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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APOLLO

LUNAR SURFACE EXPERIMENTS

MISSION REQUIREMENTS PLAN

EASEP / LGE
MISSION

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

June 1969

MSC FORM 2026A (REV MAY 68)

APOLLO LUNAR SURFACE EXPERIMENTS MISSION REQUIREMENTS PLAN

EASEP/LGE
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Prepared by General Electric Company
for
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Manned Spacecraft Center
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under

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Apollo Lunar Surface Experiments Mission Requirements Plan

EASEP / LGE
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Preface

This document is a compilation of pertinent data and information extracted from the documentation generated for the design, test, checkout, and operation of the Early Apollo Scientific Experiments Package (EASEP) and the Lunar Geology Experiment (LGE).

The information contained herein will assist in evaluating the performance of the EASEP.

Comments or questions concerning the contents of this document should be directed to the Lunar Surface Operations Planning Office (LSOPO), TD4, telephone HU3-2055.

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1.0 INTRODUCTION

1.1 PURPOSE

The Apollo Lunar Surface Experiment Mission Requirements Plan outlines the operations for the first scientific experiments package to be placed on the lunar surface and the crew activities during the lunar surface operation phases. The information contained in this plan includes data on EASEP and its limitations and constraints. This data is necessary for mission management, mission planning and the formulation of mission documentation based on hardware limitations.

1.2 SCOPE

The EASEP Mission Requirements Plan contains a statement of mission objectives, mission descriptions, and an operational timeline for the lunar surface operations.

The operational timeline consists of four phases which are defined as follows:

Phase I, Lunar Surface EVA Phase, covers the period during which the astronauts are available for specific deployment, and field geology investigations. For further information regarding astronaut activity, refer to the Apollo 11 Flight Plan.

Phase II, Lunar Surface Operation Checkout Phase, covers the period from LM ascent through the checkout and calibration of all systems.

Phase III, Forty-Five Day Phase, covers the period from PSEP power turn-on and checkout through the following 45 calendar days. The PSEP can be operational only during lunar day when sunlight is available to the solar panel arrays.

Phase IV, One-Year Phase, covers the period from day 45 through the first year of EASEP operational life.

A block diagram of events is presented in Figure 1-1 to identify the different phases of the mission.

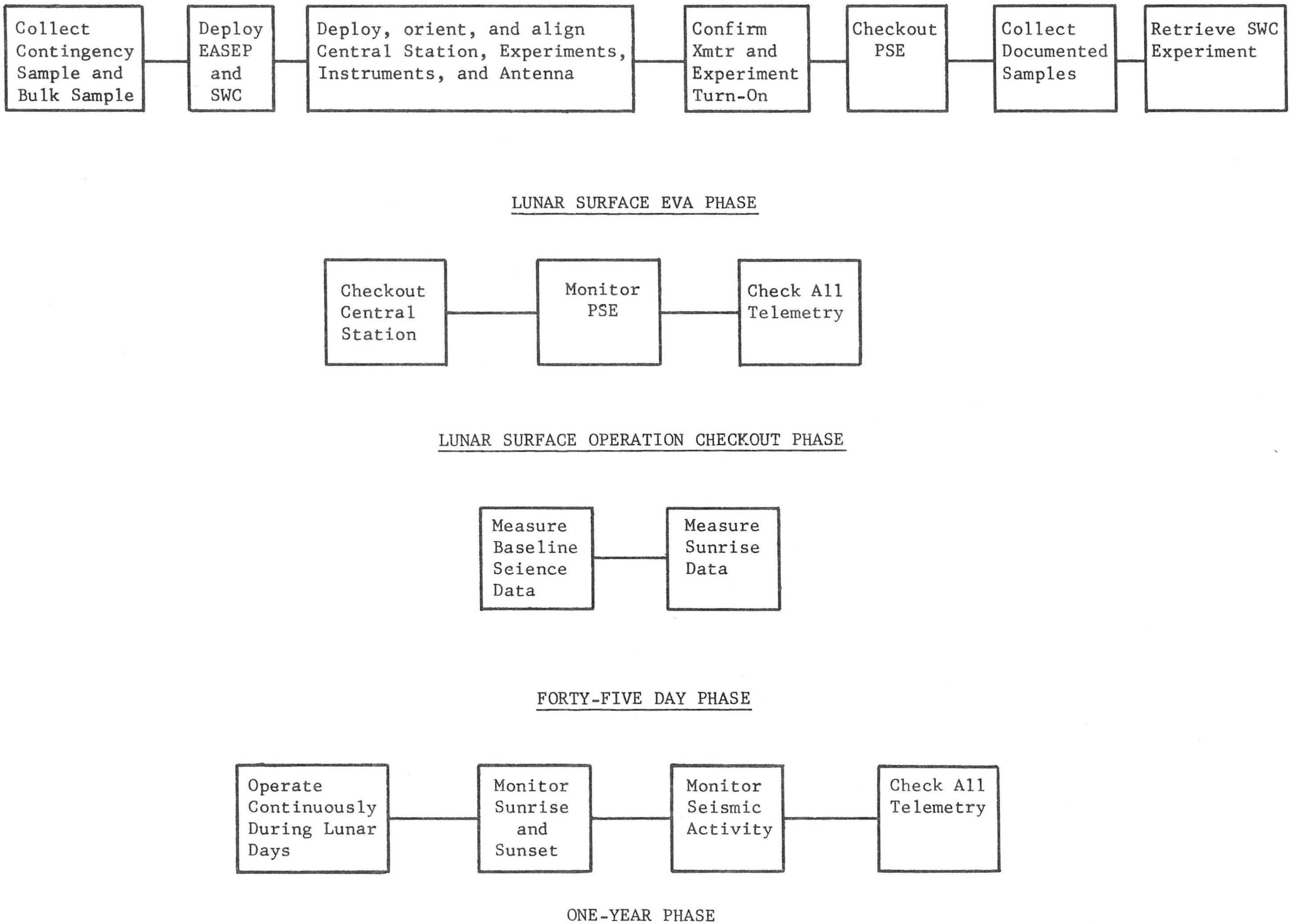


FIGURE 1-1 LUNAR SURFACE OPERATION PHASES

1.3 PRINCIPAL INVESTIGATORS (PI)

1. Passive Seismic Experiment - Dr. Gary V. Latham, Lamont-Doherty Geological Observatory.

2. Laser Ranging Retro-Reflector - Dr. Carroll O. Alley, University of Maryland.

3. Solar Wind Composition - Dr. Johannes Geiss, University of Berne.

4. Lunar Geology Experiment - Dr. Eugene M. Shoemaker, United States Geological Survey.

The P.I.'s and their co-investigators for the above experiments will assist and advise the Flight Controllers during the deployment and activation of their respective experiments. Operational methods, modes, real-time commands, and calibration procedures will be dictated by each P.I. for his experiment until a steady-state, operational equilibrium has been reached. Thereafter, the Flight Controller may reach each P.I. by phone for advice or assistance.

