NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FINAL

APOLLO 11 LUNAR SURFACE OPERATIONS PLAN

PREPARED BY

LUNAR SURFACE OPERATIONS OFFICE
MISSION OPERATIONS BRANCH
FLIGHT CREW SUPPORT DIVISION

JUNE 27, 1969

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FINAL EDITION

APOLLO 11

LUNAR SURFACE OPERATIONS PLAN

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APOLLO 11

LUNAR SURFACE OPERATIONS PLAN

(FINAL EDITION)

PREFACE

This document has been prepared by the Flight Crew Support Division, Flight Crew Operations Directorate, Manned Spacecraft Center, Houston, Texas. The information contained within this document represents the Lunar Surface Operations Plan for Apollo 11, the first planned lunar landing mission.

This is the final edition of the Apollo 11 Lunar Surface Operations Plan. The plan is under the configuration control of the Crew Procedures Control Board (CPCB) and all proposed changes to this document should be submitted to the CPCB via a Crew Procedures Change Request. Changes and comments to the plan should be directed to W. H. Wood, Jr., Lunar Surface Operations Office, FCSD.

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INTRODUCTION

1.0 INTRODUCTION

This final edition of the Lunar Surface Operations Plan defines equipment requirements, crew/equipment interfaces, and final flight planning and crew activities for lunar surface EVA operations during the first manned lunar landing mission.

This plan delineates how the lunar surface operational and scientific objectives for the first manned lunar landing mission will be accomplished through pre-mission timelining and procedures definition. Although the primary concern of this plan is the lunar surface EVA operational aspects of the mission, interface relationships are presented to provide clarity and continuity to the overall mission plan.

The nominal plan is for a single two-man lunar excursion. The planned duration will be two hours and forty minutes or upon reaching a pre-determined red line on one of the PLSS consumables. The red line is defined as having either a 30 minute supply of oxygen or a 30 minute supply of feedwater remaining after repressurization. The battery is not considered to be a constraint on the lunar surface time for this mission. Based on an estimation of each crewman's BTU expenditure to accomplish his respective EVA tasks, a PLSS expendable red line should not be reached during the EVA. The Commander is expected to expend approximately 3625 BTU's which will leave a 1175 BTU PLSS reserve or approximately 50 minutes Lunar surface time. (Metabolic profiles are presented in the Appendix, Section 5.4)

In addition to the nominal timeline, the plan presents three other timelines for the lunar EVA. One timeline is referred to as an alternate timeline and two are referred to as contingent timelines. These timelines differ from the nominal primarily by additions or deletions of tasks. The major difference in the alternate timeline, from the nominal, is the addition of the S-band erectable antenna deployment which reduces the time available for the documented sample collection. The first contingent timeline, Contingent EVA 1, is a presentation of activities for a minimum-time, one-man EVA. The second contingent timeline, Contingent EVA 2, is for a one-man, two-hour EVA.

The plan also presents two forms of timelines. The EVA timelines and a timeline for the complete lunar surface stay, from touchdown to liftoff, are in summary form. Each of the EVA timelines is also presented in an expanded timeline and abbreviated procedures form.

Detailed procedures are included for the nominal lunar EVA. Since the alternate timeline, in general, only adds the deployment of the erectable antenna and reduces the time for collection of a documented sample, detailed procedures for the entire alternate EVA would be redundant. Thus, only detailed procedures for the S-band erectable antenna deployment are included. For the contingent EVA's, the timelines present the procedures in sufficient detail that, with an understanding or reference to the nominal procedures, separate procedures are unnecessary.

SECTION 2.0

MISSION PLAN

2.0 MISSION PLAN

2.1 Mission Purpose

The primary purpose of the Apollo 11 mission is to perform a manned lunar landing and return. Subordinate objectives are to perform limited selenological inspection, photography, survey, evaluation, and sampling during the lunar stay. Data will be obtained to assess the capability and limitations of the astronaut and his equipment in the lunar environment. The accomplishment of the detailed lunar surface mission objectives and experiments will contribute an essential part to the success of the mission.

2.2 Mission Description

This section provides a brief summary of the major events for a July 16, 1969 launch date.

Launch to Earth Orbit:

The July 16 mission will allow a range of launch azimuths from 72 to 108 degrees with a window opening at 13:32:00 (hr:min:sec) gmt for a duration of 4:24:00. The spacecraft will be inserted into an approximately 100 nautical mile circular earth parking orbit for spacecraft checkout.

Translunar Injection (TLI):

The July window permits a Pacific translunar injection. The S-IVB will be re-ignited during the second earth parking orbit to provide the nominal injection.

Translunar Coast:

Two hours after TLI, the CSM will separate from the S-IV, transpose, dock and initiate ejection of the LM/CSM. Prior to lunar orbit insertion (LOI), two astronauts will enter the LM, accomplish a limited status check, and return to the command module.

Lunar Orbit Insertion:

The service module propulsion system will insert the spacecraft into an orbit of approximately 60 by 170 nautical miles. After two revolutions in this orbit for spacecraft system and orbit parameter checks, the orbit will be reduced to 66 by 54 nautical miles.

Lunar Module Descent:

During the thirteenth orbit after the Lunar Orbit Insertion, LM/CSM undocking is accomplished in preparation for lunar landing. The powered descent maneuver is initialized at pericynthion of the descent transfer orbit. For the July 16 launch, the lunar landing will be at Site 2 (previously designated II-P-6 and located at 0° 43' N, 23° 42' E). The range of sun elevation angles, for landing, will be from 10.5 to 13.5 degrees.

Lunar Surface Operations:

The planned lunar surface staytime is 22 hours. The nominal plan provides for a single, two-man EVA, with a duration of two hours and forty minutes.

Immediately after landing, the LM will be checked to assess its launch capability. After the post-landing checks, there will be a four hour rest period, with eat periods before and after, prior to preparation for EVA. Following the EVA and post-EVA activities, there will be another rest period, of four hours and forty minutes duration, prior to preparation for liftoff.

In addition to the tasks required to successfully complete the landing and ascent and the pre-EVA and post-EVA operations, the lunar surface activities will include the following major items in order of priority:

1) Photographs of the landing area through the LM cabin window.

2) Contingency sample collection.

3) EVA evaluation.

4) LM inspection.

5) Bulk sample collection.

6) Deployment of experiments: Early Apollo Scientific Experiments Package (S-031, Lunar Passive Seismology and S-078, Laser Ranging Retro-Reflector) and S-080, Solar Wind Composition.

7) Documented sample collection.

Real time TV coverage will be provided early in the EVA using the steerable antenna or, if required, the erectable antenna. Both the Goldstone and Parkes 210-foot antennas will be utilized as available.

Photography will be employed throughout the EVA to document the activities and observations.

LM Ascent:

During the LM lunar surface stay, the CSM will make the required plane change to permit a nominally coplanar rendezvous. After LM ascent and docking to the CSM, the two crewmen will transfer to the CSM with exposed film and samples of the lunar surface. The CSM will then jettison the LM using the SM RCS.

Transearth Injection:

The service module propulsion system will be used to boost the CSM out of lunar orbit. The return flight duration shall not exceed 110 hours and the return inclination shall not exceed 40 degrees.

Entry and Recovery:

Prior to atmospheric entry, the command module will be separated from the service module using the SM RCS. The nominal range from 400,000 feet altitude to touchdown shall be 1285 nautical miles. Touchdown will be in the Pacific near Hawaii approximately 11 days after launch from earth.

Post Landing Operations:

Following splashdown, the crew will egress the CM after the flotation collar has been attached, don biological isolation garments, transfer to the recovery ship by helicopter and immediately enter the Mobile Quarantine Facility (MQF). They will be transported in the MQF to the LRL at MSC. The CM, sample return containers, film, tapes and astronaut logs will also be transported to the LRL.

In order to minimize the risk of contamination of the earth's biosphere by lunar material, quarantine measures will be enforced. The crew will be quarantined for approximately 21 days after liftoff from the lunar surface.

2.3 Summary of Mission Requirements

2.3.1 Introduction

The following information is from the "Mission Requirements SA-506/CSM-107/LM-5 G Type Mission, Lunar Landing", Dated April 17, 1969. (Revised May 1, 1969)

The following single primary mission objective is assigned to this mission by the Office of Manned Space Flight (OMSF):

1) Perform manned lunar landing and return.

In addition, the following subordinate objectives are delinated by OMSF:

1) Perform selenological inspection and sampling.

2) Obtain data to assess the capability and limitations of the astronaut and his equipment in the lunar surface environment.

Finally, the following experiments have been assigned to this mission:

1) S-031 Lunar Passive Seismology

2) S-078 Laser Ranging Retro-Reflector

3) S-080 Solar Wind Composition

4) S-151 Cosmic Ray Detection

5) T-029 Pilot Describing Function

The Mission Requirements document incorporates these various objectives and experiments, details them where necessary, and places them in the proper order of priority, thereby providing the level of detail necessary for mission planning. The document notes, however, that:

1) There are no Detailed Objectives, as such, which have been derived from the primary objective of "perform manned lunar landing and return". Detailed Objectives have, however, been derived from the two OMSF subordinate objectives. The mission will be flown as an operational mission in the sense that it will be performed in the most expeditious manner possible with no interference from special tests or operations which are not necessary for the performance of this basic objective. The manner in which the detailed performance of this objective is met will be contained in the Mission Report.

2) Experiments are detailed and prioritied in the requirements document only when they are such as to require some action by the crew or otherwise impact the timeline. Thus, the Cosmic Ray Detection experiment, S-151, a passive experiment limited to post mission analysis of the flight helmets, is only mentioned and does not appear in the priority list or as a detailed objective. Similarly, the Pilot Describing Function experiment, T-029, only requires certain portions of voice and telemetry data recordings and does not appear in the list of objectives and experiments.

The Detailed Objectives for the first lunar landing mission will be objectives which concern equipment and crew operations only during the lunar surface phase of the mission. The capability to successfully complete other mission phases will have been demonstrated on prior missions.

2.3.2 Mission Objectives and Experiments

The following summary of lunar EVA objectives and experiments is in order of priority, with the objective or experiment of highest priority listed first. The order of priority is based upon the relative importance to the Apollo spacecraft development program or to the advancement of lunar science. The Detailed Objectives and Experiments are included in the Appendix, Section 5.2.

The objectives "Television Coverage" and "Photographic Coverage" will be performed in conjunction with several of the other objectives or experiments. The associated operations will take place at various points in the timeline. Hence, these two objectives cannot be assigned any specific priority in the list below and are therefore included at the end.

Priority	Objectives and Experiments	
1	A	Contingency Sample Collection
2	B	Lunar Surface EVA Operations
3	C	EMU Lunar Surface Operations
4	D	Landing Effects on LM
5	E	Lunar Surface Characteristics
6	F	Bulk Sample Collection
7	G	Landed LM Location
8	H	Lunar Environment Visibility
9	I	Assessment of Contamination by Lunar Material
10	S-031	Lunar Passive Seismology
11	S-078	Laser Ranging Retro-Reflector
12	S-080	Solar Wind Composition

13	J	Documented Sample Collection
14	K	(Included in Photographic Coverage, Change A, May 1, 1969)
-	L	Television Coverage
-	M	Photographic Coverage

SECTION 3.0

NOMINAL LUNAR EVA

3.0 NOMINAL LUNAR EVA

3.1 Timeline Description and Rationale

3.1.1 Lunar Surface Stay

The nominal plan is for two crewmen, the Commander and the Lunar Module Pilot, to remain on the lunar surface for approximately 22 hours. During this period, the crew will accomplish postlanding and pre-ascent procedures and extravehicular activity. There will be two rest and several eat periods. A timeline for the lunar surface stay is presented in Figure 3-1.

There are several considerations which are the basis for the sequence of activity for the lunar surface stay. An early rest peiod is planned which will provide rest before the strenuous pre-EVA, EVA, and post-EVA activities and insure the work day is not prohibitively long if liftoff is required before the other planned rest period. A second rest period of four hours and forty minutes is provided after the EVA before the crucial liftoff and rendezvous sequence.

3.1.2 Extravehicular Activity

The first lunar EVA is designed to maximize the return of scientific and operational data. However, the timeline permits rest periods and a gradual increase in task complexity with simple tasks initially for crew acclimation and PLSS-EMU data analysis.

There will be two major areas of evaluation during the lunar surface EVA. The first concern is with comprehensive crew familiarization and evaluation of EVA capability and the lunar environment. The investigation will be a methodical approach which will enhance the accomplishment of this EVA as well as demonstrate astronaut and equipment capability for future lunar surface exploration. The second area is the collection of operational and scientific data. The analysis of this data will assist in the update of equipment designs as well as increase our general understanding of the lunar surface.

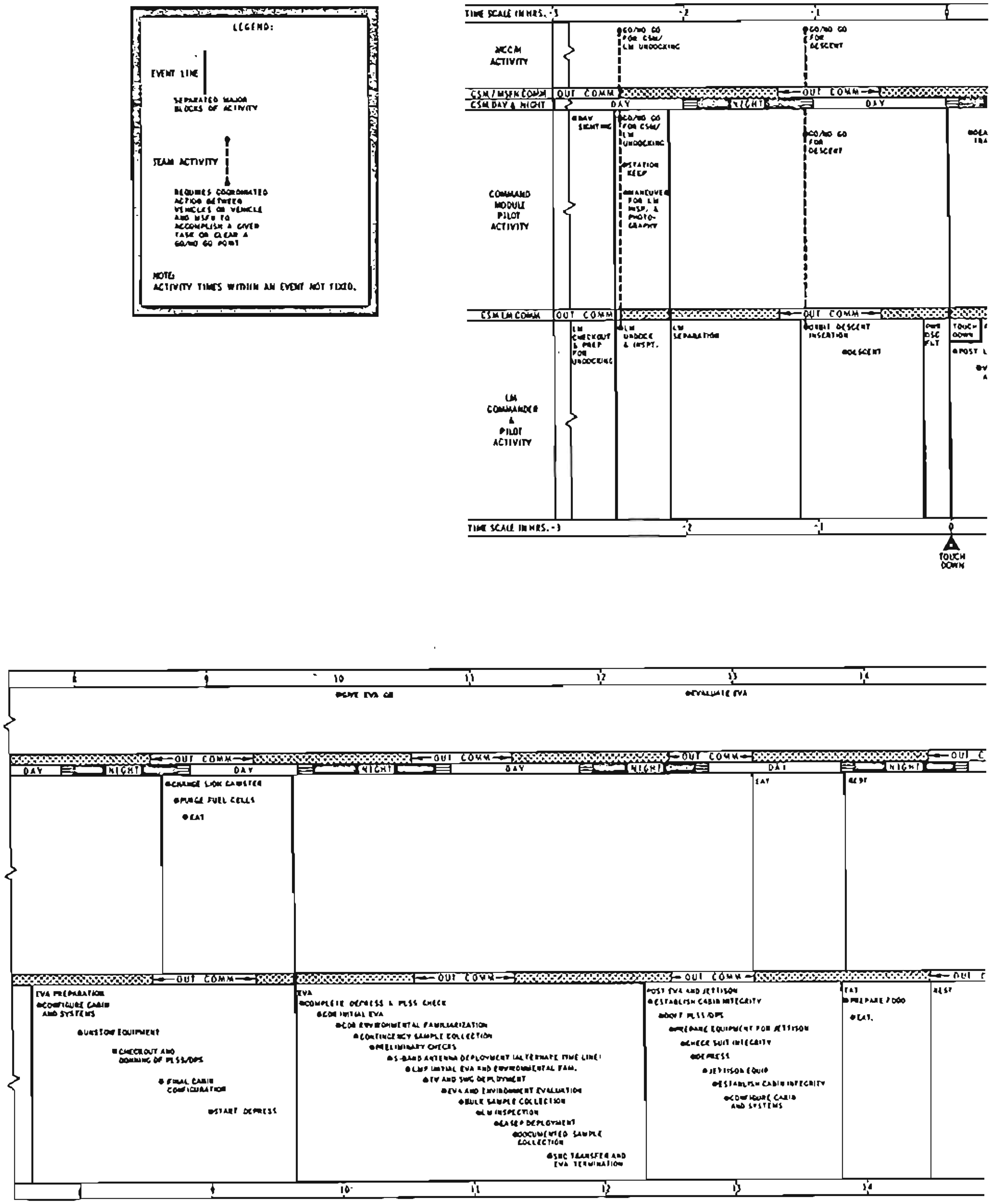
The first few minutes of the EVA, the Lunar Module Pilot (LMP) will remain inside the LM ascent stage to monitor the Commander's (CDR) surface activity and the LM systems in the depressurized state. The CDR will descend to the lunar surface to conduct several preliminary tasks. He will determine his ability to operate in the lunar environment, collect a contingency lunar sample and take still color photographs (with an electric 70mm camera) as he checks the LM and the lunar surface condition which affect the accomplishment of the EVA tasks. In addition to the TV coverage and still photographs, the LMP can visually observe and obtain sequence camera (data acquistiion) coverage to supplement the documentation of the CDR activity.

With only one crewman on the surface during the first few minutes of the EVA, a more effective PLSS telemetry data analysis can be conducted. The real time use rate for the PLSS consumables will be compared with the predicted rate to determine the PLSS capability for EVA continuation.

