



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
MANNED SPACECRAFT CENTER  
HOUSTON, TEXAS 77058

REPLY TO  
ATTN OF: FC24 (72-95)

MAY 11 1972

MEMORANDUM

TO: Distribution

FROM: FA/Acting Director of Flight Operations

SUBJECT: Flight Control Division's Baseline Operations Plan for Skylab

1. Attached is the Flight Control Division's Baseline Operations Plan (BOP) for Skylab as of May 1972. This document is a complete reissue of the original document published in August of 1970. Its purpose is to define the planned method of operation to be used for mission control of the Skylab Program for all interested agencies.
2. One recently baselined change not incorporated into the mission description section of the BOP is the use of the CSM RCS orbit trim maneuvers for maintaining a controlled groundtrack pattern for EREP pass support. The RCS trim technique is well defined in the Mission Techniques (Data Priority) Minutes. This information, when finalized, will be incorporated into the next revision of the BOP.
3. Several aspects of the Skylab Program are unresolved. These are identified as follows:
  - a. The numbers and assigned location of the EREP regional controllers have not yet been determined. In addition the EREP passes and truth sites are in the process of being selected. As a result, the personnel, truth site equipment, and communications to each site in terms of actual links and information exchange are not fully defined.
  - b. The role of the Science and Applications Directorate (S and AD) in Skylab operations needs further definition in two areas. The first is EREP support; this plan identifies a requirement for an EREP multi-discipline support team. This team would support FCD during premission, in-orbit, and post-mission EREP operations. As now visualized, S and AD would provide the team personnel. The second area in which S and AD support is not defined is in the FOMR operation. The FOMR function of adjusting experiment mission requirements and priorities underscores the need for an S and AD point-of-contact to support this function for the EREP and corollary experiments.

c. The unmanned ATM operation has not been fully defined. The current plan calls for actively supporting SO52, SO54, and SO55 eight hours per day during the unmanned intervals, and continued operation of SO55 in an MDRS data collection mode during the 16-hour period of reduced monitoring. However, studies are still being conducted on increasing the active support time.

d. Unattended ATM operations are also under consideration for the manned intervals. This involves operating the ATM from the ground when the crew is asleep or engaged in other activity. Specifically when, how much, and what experiments/modes will be operated are not yet defined.

e. FCD is continuing to study methods of providing an Alternate Mission Control Center similar in intent to that provided for Apollo in the event the MCC is incapacitated. An alternate control center is also being considered for the ALSEP/P and FS lunar science support. For Skylab, the MLLA site, the HOSC, and GSFC are candidates for the Alternate Mission Control Center.

f. The division of operations responsibilities between FCD and FCOD needs to be more clearly defined and agreed upon in several areas. These include:

- o Specific hardware and nonhardware responsibilities.
- o Experiments pointing computation.
- o PAD preparation.
- o Consumables tracking.
- o Day-to-day stowage tracking.
- o P.I. interface.

4. A final issue of the BOP will be distributed approximately six months before SL-1 launch. This final issue will contain a resolution of as many of these areas as possible. No further revisions are anticipated prior to the distribution of the final document. Please address all comments to Mr. William P. Gatlin, 483-3838, mail code FC2.

*Howard W. Vinson*

Sigurd A. Sjoberg





NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

*SKYLAB*

*BASELINE  
OPERATIONS PLAN*

*MAY, 1972*

*PREPARED BY*

*FLIGHT CONTROL DIVISION*

**MANNED SPACECRAFT CENTER  
HOUSTON, TEXAS**

1 INTRODUCTION

2 MISSION  
PLAN

3 MISSION  
CONTROL

4 MCC SUPPORT  
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5 EXPERIMENT  
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6 COMMUNICATIONS  
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A PROBLEMS  
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ISSUES

B MISSION  
COMPUTER  
FUNCTIONS

C ACRONYMS  
AND  
ABBREVIATIONS



BASELINE OPERATIONS PLAN  
FOR SKYLAB

PREFACE


This document has been prepared by the Flight Control Operations Branch, Flight Control Division, Manned Spacecraft Center, Houston, Texas, with technical assistance by Service Technology Corporation. Information contained within this document represents the Flight Control Division Baseline Operations Plan for the Skylab Program as of May 1972.

Any comments concerning the contents of this document should be directed to William P. Gatlin, 713-483-3838.

This document is not to be reproduced without the written approval of the Chief, Flight Control Division, Manned Spacecraft Center, Houston, Texas.

Approved by:

  
Eugene F. Kranz  
Chief, Flight Control Division

  
Sigurd A. Sjoberg  
Acting Director of Flight Operations



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SECTION 1  
INTRODUCTION

SKYLAB BOP  
BASIC

1.1 PURPOSE

This document represents the Flight Control Division Baseline Operations Plan for the Skylab (SL) Program, as of May, 1972. It is intended to describe the manner in which the Flight Control Division plans to conduct the Skylab Program Mission Control operations. This plan is mainly conceptual in nature and is not intended as a control document. However, it does represent the Flight Control Division operating plan at the time of publication.

1.2 APPROACH

Section 2 contains a brief summary of the mission objectives, vehicle configurations, and description of the planned flights. Section 3 discusses the mission control functions which must be accomplished to fly the program. Section 4 discusses the organization of the Mission Control Center operations to accomplish the functions outlined in Section 3.

Sections 5, 6, and 7 discuss in greater detail some of the Mission Control Center operations that are either new for Skylab, significantly changed, or just larger in scope compared to Apollo operations. Specifically, Section 5 discusses experiment operations; Section 6, communications and data management; and Section 7, flight activities scheduling.

Section 8 outlines the Skylab flight controller training plan, and Section 9 discusses the effects of multiple MCC operations during the Skylab timeframe.

\*

SKYLAB BOP  
BASIC

Appendix A contains a list of major open items and Appendix B summarizes the Skylab mission computing functions since they are greatly expanded over Apollo. Appendix C contains definitions of acronyms and abbreviations used within this document.



2 MISSION  
PLAN

SECTION 2  
MISSION PLAN

SKYLAB BOP  
BASIC

2.1 OBJECTIVES

2.1.1 Program Purpose

The purpose of the Skylab Program is to determine man's ability to live and work in space for extended periods, to extend the science of solar astronomy beyond the limits of earth-based observations, to perform earth resources observations, and to increase man's knowledge in other scientific and technical areas. The current Skylab detailed test objectives are delineated in the Skylab Mission Requirements Document.

2.1.2 Mission Objectives

The overall mission objectives in order of decreasing priority are as follows:

A. SL-1/SL-2

1. To establish the Skylab in earth orbit
2. To obtain medical data for use in extending the duration of manned space flight
3. To perform in-flight experiments

B. SL-3 and SL-4

1. To perform unmanned Saturn Workshop operations
2. To reactivate the Skylab in earth orbit
3. To obtain medical data for use in extending the duration of manned space flight
4. To perform in-flight experiments

### 2.1.3 Experiments

A summary of the experiments assigned by the Office of Manned Space Flight to the Skylab program is presented in Table 2-1. This table shows the experiment number, title, and mission assignment. The Skylab experiments are divided into the following major categories:

- 2.1.3.1 Medical.- A series of medical experiments will be carried out on the Skylab missions to determine man's ability to live and work in space for extended periods. The medical data will be used to determine the effects on the crew resulting from a space flight of up to 56 days. These effects will include man's physiological responses and aptitudes in space under zero gravity and his postflight adaptation to the terrestrial environment.
- 2.1.3.2 Earth-Resources Experiments Package (EREP).- The Skylab EREP, composed of five remote sensors, is a part of already existing international studies on the techniques and application of earth remote sensing. The Skylab EREP will provide added and more precise data on spacecraft sensing techniques and returned data correlation and application. Crop, forest, and land use surveys, fish location, and sea state surveys are EREP observation objectives.
- 2.1.3.3 Corollary.- The purpose of the corollary experiments is to conduct investigations to:
  - A. Study the effects of space environment on various materials
  - B. Obtain data on work tasks in space



TABLE 2-I.- SKYLAB EXPERIMENT ASSIGNMENTS

Number	Title	Mission assignment		
		SL-1/SL-2	SL-3	SL-4
D008	Radiation in Spacecraft	X		
D024	Thermal Control Coating (AM)	X	X	
M071	Mineral Balance	X	X	X
M073	Bioassay of Body Fluids	X	X	X
M074	Specimen Mass Measurement	X	X	X
M078	Bone Mineral Measurement	(a)	(a)	(a)
M092	In-Flight Lower Body Negative Pressure	X	X	X
M093	Vectorcardiogram	X	X	X
M111	Cytogenetic Studies of Blood	(a)	(a)	(a)
M112	Man's Immunity - In Vitro Aspect	(a)	(a)	(a)
M113	Blood Volume and Red Cell Lifespan	(a)	(a)	(a)
M114	Red Blood Cell Metabolism	(a)	(a)	(a)
M115	Special Hematological Effects	(a)	(a)	(a)
M131	Human Vestibular Function	X	X	
M133	Sleep Monitoring	X	X	
M151	Time and Motion Study	X	X	X
M171	Metabolic Activity	X	X	X
M172	Body Mass Measurement	X	X	X
M415	Thermal Control Coatings (IU)	X		
M479	Zero Gravity Flammability		X	
M487	Habitability/Crew Quarters	X	X	X
M509	Astronaut Maneuvering Equipment	X	X	
M512	Materials Processing in Space (Facilities)	X	X	
M516	Crew Activities/Maintenance Study	X	X	X
M551	Metals Melting Experiment	X	X	
M552	Exothermic Brazing Experiment	X	X	
M553	Sphere Forming Experiment	X	X	
M554	Composite Casting Experiment	X	X	
M555	GaAs Crystal Growth Experiment	X	X	
S009	Nuclear Emulsion	X		

<sup>a</sup>Performed preflight and postflight only.

TABLE 2-I.- SKYLAB EXPERIMENT ASSIGNMENTS - Concluded

Number	Title	Mission assignment		
		SL-1/SL-2	SL-3	SL-4
S019	UV Stellar Astronomy	X	X	
S020	UV/X-Ray Solar Photograph		X	
S052	White Light Coronagraph			
S054	X-Ray Spectrographic Telescope			
S055A	UV Scanning Polychrometer/ Spectroheliometer			
S056	Dual X-Ray Telescopes			
S063	UV Airglow Horizon Photography			X
S071	Circadian Rhythm - Pocket Mice		X	
S072	Circadian Rhythm - Vinegar Gnat		X	
S073	Gegenschein/Zodiacal Light		X	
S082A	UV Coronal Spectroheliograph			
S082B	UV Spectrograph			
S149	Particle Collection		X	
S150	Galactic X-Ray Mapping		X	X
S183	Ultraviolet Panorama		X	X
S190	Multispectral Photography	X	X	X
S191	Infrared Spectrometer	X	X	X
S192	10-Band Multispectral Scanner	X	X	X
S193	Microwave Radiometer Scatterometer	X	X	X
S194	L-Band Radiometer	X	X	X
T002	Manual Navigation Lightings	X	X	X
T003	In-Flight Aerosol Analysis	X		
T013	Crew/Vehicle Disturbances		X	
T018	Precision Optical Tracking	X	X	X
T020	Foot Controlled Maneuver Unit	X	X	
T025	Coronagraph Contamination Measurement		X	
T027	Contamination Measurement	X	X	X

- C. Determine the effects of zero gravity on biological materials
- D. Obtain data on maneuvering equipment for future extra-vehicular activity (EVA) requirements

2.1.3.4 Apollo Telescope Mount (ATM) experiments.- The purpose of this class of experiments is to obtain solar astronomy data for continuing and extending solar studies beyond the limits of earth observations.

## 2.2 SPACE VEHICLES

This section consists of a brief, general description of the orbital assembly (OA) which consists of the command service module (CSM) and the Skylab Workshop Systems (SWS), as shown in Figure 2-1. The CSM is explained in terms of the differences from the Apollo J-series CSM. Further information on any of the Skylab systems may be obtained from the Skylab Systems Handbooks, the Operational Data Books, and the Skylab Operations Handbooks.

### 2.2.1 Command and Service Module (CSM)

CSM 116, 117, and 118 will be flown on missions SL-2, SL-3, and SL-4, respectively. The major systems modifications or additions to the Skylab CSM's from the Apollo J-type CSM's are as follows:

- A. High-gain antenna deleted. This antenna is not needed for earth orbit.
- B. Remote antenna switching by ground added for all S-band omni antennas via both the CSM and the Airlock Module (AM) command systems.
- C. One fuel cell deleted leaving two. Two fuel cells will meet the Skylab power requirements with CSM battery backup.



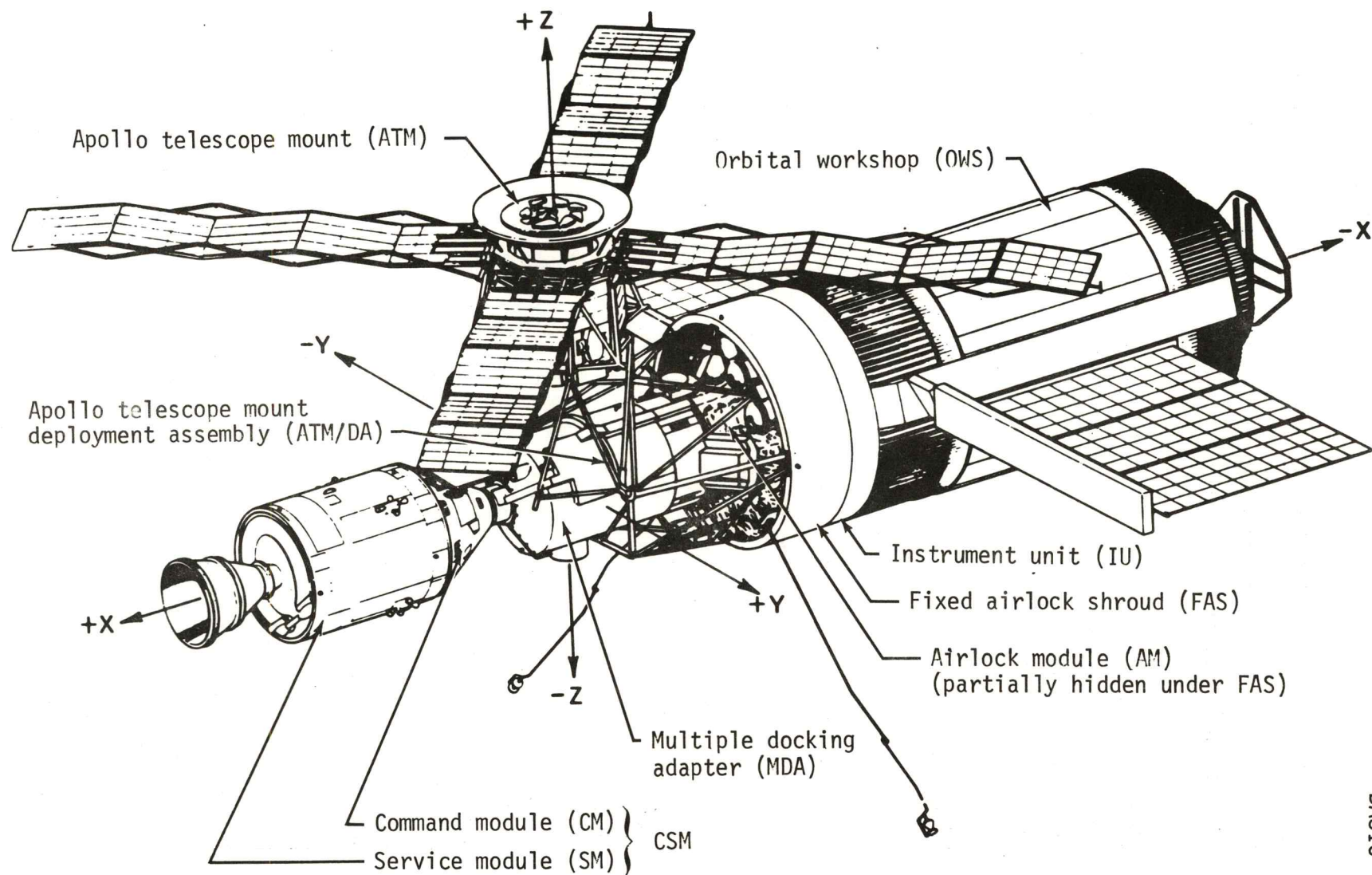


Figure 2-1.- Orbital assembly (OA).

- D. Three 500 A-h descent batteries in the SM instead of one 400 A-h battery. This is required because the fuel cells cannot be reactivated after shutdown.
- E. Two hydrogen and two oxygen tanks instead of three each.
- F. Pyro batteries (0.75 A-h) deleted and replaced with entry/postlanding-type batteries (40 A-h) giving a total of five entry-type batteries. The 30-day life of the pyro batteries is inadequate for Skylab. Proven life of the entry batteries is 140 days.
- G. Service Module water tank added to contain the water generated by using the fuel cells to cryo depletion and prevent contamination by dumping.
- H. Several blanket heaters added to various systems for thermal control during the prolonged solar-inertial attitudes of the orbital assembly.
- I. Electrical power transfer umbilicals added to supply OWS power to the CSM during the quiescent period. This is needed to transfer power to the CSM after CSM electrical power system (EPS) shutdown.
- J. CSM  $O_2$  cryo vent valve added for intravehicular activity (IVA) cryo vent.

### 2.2.2 Saturn Workshop

As shown in Figure 2-1, the Saturn workshop consists of the orbital workshop (OWS), the airlock module (AM), the multiple docking adapter (MDA), the Apollo telescope mount (ATM), and supporting structures. These are briefly defined in the following paragraphs.

#### 2.2.2.1 Orbital Workshop.-- The OWS is a modified third stage of the Saturn V launch vehicle (S-IVB stage). The liquid hydrogen

tank has been converted into crew living quarters and a work area (habitation area) and the liquid oxygen tank into a plenum area for waste matter. The J-2 engine, propellant pumps, auxiliary propulsion system, and supporting hardware have been removed from the S-IVB as unnecessary weight.

The exterior of the OWS is fitted with an aluminum meteoroid shield, a solar array system (SAS), a radiator for the refrigeration system, and two rings of  $\text{GN}_2$  bottles for a thruster attitude control system (TACS). The TACS maintains attitude control of the SWS prior to control moment gyro (CMG) spin-up and supplements the CMG's for attitude control. The meteoroid shield is deployed in orbit and protects the OWS against meteoroid penetrations. The SAS wing assemblies are also deployed in orbit and provide a source of electrical power to the OA. The radiator is hardmounted to the thrust structure on the aft end of the OWS and is used to radiate heat absorbed by the OA refrigeration system.

2.2.2.2 Airlock Module.- The AM is situated between the OWS and the MDA and contains systems for environmental control, instrumentation, electrical power, communications, and operational management of the OA. It also provides a lock compartment, hatch, and support systems for EVA's. This compartment allows EVA without interrupting the crew or systems operations in the pressurized volumes on either side of the lock.

Operational management capability for OA systems is provided by means of control and display consoles located within the AM's pressurized volume and by a digital command system (DCS) for ground control of Skylab systems.



2.2.2.3 Multiple Docking Adapter.- The MDA is basically a double-walled pressure vessel approximately 17 feet long and 10 feet in diameter which provides a permanent interface with the AM and a docking interface with the CSM. The primary function of the MDA is to provide two docking interfaces for the CSM: an axial port and a radial port. The MDA also contains the control and display consoles for management of the TACS, ATM and EREP, and provides internal storage for hardware and experiments operated on the SWS.

2.2.2.4 Apollo Telescope Mount.- The ATM consists of a rack, experiment canister, solar array, and various support subsystems. The ATM provides the OA attitude control through the CMG's. It also supplies electrical power for ATM experiments and for sharing of the OA electrical loads and equipment required to perform the ATM solar astronomy experiments.

The ATM is in a stowed position during launch with the ATM forward of the MDA axial port. At a command from the IU, the deployment mechanism rotates the ATM and locks the deployment arms into place with the ATM X-axis parallel to the OWS Z-axis. After the ATM is locked into position, the ATM solar arrays are deployed.

## 2.3 MISSION DESCRIPTION

The following mission description is based on current knowledge of the mission. While it is recognized that this information is subject to change as the program evolves, it will be used as the reference for this operations plan. For the latest information on the mission profile, the Skylab Preliminary Reference Trajectory Document, Flight Operations Plan (FOP) Minutes, and Mission Techniques (Data Priority) Minutes should be consulted.

### 2.3.1 Skylab Flight Schedule

The current baseline lift-off and recovery schedule is shown in Table 2-II. The considerations used in the selection of the Skylab lift-off times for this schedule are as follows:

#### A. Mandatory

1. Daylight in end-of-mission (EOM) recovery area(s)
  - a. Landing no earlier than civil (3 degrees below horizon) sunrise
  - b. Landing no later than 2 hours prior to civil sunset
2. Early rendezvous for SL-2 (M = 5 through 8)
3. SL-1 launch window: 1.5 hours
4. Launch interval: 90 plus or minus 6 days
5. EOM deorbit sequence coverage (for both shaping and deorbit maneuvers):
  - a. Track, telemetry, and voice at least 55 minutes prior to the maneuver.
  - b. Track, telemetry, and voice between "maneuver -55 minutes" and "maneuver -20 minutes."
6. Mission duration
  - a. SL-2: 28 days
  - b. SL-3 and SL-4: 56 days

#### B. Highly Desirable

1. Daylight in launch abort area
  - a. Launch no earlier than civil sunrise at John F. Kennedy Space Center, Florida (KSC)
  - b. Launch such that at least 3 hours remain before civil sunset at the end of the Mode II abort area
2. Early rendezvous for SL-3 and SL-4 (M = 5 through 8)

TABLE 2-II.- SKYLAB LIFT-OFF AND RECOVERY SUMMARY

Date	Launch	Launch to launch centers, day	Lift-off, eastern standard time	Recovery, local standard time	Maximum percent orbital lighting	Beta angle	
						Rndz	Deorbit
Apr 30	SL-1		12:30 p.m.				
May 1 to May 29	SL-2	1 (60) <sup>a</sup>	12:00 noon (4:45 a.m. to 1:30 p.m.) <sup>b</sup>	Atlantic 9:00 a.m. (4:30 a.m.) <sup>c</sup>	64 May 10	-12	29
July 28 to Sept 22	SL-3	88 (40) <sup>a</sup>	12:30 a.m. (4:45 a.m. to 2:15 p.m.) <sup>b</sup>	Atlantic 10:00 a.m. (5:20 a.m.) <sup>c</sup>	84 Aug 8	29	0
Nov 1 to Dec 27	SL-4	96	9:30 a.m. (5:45 a.m. to 10:45 a.m.) <sup>b</sup>	Pacific 10:15 a.m. (6:05 a.m.) <sup>c</sup>	83 Nov 6	-53	-48

<sup>a</sup>Unmanned interval between missions.<sup>b</sup>Launch limits to satisfy abort recovery area lighting constraints.<sup>c</sup>Civil time of sunrise.SKYLAB BOP  
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3. Maximum recovery lighting in primary recovery area for early (up to 10 days) SL-3 and SL-4 deorbit

C. Desirable

1. Post deorbit coverage (track, telemetry [TM], voice)
2. Dark passes: 10 minutes for inertial measurement unit (IMU) alignment in deorbit sequence
3. SL-2 and SL-3 recovery in Atlantic
4. Backup rev deorbit within medical experiment recovery constraints (recovery of crew within about one hour)
5. Maximum lighting for EREP opportunities

2.3.2 SL-1 Launch Through SWS Activation

The SL-1 SWS will be launched in a northerly direction from LC-39A at KSC and inserted into a circular orbit of approximately 235 n.mi. in altitude at an inclination of 50 degrees. After insertion, the S-II stage will be separated by retro-rockets, and the SWS will be rotated by the thruster attitude control subsystem (TACS) to a retrograde attitude. The payload shroud (PS) will be jettisoned halfway (-90 degrees) through the 180 degrees SWS maneuver to retrograde attitude. A retrograde maneuver will place the S-II stage in an orbit of approximately 235 by 203 n.mi. having a nominal lifetime of approximately 295 days. Plans call for the S-II stage to be safed by a timing sequence that begins approximately 3.5 minutes after separation. Safing includes venting the main liquid hydrogen (LH<sub>2</sub>) propellant tank, the engine gaseous nitrogen (GN<sub>2</sub>) start tanks, and the engine helium tanks, followed by the venting of the main liquid oxygen (LOX) propellant tank.

After the PS is jettisoned, the ATM will be deployed, and the TACS will orient the SWS to a solar inertial attitude. This attitude will be maintained, and the ATM solar array will be

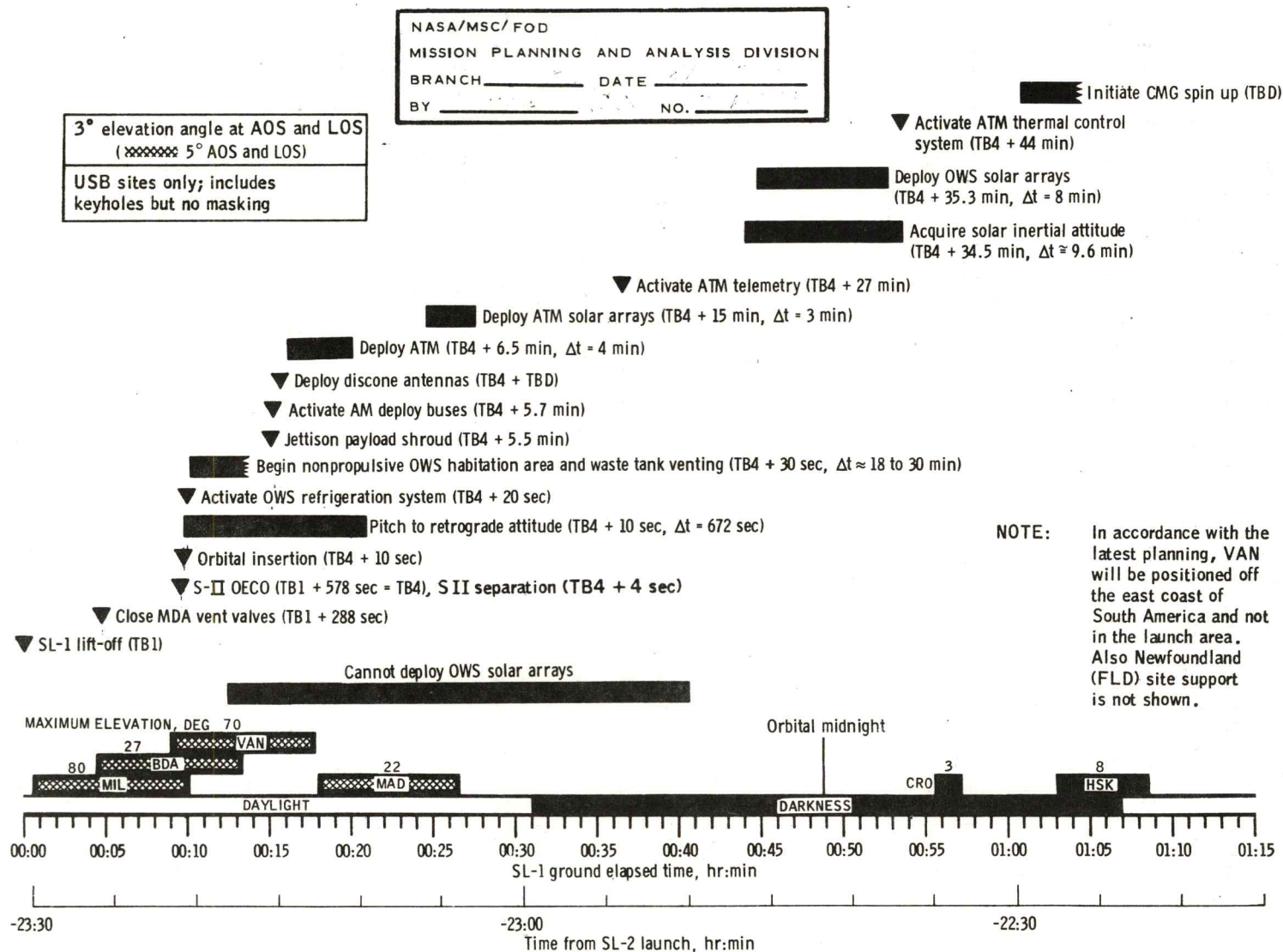
deployed. The OWS solar array will then be deployed, and activation of the control moment gyro subsystem (CMGS) will begin. (Maximum total time to reach full speed is 9 hours; time to reach 90 percent full speed is 7 hours.) The ATM thermal control system will be activated, and the meteoroid shield will be deployed. Also, the MDA/AM and the OWS will be vented to 1.3 psia  $N_2$  and repressurized with  $O_2$  to a total pressure of 5.0 psia.

A Space Flight Tracking and Data Network (STDN) tracking and lighting timeline, including the activation sequence from SL-1 launch through SL-2 launch is shown in Figures 2-2 and 2-3.

### 2.3.3 SL-2 Launch Through SWS Manned Activation

The SL-2 manned CSM will be launched in a northerly direction from LC-39B approximately 23.5 hours after the SL-1 SWS launch. The CSM will be inserted into an 81 by 120 n.mi. orbit. Then, the service propulsion system (SPS) and the service module reaction control system (RCS) will be used to complete the CSM rendezvous maneuvers and to dock with the SWS at the axial port of the MDA. The rendezvous timeline and ground track are shown in Figures 2-4 and 2-5, respectively. A rendezvous maneuver summary is shown in Figure 2-6. SWS entry and activation is scheduled with the crew in shirtsleeves. Initial activation is scheduled from 09:45 ground elapsed time (GET) to 13:30 GET, followed by a crew sleep period, and completed during 25:00 to 26:30 GET. Detailed procedures for SWS activation may be found in the ATM and MDA/AM/OWS Skylab Operations Handbooks, but major activation tasks include:

- A. Opening the MDA hatch and storing it
- B. Turning on MDA and AM interior lights and doing a visual inspection



NOTE: In accordance with the latest planning, VAN will be positioned off the east coast of South America and not in the launch area. Also Newfoundland (FLD) site support is not shown.

Figure 2-2.- SL-1 timeline from insertion through 7 1/2 hours.

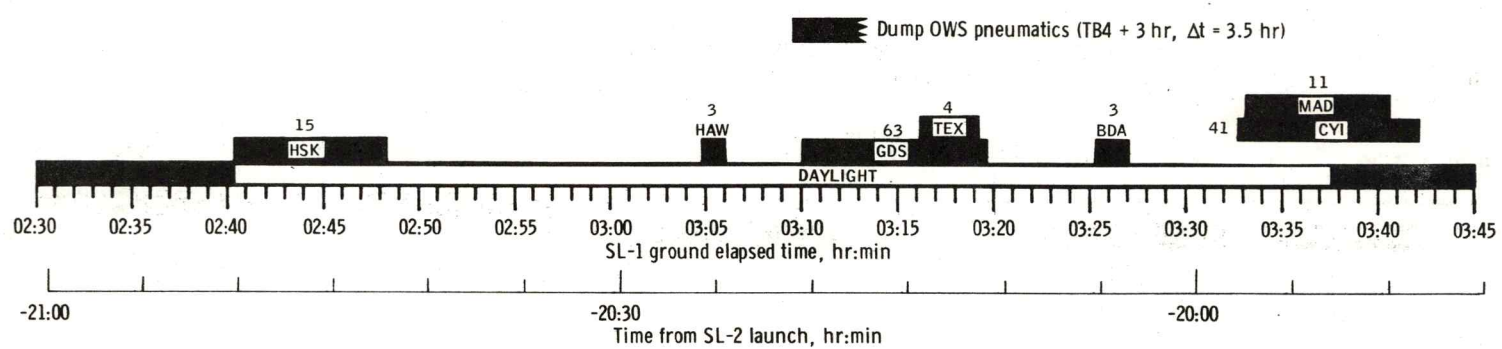
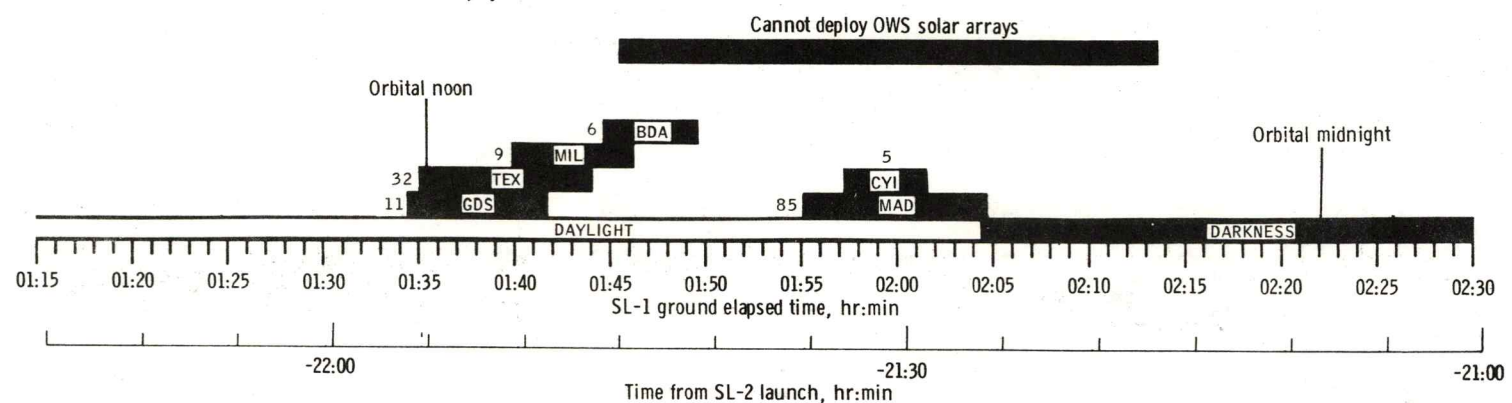


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▼ Deactivate AM deploy buses (TB4 + 1.5 hr)

▼ Deploy meteoroid shield (TB4 + 86 min)



(b) 1 hour and 15 minutes through 3 hours and 45 minutes.

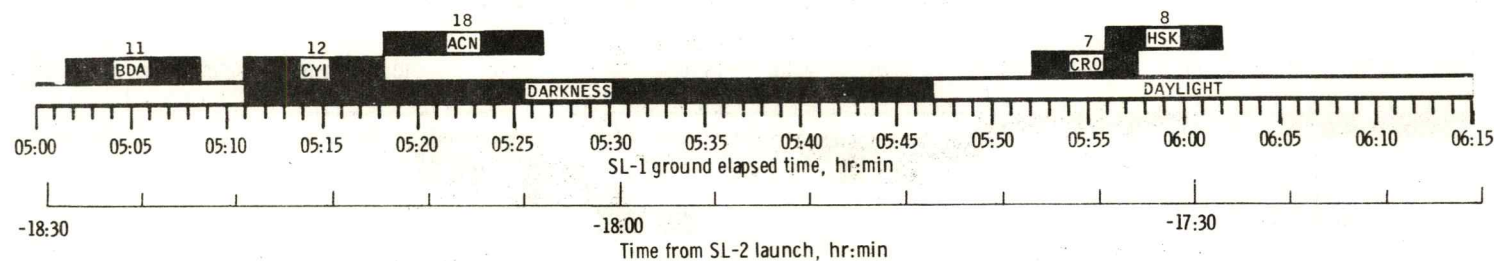
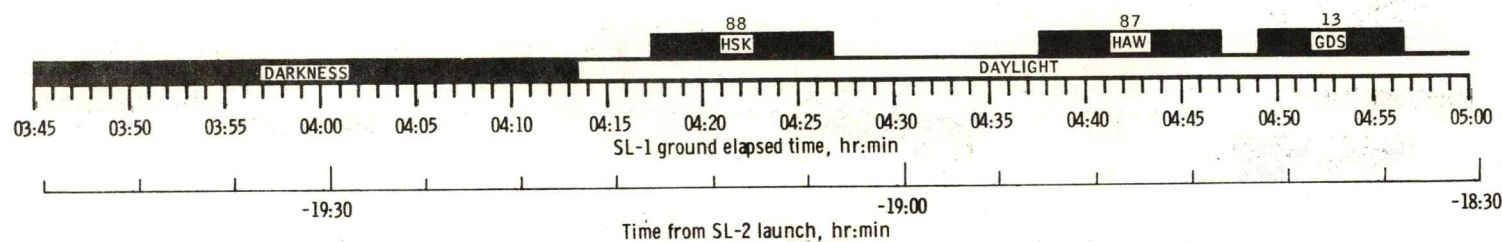
Figure 2-2.- SL-1 timeline from insertion through 7 1/2 hours - Continued.

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(c) 3 hours and 45 minutes through 6 hours and 15 minutes.

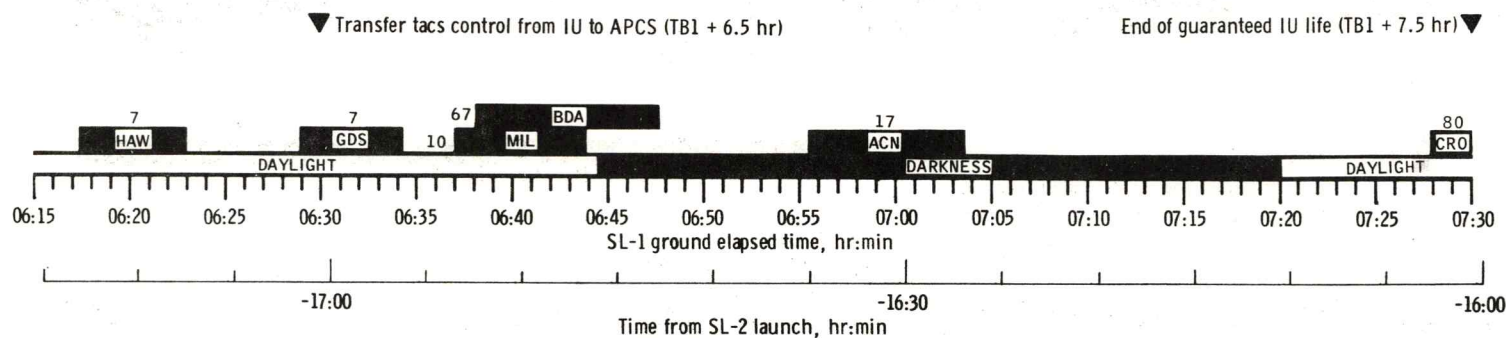
Figure 2-2.- SL-1 timeline from insertion through 7 1/2 hours - Continued.

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(d) 6 hours and 15 minutes through 7 hours and 30 minutes.

Figure 2-2.- SL-1 timeline from insertion through 7 1/2 hours - Concluded.

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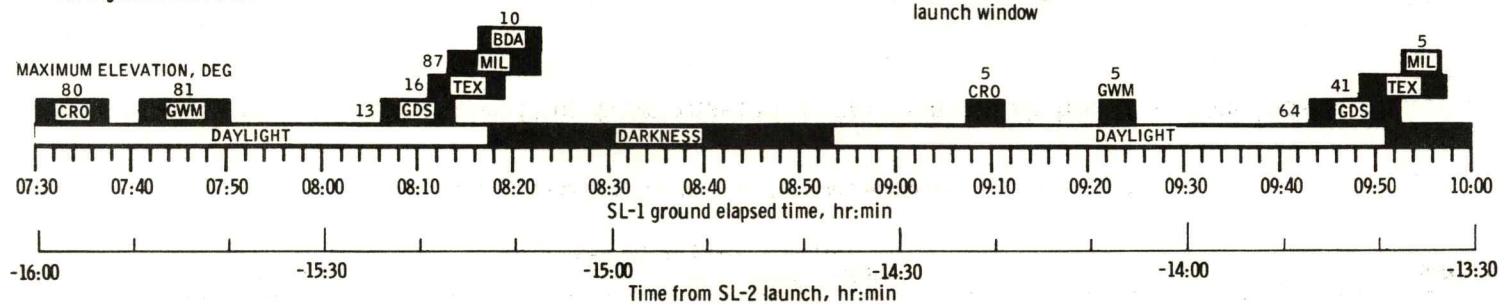
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**3° elevation angle at AOS and LOS**

USB sites only

▼End of guaranteed IU life

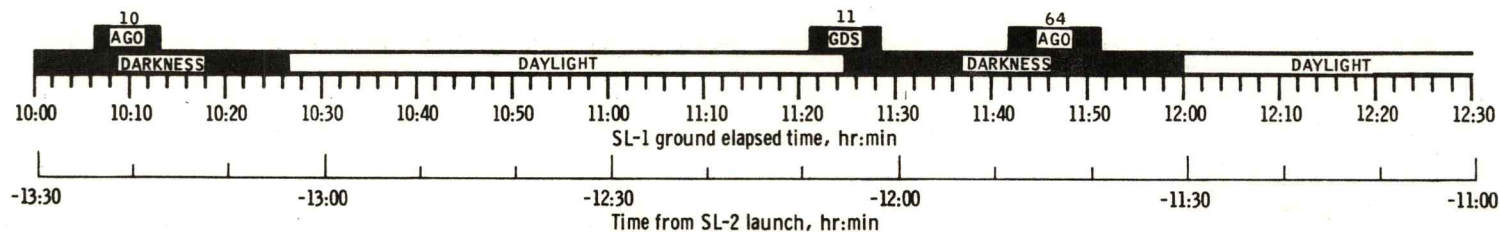
▼ Send rev 6 BDA vector  
update SL-2 targets and  
launch window



▼ Transmit TTY containing RCA 110 target load and preliminary launch window for SL-2

▼ Confirm launch vehicle performance

Send PFA, TPF,  $\Delta V P$



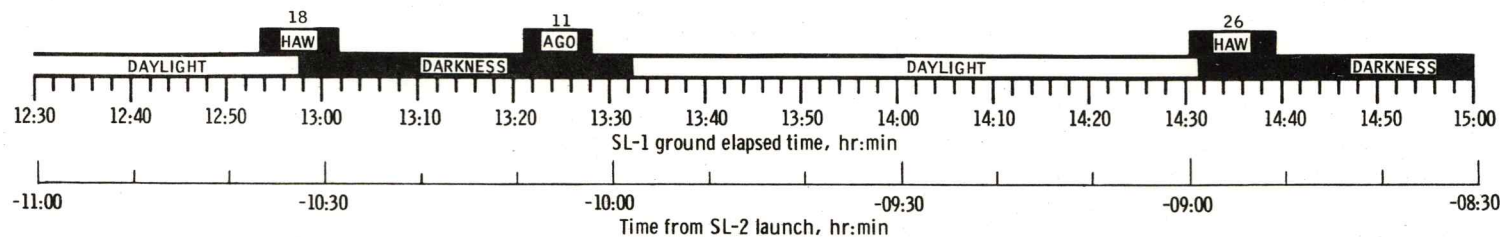
(a) 7 hours and 30 minutes through 12 hours and 30 minutes.

Figure 2-3.- SL-1 timeline from 7 1/2 hours through time of SL-2 launch.

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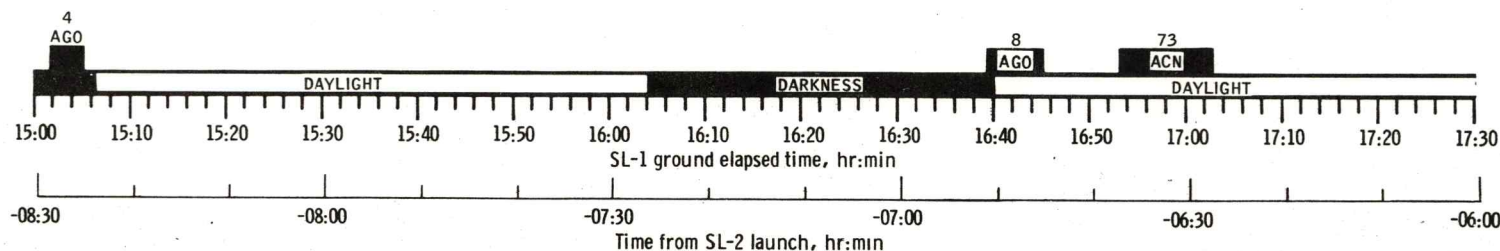
Send PFA, TPF, ΔVP  
(As many iterations as required)

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▼ MSC loads LVDC  
via DCS

▼ Sector dump of target load



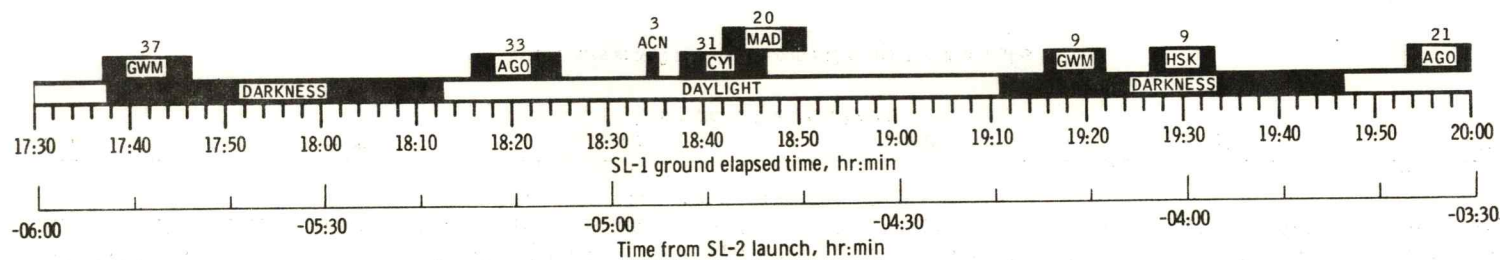
(b) 12 hours and 30 minutes through 17 hours and 30 minutes.

Figure 2-3.- SL-1 timeline from 7 1/2 hours through time of SL-2 launch - Continued.

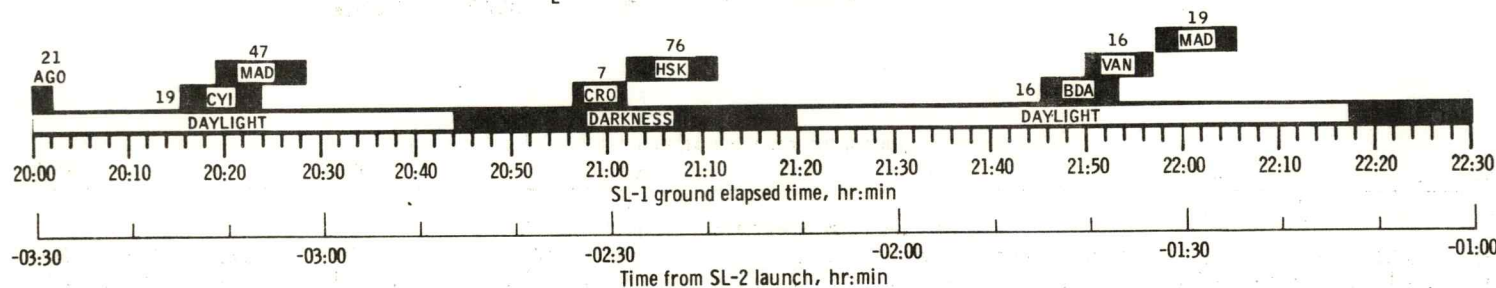
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▼ Adjust  $T_L$



(c) 17 hours and 30 minutes through 22 hours and 30 minutes.

Figure 2-3.- SL-1 timeline from 7 1/2 hours through time of SL-2 launch - Continued.

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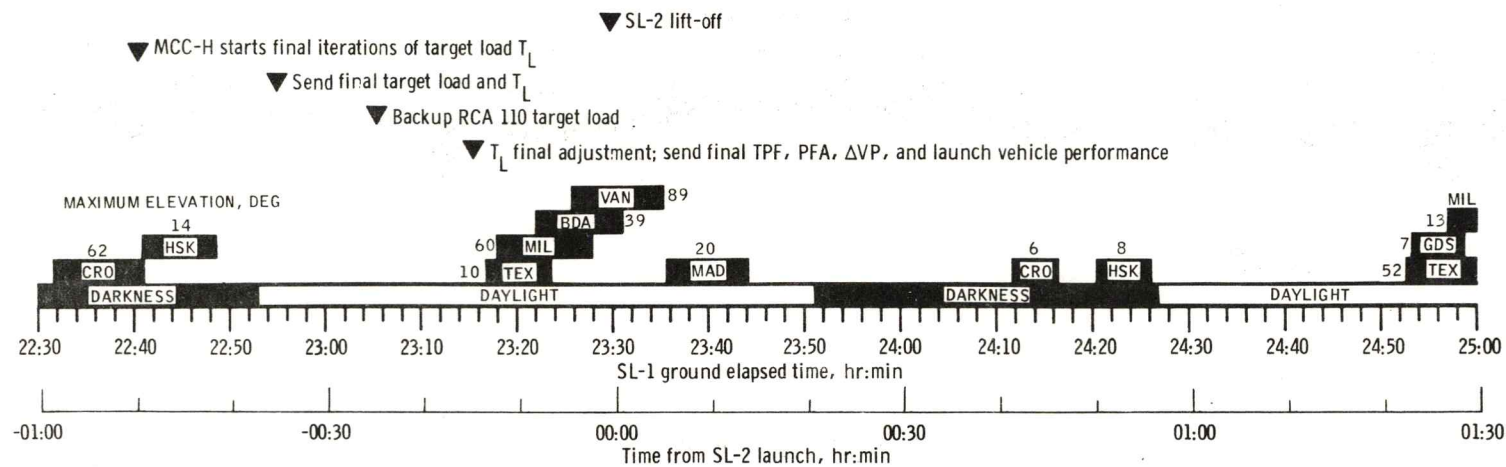
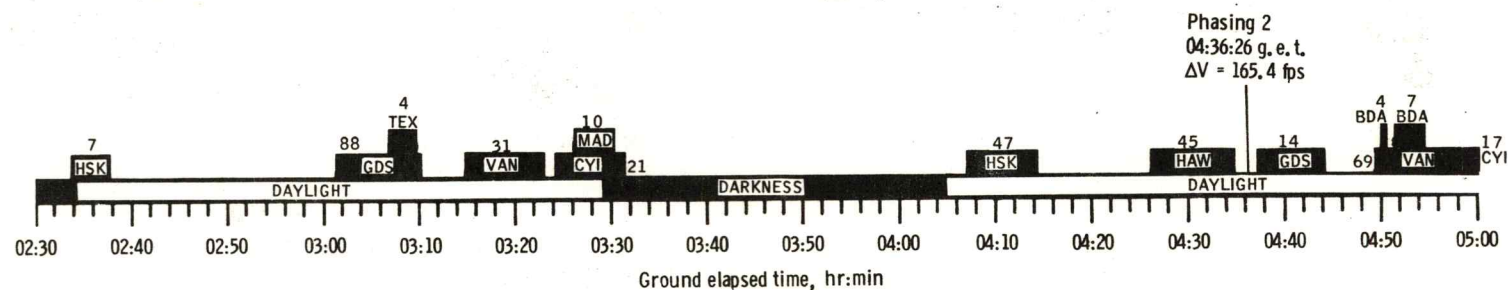
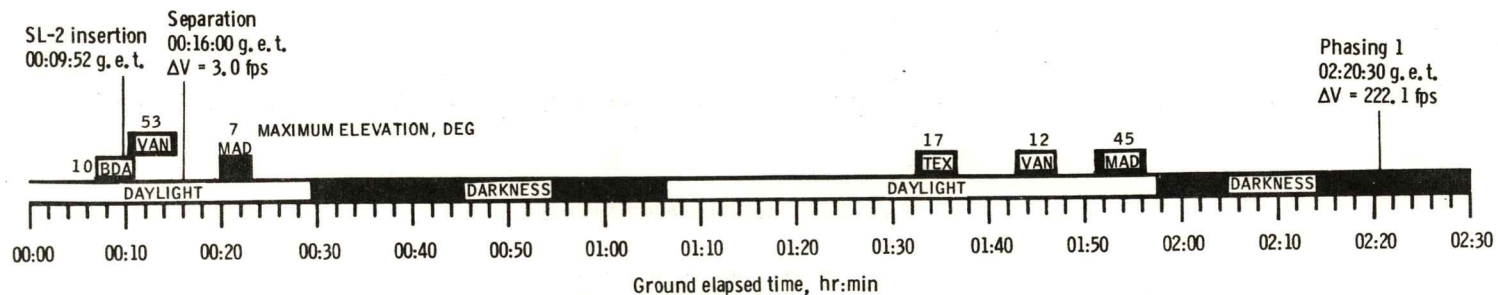


Figure 2-3.- SL-1 timeline from 7 1/2 hours through time of SL-2 launch - Concluded.

3° elevation angle at AOS and LOS  
USB sites only

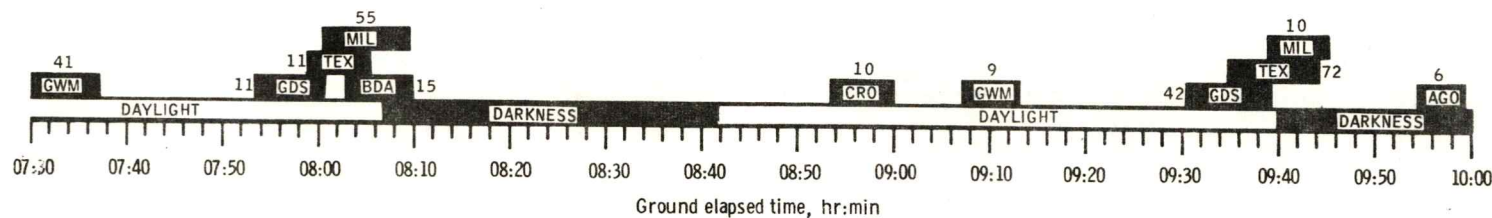
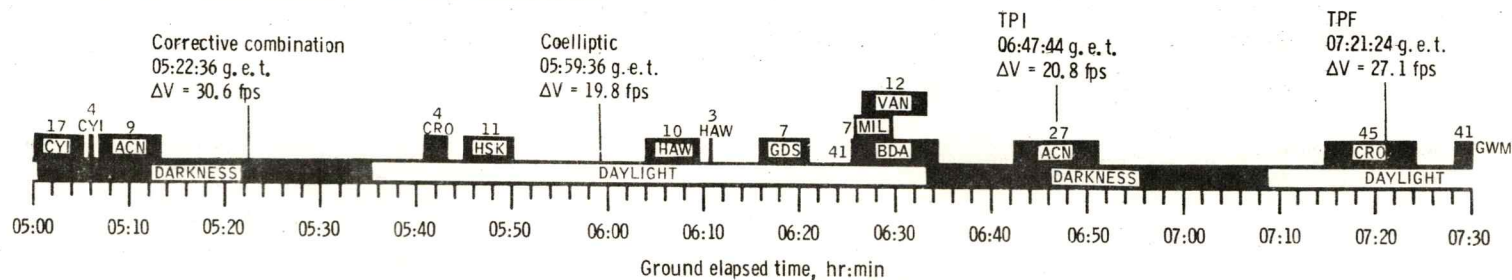
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(a) Lift-off through 5 hours

Figure 2-4.- SL-2 timeline from insertion through rendezvous.

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(b) 5 hours through 10 hours

Figure 2-4.- SL-2 timeline from insertion through rendezvous - Concluded.

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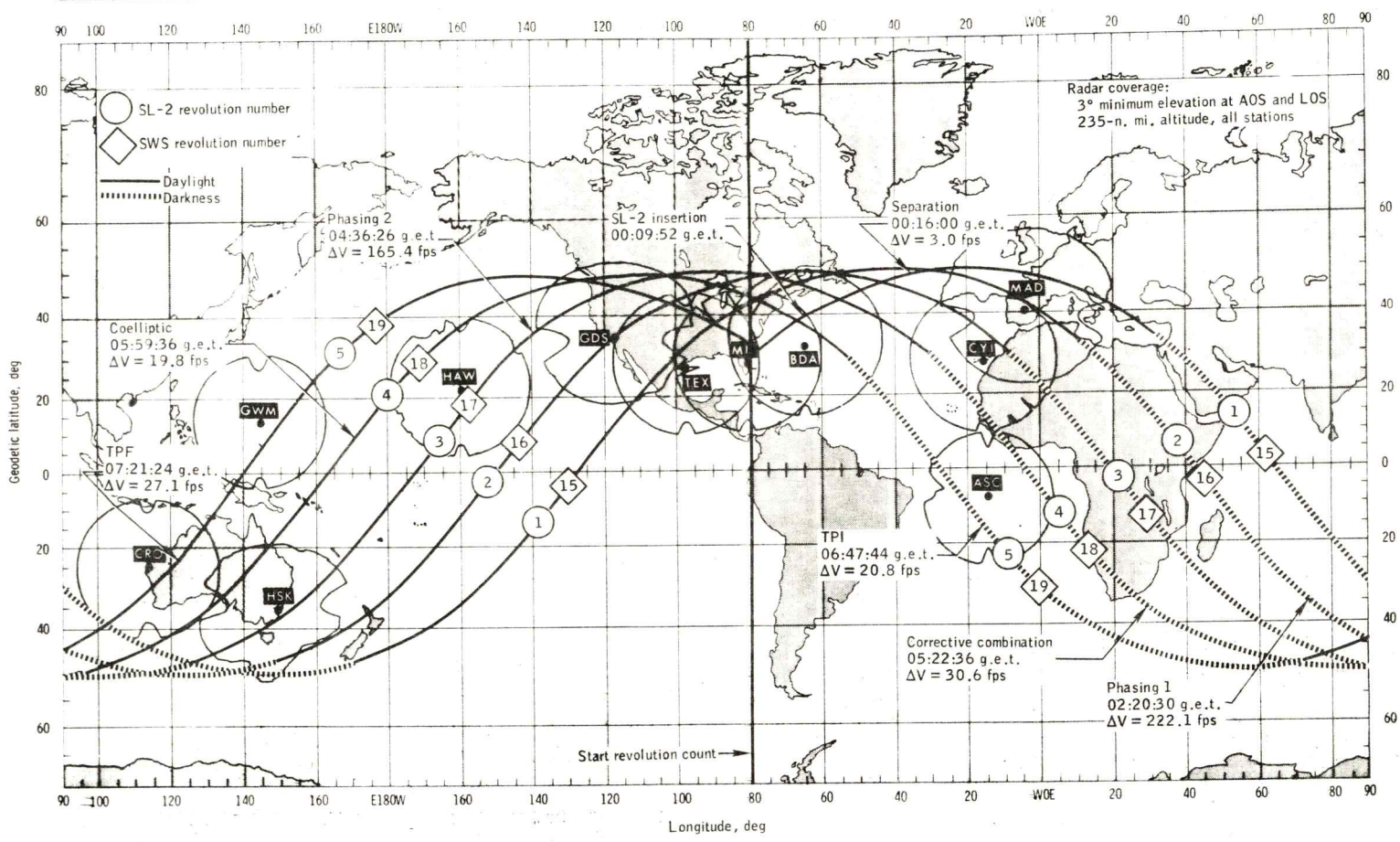
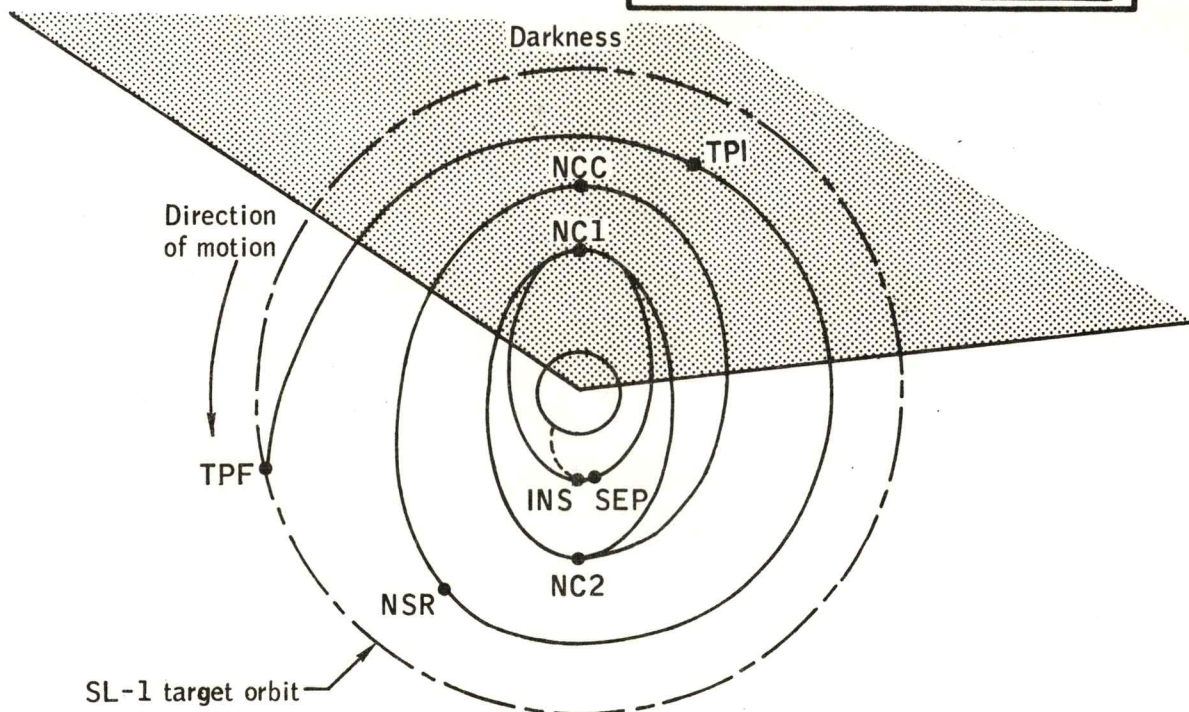


Figure 2-5.- SL-2 ground traces from insertion through rendezvous.