1.4 ABBREVIATIONS AND ACRONYMS

ABBREVIATIONS	DEFINITIONS
AMPS	Amperes
AUTO	Automatic
CAAD	Computation and Analysis Division
CAL	Calibrate
db	decibel
dbm	decibel with reference to one milliwatt
EASEP	Early Apollo Scientific Experiments Package
F	Fahrenheit
FOD	Flight Operations Directorate
FCSD	Flight Crew Support Division
kHz	kiloHertz
kv	kilovolts
kw	kilowatts
LGE	Lunar Geology Experiment
LM	Lunar Module
LP	Long Period
LRRR	Laser Ranging Retro-Reflector
ma	milliamperes
MCC	Mission Control Center
MESA	Modularized Equipment Stowage Assembly (Descent Stage)
mHz	megaHertz
MSFN	Manned Space Flight Network
mv	millivolts
PCU	Power Conditioning Unit
PDR	Power Dissipation Resistor
PDU	Power Distribution Unit
PI	Principal Investigator
PSE	Passive Seismic Experiment
SP	Short Period
SWC	Solar Wind Composition
USGS	United States Geological Survey
Vdc	Volts direct current
XMTR	Transmitter

2.0 MISSION OBJECTIVES

2.1 EASEP MISSION OBJECTIVES

The purpose of the Passive Seismic Experiment (PSE) portion of EASEP is to measure lunar seismic activity and transmit the data to receiving stations on Earth for a period of one year. The Laser Ranging Retro-Reflector (LRRR) will establish a reflector surface for laser ranging for precise measurement of Earth-Moon distances.

The major objectives of EASEP are:

1. To obtain significant scientific data with minimal astronaut extravehicular task complexity and exertion.

2. To provide crew/hardware operational experience which will maximize the probability of subsequent lunar surface mission success.

2.2 SOLAR WIND COMPOSITION EXPERIMENT MISSION OBJECTIVE

The purpose is to determine the elemental and isotopic composition of the noble gases and other selected elements in the solar wind by measurement of particle entrapment on an exposed aluminum foil sheet.

2.3 CONTINGENCY SAMPLE COLLECTION MISSION OBJECTIVE

The purpose is to collect a small sample of lunar material in the immediate vicinity of the LM during the early part of the EVA phase.

2.4 BULK SAMPLE COLLECTION MISSION OBJECTIVE

The purpose is to collect a large amount of representative lunar material including individual rock samples and fine grained fragmental material during the lunar surface EVA.

2.5 LGE MISSION OBJECTIVES

The major objective of the LGE is to correlate carefully collected samples with a variety of observational data at the LM landing site.

The LGE functional objectives are as follows:

1. Examine, photograph, and collect lunar geologic samples for return to earth and analysis in Lunar Receiving Laboratory.

2. Obtain data on field relations such as shape, size, range, pattern of alignment or distribution of all accessible types of lunar topographic features.

3. Collect samples of lunar surface material.

4. Collect core samples of lunar material.

5. Collect a gas analysis sample of lunar surface material.

6. Collect a lunar environment sample.

3.0 MISSION DESCRIPTION

3.1 EASEP MISSION DESCRIPTION

The EASEP is comprised of a central station to act as the communication center for gathering information from the scientific experiment, a data subsystem for transmitting data to and from the earth, a power center provided by a solar cell array, and two experiments as follows:

1. Passive Seismic Experiment Package (PSEP) to monitor seismic activity (Reference Figure 3-1).

2. Laser Ranging Retro-Reflector Experiment (LRRR) consisting of an array of precise optical corner reflectors (Reference Figure 3-2).

The EASEP will be transported to the lunar surface in the Scientific Equipment Bay (SEQ) of the Lunar Module (LM) descent stage. The experiment packages will be assembled on two Apollo Lunar Surface Experiment Package (ALSEP) pallets.

EASEP deployment criteria are a result of consideration of the LM shadow, sun line, LM ascent engine blast effects and the astronaut's capability. Constraints and limitations on the physical deployment of EASEP are presented in Tables 3.1-1 and 3.1-2.

The EASEP will be self-sufficient during lunar day operation, utilizing the the solar cell array for electrical power. It will collect, format and transmit scientific and engineering data to the receiving sites on earth during lunar days for a period of up to one year.

Downlink telemetry communications from the EASEP are received at one or more of the remote sites of the Manned Space Flight Network (MSFN) and forwarded to the Mission Control Center (MCC). All uplink commands to EASEP are executed by MCC for transmission by the remote sites. The 37 commands to EASEP will allow selection of redundant components plus control of the experiment range, measurement ranges, and calibration modes. The Command/Telemetry link is shown in Figure 3-4.

TABLE 3.1-1 PSEP DEPLOYMENT CONSTRAINTS

Parameter	Constraints
PSEP Orientation from LM	Must not be due East or West. Astronaut must avoid walking directly into or away from sun where visibility is worst. Astronaut will visually determine direction to be chosen.
PSEP Deployment Site	30 feet minimum from LM. Area to be free of loose material and approximately level as visually determined by astronaut. Avoid craters and slopes which would degrade thermal control of unit.
PSEP Leveling	Must be coarse leveled by astronaut within ± 5 degrees of vertical because 5 degrees is the limit of the Automatic fine-leveling gimbal system.
PSEP Alignment	The astronaut will read and record to the nearest degree, the intersection of the shadow of the gnomon on the compass rose. Final azimuth alignment must be known within ± 5 degrees accuracy with reference to lunar North or South.
Interrelation	PSEP requires a clear field-of-view in order to obtain both thermal control and scientific data. PSEP must not be shaded from the sun on the lunar surface prior to deployment.

TABLE 3.1-2 LRRR Deployment Constraints

Parameter	Constraints
LRRR Deployment Site	30 feet minimum from LM at a horizontal site. Astronaut will avoid craters and slopes.
LRRR Leveling	Must be leveled by astronaut within ±5 degrees of vertical.
LRRR Alignment	Fine alignment will be performed by the astronaut. Final azimuth alignment must be known within ±5 degrees of LRRR centerline.

3.2 SOLAR WIND COMPOSITION MISSION DESCRIPTION

The Solar Wind Composition Experiment (SWC) consists of a panel of very thin aluminum foil rolled and assembled into a combination handling and deployment container (Reference Fig. 3-3). The SWC is designed to entrap noble gas constituents of the solar wind, such as helium, neon, argon, krypton and xenon.

The crewman will remove the SWC experiment from the LM Modularized Equipment Stowage Assembly (MESA) and deploy it on the lunar surface. The experiment will remain deployed for approximately one hour and will then be disassembled. The reel and foil will be placed in a teflon bag and stored in a sample return container for return to earth.

The requirements, constraints, and limitations on the physical deployment arrangement for the SWC experiment are presented in Table 3.2-1.

TABLE 3.2-1 SWC Deployment Constraints

Parameter	Constraint
SWC Deployment Site	A reasonable distance from the LM that clears all structure or vented gases. Astronaut will avoid craters or slopes.
SWC Leveling	Must be emplaced on the lunar surface in a vertical position and facing the sun.
SWC Alignment	Alignment will be performed by the astronaut within ±30 degrees of the sun line.

3.3 CONTINGENCY SAMPLE COLLECTION MISSION DESCRIPTION

The crewman will descend from the LM with the contingency sample container and scoop up a loose sample of lunar soil. Sequence photographs will be made showing the astronaut collecting the sample. The sample container will be sealed and stowed in a pocket of the EMU until return to the LM.

3.4 BULK SAMPLE COLLECTION MISSION DESCRIPTION

Several samples of rock fragments with varied texture or mineralogy will be collected and the remainder of the sample collection will be completed with loose materials representative of the landing area. Upon completion of the sample gathering, samples will be sealed in the sample return container and prepared for transfer to the LM. Photographs of the immediate sample gathering area will be obtained.