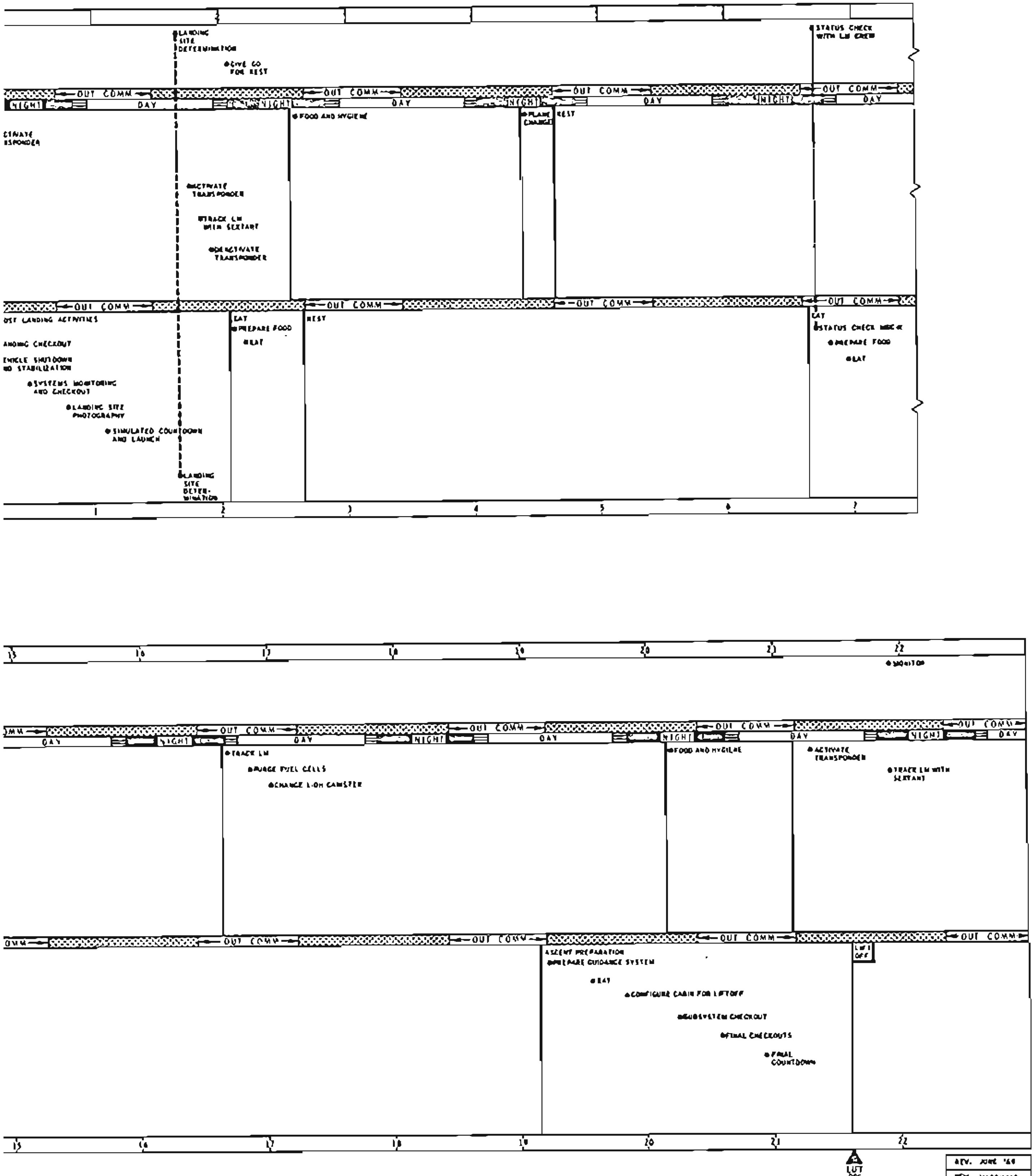
After the CDR accomplishes the preliminary EVA tasks, the LMP will descend to the surface and spend a few minutes in the familiarization and evaluation of his capability or limitations to conduct further operations in the lunar environment. After this short period of time he will deploy the Solar Wind Composition (SWC) experiment. The CDR, after photographing the LMP's egress and descent to the surface, will remove the TV camera and tripod from the descent for stage modularized equipment stowage assembly (MESA) and move them to a position for optimum coverage of the subsequent surface EVA operations. Then, while the CDR collects a bulk sample of lunar surface material, the LMP will continue to become more familiar with his ability to operate in the lunar environment as he conducts the EVA and Environment Evaluation. The LMP begins the LM inspection and is joined by the CDR after the bulk sample has been collected. When the crewmen reach the scientific equipment (SEQ) bay in Quad II, the LMP removes the Early Apollo Scientific Experiments Package (EASEP) as the CDR completes the LM inspection and photographically documents the LMP's activity. After they deploy the EASEP, the crew will select, describe, photograph, and collect samples until they terminate the EVA.

In summary, there is a general increase in task complexity for both crewmen. The conservative timeline permits the crew to follow a slow, methodical approach in accomplishing each task. Additionally, the frequent rest periods within

Figure 3-1


LEGEND:
EVENT LINE
SEPARATED MAJOR BLOCKS OF ACTIVITY
TEAM ACTIVITY
REQUIRES COORDINATED ACTION BETWEEN VEHICLES OR VEHICLE AND MSFN TO ACCOMPLISH A GIVEN TASK OR CLEAR A GO/NO GO POINT
NOTE:
ACTIVITY TIMES WITHIN AN EVENT NOT FIXED.
TIME SCALE IN HRS.
GO/NO GO FOR CSM/LM UNDOCKING
GO/NO GO FOR DESCENT
CSM/MSFN COMM
OUT COMM
CSM DAY & NIGHT
DAY
NIGHT
COMMAND MODULE PILOT ACTIVITY
STATION KEEP
CSM-LM COMM
LM CHECKOUT & PREP FOR UNDOCKING
LM UNDOCK & INSPT.
LM SEPARATION
DESCENT
LM COMMANDER & PILOT ACTIVITY
TOUCH DOWN
CHANGE LIOH CANISTER
PURGE FUEL CELLS
EAT
REST
EVA PREPARATION
CONFIGURE CABIN AND SYSTEMS
UNSTOW EQUIPMENT
CHECKOUT AND DONNING OF PLSS/OPS
FINAL CABIN CONFIGURATION
START DEPRESS
EVA
COMPLETE DEPRESS & PLSS CHECK
CONTINGENCY SAMPLE COLLECTION
PRELIMINARY CHECKS
BULK SAMPLE COLLECTION
LM INSPECTION
LASER DEPLOYMENT
DOCUMENTED SAMPLE COLLECTION
POST EVA AND JETTISON
ESTABLISH CABIN INTEGRITY
CHECK SUIT INTEGRITY
DEPRESS
JETTISON EQUIP
CONFIGURE CABIN AND SYSTEMS
PREPARE FOOD

LUNAR SURFACE ACTIVITY TIMELINE FOR 22 HOUR STAY



NAME	INITIAL	ORGN	NATIONAL AERONAUTICS & SPACE ADMINISTRATION MANNED SPACECRAFT CENTER · HOUSTON TEXAS
W.R. WOOD			S-I LUNAR SURFACE ACTIVITY TIMELINE FOR 22 HR. STAY
C. HENDRICKS			BASIC JAN '69

REV. JUNE '69
REV. MARCH '69

the timeline add to this conservatism and insure that each crewman and his PLSS remain in a nominal operating condition. However, should the EVA be terminated at any point in the timeline, the maximum data return for the time spent on the surface will be assured.

3.2 Task and Data Descriptions

Although the detailed procedures describe the steps to accomplish each task, further explanation of the desired data and data collection processes is desirable.

3.2.1 Environmental Familiarization

As mentioned previously, the timeline considerations for the lunar surface extravehicular activity will permit a slow buildup of task complexity to insure thorough crew familiarization with the lunar environment yet optimize the data return. The approach with which the crewmen will proceed will permit them to adapt to the environment while determining the ease or difficulty which they can expect through out the EVA. The first crewman to egress, after determining his initial EVA capability, can advise the second crewman on what to expect and possibly suggest methods to accomplish the additional tasks. Both crewmen's experiences will be invaluable for predicting crew capability on future lunar surface explorations.

Once on the surface, the CDR will move slowly from the footpad to check his balance and determine his ability to continue with the EVA--the ability to move and to see or, specifically, to perform the surface operations within the constraints of the EMU and the lunar environment. Although a more thorough evaluation and documentation of a crewman's capabilities will occur later in the timeline, this initial familiarization will assure the CDR that he and the LMP are capable of accomplishing the assigned EVA tasks. Also, should it be necessary to unexpectedly terminate the EVA prior to further environment evaluation, this early familiarization will insure some data return on EVA capability and the lunar surface properties.

3.2.2 Preliminary Checks

For the Preliminary Checks the CDR will transfer the 70mm EL Data camera to the surface, conduct a brief LM check and a preliminary evaluation of the lunar environment. The Hasselblad camera will enable the CDR to take still color photographs to supplement the sequence (data acquisition) camera photography which the LMP will attain through the LM ascent stage window to document the surface activity.

A brief check of the LM status is a simple task which can be used to extend the CDR's environment familiarization and, at the same time, provide an important contribution to the postflight assessment of the LM landing should a full or nominal LM inspection not be accomplished later.

The preliminary evaluation of the conditions which will influence the crewmen's surface operations, such as the terrain surface features and lighting or visibility, will also enhance the CDR's environmental familiarization as well as his assessment of an astronaut's capability to accomplish EVA tasks.

From a position near the ladder the CDR will make a general inspection of the LM and surface about the LM. For the LM and surface visible to him, he will briefly examine the gear struts, footpads, and major parts of the spacecraft to assure that the LM is stable and will provide a safe operations base for the lunar stay. An inspection of the surface will provide preliminary data on the LM effect on the surface during the landing.

3.2.3 TV Coverage

The primary purpose of the TV is to provide a supplemental real time data source to assure or enhance the scientific and operational data return. It may be an aid in determining the exact LM location on the lunar surface, in evaluating the EMU and man's capabilities in the lunar environment and in documenting the sample collections. The TV will be useful in providing continuous observation for time correlation of crew activity with telemetered data, voice comments, and photographic coverage.

TV reception, without a degradation of both voice and telemetered information, may be dependent on having the LM steerable S-band antenna radiate to a 210-foot antenna, either the Goldstone (California) or the Parkes (Australia) antenna, or deploy the S-band erectable antenna on the lunar surface. (A comparison of the performance expected with the 210-foot/steerable antennas or 85-foot/erectable antennas is presented in Table 3-1 on the following page.) The erectable antenna makes it possible to receive TV transmissions with the 85-foot antenna dishes at either Goldstone, Madrid, or Canberra, which are equivalent to the 210-foot/steerable combination.

If a 210-foot antenna is not in view or the erectable antenna has not been deployed, TV coverage may be obtained by accepting the loss or degradation of voice and telemetry. The final decision for such coverage will be made in real time and based on the quality of the communications up to that point.

For the nominal mission, with a July 16 launch date, the Goldstone and/or the Parkes antennas will be in view during the EVA. The coverage provided by the 210-foot and 85-foot antennas during the lunar stay is shown in Figure 3-2.

The TV camera will have two primary positions or fields of view for coverage of the surface activity. The camera will be mounted in the descent stage Modularized Equipment Stowage Assembly (MESA) to view the crewmen's descent to the surface and the CDR's activity in the immediate ladder area. (See Figure 3-3). After the LMP's descent to the surface, the CDR removes the camera and tripod from the MESA and places the tripod with camera on the surface in an optimum position for coverage of subsequent surface activity. (See Figure 3-4).

TABLE 3-1

PERFORMANCE MARGINS FOR LM COMMUNICATIONS*

(FM Mode - High Power)

	85' MSFN STATION		210' MARS STATION	
	NOMINAL	WORST CASE	NOMINAL	WORST CASE
Erectable Antenna				
51.2 kbps Telemetry**	+ 8.8 dB	+ 6.8 dB	+16.8 dB	+14.8 dB
EVA Voice (dual)	+ 9.2	+ 7.2	+17.2	+15.2
EVA EKG & PLSS Data (dual)	+ 3.8	+ 1.8	+11.8	+ 9.8
Television (B&W)	+ 9.7	+ 7.7	+17.7	+15.7
1.6 kbps Telemetry**	+17.4	+15.4	+25.4	+23.4
EVA Voice (dual)	+ 9.2	+ 7.2	+17.2	+15.2
EVA EKG & PLSS Data (dual)	+ 3.8	+ 1.8	+11.8	+ 9.8
Television (B&W)	+ 9.7	+ 7.7	+17.7	+15.7
Steerable Antenna				
51.2 kbps Telemetry**	+ 0.7	- 1.5	+ 8.7	+ 6.5
EVA Voice (dual)	+ 1.1	- 1.1	+ 9.1	+ 6.9
EVA EKG & PLSS Data (dual)	- 4.3	- 6.5	+ 3.7	+ 1.5
Television (B&W)	+ 1.6	- 0.6	+ 9.6	+ 7.4
1.6 kbps Telemetry**	+ 9.3	+ 7.1	+17.3	+15.1
EVA Voice (dual)	+ 1.1	- 1.1	+ 9.1	+ 6.9
EVA EKG & PLSS Data (dual)	- 4.3	- 6.5	+ 3.7	+ 1.5
Television (B&W)	+ 1.6	- 0.6	+ 9.6	+ 7.4

* Based on measured LM-5 data and MSC test data on new (1969) Motorola FM demodulator. The MSC tests were conducted in the ISD Electronic Systems Test Facility (on one unit).

** For a BER of 10^{-4}.

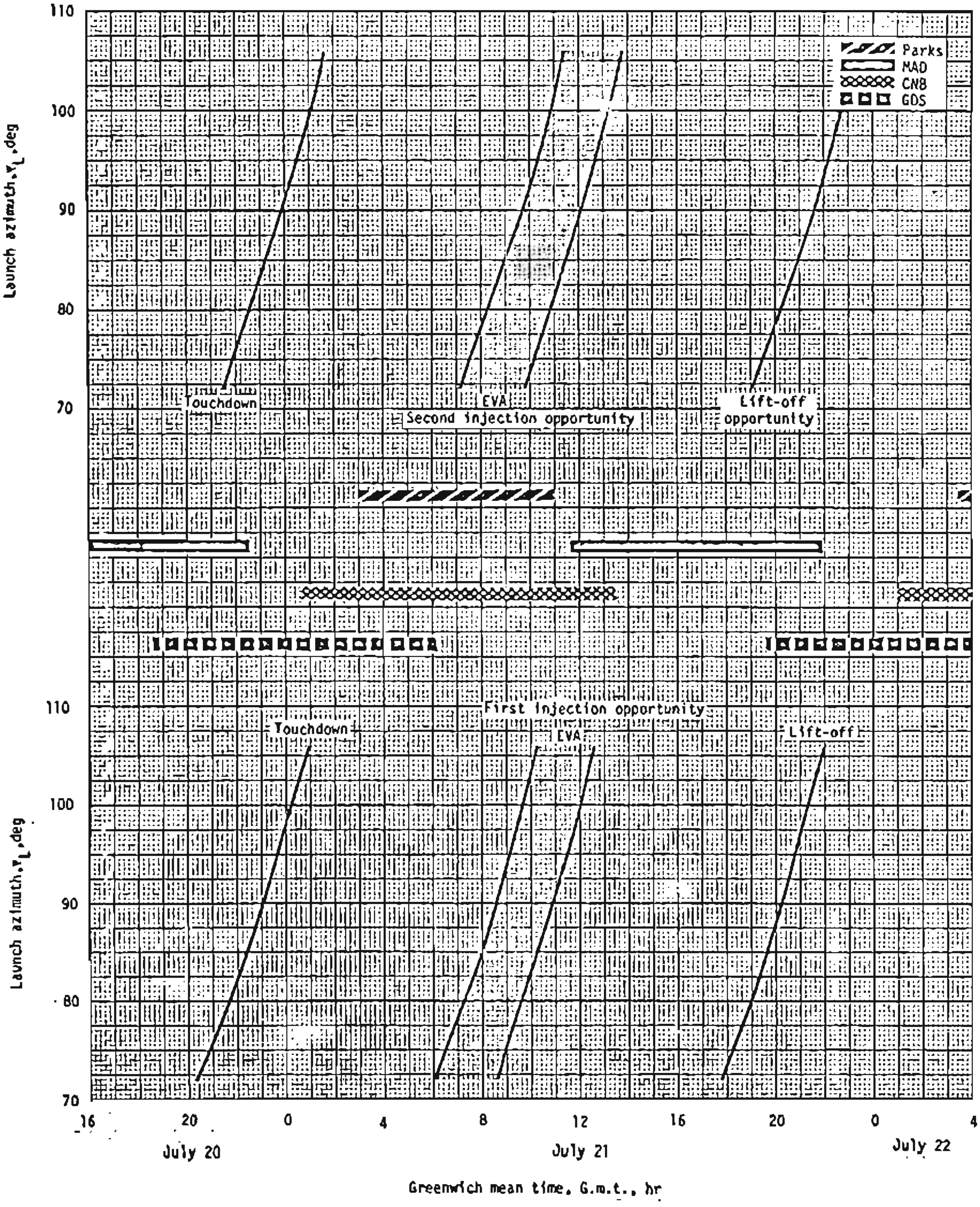


Figure 3-2. - Radar coverage during lunar stay for launch date of July 16.

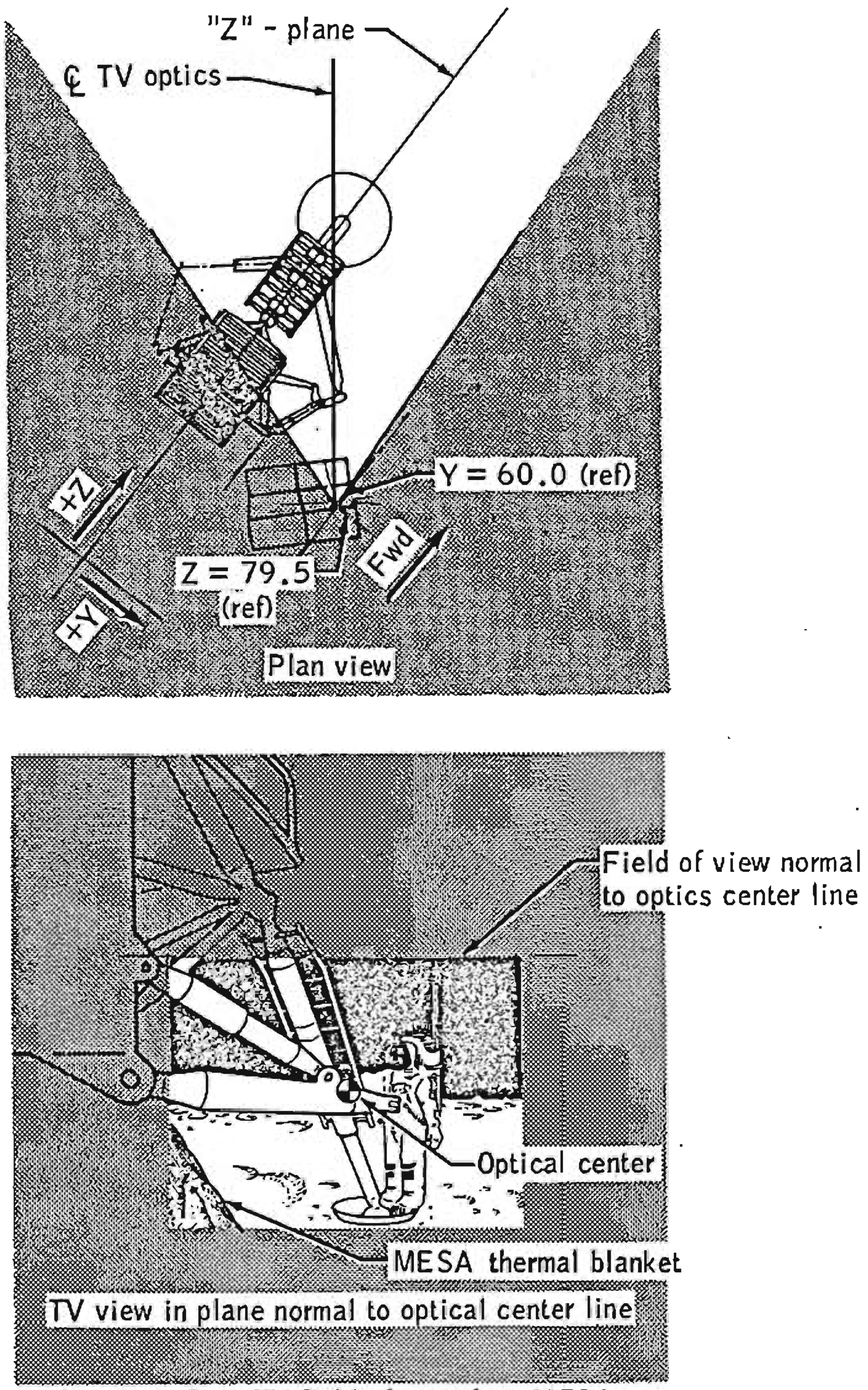


Figure 3-3. - TV field of view from MESA.

