (I_E) frame has its origin at the earth center. The I_E is used as a reference point to identify the position of celestial bodies. The X_{I_E} - and Y_{I_E} -axes lie in the equatorial plane of the earth with the X_{I_E} -axis lying along the vernal equinox. The Z_{I_E} -axis is directed through the earth north pole. The inertial system axes are fixed with respect to fixed stars.

The earth-oriented (E) frame is not an inertial system. E-frame is used for the spacecraft coordinate system in local vertical mode. Its origin is the center of mass of the spacecraft. The X_E -axis is directed toward earth magnetic north and will change its direction with changes in latitude of the spacecraft. The Y_E -axis is directed toward earth east and will also change its direction as the spacecraft orbits the earth. Both the X_E - and Y_E -axes are perpendicular to an extension of the earth radius and lie in a plane which is parallel to the earth surface directly below the spacecraft. The E-frame is shown twice in figure 2-3 to illustrate the changes occurring in the X_E -, Y_E -, and Z_E -axes direction as the vehicle moves about the earth.

The point of origin of the spacecraft body frame (B-frame) is the spacecraft center of gravity. The X_B -, Y_B -, and Z_B -axes may be aligned to arbitrary points on the vehicle forming a 90-degree triad and will change direction as the spacecraft attitude changes. This noninertial system is used as a reference to determine spacecraft attitude and attitude errors.

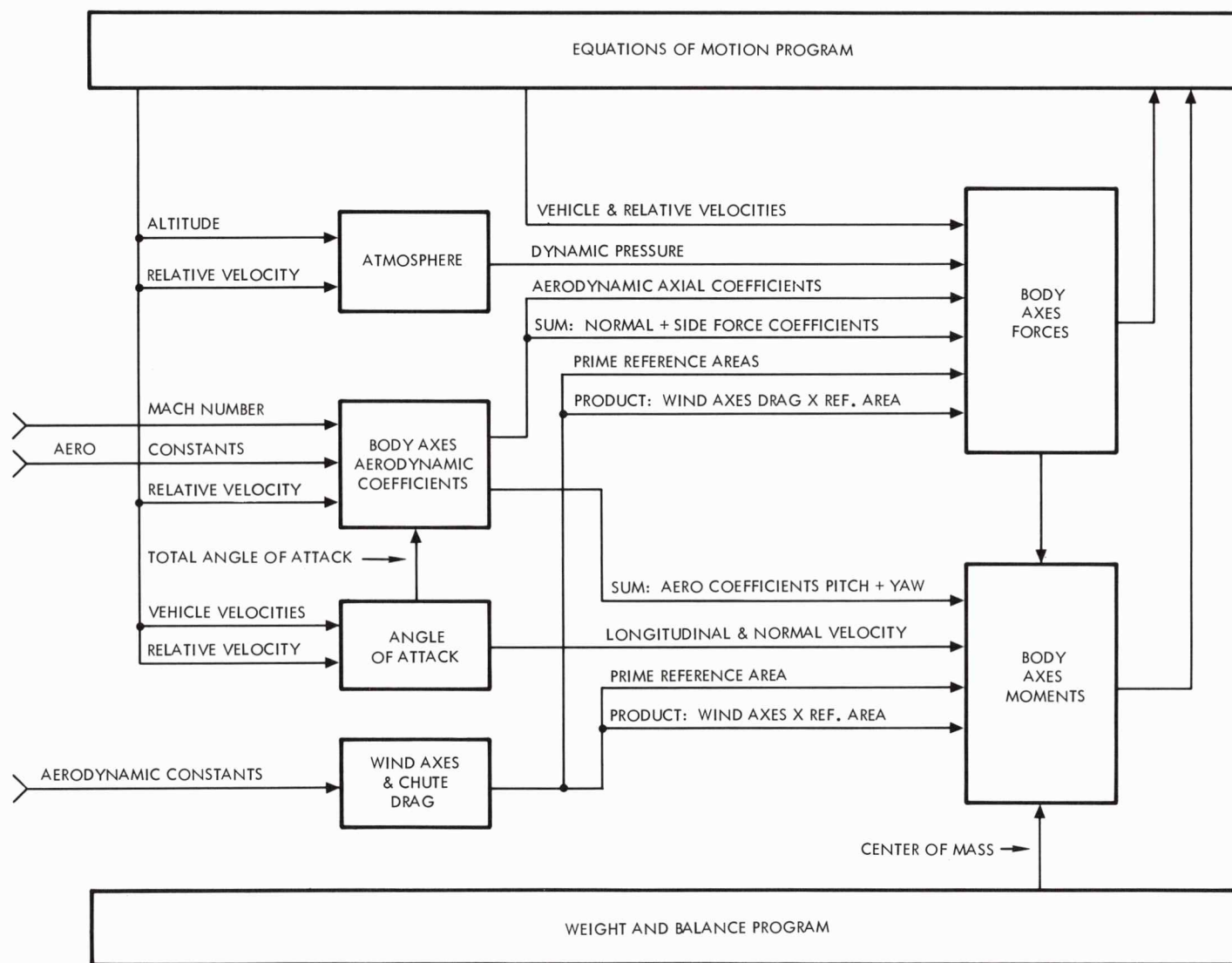
The fixed body (FB) frame is not an inertial system. The point of origin of this reference system is the physical center of the command module aft heat shield. The X_{FB} -, Y_{FB} -, and Z_{FB} -axes correspond to the X-, Y-, and Z-spacecraft body axes. Therefore, the axes directions will change with vehicle attitude changes just as the B-frame axes do. This is illustrated by the two FB-frames shown in figure 2-3.

2.2.2 AERODYNAMIC FORCES AND MOMENTS PROGRAM.

The aerodynamic forces and moments program provides simulation of the effects of spacecraft motion through the atmosphere. The results of the computations involved become factors in the equations of motion. The aerodynamic forces and moments are applicable only during phases involving movement through the atmosphere (launch, orbit, entry, and suborbital abort). The aerodynamic forces and moments generated during launch-boost are accounted for on the launch tapes and are not part of the aerodynamics forces and moments program.

Figure 2-4 is a block diagram of the aerodynamic forces and moments program. Inputs to the program are shown along the left of the figure. Constants in the computation are atmospheric density (0- to 180-n mi altitude), wind axes and parachute drag, and aerodynamic coefficients for the three spacecraft configurations. The three configurations requiring simulation are as follows:

- Command module plus service module
- Command module plus launch escape tower
- Command module only.



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Figure 2-4. Aerodynamic Forces and Moments Block Diagram

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Variable input factors to the program include altitude, velocity vector, and vehicle and relative velocities. From the constant and variable inputs, the program computes the body axes forces and moments as effected by aerodynamic forces and provides them as computation factors in the equations of motion. The aerodynamic responses in the solution of aerodynamics forces and moments are computed in terms of angle of attack, dynamic pressure, and axial velocities. Since the spacecraft is aerodynamically symmetrical, the angle of attack is computed as a single factor and the normal force is vectorially added to the side force to produce a single coefficient. The pitch and yaw moments are added in the same fashion for the same reasons.

In addition to the basic aerodynamic solution, other effects are accounted for in the program. Such items as heat shield jettison, LES motors on, etc., are switched into the solution by Boolean logic, as required.

2.2.3 WEIGHT AND BALANCE PROGRAM.

The weight and balance program simulates the mass characteristics of the vehicle during all phases of the simulated mission except launch-boost. Weight and balance characteristics during the launch-boost phase are provided either by the preprogramed tape (nonintegrated mode) or the MSCC (integrated mode).

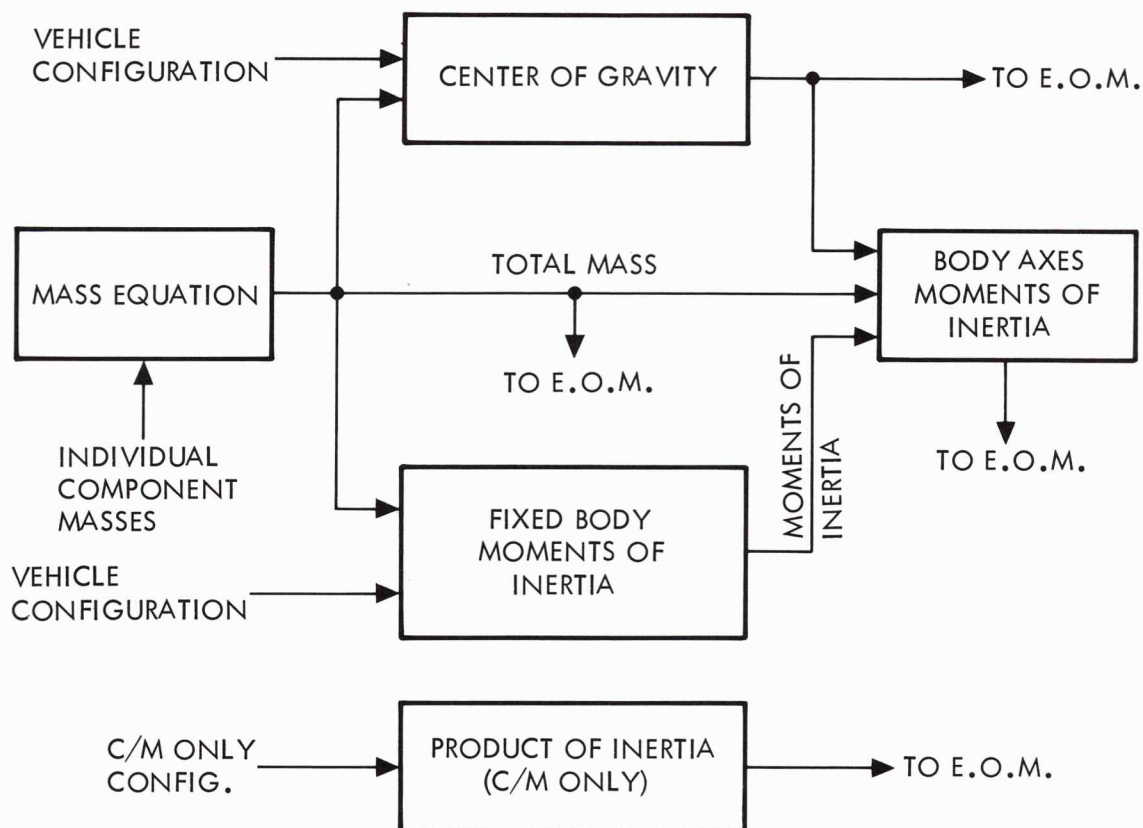
Figure 2-5 is a block diagram of the weights and balances solution. Inputs are the vehicle configurations previously described in paragraph 2.2.2 as affected by variations in the various factors of which the total mass is comprised, that is, fuel, oxidizer, cryogenics, etc. Outputs are fed to the equations of motion and include total mass, moments of inertia, products of inertia, and center of gravity location.

The total mass of the vehicle is obtained by adding the masses of the individual components of the vehicle. The mass is updated from computations made in other systems as a result of the depletion of consumables and changes in vehicle configuration (due to vehicle component separation or jettisoning).

Three moments of inertia equations compute moments of inertia in the three fixed body axes. The three resultants are then transferred to the body axes centered at instantaneous center of gravity. The fixed body moments of inertia for the entire vehicle are the summation of the fixed body moments of inertia of all individual items with the vehicle.

Equations defining the location of the center of gravity of the complete vehicle during all phases of the mission are used to establish a reference point for the moments of inertia and aerodynamic moments. The only significant product of inertia is the X-Z product of inertia for the command module. This has a constant value and will be generated when 25,000 feet altitude is reached during entry.

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Figure 2-5. Weight and Balance Block Diagram

2.2.4 S-IVB ATTITUDE CONTROL SYSTEM.

The AMS simulation of the S-IVB orbit is in the inertial attitude control mode only. Stored body-to-inertial Euler angle commands are compared with the simulated vehicle body-to-inertial Euler angles from the equations of motion. The difference is then routed to the S-IVB attitude control system. The system uses these error signals to align the vehicle body axes to the inertial frame reference. This alignment is accomplished through simulation of the S-IVB auxiliary propulsion system. In addition, the S-IVB simulation shall develop propellant utilization and run-out effects, lateral thrusting, and incremental rates.

2.3 VEHICLE SYSTEMS PROGRAMS.

Real time programs are provided to simulate the spacecraft systems in both normal and malfunctioned conditions. Section 2, Volume I of this handbook explains in detail the methods used to simulate these systems. The library of programs described later in this section illustrates the computer programs and their corresponding spacecraft system.

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2.4 SIMULATOR EFFECTS PROGRAMS.

Simulator effects programs have been developed for spacecraft smoke, aural cues, and visuals. Spacecraft smoke and aural cues systems are described in section 2, Volume I of this handbook.

2.4.1 CELESTIAL SPHERE DRIVE.

The celestial spheres (five - one for each of four windows) and SCT are positioned by means of a servo-driven three-axes gimbaled mechanism. The sine and cosine of the desired gimbal angle are routed to resolvers which, in turn, drive the gimbal axes. The mechanical operation of the visual system is discussed in section 1, Volume I of this handbook.

The block diagram in figure 2-6 shows the development of the drive signals for the celestial spheres. Direction cosines representing the angular relationship between the spacecraft body frame (B) and the inertial reference frame (I_E) are received from the equations of motion. A transformation is made to the ecliptic frame which differs from the inertial frame by 23.5 degrees (the angle between the planes of the earth equator and the solar orbit of the earth). The relationship between the windows and ecliptic frame is then computed (including the angular disposition of each window with respect to the body frame). The sine and cosine of the angles developed from the window-to-ecliptic frame transformation are the drive signals for the celestial spheres associated with the four landing and docking windows.

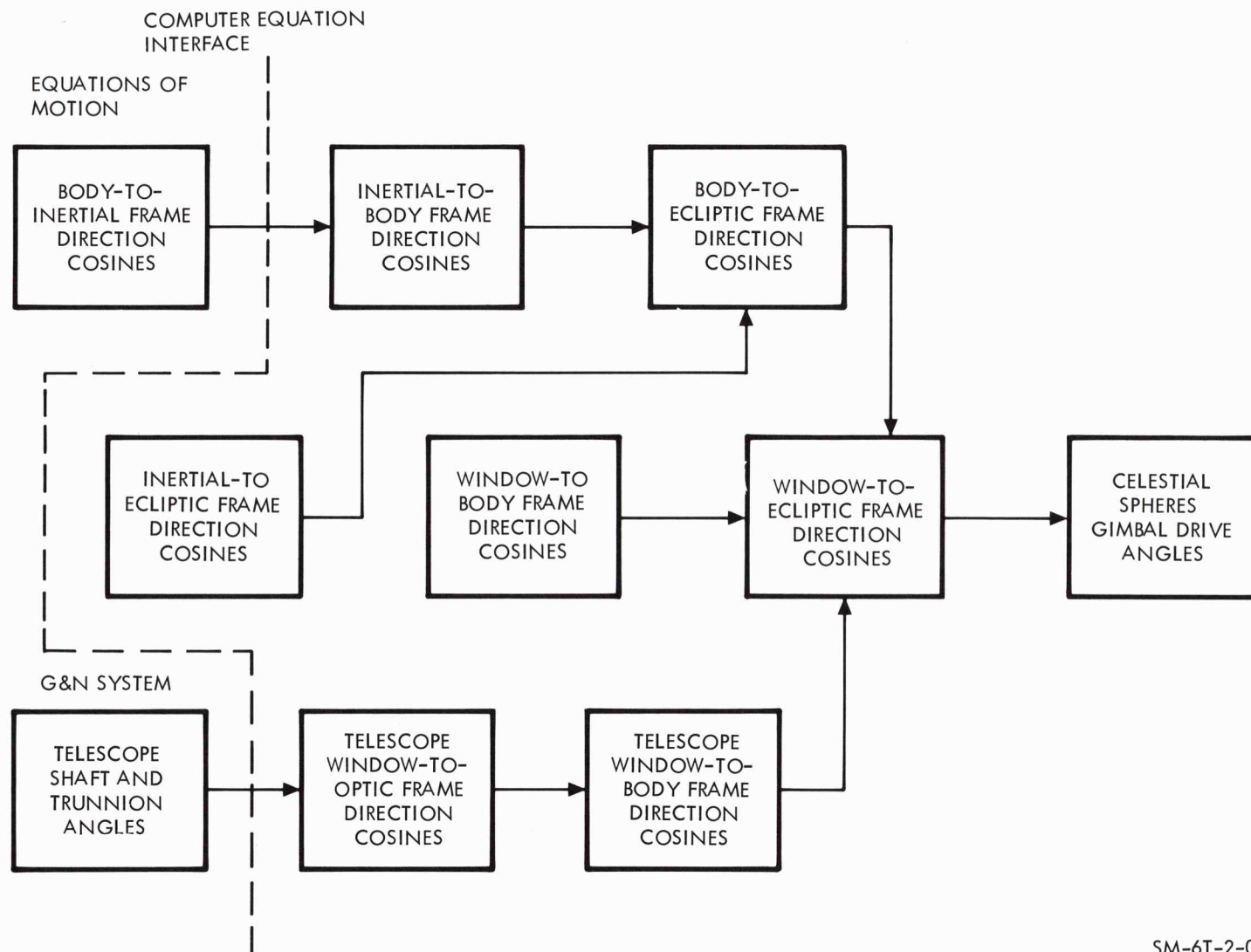
Also shown in figure 2-6 are the telescope shaft and trunnion angles from the guidance system, which are used to control the drive of the celestial sphere at the telescope window. The shaft and trunnion axes operate with respect to the optics reference frame. Transformation from window-to-optic reference frame and window-to-body frame produces the sine and cosine information required to drive the sphere.

2.4.2 OCCULTATION MASK.

The function of the occultation mask is to occult the star field whenever the earth, moon, or the target vehicle, block out the view of the star field from a window or the telescope. In the initial delivered configuration of the AMS, only earth occultation capability is provided.

The occultation mask consists of a side (or disc) projection of a reel of mylar tape that is capable of being driven along rectangular coordinates. The reel is positioned between the light source and the selected celestial sphere. The reel is designed to wind or unwind tape to depict the circular limb of the earth as it would appear from the command module.

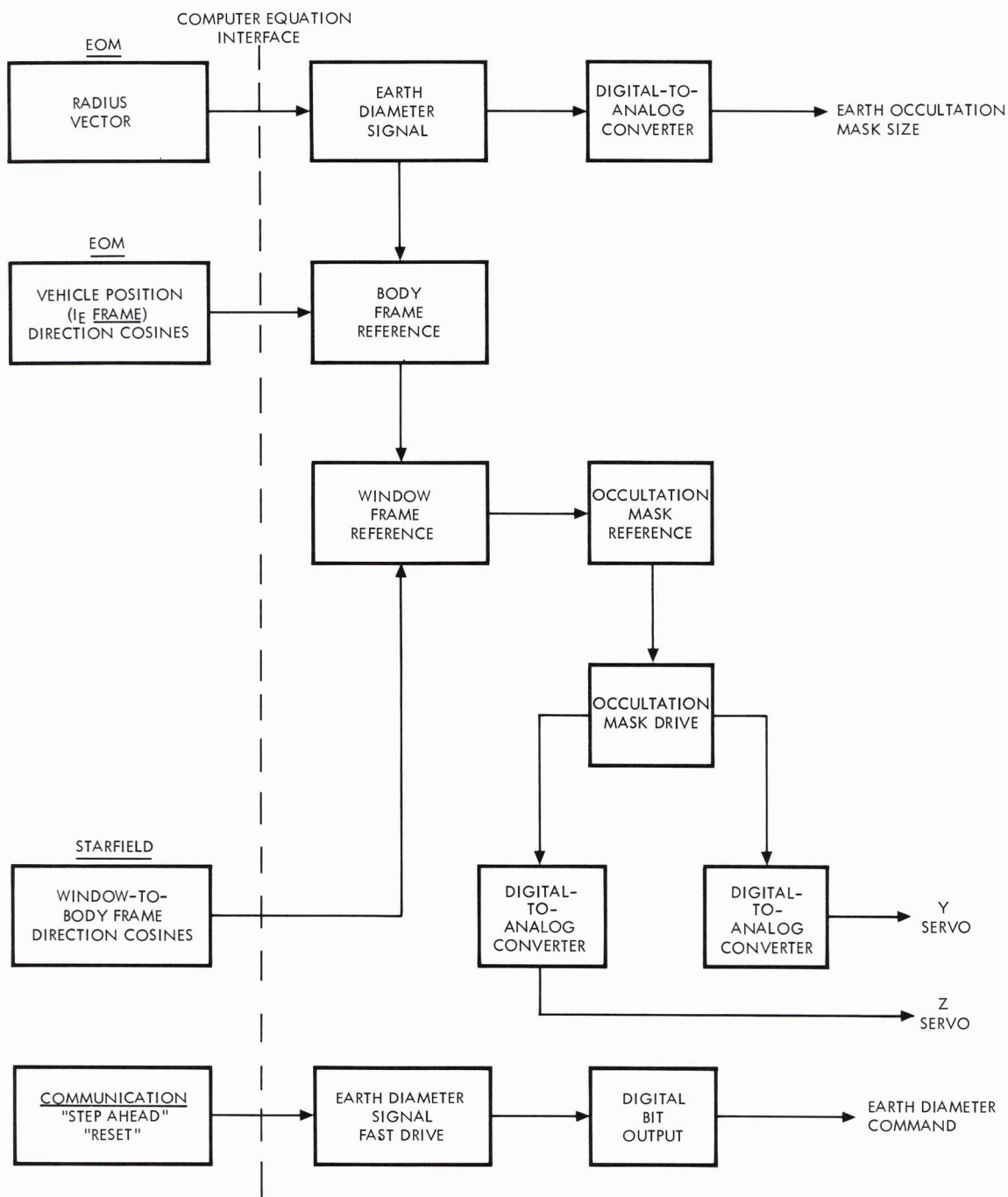
As illustrated in figure 2-7, the arc/area of the earth occultation is determined by a radius vector from the equations of motion representing the distance from the earth to the spacecraft. This signal is processed by a digital-to-analog converter, the output of which is used to control the amount of tape on the reel and, indirectly, the arc/area of the mask exposed to the window.



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Figure 2-6. Celestial Sphere Drive

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Figure 2-7. Occultation Mask

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The positioning of the occultation mask along rectangular coordinates is accomplished by servos fed by digital-to-analog converters. Coordinates representing the position vector of the spacecraft and direction cosines representing attitude are received from the equations of motion. Window-to-body frame direction cosines are received from the starfield computations. Through the transformation of these frames of references, drive signals are produced to position the occultation mask relative to the line of sight of the windows and telescope to earth.

Fast drive commands are used to drive the occultation mask diameter to a new value when commanded by "step-ahead" or "reset".

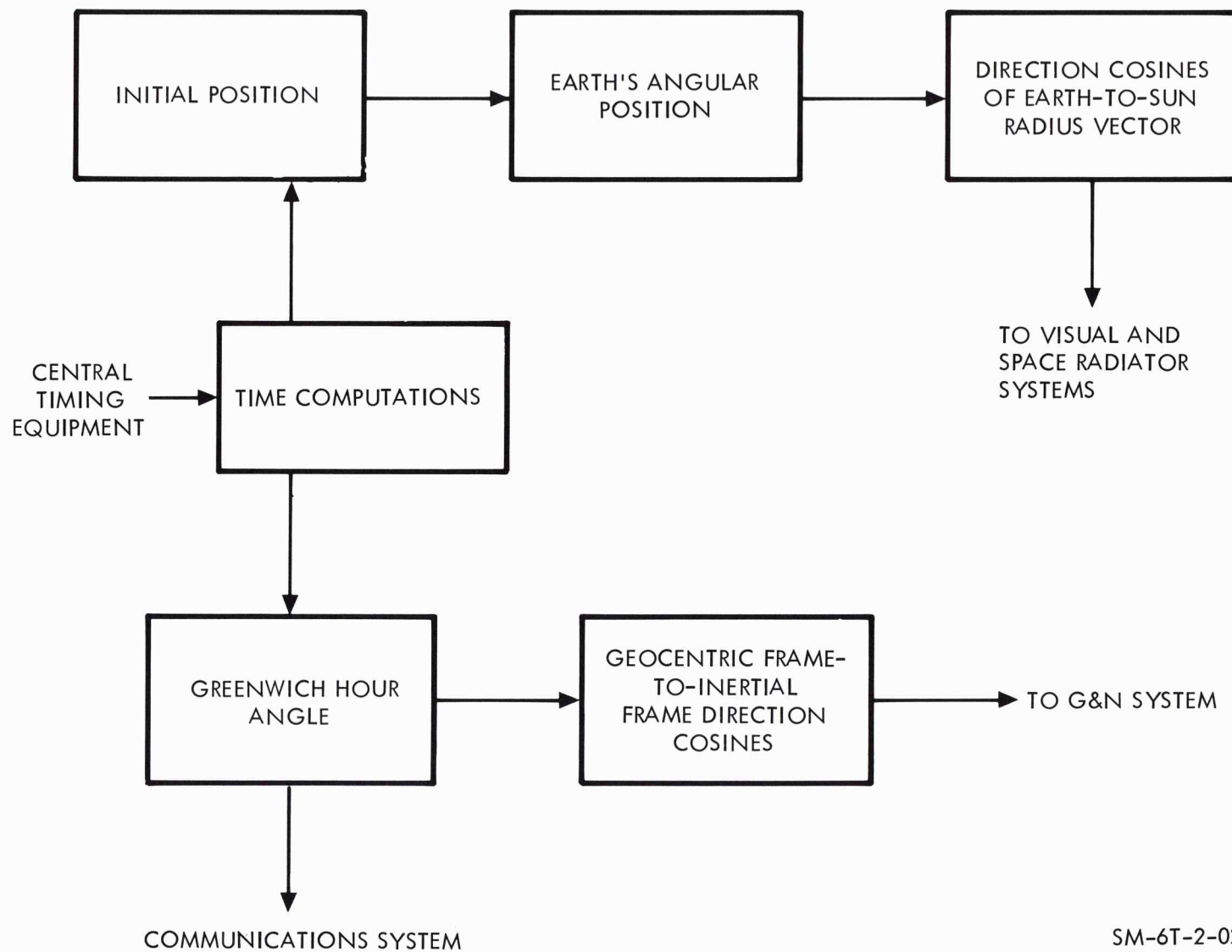
2.4.3 EPHEMERIS PROGRAM.