3.5 LGE MISSION DESCRIPTION

The fundamental ingredients of lunar field geology procedures are observation, description, documented sampling, and photography. In the general case, these operations are combined to form a series of stops or stations that constitute a geologic traverse. The specific combinations of operations at a given station and the sequence of stations are controlled by three factors:

1. The nature of the geologic terrain.

2. The equipment available.

3. The time available.

The nature of the geologic terrain can rarely be fully anticipated and therefore some degree of flexibility in procedures is always required.

The geologic sampling tools are presented in Figure 3-5.

The real-time planning of each traverse prior to egress from the Lunar Module will consist of the linking of procedures and the known geology of the site with the actual geologic setting observed by the crew. With the aid of the data and personnel in the Scientific Support Facility, the crew will make the final plans for a geologic traverse.

Samples to provide a more detailed and selective variety of lunar material will be collected in the following manner:

1. Samples will be collected using the carrier and tools stowed in the MESA and will be documented by photographs. Samples will be placed individually in prenumbered bags and the bags placed in the sample return container. Additional loose samples judged by the crew to be of particular interest will be collected and stowed loose in the Sample Return Container weigh bag.

2. Features and relationship such as shape, size, range, and patterns of alignment or distribution will be described and photographed.

3. Core samples will be collected with drive tubes provided in the sample return container.

4. A gas analysis sample of lunar surface material will be collected and sealed in the gas analysis sample container and placed in the sample return container.

5. A lunar environment sample of lunar surface material will be collected and sealed in the lunar environment sample container and placed in the sample return container.