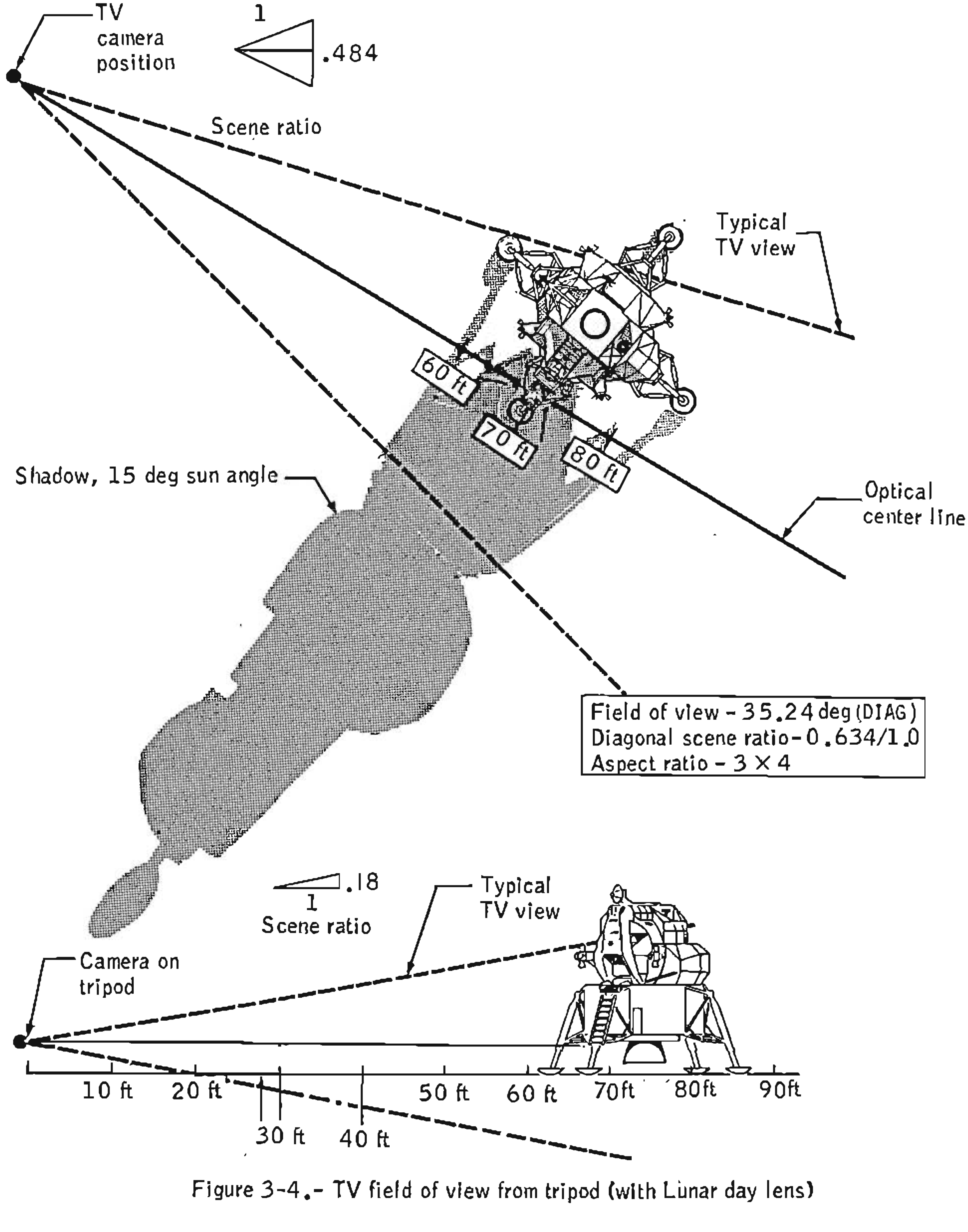


Figure 3-4.- TV field of view from tripod (with Lunar day lens)

3.2.4 S-Band Erectable Antenna Deployment (Alternate Timeline)

The S-band erectable antenna will be deployed to increase the communications capability. It's major impact to the EVA is in obtaining an equivalent communications capability that will be possible otherwise only if a 210-foot antenna is in view. This communications capability may be required for simultaneous TV, voice, and telemetered data return. (See the discussion on this subject in the previous section on TV coverage, Section 3.2.3).

The deployment of the erectable antenna is a time-consuming task—deployment time is expected to be 19 minutes. However, the TV coverage, without a degradation of voice and telemetry, gained through the use of the antenna may require it to be deployed. In this situation, although it is desirable to attain this advantage provided by the antenna and to permit the crewman inside the LM to switch to the erectable antenna earlier in the timeline, the crewman's familiarization with lunar operations before this point is considered to be insufficient to safely and effectively accomplish the deployment task.

3.2.5 Photography

Photography, still color photographs with the 70mm EL data camera, close-up stereo photographs with the Apollo Lunar Surface Close-up Camera (ALSCC), and motion pictures with the 16mm (data acquisition) camera, will be a vital part of the data collection process for the EVA. A 70mm camera, with black and white film, will be used for surface photography from the LM and will be transferred to the surface if a malfuction of the other camera occurs.

The crewmen will use the EL data camera extensively on the surface to document each major task which they accomplish. Additional photography, such as panoramas and scientific documentation, will supplement other data in the postflight analysis of the lunar environment and the astronaut's capabilities or limitations on conducting lunar surface operations.

With the ALSCC the crewmen may photograph areas of the lunar surface not disturbed during the landing or surface activity, their footprints, areas affected by the LM footpads and the scientific equipment, and other phenomena of operational and scientific interest.

The sequence camera, from the LM ascent stage window, will provide almost continuous coverage of the surface activity. The Lunar Module Pilot, who remains inside the ascent stage for the first few minutes of the EVA, will use the sequence camera to document the Commander's initial surface activities. Then, before he egresses, the LMP will position the camera for optimum surface coverage while both crewmen are on the surface. And, after the LMP ingresses, he can use the sequence camera to provide coverage of the remaining surface activity.

A complete description of the camera equipment and their operational procedures, as well as the details of the documentation provided by the three cameras, are contained in Reference 6.

3.2.6 EVA and Environment Evaluation

The primary purpose of the Environmental Familiarization period, early in the timeline, is to allow the crew sufficient time to adapt to the new environment and operating conditions. The EVA and Environment Evaluation, however, involves a detailed investigation and documentation of a crewman's capability within the constraints of the EMU, the PLSS/EMU performance under varying conditions of sunlight, shadow, crewman activity or inactivity, and the characteristics of the lunar environment which influence operations on the surface.

The preliminary familiarization will be of the most benefit in real time--to prepare the crewmen to operate during this EVA. On the other hand, the EVA and Environment Evaluation period should be of significant value for future lunar surface exploration. From the assessment of data gathered during this period, sufficient knowledge should be gained to accurately predict the capabilities and limitations of the astronaut and his equipment for future lunar surface extravehicular activity.

During the EVA and Environment Evaluation the LMP will determine, in detail, the combined effects of the EMU constraints and lunar gravity on his physical capabilities. He will compare his capabilities in this lunar environment with similar experiences during earth gravity and simulated lunar gravity exercises. He will observe how the lunar surface is affected by the actions he performs and carefully examine the terrain to determine the surface characteristics. Also, he will determine his visual perception of the surface features and his visual acuity within the constraints of the extravehicular visor assembly (EVVA).

3.2.7 Sample Collections

The nominal plan is to conduct three sample collections of lunar surface material. They are, in order of priority, the contingency, the bulk, and the documented sample collections.

The contingency sample collection is a simple task which can be accomplished within a few minutes early in the EVA timeline. This will assure the return of a small sample in a contingency situation where a crewman may remain on the surface for only a short period of time. One to two kilograms of loose material will be collected near the LM ladder and the sample bag restowed in the suit pocket to be carried into the ascent stage when the crewman ingresses.

In the bulk sample collection at least 10 kilograms of unsorted surface debris and selected rock chunks will be placed in a special container, an Apollo Lunar Sample Return Container (SRC), to provide a near vacuum environment for its return to the Lunar Receiving Laboratory (LRL). Apollo Lunar Handtools (ALHT), stowed in the MESA with the SRC, will be used to collect this large sample (30 to 60 pounds) of loose lunar material from the surface near the MESA in Quad IV of the LM. As each rock sample or scoop of loose material is collected it will be placed into a large sample bag. Placing the sealed bag, rather than the loose material directly into the SRC, also prevents contamination and possible damage to the container seals.

The documented sample collection, like that of the bulk sample collection, will involve a large mass of lunar material placed into an SRC for return to earth. However, the documented sample will differ significantly in content and in its collection process. As the name implies the documented sample collection will involve the documentation of the individual samples and the area from which they are taken. It can be classified as a very limited lunar field geology investigation.

Within the documented sample collection a core tube sample is first collected to provide an aseptic and stratified sample near the LM. At a site representative of the landing area, the crew will examine, describe, photograph, and collect rock fragments and loose surface material samples and place them individually in pre-numbered bags. The samples, in the small bags numbered one through fourteen, are placed in a large bag for transfer to and stowage in the documented sample SRC. If time permits after collecting the small bags of samples, the crew will collect two environment samples, representative of the bulk sample, and a second core tube sample. Additionally, the large sample bag will be filled, as the bulk sample bag, to return the maximum amount of surface material.

The various samples within the documented sample collection will be taken from areas near the LM out to possibly 300 feet away. Although the limiting distance from the LM for this first surface mission is 300 feet, there are several reasons for the crew to remain within 100 feet. First, since the documented sample collection will be late in the EVA, the capability of the crew and their equipment will be limited at this time. Additionally, on this first landing mission a relatively conservative approach is necessary. Also, it is unlikely that the terrain at 300 feet will be significantly different from the terrain within 100 feet of the LM.

3.2.8 Lunar Module Inspection

The purpose of the LM inspection is to visually check and photographically document the external condition of the LM after the flight to the lunar surface and the effects of the LM landing on the lunar surface. The inspection data will be used to verify the LM as a safe and effective vehicle for lunar excursions. The data will also be used to gain more knowledge of the lunar surface characteristics. In general the benefit of the inspection will serve to advance the equipment design and our understanding of the environment in which it operates.

The crewmen will methodically inspect and report the status of all external parts and surfaces of the LM which are visible to them. They will examine the lunar surface about the LM to determine the interactions of the LM footpads with the lunar soil for study of the lunar surface properties. The still color photographs with the Hasselblad and closeup cameras, will supplement their visual documentation for postflight engineering analysis and design verification. They will observe and photograph the Reaction Control System (RCS) effects on the LM, the landing gear performance, the interactions of the surface and footpads, and the Descent Propulsion System (DPS) effects on the surface as well as the general condition of all quadrants and landing struts. (Refer to Figures 3-5, 3-6, 3-7, and 3-8 for the major LM inspection points.)

3.2.9 Experiment Deployments

There are three scientific experiments which will be deployed. The Solar Wind Composition (SWC) experiment deployment, although of lowest priority, is accomplished first as it is a simple task and the results depend on the exposure time. At least an hour of exposure time is desired before it is placed in an SRC for return to earth. The other two experiments, the Passive Seismic (PSE) and Laser Ranging Retro-reflector (LR3), are deployed later but will continue to return data after the mission.

The SWC consists of a panel of very thin aluminum foil rolled and assembled into a combination handling and deployment container. It is stowed in the MESA. Once the thermal blanket is removed from around the MESA equipment it is a simple task to remove the SWC, deploy the staff and the foil "window shade", and place it in direct sunlight where the foil will be exposed to the sun's rays. The SWC is designed to entrap noble gas constituents of the solar wind, such as Helium, Neon, Argon, Krypton and Xenon. The foil is later rolled up, removed from the staff, and placed in an SRC. If it is known at the time the bulk sample SRC is packed that a documented sample will not be collected, the SWC will be placed in the bulk sample SRC. If the bulk sample SRC has been sealed before deciding not to collect the documented sample the SWC may be put into the LMP's suit pocket for transfer to the ascent stage.

At the same time the foil is recovered, the astonaut will push the staff into the lunar surface to determine, for postflight soil mechanics analysis, the depth of penetration.

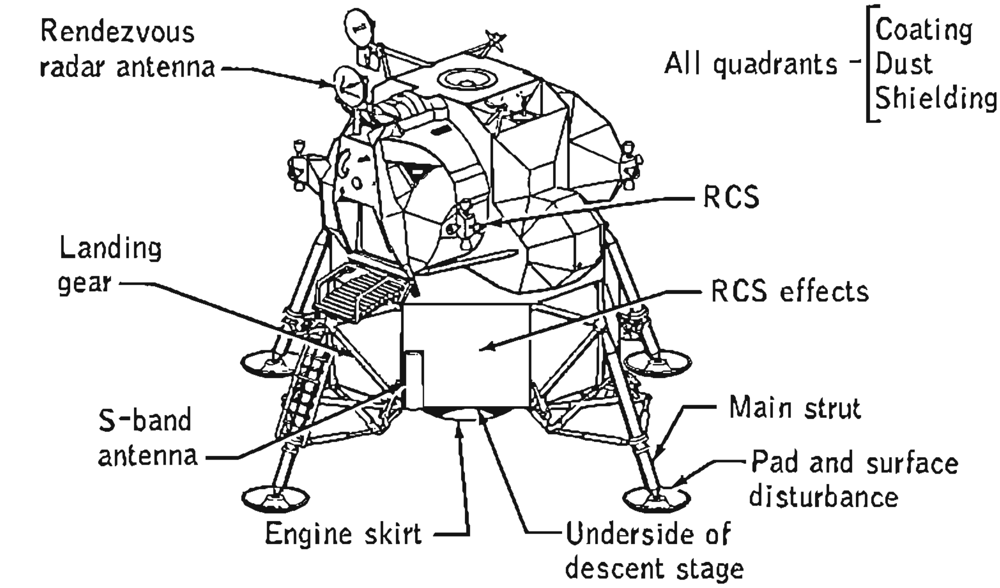


Figure 3-5. - Quad I inspection points.

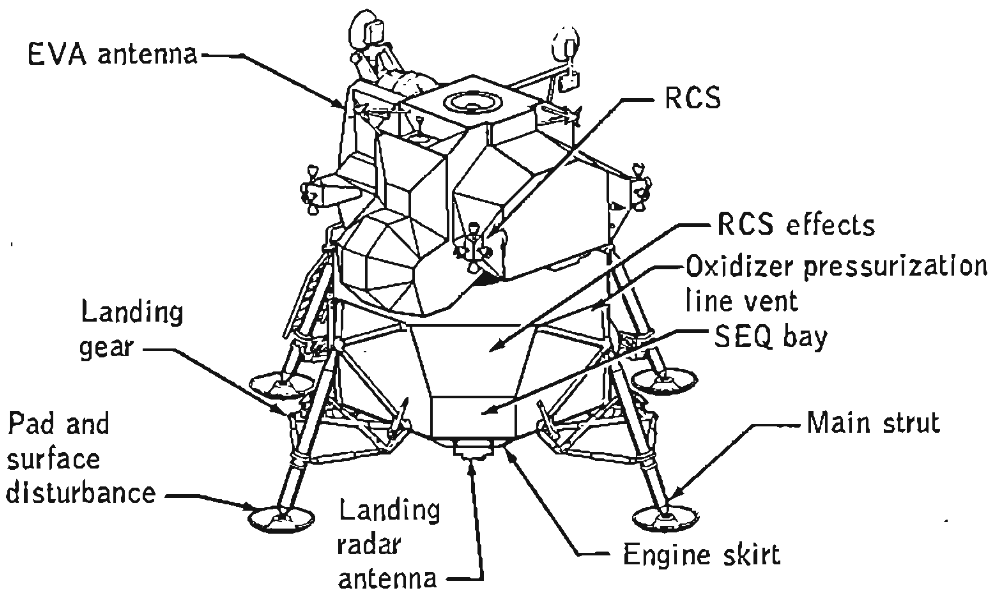


Figure 3-6. - Quad II inspection points.

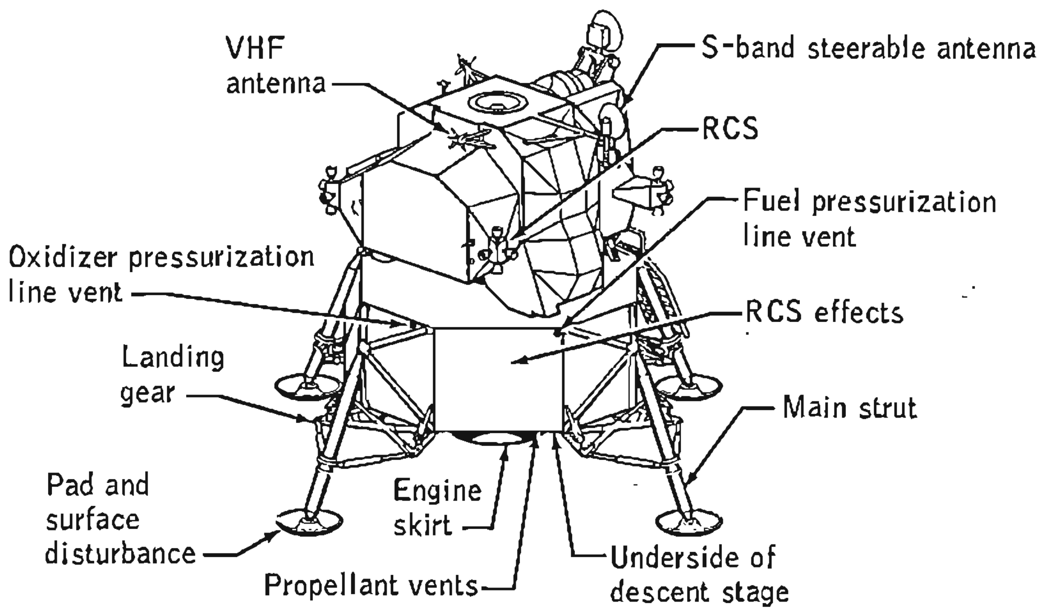


Figure 3-7. - Quad III inspection points.