The AMS ephemeris program provides the almanac data necessary to simulate the effects of the earth-solar relationship on spacecraft navigation (G&N), day-night termination (visuals), solar heat (space radiators), and communications (ground station availability). In these computations, two factors are provided as constants: the position of the sun and the earth rate of rotation in the ecliptical plane. The two significant variables in the computation are the displacement of the earth on the ecliptic plane and the position of the Greenwich meridian.

Figure 2-8 is a block diagram of the ephemeris program for the initial delivered configuration of the AMS. Time data (in day of year, hour, minute, second, and 1/20 second increments) is provided by the central timing equipment. Using a constant angular velocity for the earth rotation about the sun, the angular position of earth with respect to the sun is updated every hour. The resulting radius vector simulates the earth angular position in the ecliptical plane. The program then adjusts the computations to align with the earth equatorial plane (23.5 degrees) for simulation of the vernal equinox and its affects on day-night phases. Computation outputs are in the form of direction cosines used to drive the day-night simulation in the visual system and to establish solar heat in the simulated space radiator system.

It is also necessary to establish the position of the Greenwich meridian in its rotational path about the center of the earth for purposes of establishing which ground stations on the earth surface are in "line-of-sight" radio communications with the spacecraft. The displacement of the Greenwich meridian as a function of earth rotation is called the Greenwich hour angle (GHA). The GHA is computed by the ephemeris program and provided to the simulated communications system.

On the other hand, G&N simulation requires rotation information with respect to the earth center rather than the surface. The ephemeris program includes computations to transform the GHA data to the inertial reference frame (I_E -frame, as described in paragraph 2.2.1.3) and provides the results to the G&N system simulation.



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Figure 2-8. Ephemeris Program Flow Diagram

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The Greenwich hour angles of the sun and moon are measured from the X-inertial axis to the Greenwich meridian. These angles are functions of their initial value and the angular velocity of the earth rotation about its own axis.

2.4.4 MISSION EFFECTS PROJECTOR (MEP).

The MEP provides realistic simulation of the earth as viewed from the spacecraft windows and the telescope. Computations are required to establish the specific spacecraft geographic position and to correlate the view with spacecraft attitude. Computation outputs are used to drive servos to position earth displays with respect to the MEP screen. There are five MEP displays, one for each of the four command module windows, and one for the telescope. Positioning accuracy is critical for the telescope only, since the telescope is used for position measurement in earth orbit. Paragraph 1.8 of section 1 of Volume I of this handbook is a detailed description of the mechanical characteristics of the MEPs.

Simulation factors that are computed by the MEP program and manifested in the MEP fields of view are as follows:

- Earth scenes as a function of spacecraft position, altitude, and attitude
- Day or night illumination as a function of simulated date, time, and spacecraft position (including appropriate sunrise and sunset effects)
- Earth limb scale and profile as a function of spacecraft attitude and altitude (refer to paragraph 2.4.2).
- Views of the sun as a function of date, time, and spacecraft attitude
- Cloud cover (peripheral and random).

Earth scenes are generated as a function of simulated vehicle altitude, attitude, and position. Sunrise effect is dependent upon relative positions of the earth, sun, and the vehicle. Peripheral cloud cover is generated within the MEP anytime the simulated orbit of the spacecraft carries into an area not covered by the earth scene film. Random cloud cover is also used throughout the orbital mission. The earth horizon, or limb, is simulated as a function of vehicle altitude and attitude. The day-night termination is simulated by computing the vehicle attitude and position with respect to sun and earth positions. The relative positions will determine when daylight should be terminated. The solar image is simulated by high intensity light and is positioned in the command module window as a function of vehicle, earth, and sun positions.

These same five effects will appear in the telescope and sextant. The telescope and sextant are physically aligned along the same line. The sextant, having higher magnification than the telescope, will show greater detail of the center area seen in the telescope. The sextant provides this view from slides, which correspond to the telescope alignment angles. The slide visible through the sextant is determined by the computer, based on navigation data and shaft

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and trunnion angles. Therefore, in addition to the usual variables controlling the MEP view (vehicle attitude; vehicle altitude; and vehicle, sun, and moon positions with respect to the earth), sextant-telescope shaft and trunnion (alignment) angles must be computed. The results are used for simulated AGC programs and for slide selection and alignment in the sextant field.

2.5 SIMULATOR CONTROL PROGRAMS.

2.5.1 EXECUTIVE AND CONTROL SYSTEM.

Overall control of AMS computer operation during both on-line operation and off-line maintenance and testing is accomplished by a group of seven interrelated computer programs identified as the executive and control system. The seven programs are as follows:

- Supervisory control
- Interrupt and timing control
- Input/output control
- On-line data recording
- On-line error detection and diagnostic
- Off-line maintenance and diagnostic
- Simulator master control.

The various control and synchronizing functions of the executive and control system are listed as follows:

- Schedule and sequence all operational programs.
- Perform timing functions for the programs within the executive and control system.
- Monitor and otherwise manage the interface between the various programs of which the executive and control system is comprised.
- Continuously monitor for and respond to program interrupt commands.
- Read and accomplish switching required for selected mode(s) of simulator operation (core memory allocations, programs, routines, and subroutines, etc.).
- Monitor stored simulation data in the three computers as required for computations.
- Monitor and manage the interface between the executive and control system and other AMS programs.

2.5.1.1 Supervisory Control Program.

The supervisory control program determines which programs are operating in the AMS computers at any given time. Factors measured and responded to in

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accomplishing such control are AMS mode of operation, mission phase being simulated, normal routines for mode-phase, and priority inputs or overrides to the normal routines. Two major routines make up the supervisory control program: the scheduler routine and the phaser routine.

The scheduler routine initiates each of the programs required for the simulation in their appropriate sequence for the AMS mode-phase. As each commanded program is completed, control is returned to the scheduler routine for initiation of the next program in the schedule.

The phaser routine measures and evaluates the progress of the simulation at each iteration in which there has been no change in mission phase. The supervisory control program is permitted to reiterate in the same calling sequence. Where the phaser routine detects a change in mission phase, the phaser revises the supervisory control program to a calling sequence appropriate for the phase into which the simulation is entering. The next iteration of the supervisory control program will then occur in accordance with the new (revised) calling sequence.

2.5.1.2 Interrupt and Timing Control Program.

The interrupt and timing control program consists of two routines: the power failure interrupt routine and the real time interrupt and timing routine. The two routines result in four types of program interrupts: (1) power failure interrupt, (2) real time interrupt, (3) all fully buffered channels free interrupt, and (4) fully buffered channel free interrupt.

The purpose of the power failure interrupt is to accomplish immediate storage of all program data as a function of impending power failure so that such failure does not result in a requirement to completely reprogram when power is restored. The power failure interrupt routine is initiated in the event of an out-of-tolerance condition of the primary a-c input power. The routine stores the data in the computation registers, the status of the channel enable flip-flops, and the contents of the program register at the time the interrupt is initiated. Recovery from the power failure will cause the simulator to go into freeze mode. The instructor-operator then has the option of a run or reset mode.

The real time interrupt and timing routine synchronizes the central timing system, the supervisory control program, and the various real time functions of the simulation in process. The routine responds to the 50-millisecond interrupt from the central timing equipment. If the simulator is not in the run mode, the routine stores the data in the computation registers and control is returned to the supervisory control program. If the simulator is in the run mode, the entire real time simulation situation is updated by 50 milliseconds. When the routine is complete, the scheduler routine is re-initiated unless the most recent 50-millisecond interrupt has resulted in a requirement for change in phase. If the latter is true, the phaser routine is initiated and is followed by the initial iteration of the revised calling sequence.

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The two interrupt routines relating to fully buffered channel availability are for the purpose of maintaining supervisory control program cognizance of channels available for input-output switching.

2.5.1.3 Input-Output Control Program.

The input-output control program is provided for two purposes: to manage the computer-to-peripheral equipment interface in the freeze mode and to synchronize digital recording with real time (minute and hour quantities) when the AMS is in any mode other than freeze. The input-output control program is not to be confused with the real time input-output program discussed in paragraph 2.5.2. The real time program manages the computer-to-peripheral equipment interface in all modes other than freeze.

The program logic is illustrated in figure 2-9. When the input-output control program is initiated by the supervisory control program, a check is made to determine whether the run or freeze mode is in operation. If in the run mode, any error messages or operating instructions will be read out to the typewriter. Next, the frame counter which is incremented every 50 milliseconds is checked to see if a minute has elapsed. If not, the program returns to the main executive program. During the frame following the minute interval, control is transferred to the data recording program which records specified parameters on tape. A third check is made to determine if an hour has elapsed. If so, control is transferred to the safe store routine which automatically stores selected parameters to be used for resetting.

If the first check determines the simulator to be in the freeze mode, the typewriter is enabled for inputs to the computer. The L and D are the only valid characters that, when typed in, will initiate other routines. When L is typed in, the on-line typewriter core memory interrogation routine is called up to accept the rest of the message which requests transfer of information to or from the memory as specified. If D is typed in, control is transferred to the off-line maintenance and diagnostic interface control program.

Reset can be requested during the freeze mode. In the reset routine all parameters are reset and, upon completion, the message "interval reset complete" will be typed out and control returned to the supervisory control program.

2.5.1.4 On-Line Data Recording Program.

The function of the on-line data program is to record 152 selected variables and Boolean quantities every minute. The data quantities included in this basic 152, other data quantities available, and computer operation codes for changed data transcribed are the subject of section 5 (Simulation Output Data) of Volume III of this handbook.

When the simulator is in the run mode, the 152 selected parameters are sampled once every 1200 iteration pulses (50-millisecond rate) in the manner explained in paragraph 2.5.1.3. When the recording tape is full, a message is typed out informing the instructor-operator a new tape must be mounted.

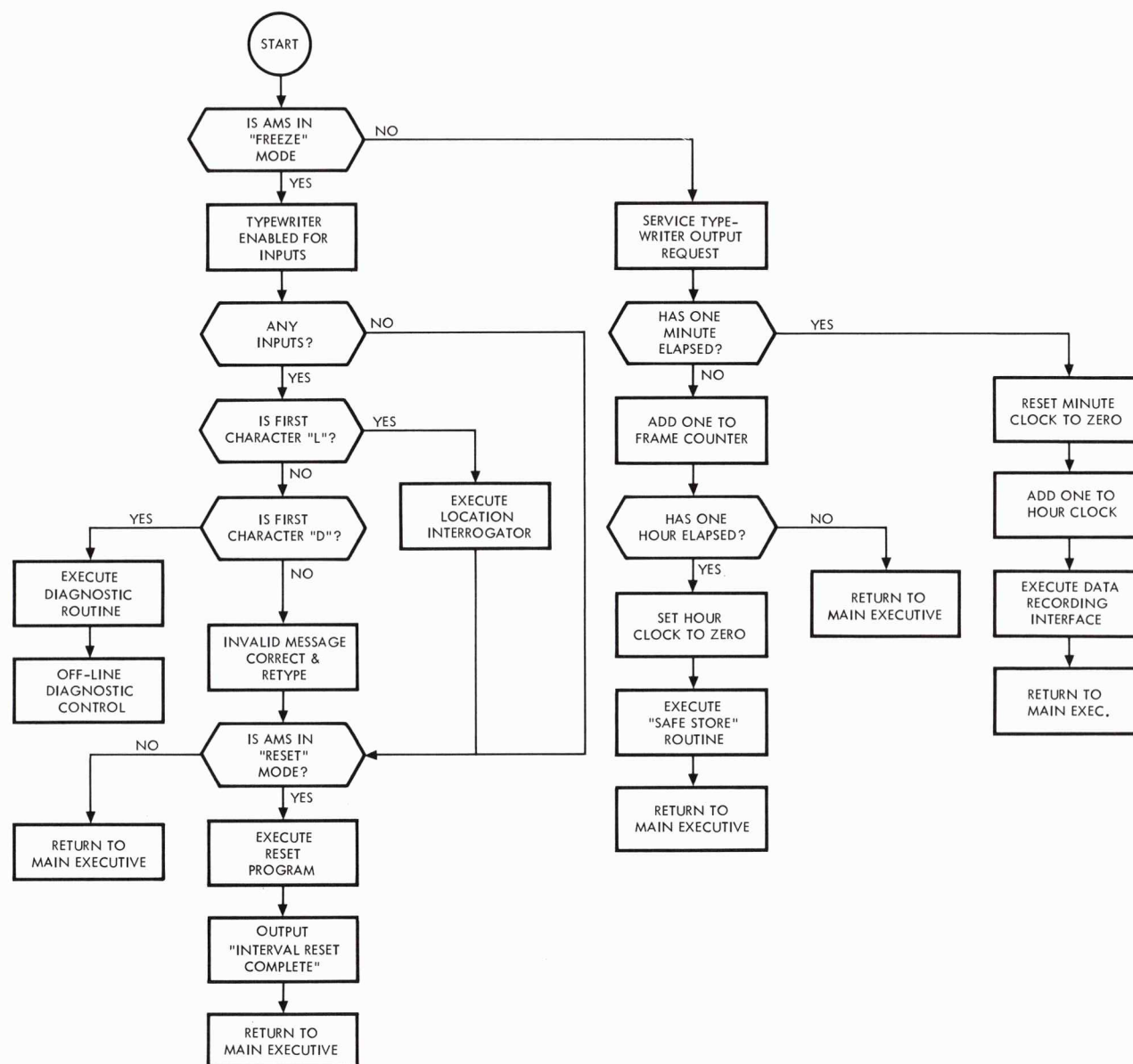


Figure 2-9. Input-Output Control Program

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2.5.1.5 Diagnostic Programs.

The two diagnostic programs included in the executive and control system are separately discussed elsewhere in this section of the handbook. The on-line error detection and diagnostic program is the subject of paragraph 2.7.1. The off-line maintenance and diagnostic program is the subject of paragraph 2.7.2.

2.5.1.6 Simulator Master Control Program.

The master control program provides the instructor-operator with the capability of controlling simulator operation through the IOS simulator control panel. The extent of control of the AMS is dependent upon the mode of operation. During an integrated mission, the instructor operates the simulator at the verbal direction of the simulation supervisor located in the mission operations control room (MOCR). In the AMS nonintegrated mode, the instructor-operator has complete control of the AMS.

The master control program computes the logic equations that provide the IOS control functions, that is, run, go, freeze, step-ahead, hold, reset, recycle, and store at least once each 0.8 seconds. The following is a brief description of the mechanization of the control functions.

- Run. When the RUN pushbutton is depressed, a command is entered into all three computers. If all computers acknowledge receipt of the command, an output is sent to the READY portion of the split-level READY-RUN indicator. The freeze function is also rendered inactive. Upon receipt of the next one-minute pulse from the time standard or GSSC, the computer output extinguishes the READY lamp and illuminates the RUN lamp indicating the beginning of real time simulation.
- Go. The go function is only active during a prelaunch condition. During an integrated mission, the simulation supervisor shall verbally notify the instructor when the mission is to begin. Upon this command, the instructor will depress the GO pushbutton which enters a command into the computer. The computer will output a signal which illuminates the READY portion of the split-level READY-GO indicator. Upon receipt of the T - 60 second discrete from GSSC, the READY lamp shall extinguish and the GO lamp shall illuminate and the countdown from T - 60 seconds commences. During a nonintegrated mission, the same procedure occurs but the T - 60 second discrete originates from the time standard.
- Freeze. The activation of the FREEZE pushbutton causes the computer to extinguish the RUN lamp, illuminate the FREEZE lamp, and real time simulation ceases at that point. Continuation of the mission will begin upon receipt of the next one-minute pulse following activation of the RUN pushbutton.

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- Hold. The hold function is only active during a prelaunch condition. During an integrated mission, the hold discrete transmitted from the GSSC causes the computer to extinguish the GO lamp, illuminate the HOLD lamp, and stop the TO/FROM LAUNCH timers, but does not stop simulated GMT clocks. The same occurs during a nonintegrated mission if the HOLD pushbutton is depressed. In both cases, re-initialization must be accomplished before the mission can continue.
- Reset. The activation of the RESET pushbutton will put the simulator into the freeze mode and initiate the reset routine of the input-output control program. The reset routine reads any one of 50 sets of variables established for initial condition points into memory location from magnetic tape.
- Recycle. Recycle is only active during prelaunch and is used in conjunction with the hold function. Activation of the RECYCLE pushbutton causes the TO/FROM timers to return to the T - 60 second condition in the integrated mode. In the nonintegrated mode, the timers return to T - 60 seconds and the launch-boost tape is returned to its start point. Activation of the GO pushbutton removes the recycle and hold functions.
- Step-Ahead. Activation of the STEP-AHEAD pushbutton also initiates the freeze mode in addition to the step-ahead mode. The computer will accept a new time from one of the following inputs: GSSC during an integrated mission, or by up-data link or typewriter during a nonintegrated mission. The computer will update all programs by this delta time. Continuation of the mission from the new point is accomplished by activating the RUN pushbutton.
- Store. Depressing the STORE pushbutton enters the computer into the store routine without interfering with real time simulation. The routine will store certain values in memory at the instructor's request. The STORE lamp is illuminated upon depressing the switch and is extinguished as a function of next one-minute pulse.

2.5.2 REAL TIME INPUT-OUTPUT PROGRAM.

The purpose of the real time input-output program is to manage the interface between the computers and the data conversion equipment. The data conversion equipment is described in paragraph 1.7.3 of Volume I of this handbook. The real time input-output program is the same in all computers and all input-output functions are under program control. All real time input-output functions are by way of the fully buffered channels (FBC) used to electrically isolate the computers. The program performs all switching (via FBC) for data transfer between computers and data conversion equipment that is either providing input to or receiving output from the computers. The program is accomplished at the basic iteration rate of 20 times per second. Accomplishing the input-output transfer for a specific item of data conversion equipment is called "servicing the device."

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The computation functions of each computer and the input-output program time share the computer memory. That is, the memory is divided into two areas: one area supports computations while the other functions with the FBCs. The two sections alternate each program frame so that all memory elements interface with both internal computations and external input-output functions. This is done to prevent both the computation functions and the FBCs from simultaneously interfacing with the same computer location.

The real time input-output program services the various devices by establishing the to-from addresses between devices and computers, establishing and controlling the sequence for input to or output from the devices, and interprets ranges (see note) as required to progress from one device to another. The program manages computer-to-computer data transfer in the same manner as for the data conversion equipment. The routines of the real time input-output program are as follows:

- Setup and intercomputer data transfer routine
- Real time input-output transfer routine
- Transfer complete routine
- Transfer failure routine.

Figure 2-10 is a flow diagram of the real time input-output program showing the routines and their relationship to each other. Inputs from the ground support simulation computer (GSSC) in the mission control center are provided to the AMS through a computer-to-computer buffer system when the simulator is in the integrated mode of operation. Input-output across the AMS-to-GSSC interface in the integrated mode is at the same 20 times per second as for the nonintegrated mode.

NOTE

Range is defined as the number of data items to be transferred to a given device. Range data is used by the input-output program to determine that transfer to one device is complete and initiate advance to the next device.

2.5.2.1 Setup and Intercomputer Data Transfer Routines.

The purpose of the setup and intercomputer data transfer routines is to perform the initial preparations for an iteration of the real time input-output program and to accomplish the initial transfer functions (intercomputer) within that iteration.

The start in figure 2-10 is representative of any 50-millisecond iteration pulse from the central timing equipment. Prior to initiating a new iteration the program checks to see that all of the transfers (or transmissions) of the previous iteration have been completed. If the previous transmission has not

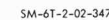


Figure 2-10. Program Real Time Input-Output Flow Chart

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been completed the transfer failure routine is initiated. If the previous transmission is completed, the all FBCs free interrupt is enabled, thereby, establishing FBC readiness for a new iteration of data transfer.

When the all FBCs free signal is received, two of the computers will accomplish intercomputer data transfer while the third computer updates SCS control inputs. When intercomputer transfer is completed, the all FBCs free interrupt is disabled.

When intercomputer data transfer is completed, the setup and intercomputer data transfer routines perform three additional subroutines as a function of all FBCs free disable. These subroutines set the ranges for each computer-DCE interface, check sense lines from the MIU and computer-to-computer buffer (integrated mode only), and reads and resets the MIU, if set. The FBC free interrupt is enabled at the completion of this routine, thereby, making the FBCs available for the real time input-output transfer routine.

NOTE

An FBCs free interrupt is generated within each computer when the computer has completed its data transfer. When all computers register FBCs free, an all FBCs free interrupt results.

2.5.2.2 Real Time Input-Output Transfer Routine.

The real time input is entered with the FBCs free interrupt and the program commences immediately to progress through computer-to-DCE channels. The routine is shown between the enter blocks in figure 2-10. The routine first resets the interrupt signal and delivers FBC range register contents to the device being serviced. The program then tests the device to see if it is the last device to be serviced in the program, has or has not been serviced, or device is busy. When the computer-to-DCE interface is established for the next device in the program, the routine establishes appropriate switching for either input or output and data transfer is accomplished. When data to be transferred is entered, the completed enter function initiates the sequence for the next device to be serviced.

2.5.2.3 Transfer Complete Routine.

When the real time input-output routine responds yes to Last Device?, the transfer complete routine is initiated. The transfer complete routine double checks Last Device? and returns control to the executive program awaiting the next iteration or start if the answer is yes. If the answer is no, the routine queries Transmission Complete? and returns to the channels for which data transfer has not been accomplished.

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2.5.2.4 Transfer Failure Routine.

Paragraph 2.5.2.1 explains that the first step in the setup and inter-computer transfer routine is to test Transmission Complete? and a yes is required to proceed with that routine. If no is the response to the test, the transfer failure routine is initiated. The logic of the routine is included in figure 2-10.

The transfer failure routine will record the device that has not completed transfer. If, after three time frames have elapsed, data transfer still has not been completed, the order of servicing the device will be modified and three more attempts will be made to transfer via the channel. If this is unsuccessful, data transfer via the next channel will be attempted. If the next channel also fails to transfer, an output device failing signal is generated. If the next channel succeeds in transferring the data, a channel failing (the previous one) signal is generated.

2.5.3 MIU PROGRAM.

The controls and displays of the malfunction insertion unit (MIU) are described at length in section 1 (Description) of Volume I of this handbook. Instructions for operating the MIU are provided in section 1 (Operation) of this volume. The MIU program is the computer software required to use the MIU for loading simulated malfunctions into the computers, enabling MIU control and displays, entering and clearing malfunctions, and processing inputs and outputs to the MIU system. The MIU program is the same for all three computers. The program involves three routines as follows:

- Initialization routine
- Main routine
- Master clear routine.

2.5.3.1 Initialization Routine.

The initialization routine is used to clear the MIU display panels, enable the MIU controls, establish initial values for the MIU program, and insert preprogramed and/or time-dependent malfunctions prior to on-line simulation. During the operation of the routine, the computer connected to the card reader and line printer is considered the master computer. The master will read in the desired malfunctions, transfer the necessary data to the other computers, and record the status of the malfunctions on the line printer.

Prior to reading in the selected malfunctions, the initialization routine establishes initial conditions by clearing all malfunctions and resetting the time-dependent counters to zero. Cards for the desired time-dependent and preprogramed malfunctions are then read into the master computer. The master computer examines the system code of each malfunction to determine its validity. If the system code is not valid, the malfunction is rejected and a message is typed out on the line printer indicating an invalid condition. If the

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system code is proper, a check is made to determine whether the master computer does contain the simulated system for which the malfunction is applicable. If not, the malfunction is transferred to the slave computer. If so, the malfunction code number is checked for validity. If valid and not a time-dependent malfunction, the malfunction is then entered into the computer and a readout is made on the line printer.

If the malfunction is time dependent, two checks are made before the malfunction is either entered or rejected. Only 15 time-dependent malfunctions can be entered into each computer and these must be spaced no less than 91 seconds apart. If a validity check of these conditions is passed, the malfunction and its time of activation (time from launch) is stored in memory as a time-dependent malfunction and a readout is provided on the line printer.

When the master computer does not contain the system for which a malfunction has been inserted, the malfunction is transferred to the slave computer. The malfunction undergoes the same checks in the slave computer as described in the master before being entered or rejected. This routine is completed when all the cards in the card reader have been processed.

2.5.3.2 Main Routine.

The MIU main routine is operational throughout the simulator run. The main routine activates each time-dependent malfunction at the proper time and enters and/or clears malfunctions through the MIU control panels on the IOS.