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		Time, g.e.t., hr:min:sec	$\Delta V$ , fps	Resultant perigee/apogee, n. mi.
INS	Insertion	0:09:52		81/120
SEP	Separation	0:16:00	3.0	81/121
NC1	Phasing 1	2:20:30	222.1	121/207
NPC	Plane change	Plane change, if necessary, occurs at node between NC1 and NC2.		
NC2	Phasing 2	4:36:26	165.4	206/216
NCC	Corrective combination	5:22:36	30.6	215/225
NSR	Coelliptic	5:59:36	19.8	225/226
TPI	Terminal phase initiation	6:47:44	20.8	227/236
TPF	Terminal phase finalization	7:21:24	27.1	234/235

Figure 2-6.- SL-1/SL-2 rendezvous orbital geometry.

- C. Connecting CSM/MDA power and communications umbilical
- D. Activating molecular sieves
- E. Verifying the ECS control system
- F. Activating the star tracker
- G. Activating the ATM controls and displays (C&D) system
- H. Activating the caution and warning (C&W) system
- I. Equalizing AM/OWS pressure, opening/stowing OWS hatch
- J. Processing and stowing M071 and M073 urine samples in freezer
- K. Activating food and water management systems

#### 2.3.4 SL-1/SL-2 Manned Orbital Phase

Following activation, the mission operation will settle down into a routine of experiments operation, and systems house-keeping. As indicated earlier, the SL-2 mission will be devoted primarily to accomplishing a series of medical experiments related to the extension of manned space flight. In addition, the mission will have objectives associated with solar astronomy, earth resources, and technical experiments. The SL-1/SL-2 mission is planned for a duration of 28 days from the launch of the SL-2 CSM.

For Skylab, the crew duty day is between 6 a.m. and 10 p.m. Central Standard Time. Each crewman is scheduled for 8 hours of sleep each day, three 1-hour eat periods each day, and 1 day off each week. Crew status reports will be voiced to the ground each morning. At the conclusion of each crew day, two crewmen are scheduled for simultaneous mission planning and off-duty periods (1 hour). One crewman will delete planning and off-duty periods each day to increase ATM viewing time.



One extravehicular activity is scheduled for SL-2 for ATM film retrieval and D021/D024 support. This will occur on about day 26, and will be scheduled for a maximum of 3 hours from egress to ingress.

A reentry simulation (dress rehearsal) is scheduled for the latter part of SL-2. This will consist primarily of a talk-through and will include exercising the guidance and navigation (G&N) sequence and data flow (reentry PAD uplink) with nominal remote site coverage.

#### 2.3.5 SWS Deactivation and SL-2 Entry Phase

After completion of the scheduled detailed objectives, the SWS will be deactivated in preparation for orbital stowage. The nominal SWS deactivation operation and transfer and stowage of return items in the command module (CM) will take place along with the normal activities during the last 3 days of the mission. The crew will deactivate the OWS, including such tasks as securing food and water management areas; turning off crew-quarters area fans, heater, and circulating fans; configuring the power distribution and control panel; and deactivating the environmental control system (ECS) in the OWS and aft AM. They will also deactivate the MDA/AM, which includes such tasks as deactivating the MDA/STS ECS; configuring the structural transition system (STS) power control panel and ATM command and display console; disconnecting the CM/MDA power control umbilical and ECS duct; and reinstalling the drogue and probe and CM tunnel hatch. The CSM will undock from the SWS and perform a fly-around of the SWS to visually inspect and take photographs prior to deorbit.

Deorbit will be performed using the SM SPS with the SM RCS held in reserve as a backup. The SPS retrofire will be

performed in two stages with approximately two orbits separating the two SPS burns. The primary advantages of a two-stage deorbit are:

- A. Two burns are more efficient if the SPS fails and the RCS must be used.
- B. The probability of a quad failure caused by overheating is less probable.
- C. One landing area to be used for both nominal (SPS) and backup (RCS) deorbit.

One landing area enhances rapid recovery of the crew as well as successful retrieval of the experiments data, especially the biomedical data. It is desirable to recover all biomedical data, as well as the crew, as quickly as possible.

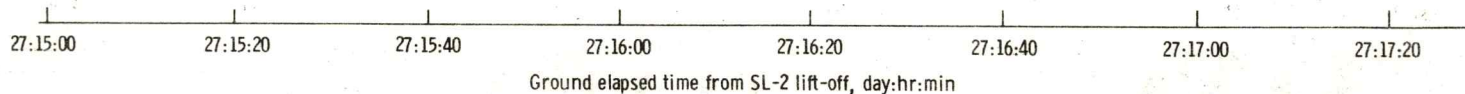
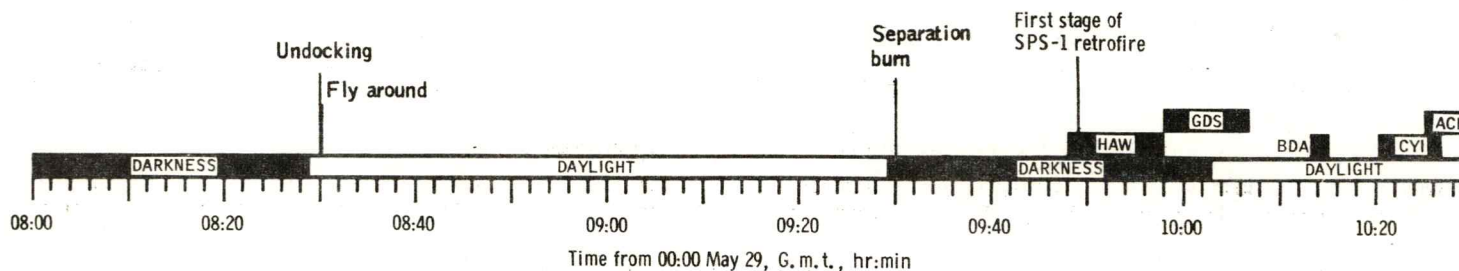
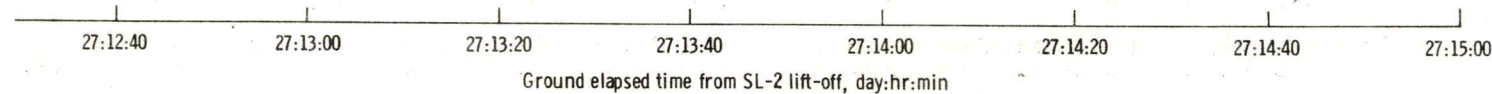
The entry phase of the mission will start at a 400,000-foot altitude (entry interface) and continue until drogue parachute deployment at a 23,300-foot altitude. Assuming planned mission duration and deorbit, recovery will occur in daylight in the West Atlantic recovery area. The entry timeline is shown in Figure 2-7, and the ground track is shown in Figure 2-8.

#### 2.3.6 SL-3 Mission

The SL-3 manned CSM mission will be launched in northerly direction on a Saturn IB vehicle from LC-39B. The SL-3 launch will occur approximately 88 days (as dictated by launch and recovery lighting considerations) after the SL-2 launch. The mission will accomplish medical, technical, and scientific experiments (see Table 2-I) and will be planned for a duration of up to 56 days from launch.

The CSM rendezvous profile, SWS activation, SWS deactivation, SWS storage, and CSM deorbit and recovery will be similar to

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(a) 5 hours 30 minutes to 10 hours 30 minutes.

Figure 2-7.- End of mission sequence for SL-2 SPS deorbit.

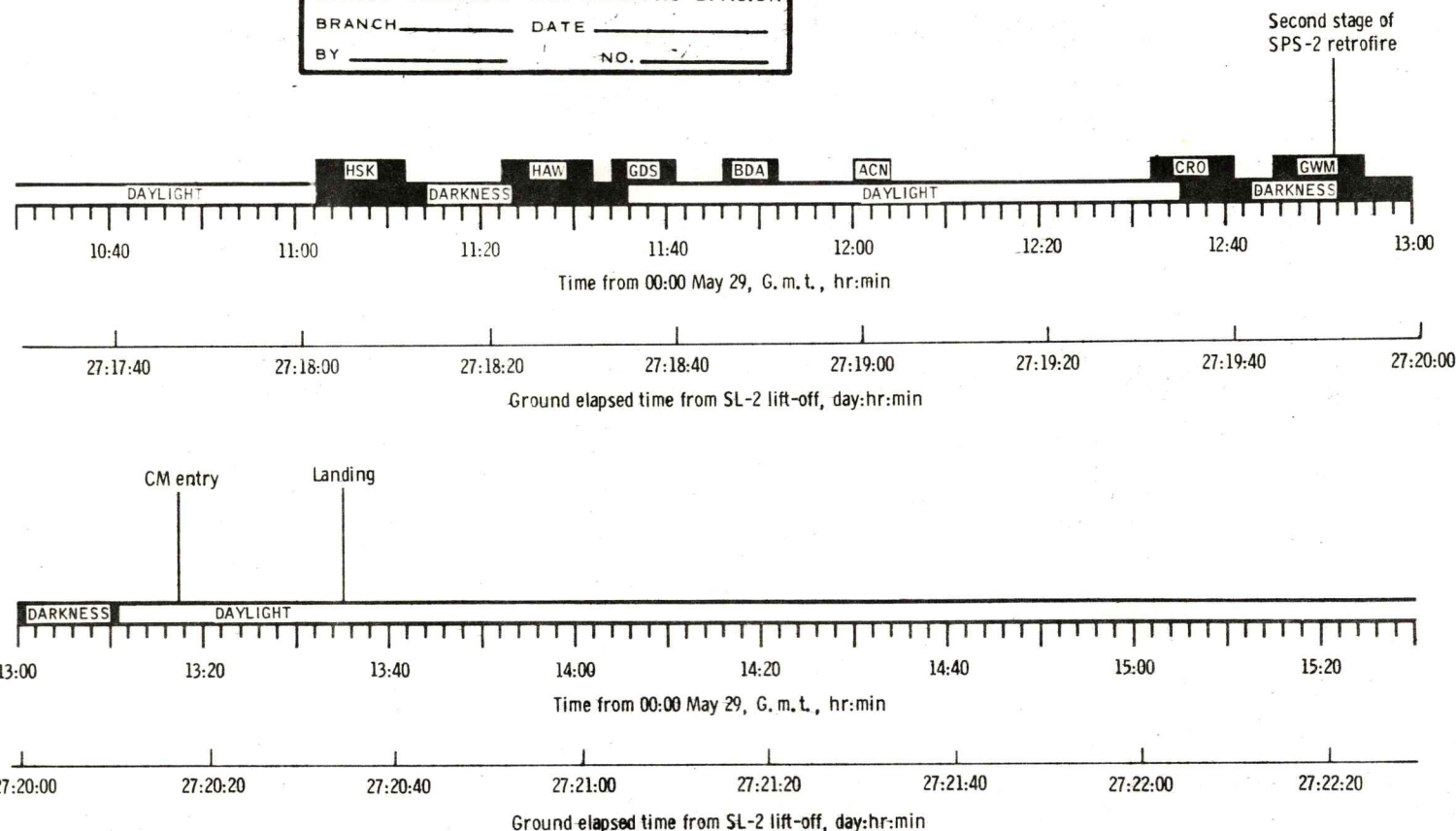
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(b) 10 hours 30 minutes to 15 hours 30 minutes.

Figure 2-7.- End of mission sequence for SL-2 SPS deorbit - Concluded.

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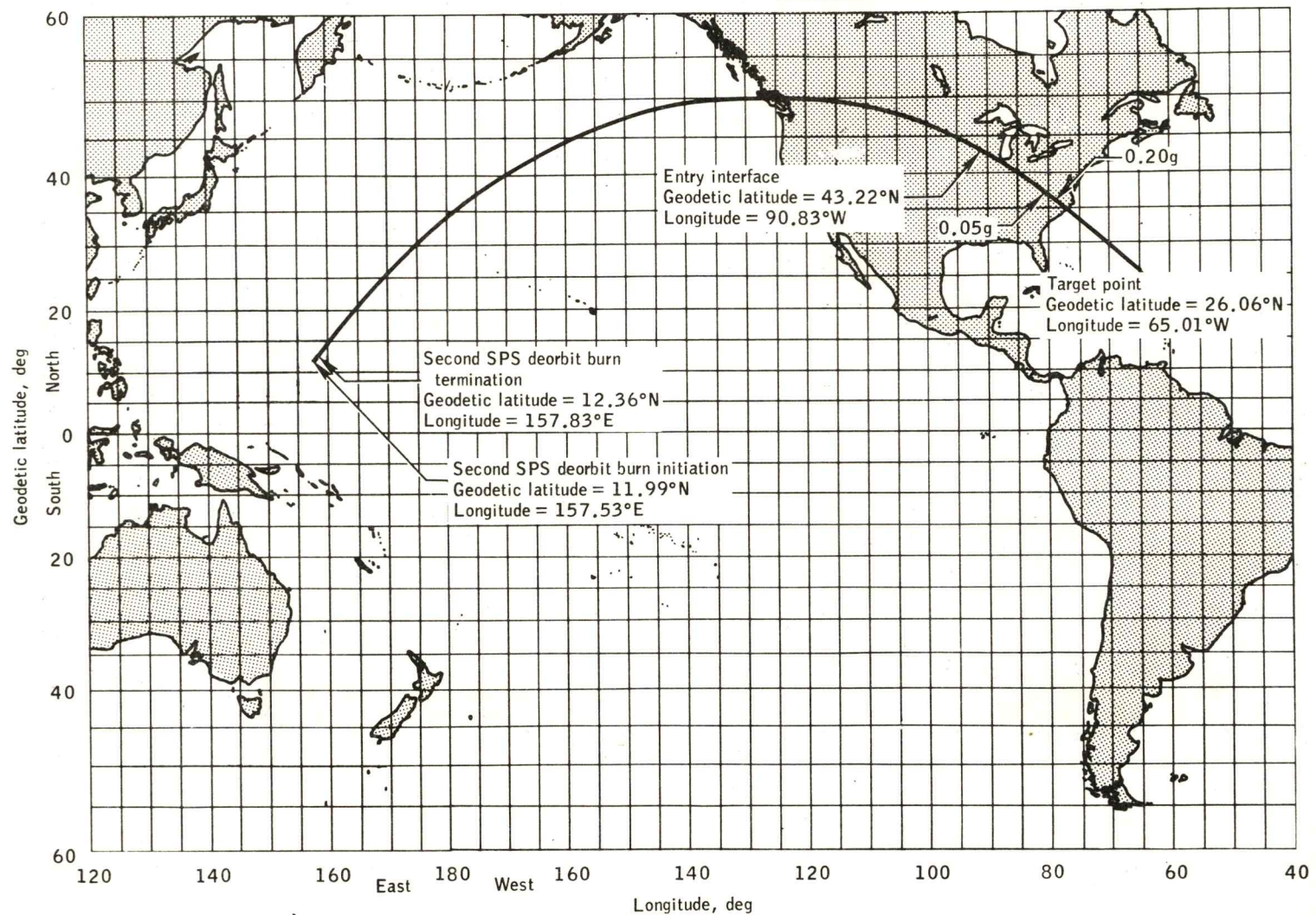


Figure 2-8.- Skylab 2 entry ground trace for an SPS deorbit maneuver.

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The first manned (SL-2) mission. Assuming planned mission duration and deorbit, recovery will occur in daylight in the Atlantic recovery area.

#### 2.3.7 SL-4 Mission

The SL-4 manned CSM revisit mission will be launched and will perform a rendezvous with the SWS similar to the SL-2 and SL-3 vehicles. The SL-4 launch will occur approximately 96 days (as dictated by launch and recovery lighting considerations) after the SL-3 launch. The mission will be primarily directed toward the accomplishment of technical and scientific experiments and will be planned for a duration of up to 56 days. (See Table 2-I for experiment assignments.) Assuming planned mission duration and deorbit, recovery will occur in daylight in the Mid-Pacific recovery area.

#### 2.3.8 Unmanned Periods

The unmanned periods are defined as those periods of time the SWS is unmanned, that is, between SL-2 undocking and SL-3 launch (approximately 56 days) and between SL-3 undocking and SL-4 launch (approximately 40 days). During these periods the SWS systems will be monitored on a routine basis, and limited operation of some of the experiments will be performed. These include ATM experiments S052, S054, and S055, and experiment S149 on the OWS. See Paragraph 3.10 for details of the unmanned period operations.

#### 2.3.9 Orbital Lifetime Considerations

Orbital decay studies performed by the Marshall Space Flight Center (MSFC) for Skylab orbital elements using the nominal,



and plus and minus two sigma predictions of sunspot number (which affects atmospheric density) show the following:

SKYLAB CLUSTER

<u>Density</u>	<u>Orbital lifetime</u>
Plus two sigma	1400 days
Nominal	2050 days
Minus two sigma	4060 days

S-II STAGE

<u>Density</u>	<u>Orbital lifetime</u>
Plus two sigma	200 days
Nominal	295 days
Minus two sigma	450 days

S-IVB STAGE (SL-2 launch date: 5/7/73)

<u>Density</u>	<u>Orbital lifetime</u>
Plus two sigma	21.6 hours
Nominal	23.1 hours
Minus two sigma	24.8 hours

PAYLOAD SHROUD

<u>Density</u>	<u>Posigrade segments lifetime</u>	<u>Retrograde segments lifetime</u>
Plus two sigma	730 days	540 days
Nominal	1100 days	820 days
Minus two sigma	1640 days	1180 days

Upon SL-4 mission completion, the SWS will be left in the solar inertial attitude, with plans for its further use presently undefined. In all likelihood, however, continual operation of the ATM experiments will be planned for this period, systems permitting. Engineering data on long-term use of the attitude pointing and control subsystem (APCS), CMG's and solar panels



will also be of interest to the MSFC design engineers. According to the Cluster Requirements Specification Document, the functional lifetime of the SWS (OWS/MDA/AM/ATM) will be 8 months.

## 2.4 RESCUE MISSION PLAN

### 2.4.1 Basics

A rescue mission plan has formally been baselined for the Skylab program. Overall mission planning for rescue is based on a minimal impact on existing flight hardware, training, and facilities. The primary objective of this capability is the safe return of the crew.

The rescue plan will be implemented only if circumstances occur which result in loss of CSM capability to safely return the Skylab crew to earth. The plan hinges on use of the OA as a shelter for the stranded crew until another CSM and Saturn launch vehicle (SLV) can be readied for flight. If rescue is deemed necessary for SL-2 or SL-3, the next-in-line CSM will be fitted with a special kit and flown as the rescue vehicle. For SL-4 rescue, a spare launch vehicle and CSM will be available.

The rescue vehicle will consist of a CSM modified to permit launch and mission operations with two crewmen and a return to earth with five crewmen. Modifications to the CSM will be made to the crew couch, attenuation systems, stowage, and environmental control and communications systems. During launch of the rescue vehicle, ballast will be carried in the empty couch and will be transferred to the OWS after docking. Present plans call for the two CSM's to time share the S-band communications link to the ground and to use very high frequency (VHF) for voice communications between vehicles.

Special provisions are also being made on the OWS to furnish uplink and downlink communications with the Skylab crew in case of total CSM communications failure. Existing VHF and teleprinter systems on the OWS will be used for this purpose through suitable modifications.

#### 2.4.2 Rescue Response Time

Rescue response time will be a function of the degree of pre-launch preparation of the next-in-line booster and spacecraft at the onset of the rescue situation. Launch preparation of the next vehicle shall continue normally until a decision is made to commit to the CSM rescue mission. Then the CSM will be modified and the total systems preparation will be accelerated. KSC has estimated the time to launch readiness after committing to rescue in the table below.

<u>Days into mission at contingency onset</u>	<u>Days to rescue launch</u>
0	48
14	34
28	26 1/2
42	16
56	10

#### 2.4.3 Mission Profile

After completion of launch readiness, the launch opportunity will be selected for proper conditions to minimize the time from launch to rendezvous. Trajectory planning for launch through insertion will be similar to that planned for the nominal mission. Total rescue mission duration will be limited to 5 days from launch to recovery. During rendezvous operations, the OA shall be maneuvered to the Z-axis parallel to local vertical (Rendezvous mode) [Z-LV(R)] attitude to

provide acquisition light support to the rescue CSM during rendezvous. Rescue CSM docking may be accomplished at the MDA radial port. Docking may take place at the axial port if the disabled CSM is jettisoned. A capability for jettison of the disabled CSM is being developed. Post-docking attitude control will be maintained by the APCS. The maximum CSM on-station stay time at the radial port is limited to 15 hours because of thermal constraints.

After committing to rescue and before rescue docking, the Skylab mission timeline will be replanned to optimize the scientific data return. An effort is now being made to prioritize the experimental data which will be transferred to the rescue CSM and returned to earth consistent with time constraints and stowage/weight capability of the rescue vehicle. Circumstances permitting, the SWS will be deactivated and prepared for nominal revisit prior to crew departure.

## 2.5 SKYLAB BACKUP MISSION

A backup SL-1 mission is planned for Skylab. This mission will be flown if, during the first 5 months of the Skylab program, a failure occurs which would preclude completion of the program.

The backup PS/MDA/AM/OWS will be shipped to KSC after manufacturing verification. After the SL-1 launch, KSC will start processing these modules to incorporate acceptance checkout requirements into the normal prelaunch checkout. The backup ATM will undergo normal acceptance checkout before delivery to KSC.

The processing rate will allow the backup SL-1 launch to be scheduled 10 months after the nominal SL-1 launch. If at the end of 5 months no need has been established for the backup mission, the hardware will be placed in storage.



3 MISSION  
CONTROL



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SECTION 3  
MISSION CONTROL

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3.1 GENERAL

The Flight Operations Director (FOD) is responsible for all operational aspects of Skylab spaceflight missions and provides the management interface between the Flight Director and Program Management. Direct responsibility for mission control, however, will be vested in the Flight Director at the Mission Control Center (MCC) throughout the mission. Flight control functions will be effected by flight controllers at the MCC utilizing the remote sites of the STDN. Mission control will be accomplished by providing in-flight analysis of the mission (mission trajectory, vehicle systems, experiment systems, scientific data, and flight plan) and by controlling the progress of the in-flight phase of the mission through the utilization of voice, telemetry, tracking, and update capabilities remoted from the MCC and STDN facilities.

The general mission control functions to be accomplished by flight controllers are as follows:

- A. Monitor and evaluate, in real and delayed time, the vehicle systems, experiment systems, scientific data, and trajectory data. Based upon these data, decisions will be made concerning the progress of the mission toward satisfying primary mission objectives and mandatory, principal, and secondary detailed test objectives (DTO's) and the need for proceeding to alternate flight plans, contingency plans, or mission aborts.
- B. Monitor and evaluate the condition of the flight crew. Based upon these data, decisions affecting crew health and safety will be made.

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- C. Perform ephemeris and maneuver updating in real time. Updated information will be passed to the spacecraft via the up-data link and voice from the MCC.
- D. Monitor, evaluate, and update flight plan activity, including experimental tasks, work/rest cycles, equipment checks, et cetera. Decisions to alter flight plan activity will be based upon such factors as crew status, spacecraft status, experiment status, STDN status, weather, et cetera.
- E. Advise the flight crew of updated mission instructions, anomalies in spacecraft systems found during ground monitoring, ground evaluation and recommendations to solve or circumvent any spacecraft anomalies, and recovery-area weather conditions.

In addition to these general functions, the specific flight control functions and responsibilities which will be carried out during the following mission phases are outlined as follows:

- A. Prelaunch test
- B. Countdown
- C. Unmanned launch
- D. Initial SWS activation
- E. Manned launch
- F. Rendezvous and activation
- G. Manned orbital operations
- H. Deactivation and entry
- I. Unmanned operations

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## 3.2 PRELAUNCH TEST

### 3.2.1 SL-1 Prelaunch Tests

Prelaunch testing of the Saturn V and the SWS will follow the same general guidelines used throughout the Apollo Program. A telemetry-data-flow test will be run prior to any direct MCC support of the space vehicle. This data-flow test may use the operational telemetry downlinks from the ATM and the AM/OWS as data sources. These data will be played through the STDN telemetry processing and display systems to verify that they are compatible with the flight telemetry.

The first test in which the MCC will directly interface with each vehicle/module [i.e., launch vehicle (LV), ATM, and AM] will be an MCC command interface test to verify that MCC commands produce the correct vehicle responses and that the proper indications are downlinked in the telemetry bit stream. For SL-1 this test will be followed by a simulation of the SWS mission, consisting of normal mission activities including SWS launch, activation, normal manned operations, and deactivation. A second MCC command interface test with each vehicle will be conducted as close to launch as possible to serve as a final interface verification, including all late telemetry and command changes to both flight and ground software and hardware.

The MCC will support the space vehicle Flight Readiness Test (FRT) to ensure that both the SL-1 space vehicle and the STDN are in a state of flight readiness. This test will also demonstrate the compatibility of all systems when they are as near as practicable to their launch configuration.

The Countdown Demonstration Test (CDDT) for SL-1 will exercise those procedures necessary to achieve an ontime launch.

Support for this test will be provided to the same degree that the actual countdown will be supported.



### 3.2.2 SL-2, SL-3, and SL-4 Prelaunch Tests

For SL-2, two MCC command interface tests will be conducted with each vehicle (CSM and LV). As with the SWS, this will be the first test in which the MCC will directly interface with each SL-2 vehicle for MCC command and telemetry verification. A second test will be repeated as close to launch as possible to serve as a final interface verification and will include all late telemetry and command changes to both flight and ground hardware and software. The MCC interface tests are required only for the first CSM mission (SL-2) unless telemetry or command changes to either onboard or ground equipment invalidate the test.

For each CSM flight the MCC may support an FRT and will support a CDDT test. The purpose of these tests for the CSM flights is essentially the same as that for the SL-1 flight.

### 3.3 COUNTDOWN

Figure 3-1 illustrates the operational sequence of the SL-1 countdown along with the operational sequence of the SL-2 countdown. The launch countdown may be monitored (voice and telemetry) on a limited basis as early as T-24 hours. However, full MCC support will not be provided until approximately T-6 hours. The SWS telemetry downlink will be active to monitor the functions listed in Table 3-I.

Spacecraft systems checkout will be accomplished by KSC using the automatic checkout equipment (ACE), and the status and gross system appraisal will be relayed to the MSFC and the MCC. This information, coupled with MCC's spacecraft checkout information and network evaluation, will provide the basis for

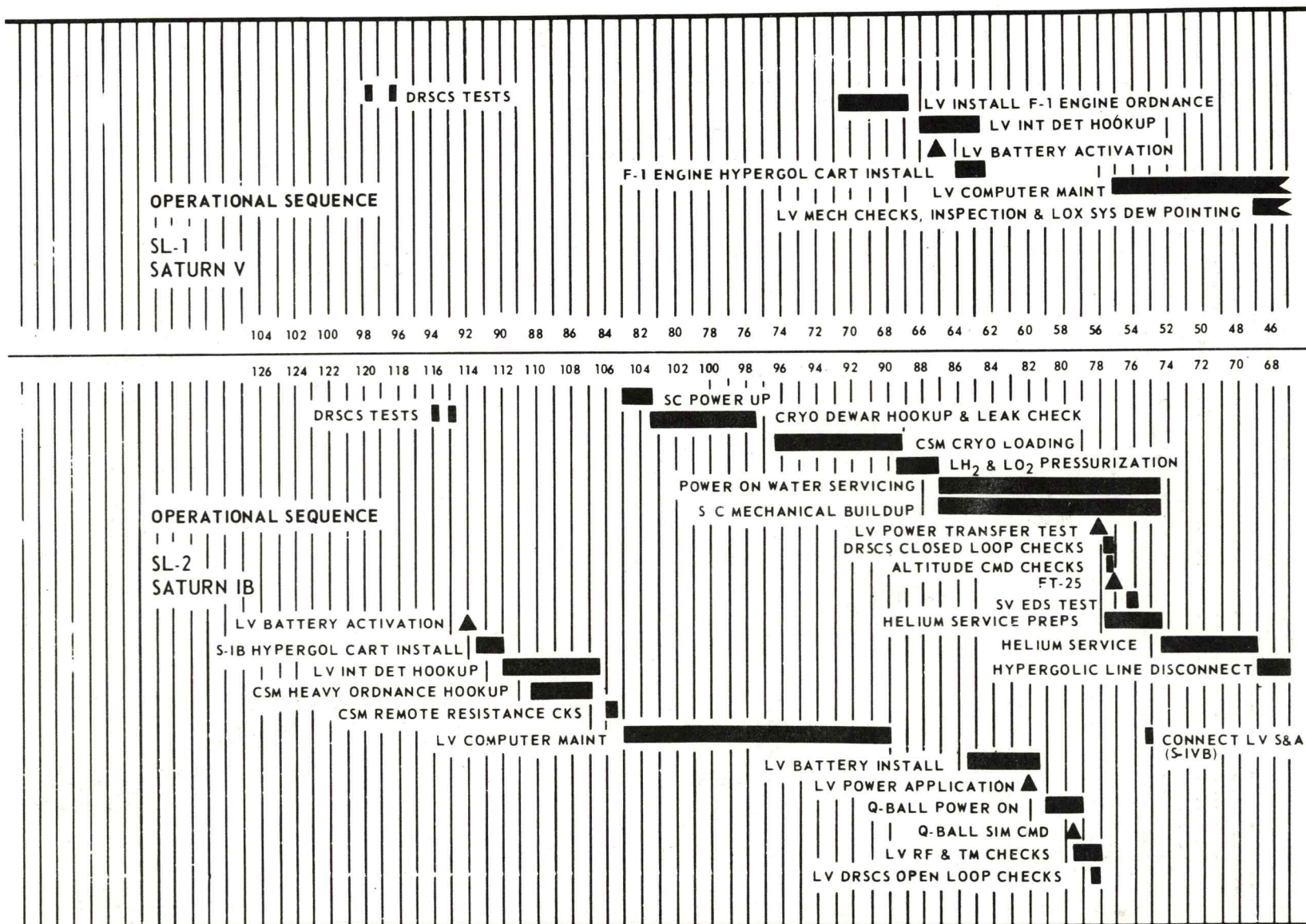


Figure 3-1.- Skylab space vehicle countdowns.



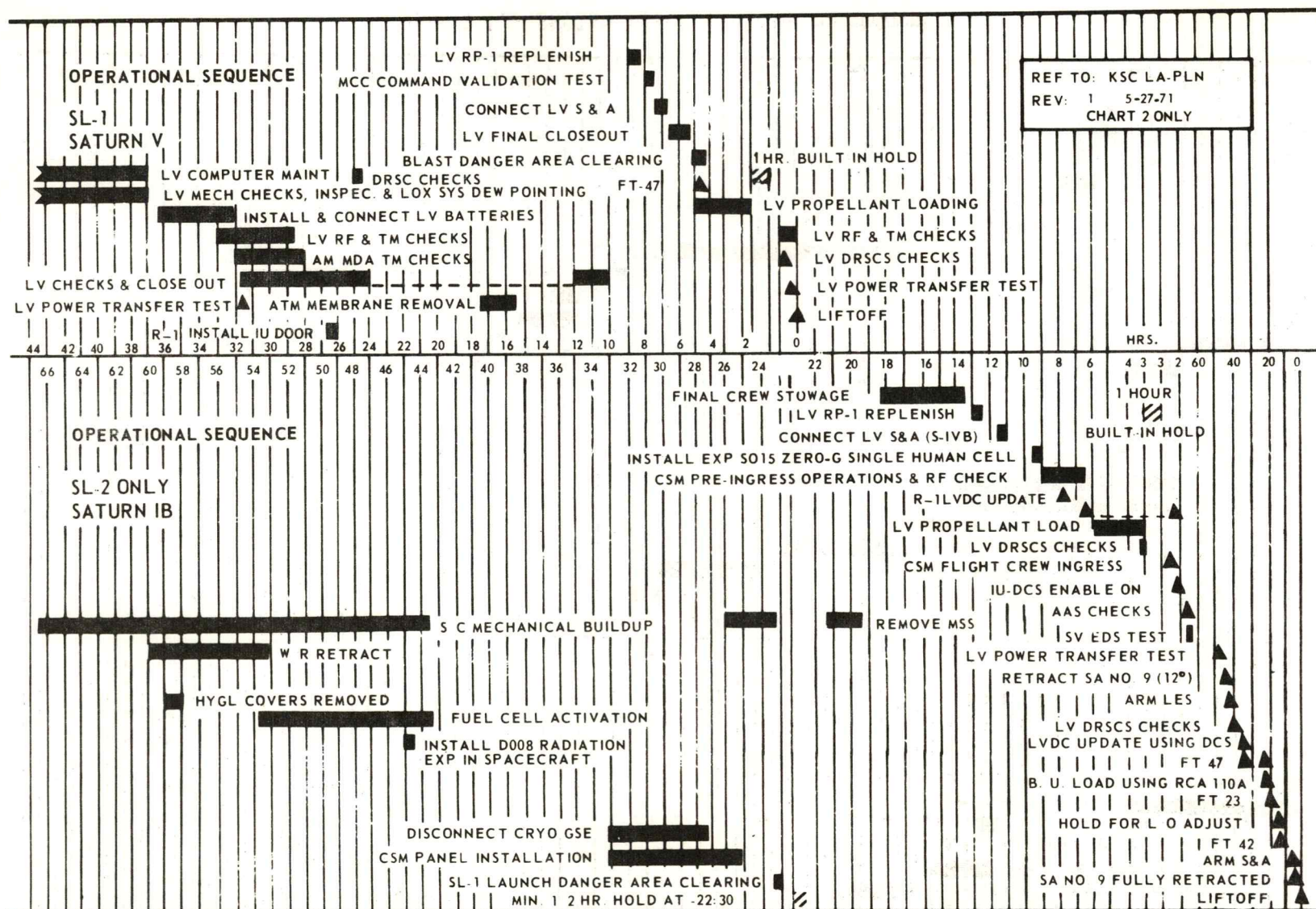


Figure 3-1.- Skylab space vehicle countdowns - Concluded



TABLE 3-I.- SWS COUNTDOWN FUNCTIONS

Function description	Commands used	Telemetry
MDA/AM is pressurized with gaseous N <sub>2</sub> to approximately 5.0 psig. The MDA/AM vent valve is closed. Following the leak check, the MDA/AM is vented to ambient. Test is performed at lift-off minus TBD hours for a minimum duration of 24 hours.	MDA/AM vent valves 1 and 2: power on/off  MDA/AM vent valves 1 and 2: open/close	MDA-vent-valve status  MDA absolute pressure  All compartments, cabin ambient ΔP
MDA/AM is pressurized with gaseous N <sub>2</sub> to 5.0 psig through ground umbilicals. The MDA/AM vent valve is locked shut. Test is performed at lift-off minus 13 hours for a TBD duration.	MDA/AM vent valves 1 and 2: power on/off  MDA/AM vent valves 1 and 2: open/close	MDA-vent-valve status  MDA absolute pressure  All compartments, cabin ambient ΔP
All OWS vent valves are closed. The LH <sub>2</sub> and LOX tanks must be pressurized to 22 psia to enable the physical structure to withstand max dynamic pressure. Function performed at lift-off minus 2 minutes.	GSE hardline	LH <sub>2</sub> tank pressure  LH <sub>2</sub> vent valve close discretes  LOX tank pressure  LOX vent valve close discretes
MDA vent valve is opened to allow internal atmosphere to vent to ambient during launch phase and to reach 5.0 psia (below relief valve cut-off). Function is performed at lift-off minus 5 minutes.	MDA/AM vent valves 1 and 2: power on/off  MDA/AM vent valves 1 and 2: open/close	MDA-vent-valve status  MDA absolute pressure  All compartments, cabin ambient ΔP
The single-pump operation of each AM coolant loop is activated by ground command. Flow will bypass the radiators up until T - 2 minutes. GSE cooling is available. Function is performed at lift-off minus 2 minutes.	Primary coolant pump A: on  Secondary coolant pump A: on	TM temperatures from specific coolant-loop points  ON-OFF discretes for each pump

NOTE: The ground command system will be activated prior to launch. There are hazardous commands associated with the SWS. Therefore, positive ground safeguards will have to be implemented to prevent these commands from being inadvertently transmitted. The management of hazardous commands is discussed in Paragraph 6.2.3.

mission GO/NO-GO decision. Specific flight control procedures during the prelaunch phases are as follows:

- A. Monitor spacecraft checkout - KSC and MCC.
- B. Monitor launch vehicle systems status - Launch Control Center (LCC), MSFC, and MCC.
- C. Verify network status - MCC and Goddard Space Flight Center (GSFC).
- D. LCC and MCC control-display status.
- E. Recovery-force status and weather decision.
- F. Transmit SL-1 targeting parameters to the SL-2 launch vehicle digital computer in the IU. Command loads will be generated at the MCC based on latest tracking data and will be transmitted to KSC at approximately T-8 hours for loading into the IU computer via the DCS. This load is also sent to the Huntsville Operations Support Center (HOSC) for verification. A final update on the target load and lift-off time will be made between T-37 and T-15 minutes. This update will again be based on MCC computation of the targeting parameters from the latest available remote site tracking data.

Both a prime and backup mode will be available for entering and updating the targeting parameters. The prime mode is the DCS, and the backup will be hardline via the RCA 110A computer at KSC using a teletype (TTY) link from the MCC.

### 3.4 UNMANNED LAUNCH

#### 3.4.1 Launch Window Planning

The time of day of the SL-1 launch establishes the framework for the launch sequences on all of the following missions that use the SL-1 as a target. The SWS can only be launched between certain times and still provide SL-2 with proper abort lighting conditions on the following day. In addition, KSC has a requirement for at least a 1.5-hour launch window. This allows KSC some time in solving problems which may occur during the count. For Skylab, a 1.5-hour window has been selected for the SL-1 launch with lift-off occurring at the beginning of the window at 12:30 p.m., Eastern Standard time (E.S.T.).

Also of concern in planning the SL-1 launch is the phase-plane relationship for launch of SL-2 the following day. The longitude of the descending node of the SL-1 orbit will be shifted about one degree west of the optimum planar point by yaw steering during the Saturn V boost to force the SL-2 launch window to occur during optimum phasing conditions. See the Skylab Preliminary Reference Trajectory document for a more comprehensive discussion of this phase-plane relationship.

#### 3.4.2 Flight Control Functions

Flight control functions for the SL-1 unmanned launch phase will consist of the following:

- A. The booster systems and trajectory will be monitored by ground controllers in order to advise the Range Safety Officer (RSO) of vehicle performance. No abort capability is planned; however, the RSO will have manual fuel cutoff (MFCO) and propellant dispersal commands for the S-IC and the S-II.



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- B. The trajectory will be monitored by the Flight Dynamics Officer, and he will provide status information to the MCC team throughout powered flight and report insertion orbit conditions.

### 3.5 INITIAL SWS ACTIVATION

The flight control functions for the initial SWS activation phase are as follows:

- A. Monitor and backup the IU functions, monitor and control all cluster systems and functions not performed by the IU, and perform systems status checks.
- B. Manage the SWS communications systems. Antenna and communications system configuration will be accomplished entirely by ground command.
- C. Track the S-II stage during the period from S-II/OWS separation to SL-1 lift-off plus 7-1/2 hours. This support will be on a non-interference basis with SWS skin tracking. S-II tracking is intended to verify successful operation of the S-II stage retrorockets and is also required to maintain an S-II ephemeris for possible recontact analysis.
- D. Track the SWS for orbit determination. Active tracking will be done on the IU S-band transponder during its lifetime, which for Skylab will be extended to 100 hours with the addition of a fourth battery on the IU. Skin tracking is also required during the period from SL-1 lift-off plus 7-1/2 hours until completion of the rendezvous. Both transponder and skin-track data will be

used in developing the OWS state vector for use in targeting the SL-2 launch vehicle and for computing post-insertion rendezvous parameters.

- E. Verify via telemetry that the S-II stage is safed. Planning now indicates that the S-II stage will be safed by a timing sequence which begins approximately 3.5 minutes after separation. No backup ground command capability will exist for initiating safing.
- F. Verify that the cluster systems are capable of supporting the mission prior to committing SL-2 to launch. Normally the cluster checkout criteria (Table 3-II) will be verified prior to launching SL-2. If it is not possible to verify a function, the decision whether to launch SL-2 will be made based on flight crew safety and on the capability of the flight crew to activate the system and/or correct the problem onboard.

### 3.6 MANNED LAUNCH

#### 3.6.1 Launch Window Planning

A variable launch azimuth technique will be used for launch of the three CSM missions. This technique allows a daily 16-minute plane launch window, 8 minutes either side of the optimum (in-plane) payload point. The boundaries in this plane window are defined by the 700-pound limit of S-IVB yaw steering propellant. The phase angle between the manned CSM and the SWS must also be considered in defining the CSM launch window because this affects the type and duration of the rendezvous. For Skylab, it is highly desirable that rendezvous and docking occur early enough to allow first day urine samples (collected for experiments M071 and M073) to be placed in the OWS freezer

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TABLE 3-II.- CLUSTER CHECKOUT CRITERIA

Criteria	Checked out by
Adequate cluster electrical power is available to support requirements.	TM
Pressure integrity of the SWS verified.	Ground command and TM
Adequate consumables: TACS, food (freezer status), water, oxygen, and nitrogen.	TM
Adequate thermal control.	TM
Attitude control capability.	TM
Adequate instrumentation.	TM
APCS operating and solar inertial attitude maintained.	EMOD and TM
The orbital parameters of the SWS must be such that mission durations of at least <u>TBD</u> * days will be possible.	Tracking and TM

\*To be determined by the Skylab Program Office for satisfactory completion of the SL-2 mission.



within 24 hours of lift-off. This requirement dictates that an early rendezvous (M = 5 through 8) be accomplished on each CSM mission.

An SL-1 nodal shift performed during the Saturn V launch (see Paragraph 3.4.1) causes the nominal lift-off time for SL-2 (opening of the M = 5 phase plane) to occur in the middle of the plane window on May 1, 1973. Figure 3-2 shows the phase-plane conditions for the nominal lift-off time. This chart also shows the phase-plane conditions if a slip in launch time occurs.

On Day 1 (May 1) an M = 5 through 8 plane window of about 8 minutes is available. If launch is slipped beyond this 8 minute window, it will be necessary to recycle to Day 2 (May 2). On May 2, about 7 minutes of an M = 7 or M = 8 phase-plane window is available. If launch is delayed on Day 2, a recycle to Days 6 and 7 will be necessary.

### 3.6.2 Flight Control Functions

Flight control procedures for the manned launch phase will consist of the evaluation of spacecraft systems, launch vehicle systems, flight crew condition, and space vehicle dynamics and trajectory. Mission abort capability will exist for cases of adverse launch vehicle and spacecraft system or trajectory conditions. Abort can be initiated automatically by the emergency detection system (from lift-off to T+171 seconds) or manually by the crew. Abort request can be initiated by the Flight Director on recommendations from the CSM Systems Engineer, the Booster Systems Engineer, and the Flight Dynamics Officer. Also, abort request can be initiated by the Flight Dynamics Officer and the Booster Systems Engineer when specific mission rules are violated. Abort request is relayed to the flight crew by voice and/or by digital uplink command. (The

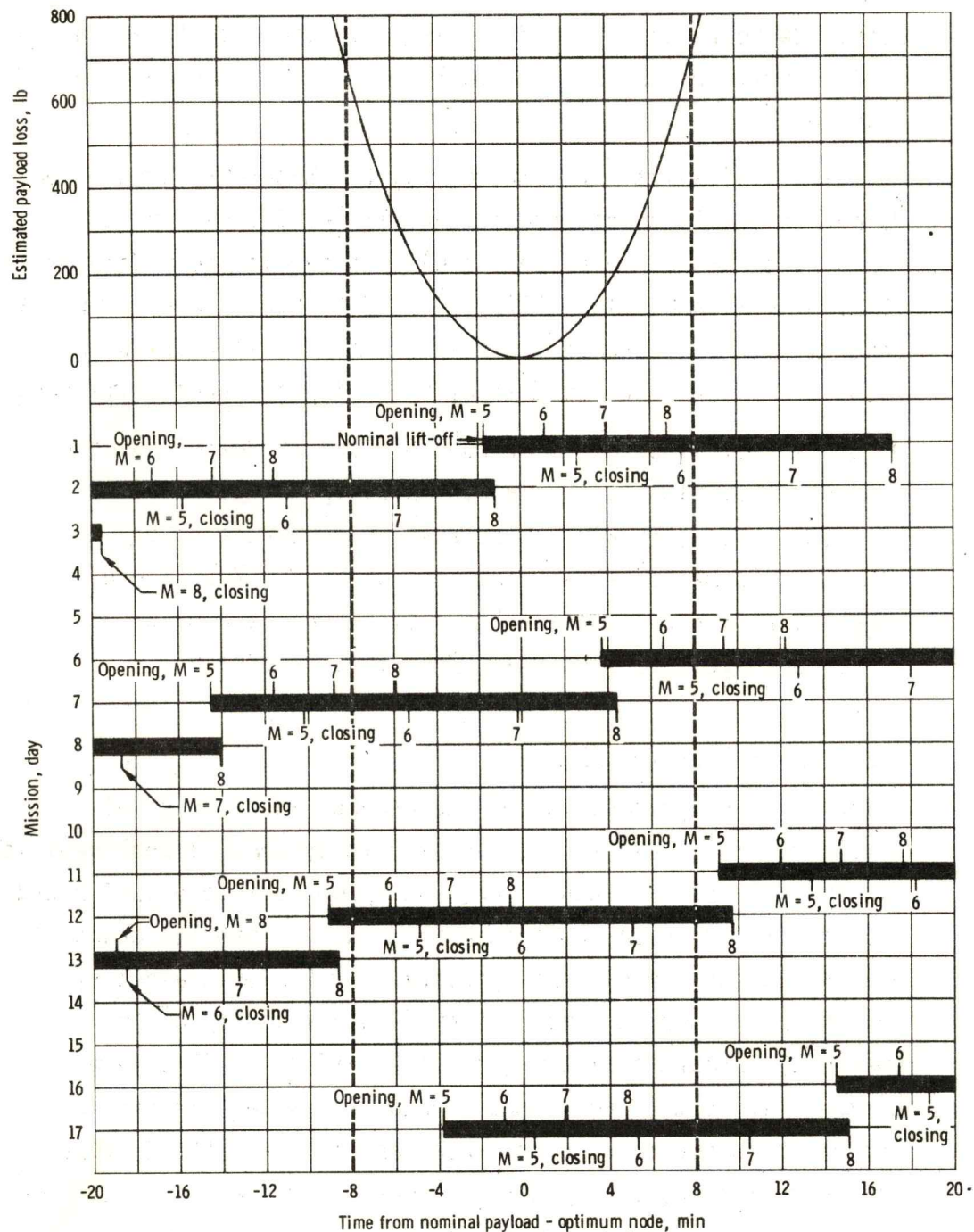


Figure 3-2.- Phase-plane launch window for northerly SL-2 launch (early rendezvous case, M = 5 through 8 only).

digital uplink command lights the ABORT light on the crew display panel.) Specific flight control procedures which are accomplished between lift-off and orbital insertion are as follows:

- A. Monitor and evaluate launch vehicle systems
- B. Monitor and evaluate spacecraft systems
- C. Monitor and evaluate the condition of the flight crew
- D. Monitor and evaluate space vehicle dynamics and trajectory
- E. Call marks on abort modes
- F. Send abort request if mission rules are violated
- G. Provide contingency maneuvers
- H. Monitor the flight plan and recommend alternate procedures to the flight crew in contingency situations
- I. Advise the flight crew of launch vehicle, spacecraft, and trajectory status

### 3.7 RENDEZVOUS AND ACTIVATION

#### 3.7.1 Disposition of the S-IVB

When separation occurs at a GET of 16 minutes, the S-IVB will be safed by venting the pressurant bottles and propellant tanks. Flight controller support will be provided throughout the IU lifetime for systems monitoring and control of the passivation activity and for orbit determination. For SL-2, Experiment M415 (Thermal Control Coatings) and for SL-4, Experiment S150 (Galactic X-Ray Mapping) will be operating for a minimum of four orbits after CSM/S-IVB separation. Experiment telemetry will be dumped through the IU a minimum of once each orbit. From the end of the IU lifetime until



reentry, the S-IVB will be skin tracked for reentry determination (on a non-interference basis with OWS tracking).

### 3.7.2 Rendezvous

Ground functions in support of the rendezvous phase will include the following:

- A. The decision to start rendezvous will be made by the Flight Director at CSM insertion. This decision will be based on satisfactory operation of the ECS, EPS, and either the primary guidance and navigation system (PGNCS) or the stabilization and control system (SCS) for maneuver execution and attitude control. In the event the PGNCS has failed, the SCS and onboard charts [with VHF for corrective combination rendezvous maneuvers (NCC's) and rendezvous coelliptic maneuvers (NSR's)] will provide an acceptable backup for the ground solution. The MCC will generate solutions for all maneuvers through the rendezvous terminal-phase initiation maneuver (TPI). The MCC will be prime for NC-1 and NC-2. However, for launches at the opening of the window, the CSM VHF ranging to the SWS should become usable just prior to NC-2 and may make the crew solution better than the MCC solution. For all maneuvers, the crew will decide whether to use the ground or the onboard solution.
- B. Throughout the rendezvous, the following checks or procedures are accomplished by the ground or crew as required:
  - 1. Pulse integrating pendulous accelerometer (PIPA) bias check
  - 2. Inertial measurement unit (IMU) realign and optics check
  - 3. IMU drift check
  - 4. Ignition attitude check
  - 5. SCS drift check
  - 6. Entry monitoring system checks
  - 7. SPS burn monitoring

- C. Target vector updates based on latest available SWS tracking data will be computed by the ground and uplinked to the CSM prior to the NC-1 maneuver and again prior to NC-2.
- D. CSM state vectors will also be determined by the ground and sent up prior to NC-1 and NC-2. After that, the on-board relative-position information (VHF and sextant) should be more accurate than that of the ground. However, the MCC will continue to generate vectors and will be prepared to uplink them in the event of an onboard problem.
- E. To support the CSM-SWS VHF ranging antenna coverage, the SWS will be maneuvered to the Z-LV(R) attitude via ground command and then back to the solar inertial mode prior to docking. As now planned, the command to do this will be sent to the SWS over the Madrid site at an SL-1 GET of about 27 hours. Reacquisition of the solar inertial mode will be ground commanded after TPI at an SL-1 GET of about 30 hours over the stateside stations.
- F. The data storage equipment (DSE) will be used to record high bit rate (HBR) data during each SPS burn, and will be dumped after each burn where no real-time burn data is available. Because of the relatively poor coverage, this will generally be the case.
- G. The ground will also be required to command the acquisition lights and docking lights on and off during rendezvous.

### 3.7.3 Activation

No unique MCC flight control functions are required during manned activation of the SWS. Normal communications and data management support will be provided. The MCC will monitor the activation and be prepared to provide assistance as required.

As indicated in Section 2, activation will be completed at approximately 26:30 GET.

### 3.8 MANNED ORBITAL OPERATIONS

During the manned orbital phases, flight operations will be active in several primary areas. Each of these areas is discussed in the following paragraphs.

#### 3.8.1 Systems Management

Although the onboard systems design for the orbital assembly incorporates a caution and warning system in each vehicle, ground controllers will remain responsible for detailed systems analysis, trend projection, consumables management, and definition of crew malfunction procedures when required. For ground-rule purposes, Flight Control Division (FCD) has stated that the CSM, ATM, and OWS systems coverage requirements are 2 minutes of good real-time coverage per 2 hours, with no gap exceeding 2 hours. As an aid in systems and experiments data analysis, onboard tape recorders are capable of storing data for 2 hours (CSM), 90 minutes (ATM), or 4 hours (OWS), if necessary. These recorders will be used for systems analysis during SWS activation and for later mission phases as required. The ATM and OWS recorders will be used extensively for experiments data. Normal command activity will include communications management functions, computer updates, and backup to crew-initiated or automatically initiated sequences. In addition, systems failure may require that commands be sent to the SWS. Specific cluster systems management areas are outlined in the following paragraphs.



3,8.1.1 Special systems management.- Aside from the type of systems monitoring and analysis presently required for Apollo (e.g., leak detection, temperature monitoring, electrical load sharing, attitudes, and rates), design features unique to the SWS necessitate additional tasks to be accomplished. These special functions assigned to the systems flight controllers include the following:

A. CMG Momentum Management

The CMG's which are used for attitude control of the Skylab cluster present a unique problem of managing the momentum of a set of three very large gyros as opposed to the management of propellants for the RCS systems of Apollo. Momentum management involves the most optimum utilization of the CMG's to maintain attitude and to perform maneuvers while insuring that undesirable momentum accumulation is minimized. The most important part of this process is to minimize use of the TACS propellant. Ground flight controllers will optimize required maneuvers through the use of a dynamic model or application program of the Mission Operations Planning System (MOPS) defined in Appendix B. Flight controllers will have the capability to change the momentum control elements in the ATM digital computer (ATMDC) momentum management program, update the TACS characteristics in the computer, cage the CMG's, use gimbal control, et cetera. They will advise and assist flight planners on possible ways to optimize planned maneuvers. Through the Flight Operations Management Room (FOMR)-HOSC interface, flight controllers will also have access to the MSFC Astrionics Simulation Laboratory to evaluate through simulations; pointing angles, maneuver times, momentum control elements, et cetera.

B. Electrical Power System (EPS) Management

The EPS for Skylab is an integrated system which involves EPS sources and loads from three modules: the CSM, the ATM, and the AM. For these modules, ground controllers will be responsible for EPS management which includes the following:

1. Evaluation and updating of EPS parameters such as the EPS loads, load sharing, and power generation changes.
2. Accounting for EPS operation and capability for both Z-axis parallel to local vertical (Z-LV) and solar inertial attitude modes.
3. Maintaining status on the orbital energy balance (energy removed per orbit versus battery charging energy for that orbit).
4. Checking for EPS constraints violation prior to planned load changes. This includes battery depth-of-discharge limit checks as well as fuel cell and solar power generation capability tests.

Ground controllers will make use of a computer application model in the MOPS for assistance in management of the EPS for Skylab. This is discussed further in Appendix B. In addition, an EPS breadboard at MSFC will be available for use in supporting real-time operations for Skylab.

- 3.8.1.2 Extravehicular activity systems (EVA) management.- During EVA, which will be required a total of six times during the three manned missions, the monitoring of EVA systems data will require additional flight controllers. Medical data monitoring during EVA will also require a complete shift of medical personnel.

Although EVA is considered a major mission activity requiring full MCC support, the responsibilities of other flight control positions should not be heavily impacted. As now planned, EVA activity will be limited to 3 hours. Also, EVA scheduling while in the South Atlantic Anomaly will be held to a minimum.

- 3.8.1.3 Thermal management.- Thermal monitoring of the cluster vehicles will continue to be, as in Apollo a prime concern of the flight control team. The additional blanket heaters added to the Skylab CSM (see Paragraph 2.2.1) are automatic but will require monitoring similar to present Apollo thermal monitoring. For nominal operations of both the CSM and OWS, this monitoring primarily involves managing the thermal system during the mission with parametric data (redlines, et cetera) developed premission and reflected in the mission rules and mission procedures.

For off-nominal conditions the thermal performance of the OWS will be analyzed through the use of a math model located at MSFC. The computer program for this model will require telemetry initialization data from the MCC. This will be furnished to MSFC on an "as needed" basis.

- 3.8.1.4 Quiescent CSM systems management.- During the long duration orbital phases of Skylab, many of the CSM systems will be powered down. The general philosophy on quiescent systems management is to accept most of the systems as normal without testing or cycling. A system will be tested or cycled when a failed test would result in a definite mission action, or when cycling is required for routine maintenance. The periodic testing activities that have been proposed in the Skylab flight plan are listed on the following page:



\*

SKYLAB BOP  
BASIC

Daily Functions	Weekly Functions
Battery voltage checks Fuel cell checks Cryo storage system monitor Battery manifold vent H <sub>2</sub> O condensate check LiOH canisters check O <sub>2</sub> regulator check H <sub>2</sub> O tank pressure check Secondary loop check SPS check RCS check	CMC time update (two site passes with time between for clocks update generation) CMC EMOD dump CMC nav update Alternate primary loop pump Top off O <sub>2</sub> supply Circulate secondary glycol loop and recheck in 1 hour Circulate primary loop radiator 2 and recheck in 1 hour Alternate inverters 1 and 2
Total time req - 20 minutes	Total time req - 25 minutes

### 3.8.2 Flight Software Management

3.8.2.1 ATMDC flight software.- During the manned phases, the operation of the ATMDC flight software will be monitored in real time much the same way as the Apollo flight software is currently monitored (i.e., event lights and special computer displays). Normal software management will consist of daily navigation and timing updates. The memory will be dumped and verified on a scheduled basis and when deemed necessary in anomaly situations. If automatic switchover of computers occurs, a memory dump will be performed as part of the troubleshooting process.