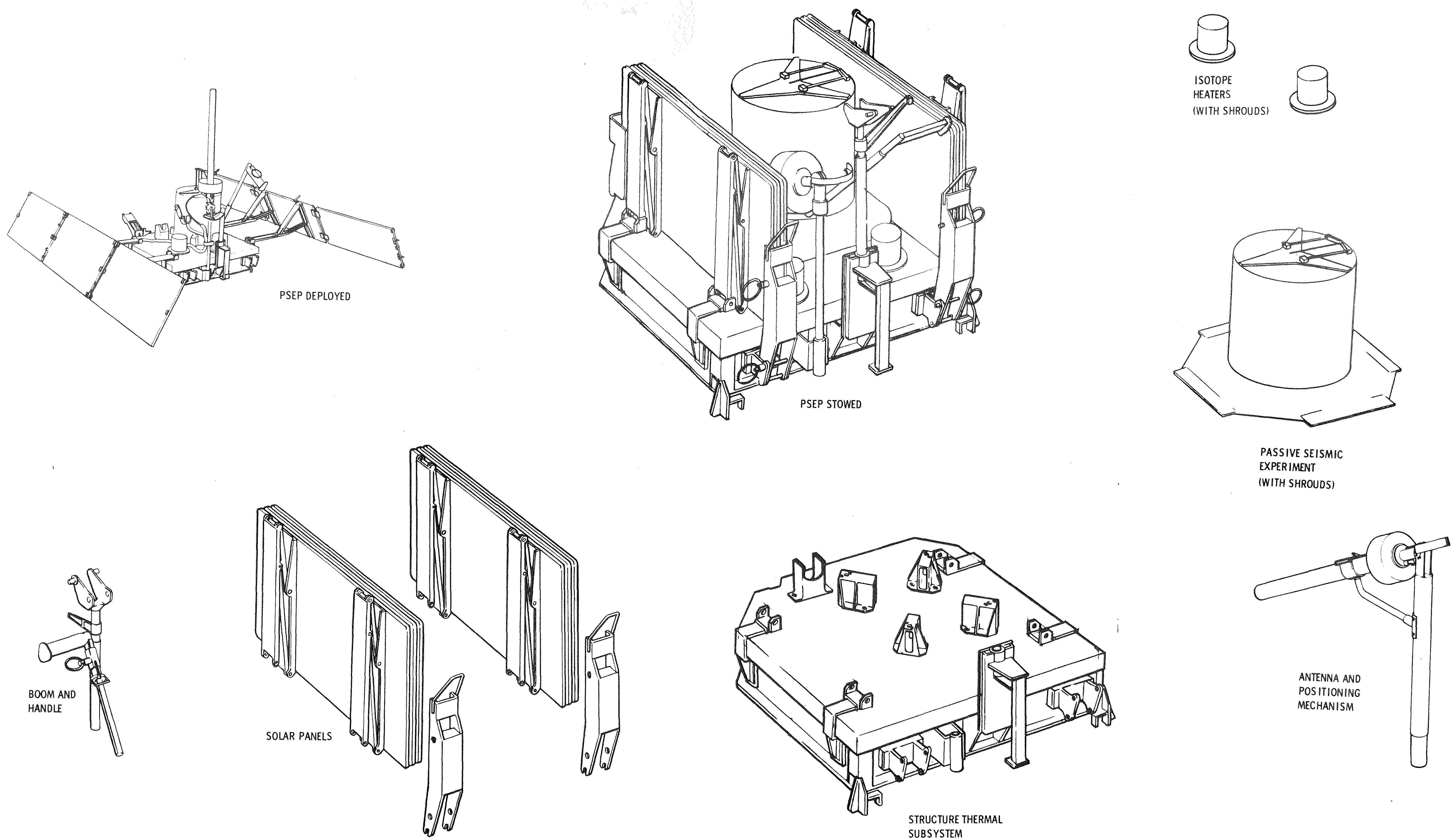


Figure 3-1 Passive Seismic Experiment Package

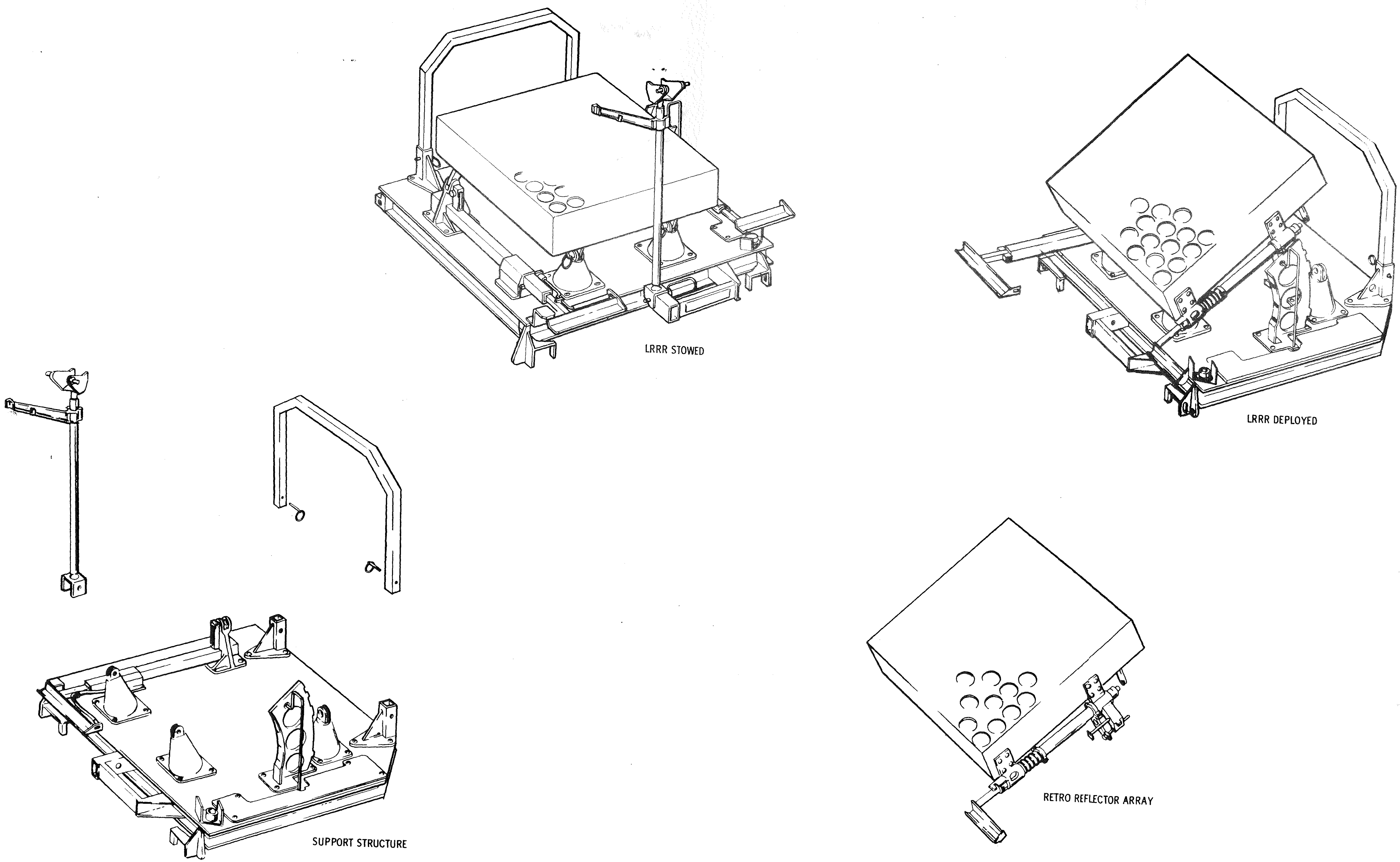
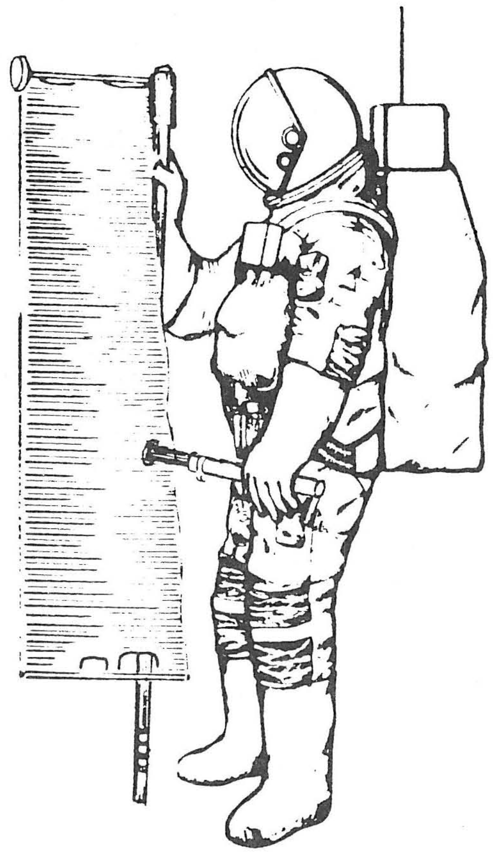