Entry into the main routine is made in response to a sense line being set when an input word from the MIU is ready. The operation of the routine is predicated upon three different situations as follows:

- Whether a time-dependent malfunction is being displayed (less than 90 seconds to entry)
- Whether it is time to display a time-dependent malfunction (90 seconds before entry)
- If a malfunction is being inserted from the MIU control panel.

If upon entry into the routine, a time-dependent malfunction is being displayed (impending), a check is made to determine whether the instructor has attempted to clear the malfunction. If not, a time-to-activate counter is decremented each iteration until the counter equals zero, at which time the malfunction is entered into the system. If the instructor has cleared the malfunction, the time-to-activate counter is reset to zero and control returned to the executive program.

The second situation occurs when no time-dependent malfunction is being displayed but the time for such a malfunction is impending. The time for each time-dependent malfunction to be displayed is stored in the computer. The

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routine checks the stored time-dependent malfunction and if the time has arrived to display the malfunction, an impending code is generated and the time-to-activate counter is set at T - 90 seconds. The routine then returns to the executive program and the next entry into the main MIU routine will follow the course described in the first situation.

If neither of the two above situations exist, the MIU routine checks the malfunction word inserted from the MIU control panel. This malfunction is given a validity check. If the validity check is passed, the computer to which the malfunction applies is located and a code number validity check is made. Upon acceptance, the malfunction address is stored which also checks whether the malfunction has been entered previously. If so, an entered code is generated; if not, the malfunction becomes active and the routine returns to the executive program.

2.5.3.3 MIU Master Clear Routine.

The master clear routine is entered once each 50 milliseconds when the master clear sense line is set by depressing the MASTER CLEAR ALL SYSTEM switch. The master clear routine is comprised of five subroutines which will clear all tables, clear all malfunctions, set the time-to-activate counter to zero, and present a visual indication on the display panel.

2.5.4 PLOTTERS AND RECORDERS PROGRAM.

The function of the plotters and recorders program is to provide a completely flexible capability to record any simulation parameter suitable from pen recorder transcription on the X-T and/or X-Y recorders. Section 5 (Simulation Output Data) of Volume III of this handbook lists the parameters and related computer operator code, address, and scale data for selecting and implementing such transcription.

Each pen and arm positioning signal of each recording device has a permanently assigned digital-to-analog converter in the DCE. Positioning signal assignments for the 24 pens of the X-T recorders and the four arms and four pens of the X-Y recorders are accomplished by means of the IOS typewriter. Typewriter inputs include computer operator codes, designation of simulation output parameters, assignment of recorder channel, and scaling data for the signal input. Typewriter input to the plotters and recorders program can only be accomplished in the freeze mode.

Scaling factors can be calculated by multiplying a scaling constant by a digital-to-analog conversion factor and dividing the product by the maximum value of the selected variable.

When the recorder and plotter panel at the IOS is set and the run mode of AMS operation is initiated, the plotters and recorders program will service the recording devices, as required, to accomplish the preselected data transcription.

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2.5.5 UTILITIES PROGRAM.

The purpose, nature, and scope of this program is undefined at the time this handbook goes to press. As data becomes available, it will be provided in future revisions.

2.6 MSCC INTERFACE PROGRAMS.

2.6.1 LAUNCH-BOOST PROGRAM (INTEGRATED MODE).

During the integrated mode of operation, GSSC provides the same outputs to the AMS as the launch-boost tape during a nonintegrated mode. The variables normally provided by the launch-boost tape are provided in the trajectory link message from the GSSC. A detailed description of the launch-boost is contained in section 3 (Nominal Training Mission) of Volume I of this handbook.

2.6.2 COMMUNICATION AND INSTRUMENTATION PROGRAM.

The AMS communication and instrumentation program controls the introduction of malfunctions into the simulated communication and instrumentation systems. A detailed description of these systems and their simulation is included in Volume I, section 2, paragraph 2.9, of this handbook.

2.6.3 MSCC INTERFACE PROGRAM.

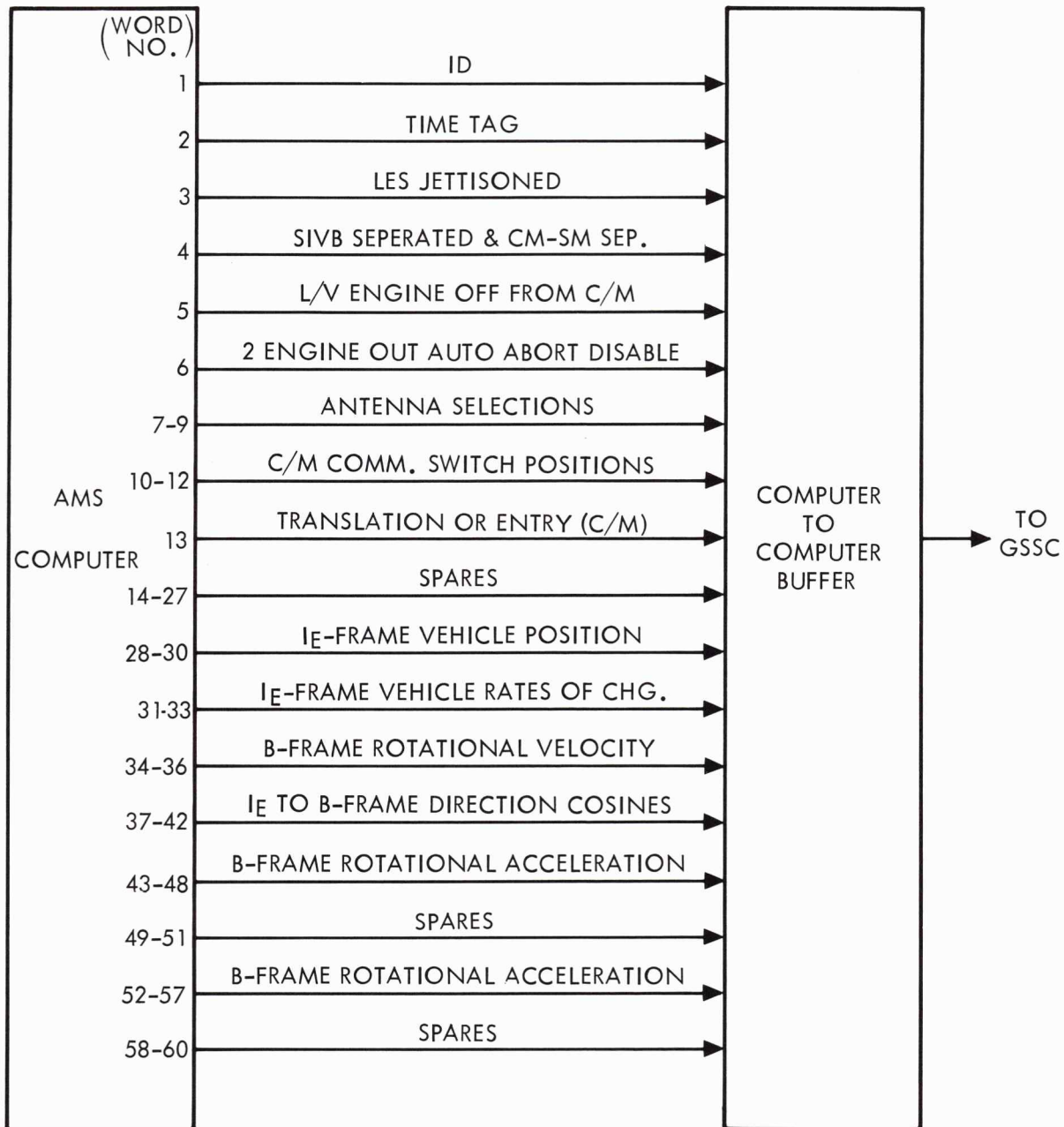
The purpose of this program is to accomplish simulated mission interface between the flight crew in the SCM, the mission control team in the MSCC, and remote site personnel on location and/or in the simulated remote sites. The simulation interface is between the AMS computer and the SCATS-GSSC in the control center. Data transfer (both input and output) is processed in the AMS by the MSCC interface program. The AMS computer is electrically isolated from the SCATS-GSSC by means of the computer-to-computer buffer.

Trajectory simulation in the integrated mode of operation involves both input to the AMS from MSCC and output from the AMS to the MSCC. Each message, both incoming and outgoing, consists of sixty 24-bit words. These 60 words will transmit five times each second. Each message has a time tag specifying when the data is to be used. The time tag is a counter which is pulsed every 200 milliseconds. The time tag is referenced to midnight prior to launch.

A block of 60 core locations in the computer containing the EOM is used to format the outgoing AMS to GSSC message. The MSCC interface program will pack the discretes, as required by the message format, and send the messages out at a rate of five per second to the buffer. The data in the 60-word message must correspond to the message time tag. The information included in the outgoing data message is shown in figure 2-11.

The GSSC to AMS incoming messages (figure 2-12) arrive at the computer-to-computer buffer at a rate of five messages per second. The AMS computer

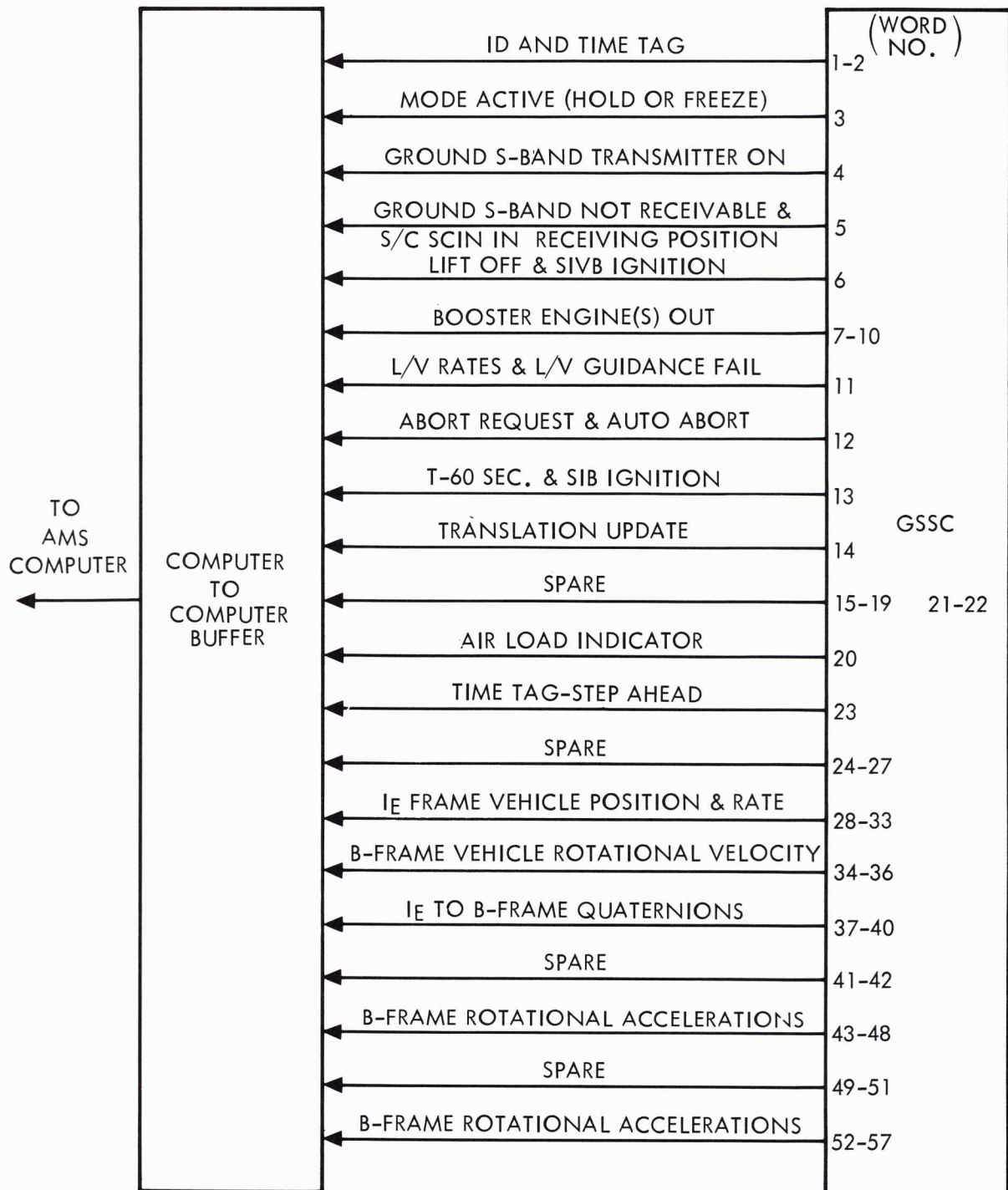
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Figure 2-11. Outgoing Trajectory Link Message

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Figure 2-12. Incoming Trajectory Link Message

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will interrogate the buffer and transfer a message into the computer memory when it is received. The program will then distribute the data to the using programs at the proper time. Interface between this program and the EOM program during integrated mode requires modification of the EOM program. Those EOM equations normally computing translational velocity and position, rotational velocity and position, rotational acceleration and translational acceleration, will be dropped from the AMS computations at various times during integrated operation. Their normal outputs will be replaced by data from the GSSC.

The interface between the MSCC interface program and other AMS programs is much simpler than the EOM interface. Data in the incoming message is transferred from the computer memory to the data pool where all intelligence is separated out of the message format. The programs requiring this data will then draw it from the data pool.

2.6.4 UP-DATA LINK PROGRAM.

The up-data link program is another program which functions only in the integrated mode of AMS operation. Simulated up-data originates in the MSCC and is received in the AMS computer. The information contained in each message is decoded by the receiving system. A description of the simulated spacecraft up-data link system is contained in Volume I, section 2, paragraph 2.9 of this handbook.

2.6.5 TELEMETRY PROGRAM.

The telemetry system simulation in the AMS makes use of a modified spacecraft telemetry package. The AMS computer supplies analog and digital data from other system simulations to this package. No special processing is required for these signals as they are already in the necessary format. The modified spacecraft telemetry package allows malfunctions to be inserted directly from the MIU to the T/M. The spacecraft telemetry system and its AMS equivalent are described in detail in Volume I, section 2, paragraph 2.9 of this document. Simulation parameters processed by the telemetry program are included in section 5 (Simulation Output Data) of Volume III of this handbook.

2.7 DIAGNOSTIC PROGRAMS.

The diagnostic programs are divided into two groups: on-line and off-line. Both groups are under control of the executive and control system (as previously explained in paragraph 2.5.1.5).

2.7.1 ON-LINE MAINTENANCE PROGRAMS.

The on-line maintenance program is for purpose of determining whether or not the AMS is functioning correctly and, when an error is detected, accomplish automatic recovery (where possible). Although the on-line maintenance program operates during an on-line simulation environment, it is only

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initiated if all other operational programs have been completed and enough time is available before a new iteration is initiated. Accomplishment of the program has no visible manifestation unless an error is detected. In cases where errors are detected, all such errors and the time of detection are printed out on the typewriter or the line printer. An error log is maintained by the program to determine whether an error is transient or intermittent. In the case of a failure from which the on-line maintenance program cannot recover, the off-line error detection and diagnostic system is initiated.

2.7.2 OFF-LINE ERROR DETECTION AND DIAGNOSTIC SYSTEM.

The error detection and diagnostic system contains the off-line programs that are used for the preflight readiness test and to troubleshoot the AMS after a failure has been detected. These programs will enable the maintenance personnel to determine whether the AMS is functioning properly and, if not, to facilitate troubleshooting and repair by fault diagnosis and/or fault isolation.

A program for each major unit of the AMS is available for fault detection and diagnostic testing. Each unit can be tested independent of all other units or as part of an integrated system test controlled by the executive program. As each major unit is tested, any manual procedures necessary for execution of the program are communicated to the operators via the line printer or typewriter. At the completion of a failure-free unit test, a positive indication is typed out on the line printer or typewriter. In case of an error, "failure detected" and the type, steady-state or intermittent, is recorded at the typewriter or line printer. The computer then comes to a stop and any further information concerning the failure is manifested to the operator via the instruction register of the computer console. The address portion of the stop instruction makes reference to the maintenance manual which contains complete information concerning the failure.

In addition to major unit test programs, subsystem test programs are utilized for error detection and diagnosis. These include programs for all systems within the command module, testing of the instructor-operator station, aural cue system, visual systems, telemetry system, and the IMCC interface equipment.

Entry into the off-line error detection and diagnostic system is made by typing D into the computer followed by the tape number and drive for the proper off-line diagnostic task.

2.8 LIBRARY OF PROGRAMS.

The following tables constitute the operational and maintenance programs developed for the use of the AMS. The programs have been divided into the following categories:

- Table 2-1. Simulator Control Programs
- Table 2-2. Diagnostic Programs
- Table 2-3. Interface-IMCC Programs
- Table 2-4. Vehicle Dynamics Programs
- Table 2-5. Simulator Effects Programs
- Table 2-6. Vehicle Systems Programs

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Table 2-1. Simulator Control Programs

Program No.	Program Name	Computer Location	Record/ File No.	Notes
28	Executive and control system			
28A	Supervisory control			
28B	Interrupt and timing control			
28C	Input-output control			
28D	On-line data recording			
28E	On-line error detection diagnostic interface control			
28F	Off-line maintenance and diagnostic interface control			
28G	Simulator master control			
29	On-line input-output			
29A	Card punch and reader			
29B	Line printer			
29C	IOS typewriter			
29D	Tape transport			
30	Real time input-output			
30A	DCE input-output			
30B	AMS computer-to-computer transfer			
31	Malfunction insertion unit			
31A	Initialization routine			
31B	Keyboard simulator			
31C	Main routine and master clear routine			
34	Plotters (X-Y); recorders (X-T)			
35	Utilities			

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Table 2-2. Diagnostic Programs

Program No.	Program Name	Computer Location	Record/ File No.	Notes
33	On-line error detection computer			
33A	Digital-to-analog; analog-to-digital			
36	Central processor exercise (on-line)			
50	Central computer			
51	Tape control units and transports			
52	Core memory			
53	Card punch-card reader control			
54	Line printer			
55	Computer console			
55A	Displays and switches			
55B	Typewriter			
55C	Paper tape punch			
55D	Paper tape reader			
56	Command module			
57	IOS and MIU interface equipment			
59	Telemetry system			
60	IMCC (integrated)			
61	Visual systems			
61A	Rendezvous servo			
61B	Starfield			
61C	Sextant and telescope			
61D	Rendezvous video			

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Table 2-2. Diagnostic Programs (Cont)

Program No.	Program Name	Computer Location	Record/ File No.	Notes
61E	Mission effect projector			
62	Executive program for off-line AMS diagnostic system			
66	Data conversion equipment			
68	AMS computer-to-computer transfer			
70	Data conversion equipment monitor			

Table 2-3. Interface-MSCC Programs

Program No.	Program Name	Computer Location	Record/ File No.	Notes
6	Launch boost nonintegrated			
21	Communications and instrumentation			
21A	Antenna effects			
21B	Power and switching logic			
21C	Central timing			
21D	Antenna effects station location			
22	S-IVB control and propulsion system			
23	IMCC interface (integrated)			
24	Up-data link			
25	Telemetry system			

Table 2-4. Vehicle Dynamics Programs

Program No.	Program Name	Computer Location	Record/ File No.	Notes
1	Equations of motion			
2	Aerodynamic forces and moments			
3	Weight and balance			
4	Ephemeris data			

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Table 2-5. Simulator Effects Programs

Program No.	Program Name	Computer Location	Record/ File No.	Notes
13	Smoke			
26	Aural			
27	Visual			
27A	Sextant starfield image generator drive signals			
27B	Telescope drive signals			
27D	Starfield globe drive signals			
27E	Mission effect projector			
27F	Occultation mask			
27G	Sun simulator (sun image projector)			

Table 2-6. Vehicle Systems Programs

Program No.	Program Name	Computer Location	Record/ File No.	Notes
7	Propulsion systems			
7A	C/M reaction control system			
7B	S/M reaction control system			
7C	Service propulsion system			
7D	Propellant utilization system			
8	Supplementary displays			
8A	Data output			
8B	Visual			
8C	True position and altitude			
9	Electrical power system			
9A	Logic			
9B	Displays			
9C	Bus equations			

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Table 2-6. Vehicle Systems Programs (Cont)

Program No.	Program Name	Computer Location	Record/ File No.	Notes
10	Fuel cells			
11	Space radiators			
12	Sequence control group-emergency detection system			
16	Caution and warning system			
17	Environmental control system			
17A	Water			
17B	Water-glycol			
17C	Suit and cabin			
17D	Oxygen			
18	Stabilization and control system			
18A	AGCU, FDAI, BMAG			
18B	Dynamic system			
18C	Thrust vector control			
19	Cryogenic storage system			
19A	Oxygen			
19B	Hydrogen			
20	Guidance and navigation			
20A	IMU			
20B	IMU temperature			
20C	Error warning			
20D	IMU-CDU			
20E	IMU-CDU difference			

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Table 2-6. Vehicle Systems Programs (Cont)

Program No.	Program Name	Computer Location	Record/ File No.	Notes
20F	Optics CDU			
20G1	Executive control; optics monitor control and automatic up-data link			
20G2	Executive control; AGC timing and mission control			
20H	AGC input-output			
20I	Prelaunch align			
20J	Launch boost			
20K1	Navigation, integration, GN1, GN2, GN6			
20K2	Navigation update, GN7			
20L	In-flight alignment			
20M	Earth orbit guidance			
20N	Powered flight			
20O	Re-entry steering			
20P	IMU mode control			

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SECTION 3

AMS UTILIZATION

3.1 PURPOSE AND SCOPE.

It is the purpose of this section of the handbook to provide a complete plan for use of the Apollo Mission Simulator (AMS) in the accomplishment of flight crew training for mission 204A. The overall plan is in the form of a training syllabus made up of a sequence of training exercises. The exercises include a recommended sequence of presentation. The sequence and the contents of the exercises are predicated on good developmental training practices, that is, from the easy to the difficult and from the simple to the complex.

Crew procedures performed in the AMS simulated command module must, as a function of authentic simulation and training effectiveness, be operational flight crew procedures. For this reason, the Apollo Operations Handbook-Command and Service Module (SM2A-03, 1 July 1965) has been established as the basic reference for AMS crew procedures. All training sessions in the syllabus are with reference to specific procedures in the 1 July 1965 revision of SM2A-03 (AMS Supplement - SM2A-03-AMS).

The contents of this section is comprised of the following items:

- A general description of the types of training of which the syllabus is comprised
- A brief description of each training session in the syllabus
- Identification of SM2A-03 crew procedures to be practiced in accomplishing the syllabus and an outline of crew procedures (from SM2A-03) for accomplishing the nominal training mission.
- A general description of how the AMS instructor handbook contents are used to prepare instructor scripts, including a brief discussion of the contents of Volume III of the handbook.

3.2 ORGANIZATION OF TRAINING SYLLABUS.

The syllabus of training for the AMS is subdivided into types of training, training exercises, training sessions, and simulator runs.

The gross identification of syllabus material is by type of training. The type of training is the different manners of simulator utilization in a progressive and developmental training evolution. Four types of training are required to complete the AMS syllabus. In the order of accomplishment, these are part task, mission task, typical mission, and specific mission training.

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Each type of training involves several training exercises. Training exercises are defined as blocks or phases of training. The accomplishment of these blocks or phases constitute specific and significant training milestones. Exercises are organized in a recommended sequence for accomplishment.

Each training exercise is made up of a group of training sessions. Sessions are the basic element of the AMS syllabus; each session being, basically, a lesson in spacecraft operation. Sessions are generally comprised of flight crew performance of all the variations of a given procedure or problem. While many of the sessions are too complex to permit completion in one continuous sitting, accomplishment of each session should be distributed in a minimum of elapsed time to permit maximum training use of comparison between the various elements of the session.

Each of the training sessions is comprised of a number of simulator runs. Simulator runs are defined, for purposes of the handbook, as each different operation of the simulator (between RUN and RESET or RE-CYCLE) for training purposes. The number of times each peculiar run must be iterated, to accomplish training objectives, is not the subject of this handbook.

3.2.1 TYPES OF TRAINING.

This paragraph explains the four types of training identified in paragraph 3.2. Each is separately discussed.

3.2.1.1 Part Task Training.

Part task training is defined as that training involving only one crewmember and one instructor-operator. The purpose of such training is to provide individual crewmember experience in the basic procedures and skills required to operate the Apollo spacecraft.

