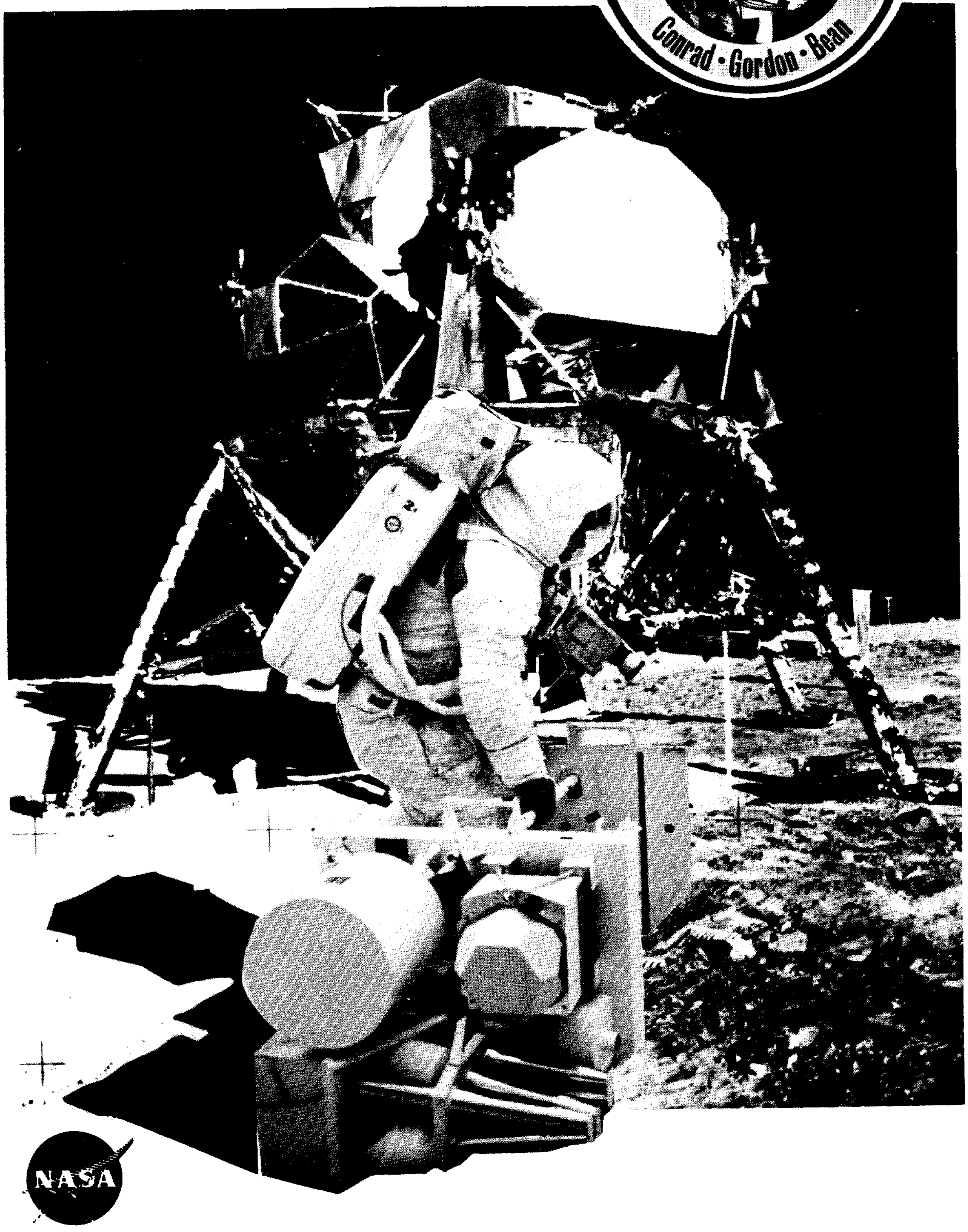
Report No. M-932-69-12

MISSION OPERATION REPORT

APOLLO 12 (AS-507)

OFFICE OF MANNED SPACE FLIGHT
PREPARED BY: APOLLO PROGRAM OFFICE - MAO

APOLLO XII
Conrad · Gordon · Bean



FOREWORD

MISSION OPERATION REPORTS are published expressly for the use of NASA Senior Management, as required by the Administrator in NASA Instruction 6-2-10, dated 15 August 1963. The purpose of these reports is to provide NASA Senior Management with timely, complete, and definitive information on flight mission plans, and to establish official mission objectives which provide the basis for assessment of mission accomplishment.

Initial reports are prepared and issued for each flight project just prior to launch. Following launch, updating reports for each mission are issued to keep General Management currently informed of definitive mission results as provided in NASA Instruction 6-2-10

Primary distribution of these reports is intended for personnel having program/project management responsibilities which sometimes results in a highly technical orientation. The Office of Public Affairs publishes a comprehensive series of pre-launch and post-launch reports on NASA flight missions which are available for dissemination to the Press.

APOLLO MISSION OPERATION REPORTS are published in two volumes: the MISSION OPERATION REPORT (MOR); and the MISSION OPERATION REPORT, APOLLO SUPPLEMENT. This format was designed to provide a mission-oriented document in the MOR, with supporting equipment and facility description in the MOR, APOLLO SUPPLEMENT. The MOR, APOLLO SUPPLEMENT is a program-oriented reference document with a broad technical description of the space vehicle and associated equipment, the launch complex, and mission control and support facilities.

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Prelaunch
Mission Operation Report
No. M-932-69-12

5 November 1969

TO: A/Administrator

FROM: MA/Apollo Program Director

SUBJECT: Apollo 12 Mission (AS-507)

No earlier than 14 November 1969, we plan to launch Apollo 12 on the second lunar landing mission. This will be the fifth manned Saturn V flight, the sixth flight of a manned Apollo Command/Service Module, and the fourth flight of a manned Lunar Module.

Apollo 12 will be launched from Pad A of Launch Complex 39 at the Kennedy Space Center. Lunar touchdown is planned for Apollo Landing Site 7, located in the Ocean of Storms about 830 nautical miles west of the Apollo 11 landing site in the Sea of Tranquility. Apollo Landing Site 7 includes the crater in which Surveyor III landed in April 1967. One of the primary objectives of this mission is to develop techniques for a point landing capability.

Primary objectives on the lunar surface include selenological inspection, survey, and sampling in a mare area; deployment and activation of an Apollo Lunar Surface Experiments Package; and development of man's capability to work in the lunar environment. Photographic records will be obtained and extravehicular activities will be televised.

Following the lunar surface phase of the mission, the crewmen will return to the Command/Service Module and remain in lunar orbit approximately 1 day to perform the remaining primary objective of obtaining extensive photography of candidate exploration sites for future missions.

The 10-day mission will be completed with landing in the Pacific Ocean. Recovery and transport of the crew, spacecraft, and lunar samples to the Lunar Receiving Laboratory at the Manned Spacecraft Center will be conducted under quarantine procedures that provide for biological isolation.

Rocco A Petrone
Rocco A. Petrone

APPROVAL:

Charles W. Mathews
George E. Mueller
Associate Administrator for
Manned Space Flight

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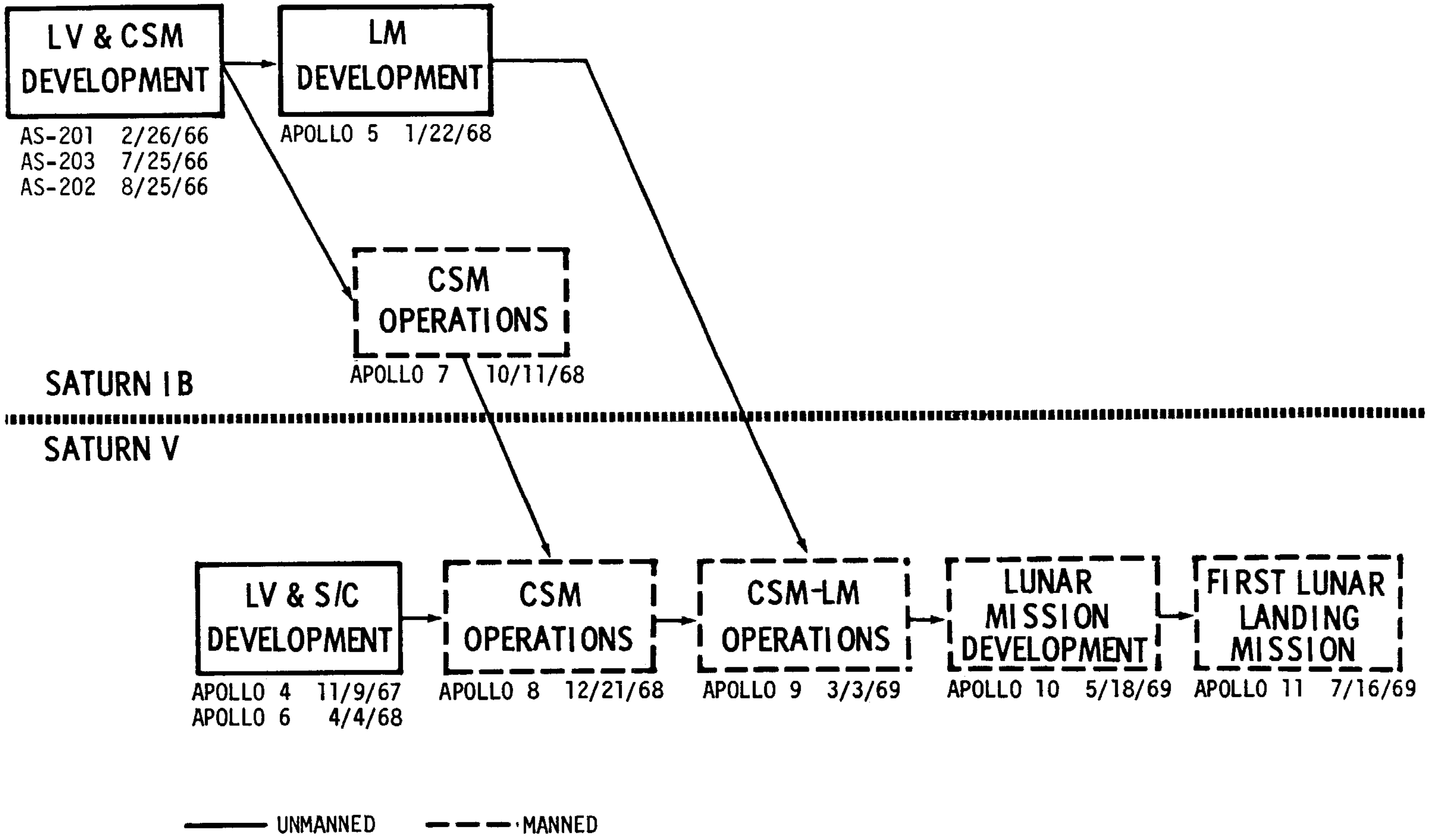
PROGRAM DEVELOPMENT