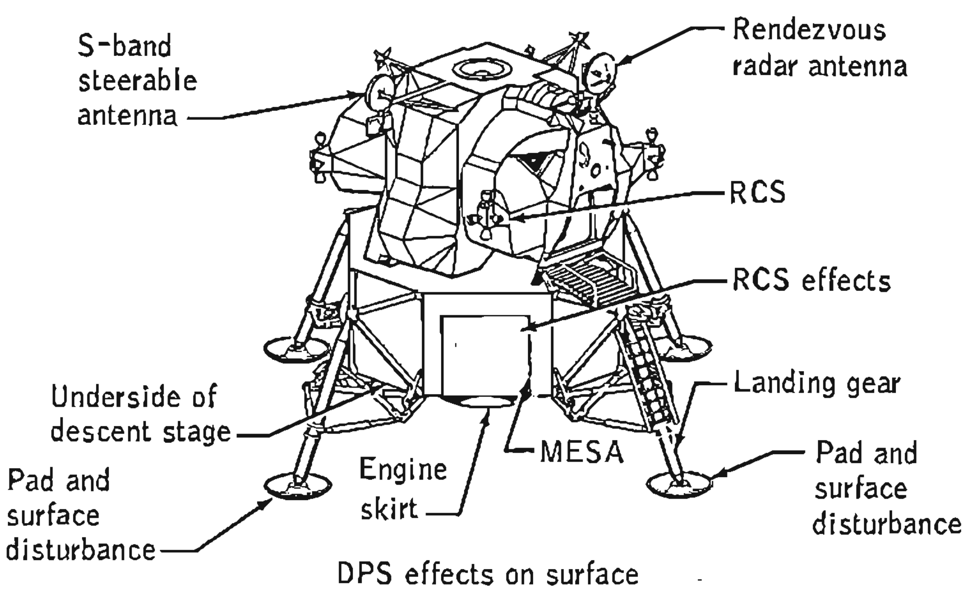


Figure 3-8. - Quad IV inspection points.

The PSE, or the PSE package (PSEP), is one of two packages of the Early Apollo Scientific Experiments Package (EASEP). It will be placed on the lunar surface to monitor lunar seismic activity and detect meteriod impacts, free oscillations of the moon, and lunar internal activity. It may also detect surface deformations and variations of external gravitational fields acting on the moon. Data from this self-contained, solar-powered experiment package should reveal the properties of the seismic events, the physical properties of the subsurface materials, and the general structure of the lunar interior.

The LR3 is also one of the two EASEP packages. The package provides a corner reflector (actually an array of 100 reflectors) for laser ranging from earth. From this experiment the nature of the earth's irregular rotation may be determined. Also, the data will help refine the lunar motions and the relative motion of the earth and moon.

The PSEP and LR3 are on separate pallets which are stowed in the Scientific Experiment (SEQ) bay of the descent stage Quad II. In the nominal deployment the LMP removes both packages and carries them to the deployment site simultaneously. The crewmen will select a level site, nominally within ± 15 degrees of the LM -Y axis and 70 to 110 feet from the LM. The selection of the site is based on a compromise between a site which minimizes the effects of the LM ascent engine during liftoff heat and contamination by dust and insulation debris (kapton) from the LM descent stage, and a convenient site near the SEQ bay.

3.2.10 Use of the Lunar Equipment Conveyor

The Lunar Equipment Conveyor (LEC) is a device which the astronauts will use during the EVA to transfer equipment to or from the ascent stage. It may also be used by the crewmen as a safety tether when moving down the ladder or as an aid in ascending to the ascent stage.

The LEC is a thin 60 foot continuous loop of one inch wide strap, which loops through a support point in the ascent stage and back to the crewman on the surface. The end of the loop is closed by two hooks, attached together, which provide a means of securing equipment to the LEC for transfer. The crewman on the surface can effect a transfer to the ascent stage by pulling the top strap which causes equipment hooked to the lower strap to move into the ascent stage.

Although the transfer of equipment with the LEC is simple in principle, the actual transfer operation can require a significant amount of time and effort - more if caution is not observed in keeping the straps untangled or if the proper operational procedures are not used. Because of the time involved (up to five minutes plus a rest period), the number of equipment transfers is kept to a minimum. In the nominal timeline three transfers are planned, one to transfer the Hasselblad camera to the surface and one transfer for each of the two SRC's.

3.2.11 EVA Termination

For EVA termination there are several advantages gained by one crewman ingressing before an SRC is transferred. Although it is possible to transfer an SRC into the ascent stage before the first crewman ingresses, the crewman inside will provide some assistance during the transfer. Additionally, he will remove the SRC and place it where it does not interfere with ingress. The first crewman to ingress will also make a LM system check, change the sequence camera film magazine, and reposition the camera to cover the SRC transfer and other crewman's ladder ascent.

As each man begins his EVA termination he will clean the EMU. Although the crew will have a very limited capability to remove lunar material from their EMU's, they will attempt to brush off any dust or particles from the portions of the suit which they can reach and from the boots on the footpad and ladder.

In the EVA termination there are two tasks which will require some increased effort. The first is the ascent from the footpad to the lowest ladder rung. In the unstroked position the vertical distance from the top of the footpad to the lowest ladder rung is 31 inches. In a nominal level landing this distance will be decreased only about four inches. Thus, unless the strut is stroked significantly the crewmen are required to spring up using their legs and arms to best advantage to reach the bottom rung of the ladder from the footpad.

The second task will be the ingress or the crewmen's movement through the hatch opening to a standing position inside the LM. The hatch opening and the space inside the LM are small. Therefore, the crewmen must move slowly to prevent possible damage to their EMU's or to the exposed LM equipment.

Before the crew closes the hatch and begins the cabin repressurization, they will jettison the equipment they no longer need. The items to jettison are the used ECS cannister and bracket, OPS brackets (adapters), and 3 armrests. Numerous pieces of loose equipment will be left on the lunar surface after they have been deployed or used during the EVA. A complete list of this equipment except for a few pip-pins, brackets, and other small pieces of the larger pieces of equipment listed, is presented as Table 3-2 on the following page.

TABLE 3-2

Loose Equipment Left on Lunar Surface

<u>During EVA</u>

- TV Equipment
  - camera
  - tripod
  - handle/cable assembly
  - MESA bracket
- Solar Wind Composition staff
- Apollo Lunar Handtools -
  - scoop
  - tongs
  - extension handle
  - hammer
  - gnomon
- Equipment stowed in sample return containers (outbound) -
  - extra York mesh packing material
  - SWC bag (extra)
  - spring scale
  - unused small sample bags
  - two core tube bits
  - two SRC seal protectors
  - environmental sample containers 0 rings and small rods in lids
  -
- Apollo Lunar Surface Close-up Camera (film cassette returned)
- EL Data Camera (magazine returned)

<u>EVA termination</u>

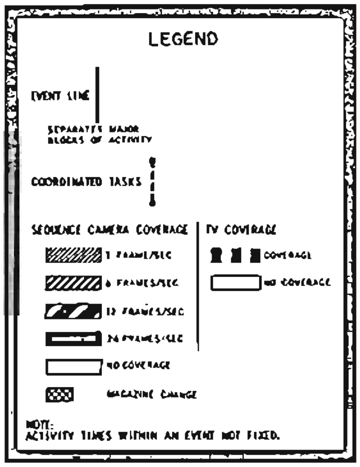
- Lunar Equipment Conveyor
- ECS cannister and bracket
- OPS brackets
- Three armrests
- Bag of used urine bags

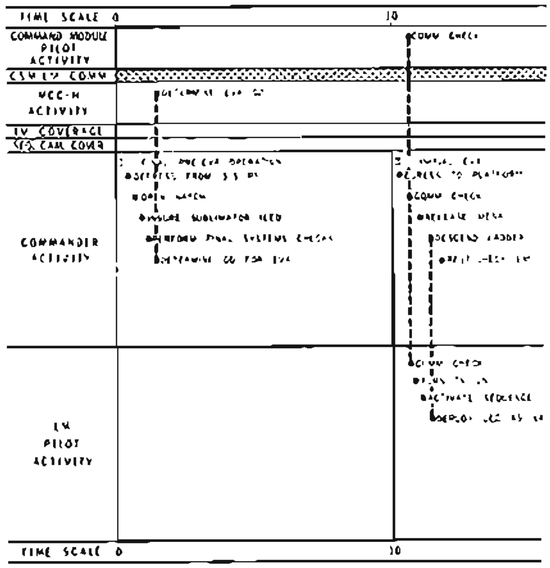
<u>Post-EVA equipment jettison</u>

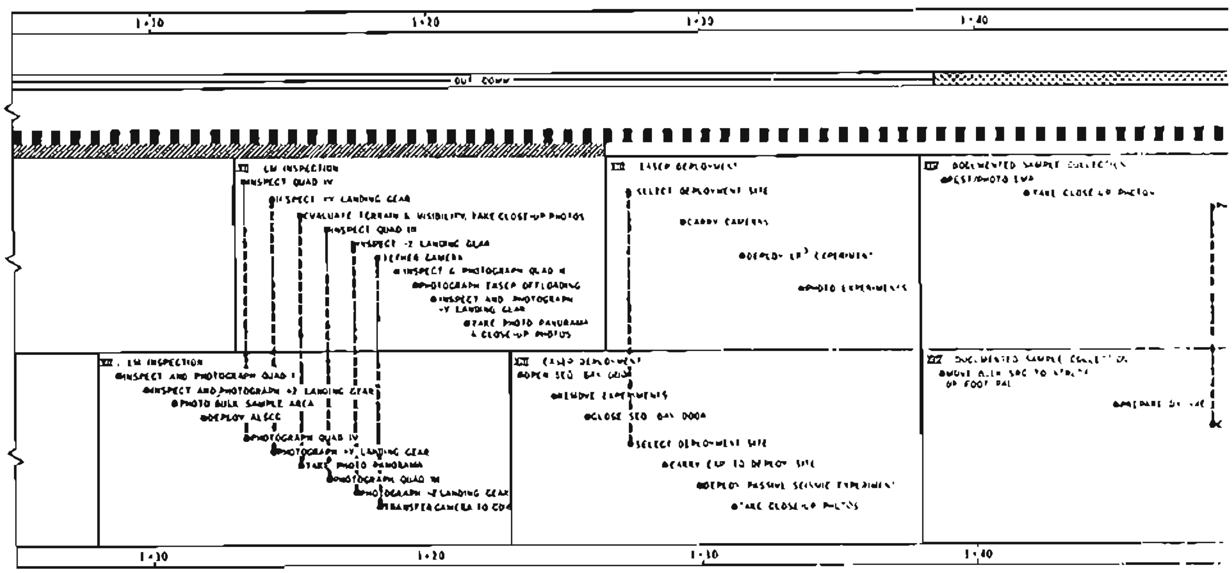
- Two Portable Life Support Systems
- Left Hand Side Stowage Compartment (with equipment inside)
- One armrest

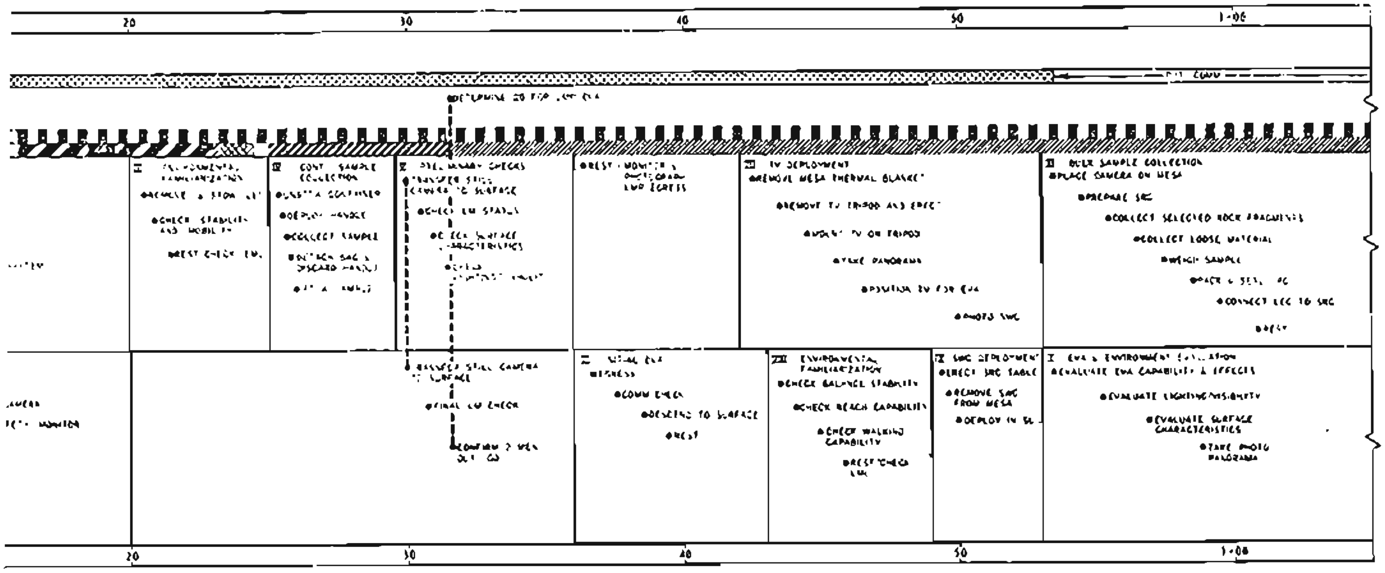
3.3 SUMMARY TIMELINE

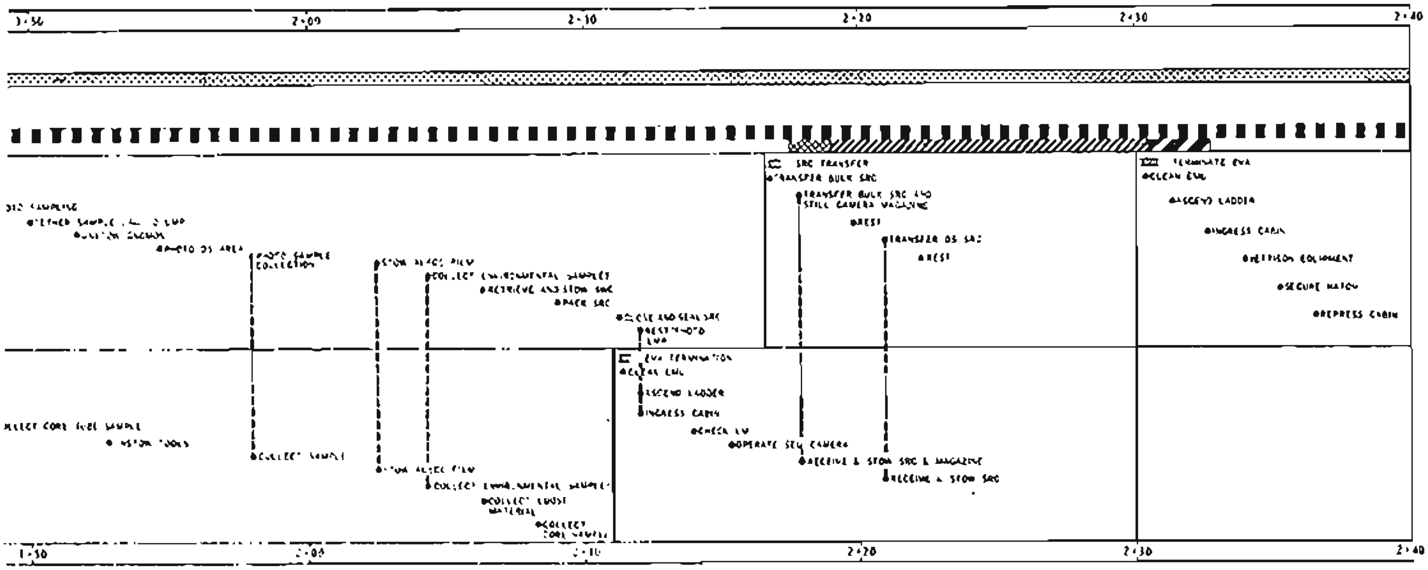
NOMINAL LUNAR SURFACE EVA











REV. JUNE 69
REV. MAY 69
REV. APRIL '69
REV. MARCH 69
REV. FEB '69
REV. JAN 69

NAME	INITIAL	ORIGIN	NATIONAL AERONAUTICS & SPACE ADMINISTRATION MANNED SPACECRAFT CENTER HOUSTON, TEXAS
W. H. WOOD		4500	3.3 SUMMARY TIMELINE NOMINAL LUNAR SURFACE EVA
C. HENDRICKS			MSC OCT. 1968

3.4 NOMINAL TIMELINE
LUNAR SURFACE EVA

31

0+00

CDR / LMP:
DEPRESS CABIN FROM 3.5 PSI
OPEN HATCH
INSURE SUBLIMATOR ICED
PERFORM FINAL SYSTEMS CHECKS
CONFIRM "GO" FOR EVA

SEQUENCE CAMERA DOCUMENTATION-
SEE LEGEND ON SUMMARY TIMELINE

NOTE: DETAILED PROCEDURES
ARE PRESENTED IN "FINAL
EVA PROCEDURES APOLLO 11"
SUBMITTED BY EVA BRANCH, FCSD

0+10

CDR:
MOVE THROUGH HATCH
CHECK INGRESS PROCEDURE

LMP:
ASSIST CDR
PLAY OUT LEC

CDR / LMP:
PERFORM COMM CHECK

CDR:
MOVE TO POSITION
AND RELEASE MESA

LMP:
MONITOR CDR ACTIVITY
PLAY OUT LEC

LMP:
TURN TV ON
START SEQUENCE CAMERA (SC)

CDR:
DESCEND TO FOOTPAD
CHECK ASCENT PROCEDURES

LMP:
PLAY OUT LEC

CDR:
STEP TO SURFACE
REST/CHECK EMU

LMP:
CHANGE SC FR TO 24/SEC

LMP:
CHANGE SC FR TO 12/SEC

0+20

CDR:
STOW LEC

LMP:
VISUALLY MONITOR CDR ACTIVITY
PROVIDE CHECKLIST ASSISTANCE

CDR:
CHECK AND DISCUSS
BALANCE/STABILITY

LMP:
CHANGE SC FILM MAG
CHANGE FR TO 6/SEC

NOMINAL TIMELINE

CDR

- REST/CHECK EMU
- UNSTOW CSC AND DEPLOY HANDLE
- EXTEND BAG COLLECT SAMPLE
- DETACH BAG AND DISCARD HANDLE
- STOW SAMPLE
- 0+30 — TRANSFER STILL CAMERA TO SURFACE
- TETHER CAMERA
- REST/CHECK EMU
- CHECK AND REPORT LM STATUS
- CHECK TERRAIN AND LIGHTING

LMP

- CHECK LM AND EMU
- START SC
- MONITOR CDR ACTIVITY
- PREPARE FOR CAMERA TRANSFER ASSIST CDR
- CHANGE SC FR TO 1/SEC
- PERFORM FINAL LM AND EMU CHECK CONFIRM "GO" FOR EVA PLACE SPARE CAMERA ON LM FLOOR
- REORIENT SC

CDR

- MONITOR AND PHOTO EGRESS
- 0+40 — MONITOR AND PHOTO LMP
- PREPARE MESA FOR TV DEPLOYMENT
- REMOVE TRIPOD
- CHANGE FROM WA TO LD LENS
- REMOVE TV CABLE
- REMOVE CAMERA CARRY TV TO DEPLOY SITE

LMP

- MOVE THRU HATCH CHECK INGRESS PROCEDURE
- PERFORM COMM CHECK
- DESCEND TO PAD CHECK ASCENT PROCEDURE
- STEP TO SURFACE REST/CHECK EMU
- CHECK BALANCE/STABILITY REACH CAPABILITY
- DETERMINE WALKING CAPABILITY