3.2.1.2 Mission Task Training.

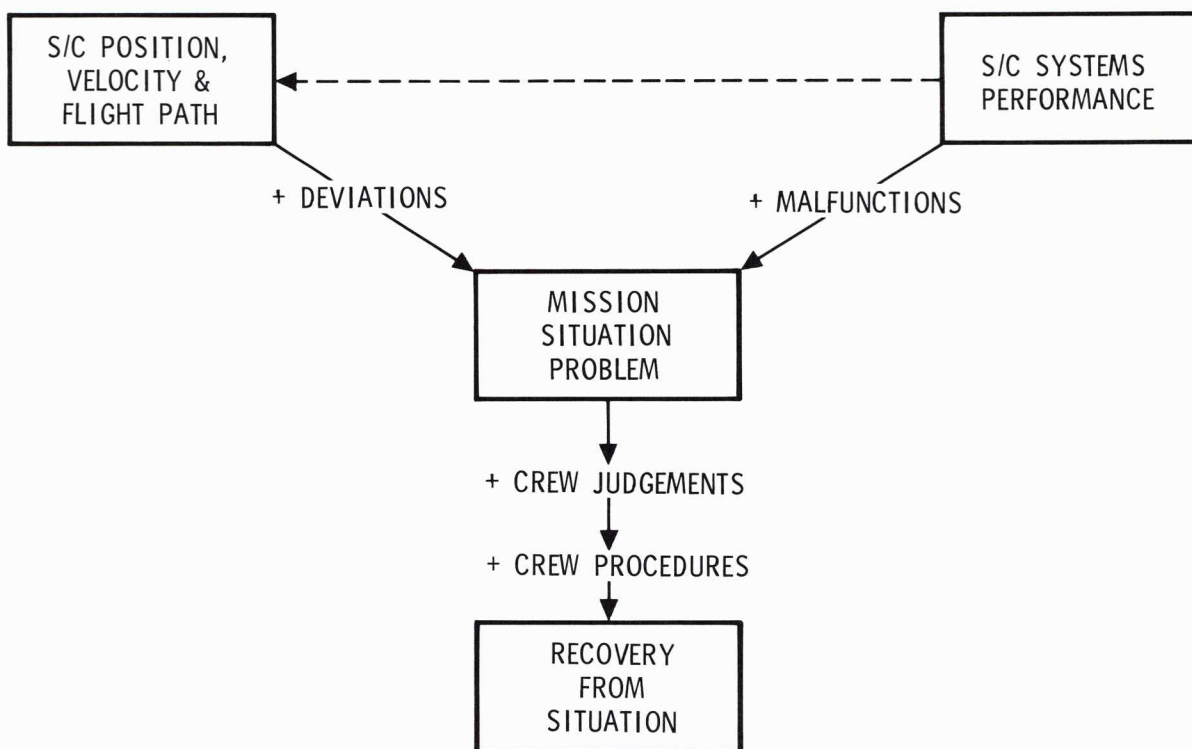
The purpose of mission task training is to provide flight crewmembers with training in the various spacecraft procedures for accomplishing specific mission events. Training includes procedures for both dynamic mission events (launch and ascent, abort, delta V, entry, etc.) and the routine procedures for sustaining spacecraft systems and monitoring flight path during orbital operations.

3.2.1.3 Typical Mission Training.

Typical mission training is defined as complete mission simulations (usually of short duration) comprised of events and situations selected for purposes of effective training. The AMS nominal training mission (and its planned variations) to be used for typical mission training purposes are the subject of section 3 of Volume I of this handbook.

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The purpose of typical mission training is twofold. The first purpose is to provide flight crews with experience in a specific set of simulated missions (that is, nominal training mission) that are representative of all aspects of the planned Apollo mission 204A. The second purpose is to provide the flight crew training in recovering from specific mission problem situations by the timely application of crew procedures. Such situations are established by simulating spacecraft system malfunctions and/or dynamic deviations as illustrated in figure 3-1.



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Figure 3-1. Development of Typical Mission Situations

3.2.1.4 Specific Mission Training.

The purpose of specific mission training is to provide the flight crew experience in the actual planned mission and all projected variations thereof. Such simulation is used to both finalize mission rules and complete flight crew training. Contents of this AMS initial delivered configuration handbook does not include details of specific mission training and it is not planned to include such data in the AF012 revision.

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3.2.2 IDENTIFICATION OF TRAINING SESSIONS.

An alphanumeric code has been established to identify training sessions in the AMS training syllabus. The code is as follows:

PT. }
MT. } Type of Training
TM. }
SM. }

1. }
2. } First, Second, Third, etc. Exercise within Type of Training
3. }
n. }

1. }
2. } First, Second, Third, etc. Session within Exercise
3. }
n. }

Examples:

PT. 2. 3 is the third session of the second part task exercise.

MT. 1. 2 is the second session of the first mission task exercise.

There is the possibility of adding a third number to the code for the purpose of identifying simulation runs within a given session; for example, PT. 2. 3. 1 is the first run of the third session of the second part task exercise. A complete outline of the AMS training syllabus is provided in table 3-1.

Table 3-1. AMS Training Syllabus Outline

Part Task Training	
PT. 1	<u>SYSTEM PROCEDURES</u> (Exercise)
PT. 1. 1	SCS operation (session)
PT. 1. 2	RCS and SPS operation (session)
PT. 1. 3	EPS operation (session)
PT. 1. 4	ECS operation (session)
PT. 1. 5	Periodic checks (session)
PT. 2	<u>NAVIGATION AND IMU ALIGNMENT</u> (Exercise)
PT. 2. 1	IMU alignment (session)
PT. 2. 2	Earth orbital navigation (session)
PT. 2. 3	G&N malfunctions and alternate modes (session)

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Table 3-1. AMS Training Syllabus Outline (Cont)

PT. 3	<u>DELTA V PROCEDURES</u> (Exercise)
PT. 3.1	Retrograde from earth orbit (session)
PT. 3.2	Hohmann transfers and plane changes (session)
PT. 4	<u>ENTRY</u> (Exercise)
PT. 4.1	G&N mode entry (session)
PT. 4.2	Entry contingencies (session)
PT. 5	<u>LAUNCH, ASCENT, AND ABORT</u> (Exercise)
PT. 5.1	Launch and ascent procedures (session)
PT. 5.2	LES aborts (session)
PT. 5.3	SPS aborts (session)
Mission Task Training	
MT. 1	<u>PRELAUNCH, LAUNCH AND ASCENT, ABORT</u> (Exercise)
MT. 1.1	Prelaunch, launch, ascent (session)
MT. 1.2	Pad and low altitude aborts (session)
MT. 1.3	High altitude LES aborts (session)
MT. 1.4	SPS aborts (session)
MT. 2	<u>ORBITAL NAVIGATION AND SYSTEM PROCEDURES</u> (Exercise)
MT. 2.1	Initial earth orbital procedures (session)
MT. 2.2	Extended mission earth orbital procedures (session)
MT. 3	<u>DEORBIT, PLANE CHANGE, AND HOHMANN TRANSFER PROCEDURES</u> (Exercise)
MT. 3.1	Preparation for and delta V for Hohmann transfer (session)
MT. 3.2	Preparation for and delta V for plane change (session)
MT. 3.3	Preparation for and delta V for deorbit (session)
MT. 4	<u>DEORBIT, ENTRY, AND POST LANDING</u> (Exercise)
MT. 4.1	Normal (G&N mode) deorbit, separation, entry, and post landing (session)
MT. 4.2	SCS mode deorbit, separation, entry, and post landing (session)
MT. 4.3	Early mission termination (session)

... continued

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Table 3-1. AMS Training Syllabus Outline (Cont)

Typical Mission Training	
TM. 1	<u>BASIC NOMINAL MISSION</u> (Exercise)
TM. 1. 1	Extended mission procedures (session)
TM. 1. 2	Orbital abort from extended mission (session)
TM. 2	<u>NOMINAL MISSION, PLANE CHANGES</u> (Exercise)
TM. 2. 1	Plane change procedures (session)
TM. 2. 2	Plane change contingencies (session)
TM. 3	<u>NOMINAL MISSION, HOHMANN TRANSFERS</u> (Exercise)
TM. 3. 1	Transfer to 105-n mi/140-n mi-elliptical orbit (session)
TM. 3. 2	Transfer from 105-n mi to 140-n mi circular orbit (session)
TM. 3. 3	Hohmann transfer from 105-n mi to 140-n mi to 105-n mi (session)

3.3 GENERAL DESCRIPTION, EXERCISES AND SESSIONS.

The purpose of these paragraphs is to explain the scope and purpose of each exercise and session in table 3-1. Detailed descriptions of and specific instructions for each session are the subject of section 1, Volume III of this handbook.

3.3.1 SYSTEM PROCEDURES (EXERCISE PT. 1).

System procedures training accomplished in this exercise encompasses those spacecraft system procedures (except for G&N) that are reiterated throughout the mission to use the systems, check system status, maintain system status, and alter system mode of operation. System procedures for the G&N system are inherent in exercise PT. 2. There are five training sessions in exercise PT. 1.

3.3.1.1 SCS Operation (Session PT. 1.1).

This session is comprised of introduction to and practice in operating the SCS and G&N systems as they relate to attitude control. Training in attitude manipulation with both SM-RCS and CM-RCS is included. Runs involved are as follows:

- Walk-through of SCS setup, power on verification, and SCS-G&N attitude and translation control modes (SM-RCS).
- Practice of SCS setup, power on verification, and attitude and translation control (SM-RCS) in G&N, SCS, and manual direct modes.
- Practice of SM-RCS attitude and translation control in G&N, SCS, and manual direct modes with selected SM-RCS jets inoperative.
- Practice of CM-RCS attitude and translation control (in non-aerodynamic free fall) in G&N, SCS, and manual direct modes with all CM-RCS jets functioning normally and with selected CM-RCS jets inoperative.

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3.3.1.2 RCS and SPS Operation (Session PT. 1. 2).

This session includes demonstration and practice of management and operating procedures for spacecraft thrusting systems. Systems involved are S/M-RCS, C/M-RCS, and SPS. Procedures are organized so that all can be accomplished by one crewman moving from station 3 to station 1. Runs involved are as follows:

- Walk-through of SPS and RCS periodic verification
- Walk-through of procedures for preparing for and accomplishing G&N mode delta V (stations 3 and 1)
- Practice preparing for and accomplishing G&N mode delta V (stations 3 and 1)
- Walk-through of procedures for SCS mode delta V (station 1)
- Practice preparing for and accomplishing SCS mode delta V (stations 3 and 1).

3.3.1.3 EPS Operation (Session PT. 1. 3).

This session includes demonstration and practice of spacecraft procedures for EPS operation. Runs involved are as follows:

- Walk-through of EPS periodic checks
- Walk-through of fuel cell purge and battery charge procedures
- Practice EPS periodic checks with simulated malfunctions

3.3.1.4 ECS Operation (Session PT. 1. 4).

This session comprises the demonstration and practice of spacecraft procedures for ECS operation. Simulations are all shirtsleeve with initial walk-throughs followed by practice runs. Runs involved are as follows:

- Walk-through of initial orbital ECS procedures (stations 1, 3, and 4)
- Practice of initial orbital ECS procedures
- Walk-through of routine orbital ECS procedures
- Walk-through ECS preparation for deorbit and entry
- Practice ECS preparation for deorbit and entry
- Walk-through waste management system procedures
- Walk-through demonstration of ECS malfunctions and alternate modes and procedures.

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3.3.1.5 Periodic Check (Session PT.1.5).

It is the purpose of this session to provide the flight crew practice in procedures for periodically checking and servicing spacecraft systems. The procedures have been organized into four functional groups for the purpose of accomplishing the required training. The groups are as follows:

- a. Attenuator panel removal and CO₂-odor absorber filter replacement
- b. Cabin air processing adjustment, space radiator activation, and suit-cabin mode change
- c. Hourly ECS flight verification, SPS periodic verification, RCS periodic verification, and EPS periodic checks
- d. Fuel cell purging and battery charging.

Simulated malfunctions are used to initiate crew action to service systems and select alternate modes and redundant subsystems. Simulation runs of which the session is comprised are as follows:

- Practice procedure groups a, b, c, and d without malfunctions
- Practice procedure groups c and d with selected malfunctions (malfunction selection set 1)
- Practice procedure group d with selected malfunctions (malfunction selection set 2)
- Practice procedure group d with selected malfunctions (malfunction selection set 2 and 3).

3.3.2 NAVIGATION AND IMU ALIGNMENT (EXERCISE PT.2).

This exercise provides training in the setup and operation of the G&N system. Such training includes setup and readiness status procedures, equipment operating procedures, navigation techniques, fault analysis, alternate modes, and redundant systems. There are three training sessions in PT.2.

3.3.2.1 IMU Alignment (Session PT.2.1).

This session includes G&N system activation and procedures for IMU and AGCU (FDAI) alignment. Runs involved are as follows:

- Walk-through of G&N activation, coarse and fine IMU alignment (manual and DSKY data insertion) and AGCU (FDAI) alignment.
- Practice of G&N activation, coarse and fine IMU alignment (manual insertion) and AGCU (FDAI) alignment.
- Practice of G&N activation, coarse and fine IMU alignment (DSKY data insertion) and AGCU (FDAI) alignment.

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3.3.2.2 Earth Orbital Navigation (Session PT. 2. 2).

This session includes the procedures for earth landmark navigation using the spacecraft G&N system. Landmark recognition is emphasized along with equipment operating procedures. Runs are as follows:

- Walk-through of landmark navigation procedures
- Practice landmark navigation procedures.
- Practice G&N activation, coarse and fine IMU alignment, and AGCU (FDAI) alignment, followed by orbit measurement.

3.3.2.3 G&N Malfunctions and Alternate Modes (Session PT. 2. 3).

This session comprises the demonstration and practice of G&N malfunctions, special procedures, and alternate modes. Runs involved are as follows:

- Practice G&N activation, IMU and AGCU alignment, and landmark sightings with simulated malfunctions
- Practice G&N system status verification and IMU fine alignment with simulated malfunctions
- Practice G&N system status verification and landmark navigation procedures with simulated malfunctions.

3.3.3 DELTA V PROCEDURES (EXERCISE PT. 3).

This exercise comprises the crew procedures for accomplishing delta V and those related navigation and system procedures required to prepare for delta V. Such preparations include navigation for determining delta V requirements and preparation of the SPS for use. The simulation runs are organized so that one crewmember may accomplish the entire sequence by moving from station 4 to station 3 to station 1. The exercise contains two training sessions.

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3.3.3.1 Retrograde from Earth Orbit (Session PT. 3. 1).

This session includes introduction of the basic delta V procedures, practice in performing delta V for purpose of deorbit in both the G&N and SCS modes, and practice in preparing for deorbit. Preparations include both navigation and system operating procedures. Runs are as follows:

- Walk-through of SPS, SCS, and G&N procedures (DSKY only) for preparing for and accomplishing G&N mode delta V
- Walk-through of SPS and SCS procedures for preparing for and accomplishing SCS mode delta V
- Practice SPS, SCS, and G&N procedures (DSKY only) for preparing for and accomplishing G&N mode retrograde
- Practice SPS and SCS procedures for preparing for and accomplishing SCS mode retrograde
- Walk-through of procedures for preparing spacecraft systems for retrograde
- Practice final orbit navigation and systems procedures for preparing for and accomplishing G&N mode retrograde.

3.3.3.2 Hohmann Transfers and Plane Changes (Session PT. 3. 2).

This session is provided for the purpose of training flight crewmembers in the navigation and system procedures for preparing for and accomplishing Hohmann transfers from one orbit to another and changes in orbital angle of inclination. Runs are as follows:

- Practice navigation and systems procedures for G&N mode delta Vs required in Hohmann transfer from 105-n mi circular orbit to 140-n mi circular orbit (including measurement of 105-n mi orbit, transient elliptical orbit, and 140-n mi orbit)
- Practice navigation and systems procedures for G&N mode delta Vs required in changing orbital angle by -1 degree, measuring the new orbit, changing again by +1 degree and measuring that orbit.

3.3.4 ENTRY (EXERCISE PT. 4).

This exercise is provided to train flight crewmembers with experience in the procedures for C/M-S/M separation, entry, and descent operations. Two sessions are involved.

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3.3.4.1 G&N Mode Entry (Session PT. 4. 1).

This session comprises the demonstration and practice of crew procedures for preparing for and accomplishing C/M-S/M separation, preparing for and accomplishing G&N mode entry, and monitor-control of the earth landing sequence. Runs are as follows:

- Walk-through of procedures for preparing for and accomplishing C/M-S/M separation, preparing for and accomplishing G&N mode entry, and monitor-control of the earth landing sequence
- Practice procedures for preparing for and accomplishing C/M-S/M separation and preparing for and accomplishing G&N mode entry
- Practice procedures for preparing for and accomplishing retrograde, C/M-S/M separation, G&N mode entry, and monitor-control of earth landing system sequence.

3.3.4.2 Entry Contingencies (Session PT. 4. 2).

This session is for the purpose of providing flight crewmembers training in the use of alternate modes, redundant systems, and manual overrides in accomplishing separation, entry, and recovery under system malfunction circumstances. Runs are as follows:

- Walk-through SCS mode entry procedures (entails C/M-S/M separation to connect with initiation point S9)
- Practice SCS mode entry (again entails separation for the same reason)
- Walk-through manual direct mode entry procedures (entails C/M-S/M separation)
- Practice manual direct mode entry (including separation)
- Practice entry in SCS mode with one C/M-RCS roll jet inactive
- Practice entry in manual direct mode with one roll jet inactive
- Practice entry in SCS mode with one yaw jet inoperative
- Practice entry in manual direct mode with one pitch jet inactive
- Practice preparation for separation, preparations for entry, SCS mode entry, and monitor-control of the earth landing sequence with sequencing malfunctions.

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3.3.5 LAUNCH, ASCENT, AND ABORT (EXERCISE PT. 5).

This exercise provides demonstration and practice of launch and ascent procedures for station 1. Procedures include monitoring sequenced events on the EDS displays, analyzing trajectory characteristics on the basis of FDAI and AGC displays, recognizing abortive situations, and initiating and accomplishing LES and SPS aborts. Since prelaunch procedures are primarily a coordinated crew activity, part task training for that mission phase would be ineffective and none is prescribed. There are three sessions in exercise PT. 5.

3.3.5.1 Launch and Ascent Procedures (Session PT. 5.1).

This session is to provide demonstration and practice in the station 1 flight crew procedures for launch and ascent to orbit. Runs are as follows:

- Walk-through of station 1 launch and ascent procedures
- Practice of station 1 launch and ascent procedures

3.3.5.2 LES Aborts (Session PT. 5.2).

This session is to provide flight crewmembers with experience in all aspects of LES abort procedures for station 1. Runs involved are as follows:

- Walk-through of pad abort sequence
- Practice LES abort procedures (5,000 to 25,000 feet)
- Practice LES abort procedures (25,000 to 30,000 feet)
- Practice LES abort procedures (30,000 to 220,000 feet)
- Practice LES abort procedures (30,000 to 220,000 feet) with sequencing malfunctions
- Practice LES abort procedures (5,000 to 25,000 feet) with sequencing malfunctions
- Practice LES abort (less than 5,000 feet) procedures with sequencing malfunctions.

3.3.5.3 SPS Aborts (Session PT. 5.3).

The purpose of this session is to provide the flight crew training in station 1 procedures for SPS abort. As the handbook goes to press,

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there is insufficient AMS and spacecraft data to define the specifics of part task training in SPS abort to orbit or SPS abort to suborbital trajectory in SCS mode. Runs in session PT.5.3 are as follows:

- Walk-through of station 1 procedures for SPS retrograde abort to suborbital trajectory (G&N mode)
- Practice station 1 procedures for SPS posigrade abort to suborbital trajectory (G&N mode)
- Practice station 1 procedures for SPS retrograde abort to suborbital trajectory (G&N mode)

3.3.6 PRELAUNCH, LAUNCH, ASCENT, AND ABORT (EXERCISE MT. 1).

This exercise provides demonstration of the coordinated crew procedures for prelaunch and crew practice of procedures for prelaunch, launch and ascent, LES aborts, and SPS aborts. Simulated malfunctions are used to induce requirements for prelaunch holds and override of sequence events during aborts. Available data on SPS abort to orbit and SCS mode, SPS abort, is prohibitive to detailed definition of training required. There are four training sessions in MT. 4.

3.3.6.1 Prelaunch, Launch, and Ascent (Session MT. 1.1).

This session comprises the demonstration and practice of crew procedures for prelaunch, launch, and ascent to orbit. Runs are as follows:

- Walk-through of crew procedures for prelaunch
- Practice crew procedures for normal prelaunch, launch and ascent to orbit

3.3.6.2 Pad and Low Altitude Aborts (Session MT. 1.2).

This session is to provide flight crew experience in crew procedures for pad and low altitude abort.

- Walk-through of crew procedures for pad abort
- Practice crew procedures for LES abort (25,000 to 30,000 feet)
- Practice crew procedures for LES abort (5,000 to 25,000 feet)
- Practice crew procedures for LES abort (Below 5,000 feet).

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3.3.6.3 High Altitude LES Aborts (Session MT. 1. 3).

This session is to provide flight crew training in procedures for LES abort between 30,000 and 220,000 feet. Runs are as follows:

- Practice crew procedures for LES auto abort (30,000 to 220,000 feet)
- Practice recognizing abortive spacecraft conditions and crew-initiated abort (30,000 to 220,000 feet).

3.3.6.4 SPS Aborts (Session MT. 1. 4).

This session is to provide training in the integrated crew procedures for SPS aborts. Such procedures include both abort to suborbital trajectory and abort to orbit. However, as of the date of preliminary handbook publication, there is insufficient AMS and spacecraft data to define the specifics of mission task training in SPS abort to orbit or SPS abort to suborbital trajectory in the SCS mode. Simulator runs are as follows:

- Walk-through of integrated crew procedures for SPS abort to suborbital trajectory (G&N mode)
- Practice integrated crew procedures for SPS abort to suborbital trajectory (G&N mode) stemming from booster failure
- Practice recognizing system failures requiring suborbital abort and accomplishing SPS abort in the G&N mode.

3.3.7 ORBITAL NAVIGATION AND SYSTEM PROCEDURES (EXERCISE MT. 2).

It is the purpose of this exercise to provide training in crew procedures for spacecraft navigation and systems management during routine phases of the earth orbital mission. Crew composition will be limited to two crewmen; in some cases, the third being assumed in rest cycle. There are two training sessions in exercise MT. 1.

3.3.7.1 Initial Earth Orbital Procedures (Session MT. 2. 1).

This session comprises the demonstration and practice of integrated crew procedures for the initial phases of orbital operations. Procedures include transfer of systems configuration from ascent to orbit, initial IMU fine alignment and navigation, and systems checkout. Simulator runs are as follows:

- Walk-through of integrated crew procedures for initial phases of orbital operation
- Practice crew procedures for initial phases of orbital operation.

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3.3.7.2 Extended Mission Earth Orbital Procedures (Session MT. 2. 2).

Training provided by this session is for a two-man operation of the spacecraft with the third member in rest cycle. The third member is, of course, not involved in or required for the procedures involved. Crew activities include system management under reduced power, coarse and fine IMU alignment, navigation, systems monitoring and checkout, and systems management and servicing. Only one definitive run is involved. Number of reiterations required for training is not a subject of this handbook. The run consists of practicing two-man crew routines for extended mission earth orbital procedures.

3.3.8 DEORBIT, PLANE CHANGE, AND HOHMANN TRANSFER PROCEDURES (EXERCISE MT. 3).

This exercise has been included in the syllabus to provide crew training in the procedures for preparing for and accomplishing delta V for different reasons throughout the earth orbital mission. Procedures include navigation, systems preparations, and SCS and G&N system operation in computing and accomplishing delta V. Three training sessions are involved. The sessions may be accomplished with either a two or a three man crew.

3.3.8.1 Preparation for and Delta V for Hohmann Transfer (Session MT. 3. 1).

This session is to demonstrate the integrated crew procedures for preparing for and accomplishing G&N mode, delta V, and to provide practice in the Hohmann transfer application of such procedures. Runs are as follows:

- Walk-through of integrated crew procedures for preparing spacecraft systems for and accomplishing initial delta V in Hohmann transfer from 105-n mi to 140-n mi orbit (G&N mode)
- Practice integrated crew procedures for Hohmann transfer from 105-n mi to 140-n mi including measuring initial orbit, IMU alignment, preparing for and accomplishing delta V to transfer trajectory, measuring transient orbit, preparing for and accomplishing circularization delta V, and measuring 140-n mi orbit (G&N mode).

3.3.8.2 Preparation for and Delta V for Plane Change (Session MT. 3. 2).

The purpose of this session is to provide additional practice of integrated crew procedures for G&N mode, delta V, as applied to changes in angle of inclination in the orbital plane. Practice of integrated crew procedures for SCS mode, delta V, in the same application is also included. Simulator runs involved are as follows:

- Practice integrated crew procedures for plane change of -1 degree followed by a plane change of +1 degree one orbit later, including measuring initial orbit, IMU alignment, preparing for and accomplishing -1-degree change (G&N mode), measuring altered orbit, preparing for and accomplishing +1-degree change (G&N mode) and measuring resulting orbit

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- Practice integrated crew procedures for plane change of -1 degree followed by a plane change of +1 degree one orbit later, including measuring initial orbit, IMU alignment, preparing for and accomplishing -1-degree change (SCS mode), measuring altered orbit, preparing for and accomplishing +1-degree change (SCS mode) and measuring resulting orbit.

■ 3.3.8.3 Preparation for and Delta V for Deorbit (Session MT. 3.3).

Training in this session is for the purpose of additional practice in integrated crew procedures for delta V, in this case, applied to retrofire from earth orbit. Practice is for both G&N and SCS modes. Included is demonstration and practice of crew procedures for preparing for the deorbit maneuver. Runs are as follows:

- Walk-through of crew procedures for preparing spacecraft systems for the deorbit maneuver
- Practice integrated crew procedure for deorbit from 105-n mi orbit including measuring of orbit, IMU alignment, and preparing for and accomplishing G&N mode retrofire
- Practice integrated crew procedures for deorbit from 105-n mi orbit including measuring of orbit, IMU alignment, and preparing for and accomplishing SCS mode retrofire.