FCD has specifically requested support from MSFC for use of the ATMDC Simulation Facilities at MSFC. The basic utilization

of this capability will be in prelaunch or real time as the need develops as follows:

- A. To determine the need for updating ATMDC flight constants
- B. To simulate ATMDC operational procedures for troubleshooting and contingency planning
- C. To verify operation of the ATMDC for proposed uplink loads
- D. To assist in the area of prelaunch program verification for the ATMDC programs

The time response for use of the MSFC flight software simulation facility will vary from essentially online support (for SL-1 launch and activation) to a 2 to 4 hour notice for callup for manual operation. For the unmanned periods, the time response is generally on the order of 1 to 2 days.

3.8.2.2 Command Module Computer (CMC) flight software.- The operation of the CMC flight software, while the CSM is active, will be monitored in real time in the same way as the Apollo CMC flight software is currently monitored. As indicated previously, a CMC erasable memory octal dump (EMOD) and navigation and time update is recommended in the flight plan on a weekly basis while the CSM is in the quiescent state.

A G&N checkout will be done during the deorbit refresher exercises now planned to be performed at deorbit minus 5 days and minus 1 day.

The Skylab Program Office is presently considering an operational test in which the CSM would be used to maneuver the OA to the Z-LV attitude and back. If this proposal is baselined, the G&N system will be powered up and checked out for this operation with ground support as required.

### 3.8.3 Medical Operations Support

The Surgeon's basic responsibilities for crew health and life systems remain unchanged. He and his team (MROD and FCD) will keep up with the progress of the mission by reviewing updated graphs of environmental parameters, reviewing selected air-to-ground (A/G) recorded voice transmissions, and analyzing data from the operational biomedical system (OBS) and from the medical experiments. Unlike Apollo, however, most of the crew health information will be obtained from the biomedical experiments and private voice communications with the crew, with the OBS data used primarily for EVA and contingency situations. Three contourscopes and one vectorscope will be available in the staff support room (SSR), and one contourscope will be available in the MOCR on the Surgeon's console. The Surgeon will also be actively involved in the flight planning cycle.

### 3.8.4 Radiation Monitoring

Operational radiation monitoring will be required in much the same manner as for present-day Apollo operations, except that the response time for analyzing solar radiation can be relaxed. Ground controllers will monitor operational radiation sensors on the OA for periodic assessment of the crew dose. See Paragraph 5.3.2.2.B for a more comprehensive discussion of this function.

Radiation support will also be provided for ATM operations. This support is discussed in Paragraph 5.3.2.2.C.

### 3.8.5 Experiments Support

The prime responsibilities of flight controllers involved in experiments support will be the following:



- A. To ensure that the required amount of useful scientific data is retrieved
- B. To advise the crew in experiment operation and malfunction analysis
- C. To provide an operational interface between the Principal Investigators and the flight control team

Because experiment operations are the mainstay of the Skylab program, a separate section (Section 5) has been devoted to the details of how this support will be provided. Also, changes in the flight plan will be required based on the evaluation of experiment data. The mechanism for accomplishing such changes is described in Section 7. Finally, the plans for collecting, processing, and displaying the large amount of experiments data expected during the manned phases are defined in Section 6.

#### 3.8.6 Trajectory Determination and Entry Planning

During the manned orbital periods, this function should remain at a low activity level. Routine ground tracking will be performed using the CSM unified S-band (USB) Doppler data. C-band skin tracking will be used for updating the ephemeris information in the Real-Time Computer Complex (RTCC) each day.

As indicated earlier, the onboard computers (ATMDC and CMC) will be updated periodically using vectors derived from the ground tracking information. In addition, current planning now includes establishing daily landing area advisories and block data updates for entry. The teleprinter system will be used for transmitting these updates to the crew.

### 3.8.7 Contamination Monitoring

Operational contamination sensors will be carried on the orbital assembly which will telemeter to ground controllers information on contamination of the external surfaces of the orbital assembly. These sensors, along with other sources of information, will provide data to the ground during both manned and unmanned phases with particular regard to the contamination-sensitive experiments carried on the Skylab. See Paragraph 5.3.3.2 for a detailed discussion of how this flight control function will be done.

### 3.8.8 Data Management

Communications and data management will continue to be a prime flight control function for the Skylab missions. Ground controllers will be responsible for maintaining optimum communications and data flow between the spacecraft and the ground. This will require frequent monitoring and control of the onboard communications systems, the STDN, and the MCC. Digital commands will be sent to the vehicle in real time for control of the antennas, tape recorders, modulation sources, and the transmitters and receivers. In addition, the ground will be responsible for correlation of all onboard timers with a common reference such as elapsed Greenwich mean time (EGMT) and for updating all onboard timers. For a detailed breakdown of the data management tasks, see Section 6.

### 3.8.9 Mission Management

Although this task will necessarily resemble present-day mission activity, a very large interface with the "outside world" will exist. Representatives from the FOD, Flight Crew Operations Directorate (FCOD), MSFC, MSC Skylab

Program Office (SLPO), Apollo Spacecraft Program Office (ASPO), Science and Applications Directorate (S&AD), Medical Research and Operations Directorate (MROD), and NASA Headquarters will all be involved in the decision-making process. The Flight Director/flight controller interface will be similar to the present. The Flight Operations Management Support (formerly SPAN) functions in mission management are described in detail in Section 4.

Due to the large number of experiments to be performed, the mission management function of crew activity scheduling will be more complicated than that for the mainline Apollo Program. For this reason, computer assistance in the form of an Activity Scheduling Program (ASP) will be provided to identify experiment scheduling constraints and to aid in conflict resolution. The scheduling effort will result in daily updates to the flight plan. Section 7 describes in detail the interfaces and mechanisms for accomplishing this crew activity scheduling, and Appendix B discusses the tool (ASP) for doing this scheduling.

The Flight Director will be responsible for providing daily reports to NASA management on Skylab mission status. These reports will be prepared for the Flight Director by the FOMR personnel under the direction of the FOD FOMR manager (see Section 4). Mission status inputs to the daily reports will be provided as required by the Mission Operations Control Room (MOCR) and SSR flight controllers, as well as the Manned Spacecraft Center (MSC) and MSFC Program Office representatives. The status report will be reviewed and approved by the Flight Director prior to being given to management.

Depending on management's preference, the daily status reports can be given verbally by the Flight Director or sent to management in written form.



Any mission problem which occurs and requires management's attention can best be handled by a direct call from the Flight Director to the appropriate management personnel. Individual flight controllers can be called upon if necessary to brief management on specific problems.

### 3.9 DEACTIVATION AND ENTRY

Flight control functions and procedures during this phase will include the following:

- A. Assisting the crew in verifying that the detailed OWS, MDA/AM, and ATM deactivation checklists are accomplished. This includes verification that the ATM C&D console is enabled for ground command and that SI49 is properly configured for unmanned operation.
- B. Uplinking the digital CMC updates to the spacecraft via the command system. These include the navigation load or state vector and a Refsmmat to setup the CSM flight director attitude indicator (FDAI) for the proper roll, pitch, and yaw attitude indication to facilitate attitude monitoring by the crew during entry.
- C. Providing a teleprinter uplink of the maneuver data (PAD) to the crew which is recorded by the crew for future use. If the command uplink is not available prior to the deorbit maneuvers, the crew will manually enter these data into the CMC. Voice uplink of this same data will be available as a backup to the teleprinter.
- D. Verifying that the flight crew has properly conducted the retrofire checklist.
- E. Confirming, via telemetry, that the CMC is executing the entry program.

F. Computing, with tracking (when available), the spacecraft impact point.

G. Advising the flight crew of the recovery area conditions.

As indicated earlier, nominal deorbit will be performed using two SPS maneuvers. Preparation for the second maneuver is similar to the first. The ground will compute and uplink the CMC navigation update for the second burn using tracking or telemetry data or burn residuals from the first SPS maneuver. If Spaceflight Tracking and Data Network (STDN) coverage is available after the second SPS maneuver, an entry postburn update will be voiced to the crew if the values are different from the preburn values.

### 3.10 UNMANNED OPERATIONS

#### 3.10.1 Post-Separation Support

After CSM separation, the SWS will continue to be supported for a continuous period of up to one day, or until the systems have stabilized. During this period the ground will command and monitor a forced blowdown of the SWS from 5 psia to 2 psia. The contamination effects of blowdown on the SWS will be closely observed by the ground via the quartz crystal microbalance-contamination sensors (QCM's). After systems stabilization, the routine storage period will begin.

#### 3.10.2 Daily Storage Operations

To minimize the risk of long-term deterioration of the SWS, periodic monitoring of the SWS systems will be performed by MCC personnel on a daily basis. The support will be divided into an active monitoring period and a reduced monitoring period. In addition to the systems support, limited operation of some Skylab experiments has been baselined for the unmanned periods and will be supported by ground controllers. The

active and reduced monitoring period activities are discussed in the following paragraphs.

3.10.2.1 Active monitoring support.- Active monitoring will be provided up to 8 hours per day by MCC personnel with a planned minimum of two remote site contacts per revolution. During this period, a team of ten to fifteen people will be required to do in-depth SWS status analysis and to perform routine maintenance functions and science support as defined below. A Flight Director will lead this team and be responsible for updated support and activity plans. Demands made on other organizations, such as site scheduling, will be transmitted at regular intervals. The unmanned period flight activity planning is described in more detail in Section 7. Unmanned phase FOMR support is discussed in Section 4. Nominal ground functions for the active period will include the following:

A. Navigation and Timing Updates

The ATMDC will be updated by ground uplink of several navigation and timing parameters. Updates will occur once per day about 3 hours after the beginning of the daily active support period. This 3-hour period allows collection and processing of a reasonable amount of C-band skin tracking information from the remote sites for computation of the SWS state vector.

B. Systems Monitoring

At the beginning of the daily active support period, MDRS systems data for the last 16 hours will first be reviewed. Then the status of all SWS systems will be actively monitored including the following:

1. Checking the consumables quantities
2. Comparing present data with predicted data



3. Evaluating the momentum management program operation for the APCS
4. Providing systems support for operation of the ATM experiments
5. Determining the spacecraft recorder requirements in support of the systems
6. Forecasting systems status for the ensuing 24 hours

Throughout the unmanned phases, the determination of any degradation in SWS systems will have to be taken into consideration in the flight planning effort for the next mission. An example of this would be loss of a CMG or solar panel degradation.

C. Experiment Operations

1. ATM

As indicated in Section 2, three of the ATM experiments (S052, S054, and S055) will be operated during the active support period. Figure 3-3 shows a typical daily timeline of unmanned activity, including ATM operations, which addresses both the 8-hour active and 16-hour reduced monitoring periods. Ground tasks for ATM operation during the active period include the following:

- a. Control of ATM experiment canister pointing (offset or sun centered).
- b. Control of ATM operating modes.
- c. Control of experiment on-off function. (S054, for example, will be turned off by the ground prior to SAA passage.)
- d. Control of filter sequences.

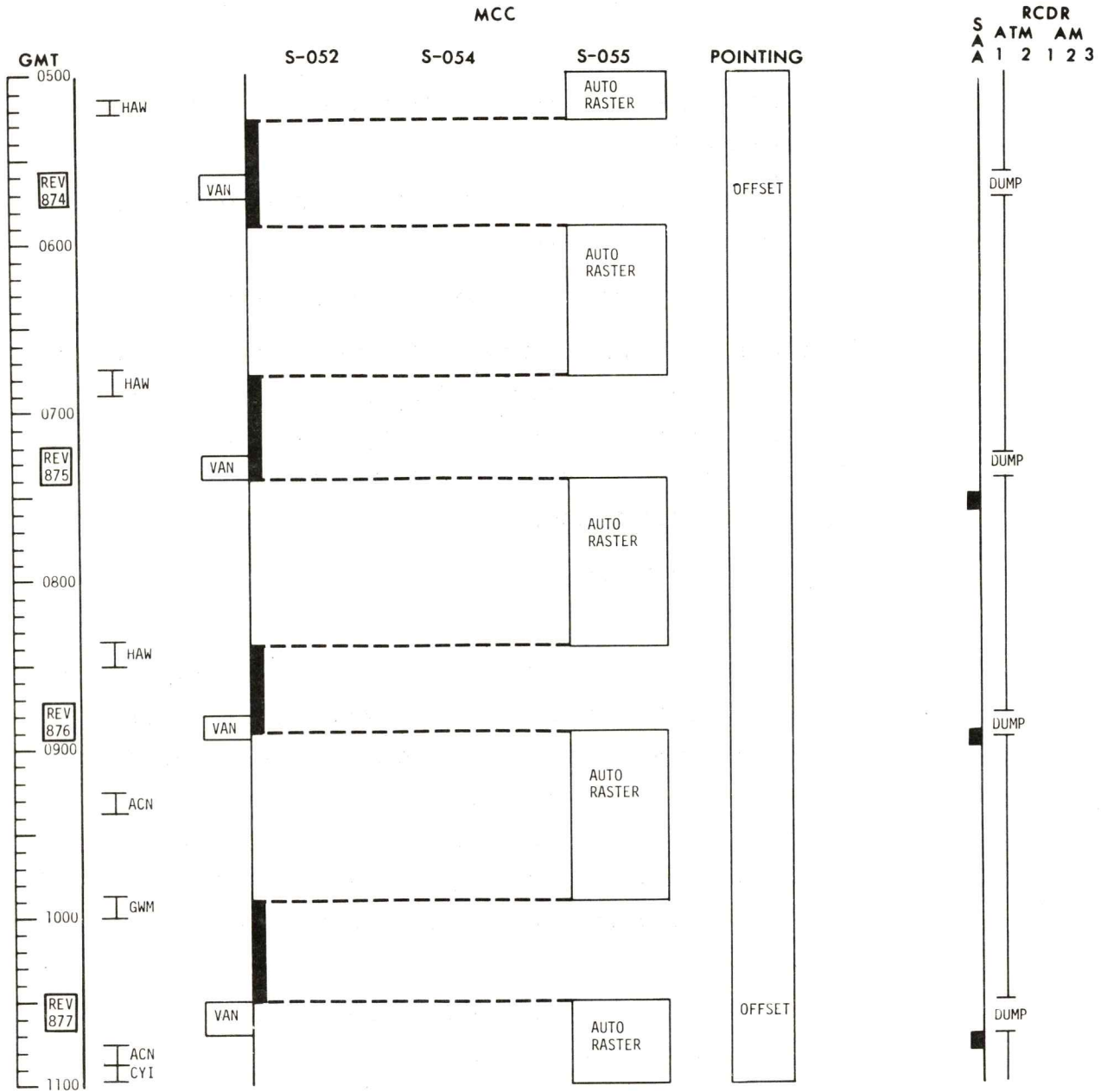


Figure 3-3.- Unmanned period typical day timeline.

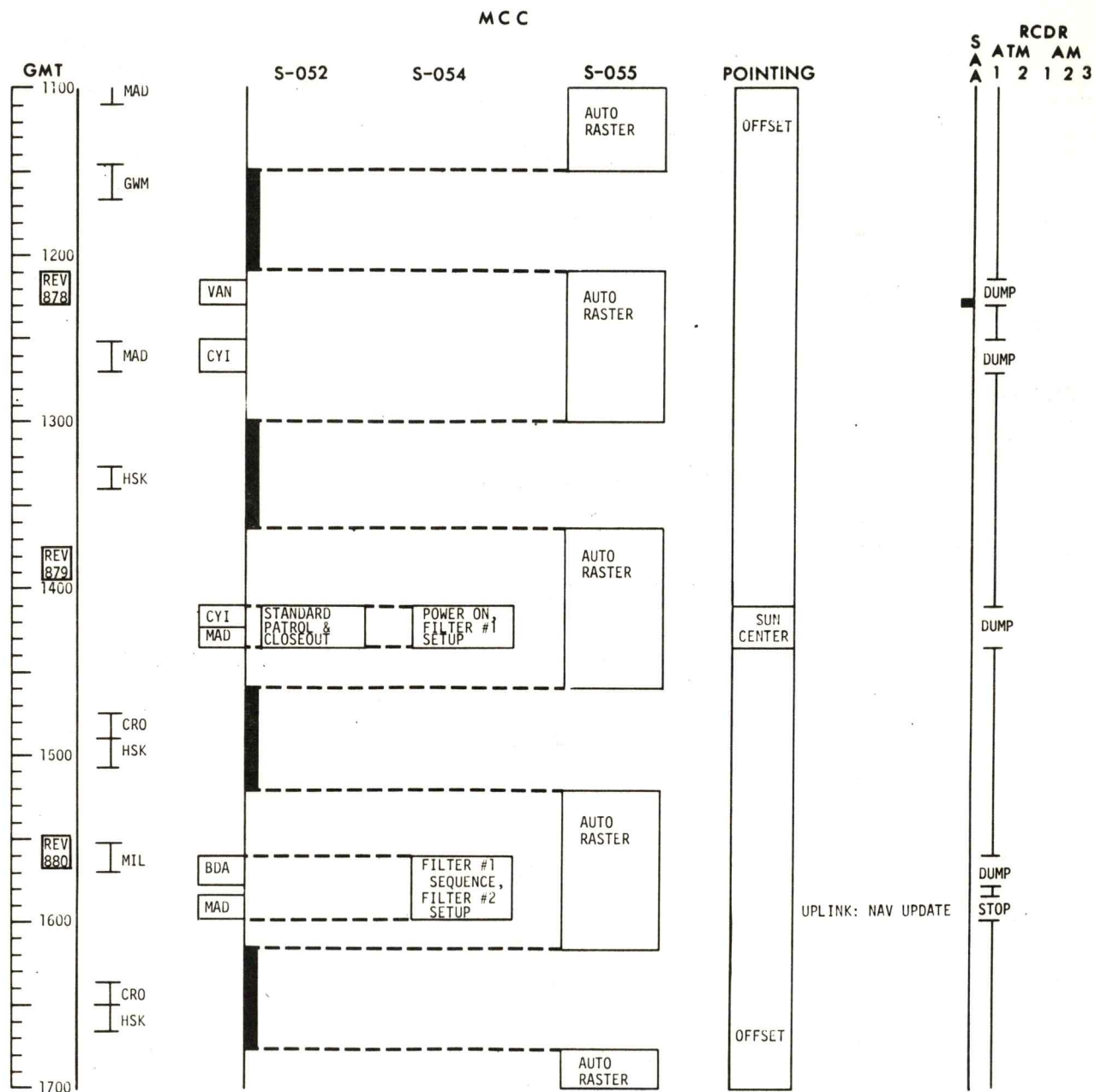


Figure 3-3.- Unmanned period typical day timeline - Continued.



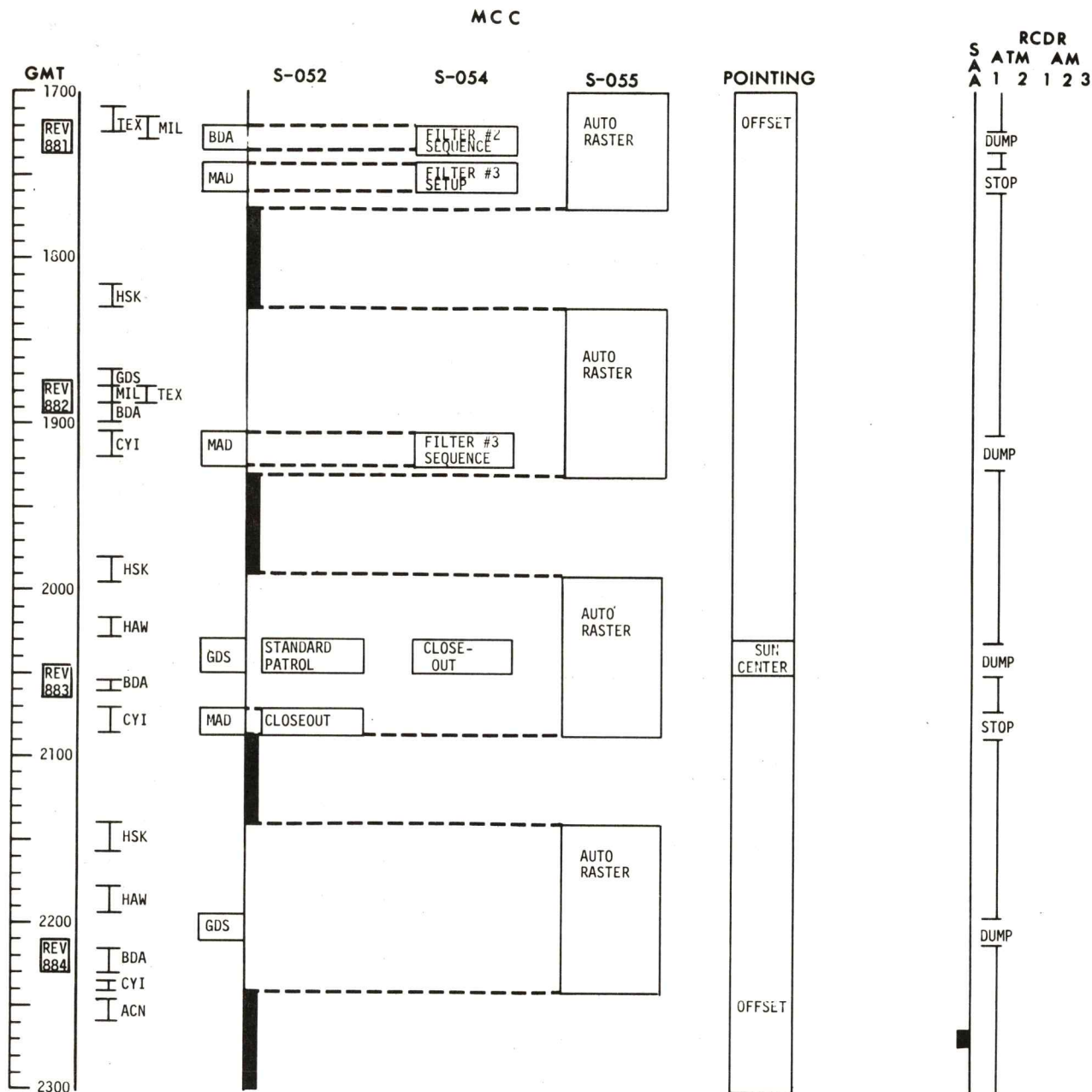


Figure 3-3.- Unmanned period typical day timeline - Continued.

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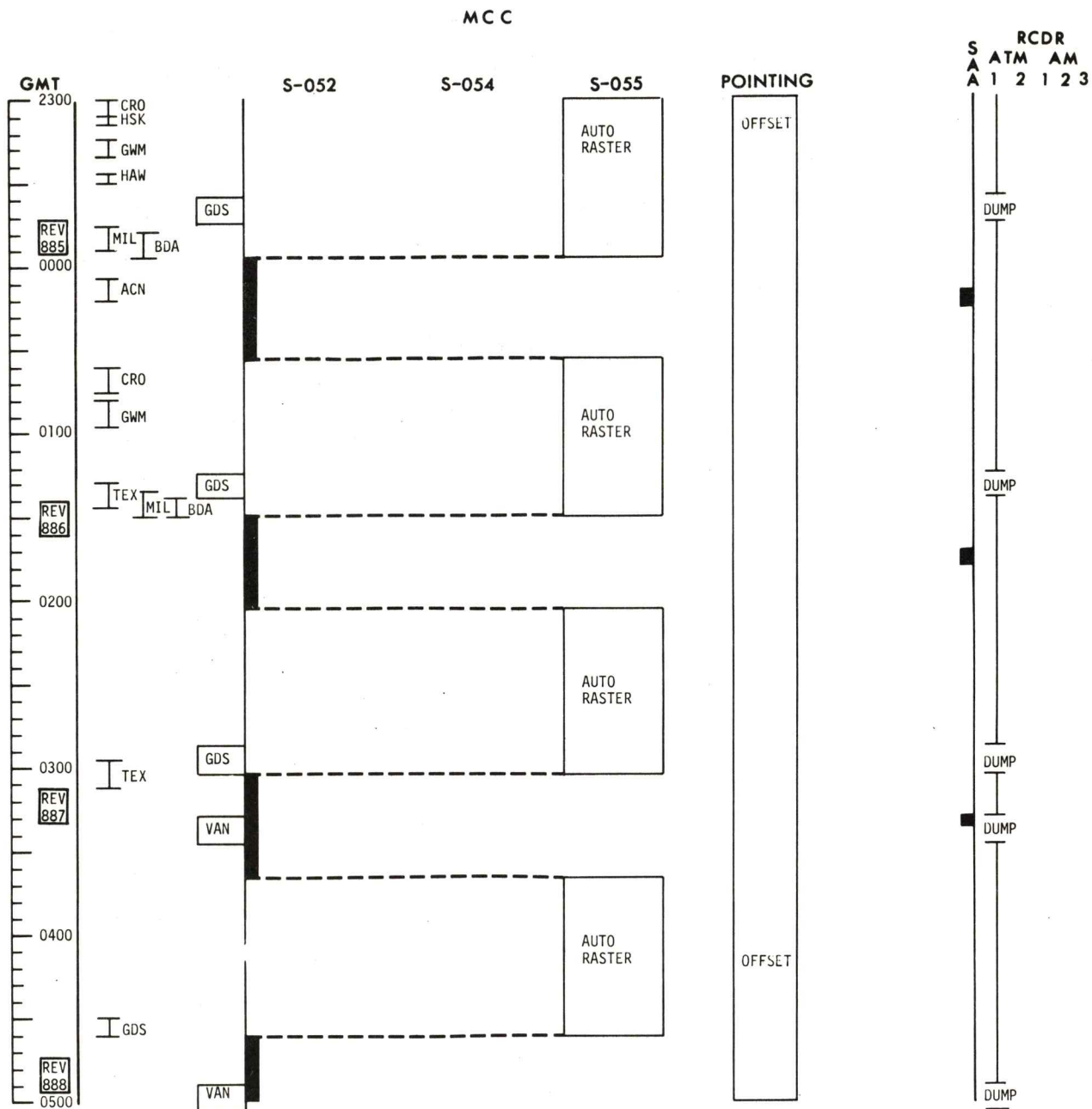


Figure 3-3.- Unmanned period typical day timeline - Concluded.

- e. Control of the aperture doors.
- f. Verification of experiment status during operation and at close out.

2. S149

The micrometeorite collection experiment, S149, will be operated during the unmanned intervals in the following manner:

- a. First, the experiment extension mechanism will be deployed approximately 3 feet out the antisolar scientific airlock by the crew prior to their departure. The cassette doors will remain closed after an integrity check by ground command.
- b. Next, after crew departure and cabin blowdown (approximately 12 hours), the cassette doors will be commanded open over a remote site by ground controllers. The opening cycle takes about 5 minutes and will be monitored by the ground in real time.
- c. Thereafter, the cassette doors will nominally remain open until prior to the next manned docking. The ground will command the cassette doors closed over a remote site prior to docking in order to avoid contamination of the experiment during docking operations.

D. Communications, Tracking, and Data Management

Routine MCC communications management commands in support of the unmanned SWS will follow essentially the same pattern as the manned period commands. These commands, which are largely repetitive in nature at each site acquisition of signal (AOS) and loss of signal (LOS), are listed on the following page:



1. ATM

- a. Primary Tape Recorder - Playback
- b. Primary Tape Recorder - Record
- c. Antenna Switch Command (based on computed remote site look angles)

2. AM

- a. Data Dump Enable - On
- b. Data Recorder Dump Execute - On
- c. Data Recorder Dump Execute - Off
- d. Data Dump Enable - Off
- e. Antenna Switch Command (based on computed remote site look angles)

To avoid loss of data due to the continuous loop design of the ATM recorder, this recorder will be dumped at least once per revolution, and shall not exceed 90 minutes of recording time.

Since both the AM receiver/decoders will be active during the unmanned period, time-to-go to command system transfer-AM timer (TR) updates will not be made on a routine basis. A TR update of the maximum value will probably be made three or four times during each unmanned period to maintain the TR register at a positive value.

Tracking support during the unmanned phases will be furnished by skin tracking the SWS each time it comes over Merritt Island launch area C-band site (MLA) and Carnarvon, Australia-STDN station (CRO) above 3-degrees elevation. MLA and CRO are presently the only sites baselined for C-band skin tracking support. These sites will be used on a 24-hour basis during the unmanned phase.

Data management during the active support period will be essentially the same as the manned period data management.

See Section 6 for a detailed description of the Skylab data management and its disposition.

E. Contamination Monitoring

During the unmanned intervals the status of the cluster contamination environment will be monitored in real time via telemetry at each remote site pass. From this information, a contamination status report will be made available (by display) for the Flight Director and ATM controllers within the first 3 minutes of each remote site pass during the active support period. The contamination level will be used as a guide by the ATM personnel in planning the operation of their experiments.

F. Support Scheduling

To avoid facilities conflicts on those days when PAD tests and simulations are scheduled in the MCC, the active support period will be scheduled around these activities. The PAD tests and simulations will usually occur during normal working hours. On those days when no PAD tests or simulations are scheduled in the MCC, the active period may be scheduled during normal office hours. In any case, in scheduling the active support period adequate STDN coverage will be considered as well as specific requirements for ATM operations.

In recognition of the need for network support of NASA programs other than Skylab, the approach to be taken in scheduling the remote sites for the unmanned periods is to use the minimum number of sites required to satisfy the systems requirements and experiment objectives. In line with this, present plans call for two site contacts per revolution during the active period, and one contact per during the reduced monitoring period.

3.10.2.2 Reduced monitoring support.- Reduced monitoring will be provided during the 16-hour period following the active support period. It will be provided through use of special programing that will provide a caution and warning limit sense operation. As now planned, this limit sense capability will reside in the MCC data retrieval system (MDRS) at the MCC. A small team (perhaps 3 to 6 people) will be responsible for collecting and monitoring the MDRS data. This team will implement a callup procedure to bring up the MCC and alert key personnel if an out-of-limits indication is received from MDRS data. If a serious SWS problem is detected during the reduced monitoring period, callup of the MCC and key personnel must occur within a reasonable period of time. The Flight Support Division has estimated a minimum of 1.5 hours for MCC callup. In case of systems problems, the capability in terms of facilities and manpower must exist to extend unmanned period support to a full 24 hours per day.

The ground functions and support operations presently planned during the reduced monitoring period are outlined below.

A. Basic Assumptions

1. Both the SWS systems and S055 will be supported via the MDRS. Real-time telemetry display will not be available during this period.
2. S055 is the only ATM experiment to be supported during the reduced monitoring period (although there is now a proposal to extend S052 operation into this period).
3. The MDRS will be used to provide near-real-time access to the vehicle telemetry data which will be played back postpass to the MCC via the all-data digital tape (ADDT).



4. Sixteen-hour support of S055 (beyond the baseline 8-hour support), is desired but not mandatory. Support may be terminated in case of facilities utilization conflicts. For S055, the support will be limited to communications and data systems operation necessary for data acquisition only. This means the following:
  - a. No quicklook data.
  - b. No experiment-pointing or mode-change commands (retargeting commands).
  - c. Data received is non-operational. No changes to experiment operation will be made because of the data received.
5. The MOPS, or equivalent, will be available to allow trajectory and vehicle attitude predictions accurate enough to provide block antenna selection and site support planning for a 24-hour increment.
6. As indicated earlier, one remote site contact per revolution will nominally be used for both vehicle systems and S055 support. S055 will not require supplemental coverage.

B. Support Operations

During the active support period, the vehicle and experiment systems will be closely monitored and evaluated each day by MCC personnel. During this active period, the MCC flight control personnel will prepare for the following 16-hour period of reduced monitoring by accomplishing the following tasks:

1. Preparing a STDN support schedule for the 16-hour operations period.

2. Generating a Command Plan which includes all configuration commands, recorder management commands, and antenna commands (the antenna commands will be based on predicted remote site look angles).

Prior to entering the 16-hour period of reduced monitoring, the vehicle will be placed in the desired configuration (ATM canister offset as required for S055). MCC personnel will verify that only the necessary vehicle commands are enabled in the remote site command computer. The operation will then be handed over to the reduced monitoring team stationed in the MCC who will monitor the MDRS data and be responsible for implementing contingency plans in the event of anomalies.

Commands will normally be initiated from the remote sites by maintenance and operations (M&O) personnel under MCC supervision. However, command initiation from the MCC is not precluded. In any event, only the necessary commands will be enabled in the Remote Site Computer Complex (RSCC), and the ATM onboard command system may be disabled as a further precaution. (The AM DCS will be used for ATM control which includes ATM antenna selection, transmitter modulation, and auxiliary storage and playback assembly (ASAP) recorder management.) Voice lines between the MCC and the remote sites will be required during this period for command coordination.

Command verification in real time will be required whether commands are initiated at the MCC or remote sites. If commands are initiated from the remote sites, the primary means of command verification will be by remote site computer detection of a DCS message acceptance pulse on the real-time telemetry bit stream, a change in received signal level, and the presence of modulation. Secondary

confirmation may be provided by remote site pulse-code modulation (PCM) ground station readout of selected parameters, primarily events. In any event, remote site command histories will be required to provide a record of systems operation and to assist in the analysis of anomalies.

The basic data status information requirements will be the same as for active support periods, except for that data normally transmitted in real-time to the MCC for display. The retrieval of S055 experiment data will be on a noninterference basis with the retrieval of data required for the MCC monitoring system. Data processing and distribution will be dependent on pre-established priorities and the efficient use of available facilities.

### 3.10.3 Pre-Docking Support

Throughout the unmanned period, a day-by-day assessment will be made of the SWS to assure its suitability for the next mission. Several items will be checked periodically including the following:

- A. Remaining consumables (TACS propellant, oxygen, nitrogen, and water) within limits required for manned habitation
- B. Adequate thermal control
- C. Adequate electrical power (OWS and ATM solar arrays operating)
- D. APCS operating and solar inertial attitude maintained
- E. Adequate communications and instrumentation
- F. Orbital parameters such that the next manned mission can be satisfactorily completed



Starting at about 24 to 36 hours prior to the launch of the next CSM, the above items will be checked once again. The SWS will then be pressurized via DCS command and monitored by ground controllers for several hours to verify pressure integrity. Any limits associated with these conditions will be determined in conjunction with the development of the Flight Mission Rules.

Several SWS events will be supported or controlled by the ground during the pre-docking period. Some of these are the following:

- A. Turn-on and control of OWS heaters (initiated by ground command) required for thermal conditioning of the SWS before habitation
- B. Activating the VHF ranging system on the OWS
- C. Acquiring the Z-LV attitude mode for rendezvous and reacquiring solar inertial mode prior to docking
- D. Turn-on and control of the SWS activation (tracking) lights and running lights

4 MCC SUPPORT  
PLAN

## SECTION 4 MCC SUPPORT PLAN

### 4.1 GENERAL

MCC operations will be conducted from a central MOCR and assisted by several SSR's, Science Rooms, and other supporting areas similar to those in Apollo operations. These other support areas include the Communications, Command, and Terminal Systems (CCATS) area, the RTCC, the Recovery Operations Control Room (ROCR), the Spaceflight Meteorology Room, a modified Spacecraft Analysis (SPAN) function, and a Data Room function. The following paragraphs discuss the MOCR, the SSR's, and the other supporting areas.

### 4.2 MOCR AND SSR

#### 4.2.1 MOCR and SSR Layout

Figures 4-1 and 4-2 illustrate the MOCR console layout and SSR room layout respectively.

#### 4.2.2 MOCR and SSR Positions/Functions

Figures 4-3 through 4-6 illustrate the MOCR and SSR organizational structure. The following paragraphs contain lists of the MOCR and SSR position functions. The nomenclature used herein is preliminary.

##### 4.2.2.1 MOCR position functions.- The following is a list of the MOCR positions, their functions, and call signs:

##### A. NASA Headquarters

A console will be provided in the MOCR for a NASA Headquarters Representative.



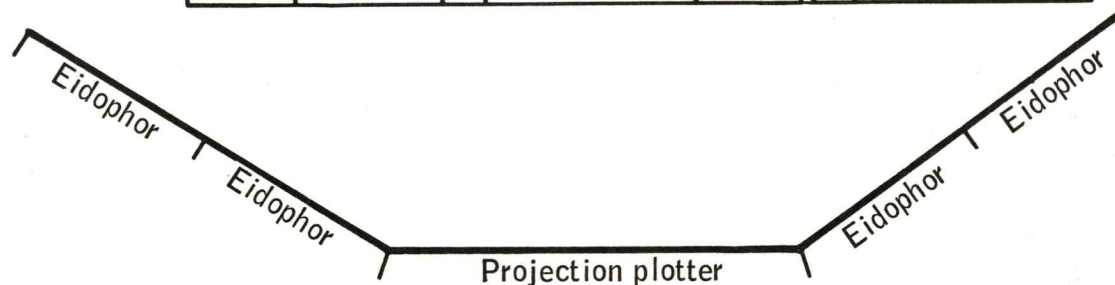
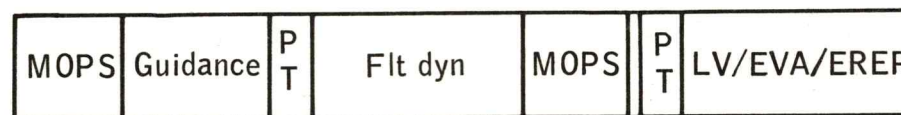
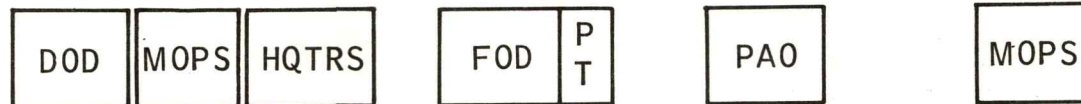
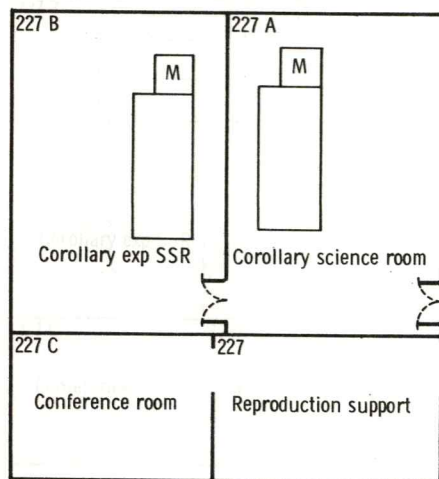
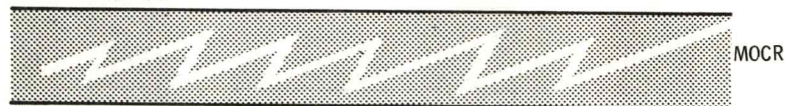
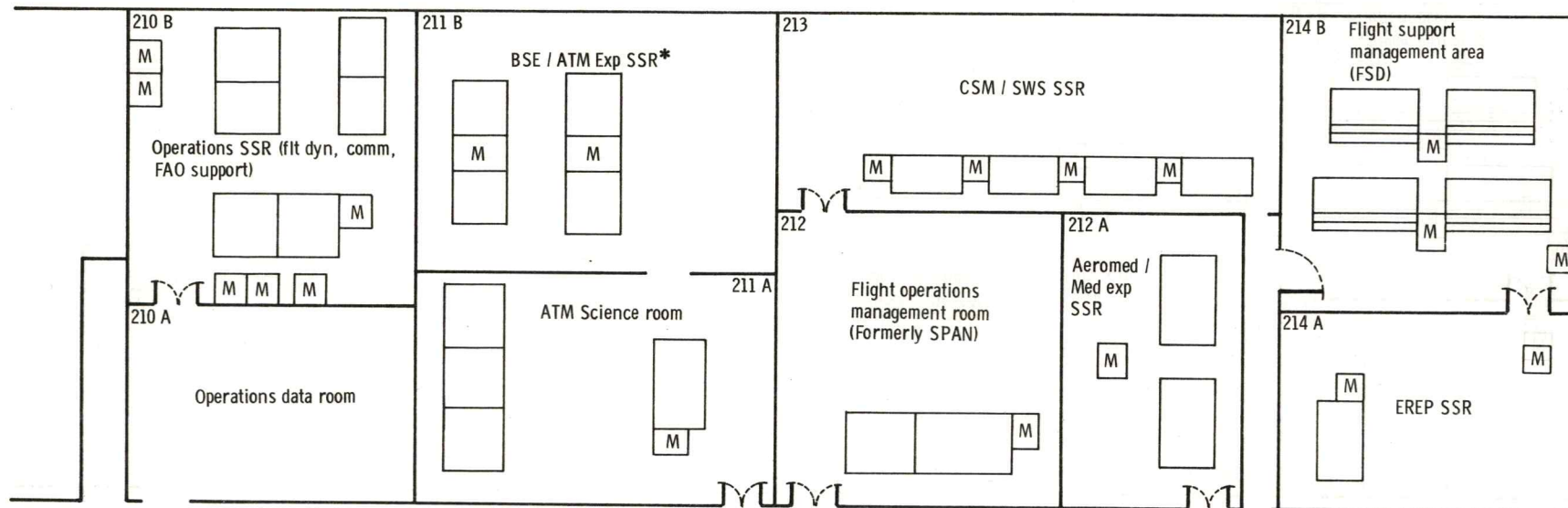


Figure 4-1.- Skylab MOCR layout.



M - MOPS Terminal

\* The booster and the ATM experiment flight controllers will use the same SSR. During prelaunch support through the IU missions, the booster flight controllers will use three consoles. Then these consoles will be reconfigured for experiment support. Reconfiguration will be accomplished by changing a software tape and using overlays for event lights and can be accomplished in less than 15 minutes. Prior to the SL-1 launch and during the unmanned phases, these consoles will be reconfigured as required for support of specific simulations and pad tests.

Figure 4-2. - Skylab SSR layout.

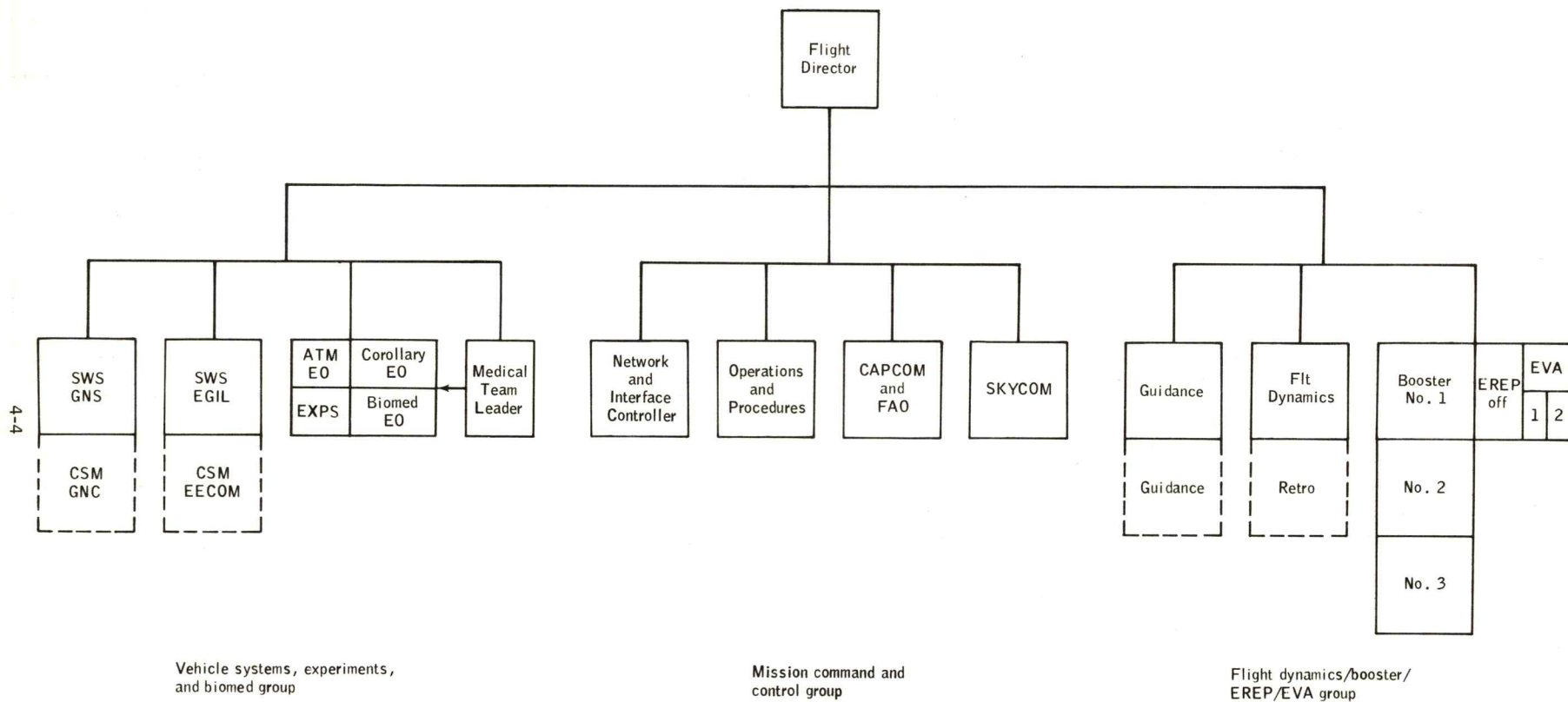


Figure 4-3.- MOCR organizational structure.



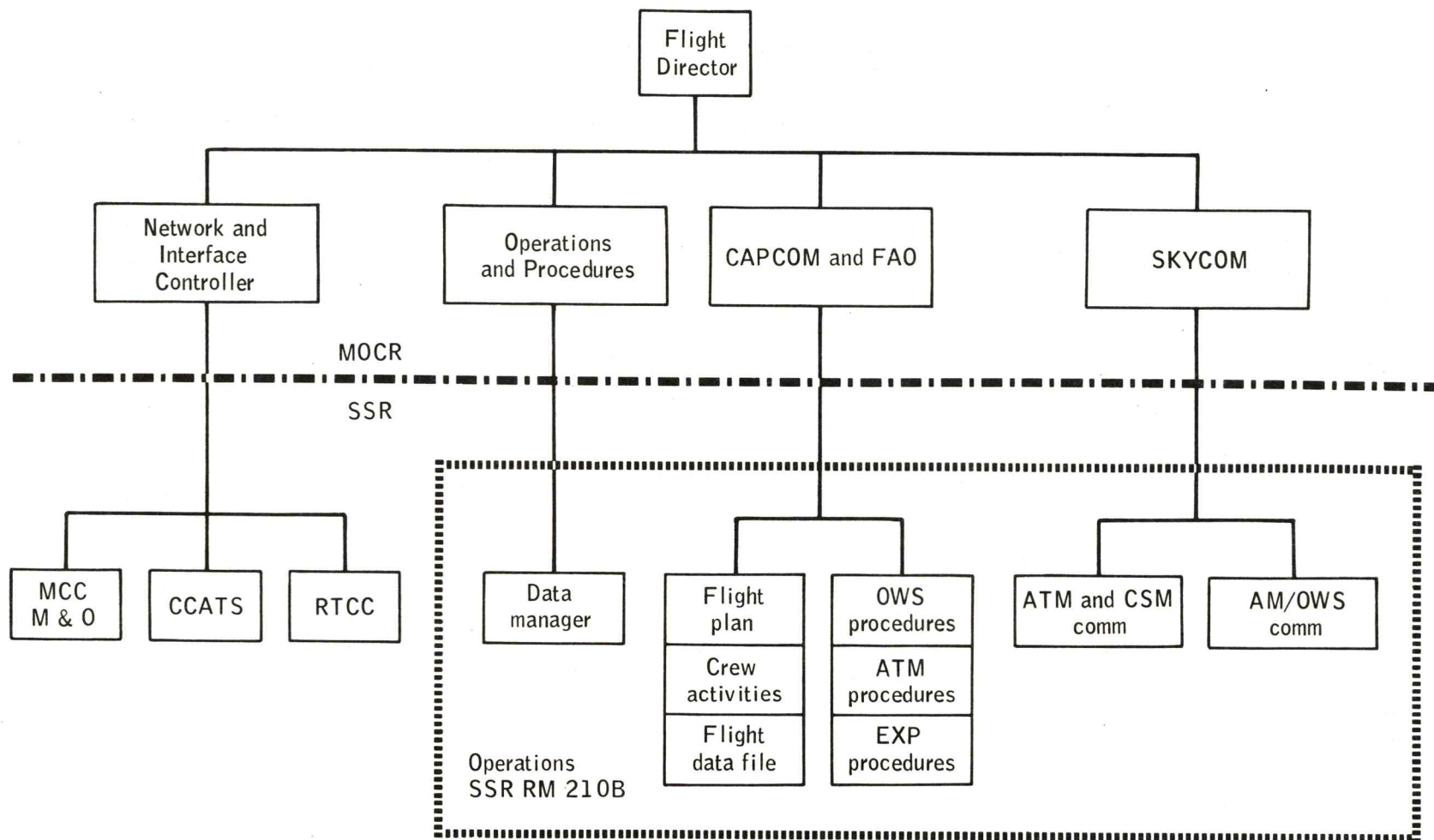


Figure 4-4.- MCCR and SSR organizational structure — mission command and control group.

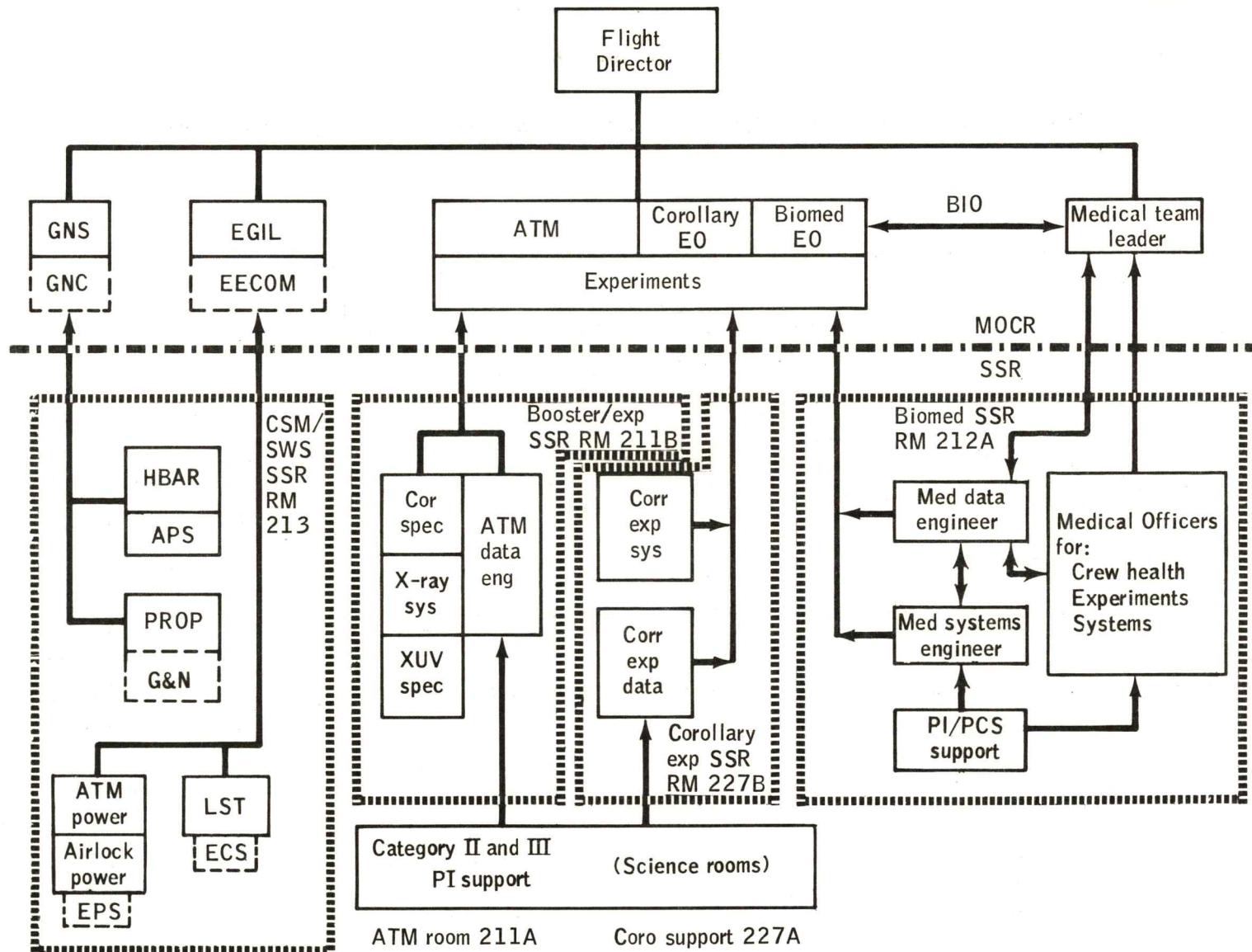


Figure 4-5.- MOCR and SSR organizational structure — vehicle systems experiments, and biomed group.

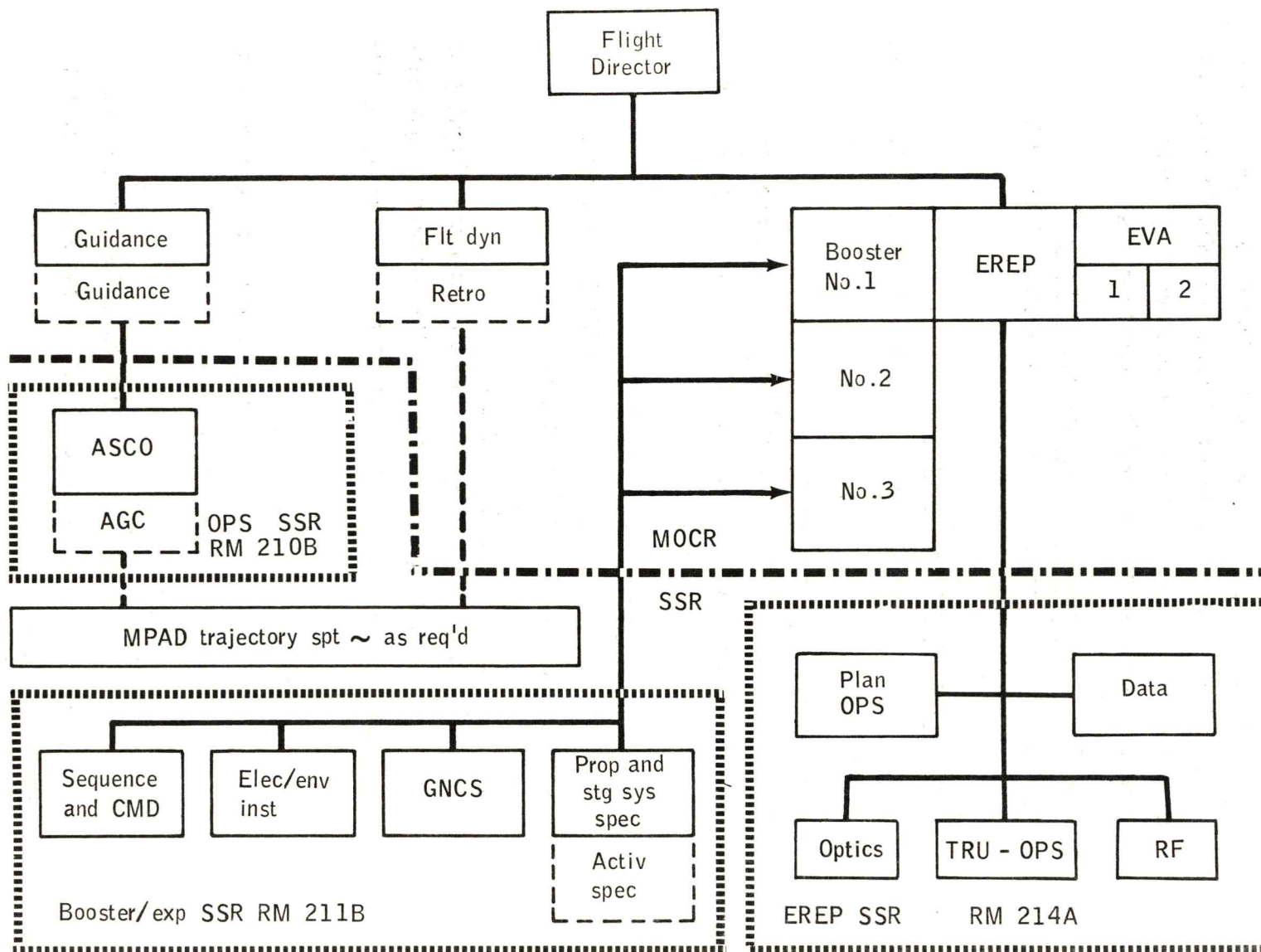


Figure 4-6.- MOCR and SSR organizational structure — flight dynamics/  
booster/EREP/EVA group.



- B. Flight Operations Director ("FOD")  
Responsible to the Director, Manned Spacecraft Center, for all operational aspects of the Skylab spaceflight missions; provides the management interface between the Flight Director and the MSFC and MSC Program Managers.
- C. Department of Defense Representative ("DOD")  
Responsible for coordination and direction of all DOD mission support.
- D. Public Affairs Officer ("PAO")  
Responsible for keeping the public informed on the progress of the mission.
- E. Flight Director ("FLIGHT")  
Responsible for MOCR decisions and actions concerning vehicle systems, vehicle dynamics, experiment operations, and MCC/STDN operations.
- F. Spacecraft Communicator ("CAPCOM")  
Responsible to the Flight Director (FD) for all voice communications with the flight crew.
- G. Flight Activities Officer ("FAO")  
Responsible for developing and coordinating the flight plan and for coordinating all changes to the onboard flight data file. He will also be responsible for coordinating experiment PAD data.
- H. Network Controller ("NETWORK")  
Responsible to FD for the detailed operational control and failure analysis of the ground system.
- I. Interface Controller ("IC")  
Directs the maintenance and operation effort of the MCC and provides a point of contact within the MCC for system interface problems.