Figure 3-2 Laser Ranging Retro-Reflector Experiment



SOLAR WIND COMPOSITION

FIGURE 3-3

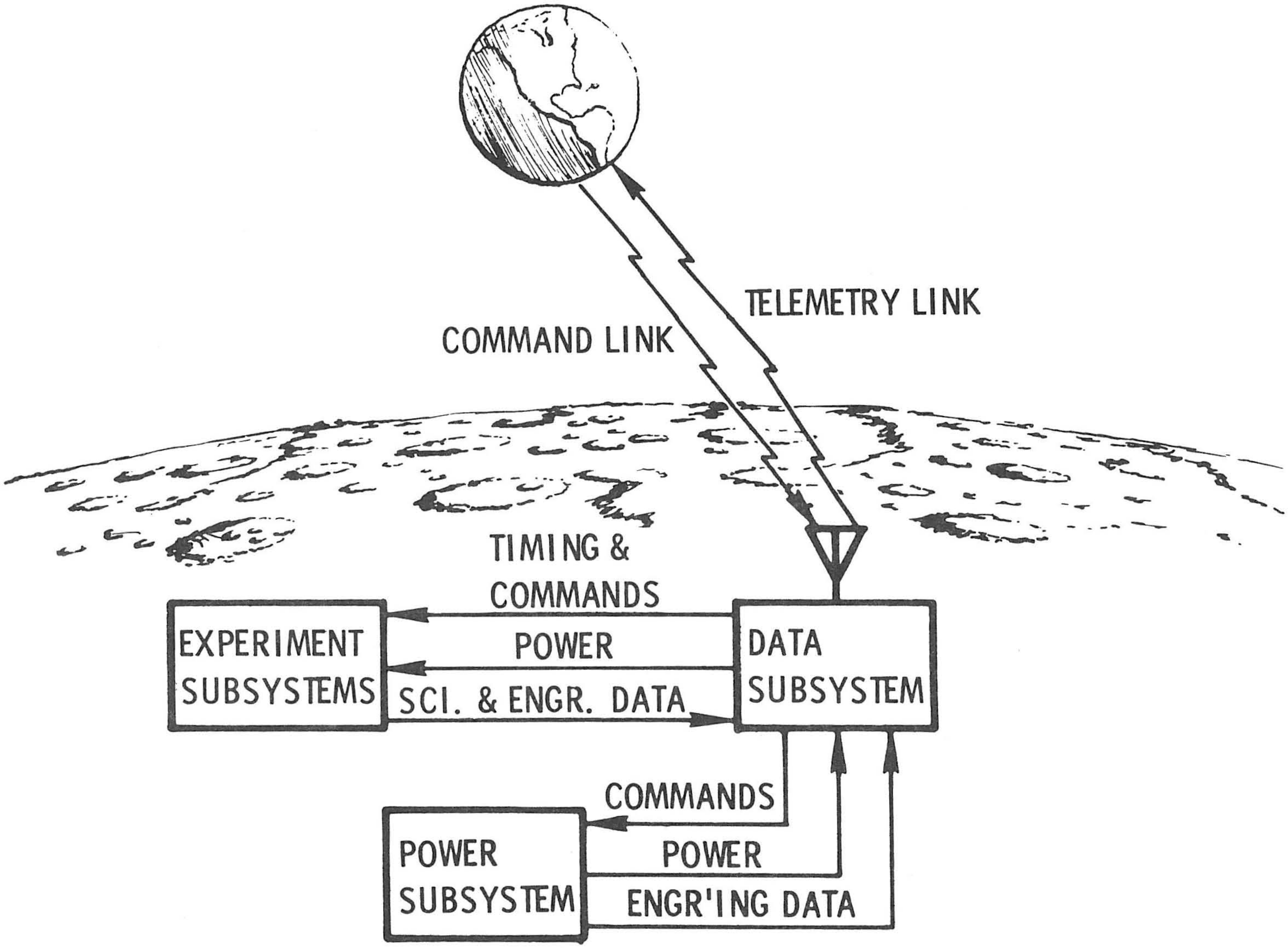


FIGURE 3-4 COMMAND AND TELEMETRY LINKS

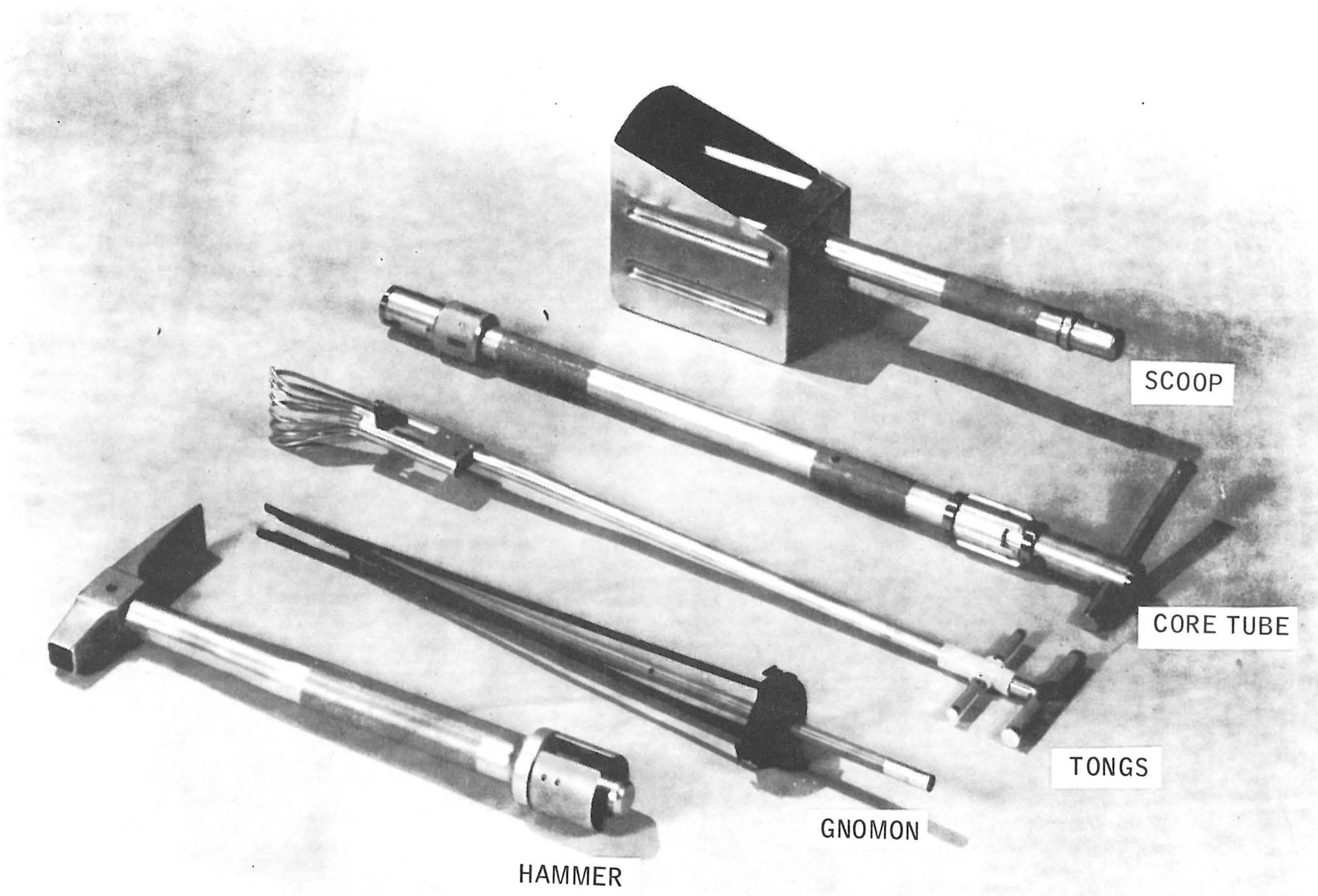


FIGURE 3-5 GEOLOGICAL SAMPLING TOOLS

4.0 PHASE I (LUNAR SURFACE EVA PHASE)

Phase I is outlined in Table 4-1 and covers the period during which the astronauts are available for specific deployment, back-up operations, and field geology investigations. Reference Apollo 11 Flight Plan for further breakdown of this phase involving astronaut activities.

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. Contingency Sample Collections	Collect a contingency sample.			
2. Solar Wind Composition Experiment	Deploy and orient the SWC Instrument.			Retrieve the SWC experiment after completion of all other EVA tasks.
3. Bulk Sample Collection	Collect samples of lunar material.			
4. Orient Central Station	Unload experiments. Orient and Level CS Assembly and erect antenna.			
5. Deploy EASEP Experiments	Deploy, orient and level: PSE Instrument. LRRR Instrument.			
6. Align Central Station Antenna	Level CS, orient antenna base, and enter prescribed offsets.	Verify antenna settings chosen by astronaut.		Preset Condition: Standby On
7. Turn On EASEP Transmitter	Deploy Solar Panels on EASEP. This automatically turns the EASEP transmitter on.	Verify reception of RF signal from EASEP		Preset: On
		Start data recorders and verify transmission of 1060 bps telemetry.		

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
7. Turn On EASEP Transmitter (Continued)		Advise astronaut via voice link that EASEP transmitter is functioning.		
	Acknowledge MCC receipt of RF signal and useful data via voice link.			
8. Passive Seismic Experiment Turn-On		A. Check experiment status telemetry, AB-4 (Channel 12, octal 264-314), for correct indication.		PSE Standby On
		B. Check reserve power status telemetry, AE-5 (Channel 8), for indication lower than octal 267.		
		C. Initiate command CD-13 (octal 036), PSE Operational Power On.		If telemetry data is interrupted for more than 5 minutes, command PSEP to Standby.

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-On (Continued)		D. Check telemetry Word 46 for verification of command reception and parity check.		
		E. Check experiment status telemetry, AB-4 (Channel 12, octal 171-215), for correct indication.		PSE Power On
		F. Check reserve power status telemetry, AE-5 (Channel 8), for indication lower than octal 264.		
		G. Housekeeping Data Check (Word 33).		
		1. Long period gain (X and Y) Channel 23.	3.0 volts	Preset condition: -30db

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-On (Continued)		D. Check telemetry Word 46 for verification of command reception and parity check.		
		E. Check experiment status telemetry, AB-4 (Channel 12, octal 171-215), for correct indication.		PSE Power On
		F. Check reserve power status telemetry, AE-5 (Channel 8), for indication lower than octal 264.		
		G. Housekeeping Data Check (Word 33).		
		1. Long period gain (X and Y) Channel 23.	3.0 volts	Preset condition: -30db

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-On (Continued)		2. Long period (Z) amplifier gain, Channel 38.	3.0 volts	Preset condition: -30db
		3. Level direction and speed, channel 53	0 volts	Preset condition: + low
		4. Short period amplifier gain, Channel 68.	3.0 volts	Preset condition: -30db
		5. Leveling mode and coarse sensor mode, Channel 24.	0 volts	AUTO, Coarse Sensor Out.
		6. Thermal control status, Channel 39.	0 volts	AUTO,On
		7. Calibration status (L.P. and S.P.) Channel 54.	3.0 volts	All Off
		8. Uncage status, Channel 69.		Caged

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-On (Continued)		H. Uncage Passive Seismometer		
		1. Initiate command CL-9 (octal 073) to Uncage PSE Sensor Assembly.		
		2. Verify command reception and acceptance (word 46).		
		3. Verify change in uncage status telemetry, word 33, Channel 69.		Uncage/Arm
		4. Repeat steps H.1 and H.2		Wait 30 seconds between Step H.1 and H.4
		5. Verify change in uncage status telemetry, word 33, Channel 69.		Uncage/Fire
		6. Observe short period scientific data on drum recorder for evidence of physical uncaging.		Adjust gain to visible signal. Consult P.I. before adjusting any gains.