■ 3.3.9 DEORBIT, ENTRY, AND POST LANDING (EXERCISE MT. 4).

This exercise is for the purpose of training the flight crew in coordinated crew procedures for preparing for retrofire (navigation and system procedures), deorbit maneuver, preparing for and accomplishing C/M-S/M separation, preparing for and accomplishing entry, monitor-control of the earth landing sequence, and postlanding procedures. There are three sessions in the exercise.

■ 3.3.9.1 Normal (G&N Mode) Deorbit, Entry, and Post Landing (Session MT. 4.1).

This session provides demonstration and practice of the crew procedures for preparing for and accomplishing C/M-S/M separation, entry, descent to touchdown, and postlanding operation. Runs are as follows:

- Walk-through of integrated crew procedures for preparing for and accomplishing C/M-S/M separation and G&N mode entry, monitor-control of earth landing sequence, and postlanding operations.
- Practice of crew procedures for preparing for and accomplishing (including orbital navigation) retrofire (G&N mode), C/M-S/M separation, entry (G&N mode), descent, and postlanding operations.

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3.3.9.2 SCS Mode Deorbit, Entry, and Post Landing (Session MT. 4. 2). I

This session provides practice of the integrated crew procedures for SCS mode retrofire and entry. Only one definitive run is involved. Number of reiterations required for training is not the subject of this handbook. The run consists of practicing crew procedures for preparing for and accomplishing (including orbital navigation) retrofire (SCS mode), C/M-S/M separation, entry (SCS mode), descent, and postlanding operations.

3.3.9.3 Early Mission Termination (Session MT. 4. 3). I

It is the purpose of this session to provide training in the integrated crew procedures for recovering from the extended mission configuration (one man in rest cycle, systems on minimum power) and accomplishing an emergency deorbit and entry. Runs are as follows:

- Walk-through of procedures for early mission termination from extended mission configuration.
- Practice crew procedures for early mission termination from extended mission configuration.

3.3.10 BASIC NOMINAL MISSION (EXERCISE TM. 1).

The scope and purpose of crew training in the basic nominal training mission is discussed in section 3 of Volume I of this handbook. This exercise is for the purpose of accomplishing the training described in that section. There are two training sessions in exercise TM. 1.

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3.3.10.1 Extended Mission Procedures (TM.1.1).

The subject of this session is a complete three-orbit mission involving launch and ascent to orbit, initial orbital procedures, navigation and IMU alignment, systems checks and servicing, systems management during power conservation, two-man routines (with third crewman in rest cycle), preparation for and accomplishment of deorbit maneuver, C/M-S/M separation, entry and descent, and postlanding procedures. Simulated malfunctions are used to provoke use of special procedures, redundant systems, and alternate modes. Runs are as follows:

- Practice crew procedures for three-orbit basic nominal mission without malfunctions
- Practice crew procedures for three-orbit basic nominal mission with simulated malfunctions to induce use of special procedures; alternate modes and redundant systems in orbit; and crew override of sequencing events during C/M-S/M separation, G&N mode entry and descent
- Practice crew procedures for three-orbit basic nominal mission with simulated malfunctions to induce use of special procedures, alternate modes and redundant systems in orbit, and retrograde and entry in SCS mode.

3.3.10.2 Orbital Abort from Extended Mission (Session TM.1.2).

It is the purpose of this session to provide crew training in procedures for recognizing requirements for and accomplishing early mission termination from 105-n mi earth orbit. Each run entails a complete simulated mission from prelaunch through postlanding procedures. Runs are as follows:

- Practice procedures for a simulated mission involving early mission termination in the G&N mode during the second orbit because of spacecraft malfunctions
- Practice procedures for a simulated mission that requires early mission termination by SCS mode retrograde and entry in the second orbit because of spacecraft malfunctions
- Practice procedures for a simulated mission that requires early mission termination by SCS mode retrograde and manual direct mode entry in the second orbit because of spacecraft malfunctions.

3.3.11 NOMINAL MISSION, PLANE CHANGES (EXERCISE TM.2).

The scope and purpose of crew training in the nominal mission, plane changes, are discussed in section 3 of Volume I of this handbook. This exercise is for the purpose of accomplishing the training described in that section. There are two training sessions in exercise TM.2.

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3.3.11.1 Plane Change Procedures (Session TM.2.1).

Training in this session includes further practice of navigation, IMU alignment, and system management procedures along with delta V procedures for the purpose of changing orbital inclination. Only one definitive run is involved. Number of reiterations required for training is not a subject of this handbook. The run encompasses a complete simulated mission from prelaunch through postlanding operation. The run is as follows: practice procedures for a simulated mission involving a -1-degree change in orbital inclination, followed one orbit later by a corresponding +1-degree change (all delta V maneuvers in G&N mode).

3.3.11.2 Plane Change Contingencies (Session TM.2.2).

This session provides training in crew procedures for dealing with various mission and system contingencies during the nominal mission, plane changes. Each run comprises a complete simulated mission from prelaunch through postlanding procedures. Runs are as follows:

- Practice procedures for a simulated mission including a -1-degree plane change and a +1-degree change one orbit later with simulated malfunctions to require second-plane change, retrograde, and entry in the SCS mode
- Practice procedures for a simulated mission including a plane change planned for -1 degree, but resulting in a larger change because of SPS overrun (manual thrusting cutoff), computation and accomplishment of plane change to intercept planned landing site, and malfunctions requiring SCS mode retrograde and manual direct mode entry.

3.3.12 NOMINAL MISSION, HOHMANN TRANSFERS (EXERCISE TM.3).

The scope and purpose of crew training in the nominal mission, Hohmann transfers, are discussed in section 3 of Volume I of this handbook. This exercise is for purpose of accomplishing the training described in that section. There are three training sessions in exercise TM.3.

3.3.12.1 Transfer to 105-n mi/140-n mi Elliptical Orbit (Session TM.3.1).

The subject of this training session is a complete simulated mission from launch to touchdown involving transfer from 105-n mi circular orbit to 105-n mi/140 n mi-elliptical orbit. The purpose of the session is to provide further practice of crew procedures for navigation, IMU alignment, delta V, and system management along with crew experience operating in elliptical orbit. Only one definitive run is involved. Number of reiterations required for training is not a subject of this handbook. The run is as follows: practice procedures for a simulated mission involving transfer from 105-n mi circular orbit to 105-n mi/140-n mi elliptical orbit with entry from orbital apogee.

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3.3.12.2 Transfer from 105-n mi to 140-n mi Circular Orbit (Session TM.3.2).

This session continues crew practice in navigation, IMU alignment, delta V, and system management procedures along with entry from 140 n mi. Each run comprises a complete simulated mission from launch through touchdown. Runs are as follows:

- Practice procedures for a simulated two-orbit mission involving Hohmann transfer from an orbital altitude of 105 n mi to 140 n mi and entry from 140-n mi orbit
- Practice procedures for a simulated mission involving Hohmann transfer from an altitude of 105 n mi to 140 n mi with SPS underrun (premature cutoff) during circularization delta V and malfunctions requiring retrograde and entry in the SCS mode.

3.3.12.3 Hohmann Transfers, 105 n mi to 140 n mi to 105 n mi (Session TM.3.3).

Training in this session provides still further practice in crew procedures for navigation, IMU alignment, delta V, and system management with emphasis on accomplishing delta V maneuvers. Each run entails a complete three-orbit mission. Runs a and b are continuous from launch to touchdown. Run c is the training summary and should be conducted from prelaunch through postlanding procedures. Runs are as follows:

- a. Practice procedures for a simulated mission involving Hohmann transfer from 105-n mi orbit to 140-n mi orbit and back to 105-n mi orbit (all delta V maneuvers in G&N mode)
- b. Practice procedures for a simulated mission involving Hohmann transfer from 105-n mi orbit to 140-n mi orbit and back to 105-n mi orbits (using simulated malfunctions to require final circularization delta V, retrograde and entry in the SCS mode)
- c. Practice procedures for a simulated mission involving Hohmann transfer to 140 n mi with malfunctions to induce azimuth error in 140-n mi orbit, computing and accomplishing plane change to intercept planned landing site, malfunctions to induce SCS mode during the plane change and retrograde, and manual direct mode entry.

3.4 CREW PROCEDURES.

Crew procedures, for purposes of this handbook, are those step-by-step procedures to be used by the crew in accomplishing simulated missions or mission segments in the SCM. As stated in paragraph 3.1, the Apollo Operations Handbook-Command and Service Module (SM2A-03, 1 July 1965) has been established as the basic reference for AMS crew procedures.

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3.4.1 APOLLO OPERATIONS HANDBOOK.

The specific revision to SM2A-03 that has been used in preparation of this handbook is that of 1 July 1965. Since the subject of the 1 July revision to SM2A-03 is spacecraft AF012, and the initially delivered AMS differs from AF012 as described in section 2 of Volume I of this handbook, the contents of the (SM2A-03) is not directly useable in the AMS. For this reason, the NAA-S&ID department providing the Apollo Operations Handbook (Apollo Site Activation and Logistics - Support Manuals Department) has prepared and provided a special AMS supplement of the 1 July revision of SM2A-03.

This supplement is identified as the Preliminary Apollo Operations Handbook Supplement - Apollo Mission Simulator Crew Procedures (SM2A-03-AMS). The source used in preparing this handbook was the initial review copy of the supplement dated 1 July 1965. Future plans to update, verify, and otherwise improve and revise the supplement are undetermined at the time this handbook goes to press.

The contents of the SM2A-03-AMS is comprised of crew procedures corresponding to those provided in section 4 (Normal/Backup Procedures) and section 5 (Abnormal Procedures) in SM2A-03. The procedures in the supplement have been prepared so that they can be accomplished with AMS controls and displays. Other AMS information corresponding to section 2 (Controls, Displays, and Systems Data) of SM2A-03 can be found in Volume I of this handbook.

3.4.2 NOMINAL TRAINING MISSION PROCEDURES.

Since SM2A-03-AMS (1 July 1965) is to be the crew procedures reference during training on the initial delivered configuration of the AMS, it is necessary to specifically define which portions of the crew procedures contained therein are to be used by the crew in each increment of training in this handbook. Therefore, since all specific training increments described in this handbook are (by definition), with respect to the nominal training mission, crew procedures from SM2A-03-AMS must be outlined for the accomplishment of the training mission. Such is the purpose of the following paragraphs and related tables.

3.4.2.1 Crew Procedures, Basic Nominal Training Mission.

The basic nominal training mission is described in paragraph 3.8, table 3-3, and figures 3-18, 3-19, and 3-20 of Volume I of this handbook. The basic nominal mission, or portions thereof, is utilized in training sessions PT.1.1, PT.1.3, PT.1.4, PT.1.5, PT.2.1, PT.2.2, PT.2.3, PT.3.1, PT.4.1, PT.4.2, PT.4.3, PT.5.1, PT.5.2, PT.5.3, MT.1.1, MT.1.2, MT.1.3, MT.1.4, MT.2.1, MT.2.2, MT.3.3, MT.4.1, MT.4.2, MT.4.3, TM.1.1, and TM.1.2.

As outline of SM2A-03-AMS (1 July 1965) procedures for accomplishing the basic nominal training mission in accordance with "Mission A" in table 3-3 of Volume I is provided in this section as table 3-2.

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Table 3-2. Crew Procedures, Basic Nominal Training Mission

Mission Time	Mission Event Crew Activity Volume I		SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title
	Table 3-2	Table 3-3			
N/A	S1		1.1		<u>Prelaunch</u> Astronaut ingress Initial checks System verification Hatch installation and C/M purge and leak check Launch preparation
-00:01:00	S2	1		P.1.1/P.3.1 P.1.2/P.2.1/ P.3.2 P.1.3/P.2.2/ P.3.3	LAUNCH BOOST
-00:00:04			1.2	A.1.1/A.2.1/ A.3.1	Ascent and initial orbit S-IB engine ignition Liftoff Roll-pitch maneuver Maximum dynamic pressure S-IVB boost Launch escape tower jettison Maximum altitude
00:10:00	S3	2			ORBIT INSERTION Orbital insertion
00:12:04		3			START FIRST ORBIT
00:15:00		4			JETTISON S-IVB
00:15:00		4.1	1.2	O.1.1/O.3.1/ O.4.1	Initial orbit
00:20:00		4.2			NAVIGATION SIGHTINGS G&N system activation Landmark sighting
		4.4/4.5	1.3.1.1 1.3.2.2.1	N.4.501 N.4.520	COARSE & FINE ALIGN IMU IMU alignment (coarse and fine)
00:42:00			1.3.2.1.1/1.3.2.1.2	N.4.523	Activate VHF-AM
00:54:00			1.3.1.7.1 1.3.1.7.3	S.3.701 S.3.704	Activate VHF-FM

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Table 3-2. Crew Procedures, Basic Nominal Training Mission (Cont)

Mission Time	Mission Event Crew Activity Volume I		SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title
	Table 3-2	Table 3-3			
01:00:00			1.3.1.6	S.3.201	ECS hourly flight verification
			1.3.1.5	S.3.310	EPS periodic verification
			1.3.1.4	S.2.100	RCS periodic verification
			1.3.1.3	S.3.400/ S.3.401	SPS periodic verification
			1.3.1.1	N.4.502	G&N periodic verification
01:05:00			1.3.1.5	S.3.305/ S.3.306	Fuel cell purge
01:12:00		4.8			INITIATE TWO MAN EXTENDED MISSION OPS
01:32:00		5.2			NAVIGATION SIGHTINGS
			1.3.2.2.1	N.4.520	Landmark sighting
01:42:04		6			START SECOND ORBIT
01:56:00		6.2			NAVIGATION SIGHTINGS
			1.3.2.2.1	N.4.520	Landmark sighting
			1.3.1.7.3	S.3.704	Deactivate VHF-FM
			1.3.1.7.1	S.3.701	Deactivate VHF-AM
02:18:00				O.1.2/O.3.2	BEGIN MINIMUM ACTIVITY OPERATIONS
				S.3.201	ECS hourly flight verification
				S.3.310	EPS periodic verification
				S.2.100	RCS periodic verification
				S.3.400/ S.3.401	SPS periodic verification
Prior to 02:15:34					INHIBIT DAY TERMINATOR
02:28:00				O.1.2/O.3.2	TERMINATE MINIMUM ACTIVITY OPERATIONS
02:30:00		7.2			NAVIGATION SIGHTINGS
			1.3.1.1	N.4.501	G&N system activation
			1.3.2.1.1/1.3.2.1.2	N.4.523	IMU alignment (coarse and fine)

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Table 3-2. Crew Procedures, Basic Nominal Training Mission (Cont)

Mission Time	Mission Event Crew Activity Volume I		SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title	
	Table 3-2	Table 3-3				
02:58:00		8.2	1.3.2.2.1	N.4.520	Landmark sightings	
			1.3.1.7.3	S.3.704	Activate VHF-FM	
			1.3.1.7.4	S.3.701	Activate VHF-AM	
			FINE ALIGN IMU AND SCS			
03:08:00		8.3	1.3.2.1.2	N.4.522	IMU fine alignment	
			TERMINATE TWO-MAN EXTENDED MISSION OPS			
03:12:04		9	START THIRD ORBIT			
03:08:00		9.1	NAVIGATION SIGHTINGS			
03:12:00				1.3.2.2.1	N.4.520	Landmark sightings
				1.3.1.6	S.3.201	ECS hourly flight verification
	1.3.1.5			S.3.310	EPS periodic verification	
	1.3.1.4			S.2.100	RCS periodic verification	
	1.3.1.3			S.3.400/ S.3.401	SPS periodic verification	
	1.3.1.1			N.4.502	G&N periodic verification	
	1.3.1.5			S.3.307	Battery charging	
	03:46:00			1.3.1.7.3	S.3.704	Deactivate VHF-FM
				1.3.1.7.1	S.3.701	Deactivate VHF-AM
	03:46:00					NAVIGATION SIGHTINGS
1.3.2.2.1	N.3.520	Landmark sightings				
1.3.1.6	S.3.205	Cabin cold-soak operations				
03:56:00	10.3	FINE ALIGN IMU AND SCS				
		1.3.2.1.2	N.4.522			IMU fine alignment
03:56:34	S8	10.4	PREPARATION FOR RETROFIRE			
04:06:00	<u>Deorbit and Entry</u>					
	1.4/1.3.2.4.1		E.1.1			Deorbit delta V procedures
			E.3.1/E.4.1			G&N delta V mode

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Table 3-2. Crew Procedures, Basic Nominal Training Mission(Cont)

Mission Time	Mission Event Crew Activity Volume I		SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title
	Table 3-2	Table 3-3			
04:21:39	S9	11	1.4	E.1.2/E.2.1/ E.3.2	DELTA V
04:22:00					Post delta V operations
04:22:00		11.1			PREPARATION FOR S/M-C/M SEPARATION
					Preseparation operations
04:26:49		12			C/M-S/M SEPARATION
					Postseparation operations
04:27:00		12.1			PREPARATION FOR ENTRY
					Pre-entry operations
04:31:54		13			.05 G START ENTRY
					Entry operations
04:31:54		13.1	E.1.4/E.3.4	R.1.1/R.2.1/ R.3.1/R.4.1	MONITOR - CONTROL ENTRY
04:40:59		13.2			MONITOR - CONTROL CHUTE DEPLOYMENT AND ELS
		14			ELS arming
					TOUCHDOWN
					Post-touchdown

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APOLLO MISSION SIMULATOR INSTRUCTOR HANDBOOK

3.4.2.2 Nominal Mission, Plane Changes, Procedures.

The nominal mission, plane changes, are described in paragraph 3.9, table 3-3, and figures 3-18, 3-19, and 3-20 of Volume I. The nominal mission, plane changes, or portions thereof is utilized in training sessions PT.1.2, PT.3.2, MT.3.2, TM.2.1, TM.2.2, and TM.3.3.

An outline of SM2A-03-AMS (1 July 1965) procedures for accomplishing the nominal training mission, plane changes, in accordance with "Mission B" in table 3-3 of Volume I is provided in this section as table 3-3.

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Table 3-3. Crew Procedures, Nominal Mission, Plane Changes

Mission Time	Mission Event Crew Activity Volume I		SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title
	Table 3-2	Table 3-3			
N/A	S1		1.1		<u>Prelaunch</u> Astronaut ingress Initial checks System verification Hatch installation and C/M purge and leak check Launch preparation
-00:01:00	S2	1		P. 1.1/P. 3.1 P. 1.2/P. 2.1/ P. 3.2 P. 1.3/P. 2.2/ P. 3.3	LAUNCH BOOST
-00:00:04			1.2		Ascent and initial orbit S-IB engine ignition Liftoff Roll-pitch maneuver Maximum dynamic pressure S-IVB boost Launch escape tower jettison Maximum altitude
00:10:00	S3	2			ORBIT INSERTION Orbital insertion
00:12:04		3			START FIRST ORBIT
00:15:00		4			JETTISON S-IVB
00:15:00		4.1	1.2	O. 1.1/O. 3.1/ O. 4.1	Initial orbit
00:20:00		4.2			NAVIGATION SIGHTINGS
			1.3.1.1	N. 4.501	G&N system activation
			1.3.2.2.1	N. 4.520	Landmark sighting
00:42:00		4.3			INHIBIT DAY TERMINATOR
00:54:00			1.3.1.7.1	S. 3.701	Activate VHF-AM
			1.3.1.7.3	S. 3.704	Activate VHF-FM

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APOLLO MISSION SIMULATOR INSTRUCTOR HANDBOOK

Table 3-3. Crew Procedures, Nominal Mission, Plane Changes(Cont)

Mission Time	Mission Event Crew Activity Volume I		SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title
	Table 3-2	Table 3-3			
00:56:00		4.5			FINE ALIGN IMU AND SCS
			1.3.2.1.2	N.4.522	IMU fine alignment
01:00:00		4.6			NAVIGATION SIGHTINGS
			1.3.2.2.1	N.4.520	Landmark sightings
			1.3.1.6	S.3.201	ECS hourly flight verification
			1.3.1.5	S.3.310	EPS periodic verification
			1.3.1.4	S.2.100	RCS periodic verification
			1.3.1.3	S.3.400/ S.3.401	SPS periodic verification
01:05:00			1.3.1.1	N.4.502	G&N periodic verification
01:14:00			1.3.1.5	S.3.305/ S.3.306	Fuel cell purge
		4.7			PREPARATION FOR DELTA V
			1.3.2.4.1	N.1.513/N.3.514/ N.4.515	G&N delta V mode
			1.3.1.7.2	S.3.721	C-band tracking and ranging, activate
01:19:46		5			DELTA V
01:21:00					G&N delta V mode
			1.3.1.5	S.3.307	Battery charging
01:21:00			1.3.1.7.2	S.3.721	C-band tracking and ranging, deactivate
		5.1			FINE ALIGN IMU AND SCS
01:32:00			1.3.2.1.2	N.4.522	IMU fine alignment
		5.2			NAVIGATION SIGHTINGS
01:42:04			1.3.2.2.1	N.4.520	Landmark sighting
		6			START SECOND ORBIT
01:56:00		6.2			NAVIGATION SIGHTINGS
			1.3.2.21	N.4.520	Landmark sightings
			1.3.1.7.3	S.3.704	Deactivate VHF-FM

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Table 3-3. Crew Procedures, Nominal Mission, Plane Changes (Cont)

Mission Time	Mission Event Crew Activity Volume I		SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title
	Table 3-2	Table 3-3			
02:44:00		7.1	1.3.1.7.1	S.3.701	Deactivate VHF-AM
				S.3.201	ECS hourly flight verification
				S.3.310	EPS periodic verification
				S.2.100	RCS periodic verification
				S.3.400/ S.3.401	SPS periodic verification
				N.4.502	G&N periodic verification
					FINE ALIGN IMU AND SCS
			1.3.2.1.2	N.4.522	IMU fine alignment
			1.3.1.7.3	S.3.704	Activate VHF-FM
			1.3.1.7.1	S.3.701	Activate VHF-AM
02:49:52		7.3			PREPARATION FOR DELTA V
			1.3.2.4.1	N.1.513/N.3.514/ N.4.515	G&N delta V mode
			1.3.1.7.2	S.3.721	C-band tracking and ranging, activate
					DELTA V
02:50:00		8	1.3.2.4.1		G&N delta V mode
			1.3.1.7.2	S.3.721	C-band tracking and ranging, deactivate
					FINE ALIGN IMU AND SCS
			1.3.2.1.2	N.4.522	IMU fine alignment
03:12:04		9			START THIRD ORBIT
03:08:00		9.1			NAVIGATION SIGHTINGS
03:12:00			1.3.2.2.1	N.4.520	Landmark sightings
			1.3.1.6	S.3.201	ECS hourly flight verification
			1.3.1.5	S.3.310	EPS periodic verification
			1.3.1.4	S.2.100	RCS periodic verification
			1.3.1.3	S.3.400/ S.3.401	SPS periodic verification

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APOLLO MISSION SIMULATOR INSTRUCTOR HANDBOOK

Table 3-3. Crew Procedures, Nominal Mission, Plane Changes (Cont)

Mission Time	Mission Event Crew Activity Volume I		SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title
	Table 3-2	Table 3-3			
03:46:00	S8	10.3	1.3.1.1	N.4.502	G&N periodic verification
			1.3.1.5	S.3.307	Battery charging
			1.3.1.7.3	S.3.704	Deactivate VHF-FM
			1.3.1.7.1	S.3.701	Deactivate VHF-AM
			1.3.1.5	S.3.205	Cabin cold-soak operations
03:56:00	S8	10.3			FINE ALIGN IMU AND SCS
03:56:34			1.3.2.1.2	N.4.522	IMU fine alignment
04:06:00					PREPARATION FOR RETROFIRE
	S9	10.4			<u>Deorbit and Entry</u>
			1.4/1.3.2.4.1	E.1.1	Deorbit delta V procedures
				E.3.1/E.4.1	G&N delta V mode
04:21:39					DELTA V
04:22:00					
	S9	11			
04:22:00			1.4	E.1.2/E.2.1/ E.3.2	Post delta V operations
04:22:00					PREPARATION FOR S/M-C/M SEPARATION
					Preseparation operations
04:26:49					C/M-S/M SEPARATION
	S9	12		E.1.3/E.2.2/ E.3.3	Postseparation operations
04:27:00					PREPARATION FOR ENTRY
					Pre-entry operations
04:31:54					.05 G START ENTRY
					Entry operations
04:31:54	S9	13			MONITOR-CONTROL ENTRY
04:40:59					MONITOR-CONTROL CHUTE DEPLOYMENT AND ELS
				E.1.4/E.3.4	ELS arming
					TOUCHDOWN
	S9	14		R.1.1/R.2.1/ R.3.1/R.4.1	Post-touchdown

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3.4.2.3 Nominal Mission, Hohmann Transfers, Procedures.

The nominal mission, Hohmann transfers, is described in paragraph 3.10, table 3-3, and figures 3-18, 3-19, and 3-20 of Volume I. The nominal mission, Hohmann transfers, or portions thereof is utilized in training sessions PT.3.2, MT.3.1, TM.3.1, TM.3.2, and TM.3.3. ■

An outline of SM2A-03-AMS (1 July 1965) procedures for accomplishing the nominal training mission, Hohmann transfer, in accordance with Mission C in table 3-3 of Volume I is provided in this section as table 3-4.