Since the first Saturn flight, the Apollo Program has been developing toward a lunar landing and exploration of the lunar surface. Each successive flight has demonstrated the performance capabilities of the space vehicle, crew, and ground support and has verified operational techniques and procedures. The first Apollo flights, AS-201 through Apollo 6, were launch vehicle and spacecraft development flights. Apollo 7, the first manned flight, demonstrated Command/Service Module (CSM)/crew performance and CSM rendezvous capability. The Apollo 8 Mission carried CSM operations further by successfully demonstrating CSM operations and selected backup lunar landing mission activities in lunar orbit. Apollo 9 was an earth-orbital mission which demonstrated CSM/Lunar Module (LM) operations and LM/crew performance of selected lunar landing mission activities in earth orbit. The final developmental mission before the actual lunar landing was Apollo 10. It evaluated LM performance in the cislunar and lunar environment and duplicated the lunar landing mission profile as closely as possible without actually landing. The success of these missions finally culminated in the Apollo 11 Mission, the first manned lunar landing and return mission. The success of the Apollo 11 Mission verified the performance of the space vehicle and support systems and proved man's capability to accomplish a lunar mission enabling the Apollo Program to proceed with detailed exploration of the lunar surface. Figure 1 traces the Apollo flight mission development phases through the first lunar landing.

The final nine lunar exploration missions in the Apollo Program will be divided into two types of missions — H-series and J-series. The four H-series missions, Apollo 12 through Apollo 15, will be flown with standard Apollo hardware and will provide increased surface stay time with two extravehicular activity (EVA) periods, improved landing accuracy, development of CSM transport techniques, and will establish a seismic network. The last five missions, Apollo 16 through Apollo 20, will be J-series missions and will be flown with modified Apollo hardware designed to extend mission duration and lunar surface stay time, to increase landed payload and sample return, to extend lunar surface EVA operations and increase mobility, and to provide for scientific experiments and mapping to be accomplished in lunar orbit.



APOLLO FLIGHT MISSION DEVELOPMENT PHASES

Fig. 1

NASA OMSF PRIMARY MISSION OBJECTIVES FOR APOLLO 12

PRIMARY OBJECTIVES

- Perform selenological inspection, survey, and sampling in a mare area.
- Deploy and activate an Apollo Lunar Surface Experiments Package (ALSEP).
- Develop techniques for a point landing capability.
- Develop man's capability to work in the lunar environment.
- Obtain photographs of candidate exploration sites.

Rocco A Petrone
Rocco A. Petrone
Apollo Program Director

Date: 31 October 1969

Charles W. Mathews
for George E. Mueller
Associate Administrator for
Manned Space Flight

Date: 11-3-69

DETAILED OBJECTIVES AND EXPERIMENTS

PRINCIPAL DETAILED OBJECTIVES

1. Contingency Sample Collection.
2. Lunar Surface EVA Operations.
3. Apollo Lunar Surface Experiments Package (ALSEP) I Deployment and Activation.
4. Selected Sample Collection.
5. PLSS Recharge.
6. Lunar Field Geology (S-059).
7. Photography of Candidate Exploration Sites.
8. Lunar Surface Characteristics.
9. Lunar Environment Visibility.
10. Landed LM Location.
11. Selenodetic Reference Point Update.
12. Solar Wind Composition (S-080).
13. Lunar Multispectral Photography (S-158).

SECONDARY DETAILED OBJECTIVES

14. Surveyor III Investigation.
15. Photographic Coverage During Lunar Landing and Lunar Surface Operations.
16. Television Coverage Through the Erectable S-band Antenna.

LAUNCH COUNTDOWN AND TURNAROUND CAPABILITY, AS-507

COUNTDOWN

Countdown (CD) for launch of the AS-507 Space Vehicle (SV) for the Apollo 12 Mission will begin with a precount starting at T-98 hours during which launch vehicle (LV) and spacecraft (S/C) CD activities will be conducted independently. Official coordinated S/C and LV CD will begin at T-28 hours. Figure 2 shows the significant events beginning with the official countdown start.

SCRUB/TURNAROUND

Turnaround is the time required to recycle and count down to launch (T-0) in a subsequent launch window. The following launch window constraints apply:

- 56 hours 09 minutes are available for turnaround between the opening of the 14 November and the closing of the 16 November launch windows.
- 29 hours 13 minutes are available for turnaround between the opening of the 14 December and the closing of the 15 December launch windows.

Scrub can occur at any point in the CD when launch support facilities, SV conditions, or weather warrant. For a hold that results in a scrub prior to T-22 minutes, turnaround procedures are initiated from the point of hold. Should a hold occur from T-22 minutes (S-II start bottle chilldown) to T-16.2 seconds (S-IC forward umbilical disconnect), then a recycle to T-22 minutes, a hold, or a scrub is possible under conditions stated in the Launch Mission Rules. A hold between T-16.2 seconds and T-8.9 seconds (ignition) could result in either a recycle or a scrub depending upon the circumstances. An automatic or manual cutoff after T-8.9 seconds will result in a scrub.

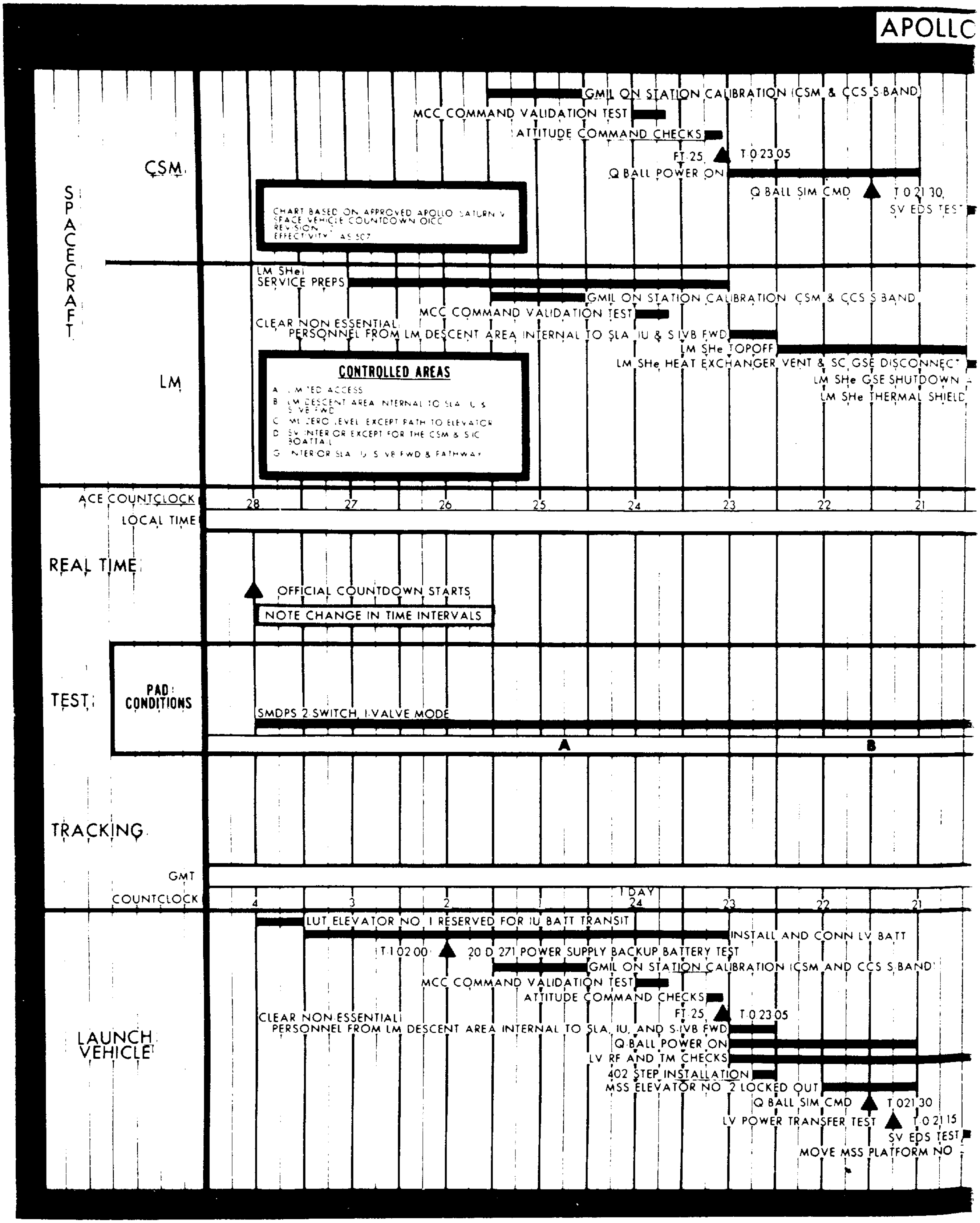
Two basic cases can be identified to implement the required turnaround activities in preparation for a subsequent launch attempt following a scrub prior to ignition command. These cases identify the turnaround activities necessary to maintain the same confidence for subsequent launch attempts as for the original attempt. The scrub/turnaround time for each case is the minimum time required to effect recycle and CD of the SV to T-0 (liftoff) after a scrub. They do not account for serial times which may be required for repair or retest of any systems which may have caused the scrub, nor do they include built-in holds for launch window synchronization. The basic difference in the two cases is the requirement to reservice the spacecraft cryogenics, which necessitates detailed safety precautions and the reuse of the Mobile Service Structure.