32

MISSION	EDITION	DATE	MISSION TIME	DAY/REV	PAGE
APOLLO 11	FINAL	JUNE 27. 1969	112+54 - 113+18	5/20	2 of 7

NOMINAL TIMELINE

0+50 — 1+00

CDR

- CARRY TV TO DEPLOY SITE
- TAKE FAST-SCAN PANORAMA OR SEVERAL POINTS OF INTEREST
- PLACE TV FOR SUB. EVA
- MOVE NEAR LMP REST/CHECK EMU
- PHOTO SWC
- PLACE CAMERA ON MESA
- PREPARE MESA FOR BULK SAMPLE COLLECTION
- PREPARE ALHT AND SRC
- COLLECT ROCKS AND LOOSE MATERIAL

LMP

- REST/CHECK EMU PULL TV CABLE FROM MESA
- ERECT SRC TABLE
- REMOVE SWC FROM MESA-DEPLOY IN SUNLIGHT
- EVALUATE AND REPORT EVA CAPABILITY AND EFFECTS ON SURFACE (TETHER CAMERA WHEN REQUIRED)
- EVALUATE AND REPORT LIGHTING/VISIBILITY

33

1+10

CDR

- REST/CHECK EMU
- PACK SRC
- CLOSE AND SEAL SRC CONNECT LEC

LMP

- AND TERRAIN IN SUNLIGHT
- EVALUATE AND REPORT LIGHTING/VISIBILITY AND TERRAIN AT SHADOW EDGE
- TAKE PHOTO PANORAMA
- EVALUATE AND REPORT LIGHTING/VISIBILITY AND TERRAIN IN SHADOW
- REPORT STATUS AND PHOTO QUAD I
- REPORT STATUS AND PHOTO +Z GEAR PHOTO BULK SAMPLE AREA

NOMINAL TIMELINE

CDR

- CARRY ALSCC
- REPORT STATUS QUAD IV
- REPORT STATUS +Y GEAR
- EVALUATE TERRAIN/VISIBILITY
- TAKE CLOSE-UP PHOTOS
- REPORT STATUS QUAD III
- REPORT STATUS -Z GEAR
- TETHER STILL CAMERA
- REPORT STATUS AND PHOTO QUAD II
- PHOTO EASEP OFF LOAD

LMP

- REMOVE ALSCC FROM MESA AND DEPLOY
- PHOTO QUAD IV
- PHOTO +Y GEAR
- TAKE PHOTO PANORAMA
- PHOTO QUAD III
- PHOTO -Z GEAR
- TRANSFER CAMERA TO CDR
- OPEN SEQ BAY DOOR

1+20

CDR

- REPORT STATUS AND PHOTO -Y GEAR
- TAKE PHOTO PANORAMA
- PHOTO EASEP OFFLOAD
- TAKE CLOSE-UP PHOTOS
- REST/SELECT DEPLOY SITE
- CARRY CAMERAS TO DEPLOY SITE
- REPORT POSITION FROM LM
- DEPLOY LR^3
- PHOTO LR^3
- MOVE TO PSE

LMP

- REMOVE PACKAGE 1 (PSE)
- REMOVE PACKAGE 2 (LR^3)
- CLOSE SEQ BAY DOOR
- CARRY EASEP PACKAGES TO DEPLOY SITE
- REST/CHECK EMU
- DEPLOY PSE
- TAKE CLOSE-UP PHOTOS

1+30

MISSION	EDITION	DATE	MISSION TIME	DAY/REV	PAGE
APOLLO 11	FINAL	JUNE 13, 1969	113+42 - 114+06	5/20	4 of 7

NOMINAL TIMELINE

CDR

PHOTO PSE

MOVE TO QUAD IV

REST/PHOTO LMP
TAKE CLOSE-UP PHOTOS

PHOTO SAMPLING

TETHER SAMPLE BAG TO LMP

UNSTOW GNOMON

SELECT DS AREA
MOVE TO DS AREA

PHOTO DS AREA

LMP

MOVE TO MESA
REST/CHECK EMU

MOVE BULK SRC TO
STRUTS OR FOOTPAD

PREPARE DS SRC
AND SAMPLING
EQUIPMENT

COLLECT
CORE
TUBE
SAMPLE

1+40

CDR

PHOTO SAMPLES
AND SAMPLE AREA
ASSIST LMP

LMP

DESCRIBE SAMPLES
AND SAMPLE AREA
COLLECT SAMPLES

1+50

2+00

MISSION	EDITION	DATE	MISSION TIME	DAY/REV	PAGE
APOLLO 11	FINAL	JUNE 27, 1969	114+06 - 114+30	5/20	4 of 7

NOMINAL TIMELINE

2+00

CDR	LMP
STOW ALSCC FILM	REMOVE ALSCC FILM STOW IN CSC POCKET
MOVE TO MESA PLACE SAMPLE BAG ON SCALE	MOVE TO MESA PLACE SCOOP BY MESA
HOLD CONTAINER SEAL AND STOW	OPEN LARGE ENVIR. SAMPLE CONTAINER. COLLECT LOOSE MATERIAL
HOLD CONTAINER SEAL AND STOW	OPEN SMALL CONTAINER COLLECT ROCK SAMPLE
RETRIEVE SWC PUSH STAFF INTO SURFACE. ASSESS FORCE. PHOTO	SCOOP LOOSE MATERIAL INTO SAMPLE BAG
PLACE SWC IN BAG	HOLD SWC BAG
PACK SRC	IF TIME AVAILABLE COLLECT CORE SAMPLE
CLOSE AND SEAL SRC	MOVE TO LADDER CLEAN EMU

36

2+10

CDR	LMP
REST/PHOTO LMP	ASCEND TO PLATFORM
	INGRESS
REMOVE CAMERA MAGAZINE AND CONNECT TO LEC	CHECK LM AND EMU
TRANSFER BULK SAMPLE SRC AND CAMERA MAG.	CHANGE SC FILM REORIENT CAMERA CHANGE FR TO 6/SEC
	ASSIST CDR, IF REQUIRED
REST/CHECK EMU	DISCONNECT AND STOW SRC AND CAMERA MAG.

2+20

NOMINAL TIMELINE

37

2+30

CDR

- LOWER LEC ATTACH TO DS SRC
- TRANSFER DS SRC
- REST/CHECK EMU
- CLEAN EMU
- ASCEND TO PLATFORM
- DISCARD LEC
- INGRESS

LMP

- ASSIST CDR, IF REQUIRED
- DISCONNECT AND STOW SRC
- CHANGE SC FR TO 12/SEC MONITOR CDR ASCENT
- DISCONNECT LEC AND PASS TO CDR
- ASSIST CDR

2+40

CDR

- JETTISON EQUIPMENT CLOSE HATCH
- CABIN REPRESS

LMP

- JETTISON EQUIPMENT CLOSE HATCH
- STOP SC
- CABIN REPRESS

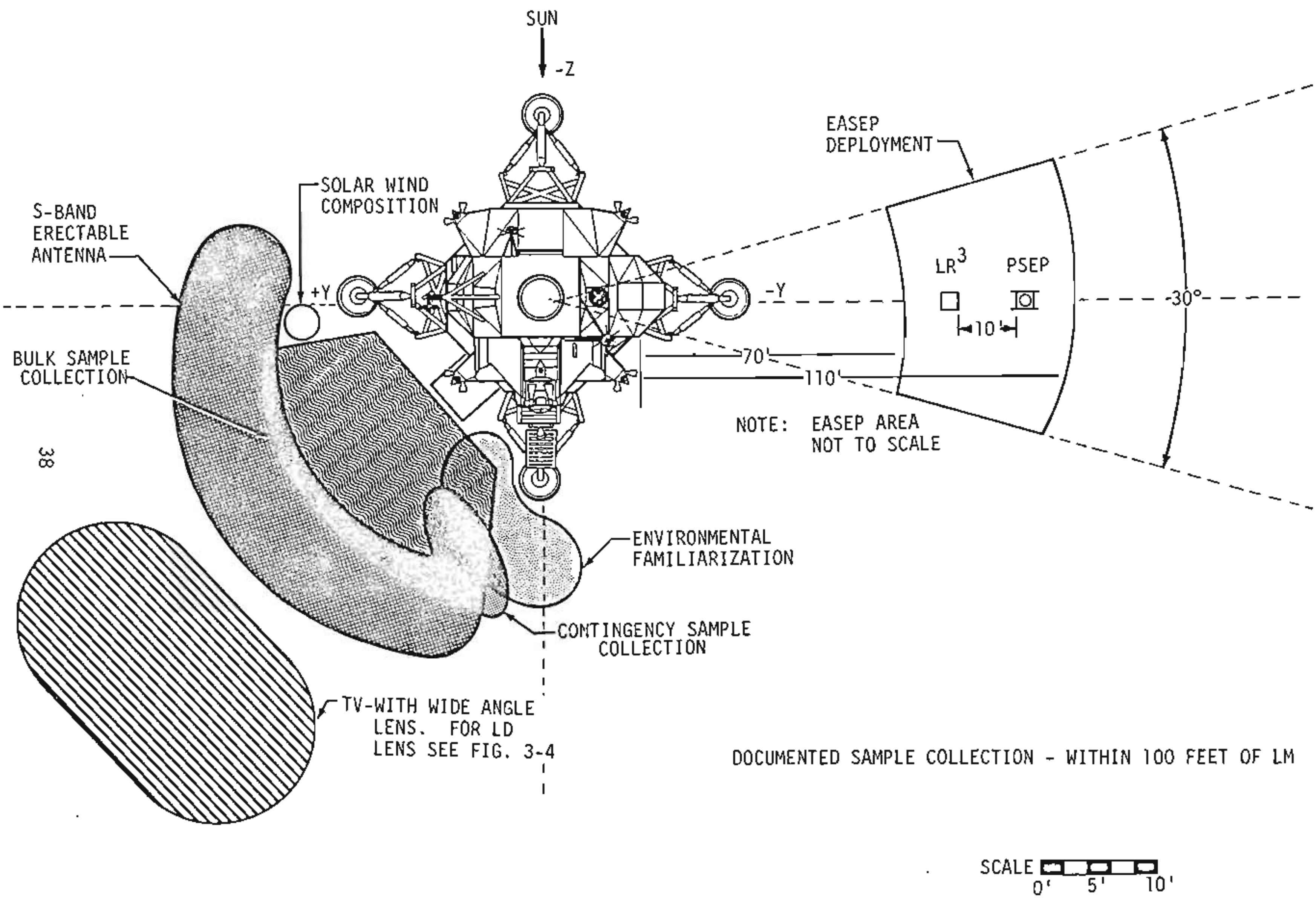


FIGURE 3-9. - PROBABLE AREAS FOR LUNAR SURFACE ACTIVITY

3.5 Detailed Procedures

3.5.1 Nominal Activities Sequence

* Nominally, the Apollo Lunar Surface Close-up Camera (ALSCC) will be deployed during the LM inspection.

3.5.2 Procedures

CDR	LMP

I. FINAL PRE-EVA OPERATIONS

NOTE: For the detailed procedures of this section, refer to the "Final EVA Procedures Apollo 11", which is submitted by the EVA Branch, FCSD

Depressurize cabin from 3.5 psi

Open hatch

Insure sublimator iced

Perform final systems checks

Confirm "go" for EVA

II. CDR INITIAL EVA

CDR	LMP
Move through hatch (with LEC tethered) Check ingress procedure	Assist CDR

Perform communications check with MSFN - Compare level, clarity and relay capability with that experienced inside the LM.
NOTE: Further mention of communications checks will be made only when communication conditions change, however, they will be conducted as required for system or crewmen monitoring.

CDR	LMP
Move to position on ladder to release MESA	Play out LEC and use as safety tether

CDR	LMP
Release MESA(If MESA does not deploy, pull manual deployment lanyard located on left side of MESA)	Turn TV on and verify TV reception
	Start sequence camera. Check orientation and frame rate at 12 frames/sec
NOTE: If the MESA will not deploy after pulling the manual deployment lanyard, the following EVA tasks cannot be accomplished: 1) TV Deployment (no TV coverage) 2) SWC Deployment 3) Bulk Sample Collection 4) Documented Sample Collection 5) SRC Transfer 6) Close-up Photography	
Descend ladder to footpad. Check pad-to-ladder ascent procedures	Play out LEC
	Change sequence camera (SC) frame rate (FR) to 24/sec
Step to surface	
Rest beside ladder/check EMU. Check RCU. Report O2 and suit pressure	Change SC FR to 12/sec. Check LM and EMU. Check RCU and report O2 and suit pressure
Assess egress/ingress capability	

III. CDR ENVIRONMENTAL FAMILIARIZATION

CDR	LMP
Detach and temporarily stow LEC on gear strut or ladder	Visually monitor CDR activity. Provide checklist assistance
In the vicinity of the ladder, check individual stability and perform preliminary mobility evaluation	
Check and report balance/stability: a. Effect of CG shift - lean forward, backward, and to each side b. Downward reach c. Arm motion effects	

CDR	LMP
Evaluate and report walking capability: a. Balance b. Best pace c. Boot penetration d. Traction e. Soil scattering (cohesion) f. Soil adhesion g. General comments	Change SC film magazine when necessary. Change FR to 6/sec
Rest/check EMU. Check RCU. Report O2 and suit pressure. Report physical comfort. Assess EVA capability.	Check LM and EMU. Check RCU Report O2 and suit pressure

IV. CONTINGENCY SAMPLE COLLECTION

CDR	LMP
Remain within a few feet of ladder Remove the CSC from suit pocket Deploy the CSC handle and pull strap at base of bag to open Collect sample (in undisturbed area) Pull locking pin on handle release lever Press release lever and separate handle from lip/bag assembly Discard handle under or away from LM Detach bag from lip assembly Discard lip assembly under or away from LM Seal sample bag Restow and secure bag in suit pocket	Start SC. Check FR at 6/sec Visually monitor CDR activity Reorient SC if necessary

CDR	LMP
V. PRELIMINARY CHECKS	
Transfer Hasselblad EL Data camera (with color film and 60mm lens) to surface:	
a. Remove LEC from temporary stowage location	Prepare to transfer the Electric Hasselblad camera to surface
b. Walk out +Z with LEC	Play out LEC. Remove LEC stowage bag and stow in LHSSC
c. Transfer camera to surface by pulling on lower strap of LEC	Assist CDR, if necessary
d. Detach camera from LEC and tether to suit. Mount camera on RCU bracket when desired	Change sequence camera FR to 1/sec
NOTE: Only the one Hasselblad camera is transferred to the surface. If a failure occurs, manual film advancemand and a fuse change are the only actions possible to correct the malfunction. If malfunction is not corrected, the 70mm Hasselblad, with black and white film and 80mm lens, can be transferred.	
e. Place LEC back at stowage location	
Check and report LM status. From immediate vicinity of the ladder, check and report:	Reorient camera to view CDR activity.
a. Stability of LM (all pads contacting surface, terrain slope, boulders, craters)	(The LMP prepares to egress)

CDR	LMP
b. Gear status (take two photos, one each of +Y and -Y, and one of +Z pad/surface) (1) Contact (2) Penetration, slip, burial (3) Stroke (4) Soil adhesion	Perform final LM and EMU check. Confirm "GO" for two-man EVA Place spare Hasselblad camera on floor at left side of +Z hatch. Check EVA tether attached
c. DPS skirt status (1 photo) d. DPS effect on surface: (1) Crater (2) Radial erosion	(Refer to the next section for LMP egress procedures)

Check terrain status for crew operations:

a. Check slope, obstructions and roughness in
   (1) MESA area
   (2) TV deployment area
   (3) S-band antenna deployment area
   (4) Quad I area

b. Check lighting/visibility status:
   (1) Bright and dark areas
   (2) TV deployment
   (3) MESA
   (4) S-band antenna area
   (5) General sampling areas (take two (stereo) photos of bulk sample and one photo, close up, of contingency sample area)
   (6) Up sun
   (7) Cross sun (two photos, one each direction)
   (8) Down sun

VI. LMP INITIAL EVA

CDR	LMP
Rest/Monitor and photograph LMP egress and descent to surface	Reorient SC
Photo (3) LMP	Move through hatch. Check ingress procedure (Pull +Z hatch closed)

CDR		LMP
	Perform communications check (Include relay check with CSM, if possible)	
Photo (3) LMP		Descend ladder to footpad
		Check pad-to-ladder ascent procedures
Photo (3) LMP		Step to surface
(Deploy TV, see procedures below)		Rest beside ladder/check EMU. Assess egress/ingress capabilities

VII. TV DEPLOYMENT

CDR	LMP
Walk to MESA	(After completion of a rest period the LMP conducts environmental familiarization, see Section VIII)
Adjust MESA height, if necessary, by pulling upward on adjustment strap	
Pull strap (velcroed) to remove MESA thermal blanket from around TV lens	
Complete removal of thermal blanket	
Remove tripod from MESA: a. Pull two straps to unsnap tripod b. Lift tripod from MESA c. Extend telescoping section d. Deploy legs e. Place on surface near right side of MESA	
Walk to right side of MESA	
Remove wide angle lens from TV camera and stow on MESA holder	
Remove LD lens from holder and attach to camera	
Pull several feet of TV cable from MESA	

CDR	LMP
Remove camera from MESA: a. Pull the two pins at the forward edge of mounting frame b. Grasp TV handle and rotate TV toward rear of MESA to free from frame c. Lift camera from frame d. Check camera temperature and report (cold, normal, hot)	
Place camera on tripod. Check camera secure	
Carry camera with tripod to site to view subsequent EVA operations (See figure 3-4)	As required, pull more TV cable from MESA
Take a step-wise, fast-scan (10 frames/sec) panorama or, if time not available, select several points of interest. Do not point camera within 20° to sun. Start panorama at approximates 22° from an upsun view, move through down sun, continue to other view 22° from up sun. Place camera on surface for a few seconds at approximately 22 1/2° increments. (15 increments are required for the panorama)	
Recheck camera temp. and report. Place TV on surface for optimum coverage of surface activity (See Figure 3-4)	
Move near LMP. Rest/check EMU. Check RCU. Report 02 and suit pressure.	
Photo SWC (stereo pair) after LMP deploys it. Return to MESA	

CDR	LMP

VIII. LMP ENVIRONMENTAL FAMILIARIZATION

CDR:

(At this point the CDR is deploying the TV, see Section VII)

LMP:

In the vicinity of ladder and in view of TV (and sequence camera, if practical), check and report balance/stability:

a. Effect of CG shift-lean forward, backward, and to each side
b. Downward reach
c. Arm motion effects

Evaluate and report reach capability (with and without support):

a. Right up
b. Right down
c. Both up and down

NOTE: Perform following evaluations within a few yards of S/C and in view of sequence camera, if practical

Evaluate and report walking capability:

a. Pace
b. Stability
c. Traction
d. General evaluation

Rest/check EMU. Check RCU. Report oxygen and suit pressure. Report physical comfort. Assess EVA capability

CDR	LMP

IX. SWC DEPLOYMENT

(At this time the CDR is deploying the TV, see Section VII)

Erect SRC table:

a. Pull Velcro tabs to free table
b. Pull table forward from stowed position and rotate into horizontal position
c. Attach Velcro tape to hold table in correct position (level, fore and aft)

Pull the two straps holding SWC and remove SWC from MESA

Walk to sunlit area

Deploy SWC:

a. Extend each section of staff until it locks. (red band should be visible) Apply a compressing force to each section to check sections locked
b. Extend shade cylinder and rotate toward red side of pivot point, i.e., red to red
c. Extend foil shade and hook to lower portion of staff
d. Press staff into surface with foil normal to sun (side marked SUN to Sun)

X. EVA AND ENVIRONMENT EVALUATION

Remove camera from MESA and tether when required in the following evaluation

NOTE: The following list of tasks is presented as a guide. The activities within this period are not limited to the items listed or the order in which they appear.