- J. Medical Team Leader ("SURGEON")  
Responsible to the FD for the analysis and evaluation of all medical activities, operational and experimental, concerned with the flight.
- K. Communications Systems Engineer ("SKYCOM")  
Responsible to the FD for management and troubleshooting the Orbital Assembly audio, communications, and data storage systems.
- L. Operations and Procedures Officer ("O&P")  
Responsible to the FD for detailed implementation of the MCC/STDN mission control procedures. He is also responsible for the monitoring and operational management of real-time mission data acquisition, retrieval, and processing.
- M. Flight Dynamics Officer ("FIDO")  
Responsible to the FD for computing and monitoring required maneuver activities, maintenance of the orbital ephemeris, and reentry planning. During routine manned orbital periods FIDO also serves as the Retrofire Officer (RETRO).
- N. Guidance Officer ("GUIDANCE")  
Responsible to the FD for monitoring performance of the IU, CMC, and ATMDC guidance and control functions and for providing updated computer information to the CMC and ATMDC as required.
- O. Retrofire Officer ("RETRO")  
Responsible to the FD for computing and monitoring the CSM deorbit maneuvers.

- P. SWS Electrical, General Instrumentation, and Life Support Systems Engineer ("EGIL")  
Responsible to the FD for monitoring and troubleshooting the orbital assembly environmental, electrical, and instrumentation systems. This includes the related CSM systems when the CSM EECOM position is not manned.
- Q. SWS Guidance, Navigation, and Control Systems Engineer ("GNS")  
Responsible to the FD for monitoring and troubleshooting the orbital assembly guidance, control, and propulsion systems. This includes the related CSM systems when the CSM GNC position is not manned.
- R. CSM Environmental and Electrical Systems Engineer ("EECOM")  
Responsible to the FD for monitoring and troubleshooting the CSM environmental, electrical, instrumentation, and sequential systems.
- S. CSM Guidance, Navigation, and Control Systems Engineer ("GNC")  
Responsible to the FD for monitoring and troubleshooting the CSM guidance, navigation, control, and propulsion systems.
- T. Experiments Officer ("EO")  
Responsible to the FD for monitoring operation of the on-board experiment equipment for all corollary experiments and for assessing the validity of the scientific data for these experiments.
- U. Biomedical Experiments Officer ("BIOMED")  
Responsible to the Flight Director for monitoring the status of the medical experiments and maintaining status of the medical experiments hardware.



- V. ATM Experiments Officer ("ATM")  
Responsible to the FD for monitoring operation of the ATM experiment equipment, canister thermal control, and television (TV) systems and for assessing the validity of the ATM scientific data.
- W. EREP Officer ("EREP")  
Responsible to the FD for monitoring operation of the EREP experiments and for assessing the validity of the EREP scientific operation.
- X. EVA Systems Engineer ("EVA")  
Responsible to the FD during EVA activities and certain IVA activities for monitoring and troubleshooting the EVA life support equipment. An EVA assistant who will support the EVA Systems Engineer will also be situated at the EVA console and there will be no SSR support.
- Y. Booster Systems Engineer No. 1 ("BSE 1")  
Responsible to the FD for integrating all SLV activities, executing command action as required, and monitoring S-IC, S-II, and S-IB stage functions and propulsion performance.
- Z. Booster Systems Engineer No. 2 ("BSE 2")  
Responsible for integrating all S-IC and S-II systems and for SWS deployment and activation systems monitoring and troubleshooting for SL-1. For SL-2/3/4, responsible for S-1B and S-1VB stages.
- AA. Booster Systems Engineer No. 3 ("BSE 3")  
Responsible for integrating all IU, electrical, and instrumentation systems monitoring and troubleshooting.

4.2.2.2 Staff Support Rooms and Science Rooms.- The following is a list of the SSR's and Science Rooms, their flight controller positions/functions:

A. Operations SSR

1. Flight Dynamics Support ("FIDO SUPPORT")  
Responsible to FIDO for providing detailed analysis and trajectory support during prelaunch, launch, rendezvous, and entry and for mass properties coordination during all phases.
2. ATMDC Software Control Officer ("ASCO")  
Responsible to Guidance, ATM, FAO, and GNS for providing detailed support for the ATMDC software functions.
3. CMC Specialist ("AGC")  
Responsible to Guidance, FAO, and GNC for providing detailed support for the CMC software functions.
4. Data Manager ("DMAN")  
Responsible to the O&P for the monitoring and operational management of all non-real-time data retrieval, processing, and distribution activities. This includes TV, ADDT, voice, photography and recovered data.
5. AM/OWS Communications ("AMCO")  
Responsible to SKYCOM for monitoring detailed status and trends and for providing malfunction analysis for the AM Communications System.
6. CSM and ATM Communications ("CATCO")  
Responsible to SKYCOM for monitoring detailed status and trends for malfunction analysis for the ATM and CSM communications systems.

7. Crew Activities Scheduler ("TIMELINE")  
Responsible to the FAO for detailed real-time flight planning and the preparation of flight plan updates. Also responsible for monitoring crew activities.
8. Flight Plan Support ("FLASP")  
Responsible to the FAO for recording DTO status, upkeep of the ASP data base, and coordinating with the long range flight planning team.
9. Experiment Procedures ("EXPRO")  
Responsible to the FAO for monitoring experiment crew procedures other than ATM and coordinating any changes to these procedures.
10. OWS Procedures Support ("WORKSHOP")  
Responsible to the FAO for monitoring OWS crew procedures and coordinating all changes to the procedures.
11. ATM Procedures Support ("SOLPRO")  
Responsible to the FAO for ATM crew procedures.
12. Flight Data File Support ("CHECKLIST")  
Responsible to the FAO for maintaining, updating, and validating the Flight Data Files.

B. Booster/ATM Experiments SSR

1. Cluster Activation Systems Specialist ("CAS")  
Responsible for providing in-depth evaluation of the SWS deployment and activation systems functionally sequenced by the IU (SL-1, only).
2. Propulsion and Stage Systems Specialist ("PSS")  
Responsible for providing in-depth evaluation of the S-IVB engine, hydraulic, propellant, and APS systems (SL-2/3/4, only).



3. Sequencing and Command Systems Specialist ("SCS")  
Responsible for providing in-depth evaluation of the launch vehicle sequencing and command systems and of the AM command system.
4. Electrical, Environmental Control, and Instrumentation Systems Specialist ("EECIS")  
Responsible for providing in-depth evaluation of the launch vehicle electrical, instrumentation, and environmental control systems, and the SWS electrical and instrumentation systems.
5. Guidance, Navigation, and Control Systems Specialist ("GNCS")  
Responsible for providing in-depth evaluation of the launch vehicle guidance, navigation, and control systems.
6. ATM Data Engineer ("ATM DATA")  
Responsible to the ATM Experiments Officer for the spectrometers, ATM thermal and TV systems, transmitting ATM commands, and radiation support.
7. H-Alpha/Coronagraph/Scanning Spectrometer ("COR SPEC")  
Responsible to the ATM Experiments Officer for detailed monitoring and troubleshooting of S054 and S056 and for assuring scientific data validity.
8. X-Ray Systems ("X-RAY")  
Responsible to the ATM Experiments Officer for detailed monitoring and troubleshooting of S052, S055, H-Alpha 1 and H-Alpha 2 and for assuring scientific data validity.
9. XUV Spectrometer ("SPECS")  
Responsible to the ATM Experiments Officer for detailed monitoring and troubleshooting of S082A, S082B, and S020 and for assuring scientific data validity.

C. ATM Science Room

The ATM Science Room is a room for the ATM Principal Investigators (PI's) and the NOAA Representative to monitor the mission activities and make inputs (see Paragraph 5.3.2). The room will operate in the same manner as the Apollo Lunar Surface Science Room with a flight controller in charge who interfaces with the BSE/ATM experiment (EXP) SSR and the ATM Experiments Officer. This flight controller position is called ATM Planning Support ("ATM PLANS") and will be responsible to the ATM Experiments Officer for interface with the ATM PI's, and the National Oceanic and Atmospheric Administration (NOAA) for ATM operations. He will also be responsible for coordinating with the FAO and providing assistance to the PI's on the development of the detailed ATM flight plan.

D. SWS/CSM Vehicle Systems SSR1. SWS Attitude and Pointing Control Systems Engineer ("APS")

Responsible to GNS for monitoring detailed status and trends and for providing malfunction analysis for the ATM attitude control system and the OWS TACS system.

2. SWS Control Moment Gyro Systems Engineer ("H-BAR")

Responsible to GNS for monitoring detailed status and trends and for providing malfunction analysis for the ATM control moment gyro system.

3. ATM Power and Instrumentation Systems Engineer ("ATM POWER")

Responsible to EGIL for monitoring detailed status and trends and for providing malfunction analysis for the ATM electrical and instrumentation systems.

4. Airlock Module Power and Instrumentation Systems Engineer ("AIRLOCK POWER")  
Responsible to EGIL for monitoring detailed status and trends and for providing malfunction analysis for the MDA/AM/OWS electrical and instrumentation systems. This will also include the related CSM systems when the CSM EPS position is not manned.
5. SWS Life Support and Thermal Systems Engineer ("LST")  
Responsible to EGIL for monitoring detailed status and trends and for providing malfunction analysis for the MDA/AM/OWS environmental control system. This will also include the related CSM systems when the CSM ECS position is not manned.
6. CSM Propulsion Systems ("PROP")  
Responsible to GNS or GNC for monitoring detailed status and trends and for providing malfunction analysis for the CSM propulsion systems.
7. CSM Guidance and Navigation Systems ("G&N")  
Responsible to GNS or GNC for monitoring detailed status and trends and for providing malfunction analysis for the CSM G&N SCS systems.
8. CSM Electrical Power and Instrumentation Systems Engineer ("EPS")  
Responsible to EGIL or EECOM for monitoring detailed status and trends and for providing malfunction analysis for the CSM electrical, sequential, and instrumentation systems.
9. CSM Environmental Control Systems ("ECS")  
Responsible to EGIL or EECOM for monitoring detailed status and trends and for providing malfunction analysis for the CSM environmental control system.



E. Aeromedical/Medical Experiments SSR

This SSR will be supported by MROD and FCD personnel. Normally the MROD personnel will have one leader in the MOCR and the rest will be "on call." These positions and their functions are listed below.

1. Medical Officer for Crew Health

Responsible to the Medical Team Leader in the MOCR for detailed analysis and evaluation of all activities concerned with crew health. He prepares a daily report on crew health for the Medical Team Conference (see Paragraph 5.3.4.2).

2. Medical Officer for Experiments

This physician is responsible to the Medical Team Leader for the evaluation of the scientific yield from the medical experiments. He provides the interface with the PI/Principal Coordination Scientist (PCS) and Biomedical Engineering Support.

3. Medical Officer for Systems

This MROD physician is responsible to the Medical Team Leader for the medical aspects of the Skylab systems operation. He prepares environmental summaries to support the experiments and prepares a report for the daily Medical Team Conference.

4. Medical Data Engineer ("MED DATA")

This is an FCD position responsible to the Medical Team Leader for obtaining processed data for medical analysis. He is also responsible to the Biomed EO for systems analysis, data, routing status, and data evaluation/validity. He prepares hardware summaries for the FD to support the experiments.

5. Medical Systems Engineer ("MED SYSTEMS")

This is an FCD position responsible to the Medical Data Engineer for analyzing biomedical data to determine hardware anomalies. He assists in all functions performed by the Medical Data Engineer.

F. EREP Experiments SSR

1. EREP Planning Operations Engineer ("PLAN-OPS")

Responsible to the EREP Officer for performing all tasks associated with EREP pass planning.

2. EREP Data Engineer ("EREP DATA")

Responsible to the EREP Officer for data operations, evaluation and status.

3. EREP Truth Data Acquisition Operations Engineer ("TRU-OPS")

Responsible for interfacing with those elements external to flight control which are required to support each data take. These include those elements which acquire the sea, land, or atmosphere based data for correlation with the Skylab EREP data.

4. EREP Optical Systems Engineer ("OPTICS")

Responsible to the EREP Officer for the systems operation and monitoring of S190A, S190B, S191, the Viewfinder Tracking System (VTS), and S192 experiments.

5. EREP RF Systems Engineer ("RF")

Responsible to the EREP Officer for the systems operation and monitoring of the S193 and S194 experiments, the EREP control and display panel, and the tape recorder.

G. EREP Science Room

An EREP Science Room will be available for EREP operations support. Unlike the ATM and Corollary Science Rooms, which are basically rooms for the PI's, the EREP Science Room will be a room for a multidiscipline support team for the EREP operation. The location, size, room equipment, and data facility for the EREP Science Room have not yet been determined.

H. Corollary Experiments SSR

1. Corollary Experiments Systems Engineer ("EXPERIMENT SYSTEMS")

Responsible to the EO for corollary experiment systems analysis and status, scientific objective assessment, and priority change recommendations.

2. Corollary Experiments Data Engineer ("EXPERIMENT DATA")

Responsible to the EO for corollary experiment scheduling, coordinating data requirements, record keeping, and performing contamination assessment.

I. Corollary Science Room

Similar to the ATM Science Room, the Corollary Science Room is a room for the Corollary PI's. The flight controller in charge is called the Corollary PI Coordinator. He will be responsible to the EO for providing the PI/flight controller interface. Except during high activity periods, this function will be performed by the Corollary Experiment Systems Engineer or the Corollary Experiments Data Engineer.

4.2.2.3 Recovery Operations Control Room (ROCR).- The ROCR will be manned around the clock during the manned portion of the mission



in support of the recovery operations discussed in Paragraph 4.3.4. ROCR positions and functions are defined below.

A. Recovery Officer ("RECOVERY")

The Recovery Officer is a NASA representative responsible to the FD for providing the NASA/DOD interface required for any DOD mission support. He is responsible for directing the overall activities of all personnel in the ROCR and the activities of NASA personnel deployed to Recovery Control Centers (RCC's), ships, and Air Rescue and Recovery Squadron (ARRS) bases.

B. Recovery Evaluator ("RECOVERY")

The Recovery Evaluator is a NASA representative responsible for making all the evaluations necessary in selecting the most desirable target points for any situation. He is also responsible for determining the actual splash point for any landing. Also, during peak periods of ROCR activity (launch and recovery), he is to help the Recovery Officer in his duties. And during certain periods he will perform the duties of the "Recovery Display" and "Recovery Data" officers.

C. Recovery Display ("RECOVERY")

Recovery Display is a NASA representative responsible for controlling all ROCR group display equipment and for recording all pertinent information concerning crew and DOD related mission activities and displaying this information on these group displays. He is also responsible for communicating with deployed NASA representatives.

D. Recovery Data ("RECOVERY")

Recovery Data is a NASA representative responsible for using the ROCR MOPS, Control Data Corporation (CDC) terminals, and the mission operations computer (MOC) system to

obtain any required data. Additionally, he is responsible for directing any activities necessary in obtaining data from any offline source.

E. DOD Manager ("DOD MANAGER")

The DOD Manager for Manned Spaceflight Support is the DOD point of contact for DOD/NASA related activities. He is responsible for directing the activities of all DOD elements supporting NASA activities.

F. DOD Executive Officer ("DOD")

The DOD Manned Space Flight Support Office (DDMS) representative is responsible to the DOD Manager for directing the activities of DOD personnel and forces assigned to NASA's efforts.

G. DOD ARIA Coordinator ("DOD ARIA")

A DDMS representative responsible for keeping Apollo range instrumentation aircraft (ARIA) personnel advised of mission activities, and for keeping the DOD Executive Officer advised of ARIA activities.

H. DOD Coordinator ("COORDINATOR")

A DDMS representative responsible for helping and backing up the DOD Primary Ops and DOD Recorder.

I. DOD PRIMARY OPS ("PRIME OPS")

A DDMS representative responsible to the DOD Executive Officer for communicating with DOD personnel at RCC's.

J. DOD Recorder ("RECORDER")

A DDMS representative responsible to the DOD Executive Officer for logging DOD activities.

K. DOD Public Information Officer (PIO) ("DOD PIO")

A DDMS representative responsible to the DOD Executive

Officer for directing the release of information related to DOD NASA-related activities.

L. DOD Communications Coordinator ("OSBORNE")

These DDMS representatives (2 positions) are responsible to the DOD Executive Officer for assuring that the Recovery Communications Network is operational.

M. Recovery Logistics Support ("LOGISTICS")

Recovery Logistics Support is a NASA representative responsible to the Recovery Officer for arranging the movement of recovery related equipment; for integrating changes in CM power down procedures and the removal of equipment and experiments from the CM; for keeping personnel external to the MCC advised of the crew, sample, and CM logistics return schedules; and for scheduling the equipment required for receiving the crew and samples when they arrive at Ellington.

4.2.3 Manning by Mission Phase

Table 4-I indicates the MOCR and SSR manning for the following mission phases:

- A. SL-1 unmanned launch through activation
- B. SL-2, 3, and 4 manned launches through rendezvous
- C. Manned orbital periods
- D. Reentries
- E. Unmanned phase active support
- F. Unmanned phase reduced monitoring support

4.2.4 Manned Orbital Period Shift Scheduling

- 4.2.4.1 Scheduling factors.- An extensive analysis has been performed by the Flight Control Division of several shift scheduling



TABLE 4-I.- SKYLAB MOCR AND SSR MANNING<sup>a</sup>

POSITION*	MISSION PHASE						POSITION*	MISSION PHASE					
	SL-1 LAUNCH THROUGH ACTIVATION	SL-2, 3, AND 4 LAUNCH THROUGH RENDEZVOUS	MANNED ORBITAL	REENTRY	UNMANNED PHASE ACTIVE SUPPORT <sup>b</sup>	UNMANNED PHASE REDUCED MONITORING <sup>b</sup>		SL-1 LAUNCH THROUGH ACTIVATION	SL-2, 3, AND 4 LAUNCH THROUGH RENDEZVOUS	MANNED ORBITAL	REENTRY	UNMANNED PHASE ACTIVE SUPPORT <sup>b</sup>	UNMANNED PHASE REDUCED MONITORING <sup>b</sup>
FD	X	X	X	X	X		SURGEON		2,3 <sup>e</sup>	X <sup>f</sup>	2,3 <sup>e</sup>		
SKYCOM	X	X	X	X	X	A	MEDICAL OFF FOR CREW HEALTH		X	X <sup>d</sup>	X		
O&P	X	X	X	X	A	A	MEDICAL OFF FOR EXP			X <sup>d, g</sup>			
DMAN	X	X	X	X	A	A	MEDICAL OFF FOR SYSTEMS			X <sup>d</sup>			
AMCO	X	X	X	X			BIOMED	X	X	X		X <sup>j</sup>	
CATCO	X	X	X	X			MED SYSTEMS			X			
EECOM		X		X			MED DATA			X			
GNC		X		X			EO	X	X	X			
PROP		X	B	X			COROLLARY SYSTEMS	F	F	X			
G&N		X	B	X			COROLLARY DATA	F	F	X			
ECS		X	C	X			COROLLARY PI COORD			X <sup>h</sup>			
EPS		X	D	X			ATM			X		X	X
EGIL	X	X	X	X	X	X	ATM DATA			X		X	
GNS	X	X	X	X	X		CORSPEC			X		X	
APS	X	X	X	X	X		X-RAY			X			
H-BAR	X	X	X	X	X		SPECS			X			
LST	X	X	C	X	X		ATM PLANS			X			
ATM POWER	X	X	X	X	X		EREP OFFICER			X <sup>k</sup>			
AIRLOCK POWER	X	X	D	X	X		EREP PLAN OPS			X <sup>k</sup>			
EVA			2 <sup>c</sup>				EREP DATA			X <sup>k</sup>			
FIDO	2	2	X	2	X <sup>i</sup>		EREP TRU-OPS			X <sup>k</sup>			
RETRO			X <sup>d</sup>	X			EREP OPTICS			X <sup>k</sup>			
GUIDANCE	X	X	X	2	E	X	EREP RF			X <sup>k</sup>			
FIDO SUPPORT	X	2	X <sup>d</sup>	2			BSE 1	X <sup>l</sup>	X <sup>m</sup>				
ASCO	X	X	X	X	E		BSE 2	X <sup>l</sup>	X <sup>m</sup>				
AGC		X	X <sup>d</sup>				BSE 3	X <sup>l</sup>	X <sup>m</sup>				
NC	2	2	2	2	X	X	CAS	X <sup>l</sup>					
IC	X	X	X	X	X	X	PSS		X				
CAPCOM	X	X	X	X	X <sup>i</sup>		SCS	X <sup>l</sup>	X				
FAO	X	X	X	X			EECIS	X <sup>l</sup>	X				
TIMELINE		X	X	X			GNCS	X <sup>l</sup>	X				
FLASP		X	X				ROCR		4 <sup>n</sup>	2 <sup>n</sup>	4 <sup>n</sup>		
EXPRO		X	X										
WORKSHOP		X	X										
SOLPRO		X	X										
CHECKLIST		X	X										

\*FOMR(SPAN) positions are discussed in Paragraph 4.3.1.

## Footnotes

<sup>a</sup>Legend: X indicates the position is manned for that phase. Letters other than X (i.e. A, B, C, D, E, and F) indicate the flight control function is combined with one or more other functions and is performed by a single operator. All functions designated by the same letter will be performed by a single operator for that phase. The numbers 2, 3, and 4 indicate the number of operators manning the position.

<sup>b</sup>Individual flight controller specialties will operate from MOCR or SSR positions as appropriate.

<sup>c</sup>Required only for EVA's and certain IVA activities.

<sup>d</sup>On call only.

<sup>e</sup>One Flight Surgeon in the MOCR and one or two in the SSR.

<sup>f</sup>For EVA, some suited IVA, and the initial occupancy and verification of the SWS, there will be a Flight Surgeon in the MOCR and one or two surgeons in the SSR, along with a biomedical engineer. During other periods, the MOCR may be manned by a medical technician or biomedical engineer with a Flight Surgeon only periodically manning the MOCR, but always on call.

<sup>g</sup>May be several Experiment Specialists.

<sup>h</sup>This function will be performed by COROLLARY SYSTEMS or COROLLARY DATA except during periods of high corollary experiment activity.

<sup>i</sup>Support required several hours per day (one shift maximum) depending on flight planning requirements.

<sup>j</sup>Support required periodically to perform contamination assessment.

<sup>k</sup>Manned as appropriate to plan and accomplish the EREP experiment passes.

<sup>l</sup>When the IU mission is complete, the booster team will terminate SWS support and recycle for prelaunch support to SL-2, which at this time is estimated to begin 9 to 10 hours before lift-off.

<sup>m</sup>Booster manning will be continual beyond rendezvous for M415 and S150 experiments support.

<sup>n</sup>NASA personnel only (no DOD).

combinations for support of the Skylab missions. In considering these combinations, the following factors were recognized.

- A. The effective utilization of all qualified personnel is of the utmost importance because of the shortage of flight control personnel.
- B. A minimum of four teams is considered practical due to the long duration of the mission. Three teams will not allow for days off from lift-off to splashdown.
- C. Each team must work a minimum of 40 hours each week.
- D. Overtime should be minimized.
- E. Daily on/off cycles must be equitable for all teams. This means that all teams should work all shifts evenly.
- F. Office time for each team is highly desirable but not mandatory. This time is desirable for planning and routine office work.

4.2.4.2 Schedule recommendation.-- As a result of FCD's analysis, the following shift schedules are recommended for the Skylab missions.

A. SL-2

For SL-2, a four-team schedule is recommended with each team working basic 8-hour shifts. This schedule, currently in wide use by industry, satisfies the 40-hour-per-week requirement, minimizes overtime, is equitable, and allows a reasonable amount of time off. However, the four-team schedule does not allow console workers periodic office time to plan for the upcoming missions.

With this four-team schedule, FCD intends to provide on-the-job MCC training for several non-console personnel



from the Mission Simulation and Requirements Branch (MSRB). These people have an excellent knowledge of the mission, experiments, and systems, but lack console experience in the real-time mission environment. This approach provides necessary training for otherwise qualified personnel and furnishes more personnel for support of the longer-duration SL-3 and SL-4 flights. More personnel will allow five teams to be used for SL-3 and SL-4. The recommended four-team schedule for SL-2 is shown below; the numbers in the blocks represent team numbers. The Midnight shift works from midnight to 8:00 o'clock; the Day shift "basically" from 8:00 to 4:00 o'clock; and the Evening shift from 4:00 to 12:00 o'clock. (In reality, the day shift will be required to work roughly 10 hours per day to provide an overlap with the morning and evening shifts for shift briefing and handover purposes).

SL-2 Flight Control Manning Schedule - 4 Teams

Midnight	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	1	1
Day	2	2	2	2	3	3	3	3	4	4	4	4	4	1	1	1	1	1	2	2	2
Evening	3	3	4	4	4	4	4	4	1	1	1	1	1	1	2	2	2	2	2	3	3

B. SL-3 and SL-4

As indicated in the above paragraph, a five-team schedule will be used for SL-3 and SL-4. Again, these teams will work in 8-hour shifts, and the shifts will be rotated. A 5-day-on/2-day-off schedule is recommended which results in no overtime, and allows office time 4 out of 5 days each week. This schedule, shown on the following page, also does not require a flight controller to work in the office on the day after coming off the console or on the day before going back on the console.



SL-3 Flight Control Manning Schedule - 5 Teams

Midnight	5	1	1	1	1	1	2	2	2	2	3	3	3	3	3	4	4	4	4	4	5	5	5	5	5	1	1	
Office		2	2	2	2				3	3		4	4				5	5	5	5			1	1	1		2	
Day	3	3	3	3	3	4	4	4	4	4	5	5	5	5	5	5	1	1	1	1	1	2	2	2	2	3	3	3
Evening	4	4	4	5	5	5	5	5	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4

SL-4 Flight Control Manning Schedule - 5 Teams

Midnight	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	4	4	5	5	5	5	5	5	1	1	1	1	1
Office		2		3	3	3			4	4	4	4				5	5		1	1				2	2	2	2	
Day	3	3	4	4	4	4	4	4	5	5	5	5	5	1	1	1	1	2	2	2	2	2	2	2	3	3	3	4
Evening	5	5	5	5	5	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	4	4	5	5	5	5

4.3 MISSION SUPPORT OPERATIONS

4.3.1 Flight Operations Management Support

4.3.1.1 Functions.- In the Apollo Program, the spacecraft analysis (SPAN) activity served as an interface between the flight operations organization and the Apollo Spacecraft Program Office (ASPO). This interface was required by the FOD for detailed technical support from the design, checkout and testing organizations through the ASPO representative. This support consisted primarily of engineering judgement of the design personnel on the operation of the vehicle systems in off-nominal situations. The SPAN interface also provided the Program Office and other program elements with a system for making recommendations to the flight operation and served as a channel for receiving and evaluating certain near-real-time information and summary data as the operation progressed. For the Skylab Program, the MSC Skylab Program Office will provide a similar interface capability for the MSC spacecraft and experiment hardware and

for MSC flight software. Similarly, the Marshall Space Flight Center will provide an interface for the MSFC-designed or MSFC-contracted flight systems software, and experiments. For Skylab, the designation of this function will be changed to Flight Operations Management Support, and the designation for the present SPAN room will be changed to the Flight Operations Management Room (FOMR).

An additional role of the FOMR will be to accommodate the complexities of specifying mission activity priorities (on request from the flight operations team) where no clear-cut guidelines have been established or where mission problems necessitate tradeoffs. Thus, the FOMR operation will accomplish the following major functions. First, it will provide detailed technical support to the flight operations team for all flight systems hardware and software. Second, it will have a modified role in providing required policy level adjustments to the experiment priorities and planned mission activities as the flight progresses. Finally, the FOMR operation will provide support to the Skylab Flight Management Team (reference memorandum from Mr. Dale O. Myer, subject: Skylab Flight Management Proposal, dated March 8, 1972).

The FOMR operation will also provide periodic experiment and systems status reports on the progress of the mission. These status reports (daily and weekly) will be used to keep management informed of mission status (see Paragraph 3.8.9). A representative of the Skylab Program Director will be situated within the FOMR to provide the necessary status information to NASA Headquarters.

The Flight Operations Management Support organization is illustrated in Figure 4-7 on page 4-45. The following paragraphs discuss the parts of this organization, its facilities, and the general method of anomaly resolution. This discussion is

followed by a discussion of the FOMR support for the unmanned phases. The new function of providing experiment priorities is discussed in Section 7.

4.3.1.2 Flight Operations Management Room (FOMR).— The FOMR is located in Room 212 in the Building 30 MCC. See Figure 4-2 for a floor plan of the FOMR. It is connected to the MOCR through consoles manned by flight operations personnel. The organization, functions, and staffing of the FOMR are discussed in the following paragraphs.

A. Organization

The FOD FOMR Manager will have overall responsibility for conducting flight operations management support activities. He will be assisted in his responsibilities by both the MSC Senior Program Office Representative, and the MSFC Senior Program Office Representative. He will also be supported by an FCD Spacecraft Systems Engineer and an FCD Experiment Controller. The FOD FOMR Manager will have responsibility for FOMR recommendations on all subjects which are to be interfaced with the flight control operations activity and he will be responsible for required communications with the Flight Director or other flight operations management personnel. Problems which affect both MSC and MSFC mission objectives or which relate to the responsibilities of both program offices will be worked out by agreement between the MSC and MSFC Senior Program Office Representatives. If agreement is not reached, the FOD FOMR Manager will provide a summary recommendation to the FD and the Director of Flight Operations. This recommendation will note any disagreements within the FOMR on a proposed course of action. An appeal route will



be available through the Flight Operations Directorate (FOD) and other MSC and MSFC channels.

B. FCD FOMR Support

The FCD controllers supporting the FOD FOMR Manager will be situated at consoles within the FOMR. The Spacecraft Systems Engineer will interface with vehicle systems flight controllers in the MOCR and SSR's for SWS and CSM subsystem operation and will coordinate FOMR spacecraft systems and software anomaly resolution work. The FCD Experiment Controller will interface with the MOCR experiment flight controllers, coordinate FOMR experiment systems anomaly resolution work, and coordinate experiment policy work with the program offices (see Section 7). These controllers will be responsible for all communications with working-level flight operation.

1. The duties of the FCD Spacecraft Systems Engineer in the FOMR are:
  - a. To interface MOCR spacecraft systems flight controllers with the support capabilities of all non-Flight Operations program elements.
  - b. To prepare Mission Action Requests for MOCR spacecraft systems flight controllers.
  - c. To track the progress of all Mission Action Requests initiated for MOCR spacecraft systems flight controllers.
  - d. To keep MOCR spacecraft systems flight controllers informed of any and all non-Flight Operations program element activity that may directly or indirectly influence their respective systems.

- e. To keep all FOMR elements fully informed as to current Flight Operations Team intentions with respect to spacecraft systems operation, management and control.
  - f. To filter all Mission Action Request traffic both to the FOMR from the Flight Operations Team and from the FOMR to the Flight Operations Team for the purpose of maintaining a coherent, relevant flow of information between these two organizations in the spacecraft systems area.
  - g. To represent the MOCR spacecraft systems flight controllers in any and all FOMR activities.
2. The duties of the FCD Experiments Controller in the FOMR are:
- a. To interface MOCR experiment flight controllers with the support capabilities of all non-Flight Operations program elements.
  - b. To prepare Mission Action Requests for MOCR experiments flight controllers.
  - c. To track the progress of all Mission Action Requests initiated for MOCR experiment flight controllers.
  - d. To keep MOCR experiment flight controllers informed of all non-Flight Operations program element activity that may directly or indirectly influence their respective experiments.
  - e. To keep all FOMR elements fully informed on current Flight Operations team intentions with regard to experiment systems operations management, and control.

- f. To filter all Mission Action Request traffic between the FOMR and the Flight Operations Team to maintain a coherent relevant flow of information.
- g. To represent the MOCR experiment flight controllers in all FOMR activities.

C. MPAD FOMR Support

For Skylab, Mission Planning and Analysis Division (MPAD) will perform a similar type of support it provided for the Apollo SPAN operation. This includes a variety of activities ranging from trajectory and mission planning to mass property data, and performance and consumables analyses. MPAD FOMR manning requirements will be evaluated during the course of the mission, and will initially be one shift per day.

D. MSC Program Office FOMR Team

the MSC Program Office FOMR Team will be made up of the MSC Senior Program Office FOMR Representative and his staff. This team will provide the only formal interface between the MCC flight operations team and the MSC Skylab Program Office elements. The MSC Program Office FOMR team will carry out its responsibility in conjunction with the FOD FOMR Manager and the MSFC Skylab FOMR Team. As shown in Figure 4-7 on page 4-45, an area has been assigned within the FOMR for the MSC Skylab Program Office Representative and his staff. Prime functions of the MSC FOMR team are the following:

1. To obtain a response to questions through the FOMR Manager from the Flight Operations Team concerning the performance, design, and limitations of the CSM vehicle, its systems, and MSC-responsible experiments hardware.



- 2. To evaluate mission requirements (experiments, DTO's, et cetera) in terms of current capabilities, objectives accomplished, and mission time remaining for the purpose of recommending changes in experiment and DTO requirements and priorities.
- 3. To ensure that the mission requirements and changes to the mission requirements and experiment priorities are properly implemented in the real-time mission planning.
- 4. To support the FOD FOMR Manager in the preparation of the Flight Director's daily report.
- 5. To review and approve all requests for information from the Mission Evaluation Room (MER) in Building 45 and to assure unity of response.
- 6. To advise MER personnel of potential problems of concern to the MCC staff.

E. MSFC FOMR Team

The Marshall Space Flight Center will also provide support to the FOD-MSC real-time operations in the FOMR. The FOMR will be the MSFC Skylab Program Manager's primary interface with the mission. All official MSFC position inputs will be made through the FOMR. The MSFC Skylab Program Manager will be represented by the MSFC Senior Program Office Representative and his staff in the FOMR. Prime functions of the MSFC FOMR team are similar to those of the MSC FOMR team, and are as follows:

- 1. To answer questions through the FOMR Manager asked by the flight operations team on the performance, design, and limitation for all MSFC-designed or MSFC-contracted flight hardware, software, and experiments.

2. To review and approve all requests for information from the Huntsville Operations Support Center (HOSC).
3. To evaluate mission status in terms of current capabilities, objectives accomplished, mission time remaining, and to recommend changes in experiments and DTO requirements.
4. To support the FOD FOMR manager in the preparation of the daily report.
5. To advise the HOSC on mission status in sufficient detail to ensure HOSC is aware of all mission accomplishments and potential problems.
6. To represent the Saturn Program Manager during SL-1 launch vehicle operations. (SL-2, 3, and 4 launch vehicle support will be the same as for Apollo missions.)
7. To provide MSFC systems simulations as requested for systems performance or contingency analysis on the following:
  - a. APCS Simulator
  - b. Power system breadboard
  - c. Thermal control system math model

These are further discussed in Paragraph 4.3.1.5.

F. Headquarters Representative

A person from NASA Headquarters will have a permanent FOMR position to represent the Skylab Program Director in FOMR activities. This representative will provide the interface with NASA Headquarters for status reports and inputs to the FOMR operation.

G. FOMR Mission Action Request

Figures 4-8 and 4-9 illustrate the general flow within the Flight Operations Management Support Organization for the resolution of anomalies. The tasks for the Flight

MOCR flight controllers	<ul style="list-style-type: none"> <li>• Initiate action request</li> </ul>
FCD spacecraft systems engineer FCD experiments controller	<ul style="list-style-type: none"> <li>• Review action request</li> </ul>
FOD FOMR manager	<ul style="list-style-type: none"> <li>• Review request</li> <li>• Approve/disapprove</li> <li>• Assign action</li> </ul>
MSFC senior rep MSC senior rep	<ul style="list-style-type: none"> <li>• Discuss action request</li> <li>• Approve/reject</li> <li>• Assign action</li> </ul>
HOSC manager MER manager	<ul style="list-style-type: none"> <li>• Discuss Action</li> <li>• Accept/reject</li> <li>• Complete action</li> </ul>
MSFC senior rep MSC senior rep	<ul style="list-style-type: none"> <li>• Discuss response</li> <li>• Accept/reject/modify</li> </ul>
FOD FOMR manager	<ul style="list-style-type: none"> <li>• Discuss response</li> <li>• Accept/reject</li> </ul>
FCD spacecraft systems engineer FCD experiments controller	<ul style="list-style-type: none"> <li>• Review response</li> <li>• Accept/reject</li> </ul>
MOCR flight controller	<ul style="list-style-type: none"> <li>• Accept/reject response</li> </ul>

↓  
Action closed

Figure 4-8.- Action request flow, flight controller initiated.



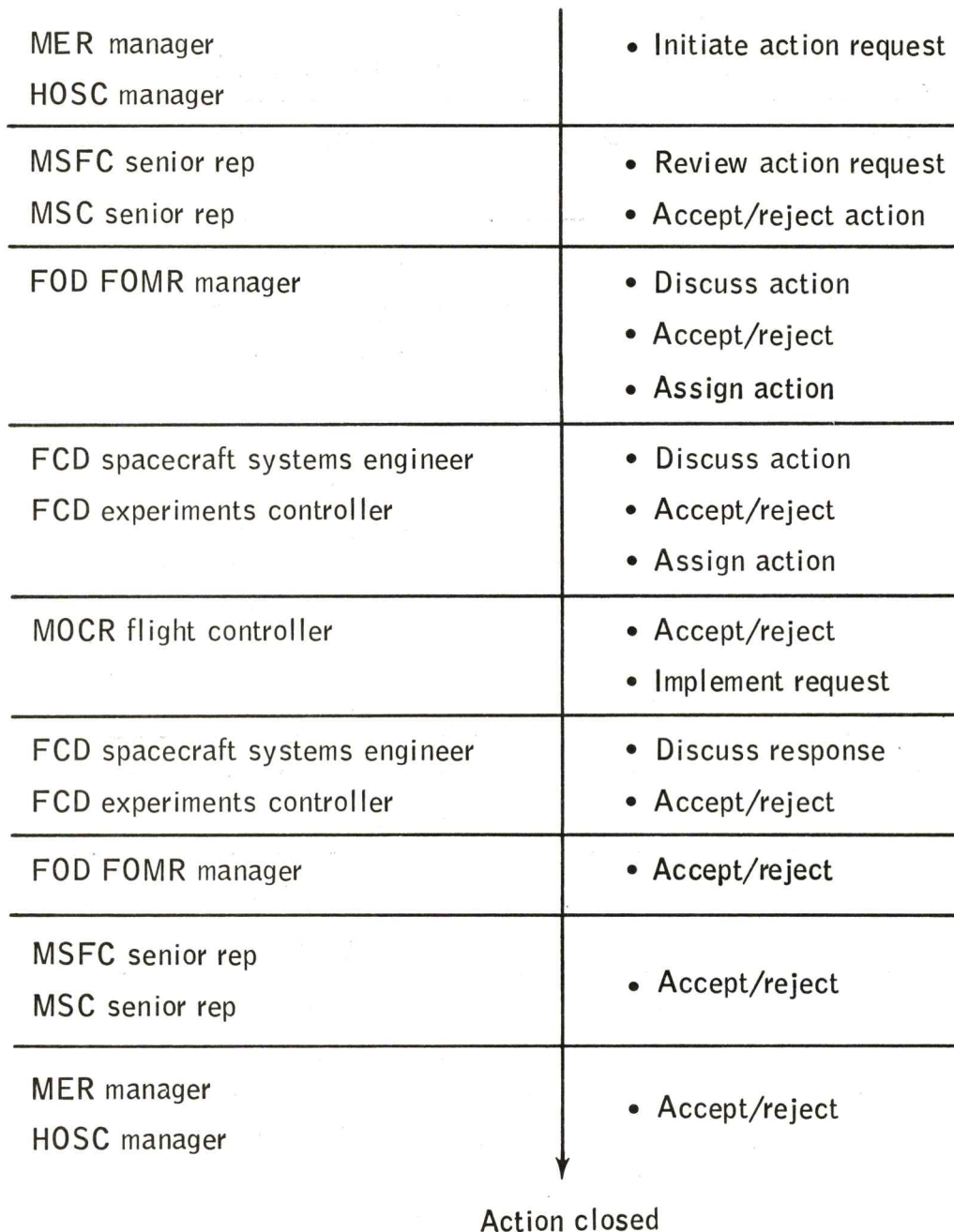


Figure 4-9.- Action request flow, FOMR initiated.

Operations Management Support team will be formulated by the applicable MOCR and SSR flight controllers in conjunction with either the FCD FOMR Spacecraft Systems Engineer or the FCD Experiment Controller. The tasks will be approved by the FOD FOMR Manager and given to the applicable FOMR Program Office Representative (MSC or MSFC or both). The FOMR Program Office Representatives will pass the task to the MER or HOSC and to contractor representatives as applicable. The task results will be passed back through the FOMR Program Office Representatives to the FOD FOMR Manager and FCD FOMR Engineer and on to the MOCR controllers.

#### H. FOMR Unmanned Phase Support

During the unmanned intervals between the CSM flights, the FOMR function will not be required on an active basis for anomaly resolution, and the FOMR manning will be reduced after SWS deactivation. The decision of when to reduce FOMR support will be made by the Flight Director and will be based on SWS systems status following deactivation. The MER and HOSC may also levy action requests on the MOCR operations through the FOMR. Formal review and approval of these requests through the FOMR will be required.

Normal manning in the FOMR during the unmanned periods will consist of the FOD FOMR Manager (duty officer), the MSC Mission Staff Engineer, the MSFC FOMR Resident Manager, and the ATM Experiments Manager. When vehicle performance or anomalies impact or jeopardize the SWS or upcoming flights, full or increased FOMR staffing will be called up. The duty officer will notify the Flight Director, who will then direct Flight Operations team and FOMR callup of the required personnel and facilities.

Contractor support personnel will be called on an "as-available" basis, and are not required to be available on an "on-call" basis during the unmanned intervals. A time delay until the next normal working day will be acceptable, although an attempt will be made to assemble an anomaly team if the situation warrants such action.

The FOMR function will be fully reactivated shortly before the next CSM launch. Again, the Flight Director will decide when this reactivation should occur.

I. FOMR personnel training

Training for the FOMR personnel, including the program office personnel, will consist primarily of participation in mission simulations. These training requirements are defined in Paragraph 8.7.

4.3.1.3 Mission Evaluation Room (MER).- The MER functions, manning, and procedures are discussed below.

A. Functions

The function of the Mission Evaluation Room within Building 45 at MSC will be to support the MSC Skylab Program Office FOMR Representative for all mission activities and analyses related to MSC-designed or MSC-contracted systems or experiments hardware. The activities within the Mission Evaluation Room will be directed and coordinated by an MER Manager. It will be the responsibility of the MER Manager to provide a single coordinated output to the MSC Program Office FOMR Representative, presenting the consolidated position of the MER organization for all queries from the FOMR and for any output which the Mission Evaluation Room desires from the FOMR organization. All inputs to the FOMR or responses to questions from the FOMR will flow from the



MER Manager to or from the MSC Program Office Senior Representative, and this will be the only official channel of communications between the two organizations.

Additional MSFC personnel required for temporary support of SL-1 activation will also be located in the MER. These people will be directly responsible to the MSFC Senior Program Office Representative in the FOMR.

B. Manning and Procedures

The plans and procedures for the operation of the MER will be prepared by the Chief, Test Division, Apollo Spacecraft Program Office (ASPO). MSC organizations will be expected to provide personnel to support the Test Division Chief in performing the evaluation and mission support functions. Personnel required will include trajectory analyses personnel, CSM and experiment systems design personnel, voice transcription personnel, and contractor personnel. MSC organizations will be expected to provide the same type of support as for previous missions.

MER personnel will not necessarily be on duty at all times, but only as the mission phases or activities dictate. A comprehensive plan for this support will be established by the Manager of the MSC Skylab Program Office and approved by the Director of the Manned Spacecraft Center. Many elements of the Building 45 MER will be on a skeleton-crew basis for much of the operation, with representatives present only for peak activities involving the hardware for which they are responsible. The MER manager will maintain the capability throughout the mission to contact key personnel at the various contractor plants and facilities in order to provide such analysis and engineering work as required to support the operation.

4.3.1.4 MSC simulation support.- The simulator facilities at MSC may be used during mission operations to develop or refine crew procedures and techniques. Usage of these facilities will be requested by the FOMR to the FAO with a Mission Action Request. MPAD personnel will develop the necessary simulation data package to support the Mission Action Request. This data package will be submitted to the FAO who is responsible for scheduling the appropriate simulator facilities and personnel. The results will be returned from the simulator area to the FAO who will deliver and discuss the run with the FOD FOMR Manager.

4.3.1.5 HOSC, Marshall Space Flight Center.- The functions, organization and manning of the HOSC are discussed on the following page. Although the charter of the Huntsville operations support organization is to provide support to both KSC prelaunch and MSC flight operations plus support to both the Saturn and Skylab MSFC program organizations, only the MSC flight operations are addressed here.

A. Functions

The MSFC FOMR team will interface directly with HOSC for solutions to hardware and software problems on MSFC-responsible systems. The HOSC will function in direct support of the MSFC Senior Program Office Representative throughout the program for both manned and unmanned phases. This support will be directed and coordinated by the HOSC Operations Support Manager, who will serve as the single point-of-contact for the MSFC inputs to the mission. This will be the official channel of program communications to support and direct the flight activity. However, an alternate or bypass channel will exist from MSFC program management to the Flight Operations Directorate for policy resolution.

The MSFC FOMR team has the responsibility of keeping the HOSC fully informed of mission progress with emphasis on potential problems that may occur.

B. Organization

The HOSC will be staffed with personnel from the MSFC program and engineering line organizations. As now planned, the HOSC Operations Support Manager will be directly assisted by an Operations Coordination Staff. The Operations Coordination Staff will be responsible for overall coordination and direction of all operations support activities including integrating the MSFC inputs to the FOMR operations reports.

C. Manning

Manning will be adjusted in accordance with the level of mission activity. During high-level mission activities, manning will be around-the-clock.

4.3.1.6

MSFC simulation support.- As indicated in Section 3, a number of support activities at MSFC will provide special systems simulations functions to supplement MCC capabilities. These activities generally use existing engineering development hardware and math models not provided at the MCC and can provide support on a contingency or scheduled basis. The support activities are listed below.

A. Target Update Team

This team will work closely with the MCC flight dynamics personnel and will verify the performance capability of the S-IB vehicle to achieve the target conditions computed by the MCC from SWS tracking information. A six-degree-of-freedom simulation will be run. After verification, the target parameters will be entered into the S-IB Launch vehicle digital computer (LVDC).



B. APCS Simulator Facilities

The APCS simulator facilities consist of several breadboard, hardware, and computer math model systems established to develop and verify ATMDC software and APCS characteristics. These facilities can be called up as required by the MCC through the FOMR for troubleshooting the APCS and verifying any ATMDC software changes.

C. Power Systems Breadboard

This MSFC breadboard will be available during the mission for callup by the MCC through the FOMR. This power systems breadboard uses flight type hardware and can be used for modeling the operation and interaction of the total orbital-assembly electrical power system.

Presently used for premission verification of power system design, this breadboard may be used during the mission for troubleshooting electrical power system problems, and for verifying contingency operating modes.

D. SWS Thermal Control System Math Model

The SWS thermal control system analysis computer program at MSFC will be made available for mission support on an "as required" basis. This math model can be used to assist in determining the thermal behavior of the SWS under various conditions and operating modes. As such, it will enable mission control personnel to enhance real-time trend and performance predictions and, in turn, refine systems management procedures.

E. Neutral Buoyancy Facility

This facility is now used for EVA training of the Skylab crews. It may be kept available during the mission for any required testing and verification of EVA procedure changes or contingencies encountered.

4.3.1.7

Data facilities.- The Flight Operations Management Support data flow is illustrated in Figure 4-7 on Page 4-45 and discussed as follows:

A. Mission Evaluation Room

The Mission Evaluation Room in Building 45 will be supported with real-time data in a manner very similar to that which is currently provided for the Apollo Program. Several DTE display channels will be provided to the MER directly from the Real-Time Computer Complex (RTCC). Some of these channels will be selectable to any of the displays currently called up within the RTCC, with selection capability being located within Building 45. The remaining channels of digital television equipment (DTE) display will be slaved to systems consoles in the vehicle systems SSR, and MER personnel will have no control over these channels. In addition, the MER will have one or more MOPS terminals.

B. Building 12

A data interface (yet undefined) will be provided to MER personnel via the Building 12 Computation and Analysis Division (C&AD) computer complex. This interface is required to provide special processing in support of experiments and CSM hardware anomalies. In addition, the Building 12 computer complex will be required to provide offline processing for several biomedical experiments for Skylab. The data interface for the experiments support is yet to be determined.

C. HOSC

The HOSC will receive both real-time data and ADDT data from the MCC to enable HOSC personnel to provide the required systems analysis for mission evaluation and

troubleshooting in support of the previously described FOMR activities. A wide-band data line will be provided for data transfer between the MCC and HOSC. Real-time data will be furnished to HOSC from SL-1 launch through manned activation. Thereafter, real-time data will not be required unless a contingency situation develops. ADDT data will be transmitted on a scheduled basis yet to be determined. One or more MOPS terminals will be located at the HOSC for HOSC access to the MDRS and ASP data. The MSFC facilities and systems will be used to process the real-time data and the data requiring fast turnaround for support of the ongoing mission.

An additional data capability will be furnished to allow effective operations within the HOSC during mission periods. This is a two-way facsimile circuit for rapid data transfer between HOSC and MSC. Engineering diagrams, real-time plots, historical data, and trouble/failure analyses will be sent back and forth regularly over this circuit. In particular, data which are compiled within the vehicle systems and experiments SSR's have proven to be the most usable and informative data regarding a given problem for a fairly immediate timeframe and this kind of data must be relayed to HOSC.

4.3.1.8 Communications.- In addition to the facilities previously discussed and the data transfer capabilities outlined, a series of communications loops will be required. These loops will interconnect the operational elements of the Building 30 FOMR, the flight controllers within the MOCR and SSR's, the evaluation personnel in the Building 45 MER, the evaluation personnel at the HOSC, and the prelaunch and experiment personnel at KSC. The configuration of these



loops is summarized in the FCD document, Summary of Ground Systems Requirements for Skylab Flight Control, August 1, 1971.

4.3.2

Flight Support Division (FSD) Operations

4.3.2.1

Operations areas.- Similar to Apollo, FSD will support mission operations through the operations areas listed below.

- A. Command, Communications, and Terminal System (CCATS)
- B. Real-Time Computer Complex (RTCC)
- C. Communications
- D. Display
- E. Simulations Checkout and Training System (SCATS)

4.3.2.2

Functions.- The operation of these areas has been changed somewhat from Apollo and is basically as follows:

A. CCATS

CCATS will be an entirely throughput operation between the STDN and the RTCC — except for Real-Time Commands (RTC's). CCATS will also provide the interface between the MOPS Terminals and MOPS computer(s) in the RTCC.

B. RTCC

The RTCC computing functions are greatly expanded over Apollo to include the MDRS and ASP. However, the number of computers required to do the Skylab computing job is still to be determined.

C. Instrumentation Support Team (IST) Personnel

The IST personnel operating in CCATS will move to the RTCC area. However, CCATS will still retain an RTC command function. The IST manning and job functions are defined in detail in the FSD document,, MCC Operations Plan, dated December 8, 1971.

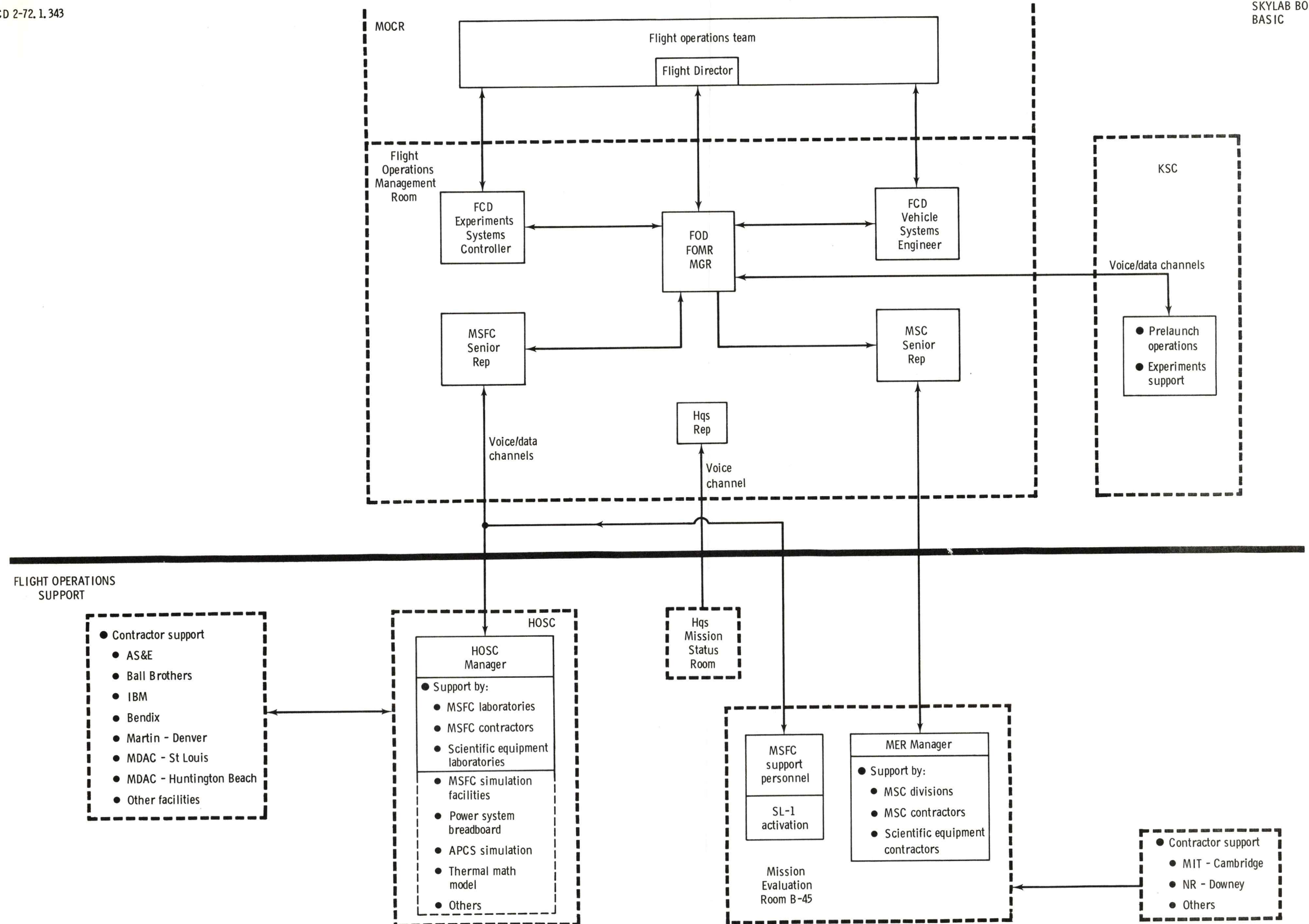


Figure 4-7. - Skylab flight operations management support plan interfaces.

- D. Flight Support Management Room (FSMR).- The present Flight Support Management Room will be upgraded to actively participate in the Flight Support Division (FSD) operations versus passive monitoring. The FSMR name will be changed to Support Management Area (SMA) which will be directed by a supervisor acting with the authority of the FSD Division Chief.

Figure 4-10 is an overview of the FSD operating organization, and the subsequent figures, 4-11 through 4-13, illustrate the operating positions and functions within the key operations areas. The final figure, 4-14, illustrates the mission control operations organization in direct support of the Network Controller as opposed to the individual operating areas. The area controllers will report to both the Network Controller and the supervisor in their individual area.

The FSD Science Controller will be responsible for the Apollo Lunar Surface Experiments Package (ALSEP)/Particles and Fields subsatellite (P&FS) facilities support and the Interface Controller will act as an assistant in the MOCR to the Network Controller, specializing in internal MCC operations. With reference to Figure 4-11.- Support management organization, all functions except those of the Network Controller, FSD Science Controller, and Interface Controller will be performed in the Support Management Area.

#### 4.3.3

##### Data Room

A Data Room, as shown in Figure 4-2, will be provided in the MCC for Skylab mission support. This room will provide a suitable working area for data analysis appropriate to subsequent mission planning. Any mission support personnel



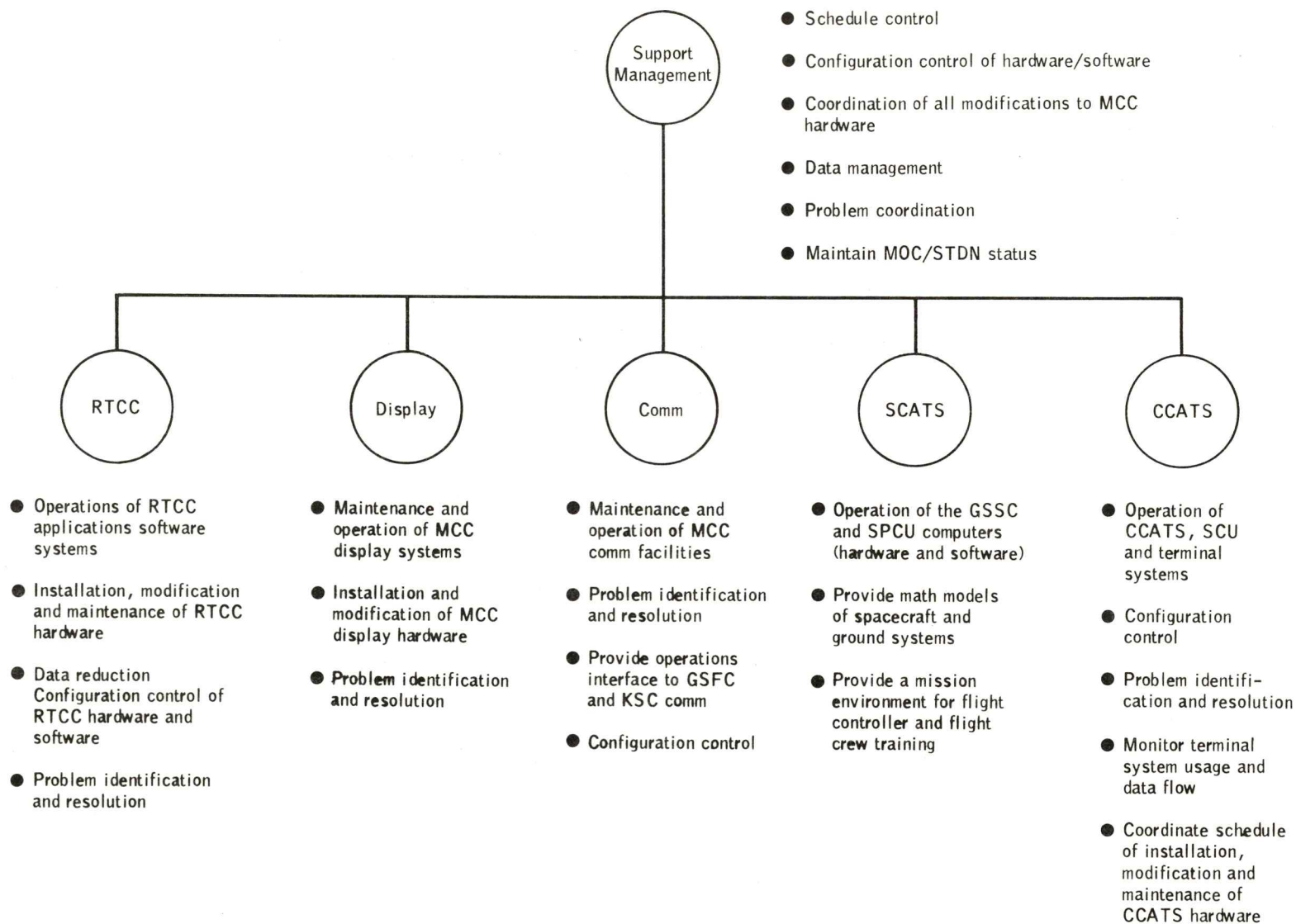


Figure 4-10.- FSD operations organization overview.