48-Hour Scrub/Turnaround

A 48-hour scrub/turnaround capability exists from any point in the launch CD up to T-8.9 seconds. This turnaround capability provides for reservicing all SV cryogenics and resumption of the CD at T-9 hours.

24-Hour Scrub/Turnaround

A 24-hour turnaround capability exists as late in the CD as T-8.9 seconds. This capability depends upon having sufficient S/C consumables margins above redline quantities stated in the Launch Mission Rules (or negotiated changes to these redline quantities) for the period remaining to the next launch window. The CD would be resumed at T-9 hours.


APOLLC
SPACECRAFT
CSM
GMIL ON STATION CALIBRATION (CSM & CCS S BAND)
MCC COMMAND VALIDATION TEST
ATTITUDE COMMAND CHECKS
FT 25
T 0 23 05
Q BALL POWER ON
Q BALL SIM CMD
T 0 21 30
SV EDS TEST
CHART BASED ON APPROVED APOLLO SATURN V SPACE VEHICLE COUNTDOWN OICC REVISION EFFECTIVITY AS 507
LM
LM SHe SERVICE PREPS
GMIL ON STATION CALIBRATION CSM & CCS S BAND
MCC COMMAND VALIDATION TEST
CLEAR NON ESSENTIAL PERSONNEL FROM LM DESCENT AREA INTERNAL TO SLA IU & S IVB FWD
LM SHe TOPOFF
LM SHe HEAT EXCHANGER VENT & SC GSE DISCONNECT
LM SHe GSE SHUTDOWN
LM SHe THERMAL SHIELD
CONTROLLED AREAS
A LIMITED ACCESS
B LM DESCENT AREA INTERNAL TO SLA IU S IVB FWD
C ML ZERO LEVEL EXCEPT PATH TO ELEVATOR
D SV INTERIOR EXCEPT FOR THE CSM & SIC BOATTAIL
G INTERIOR SLA IU S IVB FWD & PATHWAY
ACE COUNTCLOCK
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27
26
25
24
23
22
21
LOCAL TIME
REAL TIME
OFFICIAL COUNTDOWN STARTS
NOTE CHANGE IN TIME INTERVALS
TEST
PAD CONDITIONS
SMDPS 2 SWITCH, 1 VALVE MODE
A
B
TRACKING
GMT
COUNTCLOCK
4
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1 DAY
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23
22
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GMIL ON STATION CALIBRATION (CSM AND CCS S BAND)
MCC COMMAND VALIDATION TEST
ATTITUDE COMMAND CHECKS
FT 25
T 0 23 05
CLEAR NON ESSENTIAL PERSONNEL FROM LM DESCENT AREA INTERNAL TO SLA, IU, AND S IVB FWD
Q BALL POWER ON
LV RF AND TM CHECKS
402 STEP INSTALLATION
MSS ELEVATOR NO 2 LOCKED OUT
Q BALL SIM CMD
T 0 21 30
LV POWER TRANSFER TEST
T 0 21 15
SV EDS TEST
MOVE MSS PLATFORM NO

V SPACE VEHICLE COUNTDOWN

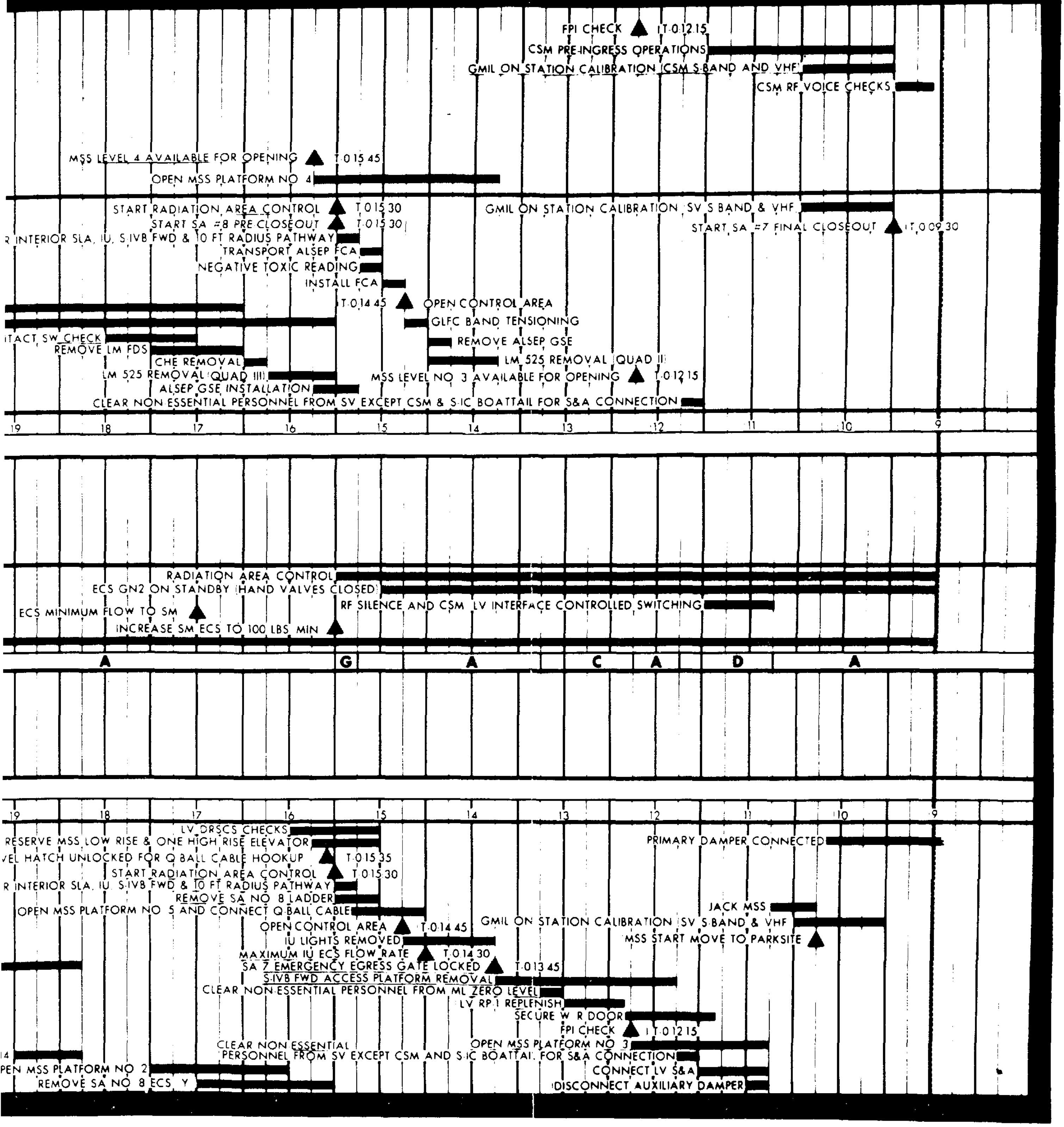
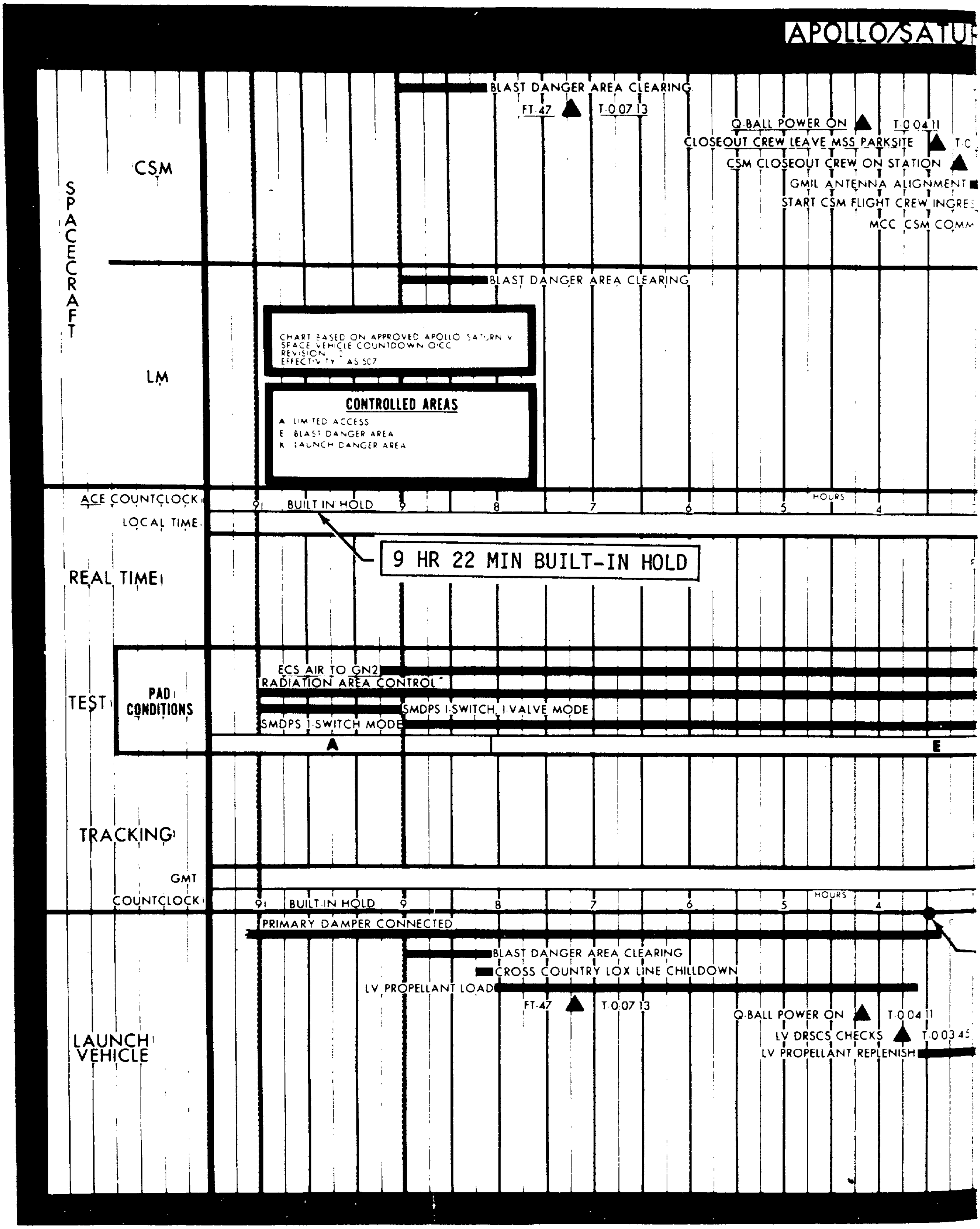