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-on (Continued)		I. Level Passive Seismometer		
		1. Verify that feed-back filter is switched OUT (preset position) by comparing LP Seismic and LP Tidal data on recorders.		During initial leveling or whenever all LP components are Off level, verify feed-back position during Step I.10. If filter is In, execute command CL-13 (octal 101) and note response.
		2. Initiate command COARSE LEVEL SENSOR. CL-14 (octal 102).		
		3. Verify reception and acceptance of command (word 46).		
		4. Check telemetry Channel 24 for change in status of COARSE LEVEL SENSOR and verification of AUTO leveling mode.		Switch as required to obtain COARSE LEVEL SENSOR and AUTO status by commands CL-14 (octal 102) and CL-15 (octal 103).

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-On (Continued)		5. Initiate and verify command CL-12 (octal 076) THERMAL CONTROL MODE SELECT.		
		6. Check shunt regulator current Channel 8. Adjust PDR's if necessary.	1.1 amps	
		7. Initiate command LEVELING POWER X MOTOR ON CL-6 (octal 070).		
		8. Verify decrease of shunt regulator current Channel 8 (or 13).	1.1 amps	
		9. Observe recorder of long period, Tidal X-axis data as leveling proceeds.	Δt 0	During initial leveling, verify that feedback filter is switched out. This can be done by verifying the time lag between tidal and seismic data. If filter is in, execute command CL-13 (octal 101) and note response.

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-On (Continued)		10. Observe S. P. Seismic data on recorder		Observe S. P. Channel
		11. When X tidal output reaches a value of 0.5V or less, initiate command CL-6 (octal 070) LEVELING POWER X MOTOR OFF.		
		12. Verify reception and acceptance of command (word 46).		
		13. Verify that shunt regulator current has returned to approximately the value measured in Event 5, Step I.7	1.1 amps	

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-On (Continued)		14. Repeat event 8, step I.8 through I.14, for Y-axis, initiating and verifying command CL-7 (octal 071) LEVELING POWER Y MOTOR while monitoring appropriate recorder.		
		15. Initiate and verify command CL-14 (octal 102) COARSE LEVEL SENSOR		
		16. Check channel 24 for change of status.	0 volts	AUTO, Coarse Sensor OUT
		17. Verify that X & Y tidal outputs are within ±0.5 volts.		If tidal outputs are not within ±0.5 volts repeat steps I.1 to I.14 deleting steps I.2 and I.3

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-On (Continued)		18. Initiate and verify command CL-8 (octal 072) LEVELING POWER Z MOTOR ON.		Initial centering of Z-axis requires following command settings: leveling in command mode, high speed and + direction. Turn Z power ON.
		19. Verify decrease of shunt regulator current (HK-8).	1.1 amps	
		20. Monitor Z-axis Tidal data as centering progresses.	Mean lunar gravity at site of ALSEP.	
		21. When a zero crossing is observed on Z tidal output, select "Leveling AUTO" mode.		
		22. When Z tidal output reaches a value of 0.5 volt or less, initiate and verify command CL-8 (octal 072) LEVELING POWER Z MOTOR OFF.		

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-On (Continued)		23. Verify that shunt regulator current has increased to approximately the value measured in Event 8, Step I.7.	1.1 amps	
		24. Verify that all tidal outputs (X, Y and Z) are within ±0.5 volts.		If tidal outputs are not within ±0.5 volts repeat steps I.1 to I.24, deleting steps I.2, I.3, I.16 and I.17.
		25. Initiate and verify command PSE FILTER IN CL-13 (octal 101).		
		26. Verify that filter has been switched IN by comparison of L.P. Seismic and L.P. Tidal data on recorders.		

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-On (Continued)		27. Execute command CL-12 (octal 076) THERMAL CONTROL MODE SELECT as required to keep within limits.		
		28. Check telemetry of thermal control status (Channel 39).	0 volts	
		J. Passive Seismometer Calibration		
		1. Initiate and verify command CL-4 (octal 066) CALIBRATION LP ON/OFF		
		2. Check for response in Tidal data and in L.P. Seismic data on drum recorders.		
		3. Check for status change in Channel 54.	1.0 volts	L.P. On S.P. Off

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-On (Continued)		4. Initiate and verify command CL-4 (octal 066) CALIBRATION L.P. ON/OFF.		
		5. Check for status change in Channel 54.	3.0 volts	All Off
		6. Initiate and verify command CL-3 (octal 065) CALIBRATION SP ON/OFF.		
		7. Check for response in SP Seismic data or recorder.		
		8. Check for status change in Channel 54.	2.0 volts	L.P. Off S.P. On

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-On (Continued)		9. Initiate and verify command CL-3 (octal 065) CALIBRATION SP ON/OFF.		
		10. Check for status change in Channel 54.	3.0 volts	ALL Off
		K. Thermal Stabilization of Passive Seismometer		
		1. Monitor sensor unit temperature and verify that trend is toward 125°F, determine gradient.	126°F	Re-level as required per event 8, step I, deleting step I.2, I.3, I.15 and I.16.
		2. Continue to monitor temperature until equilibrium is reached.		

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Passive Seismic Experiment Turn-On (Continued)		L. Collection of Baseline Passive Seismic Data 1. Record data, without further transmission of command for determination of background noise level, frequency and magnitude of detectable seismic events. 2. Fix gains at levels determined from Step L.1 above.		
9. Field Geology Investigation		The MSC Activity consists of managing the incoming geologic information in various ways: 1. Make real-time notes and sketches of traverse to transmit over closed circuit TV.		

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
9. Field Geology Investigation (Continued)		2. Make hard copy of Apollo TV images. 3. Annotate large scale versions of the astronaut data package maps. 4. Keep track of photos taken as a check on photo coverage. 5. Prepare specific questions to ask if and when appropriate.		
	A. Sample and describe the morphological features of small but predominant craters in the near area of the landing site.			Photograph sample site in stereo.

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
9. Field Geology Investigation (Continued)	B. Take scoop samples at scattered points along traverse.			Describe texture and composition; compare to other areas; photograph each sample site in stereo.
	C. Collect fragments of rocky material which appear to be representative types.			Try to move the large objects or pry beneath them after photographing their original position.

TABLE 4-1 PHASE I (LUNAR SURFACE EVA PHASE)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
9. **Field Geology Investigation (Continued)**	D. Take core tube samples preferably where layering is known to exist.			Check for layering with chisel end of hammer along traverse. Take one photograph of surface before driving tube, then stereo photographs with tube and extension handle in place. Give brief statement of impressions on: Origin of Material; How Emplaced; How Distributed or Affected Since Emplacement; Mechanical Properties
	E. Observe Morphologic type craters on horizon (Sharp-rimmed to subdued, pan-craters, funnel-shaped, dimple craters, chain and loop craters, secondary craters, etc.)			Briefly identify Morphologic type, then photograph general shape in stereo with baselines approximately 1/3 to 1/2 distance to points of interest, such as far wall. Give impressions or origin and mechanism of the craters formation (impact, volcanic, other); relative age of crater. Activities A through E will be performed consistent with the Apollo 11 Flight Plan. These activities are not necessarily listed in order or priorities.