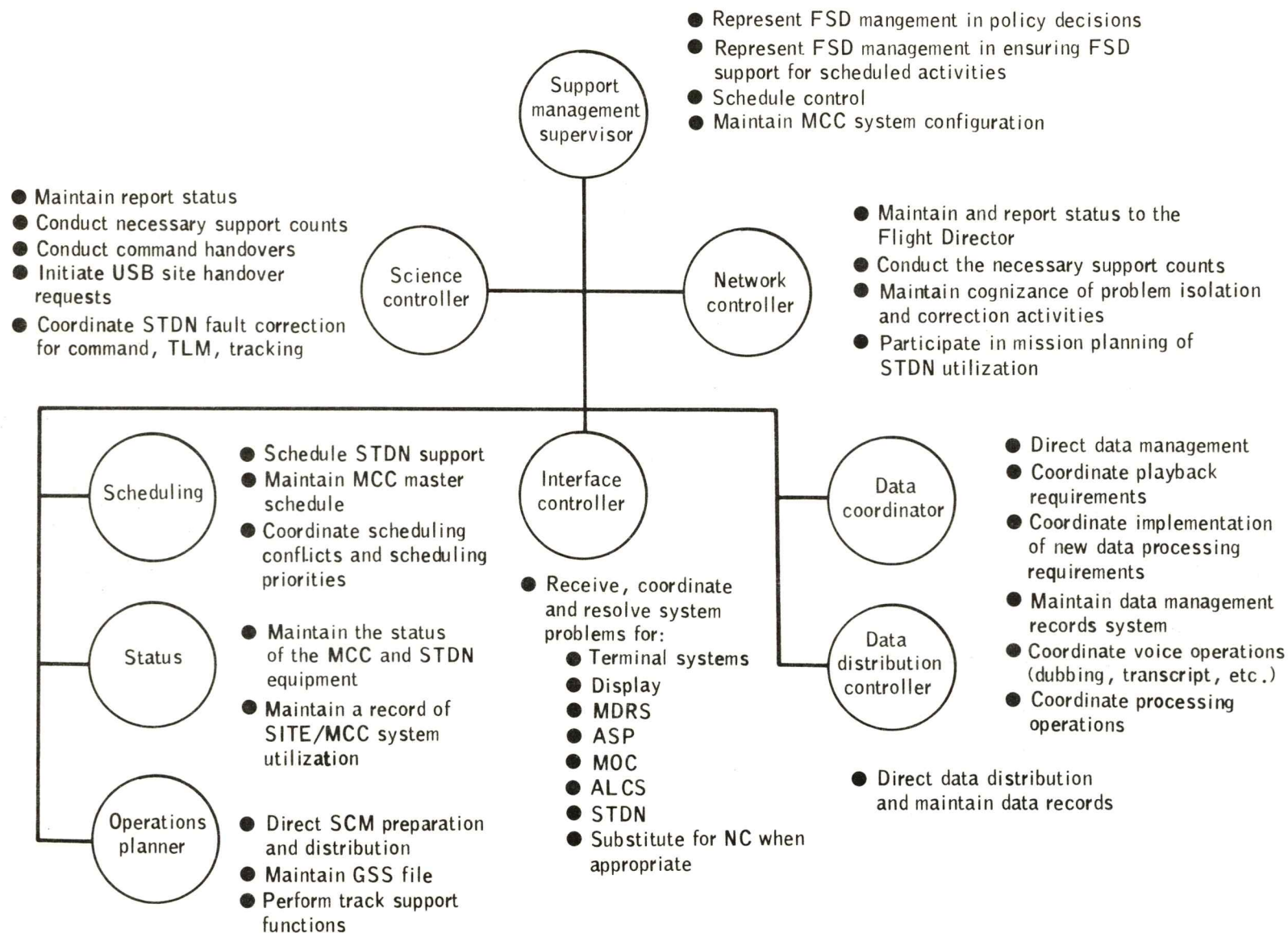


Figure 4-11.- Support management organization.

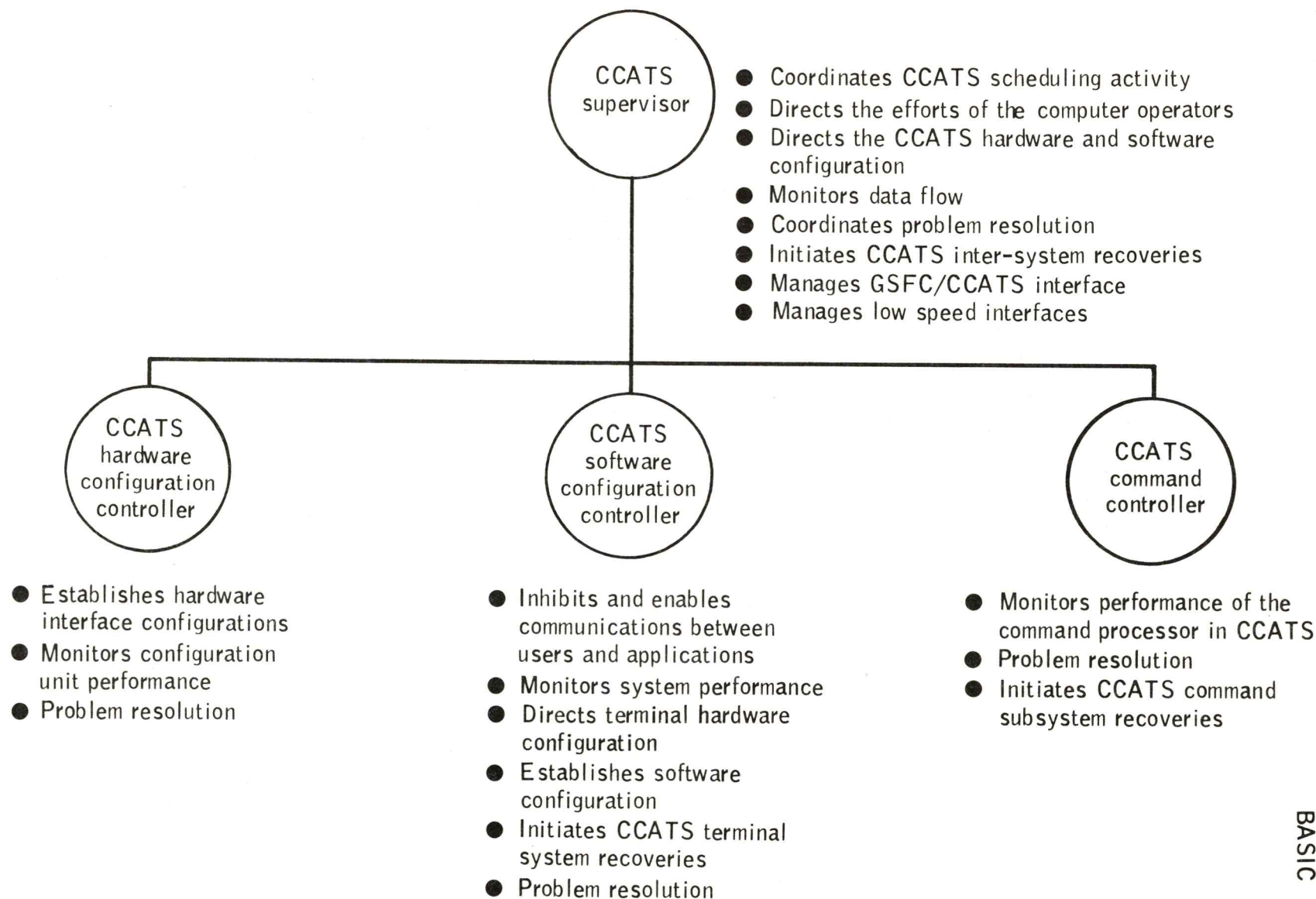


Figure 4-12.- CCATS organization.



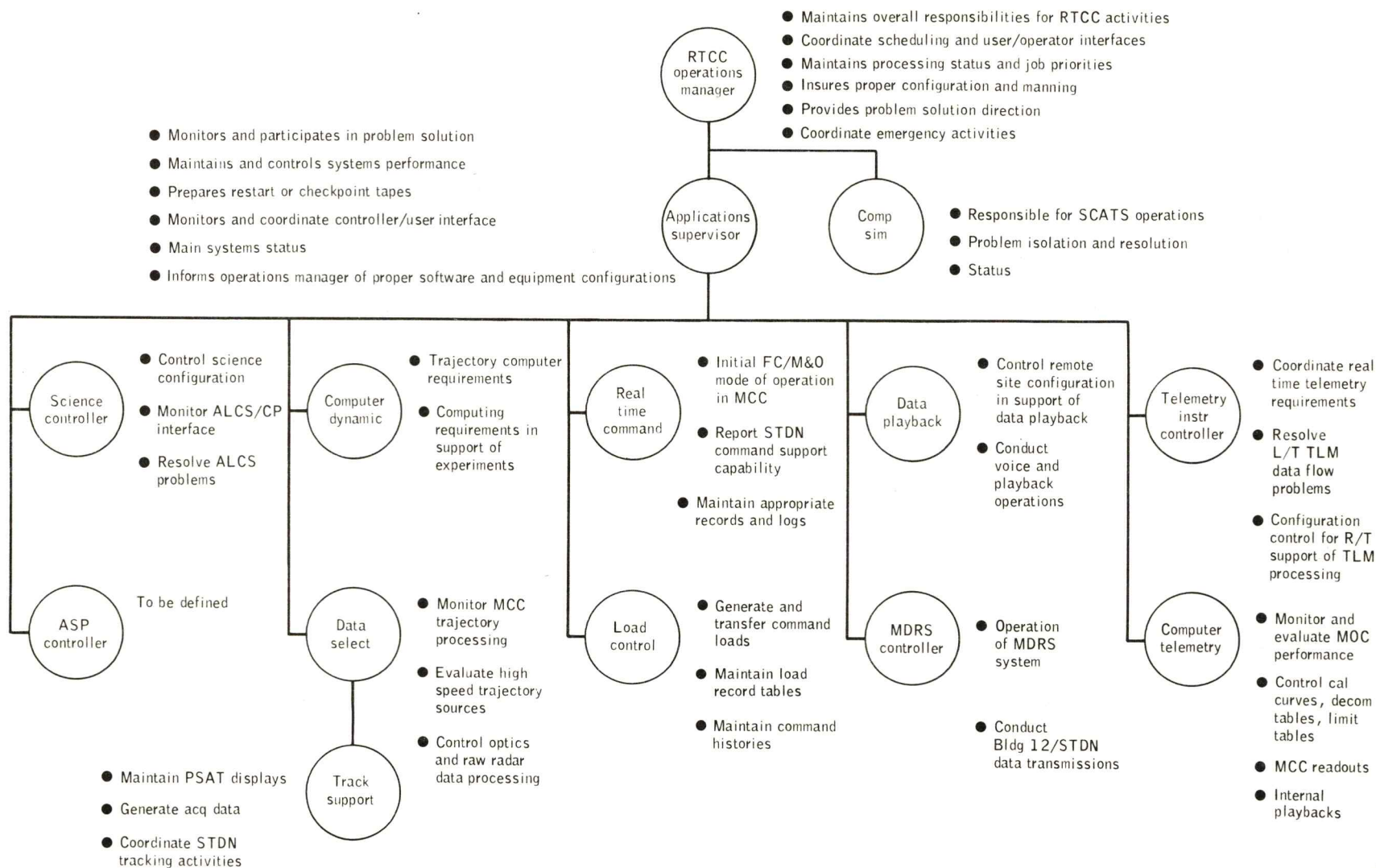


Figure 4-13.- RTCC organization.

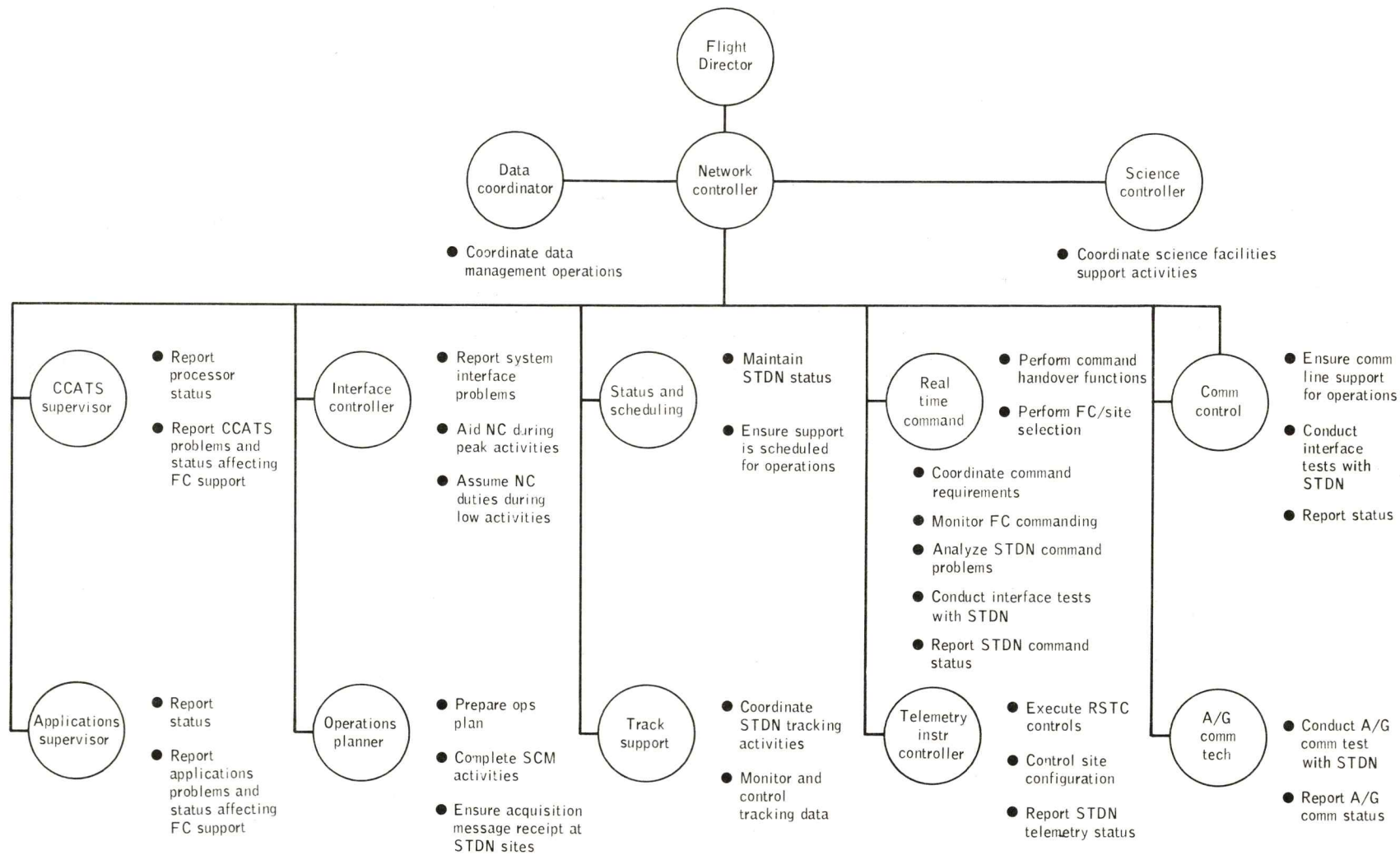


Figure 4-14 .- MCC/STDN mission control organization.

having a valid need for a working area will be allowed use of this room. These personnel would typically include experiment Principal Investigators, other experiment support personnel, Program Office personnel, and flight controllers.

The Data Room will be equipped with work tables; communications pertinent to the conduct of the missions, such as telephones and A/G and FD loop speaker monitors; and a limited display capability, such as overhead TV monitors and Microfiche viewers, for monitoring the mission progress. In addition, some facilities may be furnished for temporary storage of data.

Access to the Data Room must be limited to those personnel having a valid need to do data analysis in support of subsequent operations. The FOD FOMR Manager will manage access to the Data Room on an informal basis.

#### 4.3.4 Recovery Operations

4.3.4.1 General.- Recovery operations and procedures will be planned for all possible earth landing situations for each Skylab mission. The type of recovery support to be implemented for Skylab is typified by non-dedicated aircraft and ships; that is, Air Rescue and Recovery Squadron (ARRS) aircraft at home bases only and no ships on station during the orbital phase of the mission. Dedicated forces will be on station during the launch and end-of-mission phases only.

4.3.4.2 Recovery requirements.- It is required that the flight crew be recovered and transported in a supine position to the Skylab Mobile Laboratory within approximately one hour following the CM landing. This support will be available once per day during the last half of each mission.



4.3.4.3

Recovery plan.- Five recovery areas are defined for Skylab missions: the launch site area, launch abort area, primary landing area, secondary landing area, and contingency landing area. The following recovery support will be provided for each area:

A. Launch Site Area

If an abort is initiated between launch escape system (LES) arming and approximately 90 seconds after lift-off the CM will land in the launch site area (Figure 4-15). The following forces will provide the recovery support for this area:

1. Two heavy-lift helicopters (HH-53C)
2. A landing craft (LCU)
3. A salvage ship on standby

B. Launch Abort Area

The launch abort area extends from the launch site area to 3500 nautical miles downrange. The following forces will provide this recovery support:

1. Three HC-130 search and rescue aircraft airborne during launch.
2. Refuelable helicopters located at Patrick AFB, Florida; Pease AFB, N. Hampshire; Newfoundland; and Woodbridge, England.
3. Ships-of-opportunity will be utilized as required.
4. In addition, two secondary recovery ships (SRS) may be deployed to the area. Figure 4-16 shows the force structure.

C. Primary Landing Area

The primary recovery ship with the Skylab mobile laboratory aboard, will be on station during approximately the last

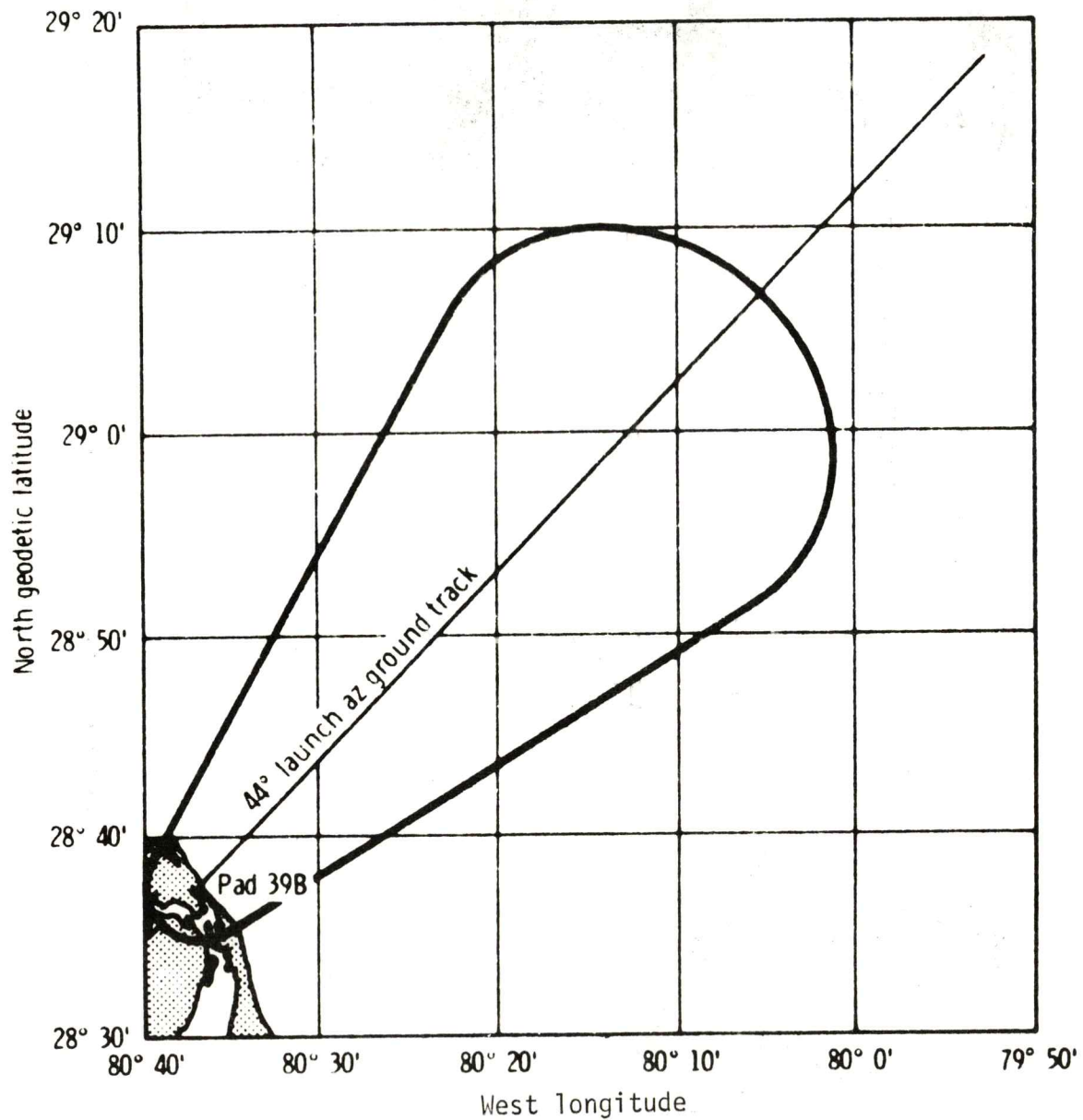


Figure 4-15.- Skylab launch site area.

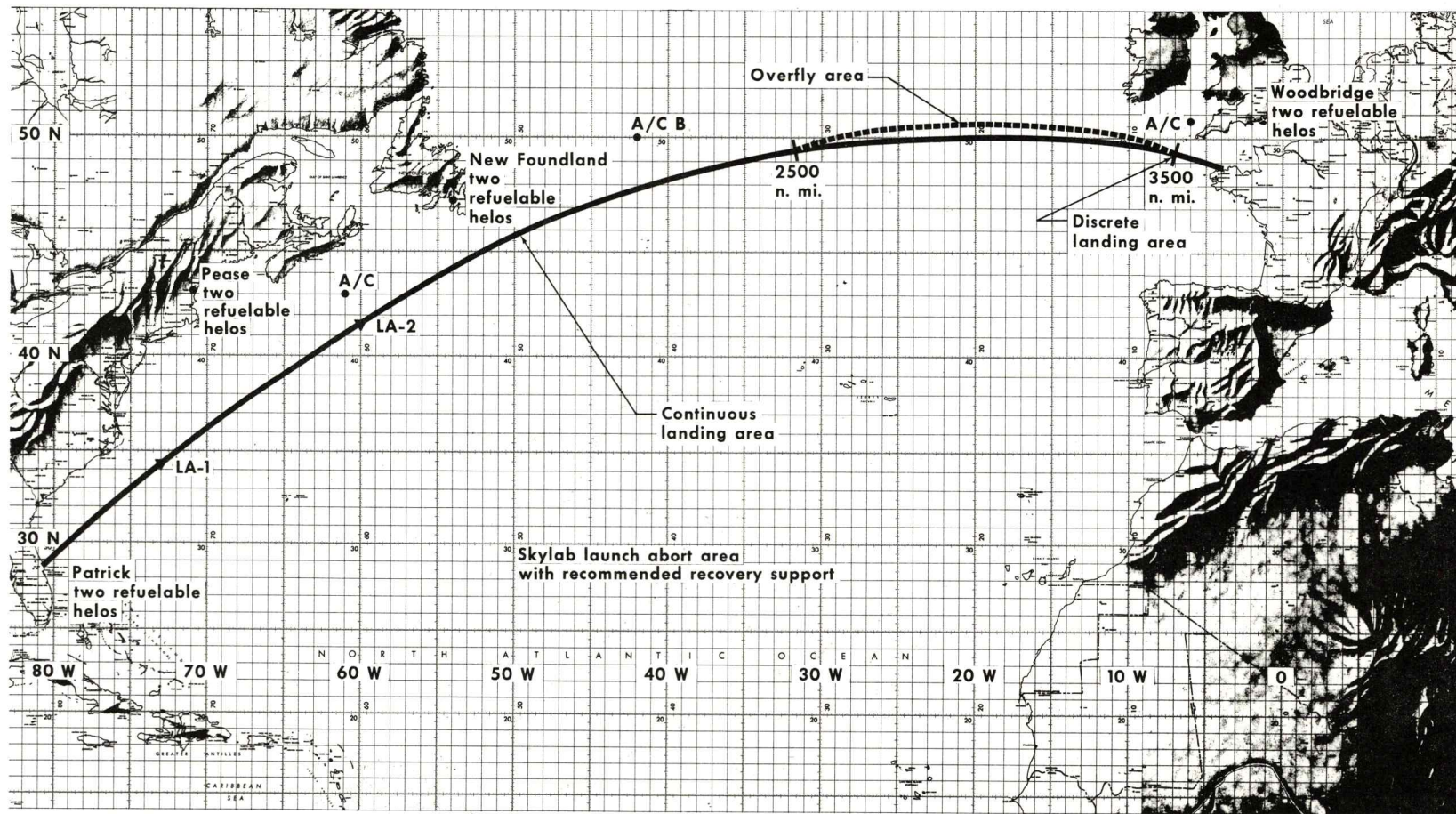


Figure 4-16.- Pre-insertion recovery force locations.



week of each mission. The following forces will provide this recovery support:

1. Primary recovery ship.
2. Four helicopters airborne in the vicinity of the PRS at time of splash (three helicopters with swimmers, one for photographic purposes).
3. Two search and rescue type aircraft (HC-130). Figure 4-17 shows a typical deployment of recovery forces in the area.

D. Secondary Landing Area

The secondary landing area is chosen in the vicinity of Hawaiian Islands and will support an early mission termination. A "fence" concept will be utilized to support the secondary landing area. This concept consists of deploying the Skylab Mobile Laboratory (MOLAB) from Houston to either Johnston Island or the islands of Kanai, Oahu, or Hawaii, depending on the location of the groundtrack (Figure 4-18) for that day. The Skylab Mobile Laboratory will be located at Houston until a decision is made to terminate the mission early or until the laboratory is air transported to the PRS for the normal end-of-recovery. Should a decision be made to terminate the mission early, a transport aircraft (C-5A) will be deployed from either Charleston AFB, South Carolina or Travis AFB, California to Ellington AFB to transport the Skylab Mobile Laboratory to one of the previously mentioned islands. The flight crew will then be retrieved by helicopters and the aircraft for the postflight biomedical examinations. In the meantime the CM will be retrieved by a secondary recovery ship. After the biomedical examinations, the

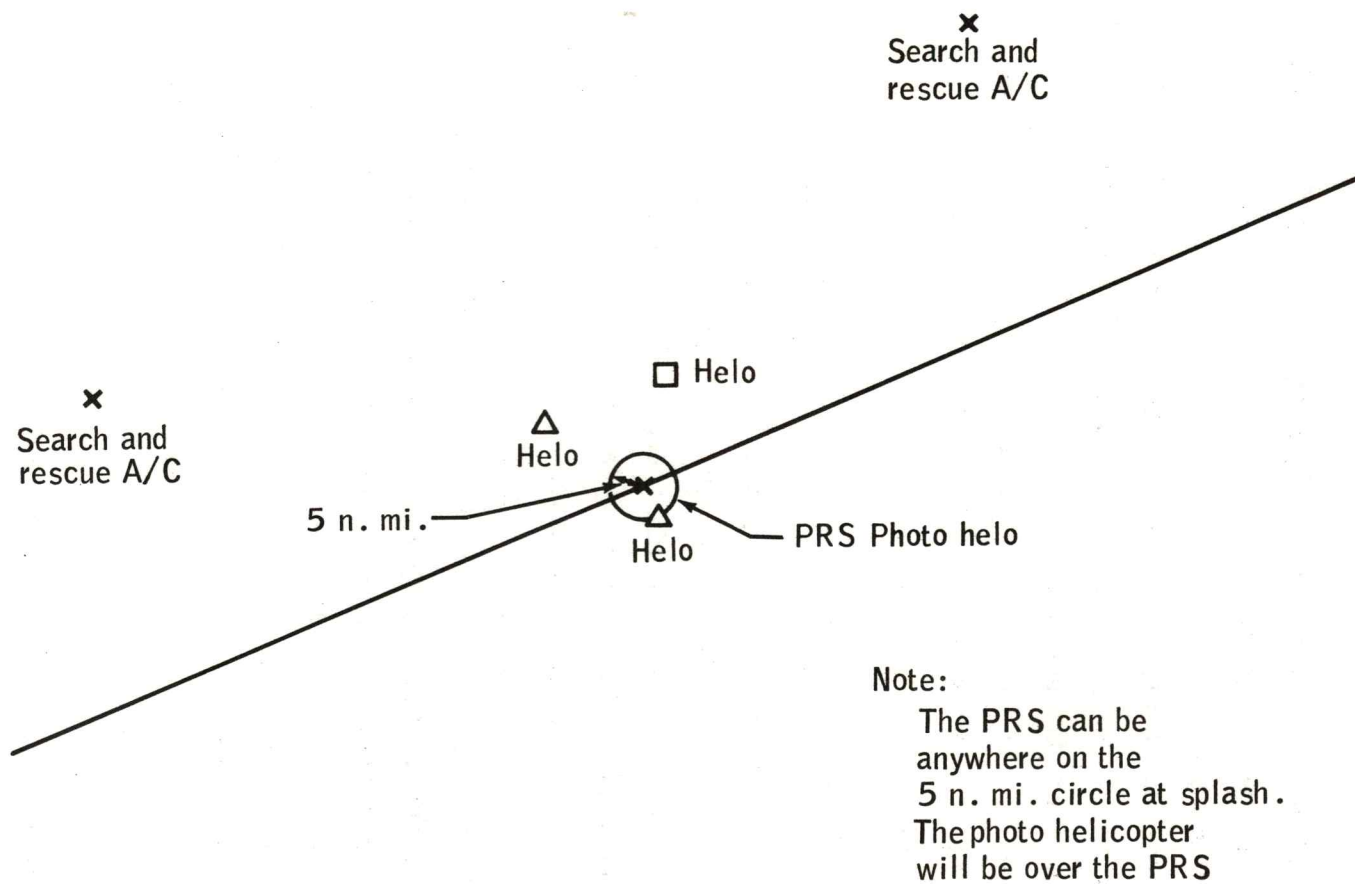
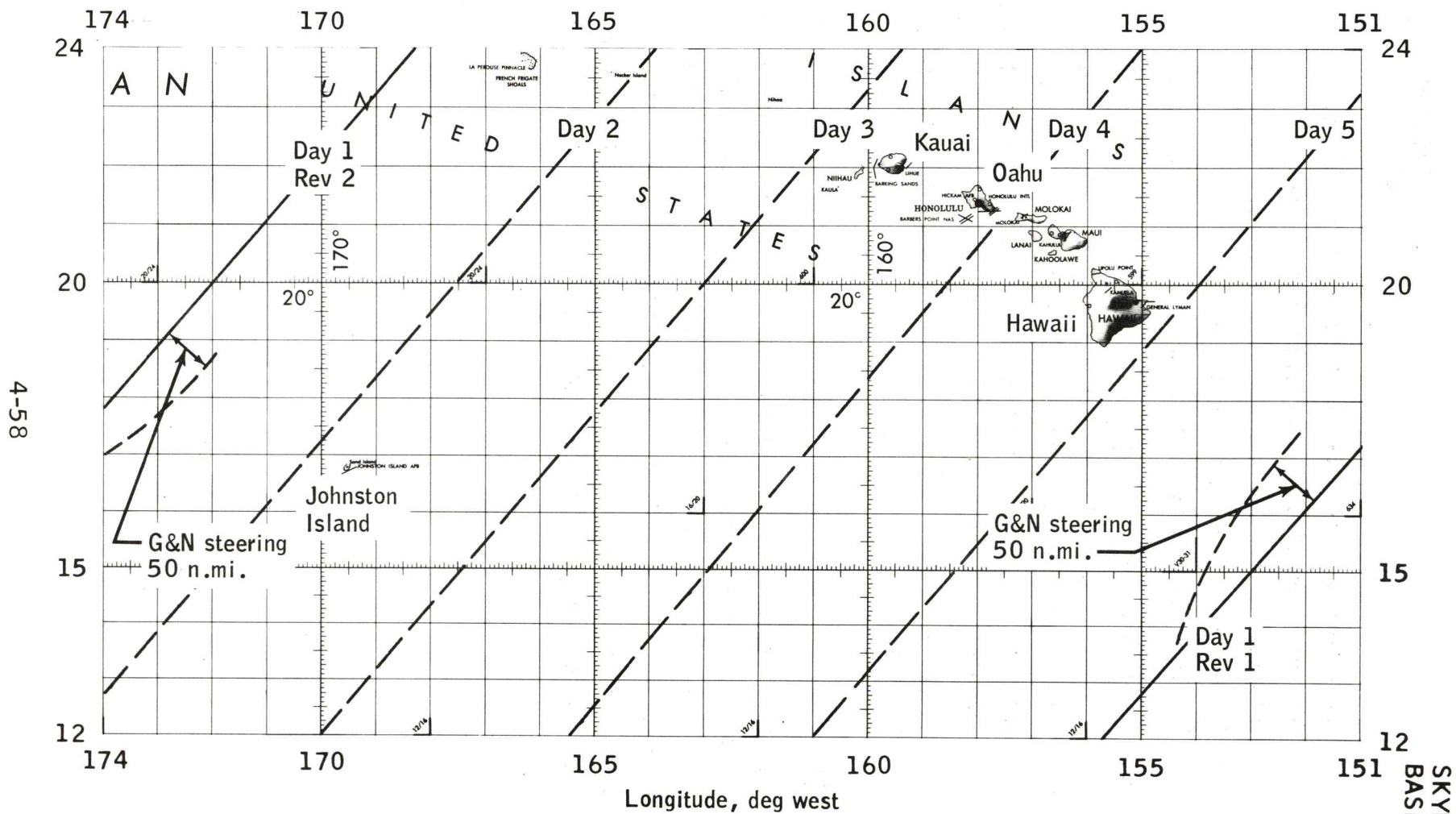


Figure 4-17.- End-of-mission recovery forces.





laboratory will be flown back to Ellington AFB at Houston. The following recovery force support is required:

1. Refuelable helicopters at Oahu.
2. Secondary recovery ship (SRS) at Oahu - on call.

E. Contingency Landing Area

The contingency landing area is all the earth's surface between 50 degrees North and 50 degrees South latitude outside of the previously described areas. The following recovery force support is required:

1. Home-based search-and-rescue aircraft (Figure 4-19).
2. Ships-of-opportunity.

4.3.5 Weather

Weather information will be supplied to the Recovery Coordinator to maintain a status of reentry conditions at all points along the groundtrack to support an anytime reentry. This information will be obtained by the MCC weather office via TTY and datafax circuits. Also, the capability exists to receive imagery data as transmitted from the weather satellites.

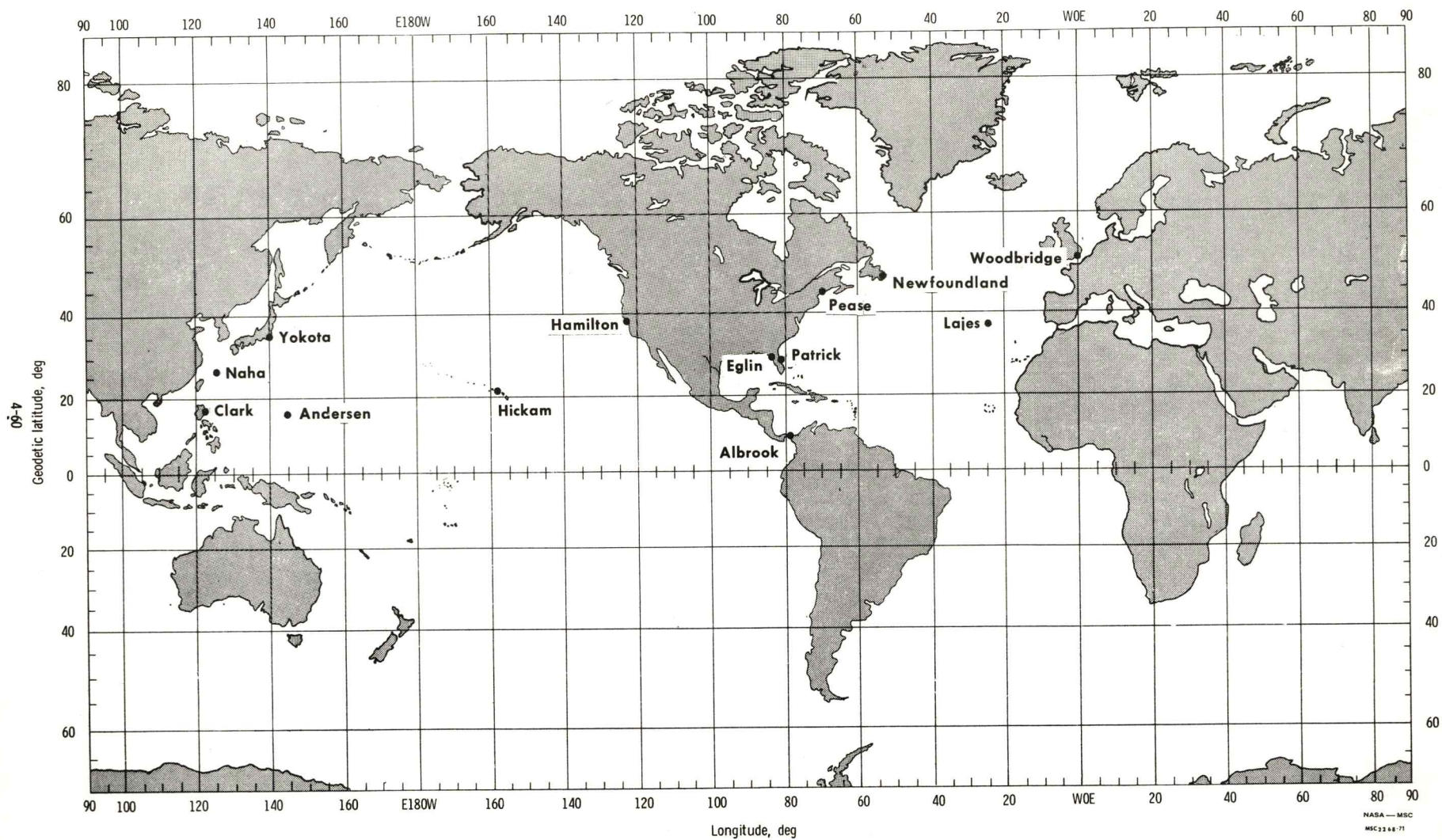


Figure 4-19.- Contingency landing area and support bases.

5 EXPERIMENT  
OPERATIONS  
PLAN



## SECTION 5

### EXPERIMENT OPERATIONS PLAN

#### 5.1 INTRODUCTION

This section discusses the way in which Skylab experiment operations will be conducted. Paragraph 5.2 discusses general responsibilities of the various organizations/individuals in the conduct of experiment operations; Paragraph 5.3 discusses the way in which operations will be conducted for the four categories of experiments-ATM, Corollary, Biomedical, and Earth Resources; and Paragraph 5.4 discusses activities between missions in analyzing experiment results and applying them to the succeeding flight. Experiment operations for the unmanned flight phases are discussed in Paragraph 3.10.2.1.C.

#### 5.2 GENERAL RESPONSIBILITIES

Several organizations and groups of individuals will participate in the conduct of the experiments. This section summarizes their various responsibilities.

##### 5.2.1 FCD Experiment Systems Flight Controllers

The FCD philosophy for experiment operations is to operate the experiment systems, to recover the scientific data for the experiment program managers, and to provide scientific data evaluation at a level necessary for real-time conduct of the mission. The flight controllers will be responsible for the following:

- A. Monitoring and troubleshooting experiment systems.
- B. Assuring that the scientific data received are valid. This will be accomplished both by correlating the scientific data

with systems status and also by consultation with Principal Investigators as applicable.

- C. Maintaining detailed current records of experiment completion, anomalies, and status.
- D. Participating in priority assessments and providing flight plan inputs for conduct of experiments.

The FCD responsibility for the conduct of the experiments will be divided between the Lunar/Earth Experiments Branch and the Space Science and Technology Branch. The Lunar/Earth Experiments Branch will be responsible for the earth resources experiments, and the Space Science and Technology Branch will be responsible for the ATM, biomedical, and corollary experiments.

#### 5.2.2 Medical Research and Operations Directorate (MROD)

MROD personnel will perform the following:

- A. Analyze the medical experiments data to assess crew health.
- B. Analyze the medical experiments data to determine its validity in satisfying the experiment objectives.
- C. Coordinate with the biomedical experiment flight controllers on operation of medical experiments as applicable.
- D. Direct functional operation of biomedical experiment ground support.
- E. Conduct daily Medical Team Conferences to discuss results of all medical data. As a result of these meetings, provide flight plan inputs for the medical experiments as discussed in Section 7.

- F. Where clear cut priorities do not exist, or when tradeoffs become necessary, MROD will determine relative biomedical experiment priorities as the mission progresses via the Biomedical Experiments Priority Panel. This panel's recommendations will be transmitted to the FOMR Mission Staff Engineer.

### 5.2.3 Principal Investigators (PI's)

The PI's will perform the following:

- A. Advise the flight controllers on their experiment systems operations (except from EREP systems operations).
- B. Advise the flight controllers and the Program Offices on the validity of their scientific data and on the degree of accomplishment of scientific objectives and, based on this, make inputs regarding further mission plan requirements (See Section 7).
- C. Be in the Science Rooms/Staff Support Rooms as applicable for operation of their experiment, and use the Data Room for more detailed analysis when data are retrieved. (On-site medical PI's and Principal Coordinating Scientist's [PCS's] may use their own lab and analysis facilities). Access to the SSR's will be controlled by the ATM Experiment Officer, the Experiment Officer, the EREP Experiment Officer, and the Medical Team Leader for their respective areas of responsibility. Coordination with the PI's on when their experiment is to be conducted will be done by the SSR/ Science Room flight controllers.



The PI's will support mission operations in real time and near-real time as required. The following four categories, or levels, of PI support have been identified:

1. Category I

The PI is present in the MCC during experiment execution. His non-availability is a constraint on the execution of the experiment.

2. Category II

The PI is present in the MCC during periods of the mission when his experiment is executed. He performs analysis of the experiment data and makes recommendations for subsequent experiment operations.

3. Category III

The PI is present in the MCC during experiment execution and is available for consultation with flight controllers. He maintains mission status visibility and provides assistance to flight controllers as requested.

4. Category IV

The PI is removed from the mission operations. He is available via telecon for consultation.

The category of support required for each experiment is listed in Table 5-I.

The PI's will have two basic mission operating functions. First, they will interface in real time and near-real time with the experiment flight controllers regarding performance of experiment systems, validity of scientific data, and future activity planning. Second, they will have an input route through the Program Offices for future flight activity planning regarding changes in experiment objectives and priorities.

TABLE 5-I.- SKYLAB EXPERIMENTS

No.	Title	PI	Dev. center	Contractor	Msn participation		
					Crew	Ground	PI Cat.
ATM experiments							
S052	White Light Coronagraph	Robert McQueen	MSFC	High-Altitude Observatory	X	X	II
S054	X-Ray Spectrographic Telescope	R. Giaconni	MSFC	Applied Science and Engineering	X	X	II
S055A	Ultraviolet (UV) Scanning Polychromator-Spectroheliometer	Edward Reeves	MSFC	HCO	X	X	II
S056	Extreme UV and X-Ray Telescope	James Milligan	MSFC	GSFC	X	X	II
S082A	Coronal Extreme Ultraviolet (XUV) Spectroheliograph	Richard Tousey	MSFC	NRL	X	X	II
S082B	Chromospheric XUV Spectrograph	Richard Tousey	MSFC	NRL	X	X	II
Medical experiments							
M071	Mineral Balance	Donald Whedon	MSC	MDAC-WD	X	X	IV
M073	Bioassay of Body Fluids	Carolyn S. Leach	MSC	MDAC-WD	X	X	IV
M074	Specimen Mass Measurement	John W. Ord	AF/MSFC	Brooks AFB	X	X	IV
M078	Bone Mineral Measurement	John M. Vogel	MSC	MSC	X	X	IV
M092	In-Flight Lower Body Negative Pressure	Robert L. Johnson	MSC	MSC	X	X	IV
M093	Vectorcardiogram	Newton W. Allebach	MSC	MMC	X	X	III
M111	Cytogenic Studies of Blood	Lillian H. Lockhart	MSC	MSC	None	None	IV
M112	Man's Immunity In Vitro Aspects	Stephen E. Ritzmann	MSC	MSC	None	None	IV
M113	Blood Volume and Red Cell Life Span	Philip C. Johnson	MSC	MSC	None	None	IV
M114	Red Blood Cell Metabolism	Charles E. Mengel	MSC	MSC	None	None	IV
M115	Special Hemotological Effects	Craig L. Fischer	MSC	MSC	None	None	IV
M131	Human Vestibular Function	Ashton Graybiel	MSC	Johns Hopkins Univ./Applied Physics Lab.	X	X	III
M133	Sleep Monitoring	James D. Frost	MSC	---	X	X	III
M151	Time and Motion Study	J. F. Kubis	MSC	Fordham Univ.	X	X	III
M171	Metabolic Activity	Edward L. Michel	MSC	MMC/MSFC	X	X	III
M172	Body Mass Measurement	John W. Ord	AF/MSFC	Brooks AFB	X	X	IV
Corollary experiments							
D008	Radiation in Spacecraft	Marion Schneider	AF/MSFC	AVCO	X	X	III
D024	Thermal Control Coatings (AM)	Karl Boebel	AF/MSFC	Goodyear	X	X	IV
M415	Thermal Control Coatings (IU)	Harry Thayer	MSFC	MSFC	None	X	IV
M479	Zero Gravity Flammability	Howard Kimsey	MSFC	MSFC	X	X	III
M487	Habitability/Crew Quarters	Caldwell Johnson	MSFC	MDAC-WD	X	X	III
M509	Astronaut Maneuvering Equipment	C. E. Whitsett	MSC	MMC	X	X	II
M512	Materials Processing in Space(Facility)	Gordon Parks	MSFC	MSFC	X	None	III
M516	Crew Activities/Maintenance	Robert Bond	MSC	MSC	X	X	
M551	Metals Melting	Robert V. Hopper	MSFC	MSFC	X		III
M552	Exothermic Brazing	Robert V. Hopper	MSFC	MSFC	X		III
M553	Sphere Forming	Earl A. Hasemeyer	MSFC	MSFC	X		III
M554	Composite Casting	Earl A. Hasemeyer	MSFC	MSFC	X		III
M555	GaAs Crystal Growth	R. G. Siedensticker	MSFC	MSFC	X		III

TABLE 5-I.- SKYLAB EXPERIMENTS - Concluded

No.	Title	PI	Dev. Center	Contractor	Msn participation		
					Crew	Ground	PI Cat.
Corollary experiments - Concluded							
S009	Nuclear Emulsion	Maurice Shapiro	MSFC	NRL	X	X	IV
S015	Zero "G" Human Cells	Phillip Montgomery	MSC	Dallas Hospital	X	X	IV
S019	UV Stellar Astronomy	Karl Heize/ James Wray	MSC	MCC	X	X	III
S020	UV X-Ray Solar Photography	Richard Tousey Dave Garrett	MSC	NRL	X	X	III
S063	UV Airglow Horizon Photography	Donald Packer	MSC	MMC	X	X	III
S0171	Circadian Rhythm - Pocket Mice	Robert Lindberg	ARC/MSFC	Ames Research Lab	X	X	III
S072	Circadian Rhythm - Vinegar Gnat	Colin Pittendrich	ARC/MSFC	Ames Research Lab	X	X	III
S149	Particle Collection	Curtis Hemenway	MSC	MMC	X	X	III
S150	Galactic X-Ray Mapping	William Krauschaar	MSFC	MSFC	None	X	IV
S183	Ultraviolet Panorama	Georges Cortes	MSFC	CNRS Marseilles, France	X	X	III
T002	Manual Navigation Sightings	Cary Hunter	ARC/MSFC	Kollsman Inst. Corp.	X	X	III
T003	In-Flight Nephelometer	William Leavitt	DOT/MSFC	MSFC	X	X	IV
T013	Crew Vehicle Disturbance	Bruce Conway	LaRC	MMC	X	X	III
T018	Precision Optical Tracker	Charles Hall	MSFC	Completed by MSFC	None	X	IV
T020	Foot-Controlled Maneuvering Unit	Don Hewes	LaRC	MMC	X	X	III
T025	Coronagraph Contamination Measurement	George Bonner	MSC	MMC	X	X	III
T027	Sample Array System	Joseph Musari	MSFC	MMC	X	X	II
T027 S073	Photometer System	Joseph Musari	MSFC	MMC	X	X	II
Earth resources experiments							
S190A	Multispectral Photographic Facility	K. J. Demel <sup>a</sup>	MSC	ITEK Corp.	X	X	IV
S190B	Earth Terrain Camera	K. J. Demel <sup>a</sup>	MSC	Actron	X	X	IV
S191	Infrared Spectrometer	T. L. Barnett <sup>a</sup>	MSC	Block Engineering	X	X	IV
S192	Ten-Band Multispectral Scanner	C. L. Korb <sup>a</sup>	MSC	Honeywell Rad. Center	X	X	IV
S193	Microwave Scatter/Radiometer and Altimeter	D. Evans <sup>a</sup>	MSC	General Electric	X	X	IV
S194	L-Band Radiometer	D. Evans <sup>a</sup>	MSC	Airborne Instruments	X	X	IV

<sup>a</sup>MSC points of contact investigators yet to be named.



#### 5.2.4 Skylab Program Offices (SLPO)

The MSC Program Office will provide overall management of the experiments assigned to MSC. The MSFC Program Office will provide overall management of the experiments assigned to MSFC and will also provide the interface with the experiments assigned to the Department of Transportation, Langley, and Ames Research Centers. The program offices will oversee the activities of the individual experiments to assure that experiment requirements are being satisfied. They will also provide the experiment systems FOMR interface for the PI's. The program offices will perform their functions from the FOMR, as discussed in Paragraph 4.3.1.2 and will provide a non-routine flight planning recommendation function for experiments, as discussed in Section 7.

The MSC Program Office has delegated responsibility for development and implementation of individual MSC developed experiments to various organizations (e.g., S&AD and MROD) within the MSC. During mission operations, these organizations will act as the Program Office representative for effecting changes in the mission objectives and experiment priorities.

#### 5.2.5 Flight Crew Operations Directorate (FCOD)

FCOD will develop the flight crew procedures for operating experiments (e.g., the crew checklists), be responsible for related crew equipment, and develop the flight plan including the required experiment operations timelines, as described in Section 7.

#### 5.2.6 Kennedy Space Center (KSC)

An experiment laboratory will be established at KSC where experiments S071 and S072, Circadian Rhythm in Pocket Mice and Vinegar Gnat, respectively; and S015, Zero Gravity Single

Human Cells, will be operated in a controlled environment. Coordination with KSC will be required to assure that the S015 environment (temperature, pressure) is maintained at KSC as close as possible to that in the spacecraft so that the only difference will be the gravity conditions. Coordination for S071/72 is required to assure that experiment activity is initiated and data samples taken at the same time. This coordination will be by telephone and accomplished by both the PI's and flight controllers as required.

#### 5.2.7 Recovery Operations Branch (ROB)

ROB will be responsible for handling and ensuring delivery of all recoverable experiment equipment and data (films, samples, specimens, voice tape, logs, etc.) to their initial receiving stations. It is expected that the recovery ship facilities will be sufficient for postflight experiment support, including handling and support of the Mobile Biomedical laboratory required on the ship. The specific requirements and plans for handling this laboratory are discussed in Paragraph 4.3.4.3.

#### 5.2.8 Experiment Responsibility and Participation

Table 5-I summarizes responsibilities and participation for the Skylab experiments. Table 5-II specifies the experiments for which the individual MOCR experiment flight controllers will be responsible.

### 5.3 EXPERIMENT OPERATIONS

#### 5.3.1 General

The following paragraphs summarize the way in which operations will be conducted for the four categories of experiments. Two

TABLE 5-II.- MOCR EXPERIMENTS RESPONSIBILITIES

ATM Experiments Officer	Experiments Officer		EREP Experiments Officer
	Corollary	Biomedical	
S052	D024	S015	T002
S054	M415	S071	S190A
S055A	M479	S072	S190B
S056	M487	M071	S191
S082A	M509	M073	S192
S082B	M512	M074	S193
D008	M516	M078	S194
S020	M551	M092	
	M552	M093	
	M553	M111	
	M554	M112	
	M555	M113	
	S009	M114	
	S019	M115	
	S063	M131	
	S073	M133	
	S149	M151	
	S150	M171	
	S183	M172	
	T003		
	T013		
	T018		
	T020		
	T025		
	T027		



aspects of the operation are discussed in other parts of the document and the details covered in those parts will not be repeated. They are the interface with the FOMR (see Paragraph 4.3.1.2) and the flight planning tasks (see Section 7).

Before discussing the individual experiment categories, the following paragraphs briefly summarize the general approach to the experiment flight control job for real-time planning, real-time operations, and post-operations tasks.

#### A. Real-Time Planning

During the activity scheduling process, the experiment flight controllers will verify that all experiment scheduling constraints have been satisfied including the identification of possible conflicts between experiment operations and spacecraft systems. If any constraints have been or need to be violated or relaxed, the experiment flight controllers will coordinate with/notify the PI and, along with other flight operations team members, resolve any problems. Data gathered from previous experiment performances will be analyzed to determine any impact on experiment procedures or scheduling. Any changes required based on previous data will be implemented and coordinated by the experiment flight controller with assistance from the PI. Experiments requiring many performances of repetitious tasks will have a premission nominal plan for execution, and any required deviations will be coordinated by the experiment flight controllers with the PI/FOMR and other mission elements as required. The biomedical experiments deviations are a special case, and will be handled by the Biomedical Experiments Priority Panel as discussed earlier.

#### B. Real-Time Performance

During the performance of experiments, the prime responsibility of the experiment flight controllers will be to answer questions about the experiment hardware or procedures. Hardware problems will necessitate troubleshooting. If improper experiment performance or hardware malfunction can adversely effect other spacecraft systems, the experiment flight controllers will coordinate with the appropriate vehicle systems engineers.

#### C. Data Recovery and Analysis

Following experiment performance, data will be returned for analysis. The analysis will generally consist of verifying valid data, assessing the hardware performance, verifying that proper procedures were used, and assuring that scientific objectives have been met. Actual daily scientific data reduction will be required for operations support of T027/S073, M509, T013, and the QCM's to provide feedback into future planning. Some processing and reduction of the biomedical data will also be accomplished within 24 hours of experiment performance. These processing results will be fed back into the mission for daily GO/NO-GO decisions on the crew health status.

The following paragraphs discuss the basic flight controller tasks and interfaces as well as any unique operations associated with the individual experiment categories.

#### 5.3.2 ATM Experiment Operations

Figure 5-1 illustrates the tasks and interfaces involved in the ATM experiment operation. The following paragraphs discuss the parts of this operation.

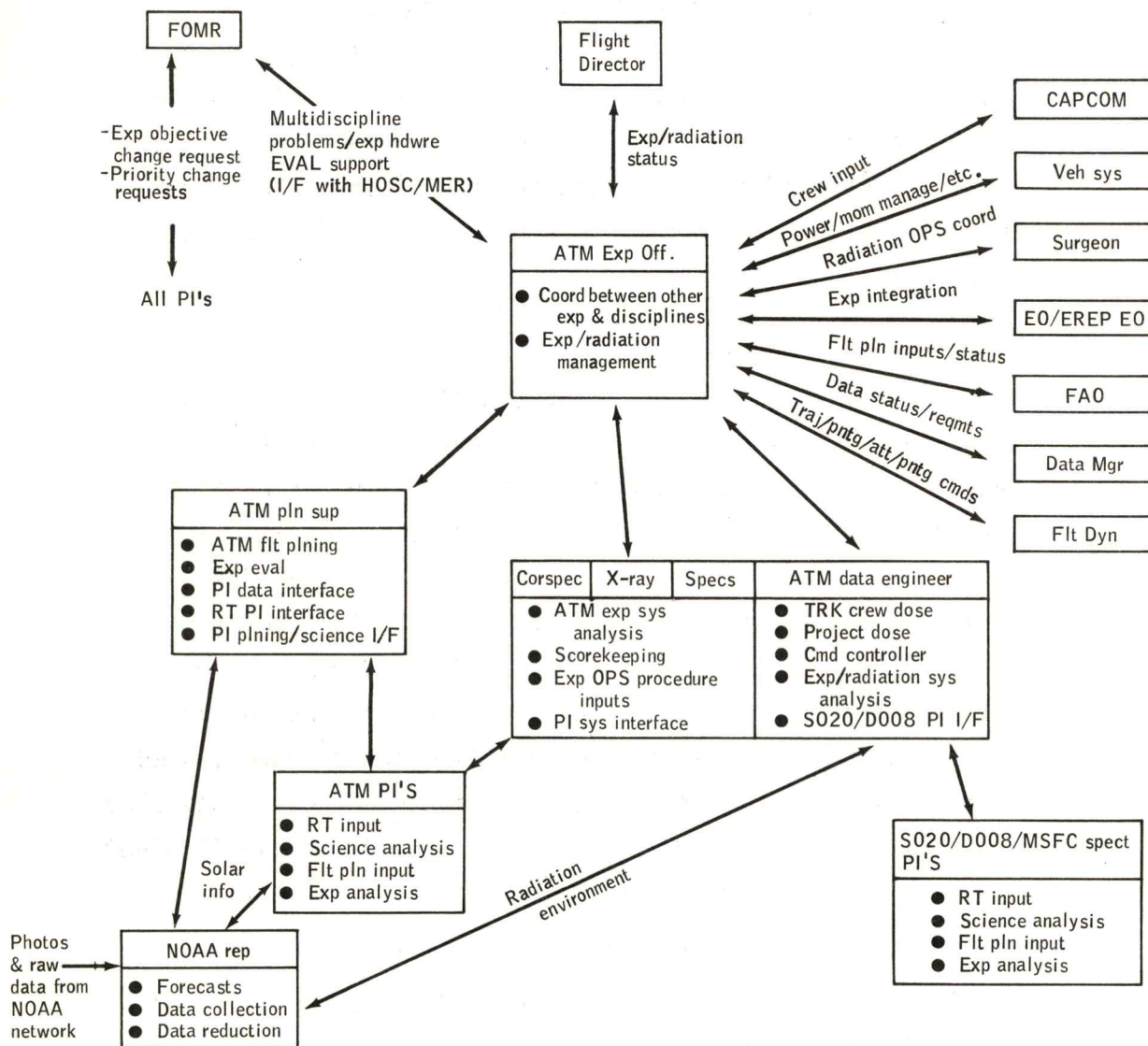


Figure 5-1.- ATM experiments/D008/S020/radiation operations.