Fig. 2


APOLLO/SATU
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CSM
BLAST DANGER AREA CLEARING
FT-47
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Q-BALL POWER ON
T-0 04 11
CLOSEOUT CREW LEAVE MSS PARKSITE
T-0
CSM CLOSEOUT CREW ON STATION
GMIL ANTENNA ALIGNMENT
START CSM FLIGHT CREW INGRE
MCC CSM COMM
LM
BLAST DANGER AREA CLEARING
CHART BASED ON APPROVED APOLLO SATURN V SPACE VEHICLE COUNTDOWN OCC
REVISION 2
EFFECTIVITY AS 507
CONTROLLED AREAS
A LIMITED ACCESS
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BUILT IN HOLD
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HOURS
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LOCAL TIME
9 HR 22 MIN BUILT-IN HOLD
REAL TIME
TEST
PAD CONDITIONS
ECS AIR TO GN2
RADIATION AREA CONTROL
SMDPS I-SWITCH, I-VALVE MODE
SMDPS I-SWITCH MODE
A
E
TRACKING
GMT
COUNTCLOCK
91
BUILT IN HOLD
9
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7
6
5
HOURS
4
PRIMARY DAMPER CONNECTED
BLAST DANGER AREA CLEARING
CROSS COUNTRY LOX LINE CHILLDOWN
LV PROPELLANT LOAD
FT-47
T-0 07 13
Q-BALL POWER ON
T-0 04 11
LV DRSCS CHECKS
T-0 03 45
LV PROPELLANT REPLENISH
LAUNCH VEHICLE

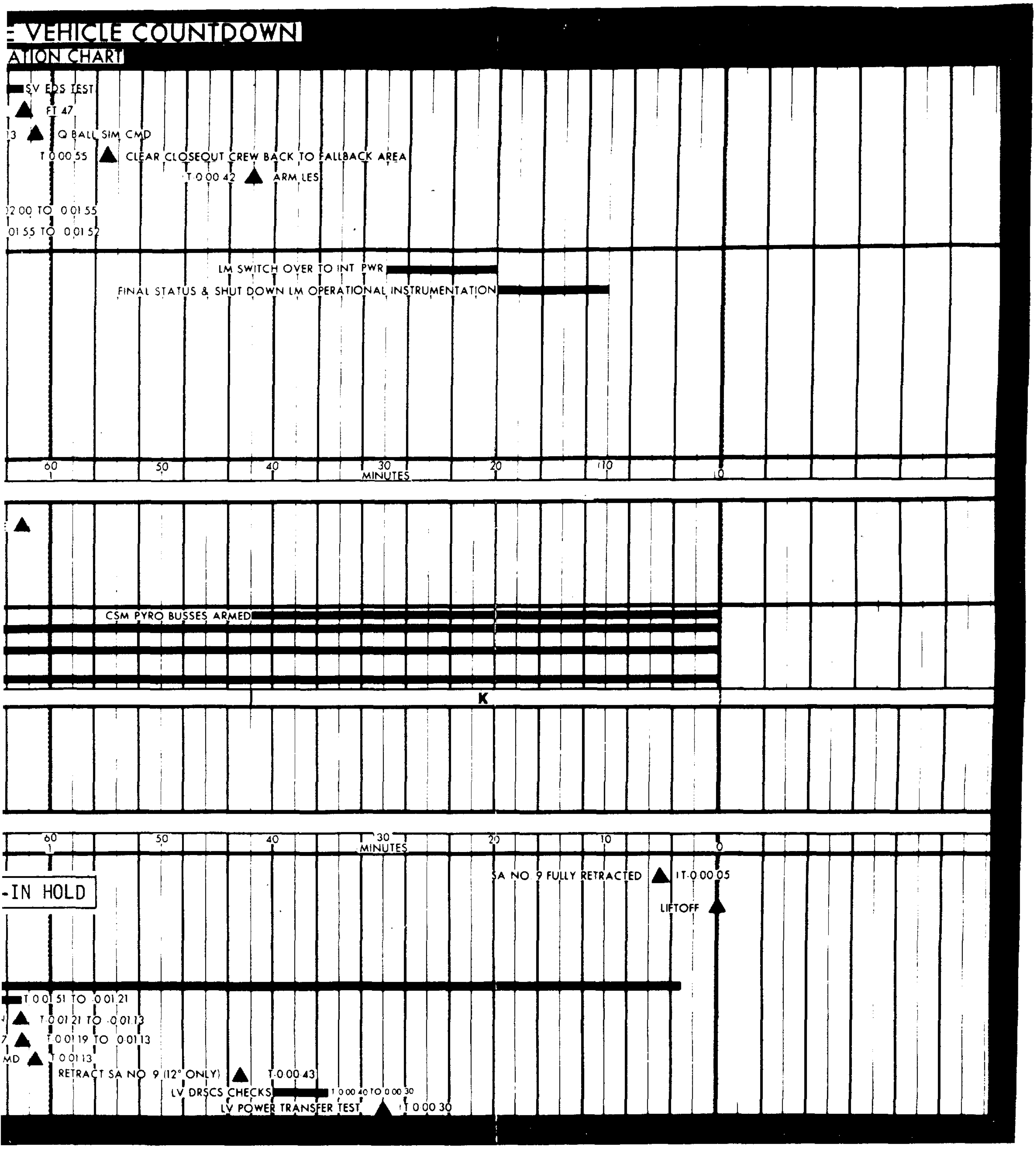


Fig. 2 (Continued)

FLIGHT MISSION DESCRIPTION

LANDING SITES

Apollo Lunar Landing Site 7 is the prime site for the Apollo 12 Mission. This site is located entirely within relatively old (Imbrian) mare material and also shares the characteristic distribution of large subdued 200-600 meter (m) diameter craters as well as the characteristic lower density of 50-200 m diameter craters. This site includes the crater in which Surveyor III landed in April 1967. One of the primary scientific objectives of landing at this site is to sample a second mare for comparison with Apollo 11 and Surveyor data in order to learn the variability in composition and age of the "Imbrium" mare unit.

Apollo Lunar Landing Site 5 is the recycle site for this mission and is located within relatively young (Eratosthenian) mare material. In contrast to Tranquility Base and Landing Site 7, the area of this site displays a large number of intermediate size craters 50-200 m in diameter and a small number of larger subdued craters 200-600 m in diameter. The site is surrounded by well-developed crater clusters of the Kepler system. Small, weakly developed crater clusters and lineaments radial to Kepler occur within the site. Thus some material derived from depth at Kepler may be presented in the surficial material, and fine-scale textural details related to the Kepler rays may also be present. There are more resolvable blocks (greater than 2 m) around craters than in the three sites to the east (Landing Sites 1, 2, and 3) suggesting that the surficial material is generally coarser grained.