PHASE I (LUNAR SURFACE EVA PHASE)

ACTIVITY CHART

Event (Geologic features to be studied)	Astronaut Activity			MSC Activity
	SAMPLING	PHOTOGRAPHY	DESCRIPTION	MONITORING
1. OUTCROP 2. Blocky Rimmed Crater 3. Blocks 4. Bright Halo Crater 5. Regolith 6. Sharp Rimmed Crater 7. Elongate Crater 8. Crater Chain 9. Mare Ridge 10. Scarp 11. Crater Cluster 12. Dimple Crater 13. Lineament 14. Subdued Crater	of • Outcrop • Blocks • Regolith using • hammer • tongs • scoop • core tubes	of • Outcrop • Blocks • regolith • geologic features • topographic features using • monoscopic • stereoscopic • panoramic with • Hasselblad • Apollo TV • Time-Sequence	of • Rock Material and Geologic features with respect to • Color, texture, composition, structure weathering or alteration. • variations-horizontal and vertical • relationships to adjacent features • comparisons with similar features • integrations of: - origins of features - sources of materials - processes	of • Sample #s • Photo #s • Descriptions and • encoding data • annotating maps and photos • prepare questions • answer questions • advise astronauts

The astronaut activity will consist of observation, photography, description, and sampling of certain geologic features conducted along the traverse. At the same time MSC will be monitoring and documenting the astronaut activity.

5.0 PHASE II (LUNAR SURFACE OPERATION CHECKOUT PHASE)

Phase II is outlined in Table 5-1 and covers the period from LM Ascent through the checkout of all subsystems.

TABLE 5-1 PHASE II, (LUNAR SURFACE OPERATION CHECKOUT PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. EPS Check	A. Check the following parameters:		
	1. 0.25 Vdc Calibration (Channel 2)	0.25 volts	
	2. 4.75 Vdc Calibration (Channel 3)	4.75 volts	
	3. Converter Input Voltage (Channel 1)	16.2 volts	
	4. Converter input current (Channel 5)	4.2 amps	
	B. Verify that system is operating on PCU #1 by checking Channel 8 of telemetry word No. 33 (Shunt Regulator #1 Current)	1.1 amps	
	C. Check PCU temperatures as follows:		
	1. Power Oscillator #1 (Channel 64)	+94°F	
	2. Regulator #1 (Channel 77)	+103°F	

TABLE 5-1 PHASE II, (LUNAR SURFACE OPERATION CHECKOUT PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. Power Supply Check (Continued)	D. Check PCU operating parameters as follows:		If either the temperature of Event 1, Step C or the parameters of Event 1, Step D, are out of limits, switch to PC 2 by transmission of Octal Command 062 (Power Conditioning Unit Reset).
	1. + 29V (on Channel 20)	+29.0 Volts	
	2. + 15V (on Channel 35)	+15.0 Volts	
	3. + 12V (on Channel 50)	+12.0 Volts	
	4. + 5V (on Channel 65)	+ 5.0 Volts	
	5. -12V (on Channel 79)	-12.0 Volts	
	6. - 6V (on Channel 80)	- 6.0 Volts	
	E. Initiate command CX-01 (octal 027) DUST DETECTOR ON.		
	F. Monitor Cell Voltage of Dust Accretion Units		
	1. Dust Cell 2 Output (Channel 26)	52 mv	
	2. Dust Cell 3 Output (Channel 41)	52 mv	
	3. Dust Cell 1 Output (Channel 84)	52 mv	

TABLE 5-1 PHASE II, (LUNAR SURFACE OPERATION CHECKOUT PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. Power Supply Check (Continued)	G. Initiate command CX-02 (octal 031) DUST DETECTOR OFF.		
2. Temperature Checks and Thermal Control	A. Check telemetry channels as indicated below for pertinent temperature measurements:		If either the temperature or power levels are outside limits, switch to back-up transmitter by transmission of Octal Command 015 (or 012).
	Location / **Channels**		
	1. Sunshield — 27, 42	-80°F	
	2. Thermal Plate — 4, 28, 43, 58, 71	+83°F	
	3. Structure Sides — 59, 87	0°F	
	4. Structure Bottom and Back — 15, 88	+ 6°F, +28°F	
	5. Inner Multilayer Insulation — 60	+64°F	
	6. Outer Multilayer Insulation — 72	+26°F	

TABLE 5-1 PHASE II, (LUNAR SURFACE OPERATION CHECKOUT PHASE)

EVENT	MCC ACTIVITY		NOMINAL VALUE	REMARKS
	Location	Channels		
2. Temperature Checks and Thermal Control (Continued)	7. Analog Data Processor Base	33	+83°F	
	8. Analog Data Processor Internal	34	+90°F	
	9. Digital Data Processor Base	46	+83°F	
	10. Digital Data Processor Internal	47	+87°F	
	11. Command Decoder Base	48	+83°F	
	12. Command Decoder Internal	49	+86°F	
	13. Command Demodulation VCO	61	+86°F	
	14. Power Distribution Unit Base	62	+83°F	
	15. Power Distribution Unit Internal	63	+100°F	
	B. Check shunt Regulator Current (Channel 8).		1.1 amps	

TABLE 5-1 PHASE II, (LUNAR SURFACE OPERATION CHECKOUT PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
2. Temperature Check and Thermal Control (Continued)	C. Optimize Central Station thermal environment by dumping reserve power into the external power dissipation resistors. Initiate commands in accordance with the following table:		

If AE-5 Shunt Current is:	Command PDR
0.6 to 1.1A	CD-5 (Octal 017) PDR #1 ON
1.1 to 1.5A	CD-7 (Octal 022) PDR #2 ON
> 1.5A	CD-5 & 7 PDR# 1 and #2 ON
< 0.6A	PDR #1 and #2 OFF

TABLE 5-1 PHASE II, (LUNAR SURFACE OPERATION CHECKOUT PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
2. Temperature Check and Thermal Control (Continued)	D. Check Verification of any commands transmitted per Event 2, Step C above (Word 46).		
	E. Check for appropriate change in shunt current for any command transmitted in Event 2, Step C above (AE-5)		
	F. Initiate command CX-01 (octal 027) DUST DETECTOR ON.		
	G. Check Dust Accretion Unit		
	1. Dust Cell 2 Temp (Channel 30)	+136°F	
	2. Dust Cell 3 Temp (Channel 56)	+136°F	
	3. Dust Cell 1 Temp (Channel 83)	+136°F	

TABLE 5-1 PHASE II, (LUNAR SURFACE OPERATION CHECKOUT PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
2. Temperature Check and Thermal Control (Continued)	H. Initiate command CX-02 (octal 031) DUST DETECTOR OFF.		
3. Transmitter Checks	A. Monitor the following transmitter temperatures:		
	1. Transmitter A Crystal Temperature, Channel 18	+75°F	
	2. Transmitter A Heat Sink Temperature, Channel 19	+75°F	
	B. Check Transmitter A AGC voltage, Channel 51	1.10V @ +75°F	
	C. Check Transmitter A Power Doubler Current, Channel 81	162ma @ +75°F	
	D. Request MSFN check of EASEP transmitter frequency. Log frequency and verify that it is within 11.5 kHz of nominal, (2276.5 mHz for EASEP)	2276.5 MHz	

TABLE 5-1 PAHSE II, (LUNAR SURFACE OPERATION CHECKOUT PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
3. Transmitter Checks (Continued)	E. Request MSFN check level of signal from EASEP. Log level and verify that it exceeds the minimum receiver input power.	30' dish -127 .2dbm 85' dish -118 .2dbm	
4. Diagnostic Checks	A. Monitor local oscillator crystal temperature A, (Channel 16).	+144°F	
	B. Monitor Channel 36 for RF level of EASEP receiver local oscillator.	6.1 dbm	

TABLE 5-1 PHASE II, (LUNAR SURFACE OPERATION CHECKOUT PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
4. Diagnostic Checks (Continued)	C. With MSFN ground transmitter radiating at rated power level, Monitor EASEP Channel 21 for prelimiting signal level of command receiver.	-88 dbm	
	D. Check for subcarrier indication, Channel 9.	No modulation present: Octal 57	
	E. Check Channel 9 for indication of availability at the command decoder of 1 KHz subcarrier when it is transmitted from MSFN.	Modulation present: Octal 275	
	F. Determine EASEP receiver center frequency by plotting MSFN transmitter frequency vs. ALSEP prelimiting signal level as transmitter is tuned across band. Log center frequency (nominally 2119 MHz $\pm$ 21 kHz).	2119 MHz	
5. Passive Seismic Experiment Checkout	A. Monitor all science data measurements on a continuous basis.		Note significant trends, especially during the turn-on period for the other experiments. During LM ascent, PSEP Scientific data must be monitored continuously so as to measure any seismic disturbance due to ascent engine blast.