5.3.2.1 Flight controller manning.-

A. ATM Experiments Officer ("ATM")

The ATM Experiment Officer will be responsible for overall operation of the ATM experiments. He is the focal point for the experiment operations and will draw upon the ATM Planning Support and the ATM experiment engineering support in the SSR.

He is responsible for the interface with the other MOCR positions and for reporting to the Flight Director on all ATM experiment activities. He will be called upon to support all flight control decisions involving vehicle systems, experiment conflicts, and real-time crew queries which pertain to ATM experiments. He has the responsibility for coordinating with the FAO for ATM PAD uplinks to the crew. He will also be responsible for supporting flight operations management decisions, flight planning tradeoffs, and maintaining detailed status of experiment accomplishment.

B. ATM Planning Support ("ATM PLANS")

ATM Planning Support will be responsible for detailed ATM flight plan development, the ATM PI interface with flight control, and the NOAA interface for the ATM.

He will generate the detailed ATM schedule throughout the mission. To accomplish this function, he will confer with the PI's and implement their scheduling requests in accordance with mission objectives, success criteria, and operational capability. He will confer with the Flight Activities Officer to obtain suitable ATM operating periods. He will present the preliminary data and options concerning schedule conflicts to the PI's. He will monitor the mission to determine and assure the implementation of the schedule and to obtain data to be used in development of the next schedule period. He will assure that ATM PI inputs in

real time are expeditiously incorporated into the flight control system.

He will receive the desired pointing information from the PI's and perform the necessary transformations to assure vehicle compatibility and proper time reference prior to transmission to the vehicle. He will receive and implement scientific data reduction requests through the use of the MDRS.

C. ATM Data Engineer ("ATM DATA")

The ATM Data Engineer will be responsible for radiation support of the various dosimeters, D008, MSC spectrometer, MSFC spectrometer systems, and the ATM thermal and TV systems.

For the radiation support function, he will provide evaluation of data gathered by the onboard operational instrumentation, provide status of the radiation hazards to the Flight Director, and provide the radiation dose limit status of each crewman to the Flight Surgeon. He will monitor the various onboard dosimeters and the D008 experiment and maintain a log.

He will interface with NOAA for data pertaining to solar radiation events. He will coordinate all inputs relative to radiation from MROD, NOAA, and supporting satellite agencies.

He will monitor and troubleshoot all operational radiation instruments. He will also monitor the MDA electron/proton spectrometer and the D008 experiment. He will be responsible for the operation of these instruments and maintain a log containing detailed records of the operation and status.

He will be responsible for transmitting commands to the ATM instruments and the thermal and TV systems. He will also provide inputs for teleprinter updates pertinent to those functions for which he is responsible.

D. H-Alpha/Coronagraph/Scanning Spectrometer ("COR SPEC")

This flight controller will be responsible for the S054 and S056 experiment systems, recovering the scientific data for the experiment program managers, and providing evaluation for the real-time conduct of the mission. He will be responsible for monitoring and troubleshooting the experiment systems and for assuring that the scientific data is valid both by correlating the instrument data with systems and operational status and also through consultation with the principal investigators. He will maintain a log containing detailed current records of experiment operation and accomplishment. He will analyze experiment operational problems and system malfunctions and provide for their solution.

He will be responsible for providing the PI with the appropriate experiment and systems data. He will aid the scheduler in flight planning by providing relevant information. He will provide the command controller (ATM Data Engineer) with appropriate command information as applicable. He will also provide inputs for teleprinter updates pertinent to those functions for which he is responsible.

E. X-Ray Systems ("X-RAY")

This flight controller will perform the same functions as ATM Experiment Systems 1 for S052, S055, H-Alpha 1, and H-Alpha 2.

F. XUV Spectrometer ("SPECS")

This flight controller will perform the same functions as "COR SPEC" for S082A, S082B, and S020.



### 5.3.2.2 Unique operations.-

#### A. Unattended ATM Operations

Present plans are to operate the ATM by commands from the ground during times when the crew is either engaged in other activity or asleep. Specifically when, how much, and what experiments/modes will be operated is not yet defined. However, the following type of planning and scheduling effort is envisioned. ATM Planning Support will coordinate with the ATM PI's on their desired operations based on the flight plan.

The ATM EO will coordinate with the FAO to establish times for unattended ATM operations and assure there are no conflicts (e.g., plans for going to Z-LV). The ATM EO will then coordinate with the FD and obtain approval. ATM Planning Support will devise the timeline, coordinate with SKYCOM on communications systems and data management requirements, and with the FAO to get the unattended operations into the flight plan.

#### B. Space Environment

The space environment task for Skylab will be done by the ATM flight controllers to determine the crew radiation dose in real time and to compare the accumulated dose with a premission established level. The ATM Data Engineer with the aid of inputs from the NOAA will provide a daily report of the crew's radiation dose to the Flight Surgeon. Flight controllers will have the capability to project the crew's dose to the end of the mission using the electron/proton spectrometer and Van Allen Belt dosimeter data. This monitoring will be rigorous for the first 5 days of flight to verify premission values and to establish baseline data. After the first 5 days, this monitoring will be accomplished once per day. For

any increase in dose rates (solar source, artificial event, or unknown source) dose determination efforts will be increased. Critical dose levels and corresponding appropriate action will be established premission.

Voice communications with the Joint Atomic Energy Intelligence Commission (JAEIC) will be used for alerting the MCC of artificial events that have occurred or are pending.

The following is a list of the other agencies that will assist the space environment function in monitoring changes in the radiation environment. Most of the information provided from these agencies will be sent to the MCC via teletype which will terminate in the Ground Communications Controllers (GCC) area in the MCC and, from this area, will be routed to the ATM Data Engineer.

1. Solar Forecast Center (SFC)

The SFC is managed by the USAF at Colorado Springs, Colorado. The SFC will provide solar forecasts and alerts to the MCC to assist Skylab flight controllers in keeping track of solar activity.

2. Space Environment Services Center (SESC)

The SESC is managed by NOAA and is located at Boulder, Colorado. During mission periods, NOAA will provide periodic solar forecasts to the MCC, as well as other data on solar activity.

3. Joint Atomic Energy Intelligence Committee (JAEIC)

For Skylab, the JAEIC shall report required information to the MCC by commercial telephone or classified TTY. The JAEIC, in conjunction with NASA Headquarters, pro-

vides the interface between the DOD and MSC for obtaining data.

#### 4. Satellite Support

Support may be provided to the MCC from various satellite programs managed by various government agencies. A representative list of such satellite support may include the following:

- a. Pioneer satellite - Ames Research Center (ARC)
- b. Explorer satellite - GSFC
- c. Applications Technology Satellite - GSFC
- d. Improved Tiros operational satellite - Environmental Science Services Administration (ESSA)

Figure 5-2 illustrates the overall flow of information for accomplishing the space environment function.

#### C. ATM NOAA Support

In addition to the space environment support, NOAA will be required to furnish MSC with solar activity data for support of the ATM experiments. This solar activity information will include location and description information on the solar chromospheric network, active regions, quiet regions, flares, prominences, filaments, and coronal activity. For the 6 months prior to SL-1 launch through the duration of the ATM operations, data will be provided to the MCC at a minimum rate of once per day.

As presently visualized, the NOAA-to-MCC interface will consist of two standard teletype receivers, two wirephoto receivers, a minimum of three standard telephones and an input/output terminal to access the NOAA time-shared computer at Boulder (to be provided by NOAA). The NOAA facility at Boulder serves as a collection point for solar data from other worldwide locations. The specific information



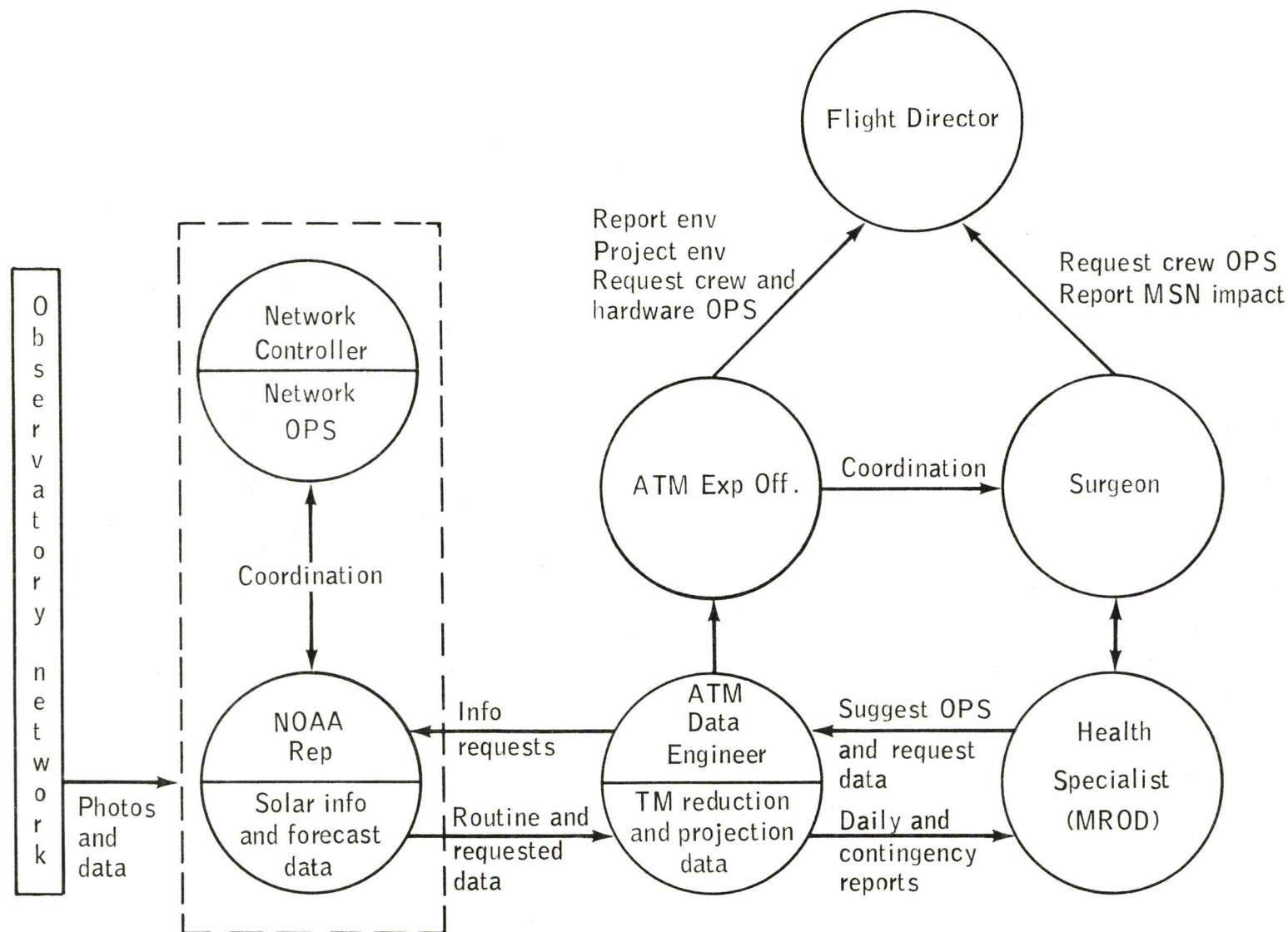


Figure 5-2.- Radiation operations flow.

required is not yet defined. However, Table 5-III is a representative list of potential requirements. The NOAA representative in the ATM Science Room will provide all the ATM PI's with this data.

### 5.3.3 Corollary Experiment Operations

Figure 5-3 illustrates the tasks and interfaces inherent in the corollary experiment operation. The following paragraphs discuss the parts of this operation.

5.3.3.1 Flight controller manning.- The corollary experiments flight control team is made up of four basic positions: the EO located in the MOCR and the corollary data and systems engineers located in the Corollary Experiments SSR. In addition, applicable Principal Investigators provide direct scientific support. The EO and two SSR positions are expected to be manned on a continuous basis. The other position (PI COORDINATOR) will be manned on an "as required" basis.

#### A. Experiments Officer ("EO")

The EO will be responsible for all the Skylab corollary experiments. He will provide the prime interface between the FD, the FOMR, and the flight controllers in the Corollary Experiments SSR. This interface is primarily concerned with experiment objectives, priorities, degrees of experiment completion, assessing the validity of data gathered, and the performance of the experiment equipment. The EO responsibilities are as follows:

1. Reviews and concurs in experiment flight plan updates.
2. Reviews and controls the real-time contamination assessment effort.

TABLE 5-III.- POTENTIAL NOAA DATA REQUIREMENTS FOR ATM SUPPORT

Requirement	Type of data needed	Maximum required frequency from NOAA
H- $\alpha$ solar data 0.5 and 2 Å bandwidths	Photograph	ASAP (min. once per day)
White light solar data	Photograph or drawing	Twice per day
CaH or CaK spectroheliogram	Photograph	Once per day
Solar magnetograms	Photograph	Continuous
K-corona	Photograph	Post SL-2 mission Post SL-3 mission Post SL-4 mission
cm, mm flux values	TTY/voice	Several times per day
cm wavelength maps	Facsimile or equivalent	Once per day
mm wavelength maps	Facsimile or equivalent	Once per day
Solar burst data	TTY/voice	Continuous
Riometers	TTY/voice	ASAP
Atmospheric noise and other ionospheric effects	TTY/voice	Twice per day
Satellite solar observation data	TTY/voice	ASAP (min. once per day)



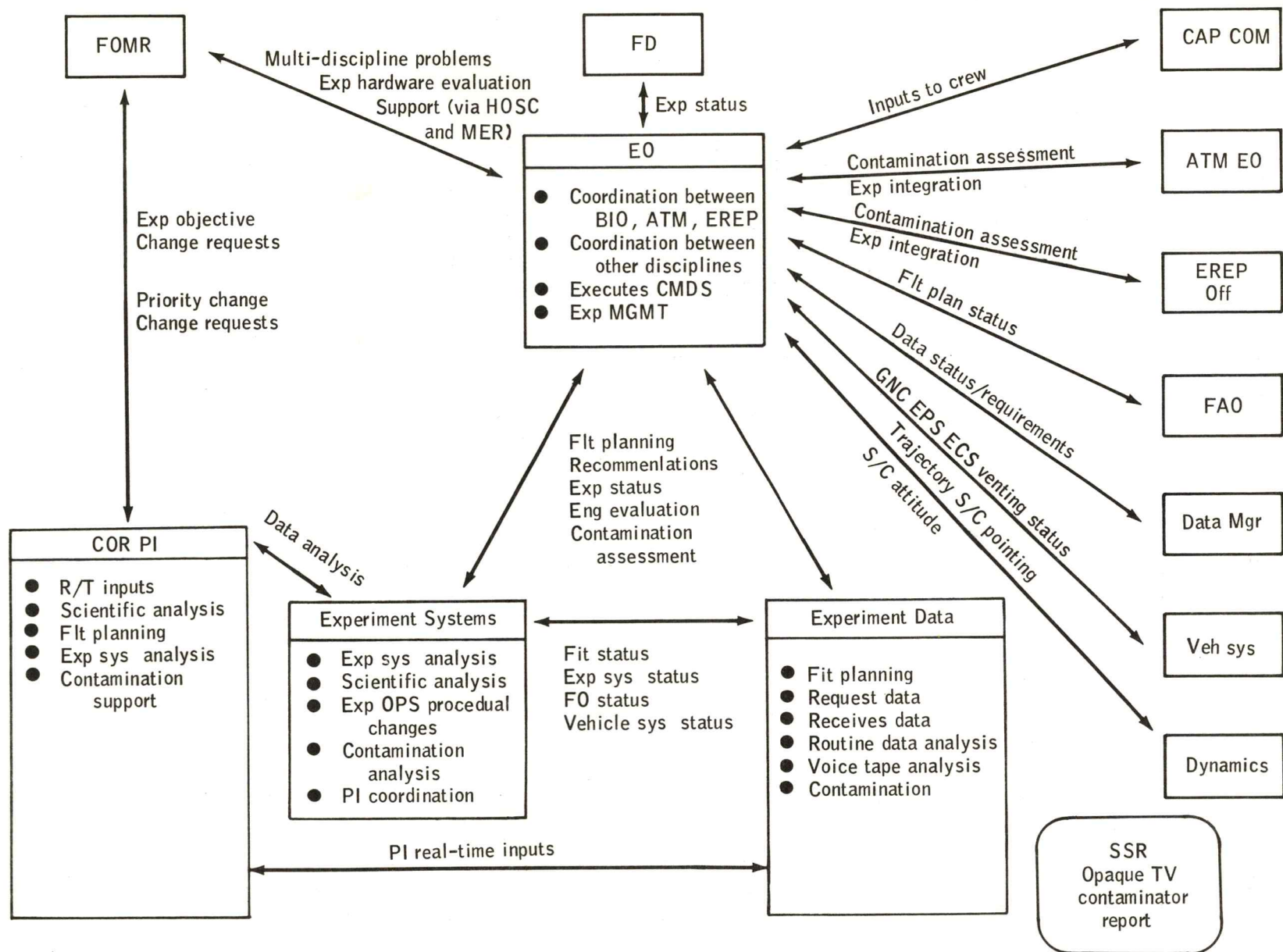


Figure 5-3.- Corollary experiment operations.

3. Assists in implementing experiment procedures as required.
4. Sends all command to corollary experiments, except the IU experiments which are commanded by the BSE.
5. Interfaces with the PI coordinator, experiment SSR, and FOMR for proposed changes in experiment timelines. He provides his recommendations to the FAO. The FAO coordinates the proposed changes with other MOCR positions and then provides the FD with recommendations.
6. Provides all MOCR operators and the FOMR with a daily status of experiment completion, data acquired, and problems encountered.
7. Coordinates radio frequency (RF) dumps with SKYCOM and remote site configurations with the O&P.
8. Coordinates with the vehicle systems engineers on anomalies which affect experiment operations.
9. Coordinates with the FOMR for hardware evaluation assistance as required.

B. Corollary Experiments System Engineer ("EXPERIMENTS SYSTEMS")

This flight controller is located in the Corollary Experiments SSR. Not all corollary experiments require the services of this position so it will be manned only when it is necessary to provide complex experiment support. He performs these tasks:

1. Provides support to the EO and FOMR as required for corollary experiment priority change recommendations.
2. Interfaces between the Corollary SSR and the PI's as required.

3. Provides support to the EO for scientific objective assessment, degrees of completion, new test request evaluations, experiment results, and proposed changes in experiment objectives.
  4. Provides experiment systems analysis and status to the EO and to the Corollary PI's as required.
  5. Provides the prime PI systems/scientific analysis interface and assists the PI in the following areas:
    - a. NRT data analysis
    - b. Assists the PI in making changes to experiment operations procedures and informs the EO of the proposed changes.
    - c. Advises the PI on how best to utilize MCC capabilities and flight operations in order to meet PI's requirements.
- C. Corollary Experiments Data Engineer ("EXPERIMENTS DATA")  
This flight controller is located in the Corollary Experiment SSR and provides the following support:
1. Provides the interface between the Experiment SSR and the EO.
  2. Acts as the focal point for detailed scheduling with the FAO of all corollary experiments. He will provide detailed scheduling information such as experiments pointing requirements, repetition rates, et cetera, to the FAO. He will be responsible for filling out all corollary experiment PAD information given to the crew. This scheduling function is performed with direct inputs from the PI and Experiments System.



3. Provides updates on experiment status to the FAO for entry into the MOPS/ASP (i.e., degrees of completion).
4. Maintains logs of corollary experiment data generated, its location, and data quality.
5. Maintains logs of crew-voiced data on corollary experiments.
6. Monitors and maintains logs of experiment-supporting housekeeping data.
7. Compiles records of corollary ground commands and data dumps.
8. Provides real-time contamination support to the E0.
9. Coordinates all data requirements for corollary experiments with the IST through the use of the MDRS.
10. Acts as the central point of contact for all PI/flight control activities during the mission.
11. Consults with and coordinates through the E0 all real-time PI inputs, comments, et cetera, during the mission.
12. Ensures that all PI's are kept apprised of the mission status and their experiment status by communicating directly with them.

#### 5.3.3.2 Unique operations.-

##### A. Contamination Assessment (normal)

The Corollary Experiments SSR will conduct an ongoing assessment of contamination outside on the orbital assembly. This assessment will be used by personnel responsible for experiments using sensors looking external to the vehicle (ATM, EREP). It will provide information for these experimenters to take into account when assessing their experiment's operation and possibly postponing certain experiment activities.

\*  
B. Contamination Assessment (emergency)

The Corollary Experiments SSR Data engineer will notify the EO immediately anytime he determines through real-time monitoring that the contamination level is approaching redline levels for those experiments being operated or planned to be operated shortly. The EO will notify the Flight Director of the situation as it relates to mission rule implementation. The EO will participate as appropriate in any MOCR discussions on this subject.

C. Contamination Operations

The Corollary Experiments Data Engineer will be responsible for the routine monitoring of contamination data using the following data sources:

1. Six sensors called quartz crystal microbalance (QCM) units, four mounted on the MDA near the EREP experiments and two on the ATM. The data from these sensors will be processed and analyzed in real time.
2. Data from T027 and T025.
3. Real-time (RT) and near-real-time (NRT) crew visual observations.
4. ECS and other spacecraft venting and thruster firing status.
5. QCM data from the T027 sample array when operating.

The evaluated data will then be displayed (opaque TV) and/or disseminated in status reports. These reports will be similar to weather reports. The details of their content are not yet defined but would probably have an overall assessment such as good, fair, or poor and detailed data in some specific units not yet defined (such as  $\text{gm/cm}^2$ ).

If it becomes apparent that an "off-nominal" contamination condition exists or may occur, he will alert the Corollary

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Experiments Systems Engineer and the Experiments Officer. The Contamination Team (see Figure 5-3) will then perform an in-depth analysis relaying their contamination "forecast" (present status and apparent trend of contaminant levels - qualitative and quantitative statements) to all MOCR operators. Individual PI's or their representatives will be notified and will determine any possible impact to their experiments. After a thorough evaluation of the contamination situation, the mission operations team will determine what steps or changes will be made to the mission profile to avoid compromising effected experiments and systems.

MSFC will have one or two people in the corollary PI Room at the start of each Skylab mission to assist in the QCM operations analysis. These people will then return to MSFC and any flight controller interface with them will be through the FOMR as for any other hardware.

A higher priority will be given to contamination monitoring during the following mission phases:

1. Prelaunch

A readout of all QCM's will be required immediately prior to launch for QCM baseline data.

2. Orbital Insertion

QCM readouts are required immediately after earth orbital insertion for a QCM baseline and are compared to the prelaunch baseline to determine launch effects.

3. CSM Rendezvous and Docking

The effects on the OWS cluster environment due to CSM venting, outgassing, and RCS firings will be measured on QCM readouts taken shortly after docking.



4. Prior to First ATM Operations

An in-depth analysis of the contamination status will be made using the QCM data prior to ATM operations.

5. Prior to Each EREP Pass

An in-depth analysis of the contamination status will be performed using QCM inputs prior to each EREP operation.

6. Other Events

Other major events which could produce detrimental effects on the cluster environment are:

- a. Mole sieve venting
- b. Condensate tank venting
- c. Waste tank venting
- d. MDA experiment venting (particulate)
- e. EVA

D. S073 and T027 Photometer Operations Interfaces

These experiments will be run simultaneously with similar sensors on the ground located at Maui, Hawaii, and similar sensors being flown on Pioneer F and Pioneer G. Coordination with the personnel in Hawaii and the Pioneer control center at ARC will be required, and dedicated telephone lines will be used for this purpose.

E. N<sub>2</sub> Venting

Experiments M509, Astronaut Maneuvering Unit, and T020, Foot Controlled Maneuvering Unit, expel N<sub>2</sub> into the cabin. The total pressure in the cabin and the percentage of N<sub>2</sub> may rise to unacceptable levels. The relief valve will open at 5.5 psia which is undesirable due to an uncontrolled vent and to potential valve reset problems. Therefore, the pressure will be kept below 5.4 psia, and O<sub>2</sub> partial pressure must be maintained (procedure to be developed) between 3.3 psi and 3.9 psi for medical experiment purposes. Also,

in order to evaluate the effect of doing M509 or T020 at a given time, an offline computer program will be used which can be given initial conditions, model the N<sub>2</sub> dumping, and compute final conditions to indicate whether the experiment can be run at that time.

This pressure management will be done as a coordinated effort between the experiments and systems flight controllers.

#### 5.3.4 Biomedical Experiment Operations

Figure 5-4 illustrates the tasks and interfaces inherent in the biomedical experiment operation.

##### 5.3.4.1 FCD flight controller manning.-

###### A. Biomedical Experiments Officer ("BIOMED")

For the biomedical experiments this position will be responsible for maintaining the status of the medical experiments hardware and for the analysis/troubleshooting of hardware problems. He will insure that adequate engineering support is provided for the medical team. In conjunction with the medical team leader, he is also responsible for medical experiments statuskeeping.

###### B. Medical Systems Engineer ("MED SYSTEMS")

The Medical Systems Engineer will be responsible for monitoring the hardware for all of the biomedical experiments, operational biomedical data systems, and other biotechnological experiments, for maintaining knowledge of other vehicle systems which may affect the above systems, and for maintaining TM calibration (see Paragraph 5.3.4.2). He is responsible for notifying the Biomedical Experiments Officer, Medical Team Leader, Medical Data Engineer, and PI/Principal Coordinating Scientists, of any hardware anomaly or impending anomalies which affect the biomedical area.

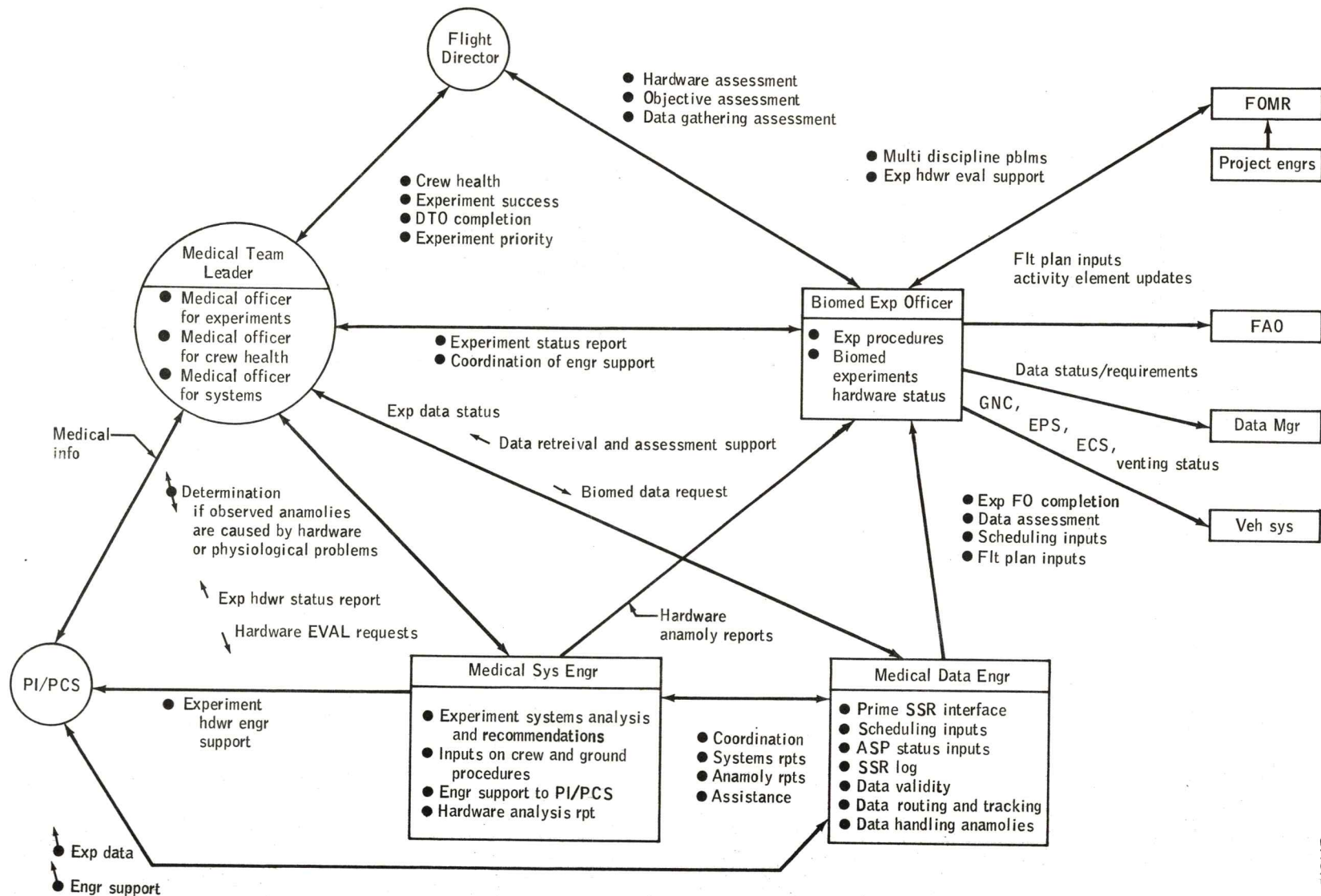


Figure 5-4.- Biomedical experiment operations.



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The specific responsibilities of the Medical Systems Engineer are as follows:

1. Supporting the Medical Team Leader and the PI/PCS on hardware questions or problems.
2. Monitoring all downlinked data for possible hardware anomalies and advising the Medical Team Leader, Medical Data Engineer, and the PI/PCS of any hardware problems or impending problems.
3. Coordinating with the SSR medical personnel to determine if observed anomalies are hardware or medically oriented.
4. Suggesting workarounds, alternates, or fixes for failed or degraded hardware.
5. Monitoring and predicting usage of experiment consumables.
6. Maintaining knowledge (via information obtained from the FAO) of stowage locations of biomedical ancillary equipment.
7. Preparing the Experiment Hardware Analysis Report portion of the SSR log (see discussion of the "MED DATA" position).
8. Monitoring other vehicle systems data (OWS, Airlock, CSM) to the extent of being able to advise the Biomedical and Experiments Officer and the PI/PCS of any adverse effect on the experiments.
9. Monitoring TM calibration data and recalibrating TM parameters as necessary (see Paragraph 5.4.3.2).

C. Medical Data Engineer ("MED DATA")

The Medical Data Engineer will be the prime contact point of the engineering support in the SSR. His responsibilities include data routing, tracking, and status; data evaluation and validity; experiment schedule planning; ASP status inputs and data handling anomalies.

The more specific responsibilities of the Medical Data Engineer are as follows:

1. Providing data evaluation engineering support to the PI/PCS and the Medical Team Leader for experiments.
2. Providing the primary engineering interface with the PI/PCS support in the Mission Operations Data Room if applicable.
3. Providing the update and status of activity elements as required and assuming responsibility for management of the biomed experiment interface with the MOPS system.
4. Maintaining the status of the biomedical experiments accomplishments, data acquired, and problems encountered.
5. Providing support to the Biomedical Experiments Officer in defining experiment scheduling opportunities.
6. Collecting and maintaining a file of premission baseline data to utilize in evaluating experiment hardware performance.

5.3.4.2 Unique operations.-

A. Experiment Flight Controller/MROD Interface

The experiment flight controllers and MROD personnel will both support the medical experiments from the Biomed SSR. The experiment flight controllers will be responsible for hardware status/operations and assuring receipt of valid

data. The MROD personnel will be responsible for assessing the data for experiment success criteria. MROD personnel will not man formal SSR console positions at all times but will periodically report into the MCC. At all other times they will be "on call".

B. Principal Coordinating Scientists (PCS's)

For some of the biomed experiments, the Principal Investigators will not be present in the MCC but will be represented by MSC personnel called Principal Coordinating Scientists. These personnel will function in the same manner as the PI's and will coordinate with the PI's as they deem necessary.

C. Venting

Three of the biomedical experiments result in some venting which will require coordination with the vehicle systems engineers: M092, Inflight Lower Body Negative Pressure, vents some cabin gas overboard; M171, Metabolic Activity, vents a very small amount overboard; and M092, Blood Pressure Measuring System, vents a small amount of N<sub>2</sub> into the cabin. None of these ventings are of the magnitude of M509 and T020 (see Paragraph 5.3.3.2), but they will require coordination with the vehicle systems engineer.

D. Telemetry Calibrations

In order to improve the experiment data, certain parameters on experiments M092, M093, and M171 will be calibrated prior to each experiment performance period. This will be accomplished by crew switching, that inputs known voltage levels to the signal conditioners. The outputs will be observed on telemetry and if they are not within certain limits, the biotechnology experiment flight controllers will notify the MSC Skylab Program Office representative in the FOMR. The FOMR will then request FSD and



CAD to adjust the calibration curves.

E. Daily Medical Team Conference

During each day of manned orbital operations, the Medical Team Leader (or his designated representative) will chair a meeting at which status reports will be given by the medical operations team on the following:

1. Crew health
2. Systems and environment
3. Experiment objectives accomplished

As a result of this conference, a report on the daily medical assessment of the flight crew, and experiment objectives accomplished will be made to the Flight Director, the Program Office (FOMR) and MROD management, on the basis of this report, the next day's experiment activities will be planned.

F. Biomedical Experiment Priority Panel

This panel will convene on an "as required" basis for re-defining priorities to the medical experiment objectives when such changes become necessary due to off-nominal experiment operation on the addition of new objectives.

This panel will be chaired by MROD management and they will make their recommendations to the FOMR.

### 5.3.5 EREK Experiment Operations

Figure 5-5 illustrates the tasks and interfaces inherent in the EREP experiment operations.

#### 5.3.5.1 Flight controller manning.-

##### A. EREK Officer ("EREK")

The EREP Officer is responsible for the overall direction of the EREP teams. He will interface with other flight controllers for coordination of the EREP plan and with the FAO to provide EREP inputs to the flight plan and to assist integration of the EREP activities. EREP is the primary MOCR position responsible for the completion of the EREP mission objectives as well as maintaining a detailed status of the EREP DTO completion.

##### B. EREK Planning Operations Engineer ("PLAN - OPS")

PLAN - OPS is responsible to the EREP Officer for performing all tasks associated with EREP pass planning. He maintains current decision data required in the pass selection operation. With support from the EREP systems engineers he prepares the EREP PADS for submittal to the EREP Officer.

##### C. EREK Data Engineer ("DATA")

DATA is responsible for all data collected during the EREP operation. He reviews the finalized EREP pass plans to insure that all data elements are properly addressed. He maintains an operations log of any specific circumstances that may occur which will have an impact on postmission data operations and evaluation. DATA will lead the Quicklook I activity (defined in Paragraph 5.3.5.3) with support from the systems engineers. He develops the strategy for the Quicklook II (defined in Section 5.4) evaluation and provides information to the Data Manager on EREP data status.

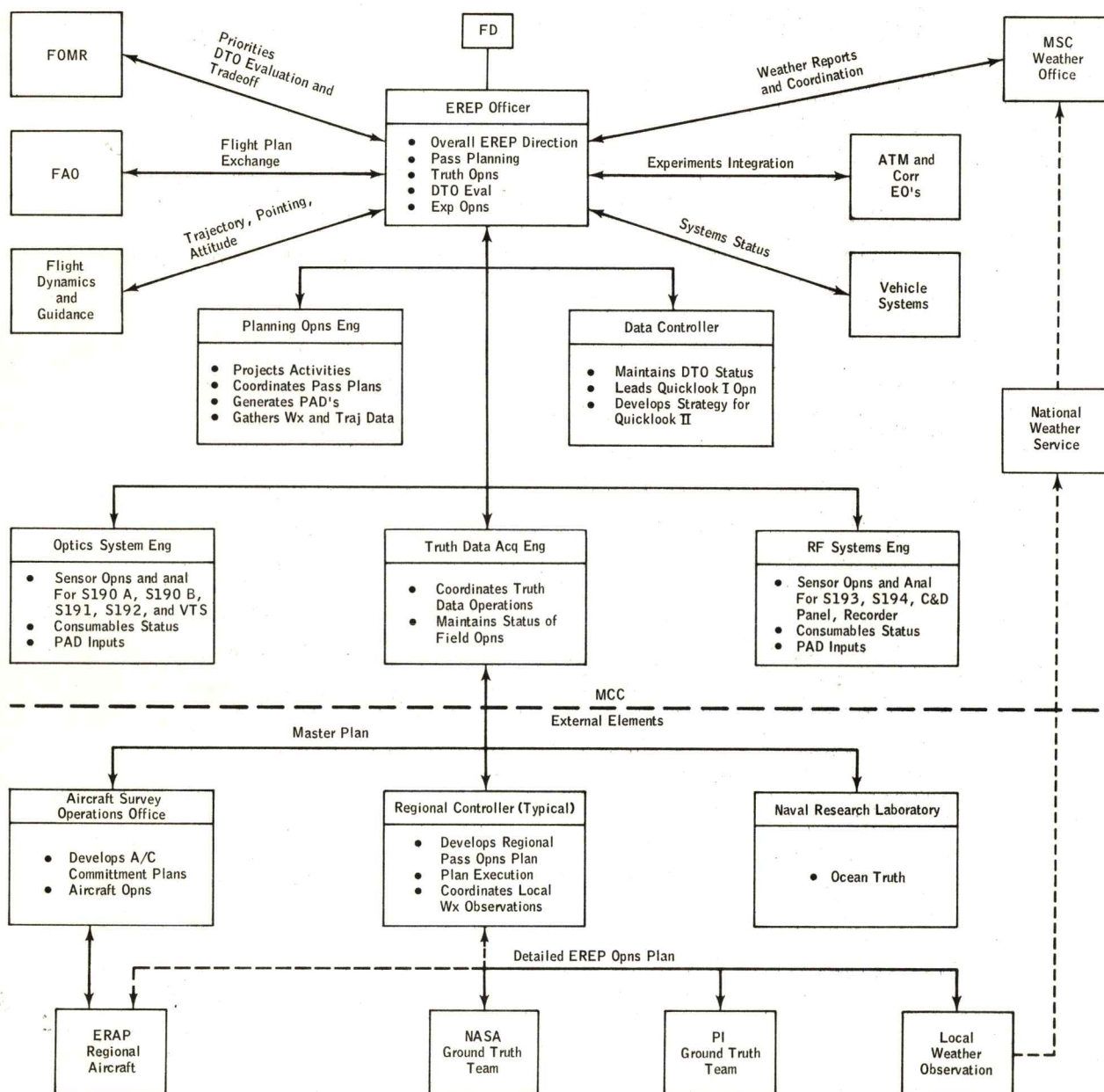


Figure 5-5.- EREP experiment operations.



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D. EREP Truth Data Acquisition Operations Engineer ("TRU-OPS")

TRU-OPS' primary responsibility is to interface with those elements external to flight control which are required to maximize the scientific value of each EREP data take. These elements are specifically related to acquisition of sea, land or atmospheric based data for correlation with the Skylab EREP data. TRU-OPS maintains cognizance of the status of the elements involved in field operations for consideration in the EREP pass planning activities. He disseminates the EREP plan, the pass objectives, and schedules to the remotely located EREP Regional Controllers. In conjunction with the Earth Observations Aircraft Program Office (ERAP) Mission Managers he develops the plan for committing the ERAP aircraft to fulfill under-flight requirements. He receives the post-pass quicklook assessments from the ground truth teams and aircraft operations personnel to support DATA in the Quicklook I activity.

E. EREP Optical Systems Engineer ("OPTICS")

OPTICS is responsible for the systems and operation of S190A, S190B, S191, the Viewfinder Tracking System (VTS), and S192 experiments. He defines the setup condition for the EREP sensors on each pass and provides anomaly resolution. He maintains consumable status for the film data used by these instruments. He also makes inputs to the PAD message development for his assigned systems.

F. EREP RF Systems Engineer ("RF")

RF is responsible for the systems and operation of the S193 and S194 systems plus the EREP control and displays panel and tape recorder. He maintains consumables status for the EREP tapes and makes inputs to PAD message development for the S193 and S194 systems. He determines system

setup conditions for each pass and provides anomaly resolution for his assigned systems.

G. EREP Regional Controllers

EREP Regional Controllers will be remotely located near concentration points of EREP objectives. They serve as planning and statusing focal points for EREP operations within their assigned region. The Regional Controller is responsible for the development and execution of the plans for acquisition of supporting data within his region during an EREP pass. He coordinates with the ERAP Mission Manager for aircraft support of passes within his area. He develops interfaces with local weather forecasters and observers within his region for meteorology support during the pass periods.

The number and assigned locations of the regional controllers for Skylab are not yet determined. This will be established in the months ahead and may include consideration of foreign regions as well as U.S. regions.

5.3.5.2 MSC multidiscipline support team.- An MSC multidiscipline support team will be required to support the EREP flight control team during premission, in orbit, and postmission Skylab operations. The specific team makeup and management has not yet been fully defined. The primary mission function of this team is to provide the EREP flight controllers a consensus science recommendation on site requirements and discipline priorities. As indicated in Paragraph 4.2.2.2.G this team will be located during the mission in the EREP Science Room, the location of which has yet to be determined.

### 5.3.5.3 EREP operations.-

#### A. Pass Planning

EREP pass planning will be accomplished on a successive filtering basis throughout the missions. Selection of EREP passes will be controlled principally by weather forecasts in the EREP target areas. To achieve a reasonable level of EREP objective accomplishments, it is mandatory that the real-time flight planning capability provide the flexibility of scheduling EREP operations when favorable weather conditions exist. The weather assessment activity is discussed in the following section. The daily flight planning cycle is presented in Section 7, including the EREP inputs to this cycle. The remainder of this section will address the pass selection and detailed pass development elements of EREP pass planning.

#### 1. Pass Selection

With the repeating ground track controlled trajectory, a limited number of acceptable characteristic passes will be available, generally repeating on 5 day intervals for 2 to 5 cycles with several opportunities occurring on any given day. The goal of the pass selection process will be to schedule and execute the pass allotment on a given mission in such a fashion that the maximum number of specific EREP objectives have been accomplished under the most favorable weather conditions. The pass selection process for a given day's operation will normally occur over a 5 day interval. This basic EREP pass selection timeline for the 5 day period is presented in Figure 5-6. The vertical scale of the block elements in the figure is intended to indicate a subjective estimate of the



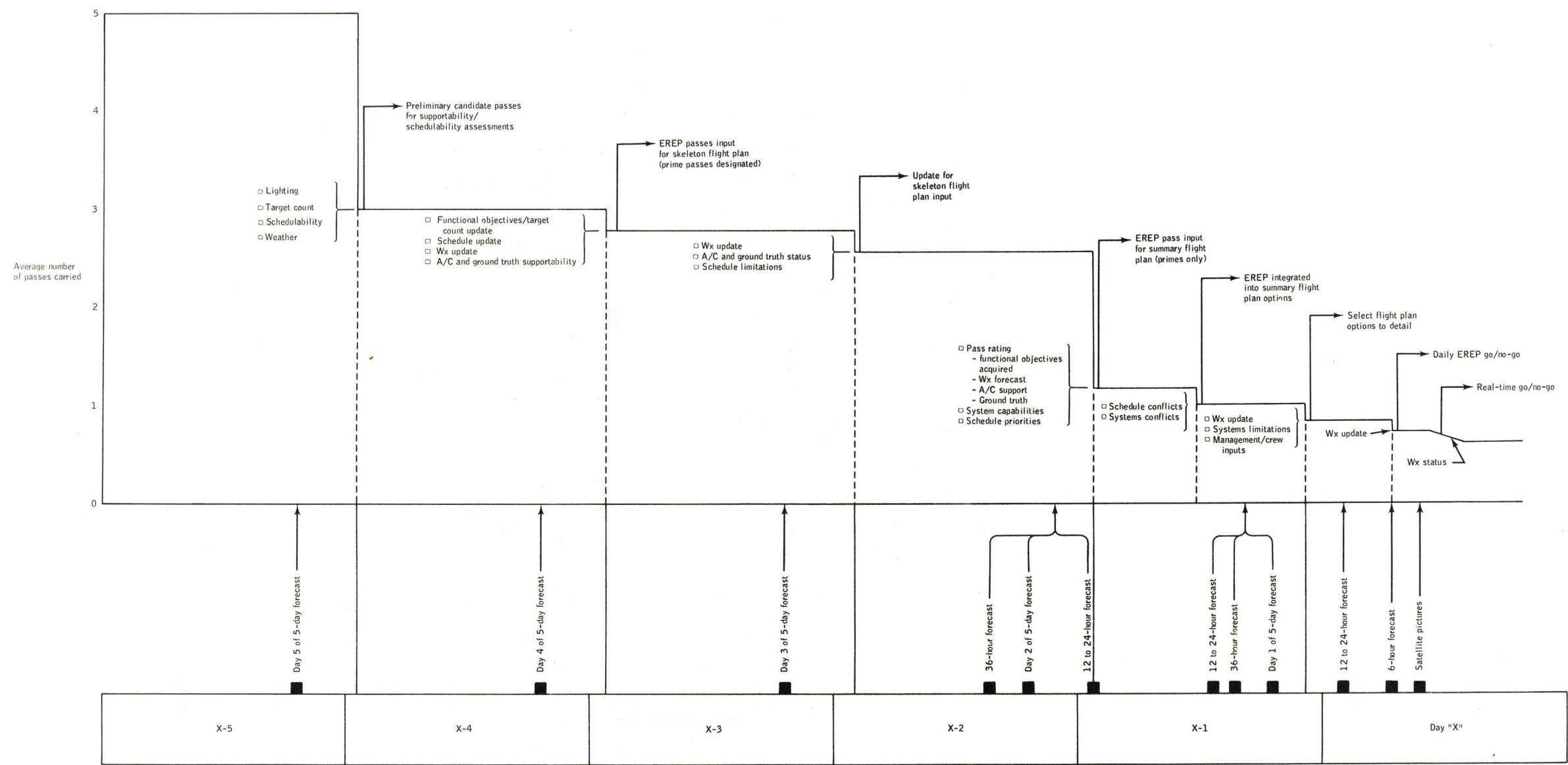


Figure 5-6. - Typical EREP pass selection timeline for mission day "X".

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average number of EREP passes still in consideration after each filtering step. The figure also indicates the schedule of weather forecast briefings which will be utilized in planning the Skylab passes for mission day "X".

## 2. Detailed Pass Planning

The detailed EREP pass planning will be accomplished in two phases. The first phase, which relates to the aircraft and ground truth operations, will be accomplished with 2 to 3-days lead time prior to the passes. This lead time is necessary to ensure scheduling and logistics support for the aircraft and ground truth forces.

The second phase of the detailed planning, which will be accomplished on the day prior to the passes and following the completion of the summary flight plan options, will address the Skylab vehicle operations. In this phase the EREP flight control team will work out the details of the EREP pass including items such as detailed timeline, instrument configurations, pointing data, consumables projections, and the required time period for the vehicle to be in the Z-local vertical attitude. The latest available weather forecast information will be utilized in determining the data-take intervals to eliminate unfruitful consumables expenditures. The output of this detailed planning phase will be the EREP PAD data.

## B. Weather Assessment

As indicated earlier, weather assessment is very critical to EREP operations. The MSC Meteorology Support Group will provide regularly scheduled weather briefings for the EREP support team with information obtained from the National

Weather Service. These briefings will include weather forecasts and reviews of general meteorological conditions for daily intervals to five days in advance. These briefings will be scheduled periodically during each day, and will cover both short term and long term forecasts. One weather briefing will be scheduled for early morning at which the "GO/NO-GO" decision will be made for today's EREP pass (as discussed in Section 7). The long term forecasts will allow the flight controllers to select tentative pass options several days in advance. An additionally important source of weather input will be through the Regional Controllers and the TRU-OPS. The Regional Controllers will provide information from the local area forecasters on the projected weather conditions for the planned pass options.

C. Ground Truth Operations

Each Regional Controller will be advised by the MCC on the planned status for the EREP passes. When notified of any passes (and associated objectives) within his region, he will finalize the ground truth data operations plan for the pass to be accomplished and disseminate this plan to the ground truth teams within the region. The Regional Controller also provides feedback to the MCC on any anomalies in the support posture of the ground truth operations element.

MSC ground truth teams will conduct field operations as specified by the Regional Controller. These teams will be responsible for measurement systems operation and data integrity. They will deliver their data to the Data Reduction Facility.

Most of the EREP Investigators will probably prefer to be present in their target areas during the EREP passes. Many



of the Investigators will have their own truth teams present in the target area during the EREP passes. Like the MSC truth teams, their principal interface to the mission operation will be through the Regional Controller in their region.

D. Oceanographic Truth Data Operations

Oceanographic truth data operations for Skylab will be conducted by the United States Navy. Data will be collected from buoys, from expendable air-dropped measuring systems, and from ships - either dedicated or scheduled as ships-of-opportunity. The principal direction for this operation will be by the Naval Research Laboratory (NRL). NRL personnel controlling this operation will serve the same type of function as the EREP Regional Controller.

E. Aircraft Underflights

Aircraft underflights are planned for each of the characteristic EREP passes available. EREP TRU-OPS will coordinate with the Aircraft Survey Operations Office at MSC in developing the aircraft commitment plans in order to provide the best coverage for the projected primary and alternate passes. As now planned, the aircraft will be available in the region the day before the projected passes. The aircraft Mission Manager coordinates with the Regional Controller for detailed development of the flight path and aircraft instrument configurations to support the EREP objectives. Data handling and logistics will be handled in accordance with established procedures for the ERAP with minor modifications to ensure compatibility with the Skylab data statusing system.

F. Real-Time Operations

After the detailed timeline is developed, PAD messages will

be prepared for uplinking to the onboard teleprinter. These PAD's will include EREP setup information, operating information (which is used as a checklist/timeline), and VTS operations information.

Ground support during real-time EREP operations will consist of an information exchange with the crew for the systems checkout and setup, monitoring of associated OA parameters, and information exchange for systems shutdown and debriefing.

#### G. Quicklook I Activities

The EREP Quicklook I activity is the post-pass evaluation of the pass success and DTO completion. Only a limited evaluation can be performed during Quicklook I, as the prime data remains onboard the spacecraft in film or tape form. The EREP Data Engineer will lead the Quicklook I activity which includes post-pass debriefings from the crew and assessment of the truth data operation, the vehicle systems operation, and observed weather data. Any peculiarities during the operation will be documented for inclusion in the postmission report, and for use during the postmission evaluation.

### 5.4 INTER-MISSION EVALUATION/ANALYSIS

A quicklook analysis of all the experiments will be accomplished during the times between SL-2 and SL-3 and between SL-3 and SL-4. Based on this analysis, in conjunction with the ongoing analysis during each flight, changes may be made in objectives, procedures, or hardware for the succeeding flight. The specific analysis that must be done, the timeframe, and participation (PI, program office, flight controller) has not been fully defined for all experiments. However, it is expected that changes in objectives and procedures will be made within established frameworks for changing the MRD, Flight Plan, and crew procedures

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with the process formally expedited to accomplish changes in the existing short time intervals.

For the EREP experiments the inter-mission analysis is called Quicklook II (in contrast to the Quicklook I evaluation performed post-pass). Quicklook II activities will be conducted by the EREP Flight Control Team and others and will start after the EREP tapes and film are delivered and processed. As a result of this evaluation, changes in the next mission EREP operations, objectives, and procedures may be made.

For the biomedical experiments, all significant analyses of the inflight experiment samples are planned to be completed by recovery plus 15 days so that an evaluation can be made for the next mission. In addition, each crew member will undergo postflight tests under the same preflight and inflight experiment conditions to establish the "return-to-normal" curve. This information may also dictate changes to the next mission experiment objectives.



6 COMMUNICATIONS  
AND DATA  
MANAGEMENT

COMMUNICATIONS AND DATA MANAGEMENT

6.1 VEHICLE COMMUNICATIONS SYSTEMS DESCRIPTIONS

6.1.1 CSM Communications System

The Skylab CSM communications system will be basically an Apollo Block II system with slight modifications primarily in the audio/intercom, antenna, and video downlink areas. The CSM audio/intercom system has been modified to interface with the SWS. There will be no high-gain antenna on the CSM, and the omni antennas will all be selectable via ground command. Finally, the ground will be able to select video for downlinking utilizing the CSM frequency modulation (FM) transmitter.

6.1.2 AM Communications System

The AM communications system consists primarily of modified Gemini equipment. The AM data system and audio/intercom system will utilize any three of four VHF transmitters for downlinking real-time data, delayed-time recorded data, or recorded voice. The AM will have three tape recorders (replaceable in flight) for recording systems, experiment, and voice data. Command capability to the AM will be through redundant ultrahigh frequency (UHF) receiver/decoders. Additionally, the AM will be equipped with Apollo VHF ranging equipment for use during rendezvous. The AM antenna system will consist of a special VHF ranging antenna, two discone antennas and a launch stub antenna (each capable of supporting telemetry and command), and a command-only stub antenna. The discone antennas and the launch stub are selectable via ground command. The command stub is hard-wired to both receiver/decoder systems.

### 6.1.3 ATM Communications System

The ATM communications system utilizes modified Saturn hardware. The data system has two VHF transmitters for downlinking real-time (R/T) and delayed-time (D/T) data. It has two non-replaceable recorders and related interface equipment to provide for the recording of systems and experiments data. The command system on the ATM will utilize redundant UHF receiver/decoder systems. Two telemetry and two command antennas are mounted on the ATM solar panels. The telemetry antennas are selectable via ground command. The two command antennas are hard-wired to the receiver/decoders.

## 6.2 COMMUNICATIONS SYSTEMS OPERATIONS

A summary of the various communications links utilized for the Skylab missions is presented in Table 6-I. Systems operation with respect to the various data transmission modes is presented in the following paragraphs.

### 6.2.1 Voice

The SWS will use the CSM as an integral part of its audio/intercom system. The system has two voice channels. One will probably be used for downlinking R/T voice or as an intercom (I/C) channel with the other being used for recording experiment voice data. All R/T and SWS intercom voice will require use of the CSM S-band system. The CSM VHF equipment will serve as a backup to the S-band system. Voice recording will normally be accomplished by using one of the voice channels and the AM recorders. Voice may also be recorded on the CSM data storage equipment (DSE) and downlinked via the CSM S-band system. SWS voice recording may be effected



TABLE 6-I.- SKYLAB RF LINKS

Vehicle	Frequency in MHz		Transmission characteristics	Purpose
	TX	RX		
CSM	2287.5		USB - PM	R/T TM - 1.024 MHz subcarrier R/T voice - 1.25 MHz subcarrier PRN (down)
	2272.5		USB - FM	D/T TM - 1.024 MHz subcarrier (backup) D/T voice - Base band (backup)
		2106.4	USB - PM	R/T TV - Base band Command - 70 kHz subcarrier PRN (up)
	259.7		AM	Voice - 30 kHz subcarrier
	296.8	259.7	AM	Voice (backup), ranging transmit
			AM	Voice (backup)
	243.0	296.8	AM	Voice (backup) Voice (backup), ranging receive Recovery beacon
ATM	231.9		PCM/FM	TM (2)
	237.0	450.0	PCM/FM PSK/FM	TM (2) Command (3)
AM	230.4		PCM/FM	TM (R/T or D/T), voice D/T (1)
	235.0		PCM/FM	TM (R/T or D/T), voice D/T (1)
	246.3	450.0	PCM/FM	TM (R/T or D/T), voice D/T (1)
	296.8	259.7	PSK/FM VHF	Command (3) Ranging
IU (4)	250.7		FM/FM	TM
	245.3		PCM/FM	TM
	2282.5	2101.8	PCM/PM	CCS
	5765.0	5690.0	Pulse	C-band radar
S-II (4)	240.2		FM/FM	TM
	232.9		FM/FM	TM
	248.6	450.0	PCM/FM FSK/FM	TM
				Secure range safety
S-IC (4)	256.2		FM/FM	TM
	244.3	450.0	PCM/FM FSK/FM	TM
				Secure range safety
IU (5)	245.3		PCM/FM	TM
	250.7		FM/FM	TM
		450.0	PSK/FM	Udata
	5765.0	5690.0	Pulse	C-band radar
S-IVB (5)	258.5		PCM/FM	TM
		450.0	FSK/FM	Secure range safety
S-IB (5)	240.2		FM/FM	TM
	256.2	450.0	PCM/FM FSK/FM	TM
				Secure range safety

- (1) Frequencies can be selectively modulated with airlock module R/T TM, D/T TM, or D/T voice.
- (2) Two different modulation inputs from the ATM can be used for these transmitters.
- (3) Two independent receiving systems on the cluster use this frequency. The two systems are distinguished by vehicle address coding.
- (4) Vehicle used on SL-1.
- (5) Vehicle used on SL-2, SL-3, and SL-4.

by the crew (as required) at any of the 13 speaker intercom assemblies (SIA's) throughout the SWS. Voice recordings made during periods not requiring an AM experiment recorder will be on the AM data recorder. Since the ATM recorders do not record voice, the AM recorders will be utilized for voice recording during ATM operations. Additionally, there is no timing on the voice track of the AM recorders. This means that both the PCM track, which has timing, and the voice track must be dumped simultaneously. The timing is extracted from the PCM track and added to the voice on the ground. Present plans are to accomplish this function at the remote sites prior to playing the downlinked recorded voice back to the MCC.

## 6.2.2 Telemetry Data

6.2.2.1 CSM.- CSM R/T PCM (HBR) will be transmitted via the CSM S-band system, as will be any CSM D/T PCM from the DSE. CSM R/T PCM will be available during each site pass for evaluation of CSM systems. Recorded CSM data should not be required for periods other than launch through SWS activation and deactivation through reentry. The CSM DSE will be required to record radiation data and crew comments, and the R/T HBR CSM data will at times include data from memory registers of certain CSM experiments (S071/S072).

6.2.2.2 AM.- AM R/T data can be transmitted by any of the AM VHF transmitters and will also be provided each site pass. AM recorded data will also utilize the VHF transmitters. The recording of systems data will normally be handled by the ground with experiment data recording being effected normally by the crew as required in accordance with their timeline. The dumping of recorded data will normally be

handled by the ground and will be performed to maintain a compatible relationship between recorders/record-time-available and experiment recording requirements.