LAUNCH WINDOWS

The launch windows for both Site 7 and Site 5 are shown in Table 1.

TABLE 1
APOLLO 12 LANDING SITES/LAUNCH WINDOWS

			NOV (EST)			DEC (EST)		
SITE	**LONG.**	**LAT.**	**DATE**	**OPEN-CLOSE**	**SEA***	**DATE**	**OPEN-CLOSE**	**SEA**
7	23°24'W.	2°59'S.	14	1122-1428	5.1°	14	1334-1658	10°
5	41°54'W.	1°41'N.	16	1409-1727	10.7°	15	1513-1847	5.3°

* SUN ELEVATION ANGLE

HYBRID TRAJECTORY

The Apollo 12 Mission will use a hybrid trajectory that retains most of the safety features of the free-return trajectory, but without the performance limitations. The spacecraft will be injected into a highly eccentric elliptical orbit (perilune altitude of approximately 1850 nautical miles (NM), which has the free-return characteristic, i.e., the spacecraft can return to the entry corridor without any further maneuvers. The spacecraft will not depart from the free-return ellipse until after the Lunar Module (LM) has been extracted from the launch vehicle and can provide a propulsion system backup to the Service Propulsion System (SPS). After approximately 28 hours from translunar injection, a midcourse maneuver will be performed by the SPS to place the spacecraft on a lunar approach trajectory (non-free-return) having a lower perilune altitude.

The use of a hybrid trajectory will permit:

- Daylight launch/Pacific injection. This would allow the crew to acquire the horizon as a backup attitude reference during high altitude abort, would provide launch abort recovery visibility, and would improve launch photographic coverage.

- Desired lunar landing site sun elevation. The hybrid profile facilitates adjustment of translunar transit time which can be used to control sun angles on the landing site during lunar orbit and on landing.

- Increased spacecraft performance. The launch vehicle energy requirements for translunar injection into the highly eccentric elliptical orbit are less than those for a free-return trajectory from which lunar orbit insertion would be performed. This allows for an increase in spacecraft payload/SPS propellant. The energy of the spacecraft on a hybrid lunar approach trajectory is relatively low compared to what it would be on a full free-return trajectory thus reducing the differential velocity ($\triangle$V) required to achieve lunar orbit insertion.

LUNAR MODULE POINT LANDING

The LM point landing capability of Apollo 12 is being enhanced in two significant areas. The first is concerned with improving the ground targeting of the Primary Guidance Navigation and Control System (PGNCS), i.e., updating the LM guidance computer with the LM's current position and velocity, and the landing site position. The second is concerned with reducing the in-orbit perturbations during the last three orbits before descent orbit insertion.

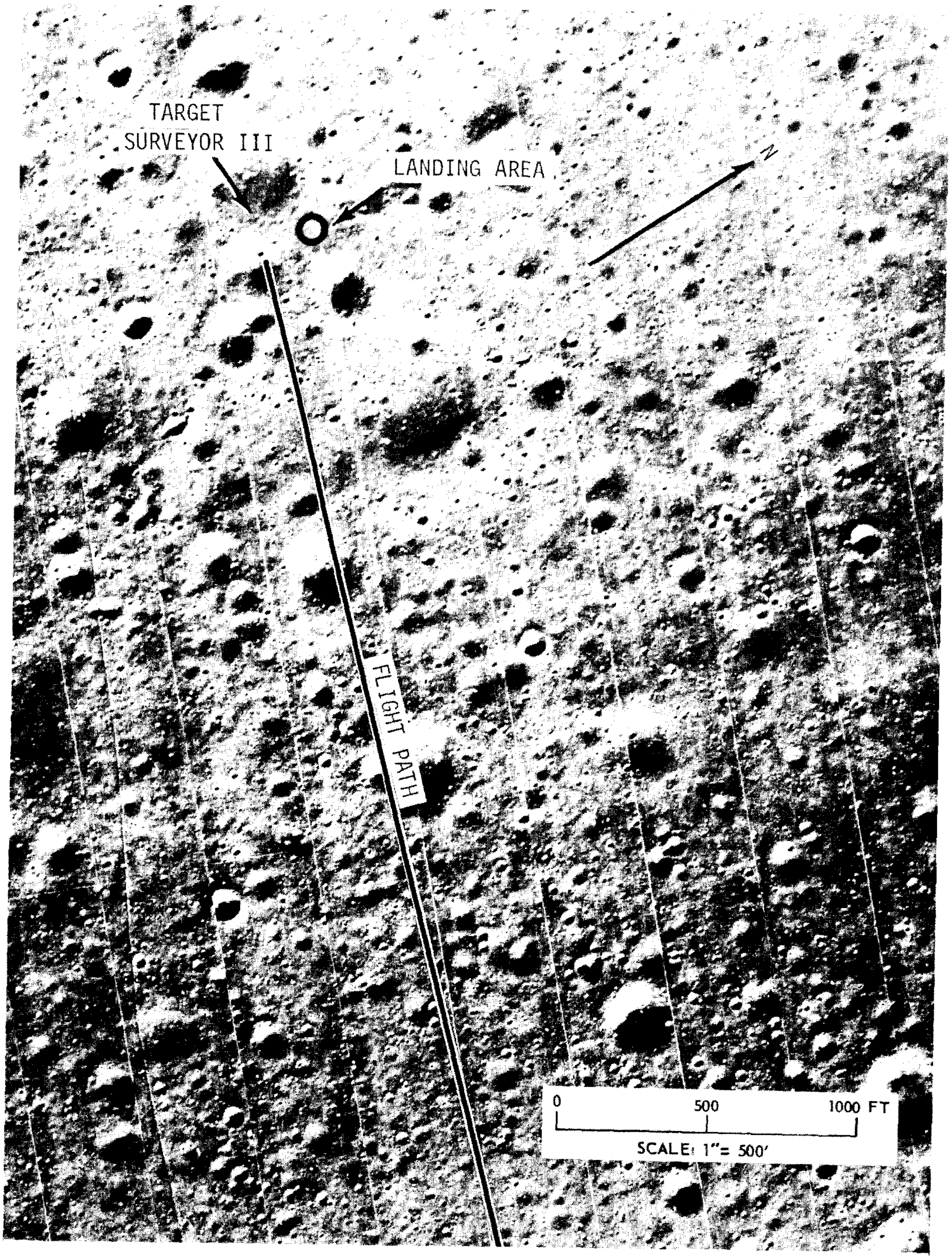
Significant improvements in ground targeting of the PGNCS include:

- Adding one more term to the computer program coverage of the lunar potential model in the Real-Time Computer Complex. This permits a significant improvement in LM orbit determination and descent targeting during a single LM orbit.
- Updating the PGNCS with the LM's position after undocking to avoid the degrading effect of this maneuver on the LM state vector.
- Updating the LM downtrack position relative to the landing site during powered descent.

Steps taken to reduce in-orbit perturbations include:

- Water and waste dumps will be avoided 8-10 hours before landing.
- LM Reaction Control System (RCS) checkout will be done with rotational maneuvers and with cold fire instead of "nulled" translational maneuvers.
- Command/Service Module (CSM) will perform undocking maneuver.
- LM undocking will be done radially to avoid downrange ΔV.
- Soft undocking will be performed.
- Landing gear inspection will be deleted if indications are nominal.
- CSM rather than the LM will be active in station keeping.
- CSM will perform separation maneuver.

Figure 3 shows the Apollo 12 landing site. Targeting will be to Surveyor III and manual control will be used to fly to the actual landing area.



APOLLO 12 LANDING SITE

Fig. 3

FLIGHT PROFILE

Launch Through Earth Parking Orbit

The AS-507 Space Vehicle for the Apollo 12 Mission is planned to be launched at 11:22 EST on 14 November 1969 from Launch Complex 39A at the Kennedy Space Center, Florida, on a launch azimuth of 72°. The Saturn V Launch Vehicle will insert the S-IVB/Instrument Unit (IU)/LM/CSM into a 103-NM, circular orbit. The S-IVB and spacecraft checkout will be accomplished during the orbital coast phase. Figure 4 and Tables 2 through 4 summarize the flight profile events and space vehicle weight.

Translunar Injection

Approximately 2.8 hours after liftoff, the launch vehicle S-IVB stage will be reignited during the second parking orbit to perform the translunar injection (TLI) maneuver, placing the spacecraft on a free-return trajectory having a perilune of approximately 1850 NM.

Translunar Coast

The CSM will separate from the S-IVB/IU/LM approximately 3.2 hours Ground Elapsed Time (GET), transpose, dock, and initiate ejection of the LM. During these maneuvers, the LM and S-IVB/IU will be photographed to provide engineering data.

An S-IVB evasive maneuver will be initiated by ground command approximately 1.6 hours after TLI. This maneuver will be performed by the Auxiliary Propulsion System (APS) of the S-IVB to impart a $\triangle$V of approximately 10 feet per second (fps) and prevent recontact with the spacecraft. Shortly thereafter, an S-IVB "slingshot" maneuver will be performed to place the S-IVB/IU onto a trajectory passing the moon's trailing edge and into solar orbit. This maneuver will be performed by a combination of continuous hydrogen venting, liquid oxygen (LOX) dumping, and an APS ullage maneuver. The total $\triangle$V imparted to the S-IVB/IU by the "slingshot" maneuver will be approximately 115 fps.