If necessary further evaluate:

a. Effect of CG shift (leaning, reach, etc.)
b. Walking capability

In undisturbed area and in view of TV and SC, if practical, observe and report:

a. Best pace
b. Technique for starting and stopping
c. Balance at increased pace and length of step
d. Traction
e. Dust
f. Boot penetration (take stereo pair)
g. Scuffing
h. Cohesion
i. Adhesion (photo boots)
j. General evaluation of EVA capability

CDR	LMP
	In each direction, up sun, down sun and cross sun, observe and report surface: a. Brightness/reflections b. Color perception c. Contrast variation d. Texture determination e. Reflection in shadow f. Rock and crater distribution g. General terrain evaluation h. Visual and terrain phenomena different from that expected Check EMU status with MSFN after stay in sunlight. Report comfort/problems Move to shadow edge and repeat lighting/visibility and terrain evaluation as above. Additionally, observe shadow edge sharpness (look down sun) Check EMU status with MSFN after stay. Take 12 photo panorama (from position 20 feet in front of +Z pad). As panorama is taken, estimate distance to several prominent terrain features. Repeat evaluation, as above, in shadow Check EMU after stay in shadow

CDR | LMP

XI. BULK SAMPLE COLLECTION

Remove camera and place on MESA

(The LMP is conducting the EVA and Environment Evaluation, Section X)

Prepare MESA:

a. Proceed to MESA
b. Insure area about MESA is suitable for operations
c. Adjust height of MESA, if required
d. Insure all equipment is accessible

Deploy ETB:

a. Unfold and position bag on right side of MESA (Check bag top folded inside bag)

Prepare SRC and ALHT:

a. Unstow scoop and hammer. Place in ETB.
b. Check security of SRC table
c. Release bulk sample SRC carry handle from detent position
d. Rotate handle 90° clockwise to release SRC from MESA
e. Pull perpendicular to MESA top with carry handle to remove from stowage position
f. Place SRC on table with T-handle up and SRC aligned with the table
g. Rotate and place the SRC on table with SRC handle pointing away from the spacecraft
h. Release the two strap latches by pressing the latch locking mechanism, with the hand on the release handle, in a sideways motion toward the center of the SRC and rotating the handle forward and upward

CDR | LMP

i. Continuing to grasp second strap latch release handle, after relase, rotate the SRC top to an open stable position. NOTE: If necessary restrain SRC with other hand on carry handle in order to break seal
j. Check the seal spacer is still in place over the seal
k. Unpack SRC. Place packing material, and small sample bags in SRC lid, in transfer bag or on MESA
l. Remove spring scale
m. Hook scale to left front of MESA
n. Attach large sample bag to scale
o. Place SWC stowage bag in SRC lid or on MESA

NOTE: If practical collect samples in view of TV and sequence camera

(NOTE: If practical use the scoop to collect rocks and loose material simultaneously. Attempt to collect same volume of rocks as loose material)

Collect rock fragments:

a. Pull strap to free vibration attenuator from tongs
b. Remove the tongs from the MESA, pull the two lanyards to release snaps
c. Move within several yards of the MESA to collect rock fragments placing each fragment into the sample bag at the time of collection
d. At the completion of fragment sampling, place the tongs in temporary stowage in the MESA or ETB

CDR | LMP

Rest/check EMU systems

Collect loose material:

a. Remove extension handle from stowed position on MESA. Pull two snap lanyards on extension handle to release. Remove vibration attenuator from small handle.
b. Remove scoop from ETB and connect to extension handle
c. Use scoop to fill sample bag with loose material. Comment on collection process, soil adhesion and cohesion, difficulty of scooping, volume of material, general evaluation

d. Disconnect extension handle from scoop. Place scoop and extension handle in temporary stowage on MESA or in ETB

Rest/check EMU systems

Pack and seal SRC:

a. Remove sample bag from spring scale
b. Place sample bag in SRC
c. Close bag and place bag in center of SRC so that bag ends are toward SRC ends.
d. Place packing material in SRC to minimize void space Use caution to keep SRC seal clean.
e. Remove seal protector. If an O-ring seal is loose, remove from SRC and discard

CDR

f. Rotate the top closed with a strap latch handle
g. Seal the SRC by rotating the two strap latches downward to the locked position

Prepare for SRC transfer:

a. Retrieve LEC from stowed position
b. Walk to SRC
c. Attach LEC lower hook (marked with "L") to SRC top-left front bracket
d. Attach LEC upper hook (marked with "R") to the SRC top-right rear bracket and lock hook

Rest/check EMU

LMP

XII. LM INSPECTION

CDR

(At this point the CDR is completing the Bulk Sample Collection, Section XI)

LMP

During inspection evaluate visual perception

Report status of Quad I:

a. Both LM stages
   (1) Coating
   (2) Dust
   (3) Shielding
b. Ascent stage (one photo)
   (1) RCS
   (2) Rendezvous radar
c. Descent stage (one photo)
   (1) Engine skirt

Report status of +Z gear:

a. Main strut (take one photo)
b. Secondary struts (two photos, one on each side)
c. Take stereo pair of pad/surface

CDR

LMP

Photo area where bulk sample was collected

Deploy ALSCC: (Deployment of the ALSCC will be delayed until the documented sample collection if behind in the timeline)

a. Remove isolator latch pin and pivot cover
b. Pull camera from MESA
c. Place camera on secondary gear strut and exert pressure on camera cover. Pull the two skirt lanyards
d. Rotate handle retaining latch
e. Swing handle clockwise 150° and pull until fully extended
f. Place camera on surface

ALSCC OPERATION

Close-up photographs will be taken by either crewman when time is available between or during other tasks. Several times within the EVA are suggested when it may be convenient for the crew to take photos. This is not a requirement to take photos nor does it prohibit them from obtaining photographs at other times which may be feasible.

In general the camera operation is:

a. Estimate position of object plane relative to camera bearing surface
b. Position camera over object (Describe object and location)

CDR	LMP
	c. If object is below ALSCC bearing surface depress skirt until object is within focus plane
	d. If object is above bearing surface tilt camera back until object is within focus plane
	e. Activate trigger located on handle grip
	f. Read and report frame counter
	g. Observe cycle completion by light on handle
Carry the ALSCC around the LM during the inspection and take photos as practical	
Report status of Quad IV:	
a. Both LM stages	
(1) Coating	
(2) Dust	
(3) Shielding	
b. Ascent stage	Take one photo of A/S
(1) RCS	
(2) Steerable antenna	
(3) Rendezvous radar	
c. Descent stage	
(1) Descent engine skirt	Take one photo of skirt
(2) MESA	Take one photo of MESA (Include all Quad IV, if practical)
Report status of +Y gear assembly:	
a. Main strut	Take one photo of main strut
b. Secondary struts	Take two photos, one on each side of secondary struts
c. Pad/surface	Take stereo pair of pad/ surface

CDR	LMP
Rest/evaluate and report lighting/ visibility in all directions, particularly S/C reflections. Observe and report terrain characteristics. Estimate distance to several prominent terrain features. Take close-up photos if possible	Take panorama (12 photos) from position approx 20 ft out from +Y pad and 30 deg CW from +Y axis or 120 deg from last panorama
Report status of Quad III:	
a. Both LM stages (same as Quad IV)	
b. Ascent stage	Take one photo of A/S
(1) RCS	
(2) Steerable antenna	
(3) VHF antenna	
c. Descent stage	
(1) Propellant vents	
(2) Fuel vent	
(3) Tanks (Oxygen, Helium (2))	
(4) Descent engine skirt	Take one photo of skirt
(5) Note if surface discolored	(Photo if surface discolored)
Report status of -Z gear assembly (same items as +Y and:	Take same photos as +Y
a. Landing track	
b. Oxidizer vent	
c. EVA antenna)	
Receive camera and tether to suit	Hand Hasselblad camera to CDR
Report status of Quad II:	(The LMP begins the EASEP deployment. See the following section)
a. Both LM stages (same as Quad IV)	
b. Descent stage (one photo)	
(1) Landing radar	
(2) SEQ bay	
Take 12 photo panorama (from 20 ft out from -Y pad and 30° CCW from -Y axis or 120° from last panorama position)	

CDR	LMP
Report status of -Y gear assembly: a. Main strut (take one photo) b. Secondary struts (one photo from each side) c. Pad/surface (take stereo pair)	

XIII. EASEP DEPLOYMENT

CDR	LMP
(At this point the CDR is completing the LM inspection. See the preceding section)	Open SEQ bay door: a. Remove thermal cover from door lanyard b. Retrieve lanyard from right side of SEQ bay (remove lower velcro strap) c. Move to position clear of door
NOTE: If LMP cannot raise door, stand clear of door and manually assist	d. Pull white portion of lanyard to raise door e. Temporarily stow lanyard on strut f. If Quad II is in a low attitude connect folded doors with velcro strap
	PACKAGES REMOVED BY BOOMS
Photograph package removal	Remove Package 1 (PSE): a. Retrive boom lanyard from package (handle) b. Move to positon clear of package (approximately 10 feet) c. Pull white portion of lanyard to unlock and move package from SEQ bay to fully extended boom position

CDR	LMP

d. Pull black and white striped portion of lanyard to lower package to surface
e. Release white portion of lanyard from base of package
f. Pull small lanyard (velcroed to handle) on package to release boom cable and lanyards. Reattach lanyard to velcro
g. Move package clear
h. Pull black and white striped lanyard to retract boom (or push boom back with hand)

Remove Package 2 (LR^3):

a. Repeat Package 1 procedure (set package clear of SEQ bay)

MANUAL PACKAGE REMOVAL

Remove Package 1:

a. Pull small lanyard, at top or bottom of package, to release hockey stick from boom
b. Remove deployment lanyard from package and pull white portion to unlock package from bay
c. Release white portion of lanyard from base of package
d. Move deployment lanyard to side clear of package
e. Manually pull package clear of SEQ bay
f. Set package on surface clear of bay area

CDR	LMP
	Remove Package 2: a. Repeat Package 1 procedure

NOTE: Simultaneous accomplishment, although indicated of the following tasks, is not required.

CDR	LMP
Photo LMP and take close-up photos as practical	Close SEQ bay door: a. Retrieve door lanyard b. Move to position clear of door c. Pull black and white stripe portion of lanyard until door is closed d. Discard lanyard

Select site for PSE and LR^3 deployments, nominally 70 ft south of the S/C

CDR	LMP
Move to deployment site with cameras. Estimate distance and position with respect to the LM	Carry PSE and LR^3 to deployment site (Nominally 70 feet out the LM-Y axis. Report site location if it is not nominal)
Place LR^3 with base toward Earth. (Astronaut faces east for Sites 1 and 2 and west for Sites 3,4, and 5). Rest/prepare area (clear rocks, smooth surface as required)	Place LR^3 package on surface (on end) in a clear, level location, if practical. Move PSE approximately 10 feet further from LM and place on surface with base toward north (Arrow on handle points to south)
Deploy LR^3: a. Simultaneously grasp deployment boom ("hockey stick") and pull pin inside carry handle. Remove and discard "hockey stick" (1)*	Rest/check EMU

CDR

b. Simultaneously grasp deployment handle and release ring (Left side of package) to release deployment handle pull pin ②
c. Pull deployment handle to extend handle six inches, to the first detent position, and to partially release array. Discard handle release ring
d. Grasp pull ring on array tilting handle, pull to remove protective cover. Discard cover ③
e. Grasp deployment handle to steady package. (4A) Grasp array tilting handle, push down rotate handle 45°. Pull outward to extend to detent position (9.5 inches) and complete array release (4B)
f. Use deployment handle to steady package. Use array tilting handle to tilt array (to detent for landing site)

LMP

Deploy PSE:

a. Prepare area (move rocks, etc.) if required
b. From base of package pull lanyard to release gnomon ①
c. Grasp carry handle with one hand and use the other to remove and discard the right solar panel-restraining pull pin ② and panel support bracket pull pin ③
d. Grasp first solar panel support bracket, rotate bracket forward lift bracket upward to release and remove first rear support bracket pull pin. ④ Discard bracket/lanyard/pull pin

* The circled numbers and symbols correspond to decals on the packages.

CDR

g. Release tilting handle (should spring back into stowed position)
h. Depress trigger on deployment handle, pull handle to extend to full ⑤ extent (an additional 27 inches) and rotate package to lunar surface
i. Check and report experiment aligned and level to within ±5°. ⑥ [ALIGN] Use gnomon shadow cast on partial compass rose for alignment. Use bubble for level indication. Use deployment handle to align and level as required

LMP

e. Repeat procedures c. and d. for the left solar panel bracket ⑤ ⑥ ⑦
f. From side of PSE pull deployment handle ("working height") pip pin ⑧ and remove "hockey stick" ⑨
g. Grasp deployment handle, rotate and pull to extend to 30 inch working height and lock in place ⑩
h. Use deployment handle to rotate package to surface
i. With deployment handle, embed package mounting tabs in lunar surface (smooth surface and align package) ⑪ [ALIGN]

CDR	LMP
Photograph scientific packages:	
CAUTION: Do not walk up-sun of the PSE. Shadows on the solar panels affect internal electronics a. Take closeup photo of LR3 b. Take stereo pair of LR3 c. Take one photo from about same distance as stereo pair but at entirely different angle d. Move to PSE e. Repeat photos as in a, b, and c	j. Check and report experiment aligned and level to within $\pm 5°$ as indicated by gnomon shadow cast on partial compass rose and bubble level, respectively. Use deployment handle to align and level as required. k. Pull antenna release lanyard from deployment handle (velcroed to handle) (12) l. Pull lanyard to deploy solar panels and antenna NOTE: If panels do not deploy, stand clear of deployment area and check rear support brackets clear of solar panels and release levers (underneath forward edge of panels) pulled m. Rotate antenna to designated landing offset (site dependent) (13) n. Recheck package level and aligned. Report shadow on compass rose
Move to the Quad IV area	Move to MESA with ALSCC. Take photos as practical. Photo footprint made while carrying EASEP
Rest/check EMU	Rest/check EMU

XIV. DOCUMENTED SAMPLE COLLECTION

CDR	LMP
Rest/photo LMP. Take close-up photos	Transfer bulk sample SRC to footpad or gear struts: a. Extend loop end of LEC until section of strap going to A/S is taut b. Lift SRC from table by left (lower) hook

CDR	LMP
	c. Carry SRC and place on footpad or secondary struts d. Temporarily stow LEC on gear strut e. Return to MESA
	Prepare documented sample SRC for sample collection:
	a. Check security of table b. Pull the lanyard on left side of TV mounting bracket to release the two pull pins. c. Remove and discard bracket under LM d. Release DS SRC carry handle from detent position e. Rotate handle 90° clockwise to release SRC from MESA f. Pull perpendicular to MESA top with carry handle to remove from stowage position g. Place SRC on table with T-handle up and SRC aligned with the table h. Rotate and place the SRC on table with SRC handle pointing away from the spacecraft i. Release the two strap latches by pressing the latch locking mechanism with the hand on the release handle in a sideways motion toward the center of the SRC and rotating the handle forward and upward

CDR	LMP
	j. Continuing to grasp second strap latch release handle, after release, rotate the SRC top to an open stable position. NOTE: If necessary restrain SRC with other hand on carry handle in order to break seal
	k. Check the seal spacer is still in place over the bottom seal
Walk to LMP	l. Remove and stow packing material on SRC lid, or in MESA or ETB
	m. Remove one core tube from SRC and place in SRC lid or ETB
	n. Remove tube caps and place in SRC lid (two caps wrapped in packing material)
	o. Remove small sample bag containing York mesh. Seal bag and place in SRC lid
	Collect core tube sample:
	a. Remove core tube from SRC (check bit attached) and connect to the extension handle
	b. Remove hammer from ETB
	c. Move to an undisturbed point near the MESA (in view of TV, if practical)
Take stereo pair after tube is pushed into surface	d. Place the core tube at the sampling location. Push tube into surface the length of the tube. Drive with the hammer if necessary
	e. Retrieve tube by pulling along its vertical axis, rotating if necessary

CDR | LMP

CDR: If procedure above is not practical or if time permits, place gnomon near prospective fragment and/or soil sample (near several samples if possible) and take two photos of sample site. From approximately five feet away, take two photos (stereo pair) from near 90° to sun line

NOTE: The types of samples and the order in which they are collected will be dependent on the terrain features investigated and crew judgement on the best investigative approach within operational limitations.

CDR: Remove a small bag(s) from large bag. Report number on bag. (Bags are numbered 1 through 14)

CDR: Open small bag and hold for LMP

LMP: Collect sample(s) with scoop or tongs. Place in bag (collect several samples if possible)
NOTE: The scoop can be used to simultaneously collect a small fragment and a small quantity of loose material

CDR: Seal small bag and place in in large collection bag

CDR: Photograph area(s) where sample(s) was taken

LMP: Select another sample and describe or select a new sample area

LMP: Pick up gnomon (if gnomon cannot be conveniently included in photographs of next sample)

CDR	LMP
If procedure above is not practical or if time permits, place gnomon near prospective fragment and/or soil sample (near several samples if possible) and take two photos of sample site. From approximately five feet away, take two photos (stereo pair) from near 90° to sun line	

NOTE: The types of samples and the order in which they are collected will be dependent on the terrain features investigated and crew judgement on the best investigative approach within operational limitations.