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Table 3-4. Crew Procedures, Nominal Mission, Hohmann Transfers

Mission Time	Mission Event Crew Activity Volume I		SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title
	Table 3-2	Table 3-3			
N/A	S1		1.1		<u>Prelaunch</u> Astronaut ingress Initial checks System verification Hatch installation and C/M purge and leak check Launch preparation
-00:01:00	S2	1		P. 1.1/P. 3.1 P. 1.2/P. 2.1/ P. 3.2 P. 1.3/P. 2.2/ P. 3.3	LAUNCH BOOST
-00:00:04			1.2		Ascent and initial orbit S-IB engine ignition Liftoff Roll-pitch maneuver Maximum dynamic pressure S-IVB boost Launch escape tower jettison Maximum altitude
00:10:00	S3	2			ORBIT INSERTION Orbital insertion
00:12:04		3			START FIRST ORBIT
00:15:00		4			JETTISON S-IVB
00:15:00		4.1	1.2	0.1.1/0.3.1/ 0.4.1	Initial orbit
00:20:00		4.2			NAVIGATION SIGHTINGS G&N system activation Landmark sighting
Prior to 00:44:34		4.3	1.3.1.1 1.3.2.2.1	N. 4.501 N. 4.520	INHIBIT DAY TERMINATOR
00:54:00			1.3.1.7.1 1.3.1.7.3	S. 3.701 S. 3.704	Activate VHF-AM Activate VHF-FM

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Table 3-4. Crew Procedures, Nominal Mission, Hohmann Transfers(Cont)

Mission Time	Mission Event Crew Activity Volume I		SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title
	Table 3-2	Table 3-3			
00:56:00		4.6			NAVIGATIONAL SIGHTINGS
			1.3.2.2.1	S.4.520	Landmark sighting
01:00:00			1.3.1.6	S.3.201	ECS hourly flight verification
			1.3.1.5	S.3.310	EPS periodic verification
			1.3.1.4	S.3.100	RCS periodic verification
			1.3.1.3	S.3.400/ S.3.401	SPS periodic verification
			1.3.1.1	N.4.502	G&N periodic verification
01:05:00			1.3.1.5	S.3.305/ S.3.306	Fuel cell purge
01:14:00		4.7			PREPARATION FOR DELTA V
			1.3.2.4.1	N.1.513/N.3.514/ N.4.515	G&N delta V mode
			1.3.1.7.2	S.3.721	C-band tracking and ranging, activate
01:19:46		5			DELTA V
			1.3.2.4.1		G&N delta V mode
01:21:00			1.3.1.5	S.3.307	Battery charging
			1.3.1.7.2	S.3.721	C-band tracking and ranging, deactivate
01:21:00		5.1			FINE ALIGN IMU AND SCS
			1.3.2.1.2	S.4.522	IMU fine alignment
01:32:00		5.2			NAVIGATION SIGHTINGS
			1.3.2.2.1	N.4.520	Landmark sighting
01:42:04		6			START SECOND ORBIT
01:42:00		6.1			FINE ALIGN IMU AND SCS
			1.3.2.1.2	N.4.522	IMU fine alignment
			1.3.1.7.3	S.3.704	Deactivate VHF-FM
			1.3.1.7.1	S.3.701	Deactivate VHF-AM
				S.3.201	ECS hourly flight verification
				S.3.310	EPS periodic verification

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Table 3-4. Crew Procedures, Nominal Mission, Hohmann Transfers(Cont)

Mission Time	Mission Event Crew Activity Volume I Table 3-2 Table 3-3	SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title
01:59:00			S. 2.100 S. 3.400/ S. 3.401 S. 4.502	RCS periodic verification SPS periodic verification G&N periodic verification PREPARATION FOR DELTA V
Prior to 02:15:34		1.3.2.4.1	N.1.513/ N.3.514 N.4.515	G&N delta V mode
				INHIBIT DAY TERMINATOR
		1.3.1.7.2	S. 3.721	C-band tracking and ranging, activate
02:04:46	7			DELTA V
		1.3.1.5	S. 3.307	G&N delta V mode Battery charging
		1.3.1.7.2	S. 3.721	C-band tracking and ranging, deactivate
	7.1			FINE ALIGN IMU AND SCS
		1.3.2.1.2	N.4.522	IMU fine alignment
02:30:00	7.2			NAVIGATION SIGHTINGS
		1.3.2.2.1	N.4.520	Landmark sightings
		1.3.1.7.3	S. 3.704	Activate VHF-FM
		1.3.1.7.1	S. 9.701	Activate VHF-AM
02:44:00	7.3			PREPARATION FOR DELTA V
		1.3.2.4.1	N.1.513/ N.3.514 N.4.515	G&N delta V mode
		1.3.1.7.2	S. 3.721	C-band tracking and ranging, activate
	8			DELTA V
		1.3.2.4.1		G&N delta V mode
			S. 3.307	Battery charging
			S. 3.721	C-band tracking and ranging, deactivate

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Table 3-4. Crew Procedures, Nominal Mission, Hohmann Transfers (Cont)

Mission Time	Mission Event Crew Activity Volume I Table 3-2 Table 3-3	SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title
02:50:00	8.2			FINE ALIGN IMU AND SCS
		1.3.2.1.2	N.4.522	IMU fine alignment
03:12:04	9			START THIRD ORBIT
03:08:00	9.1			NAVIGATION SIGHTINGS
03:12:00		1.3.2.2.1	N.4.520	Landmark sightings
		1.3.1.6	S.3.201	ECS hourly flight verification
		1.3.1.5	S.3.310	EPS periodic verification
		1.3.1.4	S.2.100	RCS periodic verification
		1.3.1.3	S.3.400/ S.3.401	SPS periodic verification
		1.3.1.1	N.4.502	G&N periodic verification
03:29:00	9.2			PREPARATION FOR DELTA V
		1.3.2.4.1	N.1.513/ N.3.514 N.4.515	G&N delta V mode
		1.3.1.7.2	S.3.721	C-band tracking and ranging, activate

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Table 3-4. Crew Procedures, Nominal Mission, Hohmann Transfers(Cont)

Mission Time	Mission Event Crew Activity Volume I		SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title
	Table 3-2	Table 3-3			
03:34:46		10	1.3.2.4.1		DELTA V G&N delta V mode
			1.3.1.5	S.3.307	Battery charging
			1.3.1.7.2	S.3.721	C-band tracking and ranging, deactivate
Prior to 03:45:34		10.1			INHIBIT DAY TERMINATOR
03:42:00		10.2			NAVIGATION SIGHTINGS
			1.3.2.2.1	S.4.520	Landmark sightings
03:46:00			1.3.1.7.3	S.3.704	Deactivate VHF-FM
			1.3.1.7.1	S.3.701	Deactivate VHF-AM
			1.3.1.5	S.3.205	Cabin cold-soak operations
03:56:00		10.3			FINE ALIGN IMU AND SCS
03:56:34	S8		1.3.2.1.2/1.3.2.1.3	N.4.522/N.1.512	IMU fine alignment
03:06:00		10.4			PREPARATION FOR RETROFIRE
			1.4/1.3.2.4.1		<u>Deorbit and Entry</u>
				E.1.1	Deorbit delta V procedures
				E.3.1/E.4.1	G&N delta V mode
04:21:39		11			DELTA V
04:22:00	S9				
				E.1.2/E.2.1 E.3.2	Post delta V operations
04:22:00		11.1			PREPARATION FOR S/M-C/M SEPARATION
					Preseparation operations
04:26:49		12			C/M-S/M SEPARATION
				E.1.3/E.2.2/ E.3.3	Postseparation operations
04:27:00		12.1			PREPARATION FOR ENTRY
					Pre-entry operations

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Table 3-4. Crew Procedures, Nominal Mission, Hohmann Transfers (Cont)

Mission Time	Mission Event Crew Activity Volume I		SM2A-03-AMS Paragraph (1 July 1965)	IOS Data Sheet(s) See Para 3.5.1.3	Title
	Table 3-2	Table 3-3			
04:31:54		13			.05 G START ENTRY Entry operations
04:31:54		13.1			MONITOR-CONTROL ENTRY
04:40:59		13.2			MONITOR-CONTROL CHUTE DEPLOYMENT AND ELS
		14		E.1.4/E.3.4	ELS arming TOUCHDOWN
				R.1.1/R.2.1 R.3.1/R.4.1	Post-touchdown

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3.4.3 VARIATIONS IN NOMINAL MISSION.

The AMS syllabus provided in this section of this handbook requires four variations of the nominal training mission. Procedures for all of the variations are included in the SM2A-03-AMS (1 July 1965). The four types of variations are:

- Aborts from suborbital trajectory
- Early mission termination from orbit
- SCS mode delta V procedures
- SCS mode and manual direct entry.

3.4.3.1 Abort Procedures.

Suborbital aborts simulated by the AMS are described in section 3 (Nominal Training Mission) of Volume I of this handbook. Crew procedures for suborbital aborts are included in paragraph 2.2 of the SM-2A-03-AMS (1 July 1965). In the initial delivered configuration of the AMS, all aborts (except pad abort) are initiated from the preprogramed launch boost tape. At the point of abort initiation, the preprogramed characteristics of the tape are discontinued and a full simulation of the abort is accomplished.

Methods of abort initiation are defined in paragraph 1.4.2.2 of this volume. Training sessions involving suborbital aborts are as follows:

- PT5.2 LES aborts
- PT5.3 SPS aborts
- MT1.2 Pad and low altitude aborts
- MT1.3 High altitude LES aborts
- MT1.4 SPS aborts

3.4.3.2 Early Mission Termination Procedures.

Early mission termination is used in conjunction with the nominal training mission for two purposes. The first is to conclude training missions during the second orbit when procedures to be practiced do not require the elapsed time of the third orbit. The second purpose is to provide the crew with training in recognizing requirements for and accomplishing early mission termination because of critical spacecraft malfunctions and/or other contingencies. Training sessions involving early mission termination are as follows:

- MT4.3 Early mission termination
- TM1.2 Orbital abort from extended mission
- TM3.2 Transfer from 105-n mi to 140-n mi circular orbit.

Procedures for early mission termination are the same as for entry on the third orbit of the nominal mission. The sequence of procedures to be inserted in the second orbit and the best points for breaking into the nominal mission are discussed in the following paragraphs.

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Early Termination of Basic Nominal Training Mission.

Initiate termination by mission plan at mission time of 02:28:00 or by critical malfunction during system checks between 02:18:00 and 02:28:00. (See table 3-2.) Sequence of procedures from SM2A-03-AMS (1 July 1965) and approximate mission times are as follows:

02:28:00 Cabin cold soak (Para 1.3.1.5)
02:28:00 Activate G&N (Para 1.3.1.1)
02:29:00 Coarse align IMU (Para 1.3.2.1.1)
02:39:00 Fine align IMU (Para 1.3.2.1.2)
02:57:00 Landmark sightings with Hawaiian landmarks
(Para 1.3.2.2.1)
03:00:00 Deorbit and entry (Para 1.4)
03:15:00 G&N mode delta V (Para 1.3.2.4.1)
03:42:00 Touchdown, Atlantic Range (approx
50°W, 20°N).

Early Mission Termination of Nominal Mission, Plane Changes.

Initiate termination by mission plan or by critical malfunction during systems checks at about mission time 02:00:00. (See table 3-3.) Sequence of procedures from SM2A-03-AMS (1 July 1965) and approximate mission times are as follows:

02:00:00 Cabin cold soak (Para 1.3.1.5)
02:00:00 Landmark sightings with African landmarks
(Para 1.3.2.2.1)
02:20:00 Fine align IMU (Para 1.3.2.1.2)
02:30:00 Deorbit and entry (Para 1.4)
02:47:00 G&N mode delta V (Para 1.3.2.4.1)
03:14:00 Touchdown southeast of Hawaii.

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Early Mission Termination of Nominal Mission, Hohmann Transfers.

Initiated termination by mission plan or by critical malfunction immediately after circularization delta V at 140 n mi. (See table 3-4.) Sequence of procedures from SM2A-03-AMS (1 July 1965) and approximate mission times are as follows:

02:05:00 Cabin cold soak (Para 1.3.1.5)

02:05:00 Landmark sightings with African landmarks
(Para 1.3.2.2.1)

02:15:00 Fine align IMU (Para 1.3.2.1.2)

02:25:00 Deorbit and entry (Para 1.4)

Time Undetermined - G&N mode delta V (Para 1.3.2.4)

Time Undetermined - Touchdown southeast of Hawaii.

3.4.3.3 SCS Delta V Procedures.

Either mission planning or G&N system malfunctions may dictate that delta V be accomplished in the SCS mode. When such is the case, SCS delta V procedures (paragraph 1.3.2.4.2) are substituted for G&N mode, delta V, procedures (paragraph 1.3.2.4.1) in the nominal mission procedures outline provided in tables 3-2, 3-3, and 3-4. Simulation runs in the syllabus involving SCS mode, delta V, are as follows (reading down from left to right):

PT.1.2.4	TM.1.1.3 (Retro)
PT.1.2.5	TM.1.2.2 (Retro)
PT.3.1.2 (Retro)	TM.1.2.3 (Retro)
PT.3.1.4 (Retro)	TM.2.2.1 (Plane change and retro)
MT.3.2.2 (Plane change)	TM.2.2.2 (Retro)
MT.3.3.3 (Retro)	TM.3.2.2 (Retro)
MT.4.2.1 (Retro)	TM.3.3.3 (Plane change and retro).

3.4.3.4 SCS and Manual Direct Mode Entry.

Crew procedures for SCS and manual direct mode entry are not specifically identified in the SM2A-03 (1 July 1965). SCS mode entry is accomplished by incorporating the procedures outlined in paragraph 1.3.2.3.3 (of SM2A-03-AMS, 1 July 1965) for SCS attitude control mode into the checklist for deorbit and entry in paragraph 1.4. Modify all references to spacecraft attitude to reflect SCS mode rather than G&N mode dynamics. Present mission plans tentatively call for a continuous slow roll during SCS mode entry.

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The SM2A-03-AMS does not, at present, include instructions for attitude control in the manual direct mode. However, manual direct entry is accomplished by the same means as SCS mode, except for the direct operation of the RCS engines. Simulation runs in the syllabus involving SCS or manual direct mode entry are as follows:

- PT.4.2 (all runs) - Entry contingencies
- MT.4.2 (all runs) - SCS mode deorbit, entry, and recovery
- TM.1.1.3 (SCS mode entry)
- TM.1.2.2 (SCS mode entry)
- TM.1.2.3 (Manual direct entry)
- TM.2.2.1 (SCS mode entry)
- TM.2.2.2 (Manual direct entry)
- TM.3.2.2 (SCS mode entry)
- TM.3.3.2 (SCS mode entry)
- TM.3.3.3 (Manual direct entry).

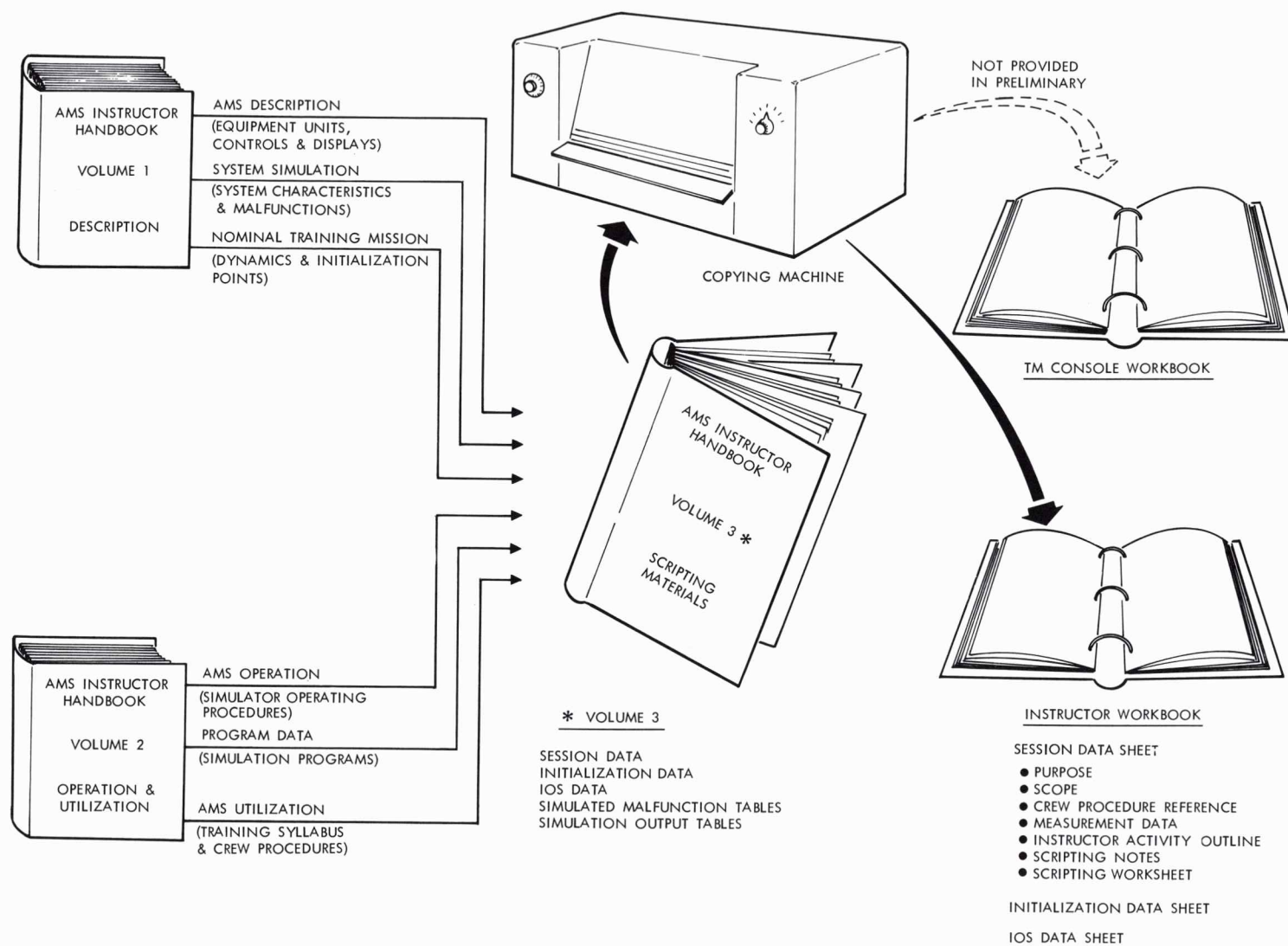
3.5 SCRIPT PREPARATION AND HANDBOOK UTILIZATION.

Volume III of this handbook contains material to be used in preparing instructor scripts for use at the IOS. The entire contents of Volume III is looseleaf bound to facilitate copying and separate binding as instructor lesson plan booklets. The material is organized to permit preparation of a separate booklet for each training session in the syllabus. Figure 3-2 illustrates the manner in which such scripts are prepared. The prepared scripts provide the specific instructor data required to accomplish the selected session. Other sections of the handbook contain material required to comprehend the mission and spacecraft aspects of the session, define the training purpose of the session, explain procedures used by the instructor to operate the simulator, and brief and debrief flight crew personnel with respect to the training session.

3.5.1 SCRIPT PREPARATION.

Prior to making use of the scripting material contained in Volume III of this handbook, the instructor-operator should be familiar with the technical contents of Volumes I and II. He should also be familiar with the crew procedures contained in the SM2A-03-AMS, supplement to the SM2A-03, both dated 1 July 1965.

When the instructor-operator is ready to use the simulator, he will review the syllabus provided in this section to select a specific training session for accomplishment. Information in sections 2 (System Simulation) and 3 (Nominal Training Mission) of Volume I, along with the contents of SM2A-03-AMS, will be used as required to supplement the brief session descriptions.



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Figure 3-2. Session Script Preparation

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3.5.1.1 Session Data Sheet.

Having selected a training session for accomplishment, the instructor-operator will find in section 1, Volume III of this handbook, the appropriate training session data sheet. A separate data sheet is provided for each session. The data sheets are comprised of seven parts as follows:

- Purpose. A brief statement of the specific training purpose for the specified training session with reference to the syllabus outlined in this section
- Scope. A brief definition of the overall scope of crew activity to be accomplished in the session (including definition of each run) with reference to the nominal training mission provided in section 3 of Volume I
- Crew Procedures Reference. Specific identification of those procedures in SM2A-03-AMS (1 July 1965) that are to be practiced by the crew during the session
- Measurement Data. A suggested set of parameters to be transcribed during the session with specific reference to the simulation output table provided in section 5 of Volume III
- Instructor Activity Outline. An outline of instructor-operator procedures used in preparing the AMS for, and accomplishing, the specified runs including initialization and malfunction selection. Procedures referenced in the outline are those provided in section 1 (Operation) of this volume. Initialization points are those defined in section 3 of Volume I (Nominal Training Mission). Malfunctions are those defined in section 4 of Volume III (Simulated Malfunction Tables) and illustrated in section 2 of Volume I (System Simulation).
- Scripting Notes. Identification of the initialization checklists from section 2 of Volume III (Initialization Data) and IOS data sheets from section 3 of Volume III (IOS Data) to be used during the session, plus any general instructions pertinent to their use
- Scripting Worksheet. Specific notes related to the contents of SM2A-03-AMS, the initialization checklists and the IOS data sheets as they are used in the specific session. Notes are normally transposed in pencil from the scripting worksheet to the IOS data sheet to which they apply.

NOTE

Data for operation of the telemetry console is not provided in this handbook. Future revisions will include data required to operate the simulator in a manner that provides authentic spacecraft signals to the MSCC-SCATS for the purpose of ground controller training.

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3.5.1.2 Initialization Checklist.

To accomplish simulation initialization at each of the nine initialization points defined in section 3 of Volume I (Nominal Training Mission), it is necessary to first establish the appropriate spacecraft systems configuration in the SCM. Section 2 of Volume III of this handbook contains initialization checklists for each of the four spacecraft stations at each of the nine initialization points. Systems configuration data in these initialization checklists takes the form of a pictorial presentation of the desired SCM controls configuration as manifested at the IOS.

A sample initialization checklist is provided in figure 3-3. The white highlighting of selected switch positions indicate the required setting for the specified initialization point. Those switches for which no highlighted position is provided have no mandatory setting for simulation initialization.

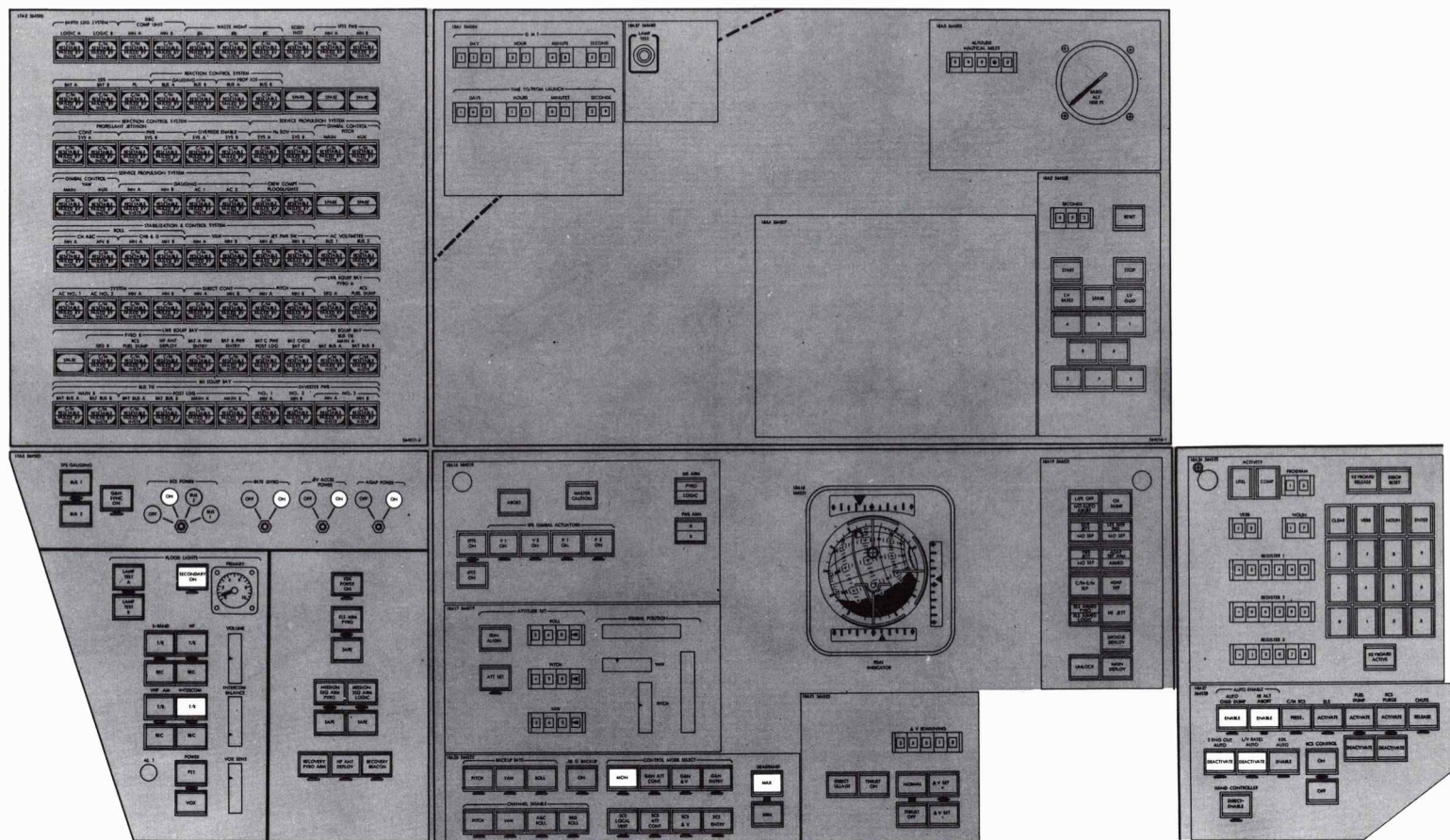
The use of the pictorial checklists rather than tables offers two advantages. The first and most significant is expediency. The IOS picture depicting the desired positions for SCM controls precludes any requirement to read through a list of all the items in a table. The instructor-operator simply checks his IOS displays against the picture and directs the crewmember to reset those controls that are in the wrong position. There is no requirement to discuss or consider those controls which are in the correct position, as indicated in the initialization checklist. The second advantage of the pictorial checklist over the tabular type is that they require substantially less paper bulk.