The spacecraft will be placed on a hybrid trajectory by performing an SPS maneuver at the time scheduled for the second midcourse correction (MCC) approximately 31 hours from liftoff. The CSM/LM combination will be targeted for a pericynthion altitude of 60 NM and, as a result of the SPS maneuver, will be placed on a non-free-return trajectory. The spacecraft will remain within a LM Descent Propulsion System (DPS) return capability.

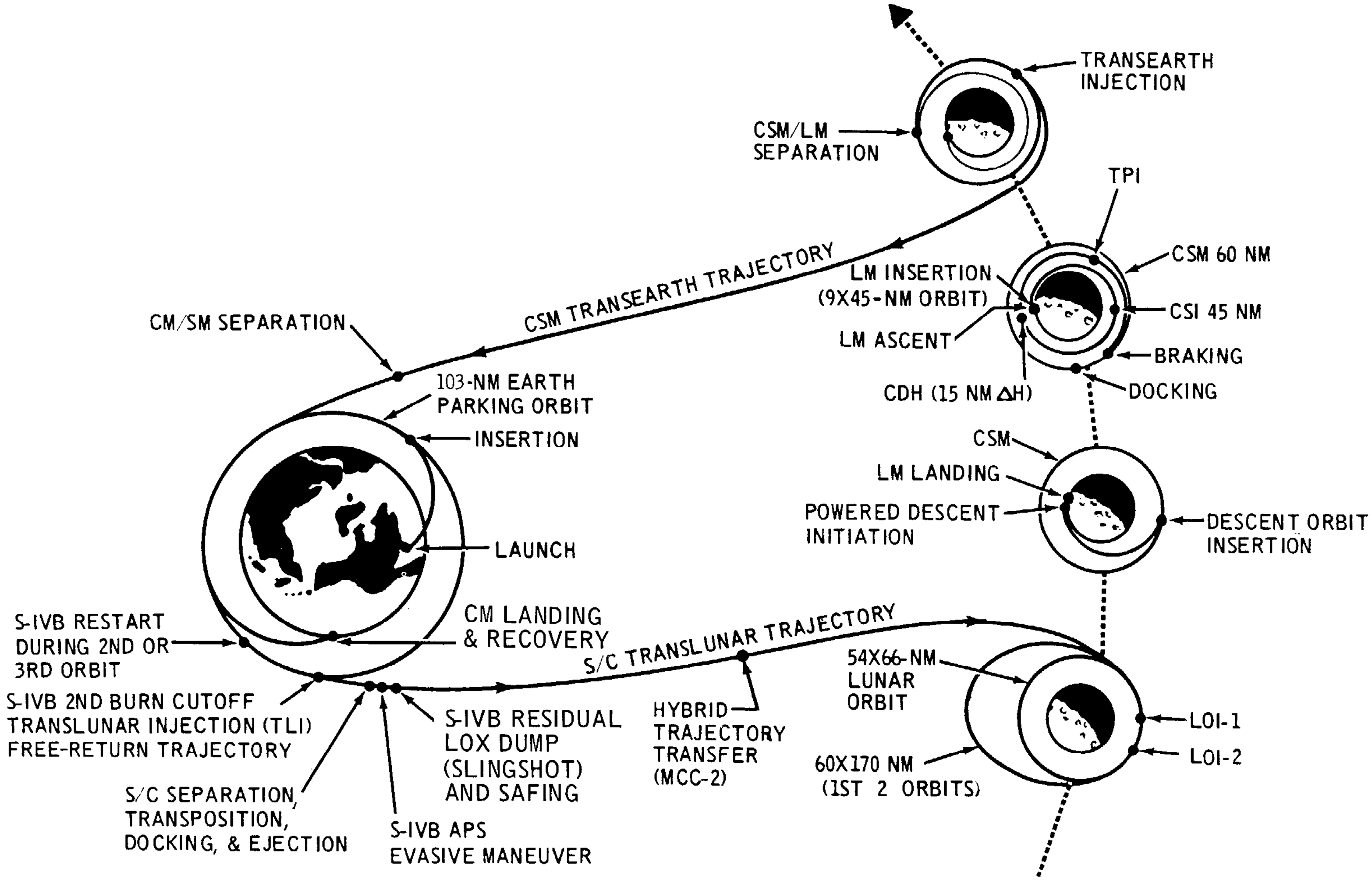


Fig. 4

APOLLO 12 FLIGHT PROFILE

TABLE 2
APOLLO 12 MISSION SUMMARY

EVENT	GET DAY:HR:MIN	DATE/EST HR:MIN	BURN DURATION (APPROX. SEC.)	REMARKS
LAUNCH	0:00:00	14/11:22		WINDOW CLOSES 1428 EST
TRANSLUNAR INJECTION (TLI)	0:02:47	14/14:09	345 (S-IVB)	PACIFIC OCEAN
MIDCOURSE CORRECTION (MCC-2)	1:06:53	15/18:15	10 (SPS)	HYBRID TRANSFER
LUNAR ORBIT INSERTION (LOI-1)	3:11:25	17/22:47	355 (SPS)	ORBIT: 59 X 169 MILES
LUNAR ORBIT INSERTION (LOI-2)	3:15:44	18/03:06	18 (SPS)	ORBIT: 53 X 65 MILES
UNDOCK	4:11:54	18/23:16	16 (CSM-RCS)	
DESCENT ORBIT INSERTION (DOI)	4:13:23	19/00:45	28 (DPS)	LM ORBIT: 59X8 MILES
POWERED DESCENT INITIATION (PDI)	4:14:20	19/01:42	679 (DPS)	
LANDING	4:14:31	19/01:53		
BEGIN EXTRAVEHICULAR ACTIVITY (EVA-1)	4:18:33	19/05:55		3 HOURS 30 MINUTES
BEGIN EVA 2	5:13:07	20/00:29		3 HOURS 30 MINUTES
LM LIFTOFF	5:22:01	20/09:23	430 (APS)	LM ORBIT 8 X 45 MILES
DOCKING	6:01:40	20/13:02		
LUNAR ORBIT PLANE CHANGE	6:15:02	21/02:24	18 (SPS)	
TRANSEARTH INJECTION (TEI)	7:04:21	21/15:43	129 (SPS)	
LANDING	10:04:35	24/15:57		LATITUDE = 16°S LONGITUDE = 165°W LOCAL TIME 09:57 (SUN RISE + 5 HR.) MISSION DURATION: 244 HR. 35 MIN.

TABLE 3
APOLLO 12 TV SCHEDULE

DAY	DATE	EST	GET	COVERAGE
FRIDAY	NOV. 14	14:42	03:25	TRANSPOSITION / DOCKING
SATURDAY	NOV. 15	17:47	30:25	HYBRID TRAJ. / SPACECRAFT INTERIOR
MONDAY	NOV. 17	02:52	63:30	EARTH, IVT, S/C INTERIOR
		20:52	81:30	PRE LOI-1, LUNAR SURFACE
		23:22	84:00	LUNAR SURFACE
TUESDAY	NOV. 18	23:12	107:50	UNDOCKING / FORMATION FLYING
WEDNESDAY	NOV. 19	06:02	114:40	LUNAR SURFACE EVA
THURSDAY	NOV. 20	00:42	133:20	EVA - 2, EQUIPMENT JETTISON
		12:37	145:15	DOCKING
FRIDAY	NOV. 21	16:17	172:55	POST - TEI / LUNAR SURFACE
SUNDAY	NOV. 23	18:37	223:15	MOON - EARTH - S/C INTERIOR

TABLE 4
APOLLO 12 WEIGHT SUMMARY

(Weight in Pounds)

STAGE/MODULE	INERT WEIGHT	TOTAL EXPENDABLES	TOTAL WEIGHT	FINAL SEPARATION WEIGHT
S-IC Stage	287,850	4,742,865	5,030,715	363,465
S-IC/S-II Interstage	11,465	---	11,465	---
S-II Stage	80,220	980,200	1,060,420	94,440
S-II/S-IVB Interstage	8,035	---	8,035	---
S-IVB Stage	25,050	235,020	262,070	28,440
Instrument Unit	4,275	---	4,275	---
Launch Vehicle at Ignition			6,374,980	
Spacecraft-LM Adapter	4,060	---	4,060	---
Lunar Module	9,635	23,690	33,325	*33,740
Service Module	10,510	40,595	51,105	11,840
Command Module	12,365	---	12,365	11,145 (Landing)
Launch Escape System	8,945	---	8,945	---
Spacecraft At Ignition			109,800	
Space Vehicle at Ignition			6,484,780	
S-IC Thrust Buildup			(-) 85,320	
Space Vehicle at Liftoff			6,399,300	
Space Vehicle at Orbit Insertion			300,269	

* CSM/LM Separation.

The earth will be photographed several times each day during this coast phase for oceanographic, global weather, and documentation purposes as the spacecraft attitude and crew time permit. The moon will also be photographed. MCC's will be made as required, using the Manned Space Flight Network (MSFN) for navigation.

Lunar Orbit Insertion

The SPS will insert the spacecraft into an initial lunar orbit (approximately 60 x 170 NM) 83.4 hours from liftoff (Figure 4). Following insertion and systems checks, a second SPS retrograde burn will be made to place the spacecraft in an elliptical orbit 54 x 66 NM. This orbit is planned to become circular at 60 NM by the time of LM rendezvous.