CDR	LMP
Remove a small bag(s) from large bag. Report number on bag. (Bags are numbered 1 through 14)	
Open small bag and hold for LMP	Collect sample(s) with scoop or tongs. Place in bag (collect several samples if possible) NOTE: The scoop can be used to simultaneously collect a small fragment and a small quantity of loose material
Seal small bag and place in in large collection bag	
Photograph area(s) where sample(s) was taken	Select another sample and describe or select a new sample area
	Pick up gnomon (if gnomon cannot be conveniently included in photographs of next sample)

CDR	LMP
Move to a new sampling area	
Repeat sampling procedure at new site(s)-until the collection bag is filled or the allotted time has elapsed. Rest/Check EMU as appropriate.	
Take surface close-up photographs if feasible	
Move to MESA with still and close-up cameras	Move to MESA with tongs, scoop, and samples
	Remove ALSCC film cassette and stow: a. Pull the two cover lanyards and remove cover b. Rotate cassette film cutter lever c. Lift cassette retaining arm d. Remove cassette and place in CSC pocket on CDR's suit.
Close CSC pocket	
Remove large sample bag from LMP and attach to spring scale on MESA	Place scoop by or on MESA
	Remove the environmental sample container, the larger of the two small containers in the SRC, and open. Remove o-ring from seal
Hold container for LMP	Hand container to CDR

CDR	LMP
	Use scoop to collect loose material from an undisturbed area where bulk sample was taken. Place sample in container. Place scoop by MESA
Seal container and place in SRC	
	Remove the gas analysis container from SRC and open. Remove o-ring seal
Hold container for LMP	Hand container to CDR
	Use tongs to collect a small rock fragment from bulk sample area and place in container.
Seal container and place in SRC	Detach tongs and place in ETB
Recover SWC: a. Move to SWC b. Withdraw staff from surface c. Roll up foil d. Rotate foil roller to detach position and remove from staff e. Let staff rest on surface, vertically and with only its weight acting on surface, report depth of penetration	Use scoop to collect rocks and loose material. Fill large sample bag to designated weight or volume
f. Push staff into surface as deep as possible Assess amount of force applied and staff depth g. If time permits photograph staff and repeat e and f several times. Check staff rigidity in surface	Place bag in SRC. Seal bag
h. Carry SWC foil to MESA	Remove SWC bag from temporary stowage on MESA and open
Insert foil into bag	Hold bag for CDR
	Seal SWC bag and place in SRC
Place York mesh sample (in SRC lid) in SRC. Place packing material in SRC to minimize void space	Collect second core tube sample if time available (See procedures on page 55) If time not available assist CDR

CDR	LMP
Transfer bulk sample SRC and magazine: (If there is time for the transfer of only one SRC, the bulk sample SRC will be transferred)	
a. Extend loop end of LEC until section of strap going to A/S is taut b. Grasp loop grip on the LEC top line c. Lift SRC from strut d. Walk to the front of the ladder with SRC suspended on LEC	
e. Walk away from ladder (in +Z direction) while holding LEC top strap (loop) to transfer magazine and SRC to A/S	Assist CDR, if required
Rest/check EMU	Disconnect and temporarily stow SRC and camera magazine
Prepare for transfer of documented sample SRC:	
a. Pull LEC lower line to transfer LEC hooks to surface b. With LEC hooks in hand, walk to SRC on MESA c. Attach LEC lower hook to SRC top-left front bracket and lock hook d. Attach upper (right) hook to SRC top-right rear bracket and lock hook	
Transfer SRC:	
a. Extend loop end of LEC until section of strap going to A/S is taut b. Grasp LEC top line by loop grip	

CDR	LMP
c. Lift SRC from table d. Walk to the front of the ladder with SRC suspended on LEC e. Walk away from ladder (in +Z direction) while holding LEC top strap loop to transfer SRC to A/S	Assist CDR, if required
Rest/check EMU	Disconnect and temporarily stow SRC

XVII. CDR EVA TERMINATION

CDR	LMP
Clean EMU by dusting with hands and wiping or kicking boots against footpad	
Ascend to platform	Change SC FR to 12/sec
	Disconnect LEC from ascent stage
Receive and discard end of LEC away from LM	Hand end of LEC through hatch to CDR
Ingress	Assist CDR, if required

Jettison ECS canister and bracket, OPS brackets (adapters), 3 armrests, bag of used urine bags

Close hatch

Repressurize cabin

SECTION 4.0

ALTERNATE AND CONTINGENT PLANS

4.0 ALTERNATE AND CONTINGENT PLANS

4.0 ALTERNATE AND CONTINGENT PLANS

4.1 Alternate EVA (With S-band Erectable Antenna Deployment)

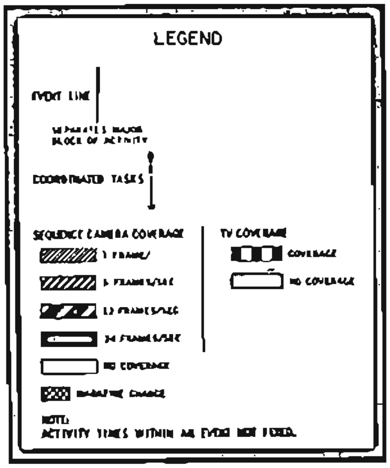
4.1.1 Description and Rationale

An alternate timeline is presented for the situation in which deployment of the S-band erectable antenna is required. Such a situation will occur if the Goldstone or Parkes (Australia) 210-foot antennas are not in view and the communications capability with the LM steerable/85-foot antenna combination is not sufficient to simultaneously obtain acceptable TV coverage and voice-biomedical and telemetry data. Thus, due to the present uncertainty of the communications capability - possible unsatisfactory equipment performance and/or contingencies which may cause mission event times to vary so that a 210-foot antenna is not in view, the erectable antenna will be carried on the mission and a real time decision made to deploy or not deploy it, i.e., follow the alternate or the nominal timeline.

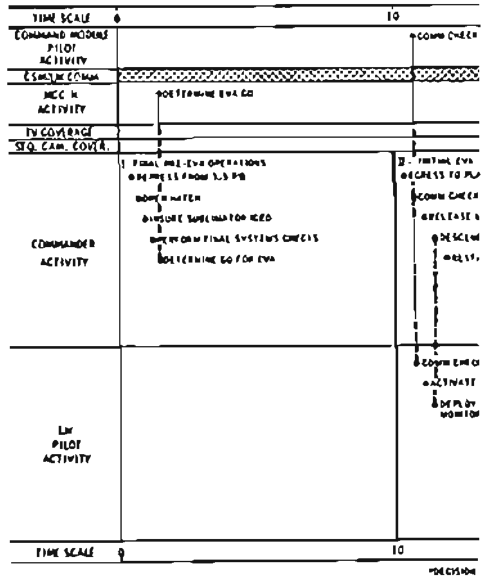
With the addition of the erectable antenna deployment, the major impact to the timeline is the reduction of time available for the documented sample collection. Also, for the alternate timeline, the LMP must delay his egress to switch to the erectable antenna after the CDR has deployed it.

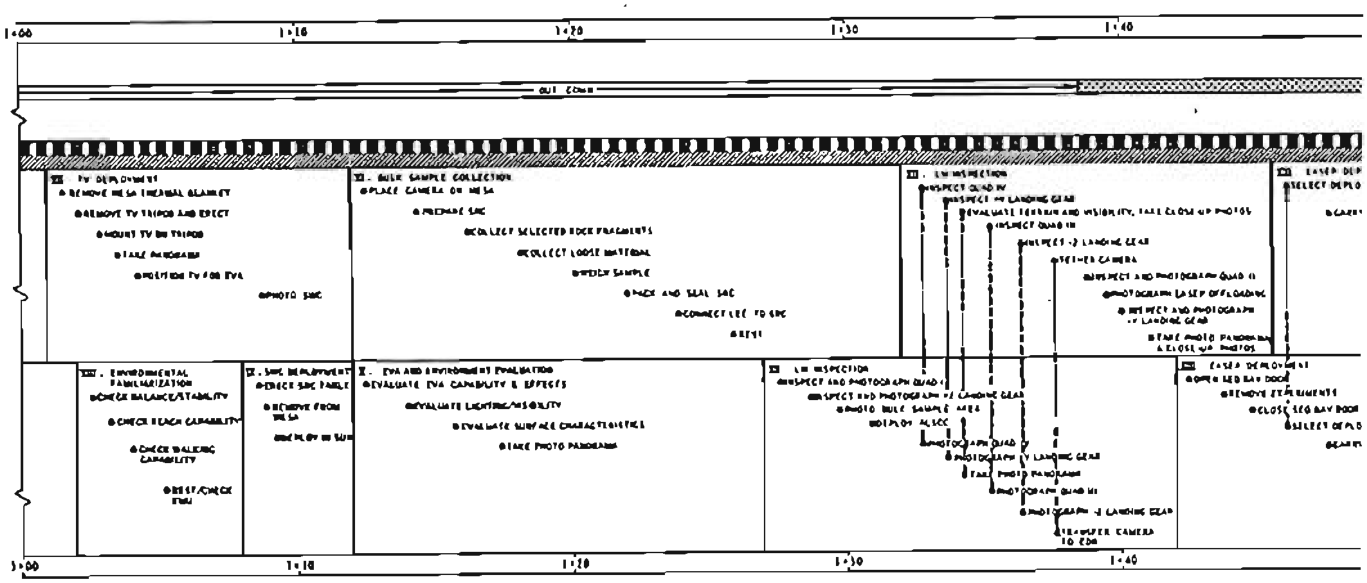
4.1.2 SUMMARY TIMELINE

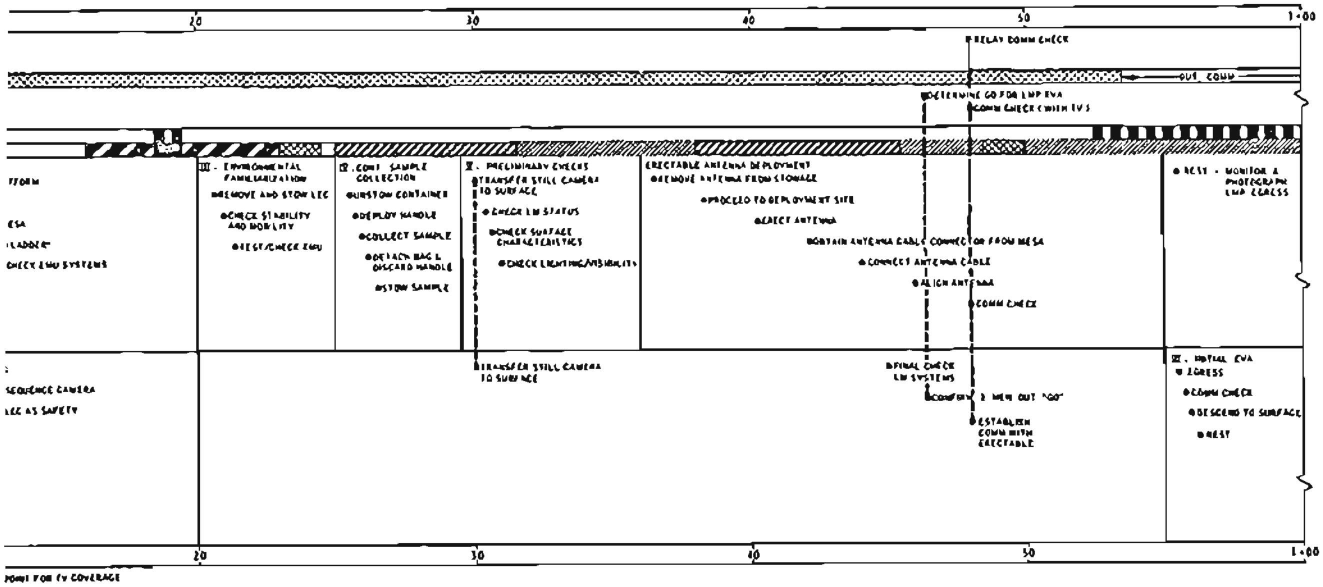
ALTERNATE LUNAR SURFACE EVA

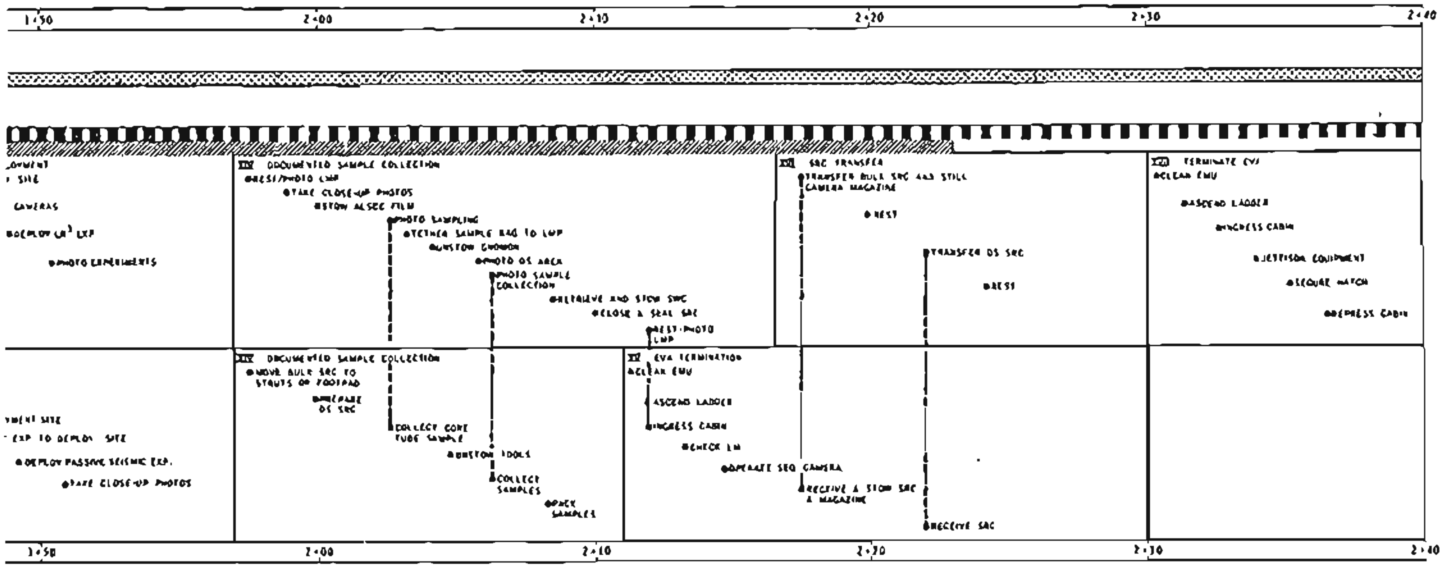


WITH DEPLOYMENT OF S-BAND ERECTABLE ANTENNA









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NAME	INITIAL	ORIGIN
W N WOOD		L500
DW/C HENDRICKS		

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER · HOUSTON TEXAS

REV JUNE 69
REV. MAY '69
REV. APRIL '69
REV MARCH 1969

4.1.2 SUMMARY TIMELINE
ALTERNATE LUNAR SURFACE EVA

BASIC JAN 1969

4.1.3 ALTERNATE TIMELINE
LUNAR SURFACE EVA

HR+MIN | CDR | LMP

0+00

DEPRESS CABIN FROM 3.5 PSI
OPEN HATCH
INSURE SUBLIMATOR ICED
PERFORM FINAL SYSTEMS CHECKS
CONFIRM "GO" FOR EVA

SEQUENCE CAMERA DOCUMENTATION-
SEE LEGEND ON SUMMARY TIMELINE

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NOTE: DETAILED PROCEDURES ARE PRESENTED IN "FINAL EVA PROCEDURES APOLLO 11" SUBMITTED BY EVA BRANCH, FCSD

0+10

CDR: MOVE THROUGH HATCH
CHECK INGRESS
PROCEDURE

LMP: ASSIST CDR
PLAY OUT LEC

CDR | LMP

PERFORM COMM CHECK

CDR: MOVE TO POSITION
AND RELEASE MESA

LMP: MONITOR CDR ACTIVITY
PLAY OUT LEC

LMP: TV ON FOR CHECK*
START SEQUENCE CAMERA (SC)

CDR: DESCEND TO FOOTPAD
CHECK ASCENT
PROCEDURES

LMP: PLAY OUT LEC

CDR: STEP TO SURFACE
REST/CHECK EMU

LMP: TURN TV ON (AND OFF)*
CHANGE SC FR TO 24/SEC

LMP: CHANGE SC FR TO 12/SEC

0+20

CDR: STOW LEC

LMP: VISUALLY MONITOR CDR ACTIVITY
PROVIDE CHECKLIST ASSISTANCE

CDR: CHECK AND DISCUSS
BALANCE/STABILITY
WALKING CAPABILITY

*TV LEFT ON IF
SATISFACTORY
TELEMETRY AND
VOICE-BIOMED
DATA RECEIVED

LMP: CHANGE SC FILM MAG
CHANGE FR TO 6/SEC

ALTERNATE TIMELINE

HR+MIN	CDR	LMP
	REST/CHECK EMU	CHECK LM AND EMU
	UNSTOW CSC AND DEPLOY HANDLE	START SC
	EXTEND BAG COLLECT SAMPLE	MONITOR CDR ACTIVITY
	DETACH BAG AND DISCARD HANDLE	
	STOW SAMPLE	
75		
0+30	TRANSFER STILL CAMERA TO SURFACE	PREPARE FOR CAMERA TRANSFER ASSIST CDR
	TETHER CAMERA	CHANGE SC FR TO 1/SEC
	REST/CHECK EMU	MONITOR CDR ACTIVITY PROVIDE CHECKLIST ASSISTANCE
	CHECK AND REPORT LM STATUS	
	CHECK TERRAIN AND LIGHTING	

HR+MIN	CDR	LMP
	REMOVE S-BAND ERECTABLE ANTENNA FROM S/C	CHECK LM AND EMU
	CARRY ANTENNA TO DEPLOYMENT SITE	CHANGE SC FR TO 6/SEC
0+40	ORIENT ANTENNA REMOVE TOP CAP	MONITOR CDR ACTIVITY PROVIDE CHECKLIST ASSISTANCE
	EXTEND MAST AND LEGS	
	REMOVE THERMAL COVER AND LIFT ANT. ONTO LEGS	
	REMOVE DEPLOY BAR AND RIB TIP PROTECTOR	
	OPEN ANTENNA DISH	CHANGE SC FR TO 1/SEC
	REMOVE CABLE FROM MESA	MONITOR CDR ACTIVITY

MISSION	EDITION	DATE	MISSION TIME	DAY/REV	PAGE
APOLLO 11	FINAL	JUNE 27, 1969	112+54 - 113+18	5/20	2 of 7

ALTERNATE TIMELINE

HR+MIN

HR+MIN	CDR	LMP
	ATTACH CABLE TO ANTENNA	CHANGE SC FILM MAG.
0+50	ROUGH ALIGN ANTENNA	MONITOR CDR ACTIVITY
	FINE ALIGN ANTENNA	S-BAND TO "LUNAR STAY" TURN TV ON CHECK COMM, LM, AND EMU DETERMINE "GO" FOR EVA PLACE SPARE CAMERA ON LM FLOOR
	REST/CHECK COMM AND EMU	REORIENT SC
	MONITOR AND PHOTO EGRESS	MOVE THRU HATCH CHECK INGRESS PROCEDURE
	PERFORM COMM CHECK	PERFORM COMM CHECK
	MONITOR AND PHOTO LMP	DESCEND TO PAD CHECK ASCENT PROCEDURE
1+00		

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HR+MIN	CDR	LMP
	PREPARE MESA FOR TV DEPLOYMENT	STEP TO SURFACE REST/CHECK EMU
	REMOVE TRIPOD	CHECK BALANCE/STABILITY REACH CAPABILITY
	CHANGE FROM WA TO LD LENS	
	REMOVE TV CABLE	DETERMINE WALKING CAPABILITY
	REMOVE CAMERA AND PLACE ON TRIPOD	
	CARRY TV TO DEPLOY SITE	REST/CHECK EMU PULL TV CABLE FROM MESA
	TAKE FAST SCAN PANORAMA OR SEVERAL POINTS OF INTEREST	ERECT SRC TABLE
1+10	PLACE TV FOR SUB. EVA	REMOVE SWC FROM MESA- DEPLOY IN SUNLIGHT
	MOVE NEAR LMP REST/CHECK EMU	
	PHOTO SWC	