TABLE 5-1 PHASE II, (LUNAR SURFACE OPERATION CHECKOUT PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
5. Passive Seismic Experiment Checkout (Continued)	B. Monitor the experiment supply voltage, Channel 20	29.0 volts	Note significant trends.
	C. Monitor the thermal plate temperatures, Channel 43.		Note significant trends and compare temperatures against other thermal plate temperatures on Channel 4, 28, 58 and 71.
	D. Check need for leveling as indicated by the Tidal output recordings.		

6.0 PHASE III, (FORTY-FIVE DAY PHASE)

Phase III is outlined in Table 6-1 and covers the period from PSEP power turn-on and checkout through the following 45 calendar days.

TABLE 6-1 PHASE III, (FORTY-FIVE DAY PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. Central Station	A. Temperature Monitor		
	1. Monitor critical Central Station temperatures. (Word 33)		Note any out-of-limit readings and significant trends toward limits.
	B. Power Monitor		
	1. Log input power, voltage, and current and output voltages every 24 hours and identify significant trends.		Continuously check the telemetry of the electrical parameters associated with the power supply.
	C. Thermal Control		
	1. Initiate and verify commands: CD-06 (octal 021) PDR #1 OFF CD-08 (octal 023) PDR #2 OFF		
	2. Check reserve power as indicated by shunt regulator current, Channel 8.		

TABLE 6-1 PHASE III, (FORTY-FIVE DAY PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. Central Station (Continued)	D. Transmitter Monitor		
	1. Check transmitter frequency at each "hand-over" from one MSFN station to the next. Log results and note any significant trend. Frequency should be: 2276.5 MHz ($\pm$11.5 KHz) for EASEP.	2276.5 MHz	
	2. Approximately once per day preferably at a fixed elevation angle at a single MSFN station, measure and record receiver input level of the signal received from EASEP. Log results and note trend daily.		
	3. Monitor and log daily the electrical parameters associated with the EASEP transmitter:		
	<u>Parameter</u> — <u>Channel</u> Trans. A, AGC Voltage — 51 Trans. B, AGC Voltage — 66 Trans. A, DC, Power Doubler — 81 Trans. B, DC, Power Doubler — 22		Note any significant trend.

TABLE 6-1 PHASE III, (FORTY-FIVE DAY PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. Central Station (Continued)			
	E. Downlink Bit Error Check		
	1. Approximately once per hour obtain results of bit error check (against the predictable first words of each EASEP frame).		Log results and note significant trends.
	F. Receiver Monitor		
	1. Log daily readings of electrical parameters associated with EASEP receiver:		
	Parameter — Channel		
	RCVR., Local OSC Level — 36		Note any significant trends.
	RCVR., Pre-Limiting Level — 21		

TABLE 6-1 PHASE III, (FORTY-FIVE DAY PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. Central Station (Continued)	2. Once per day recheck EASEP receiver center frequency as in Phase II, Event 4, Step F. Log results and note any significant trend.		Reading taken with known output from ground transmitter, e.g., 10 kW.
2. Passive Seismic Experiment	A. Monitor all science data measurements continuously on drum recorders.		
	B. Once per day record and log the following housekeeping data.		
	1. Experiment supply voltage Channel 20.	+29.0 volts	
	2. Thermal plate temperature, Channel 43.		Note significant trends and compare temperature against other thermal plate temperatures Channels 4, 28, 58 and 71.

TABLE 6-1 PHASE III, (FORTY-FIVE DAY PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
2. Passive Seismic Experiment (Continued)	C. Once per day, check need for leveling as indicated by Tidal output recordings. Relevel (automatic) as in Phase I, Event 8, Step I when required (deleting steps I.2, I.3, I.16 and I.17) CL-06 (octal 070) X-axis CL-07 (octal 071) Y-axis CL-08 (octal 072) Z-axis		NOTE: Check experiment status Channel 14 for evidence of "ripple off" during leveling.
	D. Check for evidence of automatic calibration of short period sensor at 12-hour intervals.		
	E. Once per day, calibrate long period circuitry as in Phase I, Event 8, Step J, Calibration (CL-04, octal 066).		
	F. Prepare the PSEP for survival during lunar night		

TABLE 6-1 PHASE III, (FORTY-FIVE DAY PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
2. Passive Seismic Experiment (Continued)	1. Initiate commands CD-06 (octal 021) PDR #1 OFF and CD-08 (octal 023) PDR #2 OFF		About two hours before sunset when PC 1 Reserve Power (AE-03 and AE-05) drops to about one watt, both PDR's must be commanded OFF, the PSE must be commanded to Standby, a switch-over from PC 1 to PC 2 must be commanded (062) and the transmitter must be commanded OFF (014).
	2. Command PSE to Standby.		Octal Command 037 (Experiment No. 1 Standby Power)
	3. Initiate command CD-03 (octal 014) Transmitter Off		
	G. Prepare the PSEP for second lunar day initial operation		
	1. Initiate command CD-02 (octal 013) Transmitter On		Transmitter will not be commanded on for at least 20 hours after sunrise.
	2. Proceed with turn-on and checkout of the PSE as in Phase 1, Event 8 .		Note significant trends during the turn-on period.

7.0 PHASE IV (ONE-YEAR PHASE)

Phase IV as outlined in Table 7-1 covers the period from forty-five (45) days through the first year of operational life for EASEP.

TABLE 7-1 PHASE IV, (ONE-YEAR PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. Central Station	A. Check Central Station temperatures as in Phase III, Event 1, Step A, and initiate any contingency action indicated. Log critical parameters for trend identification.		Check temperatures early in each access period, and every day during continuous coverage.
	B. Check telemetry of power supply parameters as in Phase III, Event 1, Step B. Log for trend identification. Initiate contingency action if required (e.g., switch PCU's).		Check telemetry early in each access period, and every day during continuous coverage.
	C. Check transmitter performance as in Phase III, Event 1, Step D. Log data and initiate contingency action (e.g., switch transmitters), if necessary.		Check transmitter early in each access period, and every day during continuous coverage.

TABLE 7-1 PHASE IV, (ONE-YEAR PHASE)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. Central Station (Continued)	D. Check receiver performance as in Phase III, Event 1, Step F. Log results.		Check receiver every day and near the end of each access period.
	E. Check the bit error rate of the downlink as in Phase III, Event 1, Step E. Log results.		Check downlink bit error every day and near the end of each access period.
	F. Optimize the Central Station thermal environment for the next 24-hour period as in Phase III, Event 1, Step C.		Optimize thermal control every day and near the end of each access period.
2. Passive Seismic Experiment	A. When preparing for lunar day operations proceed as in Phase III, Event G.		
	B. When preparing for PSEP survival during lunar night proceed as in Phase III, Event F.		