3.5.1.3 IOS Data Sheet.

Section 3 of Volume III contains an IOS data sheet for each crew procedure identified in SM2A-03-AMS dated 1 July 1965. IOS data sheets are comprised of two or more pages containing both pictorial and tabular information on crew procedures as their performance is manifested at the IOS. Table 3-5 provides a complete list of the IOS data sheets to be found in section 3 of Volume III, directly relates each data sheet to the procedures provided in SM2A-03-AMS, and includes a rough time approximation for the accomplishment of each procedure. In using the time estimates, it should be remembered that time required to perform in a training environment is variable as a function of training accomplished. The time in table 3-5 is estimated for crewmembers who have completed part task training only.

Format and Definition for IOS Data Sheet.

A sample figure and corresponding table are provided in this section of the handbook as figure 3-4 and table 3-6, respectively. The pictorial data sheet makes use of the highlighted (white) switch position indications in the same manner as the initialization checklist. However, the IOS data sheet also makes use of the highlight technique to identify which indicators are to be monitored and the nature of the anticipated indication. The figures are overlaid with a series of numbers and other notations. The numbers are the sequence of procedure accomplishment as established in the tabular portion of the IOS data



5-1 Initial Condition Station 1

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Figure 3-3. Sample Initialization Checklist

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Table 3-5. Table of IOS Data Sheets

IOS No.	Activity	Nominal Time	SM2A-03-AMS (Para No.)
Prelaunch			1.1 Prelaunch
P.1.1	Initial prelaunch ECS check	00:02:00	
P.1.2	Control and display check	00:04:00	
P.2.1	Control and display check	00:02:00	
P.3.1	Initial prelaunch ECS check	00:02:00	
P.3.2	Control and display check	00:04:00	
P.1.3	Launch preparation		
P.2.2	Launch preparation		
P.3.3	Launch preparation		
Ascent and Initial Orbit			1.1 Ascent and Initial Orbit
A.1.1	Ascent	00:10:00	
A.2.1	Ascent	00:10:00	
A.3.1	Ascent	00:10:00	
O.1.1	Initial orbit procedures	00:03:00	
O.3.1	Initial orbit procedures	00:03:00	
O.4.1	Initial orbit procedures	00:05:00	
O.1.2	Minimum power operations	00:00:30	
O.3.2	Minimum power operations	00:00:30	
Deorbit and Entry			1.4 Deorbit and Entry
E.1.1	Deorbit procedures	00:15:00	
E.3.1	Deorbit delta V	00:15:00	
E.4.1	Deorbit delta V	00:15:00	

... continued

APOLLO MISSION SIMULATOR INSTRUCTOR HANDBOOK

Table 3-5. Table of IOS Data Sheets (Cont)

IOS No.	Activity	Nominal Time	SM2A-03-AMS (Para No.)
E.1.2	Post delta V operations	00:04:00	
E.2.1	Post delta V operations	00:04:00	
E.3.2	Post delta V operations	00:04:00	
E.1.3	Postseparation operations	00:15:00	
E.2.2	Postseparation operations	00:15:00	
E.3.3	Postseparation operations	00:15:00	
E.1.4	ELS arming	00:07:30	
E.3.4	ELS arming	00:01:30	
Recovery Procedures			
R.1.1	Postlanding procedures		
R.2.1	Postlanding procedures		
R.3.1	Postlanding procedures		
R.4.1	Postlanding procedures		
Abort Procedures			2.2 Abort Procedures
B.1.1	Pad and low altitude abort	00:01:30+h	
B.1.2	LES aborts 25,000 to 30,000 ft	00:01:30+h	
B.1.3	LES aborts 30,000 ft to Tower jettison	00:01:30+h	
B.1.4	SPS abort		
Systems SCS			
S.1.001	G&N attitude hold mode	NA	1.3.2.3.2
S.1.002	SCS delta V	00:00:30+SPS	1.3.2.4.2
	TBSL	00:00:30+SPS	1.3.2.4.2
S.1.005	SCS attitude control	NA	1.3.2.3.3

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Table 3-5. Table of IOS Data Sheets (Cont)

IOS No.	Activity	Nominal Time	SM2A-03-AMS (Para No.)
RCS			
S.2.100	S/M-RCS periodic check	00:02:00	1.3.1.4
S.2.101	C/M-RCS periodic check	00:00:30	1.3.1.4
ECS			
S.3.201	Orbital ECS hourly check	00:02:00	1.3.1.6
S.4.202	CO ₂ -odor absorbent filter replacement	00:02:00	1.3.1.6
S.3.205	Cabin cold-soak	00:00:02	1.3.1.6
EPS			
S.3.301	EPS periodic check, cryogenics	00:00:30	1.3.1.5
S.3.302	EPS periodic check, fuel cells	00:00:30	1.3.1.5
S.3.303	EPS periodic check, d-c power	00:01:30	1.3.1.5
S.3.304	EPS periodic check, a-c power	00:01:00	1.3.1.5
S.3.305	Fuel cell hydrogen purge	00:02:00	1.3.1.5
S.3.306	Fuel cell oxygen purge	00:02:00	1.3.1.5
S.3.307	Battery charge	00:00:40+	1.3.1.5
S.3.308	Fuel cell shutdown procedure		1.3.1.5
S.3.310	EPS periodic check	00:03:30	1.3.1.5

... continued

APOLLO MISSION SIMULATOR INSTRUCTOR HANDBOOK

Table 3-5. Table of IOS Data Sheets (Cont)

IOS No.	Activity	Nominal Time	SM2A-03-AMS (Para No.)
SPS			
S. 3. 400	SPS periodic check	00:03:00	1. 3. 1. 3
S. 3. 401	SPS periodic propellant quantity gaging system check	00:02:00	1. 3. 1. 3
Navigation			
N. 4. 501	G&N system activation	00:00:30	1. 3. 1. 1
N. 4. 502	G&N periodic verification	00:00:20	1. 3. 1. 1
N. 4. 503	Program AGC for major mode	00:00:45	1. 3. 2
N. 4. 504	IMU alignment or landmark sighting preparation	00:00:30	1. 3. 2. 1
N. 4. 505	Landmark/star sighting preparation	00:00:30	1. 3. 2. 2. 1
N. 4. 506	IMU coarse alignment	00:10:00	1. 3. 2. 1. 1
N. 4. 507	IMU fine alignment	00:12:00	1. 3. 2. 1. 2
N. 4. 508	G&N landmark sighting	00:04:00	1. 3. 2. 2. 1
N. 4. 509	Inertial subsystem activation	00:03:00	1. 3. 1. 1
N. 4. 510	Computer subsystem activation		1. 3. 1. 1
N. 4. 511	Optical subsystem activation		1. 3. 1. 1
N. 1. 512	SCS AGCU alignment		1. 3. 2. 1. 3
N. 1. 513	G&N delta V		1. 3. 2. 4. 1
N. 3. 514	G&N delta V		1. 3. 2. 4. 1
N. 4. 515	G&N delta V		1. 3. 2. 4. 1
N. 4. 516	Manual IMU alignment operations		
N. 4. 520	Landmark sighting	00:04:42	1. 3. 2. 2. 1

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Table 3-5. Table of IOS Data Sheets (Cont)

IOS No.	Activity	Nominal Time	SM2A-03-AMS (Para No.)
N.1.521	G&N delta V operations	00:00:30+	1.3.2.4.1
N.4.522	IMU fine alignment	00:10:00	1.2.1.2
N.4.523	IMU coarse and fine alignment, operations	00:20:00	1.3.1.1/1.3.2.1
C&D			
S.1.700	Audio center activation, station 1, 2, & 3		1.3.1.7.1
S.3.701	VHF voice communications (MSFN contacts)	00:00:10	1.3.1.7.1
S.3.702	VHF voice, communication (monitoring)	00:00:10	1.3.1.7.1
S.3.703	Up-data link activation	00:00:10	1.3.1.7.3
S.3.704	Data storage, transmission and reception, VHF-FM activation	00:00:10	1.3.1.7.3
S.3.705	Data storage, transmission and reception, high bit rate PCM, VHF-FM	00:00:10	1.3.1.7.3
S.3.706	Data storage, transmission and reception, low bit rate, VHF-FM	00:00:10	1.3.1.7.3
S.3.707	Data storage, transmission and reception, recorded high bit rate PCM, VHF-FM	00:00:10	1.3.1.7.3
S.3.708	Data storage, transmission and reception, recorded low bit rate PCM, VHF-FM	00:00:10	1.3.1.7.3
S.3.709	Data storage, transmission and reception, high bit rate PCM	00:00:10	1.3.1.7.3
S.3.710	Data storage, transmission and reception, low bit rate PCM	00:00:10	1.3.1.7.3
S.3.711	Data storage, transmission and reception, record real time analog data	00:00:10	1.3.1.7.3

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Table 3-5. Table of IOS Data Sheets (Cont)

IOS No.	Activity	Nominal Time	SM2A-03-AMS (Para No.)
S. 3. 712	S-band PCM-TLM data transmission high or low bit rate PCM and analog	00:00:10	1.3.1.7.4
S. 3. 713	S-band PCM-TLM data transmission high or low bit rate PCM and PLSS data	00:00:10	1.3.1.7.4
S. 3. 714	S-band voice operations	00:00:10	1.3.1.7.4
S. 3. 715	S-band PCM-TLM data transmission recorded PCM	00:00:10	1.3.1.7.4
S. 3. 716	S-band PCM-TLM data transmission recorded high rate and analog	00:00:10	1.3.1.7.4
S. 3. 717	S-band PCM-TLM data transmittal low or high bit rate PCM	00:00:10	1.3.1.7.4
S. 3. 718	S-band PCM-TLM data transmittal low or high bit rate PCM ranging mode	00:00:10	1.3.1.7.4
S. 3. 719	S-band PCM-TLM data transmittal ranging only	00:00:10	1.3.1.7.4
S. 3. 720	S-band PCM-TLM data transmittal high or low bit rate PCM and TV	00:00:10	1.3.1.7.4
S. 3. 721	C-band tracking and ranging	00:00:10	1.3.1.7.2
Malfunctions			
MRC 101	S/M-RCS C&W light on		2.1.4
MEC 200	O ₂ FLOW HI light on		2.1.6.3
MEC 201	O ₂ FLOW HI light on, O ₂ flow high, cabin pressure high		2.1.6.3
MEC 202	Glycol discharge pressure abnormal		2.1.6.4
MEC 203	Suit compressor delta P indicates below normal		2.1.6.5
MEC 204	Suit temperature indicates low		2.1.6.6
MEC 205	Suit temperature indicates high		2.1.6.6

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Table 3-5. Table of IOS Data Sheets (Cont)

IOS No.	Activity	Nominal Time	SM2A-03-AMS (Para No.)
MEC 206	Cabin temperature indicates high		2.1.6.7
MEC 207	Suit pressure indicates low		2.1.6.8
MEC 208	Suit pressure indicates high		2.1.6.8
MEC 209	Cabin pressure high		2.1.6.9
MEP 301	O ₂ failure		2.1.5.3
MEP 302	H ₂ failure		2.1.5.3
MEP 303	N ₂ failure		2.1.5.3
MEP 304	O ₂ PRESS light on		2.1.5.1
MEP 305	H ₂ PRESS light on		2.1.5.2
MEP 306	Fuel cell fail light on H ₂ flow high		2.1.5.3
MEP 307	Fuel cell fail light on O ₂ flow high		2.1.5.3
MEP 308	D-C BUS A UNDERVOLT light on		2.1.5.4
MEP 310	A-C inverter and bus check		2.1.5.7-15
MEP 311	Critical loads transfer		2.1.5.7-15
MEP 312	Dual-inverter changeover		2.1.5.7,8
MEP 313	Single inverter changeover		2.1.5.9
MEP 314	Bus reset		2.1.5.9,10
MEP 315	Connect loads to bus 1		2.1.5.7,8,9
MEP 316	Overload isolation check		2.1.5.10
MEP 320	Bus 1 failure, dual-inverter operation		2.1.5.7
MEP 321	Both 1 and 2 a-c bus fail, single-inverter operation		2.1.5.9
MEP 322	BUS 1 OVERLOAD and A-C BUS 1 FAIL lights on		2.1.5.10

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Table 3-5. Table of IOS Data Sheets (Cont)

IOS No.	Activity	Nominal Time	SM2A-03-AMS (Para No.)
MEP 323	Single-inverter operation		2.1.5.10
MEP 324	Inverter temperature high, dual-inverter operation SCS operating		2.1.5.11
MEP 400	SPS PU SENSOR FAIL light on		2.1.3.5

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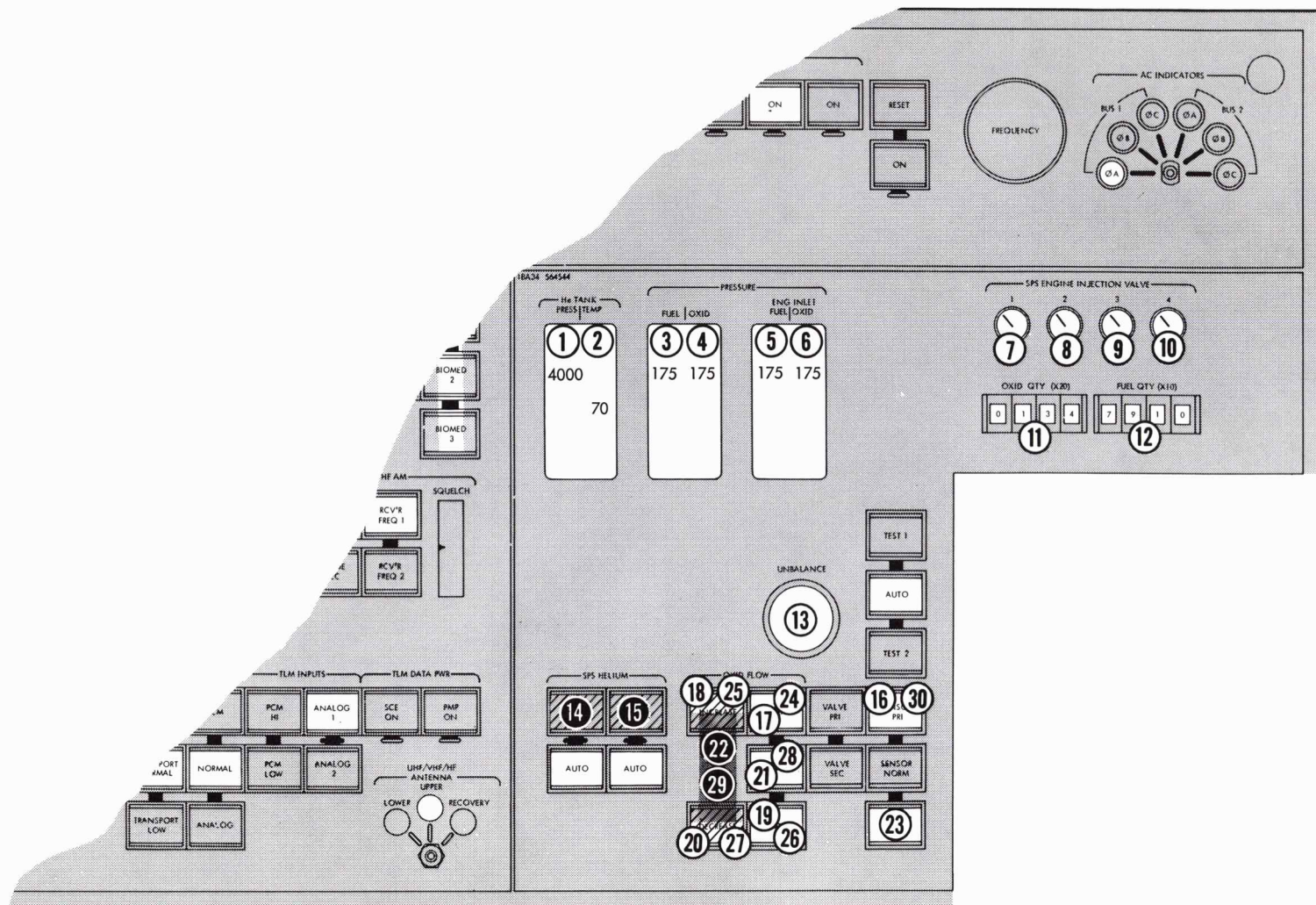
sheet. A number in a white field indicates monitor of an ON or otherwise active indicator; the numbers in black circles indicate monitor for OFF. The arrows on various gages indicate anticipated nature of change. The asterisk in the "Step" column identifies those steps in the procedure which are described in the tabular portion of the data sheet, but do not have visible manifestation on the IOS.

The tabular data sheets list the steps from the procedures in the SM2A-03-AMS dated 1 July 1965 (with some variations due the differences between crew and instructor operator involvement) and related instructor-operator data. Definition of the columns in the table are as follows:

- Step. Number in numerical sequence of the procedure, also correlating data for table and corresponding figure
- Malfunctions. Blank column for instructor-operator notation of simulated malfunctions in accordance with session data sheets
- Time. Blank column for compiling timeline of simulated missions or mission segments
- Function. Description of crew procedure steps from SM2A-03-AMS.
- IOS Visibility-Action. Description of the manner in which the step (function) in the crew procedure is manifested to the instructor-operator and instructions for instructor-operator involvement (if any)
- Notes. Space for explanatory notes or additional instructions (both typeset as part of the IOS data sheet and instructor-operator write-in in accordance with session data sheet instructions).

Each IOS data sheet listed in table 3-5 is provided with both a descriptive title and an alphanumeric identifier. The alphanumeric identifier groups the IOS data sheets into eight types of procedures as follows:

- Prelaunch (P). Those crew procedures accomplished by the flight crew prior to launch
- Ascent (A). Those crew procedures which are performed from booster ignition to MSFN confirmation of orbital attainment
- Orbital (O). Those crew procedures accomplished in orbit that are other than system and navigation procedures
- Abort (B). Those crew procedures which are performed in accomplishing safe recovery aborts from all suborbital situations
- Entry (E). Those crew procedures which are performed in preparing for and accomplishing C/M-S/M separation and entry



S.3.400 SPS Periodic Check

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Figure 3-4. Sample IOS Data Sheet (Pictorial)

Table 3-6. Sample IOS Data Sheet (Tabular)

Step	Malf	Time	Function	IOS Visibility/Action	Notes
1 through 6			RECORD PRESSURE AND TEMPERATURE PARAMETERS		
1			HE TANK PRESS ind	4000 decreasing	
2			HE TANK TEMP ind	70	
3			PRESSURE FUEL ind	175	
4			PRESSURE OXID ind	175	
5			PRESSURE ENGINE INLET FUEL ind	175	
6			PRESSURE ENG INLET OX ind	175	
7 through 10			RECORD SPS ENGINE INJECTION VALVE POSITIONS		
7			SPS ENGINE INJECT 1 ind - CLOSE	SPS ENGINE INJECTION VALVE 1 ind - CLOSE	
8			SPS ENGINE INJECT 2 ind - CLOSE	SPS ENGINE INJECTION VALVE 2 ind - CLOSE	
9			SPS ENGINE INJECT 3 ind - CLOSE	SPS ENGINE INJECTION VALVE 3 ind - CLOSE	
10			SPS ENGINE INJECT 4 ind - CLOSE	SPS ENGINE INJECTION VALVE 4 ind - CLOSE	
11 through 12			RECORD SPS REACTANTS QUANTITY READOUTS		
11			Read and log QUANTITY OX	As programed	
12			Read and log QUANTITY FUEL	As programed	

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- System (S). Those crew procedures that are performed for purposes of monitoring and maintaining spacecraft systems operation and/or utilizing the service of the systems
- Navigation (N). Those crew procedures which are performed in measuring spacecraft orbit, calculating thrusting requirements, commanding thrusting, and maintaining or changing IMU reference axes
- Postlanding (R). Those crew procedures involved in securing from the flight phase of the mission and setting up for the recovery phase.

The alphanumeric designators for the IOS data sheets are made up as follows:

X.1.1. IOS Data Sheet Number

- X. Type of procedure
 - 1. Crew station (1, 2, 3, or 4)
 - 1. Specific data sheet number by type

Prelaunch IOS Data Sheet.

For a number of reasons relating to both simulator constraints and training planning, the procedures outlined in the prelaunch IOS data sheets do not incorporate all of the procedures included in paragraph 1.1 of the SM2A-03-AMS (1 July 1965). Scope, organization, and contents of prelaunch crew procedures as depicted by the IOS data sheets are discussed in the following paragraphs.

Spacesuit and couch procedures for the simulator are not a subject of this handbook. For this reason, prelaunch IOS data sheets commence with crew procedures at step 13 (ECS status check) of paragraph 1.1 of the SM2A-03-AMS. Station 4 involvement in hatch installation (steps 12, 16, and 18) are not simulator functions, so no IOS data sheets have been provided for those procedures. The lower equipment bay procedures outlined between steps 18 and 21.5 have no training significance beyond checking switch positions and have not been included in the IOS data sheets. Cabin leak test and purge procedures outlined in step 22 of paragraph 1.1 of the SM2A-03-AMS have not been included, since the AMS does not simulate GSE inputs to the spacecraft.

The IOS data sheets for prelaunch are listed and identified in table 3-5 of this handbook. Prelaunch activity starts with step 13 (ECS status check) of paragraph 1.1 of the SM2A-03-AMS. That procedure is the subject of IOS data sheet P.1.1. As the station 1 ECS status check is completed, the station 3 ECS status check (step 14 of paragraph 1.1) is initiated. This procedure is the subject of IOS data sheet P.3.1. At the same time the crewman in station 1 initiates the station 1 controls and displays checklist (step 15, paragraph 1.1). The checklist is the subject of IOS data sheet P.1.2 which included step 22.9 of the deleted procedures, cabin leak test and purge. As the crewman in station 3 completes the ECS status checks, he starts the station 3 controls and displays checklist comprised of steps 17, 25, and 26 of paragraph 1.1. The IOS data sheets for this procedure is P.3.2.

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Station 2 activity in the prelaunch procedures for the AMS begins with the station 2 controls and displays checklist (step 23, paragraph 1.1) and continues with RCS status checks (step 24, paragraph 1.1). These procedures are the subject of IOS data sheet P.2.1.

Steps 28 through 33 of paragraph 1.1 of SM2A-03-AMS are the final launch preparations for the three crew stations. Station 1 sets the sequencing controls in accordance with step 28 and preparation of the SPS and SCS per steps 30 and 32. The crewmember in station 3 activates the telecommunications equipment in accordance with step 29 (IOS data sheet P.3.3) and station 2 is limited to monitoring functions until steps 34 through 37 where all three stations participate. Station 1 and station 3 activity in steps 28 through 37 is included in IOS data sheets P.1.3 and P.3.3, respectively. Station 2 involvement is the subject of IOS data sheet P.2.2.

Launch and Ascent IOS Data Sheet.

Launch and ascent procedures are the subject of steps 1 through 38 of paragraph 1.2 of the SM2A-03-AMS (1 July 1965). Launch activities are primarily a function of station 1 with station 2 and 3 activities limited to monitoring system parameters and communicating with MSFN. At 150,000 feet, the crewman in station 2 accomplishes ECS switching functions outlined in step 20. Crew procedures for stations 1, 2, and 3 during launch and ascent are depicted in IOS data sheets A.1.1, A.2.1, and A.3.1, respectively.

Special Earth Orbital Procedures IOS Data Sheet.

Two sets of crew procedures have been identified as special earth orbital procedures. All other orbital activities are made up of either systems operation-management or navigation activities. The two sets of procedures are initial orbital procedures as reflected in steps 39 through 49 of paragraph 1.2 of the SM2A-03-AMS (1 July 1965), and minimum power procedures for station 1 and 3. The minimum power procedures are not presently included in the SM2A-03-AMS. The IOS data sheets for stations 1, 3, and 4 procedures during the start of initial orbit are O.1.1, O.3.1, and O.4.1, respectively. The IOS data sheets for minimum power activities are O.1.2 and O.3.2.

Deorbit and Entry IOS Data Sheet.