6.2.2.3 ATM.- ATM R/T data will utilize one of its two VHF transmitters each site pass. D/T experiment and systems data will be recorded on one of the two recorders and dumped as required (at least once per rev) on the other VHF transmitter. Plans are to use only one recorder at a time, with the other recorder being brought online only after a failure of the primary recorder. Normally, the crew will effect recording of experiment data with the ground handling the recording of any special systems data as required. The ground will normally perform the functions necessary to dump the recorder.

6.2.3 Commands

In general, from a ground viewpoint, commanding techniques utilized for Skylab will be similar to those utilized in Apollo. Command modes (Mode I, Mode II, Map Override, et cetera) will be the same as for Apollo. An additional mode will be provided to allow flight controllers to verify commands uplinked to the ATM prior to transmitting their execution request. Also, since the ATM command system will accept either true or complement command data, the capability will be provided to allow the flight controller to select true or complement data for uplinking. A technique will also be provided for "safing" certain critical commands specified on a mission phase basis to guard against their being uplinked at an improper time. An inventory of these safed commands will be kept and an attempt to uplink one will result in a flag to the operator.



6.2.3.1 Real-time commands (RTC's).- The CSM, AM, and ATM will all utilize RTC's to allow the ground to perform certain onboard functions. Most of the RTC's sent on a regular basis will be sent by the Communications Systems Engineer (CSE) for managing the data transmission and recording systems. RTC's will utilize the command system of the particular vehicle to which they are addressed. However, as indicated in Paragraph 3.10, a special interface has been provided, to allow configuration of the ATM data system for R/T data and normal recorder dumps through the AM command system. This technique allows the crew to use the ATM digital address system (DAS) without inhibiting routine communications system commands. Additionally, selection of the CSM omni antennas can be accomplished through the AM command system.

In certain instances, the performance of an onboard function will require the uplink of a number of RTC's. These will normally be handled as multiple word RTC's initiated as a single RTC. Command spacing, retransmission plans, et cetera, will be handled in a manner similar to Apollo.

Special provisions must be made for commanding during the unmanned operations periods. See Paragraph 3.10 for details.

6.2.3.2 Command loads.- Each vehicle (CSM, AM, and ATM) will require the uplink of certain command loads. CSM loads (navigation, CMC timing, Refsmmat, entry, et cetera will be similar to those used in the Apollo Program. The Central Timing Equipment (CTE) update will also be used. The ATM will have several computer loads and the AM will have TR and time-to-go equipment reset-AM timer (TX) updates and teleprinter loads. TR and TX loads are timing updates to timing registers used to aid in the configuring of the communications systems. The TR function is used to switch AM receiver/decoders should

the prime system fail. The TX function will probably be used each site pass to reconfigure recorders and transmitters at the end of the pass. It can also be used to turn off the rendezvous lights or zero the AM Greenwich mean time (GMT) timer at midnight when required. Teleprinter loads, due to their unique nature, are discussed in the following paragraphs as an essentially separate type of commanding function.

6.2.3.3 Teleprinter messages.- Teleprinter uplinks will use the AM UHF command system as the message carrier. Messages can be generated manually or automatically and will originate only at the MCC.

Manual message generation may be accomplished by using Mission Operations Planning System (MOPS) terminals or the Command/Load Controller's manual entry device (MED). Message generation will primarily be done using a MOPS terminal. The user has several options from which to choose following his decision to generate a message. He may call up "background" information and simply fill in the blanks. These background forms will normally be defined prior to launch and entered into the teleprinter message forms data-base, but they can also be generated in R/T during the mission. There is a general display from which the user can generate any kind of "free lance" message he desires. However, no line in the message may exceed 30 characters. The user has the capability to change characters, shift lines, or delete lines of both the background data and the data he has input.

After message generation, the user will notify the appropriate flight controller and a teleprinter message sequence number will be assigned. The message will then be transferred to the Teleprinter Planning Table (TPT) in the MOPS.

Once in the TPT, message access for modification is limited to provide a degree of security. After all teleprinter uplink planning has been completed, the messages are transferred to the Teleprinter Load Table in the Mission Operations Computer (MOC) for actual load generation. Teleprinter messages will be uplinked as a load or several loads depending on the message length. Each teleprinter load can consist of up to 50 lines of data. Thus a message of less than 50 lines will require only one teleprinter load. A message of greater length will require an appropriate number of loads to accommodate its length. The capability exists to build up to six teleprinter loads and store them at the MCC. The remote site can store up to three teleprinter loads simultaneously, and in most cases, uplink all three during a site pass if required.

Expected teleprinter messages, message lengths, and their transmittal rates are estimated as follows:

- General Flight Plan - 48 lines - Daily
- Detailed Flight Plan (3) - 105 lines total - Daily
- ATM Solar Activity PAD - 40 lines - Daily
- ATM Schedule - 36 lines - Daily
- Next Station Contact PAD - 48 lines - Daily
- Block Data - 20 lines - Daily
- General Messages (3) - 15 lines - Daily
- EREP Setup PAD - 40 lines - As required
- Viewfinder Tracking System PAD - 25 lines - As required
- EREP Operations PAD - 50 lines - As required
- Experiment PAD's - As required
  - D008 - 7 lines
  - S009 - 7 lines
  - S019 - 20 lines



S020 - 7 lines  
S063 - 10 lines  
S073/T027 - 15 lines  
S149 - 7 lines  
S183 - 5 lines  
T025 - 5 lines

It is estimated that actual uplink time per day required for teleprinter messages will be approximately 9 minutes. On days when an EREP pass is scheduled, however, the time required should be about 12 minutes.

Due to the length of time required to uplink teleprinter messages, the remote sites will have the capability to interrupt message uplinks for any other required commanding and resume the message uplinks automatically.

Presently, investigations are underway to identify all teleprinter requirements and to further establish the operational procedures for the teleprinter. Information obtained from these investigations will be contained in a Teleprinter Utilization Plan, which will be published as soon as all requirements and operational procedures have been established.

#### 6.2.4 Video

Video from the SWS will be available through the CSM via the S-band FM transmitter. The source of the TV signal is selectable by means of switches located in the MDA and the CSM. It is possible to select video from either of the two TV monitors on the ATM control and display panel, the five SWS portable TV camera input stations, or the CSM portable TV camera input station. The ground has the capability (via command) to configure the CSM for video transmissions and return it to its normal state. Action will still be

required by the crew, however, to configure the TV camera, power/video umbilical, MDA video switch, lighting, et cetera. Since the CSM FM transmitter is also used to downlink recorded CSM experiment and systems data, its use for the purpose of downlinking TV will have to be on a time-shared basis. Certain ATM experiments will require the downlinking of ATM video possibly each site pass. Additionally, video of the Skylab EVA's will be downlinked as will be certain onboard crew activities for PAO purposes. Sites having a R/T TV capability (Goldstone, California-STDN station [GDS] and MIL) will be remoting R/T TV normally once per day and probably near the end of the crew workday during ATM operations or other special crew activities. All sites will be utilized for the recording of downlinked video with the tapes being mailed back to the MCC. Video recorded at GDS and MIL, however, will be played back to the MCC on a daily basis just prior to or immediately after the R/T TV pass.

#### 6.2.5 Tracking

Normal ephemeris determination during docked periods will utilize Doppler, along with C-band skin track from MLA and CRO. During undocked periods, the issue of tracking adequacy is most serious for the SL-2 launch and rendezvous support. During the approximately 24 hours between SWS insertion and SL-2 launch, all initial workshop activation must occur, and numerous planned venting-type disturbances have been identified. Only eight passes over the CRO and MLA sites, six of which have elevation angles less than 10 degrees occur in this 24-hour period, and launch targeting must be based on the data from this 24-hour span. Three-sigma  $\Delta V$  costs resulting from three-sigma tracking accuracies with both sites

supporting are currently marginal. Therefore, the command and communications system (CCS) USB beacon will be powered sufficiently long to include the entire rendezvous sequence. The C-band support for SL-3 and SL-4 launch targeting and rendezvous is thought to be adequate, since there is a long period of undisturbed coasting flight (assuming that no vents are identified in the re-activation timeline) during which a good ephemeris can be established using CRO and MLA sites.

The North American Air Defense Command (NORAD) could be used to augment tracking capability; however, this is not presently a requirement. NORAD does maintain a vector which is updated every day or two. If all S-band tracking is lost, NORAD could be asked to increase their tracking of the CSM and/or SWS and to update their vector more frequently.

### 6.3 NETWORK DESCRIPTION

#### 6.3.1 Sites and Capabilities

The network utilized for Skylab will be the STDN managed by GSFC and will primarily consist of eight 30-foot sites, three 85-foot sites, the Vanguard tracking ship (VAN), and a new station to be located in Newfoundland. The new station in Newfoundland is required for monitoring and backup command for the SL-1 activation sequence. At this time no requirements exist for having S-band at this site. It will have (as a minimum) the capability to receive and process VHF telemetry links from the AM and IU, transmit UHF commands to the AM, and perform command and telemetry processing comparable to other network stations. Additionally, VHF A/G may be provided at Newfoundland to support the manned Skylab launches. VHF telemetry and UHF command capability will be provided at Honeysuckle, Australia-STDN station (HSK), Madrid, Spain-STDN station (MAD), and GDS.



The VAN will not be used to provide launch coverage as in the past. Instead, it will be positioned in the Atlantic just off the coast of South America to provide badly needed orbital support from that geographic area. Additionally, the VAN will have a new capability to record color video. A summary of Skylab remote site capabilities is presented in Table 6-II.

#### 6.3.2 Site Utilization

Analysis of the Skylab trajectory reveals that each low-latitude site will have two series of passes per day, with the series separated by 4.5 to 10 hours. Each series consists of two to three consecutive passes. Using this information and specific trajectory data for 2 mission days, it was determined that the low-latitude sites would be required to provide approximately 4.5 hours of full operational support per day. With the 4 hours of prepass preparations considered as part of the site manning and approximately 1 to 2 hours of post-support work possibly required, the total support time required per day approaches 11 hours.

The 85-foot sites are located at higher latitudes and normally have six or seven passes per day occurring as a single series. Full operational support will be required approximately 9 hours per day, but with the prepass preparation time (5 hours per series of passes at an 85-foot site) added, plus 1 to 2 hours of post-support work, the total support time required is approximately 16 hours per day.

TABLE 6-II.- SKYLAB REMOTE SITE CAPABILITY

Site	TRK		TM		CMD		A/G		TV		Lines		Comments	Notes
	C B A N D	U S B	V H F	U S B	U H F	U S B	V H F	U S B	R E C O R D	R E A L T I M E	V D	T Y		
USB capability														
A C N		H	X	X	X	X	X	X	X	X		5 2	COMSAT VHF A/G is simplex only, same antenna used for A/G and TM.	1
B D A		H	X	X	X	X	X	X	X	X		5 2	VHF A/G is simplex only, 2 VHF antennas exclusively for A/G, 3 for TM.	
C R O	H	H	X	X	X	X	X	X	X	X		5 3	COMSAT FPQ-6 can skin track in all cases VHF A/G is simplex/duplex selectable as needed, 2 VHF antennas exclusively for A/G, 3 for TM.	
C Y I		H	X	X	X	X	X	X	X	X		5 2	COMSAT VHF A/G is simplex/duplex selectable as needed, 2 VHF antennas exclusively for A/G, 3 for TM.	
G W M		H	X	X	X	X	X	X	X	X		5 2	VHF A/G is simplex only, same antenna is used for A/G and TM.	1
H A W		H	X	X	X	X	X	X	X	X		5 2	VHF A/G is simplex/duplex selectable as needed, 2 VHF antennas exclusively for A/G, 3 for VHF TM.	
M I L		H	X	X	X	X	X	X	X	X		5 3	VHF A/G is simplex/duplex selectable as needed, 2 VHF antennas.	1
T E X		H	X	X	X	X	X	X	X	X		5 2	VHF A/G is simplex/duplex selectable as needed, 2 VHF antennas exclusively for A/G, 3 for TM.	
V A N	H	H	X	X	X	X	X	X	X	X		5 2	COMSAT VHF A/G is simplex only, 2 A/G antennas, 1 VHF TM.	1
G D S		H	X	X	X	X	X	X	X	X		5 2	VHF A/G simplex	
H S K		H	X	X	X	X	X	X	X	X		5 2	VHF A/G simplex	2
M A D		H	X	X	X	X	X	X	X	X		5 2	COMSAT, VHF A/G simplex	2
C I F			X	X									Transfers data to MCC	
M L A	H											1 1		
F L D			X		X									3

## NOTES:

1. The VHF telemetry preamp is muted when site transmits on 259.7 MHz resulting in the loss of all VHF telemetry data.
2. Capability for R/T TV exists, but not planned to be used.
3. Exact equipment capabilities for the Newfoundland site have not yet been defined at this time.
4. H = high speed

### 6.3.3 Network Data Flow and Loading Estimates

6.3.3.1 Data voice circuits.- Skylab flight operations are expected to require a maximum of six 3-kHz voice/data lines to each site to be utilized as follows:

- A. Three lines, with 7.2-kbps modems, for telemetry data
- B. One line for air/ground voice
- C. One line for network coordination and air/ground voice backup
- D. One line, with 7.2-kbps modems, for high-speed tracking and digitized biomedical data and commands

The high-speed tracking data line will be required only during launch. Telemetry data will be processed to interface with the 7.2-kbps data modems. The high-speed tracking data will be sent back on the 7.2-kbps line in a 2.4-kbps format. The digitized biomedical data will use the remaining 4.8-kbps of the line. In addition to the high-speed voice/data lines, two teletype circuits will be required to each USB site and one to the C-band radar at MLA for low-speed tracking data, acquisition messages, and miscellaneous TTY traffic.

6.3.3.2 Command data.- The command system will be required to access approximately 1180 RTC-type individual commands, in addition to ATM and CSM computer loads, timing updates, test words, and teleprinter data. The capability will be retained to initiate by a single push button indicator (PBI), certain RTC's that require quick access for time-critical functions or multiple-function RTC's (functions requiring two or more commands to execute) which would not be operationally feasible via the digital select matrix (DSM). In addition a requirement has been identified to update the complete memory of the ATM computer on a word-by-word basis.



Booster command requirements, not included in these figures, are expected to total 170 commands for SL-1 and 140 commands each for SL-2, SL-3, and SL-4. Again, in addition to regular commanding, the command system will be required to accommodate teleprinter loads as discussed previously in Paragraph 6.2.3.3.

6.3.3.3 Telemetry/high-speed data.- The Skylab Program differs significantly from the Apollo Program in the technique used to retrieve mission data. The Skylab support network will utilize a new Data Redundancy Removal (DRR) system for the transmission of data from the remoted sites to the MCC. This system will allow the retrieval of all downlinked data in real time or near-real time (within 24 hours). Each parameter in the telemetry downlink is a succession of samples. DRR uses a mathematical standard for judging which of these samples contain no information (i.e., redundant) and deletes those samples. Thus, only meaningful (non-redundant) or change-only samples are transmitted to the MCC. This results in a possible data compression ratio of 20:1. The amount by which a sample may change from the previous sample before it is determined to be of informational value will be expressed in terms of a "K" factor. For the PCM telemetry downlink, K is expressed in units of PCM counts. For a K-factor equal to zero the sample must differ from the previous sample by at least one PCM count to be transmitted. A K-factor of one would require a change of at least two PCM counts for the sample to be transmitted.

In order to handle the three Skylab R/T downlinks (CSM 51.2 kbps, AM 51.2 kbps, and ATM 72 kbps) plus the required ID, time tagging and error protection information, three 7.2-kbps data lines are required. Should the data activity

\*

of the downlinks become so high that the total amount of data which must be transmitted to the MCC approaches the 21.6-kbps output limit, the data output will be automatically reduced. Processing controls will reduce the data transmission capability by increasing the K-factors of preselected parameters to a predetermined number, reducing sampling rates, deleting data, or any of these three in the stated order on a vehicle priority basis.

To insure that no data is lost should these output reduction techniques be applied, an all-data digital tape (ADDT) will be made at the remote site. This R/T ADDT will record all parameters utilizing a K-factor of zero. The ADDT will then be played back to MCC postpass. Dump ADDT's will also be made from recorded tapes of any dumps made at the remote site. The dump ADDT will be transmitted to the MCC postpass, probably after the completion of the transmission of the R/T ADDT.

DRR will not be compatible with certain data parameter groups (high-speed tracking and R/T biomed). These will be handled similar to Apollo data by using fixed formats.

#### 6.4 DATA MANAGEMENT

The success of the Skylab Program is to a great degree dependent upon the effective management of the acquisition, retrieval, processing, and distribution of both systems and experiments data. The data management techniques being implemented for Skylab are designed to achieve an orderly and timely flow of telemetered, tracking, and support data from the remote sites to the MCC, and to the data user.

How the FOD is planning to handle the Skylab data management tasks is described in the following paragraphs.

#### 6.4.1 Flight Control Data Management Team

Primary data management responsibilities within FCD are assigned to the O&P Officer and the Data Manager. The basic responsibilities of these two flight controllers were defined earlier in Paragraph 4.2.2. Their specific duties are listed below.

A. O&P Officer - The O&P is responsible for all data requirements and activities which call for real-time data.

Specifically he:

1. Insures that the requirements for transmission of real-time telemetry data from the remote sites to the MOC are met.
2. Coordinates all playback requests for real-time telemetry or operational biomed data from the remote site to the MCC.
3. Coordinates all prepass changes to the remote site configuration due to vehicle downlink priority changes or vehicle configuration changes. This includes changes to uplink or downlink modes or downlink processing requirements.
4. Provides final FCD approval of the Site Configuration Worksheets, and acts as the central point of contact for resolving any conflicts in this area.
5. Establishes the data retrieval priorities from the remote sites to the MCC, and resolves any conflicts.



6. Coordinates all requests for K-factor changes to the remote site telemetry processor data compression system.
  7. Coordinates the biomed data playbacks from the ADDT Processor to the MOC.
  8. Coordinates all requests for wirephoto service to obtain copies of the downlinked video.
  9. Controls DTE channel allocations between output systems and establishes DTE channel priorities should a DTE system fail.
- B. Data Manager - The Data Manager is responsible to the O&P in all matters pertaining to non-real-time data requirements and activities. Specifically he:
1. Coordinates all new or changed data processing requirements. This includes assuring appropriate approval and forwarding of these requirements to FSD's Data Coordinator.
  2. Monitors all data retrieval processing, priority, and distribution problems. Participates in defining new procedures or corrective action.
  3. Insures that all requirements for ADDT data and voice transmission to the MCC are met.
  4. Assists in resolving any priority conflicts on requests for priority data processing.
  5. Monitors downlinked data quality. When required, requests data retransmission from the vehicle or remote site.

All non-mission (test) data requirements are submitted individually by the PT to the appropriate implementing agency.

The implementing agency is the organization having the processing facility for satisfying the data request. It will review each requirement and coordinate any questions concerning the details of the requirement with the approving organization and the data requestor. Upon accepting the requirement, the implementing agency will establish a schedule for the development, implementation and checkout of the hardware/software system required to process the data and provide the requested output.

The implementation assignments for data requirements, DRF, SR, or memoranda, will be maintained by the FSD in the Requirements Status System (RSS). The RSS is a computerized data base which has a multiple sort capability. The requirements will be entered as received by FSD and updated as implementation assignments are accomplished. The RSS will reflect implementation assignment status by referencing the appropriate data development plan in the comment field of the printout.

The implementation status of a requirement will be maintained by the processing organization assigned the responsibility for designing and implementing the processing system. Refer to the Data Acquisition and Management Plan, dated March 24, 1972, for how implementation status may be obtained from the implementing organizations.

- 6.4.2.2 Mission data requirements flow.- The definition, approval, and implementation of data requirements during the mission period will be handled differently from that of the premission period. The primary changes from the permission requirements flow is the inclusion of the operational data management positions into the

flow for approval and implementation. Also, the Mission Data Request Form (M-DRF) will be used by the flight control team to request operational data outputs. The mission data requirements flow is defined in detail in Paragraph 4.1.2 of the Data Acquisition and Management Plan, March 24, 1972.

#### 6.4.3 Data Acquisition and Retrieval

The remote sites will receive the real-time and dumped telemetry, voice, and television downlinks. The real-time telemetry will be processed and transmitted to the MCC using the DRR techniques described in Paragraph 6.3.3.3. The real-time voice will be transmitted to the MCC without delay. The remote site computers will create the real-time and dump ADDT tapes for transmission to the MCC Data Retrieval System (MDRS). As the ADDT tapes are being processed and transmitted to the MCC, the remote site processors will utilize Data Management Summary Processor (DMSP) software to generate Data Management Summary (DMS) messages which provide a summary and status of all data received at a site during a pass. The television downlink will be handled as described in Paragraph 6.2.4. The dumped voice from the AM and DSE will be processed and time correlated at the remote site to within plus or minus 1 second. All ADDT data, both RT and dump, will be transmitted to the MCC. The goal is to retrieve this data within 90 minutes of LOS under normal operating conditions. Under abnormal operating conditions the priority data will be retrieved first and any remaining data will be retrieved at the end of the remote site day with all data being cleared in 24 hours.

#### 6.4.4 Real-Time Display and Control

The acquisition and transmission to the MCC of the real-time telemetry, voice, and television is the only data management



for processing and copying in accordance with an MSC approved Skylab Flight Film Distribution Plan, published by PT.

6.4.7.3 Inflight crew logs.- The inflight crew logs will be reproduced and distributed under the direction of PT in accordance with the Inflight Log Distribution Plan.

6.4.7.4 Voice data processing.- Master voice data tapes will be prepared by the FSD. These tapes will be chronological, time-tagged, voice tapes for all real-time voice data downlinks and for each on-board recorder with dump voice capability. Master voice tapes will provide a complete history of all voice data downlinked from the OWS.

Voice data transcripts will be made from these master voice tapes for publication as specified in the DRF's.

The control and distribution of private voice data is the responsibility of the FCOD. Refer to Paragraph 4.2.2.2 of the Data Acquisition and Management Plan for a complete definition of private voice data.

#### 6.4.8 Data Distribution

The C&AD is establishing a DDC for the distribution of Skylab data. This center will handle the distribution of all operational and non-operational data outputs, plus the delivery of interim data outputs from one processing facility to another. Data outputs processed in other MSC facilities may be delivered to the DDC for distribution to the data recipient or directly to the data recipient from the processing facility depending upon the type of data, the response time, and mutual agreements between C&AD processing organizations. All operational data for delivery to the MOCR and SSR's will be delivered by the DDC to the appropriate SSR.

#### 6.4.9 Data Statusing

Special data management displays and processors have been established within the MOPS for statusing the processing and distribution of all Skylab data requested using the DRF or SR forms. This system will contain the processing status for all data for the past 48 hours. This data status will be written onto magnetic tapes for historical purposes and can be recalled through a MOPS terminal for update or review purposes as required. The acquisition and retrieval status will be reported from the remote sites to the data statusing system approximately 15 to 20 minutes after LOS. Each processing facility will also maintain the status of all Skylab data processing. This status will be entered promptly into the statusing data base through MOPS terminals so as to provide a current data base to drive the displays.

#### 6.4.10 Recovery Data Handling

The acquisition and handling of data returned from the OWS is described in the Recovery Operations Plan to be published by the Recovery Operations Branch of FCD.

7 ACTIVITIES  
PLANNING AND  
SCHEDULING.



## SECTION 7

### ACTIVITIES PLANNING AND SCHEDULING

#### 7.1 INTRODUCTION

This section discusses the way Skylab mission operations and particularly the crew activity schedule will be planned and modified as required during real time. The purpose of this continuous planning and review of the mission operations is to ensure that the flight crew activities are giving the best returns, both scientifically and operationally, considering mission objectives, experiment and vehicle systems status, flight crew status and capability, and additional or modified requirements placed on the mission after launch. This section summarizes the activity scheduling operations and interfaces for the manned and unmanned mission phases and presents the special planning considerations for experiment operations. The interface of real-time crew procedures support to flight planning and mission operations is also discussed.

#### 7.2 GENERAL RESPONSIBILITIES

The activity scheduling process involves interfaces with numerous NASA contractor and experiment oriented groups including inputs and iterative reviews by members of these groups who are part of the Flight Control Team. The Flight Planning and Crew Procedures Support Team has the primary function of performing flight activities scheduling. This team (in performing activities scheduling) is the primary user of the ASP segment of the MOPS.

In previous sections, numerous MOCR, SSR and FOMR positions have been described which have direct responsibilities for review of mission progress against the objectives, for recommendations as to revision of those objectives or their priorities, for proposed modifications to mission operations techniques and for direct inputs to the flight plan and onboard flight data file. The role of the Flight Planning and Crew Procedures Support Team can be related to other functions that have direct impact on the flight crew's activities as follows:

Under the direction of the Flight Director, the FAO and his team are the focal point and the final implementation group for all changes to the crew activities schedule and the crew procedures.

#### 7.2.1 Flight Planning and Crew Procedures Support Team

Figure 7-1 illustrates the tasks, relationships and general lines of communications of the members of the Flight Plan and Crew Procedures Support Team and also depicts the most representative data interfaces of the team with the other segments of the Flight Control Team. The Flight Plan and Crew Procedures Team is under the direction of the FAO and is made up of six basic positions in addition to the FAO. The FAO shares a console with the FCOD CAPCOM in the MOCR. The six other team members are located in the Operations SSR. The FAO and four of the SSR positions are expected to be manned on a continuous basis. Only the detailed systems and experiments procedures positions may be manned less than full time.

Specific functions of the FAO, and SSR positions are outlined in Paragraph 4.2.2 (MOCR and SSR Positions/Functions).

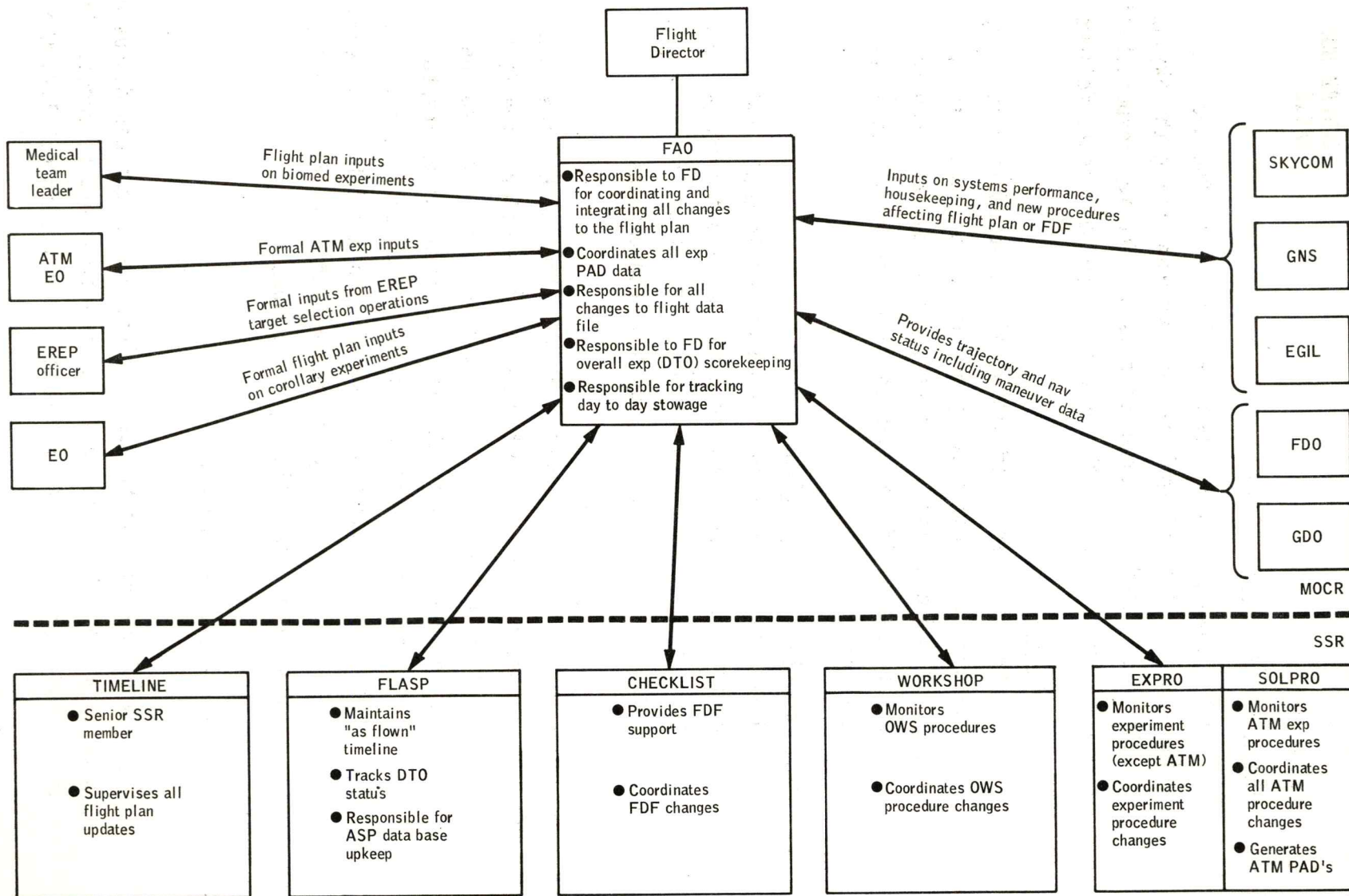


Figure 7-1 .- Activities scheduling and procedures support operations.



### 7.2.2 MOPS/ASP Responsibilities

The flight planners under the direction of the FAO are the prime users of the ASP applications program during the Skylab premission, manned, and unmanned phases. The key responsibilities of the flight planners with respect to the ASP are as follows:

A. Data Base

Maintain a current definition of all scheduling activity elements and their descriptors in the data base at all times and exercise the necessary configuration control to assure the validation and coordination of all data base changes.

B. "As Flown" Flight Plans

Update the MOPS/ASP on mission accomplishments and all activities which have been completed and therefore impact scoring, the planning of future activities, or the expenditure of mission resources such as consumables.

C. Master Flight Plans

Maintain current projected flight plans within the MOPS/ASP for use or review by other flight controllers, the FOMR and management. Primary emphasis will be given to the current definition of the next 24 hours activities, but every attempt will be made to have representative timeline projections to the end of the mission available. Inherent in this responsibility is the task of exercising configuration control over flight plan changes.

### 7.3 THE FOMR ACTIVITIES PLANNING INTERFACE

The role of the FOMR in Skylab missions operations was discussed in Paragraph 4.3.1.2, including the functions and responsibilities of key FOMR positions. As indicated in Paragraph 4.3.1.2, the

FOMR does not play a routine role in flight activities planning. The FOMR's prime role in activities planning is to resolve scheduling conflicts which may occur in the daily planning cycle when such conflicts cannot be resolved by the flight control team. The FOMR may also provide policy-level adjustments and recommendations to planned mission activities as the flight progresses. In terms of statuskeeping, the FOMR will be responsible for maintaining cognizance of DTO and flight plan status. However, the flight controllers are responsible for the statuskeeping of the individual experiments, and the FAO is responsible for overall statuskeeping.

#### 7.4 ACTIVITY SCHEDULING OPERATIONS

##### 7.4.1 General

A flight activities scheduling cycle will be used daily in the MCC to generate the next day's flight plan. The purpose of this daily flight planning cycle is to ensure the optimum choice of flight operations activities considering currently defined flight objectives, science return, and crew status. The planning sequence requires inputs from the prime MOCR controllers to the FAO and Flight Director. The general planning cycle is described in this section.

The unmanned phase planning cycle differs significantly from the planning sequence for the manned phase and is discussed separately in Paragraph 7.6.

##### 7.4.2 Daily Scheduling Cycle

The daily scheduling cycle selected for Skylab calls for first developing a summary flight plan (and alternates) for the next day's activities. This will be accomplished by the morning shift of flight controllers on console from midnight to 8:00 o'clock.

Today's flight plan would next be executed by the day shift. The evening shift flight controllers would later develop the detailed flight plan. This approach spreads the MOCR activities over a 24-hour period, and allows two discrete mission planning periods. It also separates the major mission planning activities from the mission high-activity period.

Figure 7-2, shows the daily flight activity scheduling cycle, and Table 7-1 defines the milestones and detailed flight control activities in support of this cycle. As indicated earlier, the cycle begins during the midnight to 8:00 o'clock shift with each MOCR controller providing inputs to the Flight Director and FAO on proposed activities for the next day. For example, Figure 7-2 shows that the Day 11 activities are planned during the early part of Day 10. At about 0200 on Day 10, the Flight Director conducts a planning meeting to summarize the Day 11 preliminary inputs and assess potential problem areas. From this meeting, the options will be defined from which the FAO develops the summary flight plans using the ASP. These plans may number from one to four depending on whether EREP passes are planned for the following day. If so, alternate EREP passes must be planned to provide flexibility in scheduling EREP operations during acceptable weather conditions. Other experiment activities will be adjusted to accommodate the EREP options. On days when no EREP passes are planned, only one summary flight plan will be developed.

The FAO next submits the proposed summary flight plans to the MOCR operators. Each MOCR operator will review and approve these plans or provide feedback as required to the FAO and Flight Director. Both the Flight Director and FAO will participate in negotiation of any conflicts which may occur at this time. Those scheduling conflicts which cannot be



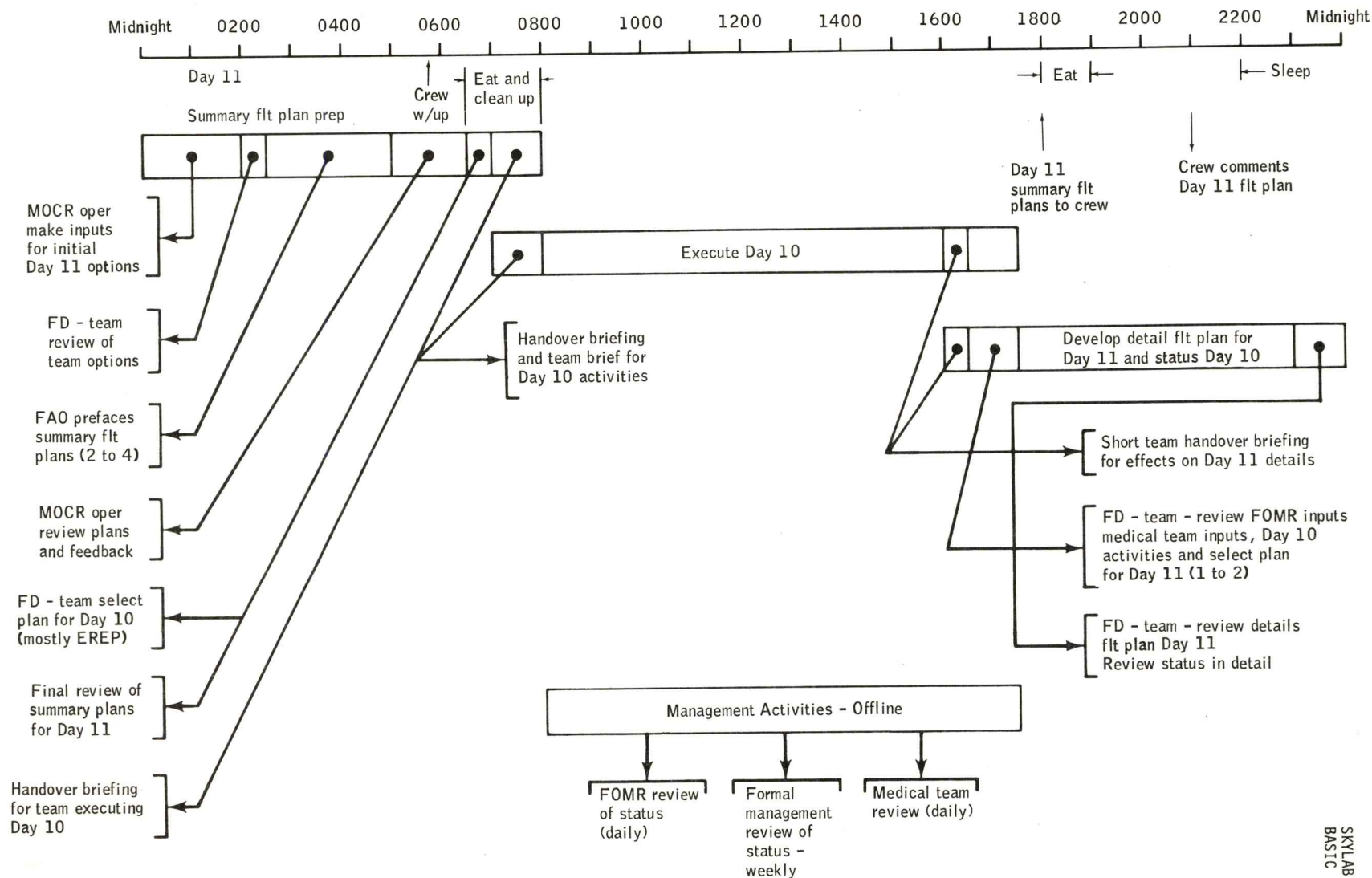


Figure 7-2.- Daily flight planning cycle.

TABLE 7-1.- PLANNING INTERFACES, EXAMPLE: DAY 10 AND 11.

MILESTONE	ATM	EO (BIOMED)	EO (COROLLARY)	EREP	EGIL/GNS	SKYCOM	ASCO/FDO	FAO
0000 - 0200 PRELIMINARY DAY 11 INPUTS TO FD AND FAO	IDENTIFY SPECIAL VIEWING TIME REQUIREMENTS - CONSECUTIVE PASSES - SPECIFIC PASSES	• IDENTIFY CHANGES TO PREVIOUSLY PLANNED MEDICAL GUIDELINES (REPRESENTS SURGEON) • IDENTIFY PLANNED CONSTRAINTS VIOLATION • IDENTIFY NEW CONSTRAINTS AND SPECIAL CONSIDERATIONS	• IDENTIFY CANDIDATE EXPS, INCLUDING FO'S, RELATIVE PRIORITIES AND SPECIAL CONSIDERA- TIONS • IDENTIFY PLANNED CONSTRAINTS VIOLATIONS • IDENTIFY NEW CONSTRAINTS	• INPUTS CANDIDATE PASSES AND TYPES, E.G., 60°, 120°, ZLV, OR SOLAR INERTIAL FOR DAY 11 • ALSO PROVIDES INPUTS FOR PASSES ON DAYS 12 AND 13 FOR SCHEDULE ANALYSIS	• MAKE INPUTS TO FAO FOR DAY 11 FLIGHT PLAN OPTIONS. E.G., M509 ATMOSPHERIC ADJUSTMENTS, MOMENTUM DUMP INHIBIT DEPLETIONS, ETC. • REVIEW DAY 10 CONSUMABLES STATUS AND PROVIDE UPDATED PADS TO FAO • REVIEW DAY 10 FLIGHT PLANNING	IDENTIFIES TAPE RECORDER REQUIREMENTS NOT ASSOCIATED WITH CREW ACTIVITIES SUCH AS HOUSEKEEPING DATA AND UNMANNED EXPERIMENT REQUIREMENTS	• SCHEDULES TIME/SITE FOR NAV. UPDATE • SCHEDULES TIME/SITE FOR BLOCK DATA UP- LINK (AFTER 1200) • WHEN REQUIRED PRO- VIDES INPUTS ON EREP MANEUVER PAD'S MISSION TIMER (ATMDC CLOCKS), UPDATES, STAR TRACKER UPDATES AND EXPERIMENT INSTRUMENT CALIBRA- TIONS	ACCEPTS PRELIMINARY INPUTS AS DEFINED BY AEO, EO, EREP, INCO, EGIL/GNS, AND ASCO/ FDO
0200 - 0230 FD PLANNING MEETING	• ATTENDS MEETING AND EXPLAINS REQUIRE- MENTS • IDENTIFIES NECESSARY OPTIONS	SAME AS ATM	SAME AS ATM	ATTENDS MEETINGS AND EXPLAINS REQUIREMENTS INCLUDING NECESSARY OPTIONS FOR EREP	ATTENDS MEETING AND EXPLAINS SYSTEMS INPUTS AND CONSTRAINTS	ATTENDS MEETING AS RE- QUIRED TO IDENTIFY POTENTIAL CONSTRAINTS	ASCO ATTENDS MEETING TO EXCHANGE INFOR- MATION AND IDENTIFY OPTIONS, IF REQUIRED	ATTENDS MEETING AND SUMMARIZES ALL PRE- LIMINARY INPUTS AND PROVIDES ASSESSMENT OF POTENTIAL PROBLEM AREAS
0230 - 0400 PREPARE SUMMARY FLIGHT PLAN OPTIONS FOR DAY 11				EREP INPUTS DAY 10 PAD UPDATES TO FAO				FAO RUNS ASP PROGRAM AND PROVIDES EACH SUMMARY FLIGHT PLAN OPTION TO MOCR OPERATORS WHEN AVAILABLE
0400 - 0600 SUMMARY FLIGHT PLAN REVIEW	REVIEWS, NEGOTIATES WITH MOCR PERSONNEL, AND APPROVES SUMMARY FLIGHT PLAN OPTION	SAME AS ATM	SAME AS ATM	• REVIEWS SUMMARY FLIGHT PLAN OPTION. NEGOTIATES IF REQUIRED WITH MOCR PERSONNEL • APPROVE SUMMARY FLIGHT PLAN OPTIONS	• EGIL/GNS REVIEW OF DAY 11 FLIGHT PLAN OPTIONS • EGIL PERFORMS PEARL RUNS • GNS PERFORMS MMP RUNS	• REVIEWS AND MODIFIES TELEVISION AND TELE- PRINTER SCHEDULING AS SHOWN IN THE SUMMARY FLIGHT PLANS BY NE- GOTIATING WITH APPLICABLE MOCR OPERATORS. • ASSISTS IN RESOLVING CON- FLICTS DUE TO TAPE RE- CORDER CONSTRAINTS • TRANSMITS DAY 10 TELEPRINTER PADS	ASCO REVIEWS OPTIONS, NEGOTIATES AS REQUIRED, AND APPROVES OPTIONS	• PROVIDES SUMMARY FLIGHT PLANS AND PARTICIPATES IN NEGOTIATION OF CONFLICTS • PROVIDES FD SET OF APPROVED SUMMARY FLIGHT PLANS
0600 - 0630 WEATHER REVIEW AND EREP EVALU- ATION FOR DAY 10				• PARTICIPATES IN WEATHER REVIEW WITH FAO AND FLIGHT DIRECTOR. • RECOMMENDS DAY 10 FLIGHT PLAN ON BASIS OF WEATHER FORECAST				PARTICIPATES IN WX REVIEW WITH FD AND EREP CONTROLLERS
0630 SELECT THE APPROPRIATE DAY 10 FLIGHT PLAN								NOTIFIES CREW (CAPCOM) OF THE DAY 10 (TODAY'S) FLIGHT PLAN BASED ON EREP GO/NO GO DECISION
0700 - 0800 SHIFT CHANGE	SHIFT HANDOVER BRIEF DAY SHIFT ON DAY 10 ITEMS	SAME AS ATM	SAME AS ATM		HANDOVER TO DAY SHIFT. BRIEF DAY SHIFT ON DAY 10 ZLV MANEUVERS, CONSUMABLES STATION, MOMENTUM DUMP INHIBITS, SYSTEMS STATUS.	HANDOVER TO DAY SHIFT AND BRIEF ON DAY 10 ITEMS	SHIFT HANDOVER AND BRIEFING ON DAY 10 ITEMS	

TABLE 7-1.- PLANNING INTERFACES, EXAMPLE: DAY 10 AND 11 - Concluded.

MILESTONE	ATM	EO (BIOMED)	EO (COROLLARY)	EREP	EGIL/GNS	SKYCOM	ASCO/FDO	FAO
0800 - 1600 DAY SHIFT EXECUTE DAY 10								<ul style="list-style-type: none"> <li>•(1000 - 1400) FDO IDENTIFIES NEED FOR ORBIT SHAPE MANEUVER ON DAY 11. DETAIL PAD DATA ON MANEUVER GENERATED AFTER TRAJECTORY UPDATE.</li> <li>•FDO ALSO GENERATES BLOCK DATA FOR 3RD DAY INTO FUTURE (UPLINKED TO CREW)</li> </ul>
1600 EVENING SHIFT REPORTS IN. DAY SHIFT STAYS ON CONSOLE								
1600 - 1630 AFTERNOON FLIGHT DIRECTOR'S MTG	<ul style="list-style-type: none"> <li>•ACCEPTS AND REVIEWS ANY FOMR COMMENTS RECEIVED ON NEXT DAY'S FLIGHT PLAN</li> <li>•REVIEWS, NEGOTIATES AND APPROVES SELECTION OF FINAL SUMMARY PLANS FOR NEXT DAY</li> <li>•ACCEPTS AND REVIEWS ANY FOMR COMMENTS ON LONG DURATION FLIGHT PLAN</li> </ul>	SAME AS ATM	SAME AS ATM					ASCO, FDO, AND IN SOME CASES THE GDO WILL ATTEND THE MEETING AS NECESSARY TO IDENTIFY POTENTIAL PROBLEMS PRIOR TO DAY 11 DETAILED FLIGHT PLANNING EFFORT
1630 - 1700 SHIFT CHANGE	HANDOVER TO EVENING SHIFT	SAME AS ATM	SAME AS ATM		HANDOVER AND BRIEFING TO EVENING SHIFT. BRIEF EVENING SHIFT ON EVENTS OR SYSTEMS PROBLEMS THAT WILL AFFECT DAY 11 PLANNING.			
1800 APPROVED SUMMARY FLIGHT PLAN TO CREW						SCHEDULES THE APPROVED SUMMARY FLIGHT PLAN OPTIONS FOR UPLINK AND TRANSMITS MESSAGE TO CREW		PREPARES THE APPROVED SUMMARY FLIGHT PLAN OPTION(S) FOR UPLINK
2000 - 2400 COMPLETE DE- TAILED DAY 11 FLIGHT PLANS AND PADS. PROVIDE DAY 10 STATUS REPORTS TO FLIGHT DIRECTOR AND FAO	<ul style="list-style-type: none"> <li>•RECEIVES CREW COMMENTS</li> <li>•PROVIDES DETAILED ATM VIEWING PROGRAM AND ASSOCIATED TV DOWN-LINKS</li> <li>•CALCULATES ATM POINTING DATA</li> <li>•PROVIDES FAO DETAILED DATA FOR: <ul style="list-style-type: none"> <li>•SOLAR ACTIVITY PAD</li> <li>•ATM SCHEDULE PAD</li> <li>•FLARE PAD</li> </ul> </li> <li>•REVIEWS AND APPROVES TELEPRINTER PADS</li> <li>•ATM STATUS REPORT TO FD AND FAO FOR DAY 10</li> </ul>	<ul style="list-style-type: none"> <li>•RECEIVES CREW COMMENTS</li> <li>•PROVIDES ANY SPECIAL INSTRUCTIONS INPUT RELATING TO MEDICAL AND BIOTECHNICAL EXPERIMENTS OPERATION FOR TRANSMITTAL VIA GENERAL PAD</li> <li>•REVIEW AND APPROVE GENERAL PADS ASSOCIATED WITH MEDICAL AND BIOTECHNICAL EXPERIMENT OPERATIONS</li> <li>•BIOMED STATUS REPORT TO FD AND FAO FOR DAY 10</li> </ul>	<ul style="list-style-type: none"> <li>•RECEIVES CREW COMMENTS</li> <li>•PROVIDES OBSERVATIONAL TARGETS</li> <li>•CALCULATES POINTING DATA</li> <li>•PROVIDES SPECIAL INSTRUCTIONS TO EXPERIMENT PAD INCLUDING PROCEDURAL RECOMMENDATIONS</li> <li>•REVIEWS AND APPROVES EXPERIMENT PADS</li> <li>•COROLLARY STATUS REPORT TO FD AND FAO FOR DAY 10.</li> </ul>	<ul style="list-style-type: none"> <li>•RECEIVE CREW COMMENTS. SELECTS CANDIDATE PASSES FOR DAYS 14 AND 15</li> <li>•GENERATES PADS FOR DAY 11 AND TRANSMITS TO FAO</li> <li>•EREP STATUS REVIEW WITH FD AND FAO THROUGH DAY 10</li> </ul>	<ul style="list-style-type: none"> <li>•START/CONTINUE PEARL/MMP RUNS FOR DAY 11 DETAILED FLIGHT PLANS</li> <li>•PREPARE DAY 11 CONSUMABLES STATUS PAD FOR FD AND FAO</li> <li>•IF NECESSARY, RERUN PEARL/MMP BASED ON DAY 10 PROBLEMS</li> <li>•EFFECT CREW PROCEDURE CHANGES (VIA THE FAO) IF REQUIRED</li> <li>•BEGIN ACCUMULATING DAY 12 FLIGHT PLAN INPUTS</li> </ul>	<ul style="list-style-type: none"> <li>•RECEIVES CREW COMMENTS</li> <li>•REVIEWS TELEPRINTER PAD FORMATS FOR ACCEPTABILITY</li> <li>•RESOLVES CONFLICTS DUE TO RECORDER CONSTRAINTS</li> <li>•REVIEWS DETAILED ATM VIEWING PLAN AND RESOLVES TV CONFLICTS WITH THE AEO</li> </ul>	<ul style="list-style-type: none"> <li>•MONITORS CREW COMMENTS</li> <li>•COMPILES FINAL NUMBERS FOR THE EREP MANEUVER PADS</li> <li>•COMPUTES PAD DATA FOR STAR TRACKER UPDATE.</li> </ul>	<ul style="list-style-type: none"> <li>•RECEIVES CREW COMMENTS</li> <li>•REVIEWS AND FORMATS PAD MESSAGES BASED UPON INPUTS FROM MOCR PERSONNEL.</li> <li>•PROVIDES PADS FOR REVIEW PRIOR TO TRANSMISSION</li> <li>•ACCEPTS (FOR THE FLIGHT DIRECTOR) ALL MOCR OPERATOR STATUS REPORTS FOR DAY 10.</li> </ul>



resolved by the flight control team will be taken to the FOMR for resolution. This activity results in a final definition of the summary flight plan options for the following day (Day 11).

Next, from about 0600 to 0630, a weather briefing will be conducted for the Flight Director, FAO, and EREP flight controllers. At this time, the flight plan for today (Day 10) will be selected on the basis of the weather conditions in the proposed EREP viewing areas. The flight crew will be notified of today's flight plan, and the Day 10 activities will begin at about 0700 after the crew's eat period.

Day 10 activities will be executed from about 0700 to 1700 under the purview of the MCC day shift. The day shift will be required to work about 10 hours in order to overlap both the morning and evening shifts. This provides continuity of planning and operation, and allows time for handover and shift briefings.

During the normal workday several reviews will take place. These include a daily FOMR review of status (discussed in Paragraph 4.3.1) and the daily Medical Team Conference (discussed in Paragraph 5.3.4.2). In addition, a formal flight management review will be conducted each week during the mission for apprising management officials on mission status. Any recommendations made as a result of these reviews, will be given to the appropriate flight controllers for scheduling consideration.

At 1600, the evening shift of flight controllers will report in and attend the afternoon Flight Director's meeting. During the evening handover briefing, the day shift will brief the evening shift on anything that can effect the Day 11 detailed flight plan. The FAO and evening shift of flight controllers then begin preparation of the detailed Day 11 flight plans

from the summary flight plans prepared earlier. They will consider inputs from the FOMR and medical team (resulting from mission status reviews) that affect Day 11 activities. However, every attempt will be made to keep these inputs out of the Day 11 detailed flight plan. Normally these inputs will be accepted for the following day (Day 12). The Day 11 plan, developed by the preceeding midnight shift, will be changed only if absolutely necessary. This implies that the Day 11 schedule must be independent of the results of Day 10 accomplishments.

At about 18:00 (depending on STDN coverage), the approved Day 11 summary flight plans will be uplinked to the crew via the teleprinter. This will be done during that period of time set aside for this purpose near the end of the crew's work day. This allows the crew time to review the plans and pass any comments to the ground before the detailed plans are developed. The crew's comments and recommendations will be passed on to the Flight Director, FAO, MOCR operators and FOMR for their consideration.

The detailed Day 11 flight plans will next be completed by the evening shift from about 2000 to 2400. The FAO coordinates this effort with the MOCR operators. Crew comments, the effect of Day 10 problems, the detailed experiment planning tasks, and all PAD's will be used to complete the detailed Day 11 plans which will be uplinked to the crew via the teleprinter. A final decision on which plan to execute will be made the next morning after the EREP weather briefing. Again, only one detailed plan will be prepared if no EREP passes are planned.

Another major activity which is accomplished during the evening shift is status reporting for the day's activities. Each MOCR discipline (for example, the EREP Officer, ATM EO, BIOMED EO, and COROLLARY EO) will submit a daily report to the FAO. The FAO will then integrate these individual scoring inputs

(including the crew utilization time) into a summary status report for his own use which will also be provided to the FCD Experiments Controller in the FOMR. This report will contain a tabulation of the experiments completed (or percentage of their completion) and the current experiments systems status and configuration.

Paragraph 7.4.2 essentially completes the daily flight planning cycle for Skylab. The detailed flight controller activities in support of this scheduling cycle are contained in Table 7-I.

#### 7.4.3 Inflight Statuskeeping

Skylab flight controllers will be responsible for maintaining status or "scoring" the detailed test objectives. Statuskeeping is required to provide the Flight Director and other members of the flight control team with mission accomplishment status in order to influence inflight planning. A second objective is to provide a status report to Program Management on mission progress.

Status will be maintained by each discipline according to the mission requirements specification. This includes scoring of both systems and experiment test objectives which generally fall into the following categories:

- ATM
- EREP
- Biomedical
- Corollary
- Systems

In addition, the flight controllers will keep a daily account of the mission hours utilized for each of the above categories. This will be compared periodically to the total hours allocated premission to each category.



The Biomedical, Corollary, and Systems DTO's are identified in the Skylab Mission Requirements Document. Scoring of these categories consists of assessing the validity of the performed test objectives and maintaining a record of these activities.

Assessing the validity of the test objectives performed requires a quicklook analysis of the data and verification of the test conditions by the flight controllers and PI team. An example of a typical Biomedical Experiment Tracking Form is shown in Table 7-II.

ATM statuskeeping, on the other hand, will be a simple measure of viewing time accomplished, compared to the minimum viewing time commitment NASA has made to the ATM PI's. ATM test objectives as such are academic because of the nature of the ATM - it is basically an observatory. Because of this, the ATM PI's have NASA sanction to use the time as they desire within the bounds defined by the ATM building blocks. How the time is used, however, will be tracked in detail and made available.

The EREP experiment statuskeeping will be accomplished by evaluation of available information on sensor operation, crew comments, and actual weather conditions against the DTO requirements in the MRD. The exact technique selected will be influenced by whether the RF downlink now under proposal will be baselined for EREP. This link will allow transmitting the EREP sensor data directly to the ground during the mission. The present configuration only allows data recording onboard with the quicklook analysis to be performed post-mission after data recovery.

As indicated above, statuskeeping is a flight operations team function, as opposed to a program management function and the ultimate responsibility rests with the Flight Director. The Flight Director, in turn, delegates authority for maintaining detailed status to the individual disciplines with the FAO

PILOT/BIOMEDICAL EXPERIMENT STATUS: GMT

7-14

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serving as the integrator responsible for the overall status of mission accomplishments. The FAO status report will be made available to the flight controllers and Program Management in the FOMR or elsewhere. Any discussion of the scoring from elements outside the flight control team will be formally handled through the FOMR. Figure 7-3 shows the scoring inputs to the FAO from the MOCR operators.

## 7.5 CREW PROCEDURES SUPPORT

In addition to the activity scheduling functions, the FAO is responsible to the Flight Director for coordinating all changes to the crew procedures and the onboard Flight Data File. The FAO's responsibility extends to ensuring adequate validation of all procedural changes from a crew operations point of view.

### 7.5.1 Crew Procedures Change Coordination

There are numerous sources of proposed modifications or additions to the procedures to be followed by the crew in operating the vehicle and experiment systems or in carrying out the in-flight operations. Mission anomalies or opportunities to improve the science return or system performance would be the most common reasons for modifications. Procedures change proposals can originate with the MOCR operators, with FOMR personnel via the MOCR operators, or be implied by modifications to scientific objectives or the activity schedule. Whatever the source or the level of procedural detail in the proposal, it is the responsibility of the FAO and his team to evaluate the proposal. The Flight Director will be advised of the change proposals and the progress and results of their evaluation, including the impact of the procedures change on the activity schedule.



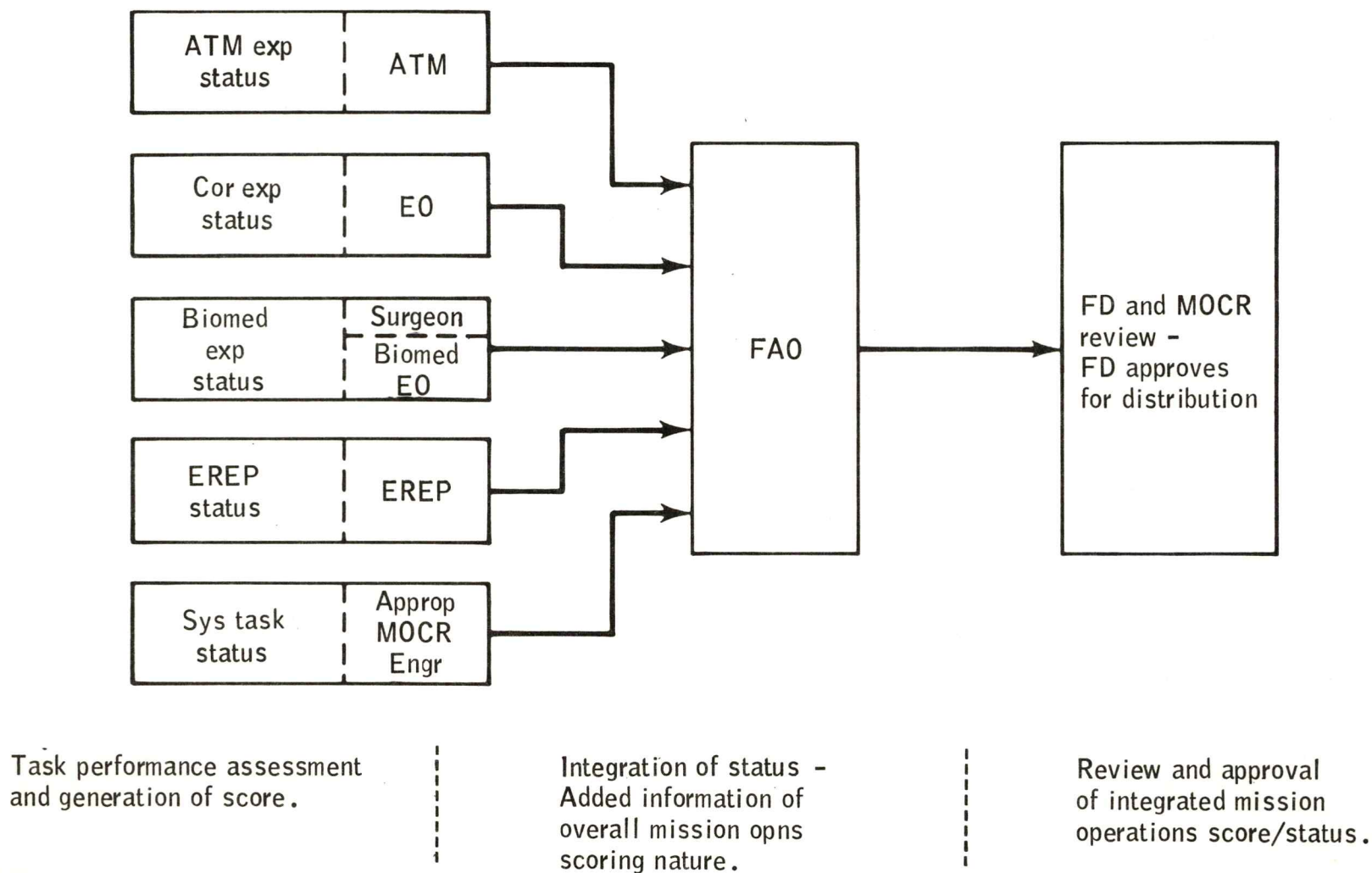


Figure 7-3.- Skylab statuskeeping.