Because lunar orbit insertion (LOI) always occurs behind the moon, the crew will be required to evaluate the progress of the maneuver without ground support. Although two LOI burns are required to produce a near circular orbit, the monitoring requirements primarily impact the first burn (LOI-1), because the second burn (LOI-2) lasts for only approximately 18 seconds. The horizon and several stars should be visible from the Commander's (CDR's) rendezvous window and may be used as a backup to the optics for the orientation check prior to SPS ignition.

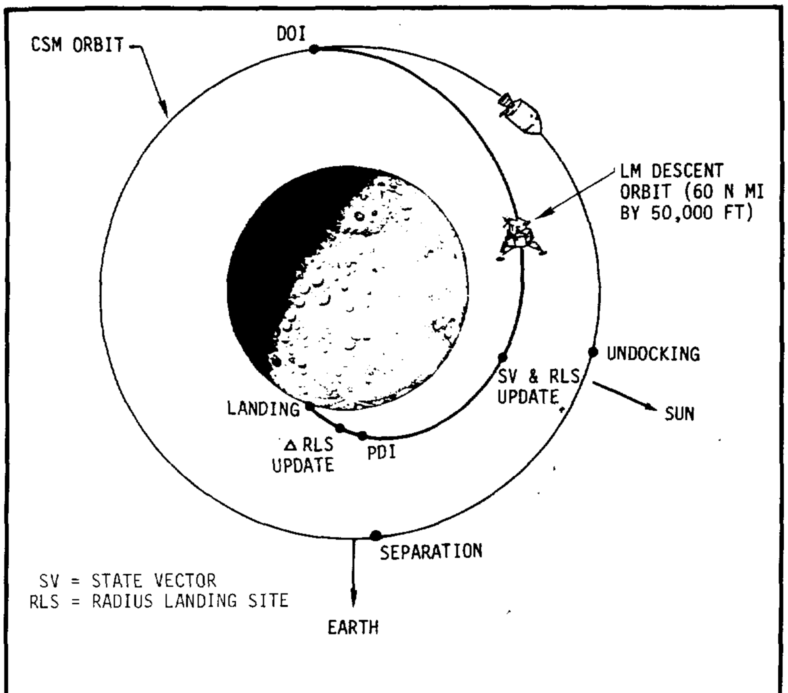
Lunar Orbit Coast

After LOI-2 the Lunar Module Pilot (LMP) and the CDR will enter the LM to perform housekeeping and the initial LM activation. Subsequently, a rest and eat period of approximately 8.5 hours will be provided for the three astronauts prior to LM activation and checkout.

The CSM will separate radially upward from the LM at approximately 20.7 hours from LOI-2 using the soft undocking technique. The docking probe capture latches will be used to minimize separation ΔV perturbations. After undocking, the CSM will maintain a distance of 40 feet from the LM. The LM will not perform any inspection maneuvers (e.g., landing gear inspection), unless there is a real-time indication that the landing gear did not deploy properly.

Lunar Module Descent

The DPS will be used to perform the descent orbit insertion (DOI) maneuver approximately 1.5 hours after CSM/LM separation. This maneuver places the LM in a 60-NM by 50,000-foot orbit as shown in Figure 5.



LM DESCENT EVENTS

Fig. 5

Powered descent initiation (PDI) will occur near the pericynthion of the descent orbit (Figure 6). The vertical descent portion of the landing phase will start at an altitude of approximately 100 feet for an automatic approach. Present plans provide for manual takeover by the crew at an altitude of 500 feet.

During descent the lunar surface will be photographed to record LM movement, surface disturbances, and to aid in determining the landed LM location.

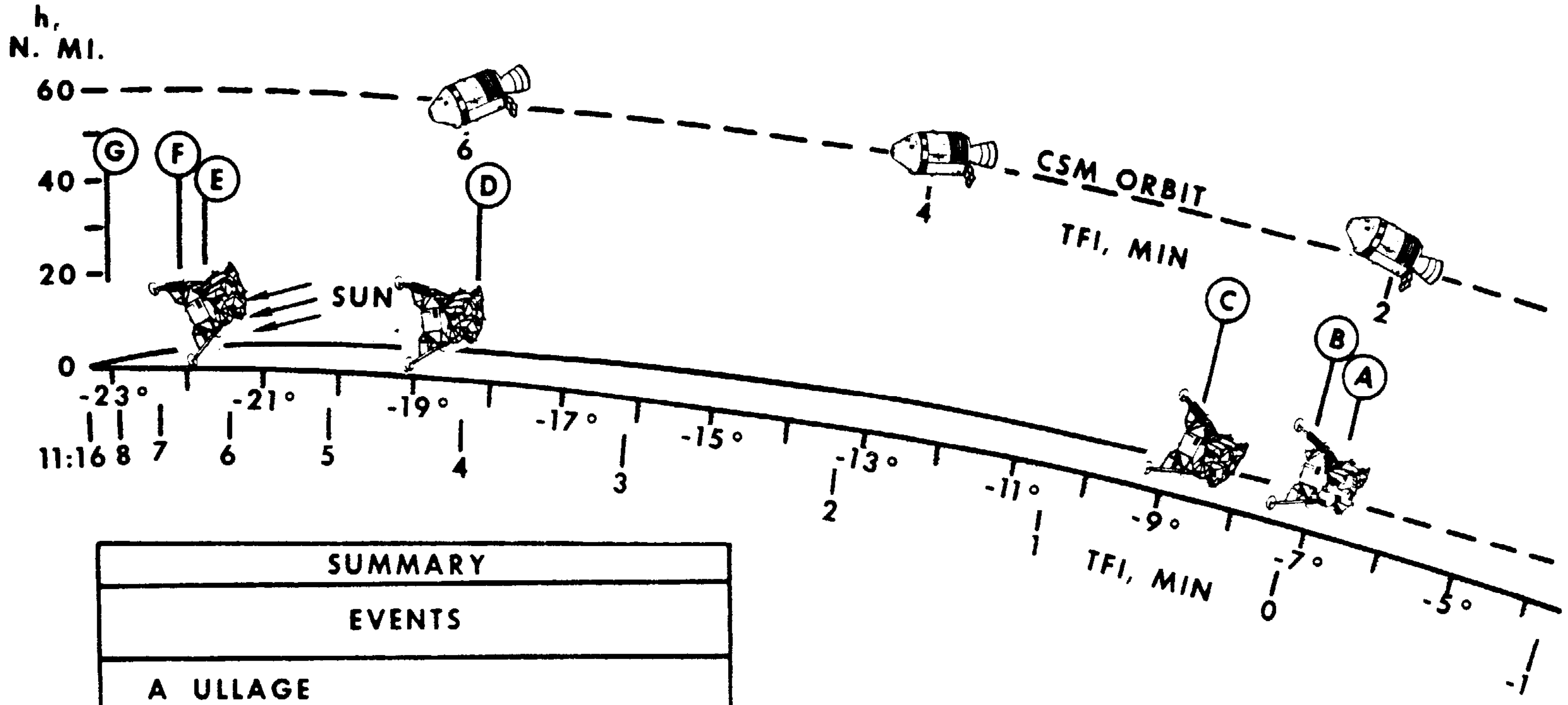
Lunar Surface Operations

Postlanding

Immediately upon landing, the LM crew will execute the lunar contact checklist and reach a stay/no-stay decision. After reaching a decision to stay, the Inertial Measurement Unit will be aligned, the Abort Guidance System gyro calibrated and aligned, and the lunar surface photographed through the LM window. Following a crew eat period all loose items not required for extravehicular activity (EVA) will be stowed.

EVA 1

The activity timeline for EVA 1 is shown in Figure 7. Both crew members will don helmets, gloves, Portable Life Support Systems (PLSS), and Oxygen Purge Systems (OPS) and the cabin will be depressurized from 3.5 pounds per square inch (psi).



SUMMARY

EVENTS

A	ULLAGE
B	POWERED DESCENT INITIATION
C	THROTTLE TO FTP
D	LANDING RADAR (LR) ALTITUDE UPDATE
E	THROTTLE RECOVERY
F	LR VELOCITY UPDATE
G	HIGH GATE

TFI – Time From Ignition
FTP – Full Throttle Position

Fig. 6

LM POWERED DESCENT

TIME SCALE 0 | 10 | 20 | 30 | 40

COMMAND MODULE PILOT ACTIVITY

CSM/LM COMM
IN COMM
OUT COMM

MCC-H ACTIVITY
●COMM CHECK
●CONFIRM "GO" FOR EVA

TV COVERAGE

SEQ. CAM. COVER.