ALTERNATE TIMELINE

HR+MIN	CDR	LMP
	PLACE CAMERA ON MESA	EVALUATE AND REPORT EVA CAPABILITY AND EFFECTS ON SURFACE (TETHER CAMERA WHEN REQUIRED)
	PREPARE MESA FOR BULK SAMPLE COLLECTION	
	PREPARE ALHT AND SRC	
	COLLECT ROCKS AND LOOSE MATERIAL	EVALUATE AND REPORT LIGHTING/VISIBILITY AND TERRAIN IN SUNLIGHT
1+20		EVALUATE AND REPORT LIGHTING/VISIBILITY AND TERRAIN AT SHADOW EDGE
		TAKE PHOTO PANORAMA

HR+MIN	CDR	LMP
	REST/CHECK EMU	EVALUATE AND REPORT LIGHTING/VISIBILITY AND TERRAIN IN SHADOW
		REPORT STATUS AND PHOTO QUAD I
	PACK SRC	REPORT STATUS AND PHOTO +Z GEAR PHOTO BULK SAMPLE AREA
1+30	CLOSE AND SEAL SRC CONNECT LEC	REMOVE ALSCC FROM MESA AND DEPLOY
	CARRY ALSCC REPORT STATUS QUAD IV	PHOTO QUAD IV
	REPORT STATUS +Y GEAR	PHOTO + Y GEAR
	EVALUATE TERRAIN/VISIBILITY TAKE CLOSE-UP PHOTOS	TAKE PHOTO PANORAMA

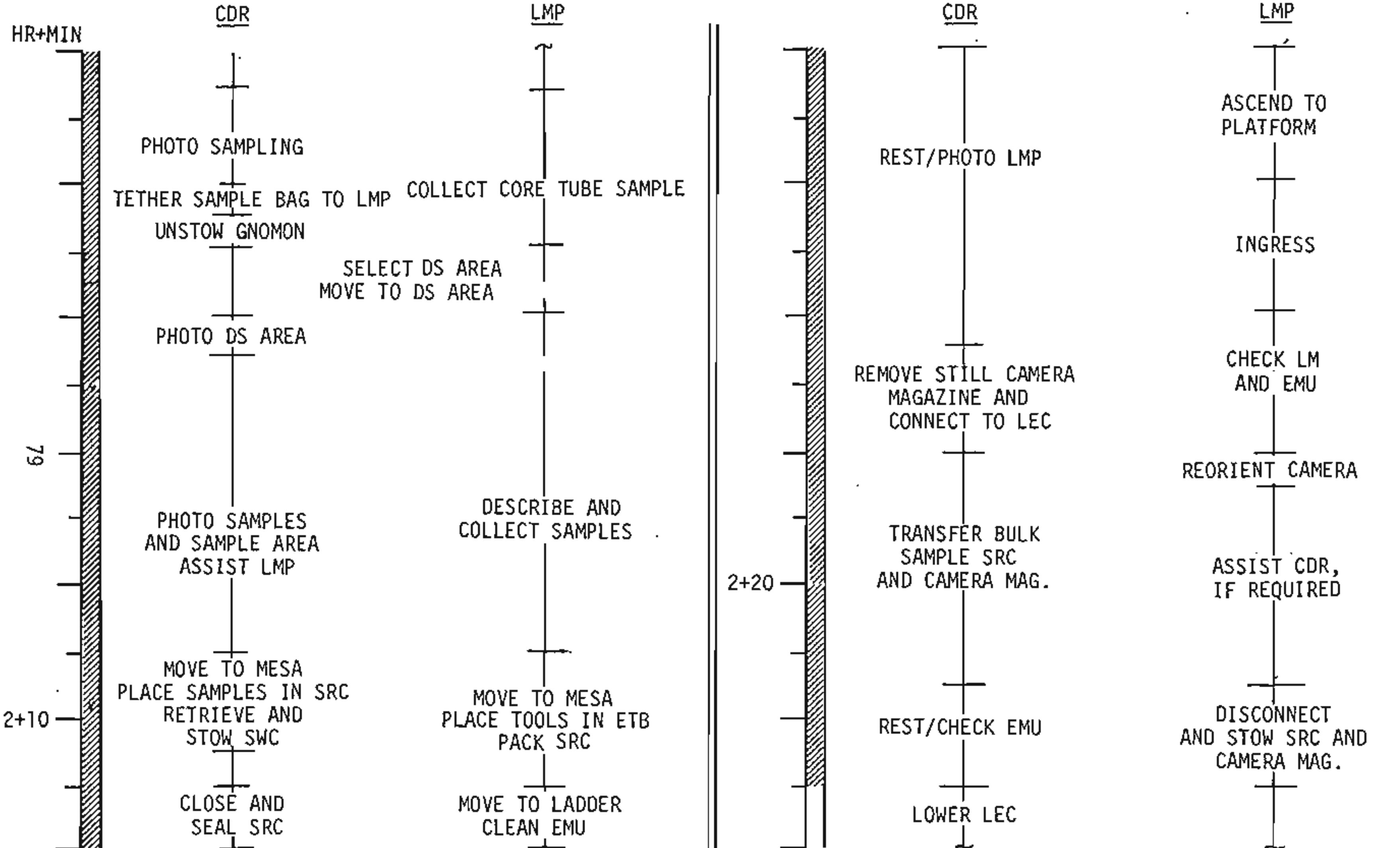
ALTERNATE TIMELINE

HR+MIN	CDR	LMP
	REPORT STATUS QUAD III	PHOTO QUAD III
	REPORT STATUS -Z GEAR	PHOTO -Z GEAR
1+40	TETHER STILL CAMERA	TRANSFER CAMERA TO CDR
	REPORT STATUS AND PHOTO QUAD II	OPEN SEQ BAY DOOR
	PHOTO EASEP OFFLOAD	REMOVE PACKAGE 1 (PSE)
	REPORT STATUS AND PHOTO -Y GEAR	
	TAKE PHOTO PANORAMA	REMOVE PACKAGE 2 (LR^3)
	PHOTO EASEP OFFLOAD TAKE CLOSE-UP PHOTOS	CLOSE SEQ BAY DOOR
	REST/SELECT DEPLOY SITE	

HR+MIN	CDR	LMP
	CARRY CAMERAS TO DEPLOY SITE REPORT POSITION FROM LM	CARRY PSE TO DEPLOY SITE
1+50	DEPLOY LR^3	REST/CHECK EMU
	PHOTO LR^3	DEPLOY PSE
	MOVE TO PSE	
	PHOTO PSE	TAKE CLOSE-UP PHOTOS
	MOVE TO QUAD IV	MOVE TO MESA REST/CHECK EMU
	REST/PHOTO LMP TAKE CLOSE-UP PHOTOS REMOVE ALSCC FILM AND STOW IN SUIT	MOVE BULK SRC TO STRUTS OR FOOTPAD
		PREPARE DS SRC AND SAMPLING EQUIPMENT
2+00		

MISSION	EDITION	DATE	MISSION TIME	DAY/REV	PAGE
APOLLO 11	FINAL	JUNE 27, 1969	114+06 - 114+30	5/20	5 of 7

ALTERNATE TIMELINE



MISSION	EDITION	DATE	MISSION	DAY/REV	PAGE
APOLLO 11	FINAL	JUNE 27, 1969	114+30 - 114+54	5/20-21	6 of 7

ALTERNATE TIMELINE

CDR	LMP
ATTACH TO DS SRC	ASSIST CDR, IF REQUIRED
TRANSFER DS SRC	
REST/CHECK EMU	DISCONNECT AND STOW SRC
CLEAN EMU	MONITOR CDR ASCENT
ASCEND TO PLATFORM	
DISCARD LEC	DISCONNECT LEC AND PASS TO CDR
INGRESS	ASSIST CDR

2+30

CDR	LMP
JETTISON EQUIPMENT CLOSE HATCH	
	STOP SC
CABIN REPRESS	

2+40

4.1.4 Detailed Procedures

Refer to the Nominal Lunar EVA Detailed Procedures Section 3.5, for the procedures which precede the S-band Erectable Antenna Deployment.

CDR	LMP
S-BAND ERECTABLE ANTENNA DEPLOYMENT	
Transfer antenna to deployment site:	
a. Walk to antenna stowage position (Quad I)	
b. Remove thermal shield	
c. Remove Velcro straps and pull to release pins at base of antenna	
d. Grasp antenna by deployment "shimmy" bar and folded lift handle	
e. Pull antenna out and down by lift handle to clear LM structure	
f. Hold antenna by deployment bar and deploy folded lift handle by pulling handle out of stowage detent and down to locked position	
g. Rotate antenna to horizontal position and carry the antenna to the deployment site by the shimmy bar (NOTE: The site to be used should provide a clear view of Earth and be approximately 20 feet from the MESA).	When CDR moves into SC field of view, change SC frame rate to 6/sec
h. Place the antenna down with the bottom antenna handle resting on the surface and the orientation arrow on top cap pointing to Earth.	

CDR | LMP

Remove top cap:

a. Release each of the three leg clamps by rotating them out and down
b. Depress the three leg tips and push them radially outward to free the antenna top cap
c. Discard metal top cap and foam piece in area away from the LM

Raise antenna mast:

a. While holding the antenna vertical, grasp antenna horn top plate and raise the first section of the antenna feed support. (Insure the first section only is deploying by applying a 2-finger pressure on outer mast section. The outer section has orange stripes.)
   CAUTION: Do not touch helix element when extending feed assembly
b. Check first section fully deployed and locked in detent
c. Extend the second antenna feed support section in the same manner as the first. Check the second section fully extended and locked in detent.

Deploy tripod:

a. Extend antenna legs by placing 2 fingers about the leg section and applying force against loops on either side of leg. Continue to extend each leg section to the proper length, i.e., the proper paint ring and lock with clamps. Check adequacy of each leg lock
b. Check antenna point toward earth by arrow on rib programmer

CDR	LMP
c. Move around to the right into the antenna lifting position by the shimmy bar	
d. Pull each of three Velcro leg retension straps and let the legs fall outward to a horizontal position on the surface	
e. Remove thermal covering from antenna and discard away from LM	
f. Lift the antenna from the surface using both hands on the shimmy bar until the antenna is high enough to permit the crewmember to grasp the lift handle	
g. While holding the antenna aloft with one hand, grasp lift handle with other hand	
h. Lift the antenna to the high detent position	
i. Check each leg locked securely in detent by holding the antenna aloft with one hand and pushing outboard on the legs individually	
j. Set antenna on surface	
k. Release pull pin fastener at base of shimmy bar. Pull deployment bar down and away from antenna	
l. Discard bar in the area away from the LM	
m. Firmly implant each leg into surface	
Open antenna reflector:	
a. Remove rib tip protector and allow it to slide down antenna leg to surface	
b. Uncoil antenna reflector release cable from around antenna. Hold cable taut and in straight line to plunger	
c. Remove release trigger guard pin and discard in area away from LM	
d. Graps an antenna leg with free hand and position self at arms length from leg	
e. With head down, squeeze release trigger to deploy antenna dish.	

CDR

Attach antenna cable:

a. Walk to front of MESA, adjust MESA if necessary
b. Pull Velcro straps to free left side of thermal blanket
c. Unfold left side of blanket to permit easy access to cable
d. Release antenna cable connector by pulling Velcro tab and snap free
e. Grasp cable connector and pass the connector under the MESA support strap
f. With cable connector in hand, walk to the left of the antenna
g. Walk past the antenna and deploy the cable completely (until black and white striped section visible)
h. Walk to antenna
i. Connect antenna cable by mating the two connector parts - turning the outer part clockwise as viewed from cable end

Rough align antenna:

a. Move around antenna leg to rough antenna alignment position
b. Unstow alignment crank by pushing down and away on crank handle
c. Uncoil crank cable by passing crank around and behind the antenna base
d. Rough align antenna in pitch (CCW rotation of the handle pitches the antenna down)
e. Rough align antenna in azimuth. Pull antenna crank out from housing then rotate handcrank to change antenna azimuth

LMP

Change SC FR to 1/sec

Change SC film magazine when necessary

CDR

Fine align antenna:

a. Press each leg into surface
b. Check antenna alignment by sighting along antenna mast and using optical alignment sight
c. Fine align antenna, as required, by using remote control crank-handle "in" for pitch and "out" for azimuth

Rest-check communications and EMU systems. Take one photo of antenna

LMP

Switch to erectable antenna-S-band selector to "Lunar Stay" (FM, Mode 10)

Perform communications check. Check signal strength indication > 1.0. Verify voice and telemetry with MSFN. Check LM and EMU systems. Determine "GO" for EVA

Refer to the Nominal EVA procedures, Section 3.5, for the LMP Initial EVA procedures.

4.2 Contingent EVA 1 - Minimum Time, One Man

4.2.1 Description and Rationale

For various reasons, on the first lunar landing mission only a very limited time may be available to accomplish the EVA.* For such a situation the choice of objectives are, first, those with the highest priority and, secondly, those which can be accomplished in a short period of time and do not require the accomplishment of a previous task. The timeline presented here, referred to as the Contingent EVA 1 or Minimum-Time, One-Man EVA, is to optimize the accomplishment of the choice of objectives by providing the maximum data return for the minimum amount of time expended. (An EVA timeline of approximately 49 minutes).

There are several other considerations which enter into the selection of the tasks and the procedural detail of the activities for a minimum time EVA. As this will be an unplanned or contingent EVA, it is desirable to have the procedures and sequence of events closely related to the nominal. Either crewman should be equally capable of conducting the desired tasks and contributing to the data returned. And in general, to achieve the maximum diversified data collection, the crewman on the surface will not go into the procedural detail, particularly with verbal descriptions, as he is expected to in the nominal timeline.

In this contingent EVA, for the environmental familiarization, the crewman will spend only enough time to assure himself that he can safely proceed with the EVA. After the contingency sample collection he will continue to become more adapted to the new environment as he conducts a limited EVA evaluation. Primarily, this EVA evaluation will involve a brief investigation to determine an astronaut's general capabilities or limitations for conducting EVA tasks within the lunar environment. Photographs taken during this evaluation will be a postflight aid to the crewman's recall and the documentation of this activity. A limited LM inspection, with very brief comments and several documentary photographs, can be conducted for the forward half of the spacecraft within a few minutes. To conclude the surface activity the crewman will take a photographic panorama and possibly a few additional photographs of documentary value.

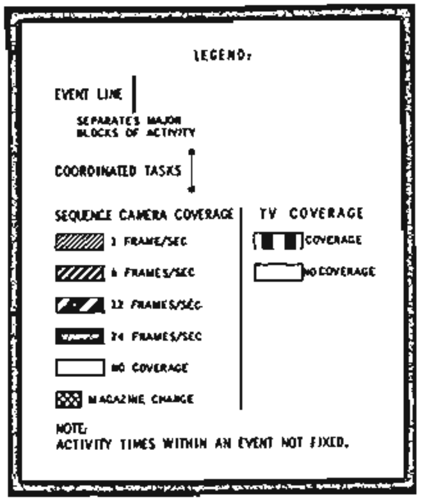
In conclusion it should be mentioned that the crewman's surface activity will be confined to an area where he can be constantly monitored by and in communications with the crewman inside the LM. Practically all of the activity can be documented with the sequence camera, and, if the communications capability exists, with the TV. Also, there should be sufficient time and activity for a thorough PLSS analysis.

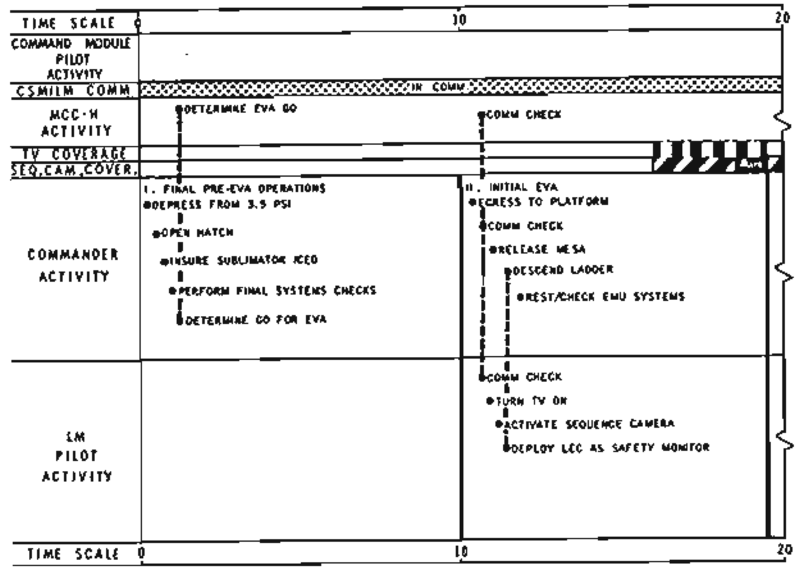
* The final Flight Mission Rules for Apollo 11 will govern the selection of the crewman to egress and the EVA he will accomplish.

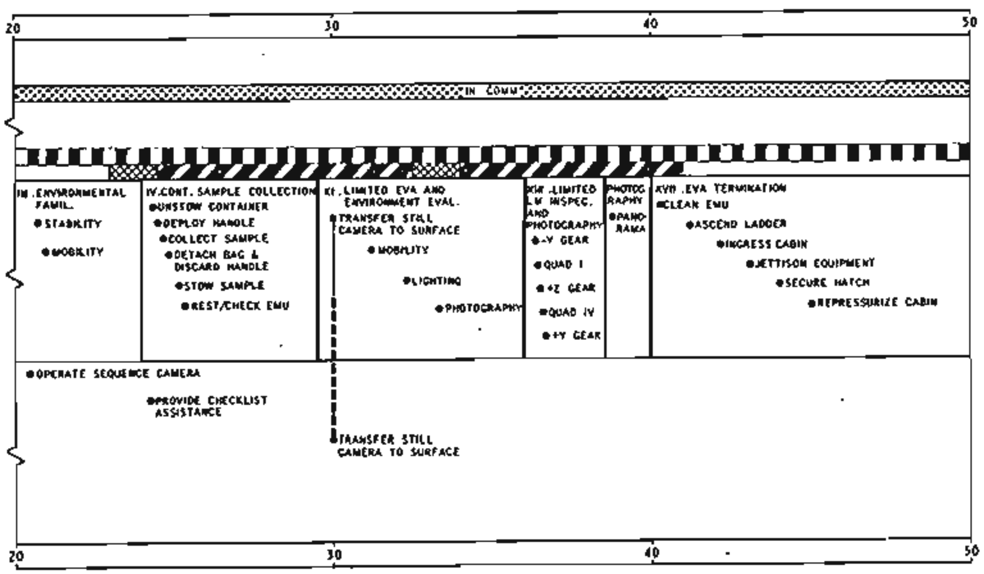
4.2.2 SUMMARY TIMELINE

CONTINGENT EVA I

MINIMUM TIME, ONE MAN







			REV. APRIL '69
			REV. MARCH '69
			REV. FEB '69
NAME	INITIAL	ORIGIN	NATIONAL AERONAUTICS & SPACE ADMINISTRATION MANNED SPACECRAFT CENTER · HOUSTON TEXAS
W.H. WOOD	[illegible]	LSOO	4.2.2 SUMMARY TIMELINE CONTINGENT EVA I
DR/C HENDRICKS	CH		BASIC JAN. 1969