If it appears advisable to implement the change proposal, the Flight Data File Support Engineer ("CHECKLIST") will assist the FAO by preparing a detailed flight data file update for submittal to the Flight Director. The Flight Data File Support Engineer will be assisted by FCOD and Contractor procedures development specialists also located in the OPS SSR.

The detailed flight data file update will be reviewed by all affected MOCR operators and by the cognizant FOMR personnel who can obtain contractor and experimenter comments. Upon resolution of any conflicts by the Flight Director, the FAO will direct preparation of the final flight data file update for the crew. After obtaining Flight Director approval of the update, the FAO will ensure proper change control documentation and distribution of the revision for all copies of the flight data file in the MCC.

#### 7.5.2 Crew Procedures Change Validation in Simulators

The FAO is also responsible to the Flight Director for coordinating the validation of the crew procedures and technique change proposals and time critical activity schedule modifications in the various FCOD mission simulators, part task trainers or mock-ups. Use of these facilities will be by request to the FAO from the FOMR. The FAO will then develop a simulation plan for approval by the Flight Director. The FAO will then proceed to solicit inputs to the simulation from the other MOCR operators and from the MSC and MSFC Program Office representatives in the FOMR. The FOMR inputs should include contractor recommendations. The FAO will also request that the FOMR develop the data package necessary to initialize the simulation.

The FAO then forwards the necessary flight plan, flight data file, and simulator initialization data (prepared by MPAD) plus the simulation objectives to the appropriate FCOD group and negotiates

a schedule for the Flight Director's approval. The FAO and his team monitor the progress of the simulation and distribute the results of the evaluation as officially reported by FCOD. The results are then incorporated into the procedures and activity scheduling cycle.

#### 7.6 UNMANNED PHASE ACTIVITY PLANNING

During the unamnned phase, the daily flight activity timeline will again be planned by the FAO and the flight controllers. As indicated earlier, the prime experiment operation will be with three of the ATM experiments. The PI's for these instruments will be available in the MCC during this period and will make their scheduling recommendations through the ATM flight controllers.

All activity inputs will be passed to the Flight Director from the flight controllers. Until the unmanned phase activities are completely defined, it is not clear how frequently inputs to the Flight Director will be required. In any event, when all the inputs are passed to the Flight Director, the Flight Activities Officer is assigned the responsibility for developing the activities schedule. Since the number of activities to be planned is far less than that required for the manned phases, activity scheduling should not require a significant effort. The planning will be done daily during the normal activity support periods and the FAO accomplishing the planning will be available in the MOCR only for the period required to construct the activity schedule and complete a review with the flight control team. He will then be available on call in his office area. The Flight Director will resolve planning conflicts within the team. Conflicts which cannot be resolved by the flight control team will be passed back to the FOMR for a decision.





SECTION 8  
TRAINING

8.1 GENERAL

This section summarizes the current definition of the Skylab Program flight controller training plan. A more detailed description encompassing the entire spectrum of training requirements is available in the Flight Control Training Plan for the Skylab Program, dated October 15, 1971.

Through application of systems analysis, a fully integrated Skylab training program is being established. The best method of controller training consonant with cost considerations and leadtime will be utilized.

Five categories of training methods will be used to prepare new flight controllers to enter successfully into a function in a new environment or to upgrade existing flight controllers. These methods are the following:

- A. Programmed instruction texts
- B. Classroom briefings
- C. Crew station training
- D. On-the-job training
- E. Simulations

A schedule reflecting the general timeframe for each category of training is shown in Figure 8-1.

8.2 PROGRAMMED INSTRUCTION (PI) TEXTS

Programmed instruction texts will be available for those technical areas that do not change appreciably from mission

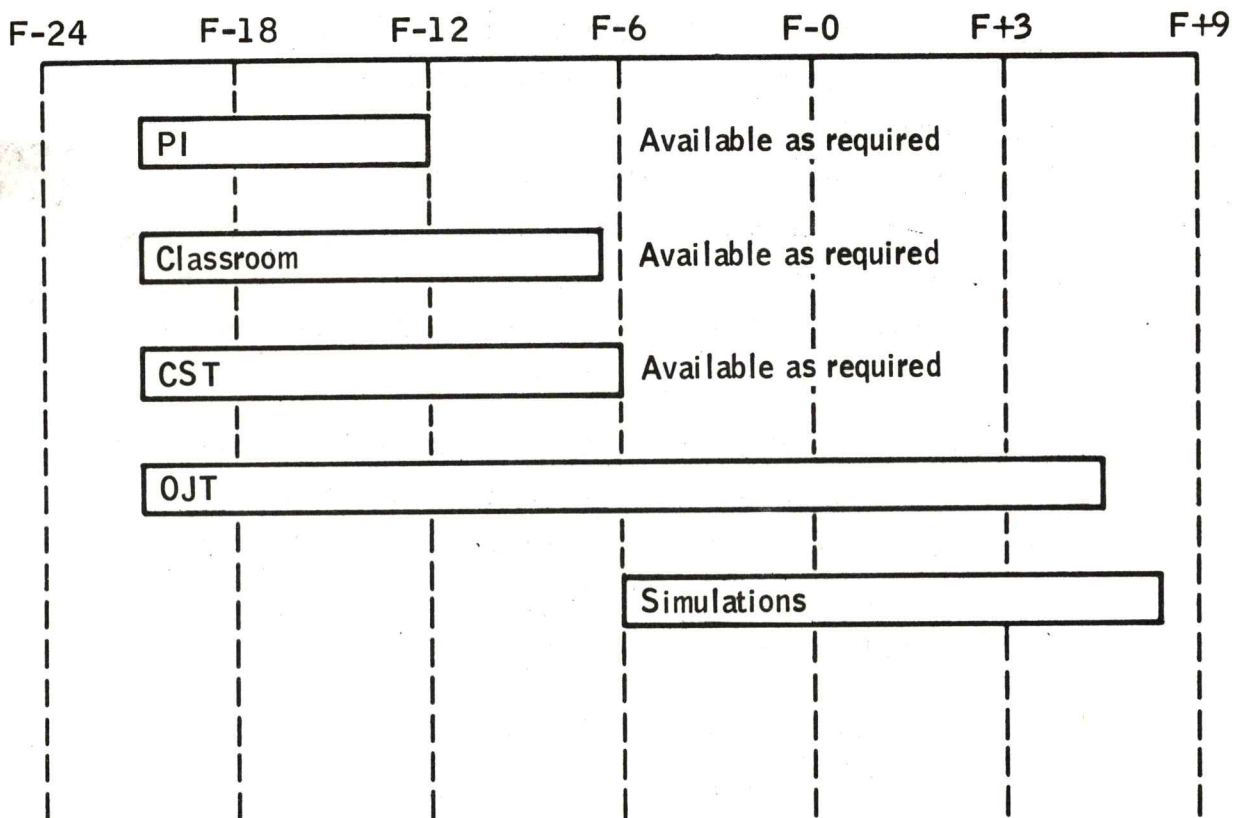


Figure 8-1.- Skylab training schedule.



to mission. Specific curricula in which it is planned to utilize PI's are as follows:

- A. Introduction to space navigation and orbital mechanics
- B. Basic telemetry
- C. Introduction to flight control
- D. CSM systems

### 8.3 CLASSROOM BRIEFINGS

Flight controllers will be provided with classroom training on orbital assembly systems and other relevant Skylab areas. Each series of briefings will vary in length and depth, dependent upon specific needs of the controllers. Subject matter, content, and course length will be reflected in individual course outlines published prior to class presentation.

The following is a list of orbital assembly systems and other Skylab areas in which briefings are required:

- A. SWS orientation
- B. SWS systems
- C. CSM systems
- D. Experiments
- E. Experiments support systems
- F. Astronaut/flight-controller experiment interface

### 8.4 CREW STATION TRAINERS

The crew station trainers in support of Skylab will consist of the necessary structures and mockups to provide activation of displays and controls for the following orbital

assembly hardware:

- A. CSM - Command and service module
- B. MDA - Multiple docking adapter
- C. ATM - Apollo telescope mount
- D. STS - Structure transition section
- E. OWS - Orbital workshop

## 8.5 ON-THE-JOB TRAINING (OJT)

Since much of the flight controller learning occurs at the desk during the development and review of systems handbooks, mission rules, and other required documentation, the role of OJT cannot be overlooked; it is an integral part of the Flight Control Division training system.

## 8.6 SIMULATIONS

### 8.6.1 General

A series of premission simulations will be performed to exercise the flight controllers and flight crews in a simulated mission environment. These simulations will be conducted by utilizing the Mission Control Center (MCC), the Apollo simulation checkout and training system (ASCATS), the Skylab flight crew mission simulators (FCMS's), and the STDN. The ASCATS will include vehicle math models of the S-IB, S-IVB, S-V, SWS, CSM, and selected experiments and will provide the interface between the simulated vehicles (math models and FCMS's) and the MCC. The ASCATS will also provide telemetry and tracking data to the MCC and will process commands from the MCC to the vehicle models (math models or FCMS's). The FCMS's will consist of a command and service module and a Saturn workshop (ATM, MDA, S-IVB,

and AM). The STDN will be utilized only during network simulations in which all telemetry and tracking data will be provided by prerecorded tapes.

In addition to the premission simulations, reentry simulations may be performed during SL-2, SL-3, and SL-4 for flight controller practice. The Command Module Simulator/SWS math model may be used in conducting these simulations which will essentially consist of a dry run of reentry to be performed by the flight controllers and the next-in-line crew.

As indicated in Section 2, a reentry talkthrough (dress rehearsal) will also be performed with the onboard crew for each manned mission. This will consist basically of exercising the G&N sequence (except for a critical function like arming the pyros) and data flow (reentry pad uplink) with nominal remote site coverage.

#### 8.6.2 Simulation Exercise Summary

Table 8-I presents a summary of the simulation exercises, simulation modes, and days of simulations for each Skylab mission.

#### 8.6.3 Simulation Schedule

Figures 8-2 and 8-3 show the presently planned simulation schedule for SL-1/SL-2, SL-3, and SL-4. All simulations except for the reentry simulations which occur during the manned intervals are included.

The following guidelines were used in developing these schedules:

- A. Total simulation days per week should not exceed three.
- B. One day of each mission phase should be simulated as near launch as possible.



TABLE 8-I.- SIMULATION EXERCISE SUMMARY

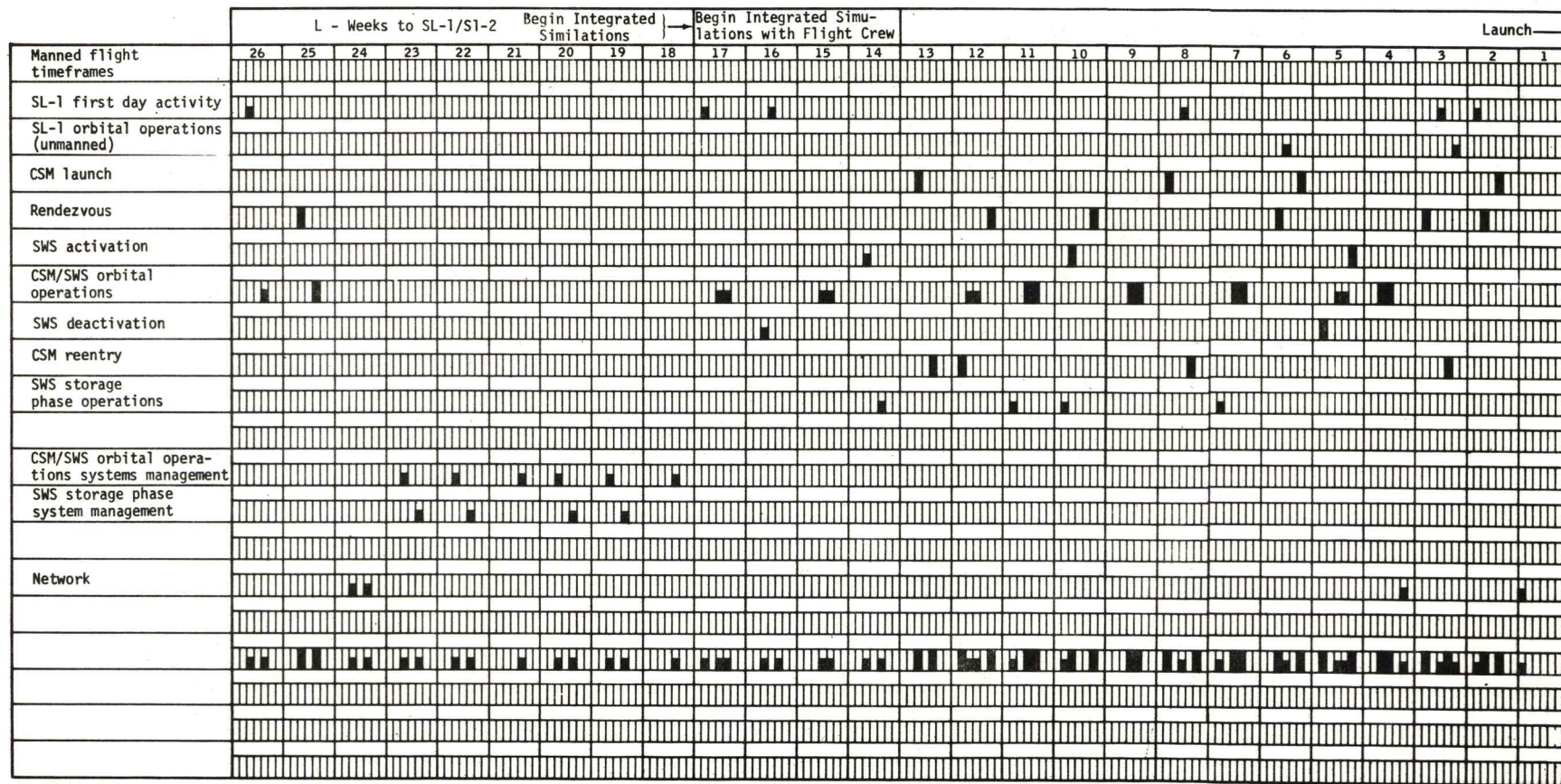
<u>Exercise</u>	<u>Mode</u>	<u>SL-1/2, days</u>	<u>SL-3, days</u>	<u>SL-4, days</u>	<u>Totals</u>
1. SL-1 first day activity	SWS MM	6 <sup>a</sup>			6
2. SL-1 orbital operations (unmanned)	SWS MM	2			2
3. CSM launch	CMS	4	3	3	10
4. Rendezvous	CMS/SWS MM Network	6 <sup>a</sup> 2	5	4	15 2
5. SWS activation	CSM/SWS MM CMS/SLS	1 2	2	2	1 6
6. CSM/SWS orbital operations	CSM/SWS MM CMS/SLS Network	9 <sup>a</sup> 9 <sup>a</sup> 2	2 6	4	11 19 2
7. SWS deactivation	CSM/SWS MM CMS/SLS	1 1	1	1	1 3
8. Reentry	CMS/SWS MM CMS/SLS	3 <sup>b</sup> 2	4 <sup>c</sup> 1	2 <sup>c</sup> 1	9 4
9. SWS storage phase operations	SWS MM	4			4
10. CSM/SWS orbital operations systems management	CSM/SWS MM	6			6
11. SWS storage phase systems management	SWS MM	4			4
Subtotals	Flight Control only	37	2		
	With Flight Crew	27	22	17	
Totals		64	24	17	105

MM = GSSC math model  
SLS = Skylab simulator  
CMS = Command module simulator

<sup>a</sup>Includes 1 day of simulations about launch minus 6 months.

<sup>b</sup>Includes one simulation during SL-2.

<sup>c</sup>Includes two simulations during CSM/SWS flight.



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## Legend

- — Simulations with flight crew and flight controllers
- — Simulations with flight controllers only

Figure 8-2.- SL-1/SL-2 simulation schedule.



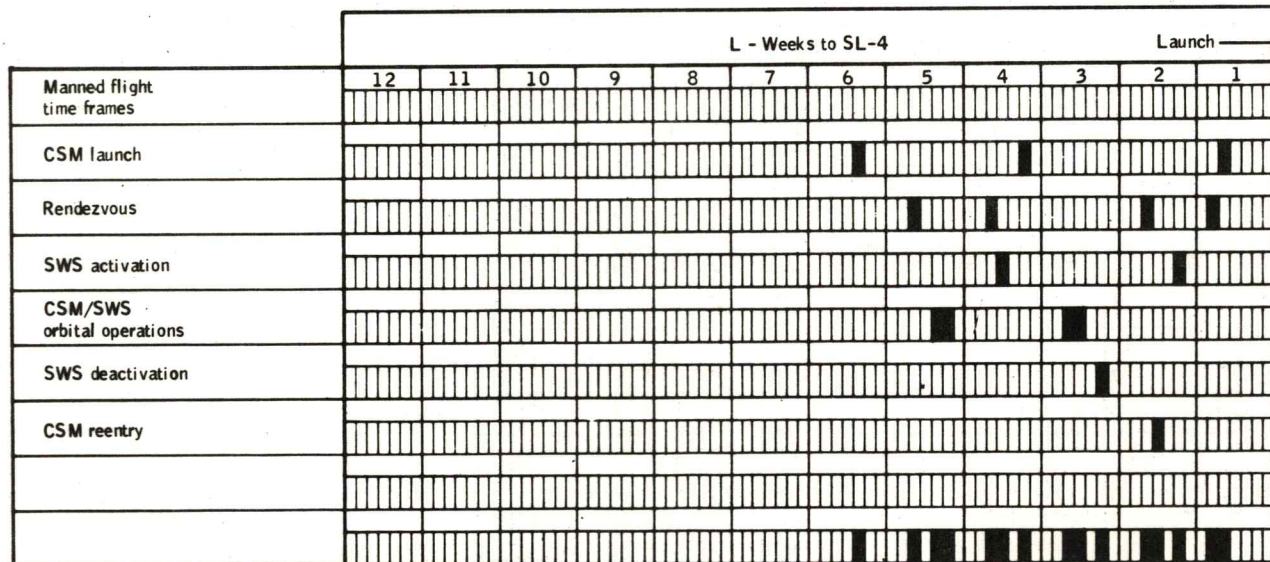
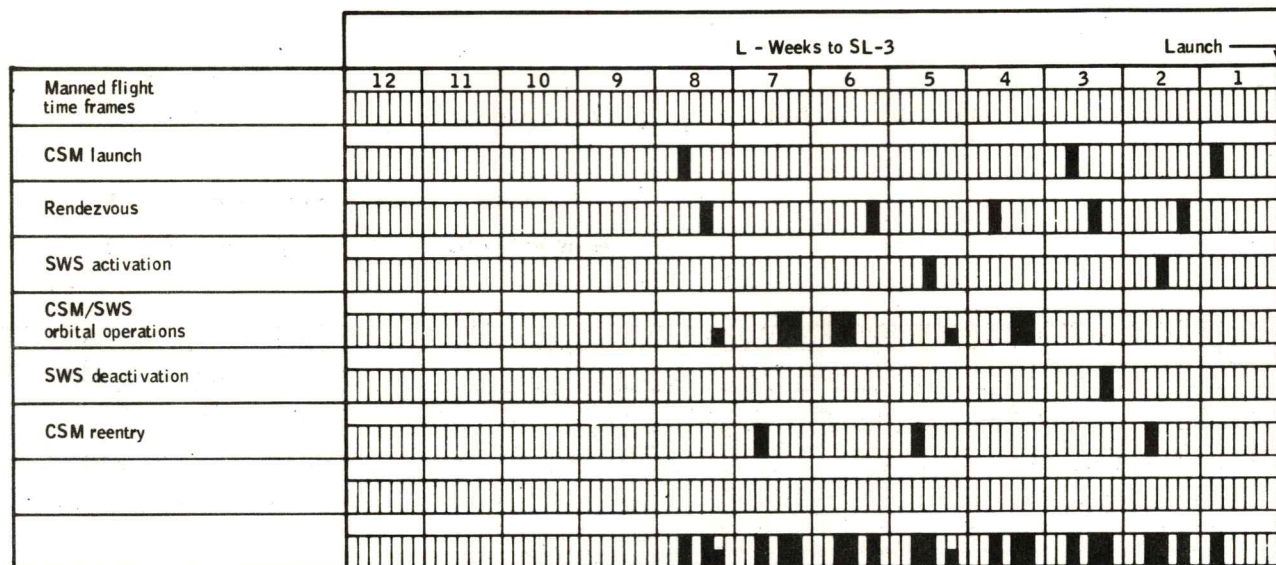


Figure 8-3.- SL-3 and SL-4 simulation schedules.



- C. Phases which are more critical take priority over other, less critical phases.
- D. One day of each mission phase should be simulated early in the schedule.

## 8.7 FOMR PERSONNEL AND PRINCIPAL INVESTIGATOR TRAINING

### 8.7.1 FOMR Personnel

The training requirements for the FOMR personnel are outlined in the previously referenced document Flight Control Training Plan for the Skylab Program, dated October 15, 1971. The requirements in the training plan apply to all FOD and program office (MSC and MSFC) personnel who will man positions in the FOMR. In addition to these basic requirements, it is recommended that the MSC and MSFC program office personnel attend the 3-day seminar defined on the following page.

### 8.7.2 Principal Investigator Training

Training for the Principal Investigators and their associates will be limited to that necessary to enable them to perform their duties and responsibilities for mission operations. The minimum training requirements can be satisfied through participation in an FCD three-day seminar covering all aspects of flight control operations, and participation in a minimum of two full days of mission simulations. This requirement applies only to those PI's who have defined MCC responsibilities (Categories I, II, and III). Each affected PI will be contacted by the FCD regarding his simulation training requirements. The tentative training requirements are identified on the following page.

A. Seminar

A three-day seminar will be conducted by the FOD which will serve to orient the PI and his associates. This seminar will be conducted in late 1972 and may be organized approximately as follows:

1. Day 1 - Systems and Experiment Orientation

Overviews of each vehicle module and experiment.

2. Day 2 - Ground Support Systems

An overview of the MCC and the STDN.

3. Day 3 - Operations Team Orientation

Essentially an overview of flight control operations.

B. Mission Simulations

The CSM/SWS orbital simulations called out in Table 8-I will be most beneficial to the PI's. These simulations are described in the previously referenced FCD training plan. A minimum of two simulations is required but more exercises are recommended.

9 MULTIPLE  
OPERATIONS



SECTION 9  
MULTIPLE OPERATIONS

9.1 GENERAL REQUIREMENTS

Several activities other than Skylab will occur during the Skylab timeframe. These activities are briefly examined in this section with particular regard to facilities requirements. At the present time, the Flight Support Division is evaluating the impact of these activities to the MCC and STDN. It is important to evaluate the multiple operations situation now because of the development of the new Skylab data system. This system includes the new DTE system, MOPS terminals, ASP, MDRS, and ADDT data transfer from the remote sites.

9.2 MAJOR PROGRAM ACTIVITIES

The major program activities that must be considered are addressed in the following paragraphs.

9.2.1 Apollo and Skylab

Skylab planning is based on the management guideline that no lunar missions will be flown during Skylab. Therefore, the capability of supporting real-time Apollo and Skylab will not be planned during the Skylab timeframe. However, concurrent Skylab simulations and Apollo 17 operations will occur as shown in the Skylab Apollo mission activity schedule contained in Figure 9-1.

9.2.2 ALSEP and P&FS Support

Lunar science activities will continue to be supported from the MCC throughout the Skylab timeframe. It is expected

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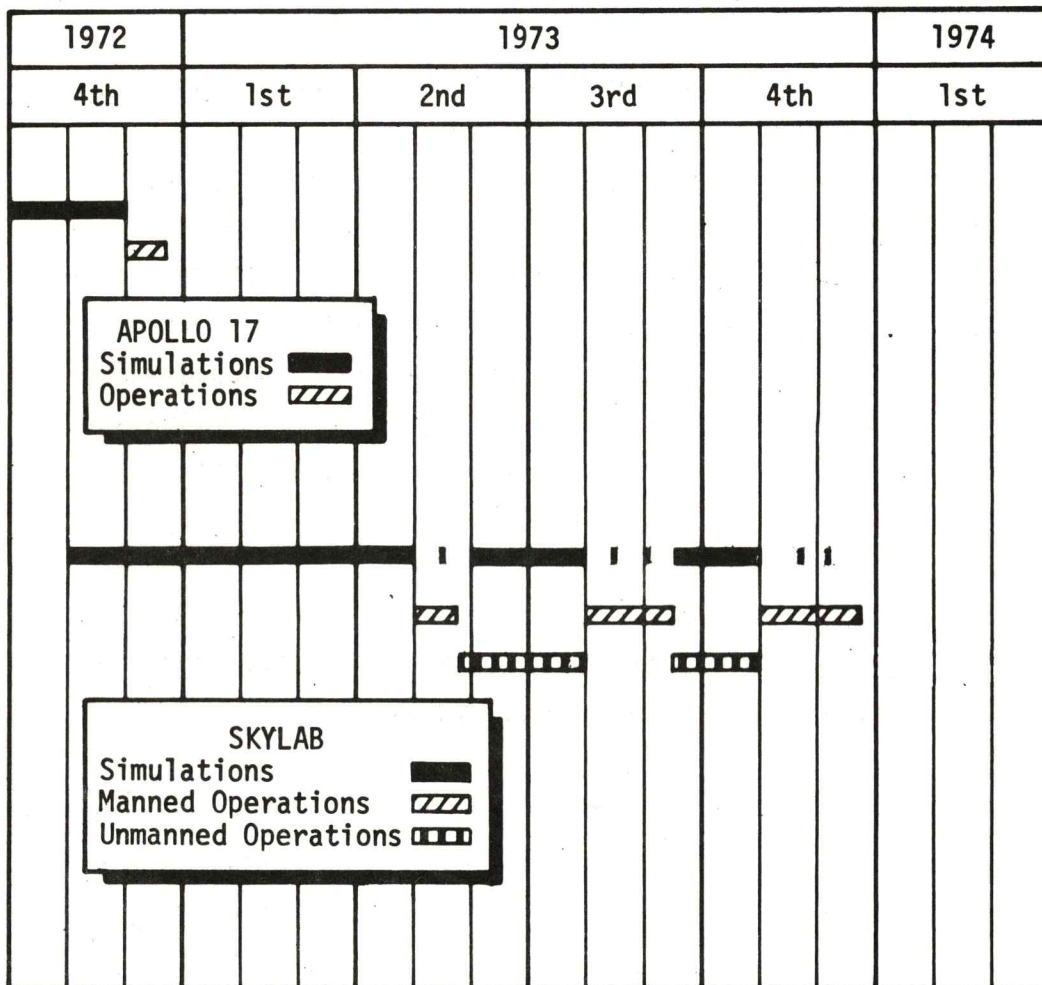


Figure 9-1.- Skylab/Apollo mission activity schedule.

that up to five ALSEP's and two P&FS's will be active during Skylab. During lunar day, routine 4-hour per day support from the MCC is anticipated for ALSEP. This support will be reduced to perhaps a monitoring operation every other day during lunar night. It is assumed that P&FS operations will be combined with ALSEP into one integrated MCC operation using common facilities and support periods.

### 9.2.3 Skylab Simulation and PAD Tests

In addition to lunar science activity during Skylab, simulations and PAD tests will be conducted which will also overlap the Skylab operation. The PAD tests will be scheduled during the unmanned periods between flights, while the simulations will overlap both the manned and unmanned periods with almost all of the simulations occurring between flights for the next-in-line flight (see Figure 8-3). The major areas of concern are the proposed reentry simulation periods during manned operations, and those periods during unmanned operations when the simulations/PAD tests are run concurrently with the unmanned SWS and lunar science activity. All these activities require support and may cause facilities conflicts at the MCC and the STDN sites. The MCC and STDN facilities considerations for multiple operations are discussed in the next two paragraphs.

## 9.3 MCC CONSIDERATIONS

### 9.3.1 ALSEP/P&FS Support

Support of ALSEP/P&FS lunar science activities will be provided from the present ALSEP facility as a stand-alone type of operation. The facility includes a control area, science area



consoles and displays, and RTCC computer support. It is assumed that the present ALSEP facility has sufficient capability (or expansion capability) to handle any increased support during the Skylab time period. It is further assumed that only one RTCC computer (and program) will be sufficient for the total lunar science load during Skylab.

### 9.3.2 Skylab

9.3.2.1 Manned phase activities.- No major facilities conflicts are anticipated during the manned intervals. Lunar science activity does overlap the manned period but, as mentioned earlier, a separate facility will be dedicated to this activity. Reentry simulations, however, may be performed periodically during the manned periods with one scheduled for SL-2, and two each scheduled for SL-3 and SL-4. Reentry simulations will be conducted for the benefit of the ground flight controllers using the normal CMS/SWS math model and will last up to 6 hours. It is recommended that these simulations (if required) be planned to occur during the Skylab crew's sleep period. This permits a reduction in personnel devoted to monitoring the Skylab.

The second floor MOCR and SSR's in the MCC can be used to support the deorbit simulation using the normal consoles and display system. The ongoing Skylab operation support can be relegated to one of the SSR's using one or more consoles to monitor MDRS data from the SWS. The newly developed DTE display system will allow these consoles to monitor the SWS independently of the simulation. MDRS data should be sufficient for monitoring the SWS during the relatively short period of simulation overlap. However, the use of real-time data for monitoring the OWS is not precluded.

This requires an additional RTCC and may involve shutting-down the real-time CSM data link in the OA to avoid mixing real-time data with simulation data on like vehicles in the MCC. Commanding to the OA during this period will be required for communications systems management. These commands can be initiated from either the MCC or remote sites. If deemed necessary to avoid conflicts with the ongoing simulations, command initiation and verification can be accomplished by remote site personnel under MCC supervision.

With the newly developed Skylab data system, the RTCC computers will be the pacing item for multiple operations support. The RTCC job functions for supporting the reentry simulation concurrent with SWS monitoring have been estimated by the Mission Simulation and Requirements Branch to be as follows:

#### MANNED PERIOD MULTIPLE RTCC FUNCTIONS

<u>Activity</u>	<u>RTCC Function Required</u>
Reentry simulation	GSSC Simulation MOC
ALSEP/P&FS	ALSEP RTCC
Skylab SWS support	Operational MDRS

The ALSEP/P&FS support can likely be scheduled around the reentry simulation and ongoing Skylab activity if facilities conflicts arise. In summary, no major conflicts are envisioned during the manned periods while conducting reentry simulations. (MDRS data may have to be used for maintaining the OA).

- 9.3.2.2 Unmanned mission activities.- As discussed in detail (see Section 3), the SWS/ATM will be supported actively for a nominal period of 8 hours per day during the unmanned intervals. The remaining 16 hours of the day will be devoted to

reduced monitoring of the SWS via the MDRS. The PAD tests and simulations for the next flight will be performed during this period of reduced monitoring to avoid conflicts with the active support period. Approximately 25 simulations and PAD tests are planned between SL-2 and SL-3, and 18 between SL-3 and SL-4. This averages out to roughly three simulations/PAD tests every 7 days during the unmanned periods. Each simulation will require about 10 hours to perform, while the PAD test duration will vary from 8 to 16 hours. The concurrent RTCC computer functions estimated for the simulations, ALSEP, and reduced monitoring OWS/ATM support are listed in Table 9-I. It should be emphasized that the requirements listed in Table 9-I are for computer functions only — not necessarily computers. Depending on the outcome of the FSD study and development effort, some of the above functions may be combined into a single computer.

During the 8-hour active-support period (in contrast to the reduced monitoring period), only the unmanned SWS will be supported and this will require operational MOC, MDRS, and ASP. The ASP will be required for only a few hours each day to develop the next day's flight plan.

With regard to the control areas required for the unmanned activities, the simulations should be conducted from the MOCR and SSR's in the MCC. Reduced monitoring of the SWS can be performed concurrently using MDRS data at one or two MOCR or SSR consoles, independently from the ongoing simulations. The location of these consoles is again yet to be determined. PAD test support during the unmanned periods is yet to be resolved. However, PAD test support from the KSC area by MCC personnel may be a viable candidate. This approach will generally alleviate the facilities problem caused by multiple operations.



TABLE 9-I.- UNMANNED PHASE REDUCED MONITORING RTCC FUNCTIONS

Activity	RTCC Function Required
<u>ALSEP/P&amp;FS</u>	ALSEP RTCC
<u>Skylab 16-hour Reduced Monitoring Support</u>	Operational MDRS, Operational ASP <sup>a,b</sup>
<u>Simulations</u>	
CSM Launch Abort	GSSC, Simulation MOC
All Others	GSSC, Simulation MDRS, Simulation ASP <sup>c</sup> , Simulation MOC

<sup>a</sup>Required for development of next mission Flight Plan. May be needed only a few hours each day.

<sup>b</sup>Assumes no S052 support; only SWS systems and S055 MDRS data collection. If S052 support is baselined, an operational MOC will be required.

<sup>c</sup>Only the EPS Model and the Momentum Management Model are required in the simulations ASP.

#### 9.4 STDN CONSIDERATIONS

The STDN work load during the Skylab timeframe has been estimated by GSFC to be as follows:

Skylab 1-4	Continuous support of all sites during manned intervals; reduced support during storage.
ALSEP (5 active)	Continuous recording support of 30-foot sites; average of four sites; 8 hours/day/site; 85-foot sites as required.
P&FS	Concurrent with ALSEP site support as indicated above.
ERTS-B	Three to four sites; four to five passes/day
Pioneer	Eighty-five foot sites only; five passes/wk, 4 to 11 hours/pass for Pioneer IX; F, and G.
Mariner	Eighty-five foot sites only; five passes/wk, 11 hours/pass
Nimbus E	HSK, MAD, and GDS only; four passes/site/day

As a result of this heavy workload, the network resources can no longer be committed as a dedicated network to a specific program. A workable priority system will be adopted for the resolution and avoidance of conflicts between the requirements/programs. GSFC is working with FSD in defining this priority system. In addition, GSFC is developing a computerized program to be used in network scheduling that will optimize daily

support of the STDN and resolve site conflicts. Finally, GSFC, in recognizing that the STDN can no longer commit extended blocks of non-contact time to a specific project, has established a goal of reducing site turnaround time to 5 to 20 minutes. All operational and engineering elements within GSFC will design to this goal.



A PROBLEMS  
AND OPEN  
ISSUES

APPENDIX A

PROBLEMS AND OPEN ISSUES

1.0 Multiple Operations

As indicated in Section 9, plans are not firm on how multiple operations will be supported during Skylab. The unmanned period computer requirements are of particular concern. These requirements apparently can exceed the computer facilities available. The Flight Support Division became aware of this problem when they were recently given a list of all the flight control computer requirements for each Skylab mission phase. FSD is working on the problem now and is considering combining functions into single computers. In addition, the control areas, displays and command requirements will be evaluated for multiple operations support to make the best use of these facilities. Also PAD test support from the KSC area, will be evaluated.

Tight schedule control will provide the best means of avoiding or reducing facilities conflicts during Skylab. This will be accomplished through the use of a workable priority system which must be established for each activity to be supported.

2.0 Unmanned/Unattended ATM Experiments and Associated Proposals

During the past year three of the ATM experiments - S052, S054, and S055 - were baselined to be operated for up to 8 hours per day during the unmanned intervals. These experiments will be supported from the MCC (see Paragraph 3.10). Since the time these three experiments were baselined, two additional proposals for ATM unmanned period operation have

been made by the MSC Skylab Program Office. The first proposal calls for continued operation of S055 during the reduced monitoring period (24 hours per day). Because S055 operation causes little impact on the MCC, FOD will support this operation in an MDRS data collection mode during the reduced monitoring period. The second proposal calls for a nominal 12-hour operation of S052 for synoptic observations of the sun. Rather than trying to respond piecemeal to this last proposal, FOD has requested a complete statement of specific requirements for ATM operation during the unmanned periods from the Skylab Program Office. When these requirements become available, the FOD will then develop a support plan which will assure that all objectives can be met. In the meantime, 8-hour active support of S052, S054, and S055, and 16-hour reduced monitoring support of S055, remain baselined for the unmanned periods.

Unattended ATM operations are also under consideration for the manned periods. Present plans are to operate the ATM from the ground when the crew is either engaged in other activity or asleep. Specifically, when, how much, and what experiments/modes will be operated is not yet defined.

### 3.0 MCC Location for Unmanned Period Reduced Monitoring

The question of where to locate the unmanned period reduced monitoring operation is as yet unresolved. As recommended in Section 9, one or more MOCR or SSR consoles could be used for monitoring MDRS data from the SWS. This would allow the other MOCR and SSR consoles to be available for the simulations that will be conducted during the same period. The new DTE display system in the MCC allows independent console monitoring of the SWS from either the MOCR or SSR areas.



4.0 VAN Ship Location

The VAN will not be used to provide launch coverage as in the past. It will be used for orbital coverage instead, at a location to be selected to optimize coverage of SL-1 activation. The exact location of this ship still needs to be determined and negotiated with the foreign countries involved.

5.0 Nitrogen Venting

Experiments M509, Astronaut Maneuvering Unit, and T020, Foot Controlled Maneuvering Unit, expel  $N_2$  into the cabin which may cause the percentage of  $N_2$  to rise to unacceptable levels. As discussed in Paragraph 5.3.3.2.C, the procedures for pressure management will be worked out in the months ahead.

6.0 Regional Controllers/Truth Sites

The numbers and assigned location of the EREP Regional Controllers is not yet determined. Also, the truth sites for EREP are still in the process of selection. Consequently, the personnel and equipment at each site, the communications, in terms of the information which needs to be exchanged and the actual links, are not yet defined.

7.0 Inter-mission Evaluation/Analysis of Experiment Data

Evaluation/Analysis of scientific data will be made between SL-2 and SL-3 and between SL-3 and SL-4 to determine whether to make changes in objectives, procedures and/or hardware for the succeeding flight. The timeframe, the participation, and how the detailed evaluation/analysis will be done are yet to be established.

8.0 Data Management

The responsibilities for handling mission data have been defined. However, the detailed plans and procedures for managing the data that is not directly used in the mission control job, from the remote sites through to the ultimate users, are still being developed by FSD and FCD.

9.0 Alternate Mission Control Center

The method of providing an alternate mission control center for Skylab has yet to be determined. Similar in intent to the alternate control center provided for Apollo, this control center would be used in the event the MCC is incapacitated. Alternate lunar science (ALSEP) support must also be considered; however, this could be a separate facility. For Skylab operations, the MILA site, HOSC, and GSFC are possible candidates for the alternate mission control center.

10.0 Effect of Launch Delays on EREP Viewing Opportunities

The effect of launch delays on the EREP experiment viewing opportunities needs to be fully assessed by FOD in the months ahead. Good lighting for EREP recurs on a periodic cycle, and the duration of good viewing opportunities for U.S. targets varies with the time of year. A parametric analysis needs to be performed to establish a data base of viewing opportunities, lighting, and Beta angle as a function of the time of year. This data base in turn should allow some flexibility in accommodating launch delays.

B MISSION  
COMPUTER  
FUNCTIONS



APPENDIX B  
MISSION COMPUTER FUNCTIONS

I. REAL-TIME PROCESSING

Any processing necessary in real time will be accomplished by the CCATS (Univac 494) and MOC (IBM 360) computers with backups provided for each. These computers will perform functions for Skylab basically similar to functions they performed for Apollo.

A. CCATS

The primary function of CCATS is to interface the MCC with GSFC and to route telemetry, tracking, and command data to the proper areas for processing.

B. MOC

1. General.-

The MOC is required to process telemetry, tracking, and command data for various operational purposes. A data flow and transfer capability is required between the MOC and both CCATS and MOPS.

2. Command Processing.-

The capability is required of the MOC to generate and store command loads, to assign load numbers, and to maintain an inventory of loads in storage.

3. Teleprinter Processing.-

The MOC will provide the capability to generate and format teleprinter messages which will be translated into command loads. Messages will be available for review and correction prior to transfer to the remote sites.

4. Telemetry Data Processing.-

The MOC will process real-time telemetry data received from CCATS and provide this data to the user via a variety of displays and output devices. Limit sense processing, calibration, and special computations will be used as in Apollo. In addition, the capability to mix any combination of vehicle data, trajectory data, or onboard computer data on any display or plot will be provided.

5. Ephemeris Generation and Venting.-

In addition to telemetry processing capabilities, the MOC is required to have a dual ephemeris capability, each independent of the other. Each ephemeris will have two stored blocks of data, one fixed to current time and the other movable as required to accomplish future planning. Both data blocks will be 48 hours in length.

The capability to manually specify a vent profile in real time will also be provided.

## II. NON-REAL-TIME PROCESSING

The MOPS computers will both satisfy the bulk of the near-real-time monitoring requirements and also contain the majority of the planning tools.

The MOPS system interfaces directly with interactive CRT terminals that will be installed in the MOCR/SSR and adjacent areas. The Flight control procedure will be to generate required processing via the terminal for display on either the terminal or DTE. Microfiche and hardcopy printer outputs will also be available.

The MOPS will be required during the entire mission period. This includes the 16-hour unmanned phase for S055 support when the MOC is not required. MOPS primary uses during this 16-hour phase will be to supply trajectory and attitude predictions and to perform a caution and warning limit sense function for the systems parameters.

Several application programs that will be used to provide specific computational support are defined below.

A. ASP (Activity Scheduling Program)

The ASP is a computer program residing in an IBM 360. The ASP required to support the scheduling and planning of the Skylab mission activities in both a premission and mission environment. Constraint analysis will be based on the availability of the crew, hardware, trajectory, attitude and pointing, and consumables. Constraint analyses are performed in support of the scheduling algorithm which attempts to schedule a flight plan free of conflicts.

B. PEARL (Program for EBS Analysis and Rapid Look-Ahead)

The PEARL is intended for evaluation of the electrical power capability of the OA based on the detailed trajectory, attitude, earth-sun trajectory relationships, and the onboard equipment status. The routines involved will consist of detailed models of the ATM and OWS solar arrays; the ATM and AM power channels; the CSM fuel cells; the AM, ATM, and CSM batteries; and other EPS related onboard equipment.

The PEARL is used in conjunction with the ASP to assist in scheduling mission activities.



C. MMP (Momentum Management Program)

The MMP is intended to evaluate the attitude profile contained in the ASP to determine if that profile is within the capability of the CMG's, to predict TACS firings, et cetera. The model will integrate the torques produced by drag, vents, and the gravity gradient and will then react to those torques by reorienting the CMG gimbals to absorb the changes in angular momentum.

D. ADDT (All Data Digital Tape)

The MCC ADDT system is designed to create and maintain telemetry data bases over an extended period of time (36 to 48 hours). It logs all post-pass data from all Skylab sites.

E. MDRS (MCC Data Retrieval System)

The MDRS is designed to retrieve and process telemetry and trajectory data from the established data bases. This data will be retrieved in a near-real-time environment and provided to the uses via a variety of output devices and displays.

The types of logical and mathematical computations required in the MDRS are similar to the processing in the MOC.

The large majority of MDRS data requirements will be generated from the CRT terminal and displayed on the terminal or DTE in a tabular format. A limited display generation capability with a fixed output rate and duration will also be available directly from the MOCR or SSR console.

The tabular MDRS displays may be designed with a limit search routine, a maximum/minimum search routine or another routine. A routine design could be chosen according to the particular data that would be displayed.

## III. PROGRAM INTERFACES

Program Interfaces relating the functions of the several computer systems are necessary to enable certain required processing. Although all interfaces are not finalized, those already defined may be summarized as follows:

<u>Interface</u>	<u>Example of Data Transferred</u>
MOC to MDRS	1. DRR data editing status 2. STDN site status information 3. Look angle plots and digitals
ASP to MMP	Initialization Data in terms of an attitude profile, key trajectory parameters and certain APCS configuration data
ASP to PEARL	Initialization data in terms of a load profile, key trajectory parameters, and certain attitude information
MDRS to MMP	Several telemetry parameters which define an initial momentum state
MDRS to PEARL	Load profile
MOC to MMP	Several telemetry parameters which define an initial momentum state
MOC to PEARL	Several telemetry parameters used for initialization such as system temperatures, voltages, currents, and state of charge
MMP to ASP	Detailed attitude data tables for all momentum desaturation maneuvers

PEARL to MOC	Battery state of charge predictions, key
PEARL to MDRS	EPS parameters, etc., for comparison with
	"snapshot" real-time data or ADDT data
MMP to MOC	Momentum predictions and key APS parameters
MMP to MDRS	for various times in the future to be com-
	pared with "snapshot" real-time data or
	ADDT data

#### IV. OFFLINE PROCESSING

##### A. CROSS (Computer Resource Operational Scheduling System)

The CROSS is a computer program implemented to support the scheduling and planning of the Building 30 Skylab major systems resources including the 360/75 and 494 computers and terminal equipment. This program is to schedule multiapplications of computer facilities including operation in an online or job shop mode.

##### B. Building 12 Computers

The Computation and Analysis Division (C&AD) will support the flight with special processing via the Building 12 computer complex. This support will mainly consist of offline processing for hardware anomalies, and biomedical experiments data processing. With the biomed experiments, the response time is expected to be within 24 hours.



C ACRONYMS  
AND  
ABBREVIATIONS

APPENDIX C

ACRONYMS AND ABBREVIATIONS

(A)

A/C	aircraft
ACE	automatic checkout equipment
ACN	Ascension Island (STDN NASA station)
ACS	attitude control system
ADDT	all-data digital tape
AFB	Air Force Base
A/G	air-to-ground
AGC	CMC Specialist (flight control position)
A-h	ampere-hour(s)
ALSA	astronaut life-support system
ALSEP	Apollo lunar surface experiments package
AM	airlock module
AMCO	AM/OWS Communications (flight control position)
AM	amplitude modulation
AOS	acquisition of signal
APCS	attitude pointing and control subsystem
APS	attitude propulsion system (S-IVB)
ARC	Ames Research Center
ARIA	Apollo range instrumentation aircraft
ARRS	air rescue and recovery squadron
ASAP	auxiliary storage and playback assembly
ASCATS	Apollo simulation and checkout system
ASCO	ATMDC Software Control Officer (flight control position)
ASP	activity scheduling program
ASPO	Apollo Spacecraft Program Office
ATM	Apollo telescope mount
ATM	ATM Experiments Officer (flight control position)
ATM/DA	Apollo telescope mount deployment assembly
ATMDC	ATM digital computer

(B)

BDA Bermuda (STDN NASA station)  
BIOMED Biomedical Experiments Officer (flight control position)  
BMDADS biomedical data analysis display system  
BSE Booster Systems Engineer (flight control position)

(C)

C&AD Computation and Analysis Division  
CAPCOM Spacecraft Communicator (flight control position)  
CAS Cluster Activation Systems Specialist (flight control position)  
CATCO CSM and ATM communications (flight control position)  
CCATS communications, command, and terminal system  
CCS command and communications system  
C&D controls and display(s)  
CDC Control Data Corporation  
CDDT countdown demonstration test  
CM command module  
CMC command module computer  
CMD command  
CMD Command Systems Specialist (flight control position)  
CMG control moment gyro  
CMG flight control position responsible for the SWS attitude control systems (TACS and CMG's)  
CMGS control moment gyro subsystem  
CMS command module simulator  
CONUS continental United States  
CRO Carnarvon, Australia (STDN station)  
CROSS computer resource operational scheduling system program  
CRT cathode ray tube  
CSB CSM Systems Branch



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CSE	communications systems engineer
CSM	command and service module
CST	central standard time
CTE	central timing equipment
C&W	caution and warning
CYI	Grand Canary Island (STDN NASA station)
(D)	
DAC	digital-to-analog converters
DAL	Data Analysis Laboratory
DAS	digital address system
DBP	descent battery pack
DCS	digital command system
DDC	Data Distribution Center
DDMS	DOD Manned Space Flight Support Office
DMAN	Data Manager (flight control position)
DMSP	data management summary processor
DOD	Department of Defense
DRA	data reformatter assembly
DRC	data reduction complex
DRF	data request form
DRR	data redundancy removal
DRUL	down-range uplink
DSE	data storage equipment
DSKY	display keyboard
DSM	data status messages
DSM	digital select matrix
D/T	delayed time
DTE	digital television equipment
DTO	detailed test objective
D/TV	digital to television

\*

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BASIC

E

ECG electrocardiograph  
ECS environmental control system  
EDP electronics data processor  
EDS error detection system  
EECIS Electrical, Environmental Control, and Instrumentation  
Systems Specialist (flight control position)  
EGMT elapsed Greenwich mean time  
EMOD erasable memory octal dump  
EO Experiments Officer (flight control position)  
EOM end of mission  
EPS electrical power system  
ERAP earth observations aircraft program office  
EREP earth-resources experiments package  
ERTS earth-resources technology satellite  
ESB Experiments Systems Branch  
ESM Experiment Systems Monitor (flight control position)  
ESSA Environmental Science Services Administration  
E.S.T. Eastern Standard Time  
ETC earth terrain camera  
ETR Eastern Test Range  
EVA extravehicular activity  
EVA EVA Systems Engineer (flight control position)  
EXP experiment  
EXPRO Experiment Procedures (flight control position)

F

FAO Flight Activities Officer (flight control position)  
FAS fixed airlock shroud  
FCD Flight Control Division  
FCMS flight crew mission simulator  
FCOB Flight Control Operations Branch

FD	Flight Director (flight control position)
FDAI	flight director attitude indicator
FDB	Flight Dynamics Branch
FDO	Flight Dynamics Officer (flight control position)
FIDO	Flight Dynamics Officer (flight control position)
FLD	STDN site at Newfoundland
FLASP	Flight Plan Support (flight control position)
FM	frequency modulation
FMS	food management system
FOD	Flight Operations Directorate
FOD	Flight Operations Director
FOMR	Flight Operations Management Room
FOP	Flight Operations Plan
FPS	feet per second
FRT	flight readiness test
FSD	Flight Support Division
FSMR	Flight Support Management Room
FTS	functional test specification
<div style="border: 1px solid black; border-radius: 50%; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center; margin: 10px 0;">G</div>	
GCC	ground communications controllers
GDO	Guidance Officer (flight control position)
GDS	Goldstone, California (STDN NASA station)
GDS-X	Goldstone wing site
GET	ground elapsed time
GMT	Greenwich mean time
GMTLO	GMT of lift-off
GN <sub>2</sub>	gaseous nitrogen
G&N	guidance and navigation
G&N	CSM Guidance and Navigation Systems (flight control position)
GNC	CSM Guidance, Navigation, and Control Systems Engineer (flight control position)



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GNCS Guidance, Navigation, and Control Systems Specialist  
(flight control position)  
GNS SWS Guidance, Navigation and Control Systems Engineer  
(flight control position)  
GOSS ground operational support system  
GSFC Goddard Space Flight Center  
GSE ground support equipment  
GSSC ground support simulation computer  
GWM Guam, Marianas Islands (STDN NASA station)

H

HAW Hawaii (STDN NASA station)  
HBR high bit rate  
HF high frequency  
HCO Harvard College Observatory  
HOSC Huntsville Operations Support Center  
HS high speed  
HSD high-speed data  
HSK Honeysuckle, Australia (STDN NASA station)  
HSK-X Honeysuckle wing site  
HSP high-speed printer  
HSS habitability support system

I

I/C intercom  
IMU inertial measurement unit  
IST Instrumentation Support Team  
IU instrument unit  
IVA intravehicular activity

J

JAEIC Joint Atomic Energy Intelligence Committee  
JPL Jet Propulsion Laboratory

\*

SKYLAB BOP  
BASIC

(K)

kbps kilobit(s) per second  
kHz kilohertz  
KSC John F. Kennedy Space Center, Florida

(L)

LBR low bit rate  
LC launch complex  
LCC Launch Control Center  
LCU landing craft  
LES launch escape system  
LH<sub>2</sub> liquid hydrogen  
LOS loss of signal  
LOX liquid oxygen  
LS low speed  
LSB LM Systems Branch  
LV launch vehicle  
LVDC launch vehicle digital computer

(M)

M Rev number  
MAD Madrid, Spain (STDN station)  
MAD-X Madrid wing site  
MCC Mission Control Center  
MDA multiple docking adapter  
MDAC-WD McDonnell-Douglas Western Division  
MDRD Mission Data Requirements Document  
M-DRF Mission Data Request Form  
MDRS MCC data retrieval system  
MED manual entry device  
MER Mission Evaluation Room  
MFCO manual fuel cutoff

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MHZ	megahertz
MIL	Merritt Island, Florida (STDN NASA station)
MILA	Merritt Island launch area
MLA	MILA C-band site
MM	math model
MMC	Martin Marietta Corporation
MMP	momentum management program
M&O	maintenance and operations
MOC	mission operations computer
MOCR	Mission Operations Control Room
MOD	Mission Operations Director
MOLAB	Skylab mobil laboratory
MOPS	mission operations planning system
MOW	Mission Operations Wing
MPAD	Mission Planning and Analysis Division
MRD	Mission Requirements Document
MROD	Medical Research and Operations Directorate
MSC	Manned Spacecraft Center
MSFC	Marshall Space Flight Center
MSFN	manned space flight network (now called STDN)
MSRB	Mission Simulation and Requirements Branch
<div>N</div>	
N <sub>2</sub>	Nitrogen
NASA	National Aeronautics and Space Administration
NC-1	first rendezvous phasing adjustment maneuver
NC-2	second rendezvous phasing adjustment maneuver
NC	network controller
NCC	corrective combination rendezvous maneuver
NH	rendezvous height adjustment maneuver
n.mi.	nautical miles
NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Air Defense Command



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NRL	Naval Research Laboratory
NRT	near real time
NSR	rendezvous coelliptic maneuver
(0)	
O <sub>2</sub>	Oxygen
OA	orbital assembly
OBS	operational biomedical systems
OJT	on-the-job training
O&P	Operations and Procedures Officer (flight control position)
OWS	orbital workshop
(P)	
PAD	pre-advisory data (voice or teleprinter updates)
PAO	Public Affairs Officer
P/B	playback
PBI	push button indicator
PCM	pulse-code modulation
PCS	pointing control system of the ATM
PCS	Principal Coordinating Scientist
PEARL	program for EPS analysis and rapid look-ahead
P&FS	Particles and Fields Subsatellite
PGA	pressure garment assembly
PGNCS	primary guidance and navigation system
PI	Principal Investigator
PI	programmed instruction
PIO	Public Information Officer
PIPA	pulse integrating pendulous accelerometer
PM	phase modulation
PRN	pseudorandom noise
PROP	CSM Propulsion System (flight control position)
PRS	primary recovery ship
PS	payload shroud

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PSF	prime subframe
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gage
PSS	Propulsion and Stage Systems Specialist (flight control position)
PT	ASPO Test Division
PT	p-tube
PTL	Photographic Technology Laboratory
PSM	propellant storage module
Q	
QCM	quartz crystal microbalance-contamination sensor
R	
RCC	Recovery Control Center
RCDR	recorder
RCS	reaction control system
RETRO	Retrofire Officer (flight control position)
RF	radio frequency
ROB	Recovery Operations Branch
ROCR	Recovery Operations Control Room
RSDP	remoted site data processor
RSO	Range Safety Officer
RSCC	remote site computer complex
RSS	requirements status system
RT (R/T)	real time
RTC	real-time command
RTCC	real-time computer complex
S	
S-	Saturn stage (prefix)
SAA	South Atlantic Anomaly

\* 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000

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S&AD	Science and Applications Directorate
SAS	solar array system
SCATS	simulations checkout and training system
SCS	Sequencing and Command Systems Specialist (flight control position)
SCS	stabilization and control system
SESC	Space Environment Services Center
SFC	Solar Forecast Center
SIA	speaker intercom assembly
SL	Skylab
SLA	spacecraft LM adapter
SLPO	Skylab Program Office
SLS	Skylab simulator
SLV	Saturn launch vehicle
SM	service module
SMA	support management area
SOLPRO	ATM Procedures Support (flight control position)
SPAN	spacecraft analysis
SPAN	solar particle alert network
SPS	service propulsion system
SR	statement of requirement
SRS	secondary recovery ships
SSR	Staff Support Room
STADAN	space tracking and data acquisition network
STDN	spaceflight tracking and data network (STADAN plus MSFN)
STG	Stage Systems Specialist (flight control position)
STS	structural transition section
SWS	Saturn workshoop
(T)	
T	Time
TACS	thruster attitude control system



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TBD	to be determined
TCS	thermal control system of the ATM
TEX	Texas (STDN NASA station)
TM	telemetry
TPF	rendezvous terminal-phase finalization maneuver
TPI	rendezvous terminal-phase initiation maneuver
TPT	teleprinter planning table
TR	time-to-go to command system transfer (airlock module timer)
TRK	track
TTY	teletype
TV	television
TX	time-to-go to equipment reset (airlock module timer)
U	
UDL	update link
UHF	ultrahigh frequency
USB	unified S-band
UV	ultraviolet
V	
VAN	USNS Vanguard (Apollo ship)
VCG	vectrocardiograph
VHF	very high frequency
VTs	viewfinder tracking system
W	
WBD	wide-band data
WMS	waste management systems
Wx	weather
X	
X-Ray	X-Ray Systems (flight control position)

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(Z)

Z-LV	Z-axis parallel to local vertical
Z-LV(R)	Z-axis parallel to local vertical (rendezvous mode)
ZPN	impedance pneumograph

#### SYMBOLS

$\Delta h$	height change
$\Delta v$	velocity change
$\Delta P$	pressure change

**SKYLAB**

**BOP**

**BASELINE  
OPERATIONS PLAN**

**MAY, 1972**



**FCD  
MSC  
NASA**