Deorbit and entry procedures in paragraph 1.4 of the SM2A-03-AMS (1 July 1965) have been divided into four sequential groups for use in the AMS: those involved in preparing for and accomplishing retrograde, those involved in preparing for and accomplishing C/M-S/M separation, those involved in preparing for and accomplishing entry, and those required to arm and monitor-control the earth landing sequence.

Procedures for preparing for and accomplishing retrofire are included in steps 1 through 8 of paragraph 1.4 of the SM2A-03-AMS. The IOS data sheets for these procedures are E.1.1, E.3.1, and E.4.1.

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Procedures for preparing for and accomplishing C/M-S/M separation are included in steps 9 through 34 of the SM2A-03-AMS; steps 11, 17, 18, and 20 in the SM2A-03 are in error and should be omitted. The IOS data sheets for the procedures are E.1.2, E.2.1, and E.3.2.

Procedures for preparing for and accomplishing entry are included in steps 35 through 63 in paragraph 1.4 of the SM2A-03-AMS. The IOS data sheets for the procedures are E.1.3, E.2.2, and E.3.3.

Procedures for arming, otherwise operating, and monitoring the earth landing sequence are included in steps 64 through 82 in paragraph 1.4 of the SM2A-03-AMS. The IOS data sheets for the procedures are E.1.4 and E.3.4.

Postlanding Procedures IOS Data Sheet.

Postlanding procedures are the subject of paragraph 1.5 of the SM2A-03-AMS (1 July 1965). The IOS data sheets for stations 1, 3, and 4 are R.1.1, R.3.1, and R.4.1, respectively.

System and Navigation IOS Data Sheet.

The IOS data sheets for system management are provided in paragraph 1.3 of the SM2A-03-AMS (1 July 1965). They have been subdivided into two groups for use in the AMS: system procedures and navigation procedures as explained in paragraph 3.5.1.3 of this volume of the handbook. In many cases paragraph numbering of individual procedures in the SM2A-03-AMS is prohibitive to numerical cross-referencing in table 3-5. However, titles for system and navigation IOS data sheets and the SM2A-03-AMS system management procedures are common and cross-correlation can be accomplished by topic rather than paragraph number.

Malfunction IOS Data Sheet.

The IOS data sheets have been provided for only those malfunctions that develop into complex operations. Where a malfunction is overridden by positioning of a few simple controls, data provided in section 4 (Malfunction Data) of Volume III of this handbook will suffice. Malfunction procedures from the SM2A-03-AMS (1 July 1965), which have been supported with IOS data sheets, are listed in table 3-5. The listing is by IOS data sheet number, malfunction procedure title, and the SM2A-03-AMS paragraph number.

3.5.1.4 Compiling the Script.

Figure 3-5 illustrates the complete sequence of instructor-operator involvement in preparing for and accomplishing an AMS training session in accordance with this handbook. Figure 3-2, provided earlier in this section of the handbook, illustrates the preparation of the session script in greater detail. The steps involved in preparing a script for a selected session are as follows:

- a. Remove applicable session data sheet from section 1 of Volume III.
- b. Remove applicable initialization checklists from section 2 of Volume III (per instructions in session data sheet).



SELECT SESSION (FROM SYLLABUS SECT. 3 VOL 2)

- REFERENCES:
- NOMINAL TRAINING MISSION (SECT. 3 VOL 1)
 - APOLLO OPERATIONS HANDBOOK AMS SUPPLEMENT (SM2A-03-AMS)



PREPARE INSTRUCTOR SCRIPT (FROM SESSION DATA SHEET SECT. 1 VOL 3)

REFERENCES:

- NOMINAL TRAINING MISSION (SECT. 3 VOL 1)
- APOLLO OPERATIONS HANDBOOK AMS SUPPLEMENT (SM2A-03-AMS)
- SIMULATION OUTPUT TABLES (SECT. 5; VOL 3)
- EXPLANATIONS AS REQUIRED FROM:
 - SYSTEM SIMULATION (SECT. 2 VOL 1)
 - PROGRAM DATA (SECT. 2 VOL 2)
- OPERATING PROCEDURES (SECT. 1 VOL 2)
- BACKED AS REQUIRED FROM AMS DESCRIPTION (SECT. 1 VOL 1)
- SIMULATED MALFUNCTION TABLES (SECT. 4 VOL 3)
- BACKED AS REQUIRED FROM SYSTEM SIMULATION (SECT. 2 VOL 1)
- INITIALIZATION DATA SHEETS (SECT. 2 VOL 3)
- BACKED AS REQUIRED FROM NOMINAL TRAINING MISSION (SECT. 3 VOL 1)
- IOS DATA SHEETS (SECT. 3 VOL 3)
- BACKED AS REQUIRED FROM:
 - AMS UTILIZATION (SECT. 3 VOL 2)
 - APOLLO OPERATIONS HANDBOOK AMS SUPPLEMENT (SM2A-03-AMS)
- IOS DATA SHEET IN ACCORDANCE WITH INSTRUCTIONS IN SESSION DATA SHEET (SECT. 1 VOL 3)



BRIEF CREW

REFERENCES:

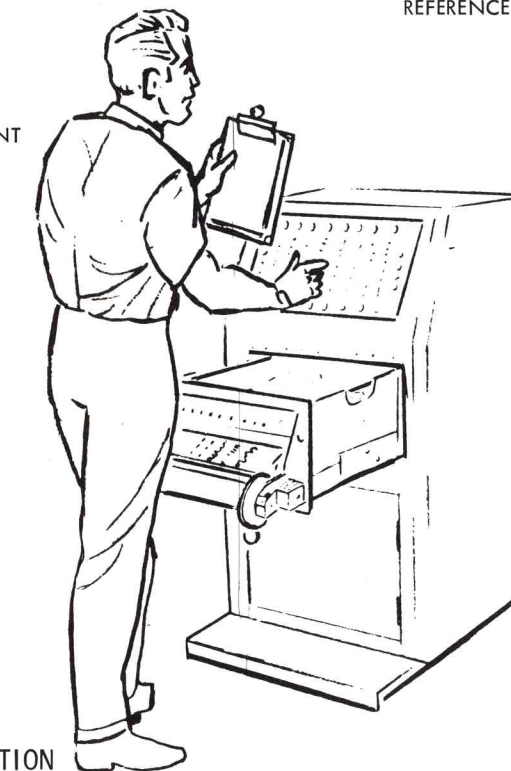
- SESSION DATA SHEET (SECT. 1 VOL 3)
- NOMINAL TRAINING MISSION (SECT. 3 VOL 1)
- SYSTEM SIMULATION (SECT. 2 VOL 1)
- AMS DESCRIPTION (SECT. 1 VOL 1)
- APOLLO OPERATIONS HANDBOOK AMS SUPPLEMENT (SM2A-03-AMS)



ACCOMPLISH SESSION

REFERENCES:

- COMPLETED INSTRUCTOR SCRIPT
- APOLLO OPERATIONS HANDBOOK AMS SUPPLEMENT (SM2A-03-AMS)



SET UP SIMULATION

REFERENCES:

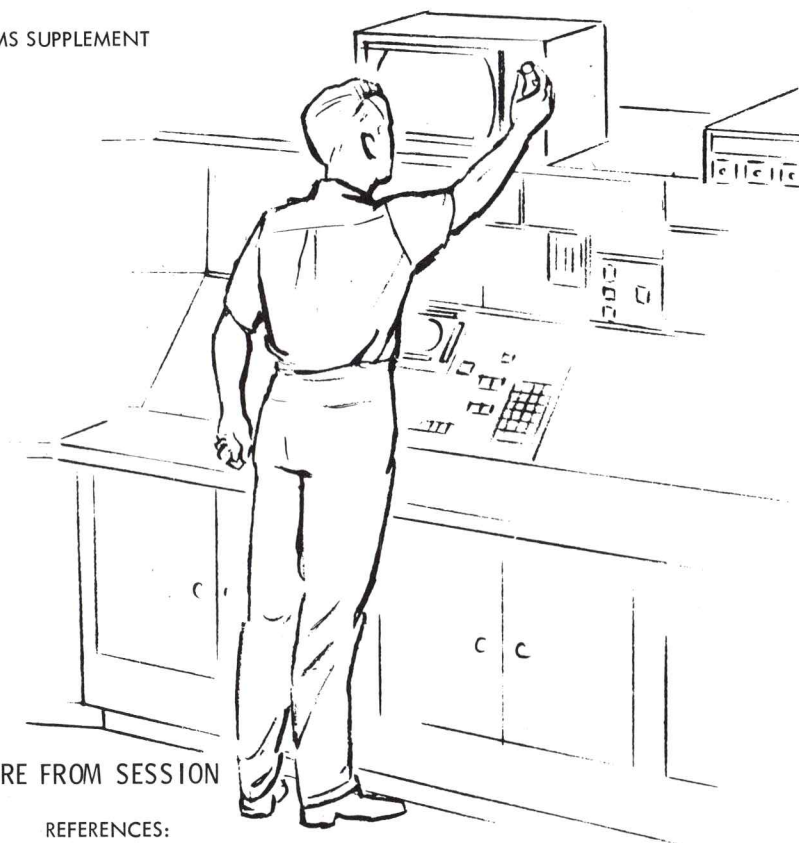
- SESSION DATA SHEET (SECT. 1 VOL 3)
- AMS OPERATION (SECT. 1 VOL 2)
- BACKED UP BY AMS DESCRIPTION (SECT. 1 VOL 1)



DE-BRIEF CREW

REFERENCES:

- NOMINAL TRAINING MISSION (SECT. 3 VOL 1)
- SYSTEM SIMULATION (SECT. 2 VOL 1)
- APOLLO OPERATIONS HANDBOOK AMS SUPPLEMENT (SM2A-03-AMS)
- TRANSCRIPTION DATA FROM AMS RECORDERS FOR PERFORMANCE EVALUATION



SECURE FROM SESSION

REFERENCES:

- AMS OPERATION (SECT. 1 VOL 2)
- AMS DESCRIPTION (SECT. 1 VOL 1)

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- c. Remove applicable IOS data sheets from section 3 of Volume III (per instructions in session data sheet).
- d. Copy session data sheet, initialization checklist and IOS data sheets and return originals to looseleaf Volume III.
- e. Arrange IOS data sheets in accordance with instructions provided in the session data sheet.
- f. Annotate the IOS data sheets in accordance with instructions provided in the session data sheet.
- g. Arrange the completed instructor script with session data sheet first, initialization checklist second, and compiled IOS data sheets last, and staple or otherwise bind.

3.5.2 SESSION ACCOMPLISHMENT.

It will not be necessary for the instructor-operator to prepare a script every time the simulator is used. Once an instructor script has been prepared (as outlined in paragraph 3.5.1), it may be used over and over again. Whether a new script is prepared or a preprepared script is used, the procedures for accomplishing a session are the same. (See figure 3-3.)

The first and last phases of training session accomplishment are the crew briefings to be provided. The two-conference type training briefings are for different purposes and must be separately prepared. The complete task of training session accomplishment (as illustrated in figure 3-3) is discussed in the following paragraphs.

3.5.2.1 Presimulation Briefing.

The purpose of the presimulation briefing is to introduce the flight crew to the purpose and scope of the planned session, provide any crew background in simulated spacecraft configuration and simulated mission plan required, and introduction to the crew procedures to be used. The briefing should be primarily controlled by the instructor-operator with questions as required by the crew.

Reference materials for session preparation are provided in this handbook and the SM2A-03-AMS (1 July 1965) to the SM2A-03. The nature of the use of these references is as follows:

- Session Data Sheet (of Completed Script). Purpose and scope of planned session
- AMS Description (Section 1, Volume I). As required to explain SCM control and indicator functions; may be used in conjunction with table 2-2 from Volume I to explain differences between AMS and AF012
- System Simulation (Section 2, Volume I). As required to explain spacecraft systems simulated in the AMS; should have extensive application in part task training and little or no application in mission task and typical mission training

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- Nominal Training Mission (Section 3, Volume I). As required to explain the mission plan and mission events to be simulated in the AMS; should have extensive application in mission task and typical mission training and only limited application in part task training
- Apollo Operations Handbook, AMS Supplement (SM2A-03-AMS, 1 July 1965). Crew procedures to be practiced during the training session.

3.5.2.2 Use of Completed Script.

Instructor-operator procedures for the AMS are the subject of section 1 of this volume. Special instructions which are supplemental to section 1 (Operation) are included in the session data sheet. Contents of section 1 as amended by the session data sheet will be used by the instructor-operator to set up for and secure from the training session.

During initialization and accomplishment of each simulation run in the session, the instructor-operator should work primarily from the initialization checklist and the IOS data sheets, and annotation of these items should be made accordingly. Reference to other portions of the handbook during actual on-line simulation would interfere with instructor-operator concentration on the simulation-training situation.

3.5.2.3 Postsimulation Debriefing.

The purpose of the postsimulation debriefing is to review the results of the completed training session. The debriefing should be primarily controlled by the performing flight crewmembers for the purpose of understanding and interpreting results. The instructor-operator should assist with reference materials and personal observations. Reference materials and their applications are as follows:

- Instructor-Operator Notes (During Run or Session). For instructor-operator observations and comments
- Instructor Script. For training session history
- Nominal Training Mission (Section 3, Volume I). As required to review the mission plan and circumstances surrounding mission events; should have extensive application in mission task and typical mission training and only limited application in part task training
- System Simulation (Section 2, Volume I). As required to explain simulated malfunctions, MSFN systems data and systems performance; is applicable to all sessions involving simulated malfunctions
- Apollo Operations Handbook AMS Supplement (SM2A-03-AMS, 1 July 1965). As required in discussion of crew procedures accomplished during the session

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- Data Transcriptions from AMS. For performance evaluation of the session with data transcribed by X-T and X-Y plotters and digital tape recorders.

NOTE

Completely effective crew performance measurement requires calibrated performance standards addressed to the specific parameters transcribed. Such performance standards are not presently included in this handbook.

3.5.3 REFERENCE TABLES.

Sections 4 and 5 of Volume III contain reference tables for setting up and operating the AMS. Tables are for two functional purposes. The first purpose is as reference material for the training sessions and simulation runs included in the AMS syllabus contained in this handbook. The second purpose is as basic data to be used in the preparation of additional sessions and runs above and beyond those defined in this handbook.

3.5.3.1 Simulated Malfunction Tables.

Section 4 of Volume III contains a complete list of the spacecraft malfunctions simulated in the initial delivered configuration of the AMS. The malfunctions are identified by MIU number and descriptive title and are individually supported with descriptions of manner of manifestation to the crew (and instructor) and appropriate crew response information. The malfunction tables are broken into systems, and malfunctions listed in the tables are also illustrated in the respective system flow diagrams provided in section 2 of Volume I (System Simulation).

3.5.3.2 Simulation Output Tables.

Section 5 of Volume III contains a complete list of spacecraft and mission simulation outputs available to X-T and X-Y recorders, tape recorders, the electronic typewriter, and the TM console. The tables will be grouped by computer program. Contents of the table includes the following:

- Program symbol for each simulation parameter
- Description of each simulation parameter
- Unit of measurement of each parameter
- Identification of parameters available in TM console channels
- Identification of parameters normally transcribed on digital tape.

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3.5.4 COMPILING ADDITIONAL SESSIONS.

The number of simulated situations, simulator runs, and training sessions conceivable on the AMS is, of course, infinitely larger than those in the syllabus contained in this handbook. However, where situations, runs, and sessions, not included in the syllabus are required for any purpose, the handbook contents can be used to prepare additional session data sheets. The procedure for using the SM2A-03-AMS (1 July 1965) to prepare additional session data sheets is shown in figure 3-6 and discussed in the following paragraphs.

3.5.4.1 Requirements for Additional Sessions.

Requirements for additional training sessions and simulation runs can occur for any number of reasons. Additional sessions may be desired in any of the types of training in the syllabus provided in this handbook (part task, mission task, and typical mission). There is a complete set of specific mission training sessions to be prepared. Crew procedures development and verification will produce requirements not covered by session in the syllabus, and so will development and verification of mission rules.

Whenever there is a requirement to use the simulator for a purpose and/or in a fashion other than chronological accomplishment of the syllabus, the procedures illustrated in figure 3-6 should be followed.

3.5.4.2 Use of Existing Sessions.

The first step is to prepare an accurate definitive statement of the requirement to be met and review the syllabus provided in this section to see if any of the sessions defined therein will meet the requirement or can be modified to meet the requirement. If any of the existing sessions will meet the requirement, session data for the special purpose is established and the appropriate session data sheet can be removed from section 1 of Volume III and used to prepare the required script.

Where it appears that an existing session can be modified to meet the requirement, the session data sheet should be removed from section 1 of Volume III, reviewed, modified as required, and used to prepare the required script.

3.5.4.3 New Session Purpose and Scope.

If none of the existing sessions can be adjusted to meet the special requirement, the requirement becomes the PURPOSE of a new session data sheet.

The second step in preparing a new training session is to review the nominal training mission (section 3, Volume I) and establish which phase or phases of the mission should be used, which variations in the defined mission

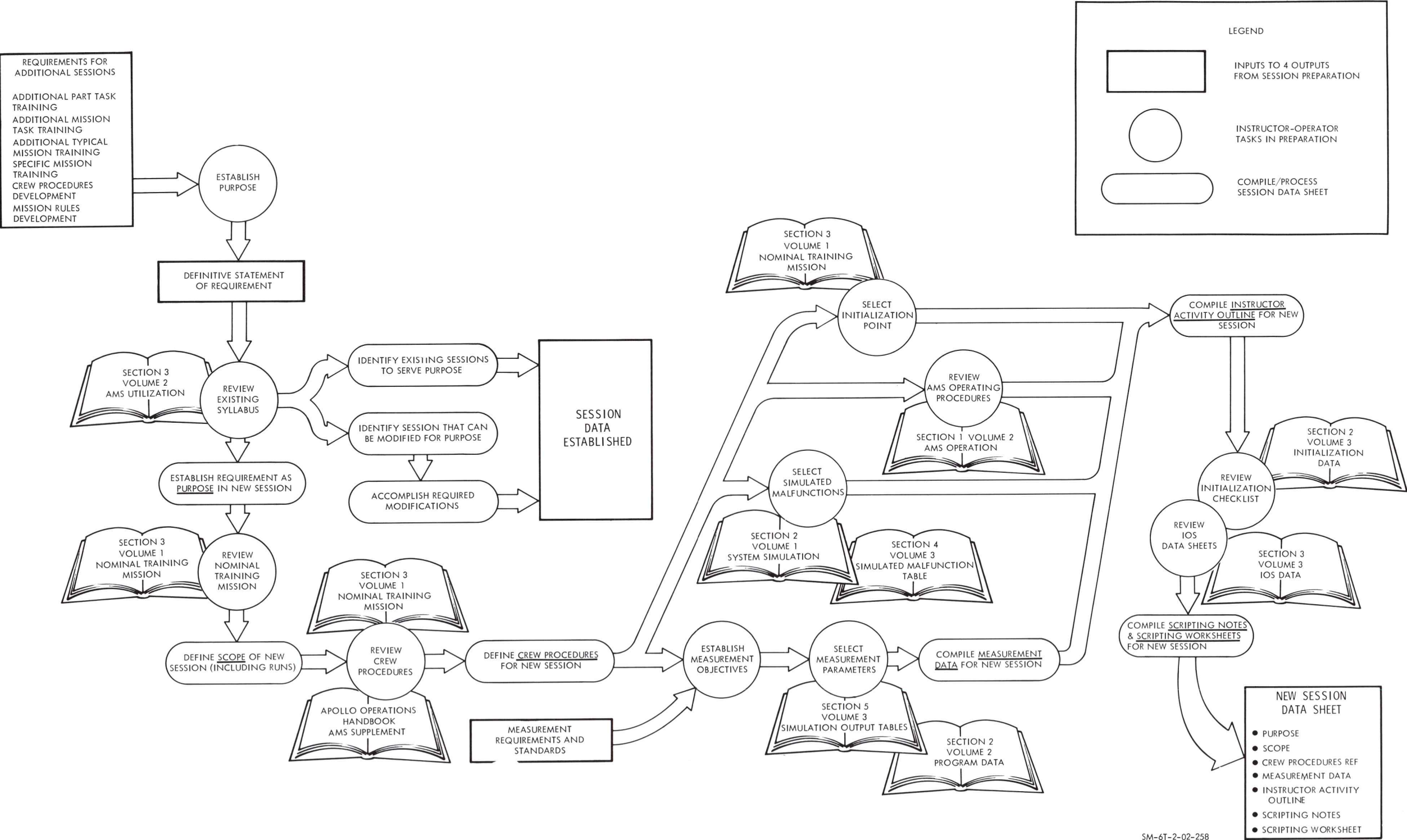


Figure 3-6. Preparing New Session Data Sheets from Handbook

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are required, and what simulator runs will be required to fulfill the stated purpose of the session. A general description of the scope of the session and a definitive list of the simulator runs involved should be transcribed on the new session data sheet as the SCOPE of the session.

3.5.4.4 Crew Procedures and Measurement Data.

With purpose and scope defined, the next step in preparing a new training session is to review crew procedure references for the purpose of determining which procedures are to be performed by the crew in the SCM. This is done by reviewing the SM2A-03-AMS (1 July 1965) with respect to the nominal training mission. Tables 3-2, 3-3, and 3-4 of this section will also be useful in identifying crew procedures for the session. When the specific sections and paragraphs of SM2A-03-AMS to be performed in the session are identified, they should be transcribed as the CREW PROCEDURES REFERENCE data on the new session data sheet.

As has been previously stated in this section, crew performance measurements are not the subject of this handbook. However, with a known measurement requirement and standard, the handbook can be used to establish and implement a measurement objective, that is, propellant consumption per axis per real time, entry trajectory errors versus RCS thrusting per axis, etc. When such machine transcription objectives are defined, the required parameters (and related programming operators and scale factors) can be located in the simulation output tables in section 5 of Volume III. The machine measurement objective and specific parameters information should be noted on the new session data sheet as MEASUREMENT DATA.

3.5.4.5 Instructor Activity Outline.

Prior to compilation of the INSTRUCTOR ACTIVITY OUTLINE, it is necessary to select the program initialization point(s) and simulated malfunctions to be used in each run. Initialization points (and required fast time to get to run start points) are selected from the nominal training mission (section 3, Volume I). Two important considerations must be applied in selecting initialization points. The first is that enough elapsed time is included to accomplish crew procedures planned for the run. Table 3-5 in this section includes time approximates for each procedure. The second consideration is that navigation sightings require both daylight and landmark availability. Figures illustrating day-night phases and landmarks available in the nominal training mission are to be found in section 3 of Volume I.

Selection of simulated malfunctions to be used in the new training session is made from the simulated malfunction table in section 4 of Volume III. Descriptions of systems simulated are provided in section 2 of Volume I (System Simulation) and should be useful in comprehending and interpreting the malfunction descriptions in the table.

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When initialization point(s) and simulated malfunctions are selected the INSTRUCTOR ACTIVITY OUTLINE is prepared. The primary reference for preparing the outline is the contents of section 1 (AMS Operation) of Volume II. The outline is to supplement the checklists contained in that section with those details necessary to accomplish the specific runs of which the new session is comprised. Contents of the outline must include, but is not necessarily limited to, the following items:

- Identification of simulator complex checklist to be used
- Variations in and exceptions to the selected checklist
- Identification of MEP film cassettes and slide magazines required (if any)
- Program operator codes for setting up and initiating the required computer programs
- Desired position of all simulator controls requiring instructor-operator position selection
- Specific details of initialization and fast time to run start point(s)
- Malfunction codes and manner of insertion for all selected simulated malfunctions
- Simulator communications system configuration to be used
- True trainee environment setup
- Supplemental instructions for transcription devices above and beyond those listed under MEASUREMENT DATA (if any).

3.5.4.6 Scripting Data and Script Preparation.

When the instructor-operator has completed the preparation of the INSTRUCTOR ACTIVITY OUTLINE, he is ready to do detailed planning of the IOS script. If he desires to add the new session to the basic AMS session library, he can complete the new session data sheets by compiling the SCRIPTING NOTES and SCRIPTING WORKSHEET. When the application of the new session does not require a permanent and complete session data sheet, the IOS script can be directly prepared without compiling the scripting instructions.

To either compile the scripting instructions or directly prepare the IOS script, it is necessary to identify the initialization checklist(s) and IOS data sheets required for the session. IOS data sheets are identified with the CREW PROCEDURES (already listed on new session data sheet) as shown in table 3-5 of this section. If the session data sheet is to be completed, the identification of these data items and their sequence of presentation should be noted under scripting instructions. If the script is to be directly prepared, the items should be copied and arranged in their order of presentation.

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Where a timeline of the planned runs is required, instructions for annotating IOS data sheets should be compiled under SCRIPTING NOTES. Where the script is directly prepared, the timeline can be directly noted under "Time" on the IOS data sheet.

Other notes relative to the specific session-runs being planned may be noted on the SCRIPTING WORKSHEET (where a session data sheet is being prepared) or directly noted on the IOS data sheet. Such notes must include the following:

- The number of each selected malfunction under Malf in direct alignment with the procedure step to which it relates
- Title and description of each malfunction under Notes
- Anticipated response to each malfunction under Notes
- Instructions for any up-data link operation (including participation in navigation procedures)
- Notes for instructor simulation of MSFN in the nonintegrated mode
- Any instructions required to transition from one IOS data sheet to another in session-run accomplishment.