COMMANDER ACTIVITY

FINAL PRE-EVA OPERATIONS
- START EVA WATCH
- LM FWD DUMP VLV - OPEN
- LM FWD DUMP VLV - AUTO.
- PLSS FEEDWATER - OPEN
- OPEN HATCH
- RELEASE PLSS ANTENNAS

CDR EGRESS
- MOVE THROUGH HATCH
- COMM CHECK
- DEPLOY LEC
- DEPLOY MESA
- DESCEND TO SURFACE

CDR ENVIRONMENTAL FAMILIARIZATION
- CHECK MOBILITY AND STABILITY
- CHECK REACH AND WALKING CAPABILITY
- CHECK AND REPORT LM STATUS

CONT. SAMPLE COLLECTION
- UNSTOW SAMPLER
- DEPLOY HANDLE
- COLLECT SAMPLE
- STOW SAMPLE

ETB TRANSFERS
- REMOVE MESA BLANKET
- ERECT MESA TABLE
- DEPLOY ETB
- REMOVE & STOW ETB CONTENTS
- PACK PLSS CONSUMABLES & CONTINGENCY SAMPLE IN ETB
- ATTACH LEC TO ETB
- TRANSFER ETB INTO LM
- REST/CHECK EMU
- TRANSFER ETB TO SURFACE
- ATTACH ETB TO MESA

LMP & CON
- PHOTO LM
- PHOTO

LM PILOT ACTIVITY

- PREP CONNECT LEC
- COMM CHECK
- PASS LEC TO CDR
- OPERATE SEQ. CAMERA
- MONITOR AND PHOTO CDR

- OPERATE SEQ. CAMERA
- PERFORM FINAL LM & EMU CHECK
- CONFIRM "GO" FOR EVA
- OPERATE SEQ. CAMERA
- ASSIST CDR
- STOW PLSS CONSUMABLES & CONTINGENCY SAMPLE IN LM
- PACK CAMERA IN ETB
- TRANSFER ETB TO SURFACE
- CHANGE SEQ. CAMERA MAG
- STOW LEC

LMP EGRESS
- MOVE THROUGH
- CLOSE HATCH
- DESCEND

TIME SCALE 0 | 10 | 20 | 30 | 40

1+45 | 1+50 | 2+00 | 2+10 | 2+20

OUT COMM

ALSEP SYSTEM INTERCONNECT
- POSITION SUBPALLET
- REMOVE SIDE FROM SUBPALLET
- CONNECT SIDE CABLE TO CENTRAL STATION
- STOW CARRY BAR ON SUBPALLET
- UNSTOW & POSITION PSE STOOL

SWE DEPLOYMENT
- REMOVE SWE FROM CENTRAL STATION
- DEPLOY SWE
- LEVEL & ALIGN SWE
- PHOTOGRAPH SWE
- REST/CHECK EMU

LSM OFFLOAD
- REMOVE LSM FROM CENTRAL STATION
- PLACE LSM ON SURFACE CLEAR OF CENTRAL STATION
- CHECK LSM CABLE CLEAR OF SUNSHIELD

SUNSHIELD DEPLOYMENT
- RELEASE PERIMETER BOYD BOLTS
- RELEASE ANTENNA & CABLE BOYD BOLTS
- RELEASE INNER BOYD BOLTS
- RAISE SUNSHIELD
- DEPLOY SIDE CURTAINS

ANTENNA INSTALLATION
- INSTALL ANTENNA MAST
- INSTALL ANTENNA ON MAST
- SET AZIMUTH & ELEVATION OFFSETS
- LEVEL & ALIGN ANTENNA

ALSEP ACT
- CHECK LM COMPLETE DEPLOYME
- REPORT
- DEPRESS
- REPORT
- TURN
- REQUE TURN
- CONF RECE GROU

ALSEP SYSTEM INTERCONNECT
- POSITION ALSEP PKG #2
- POSITION ALSEP PKG #1
- DEPLOY RTG CABLE
- REPORT AMPS
- CONNECT RTG CABLE TO CENTRAL STATION

PSE DEPLOYMENT
- REMOVE PSE FROM CENTRAL STATION & CARRY TO DEPLOYMENT SITE
- PLACE PSE ON PSE STOOL
- DEPLOY THERMAL SKIRT
- LEVEL PSE
- REPORT LEVEL AND ALIGNMENT
- PHOTOGRAPH PSE
- REST/ CHECK EMU

LSM DEPLOYMENT
- CARRY LSM TO DEPLOYMENT SITE
- DEPLOY SENSOR ARMS
- REMOVE PRA COVER
- LEVEL AND ALIGN LSM
- REPORT LEVEL AND ALIGNMENT
- PHOTOGRAPH LSM

SIDE DEPLOYMENT
- CARRY SIDE TO DEPLOYMENT SITE
- DEPLOY GROUND SCREEN
- DEPLOY CCIG
- LEVEL AND ALIGN SIDE
- REPORT LEVEL AND ALIGNMENT
- PHOTOGRAPH SIDE

ALSEP PHOT
- PHOT CENT
- PHOT SWE WIT STAT BACK
- RES EMU

1+45 | 1+50 | 2+00 | 2+10 | 2+20

2+40 | 2+50 | 3+00 | 3+10 | 3+20

OUT COMM

SRC 1 PACKING
- UNSTOW & OPEN SRC
- INSTALL SCALE & WEIGH BAG ON MESA
- SEAL ORGANIC CONTROL SAMPLE
- REMOVE SIDE BAGS
- COLLECT LOOSE SAMPLE MATERIAL
- PACK SAMPLES IN SRC
- TETHER TONGS
- REST/CHECK EMU

DOCUMENTED SAMPLE COLLECTION
- COLLECT DOCUMENTED SAMPLE

**
4 - HOUR EVA TIMELINE EXTENTION

CORE TUBE SAMPLE
- REMOVE SIDE BAGS
- PHOTO CORE TUBE SAMPLE SITE
- COLLECT CORE TUBE SAMPLE
- PHOTO CORE TUBE
- STOW CORE TUBE IN SRC 1
- REST/CHECK EMU

HTC LOADING
- POSITION HTC
- STOW TOOLS ON HTC
- POSITION TV FOR DOCUMENTED SAMPLE COLLECTION

DOCUMENTED SAMPLE COLLECTION
- COLLECT DOCUMENTED SAMPLE

2+40 | 2+50 | 3+00 | 3+10 | 3+20

RFACE ACTIVITY TIMELINE -EVA I

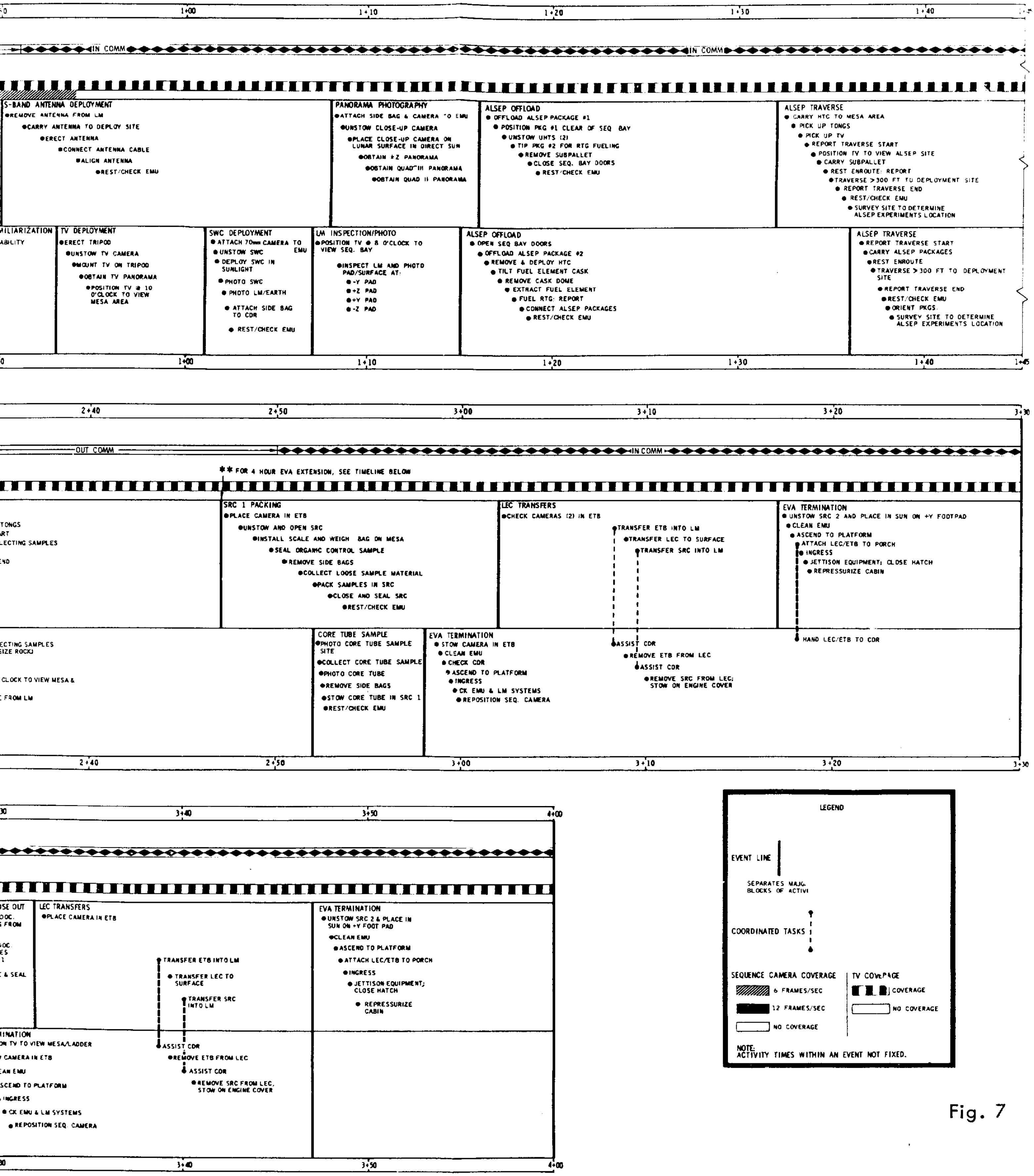
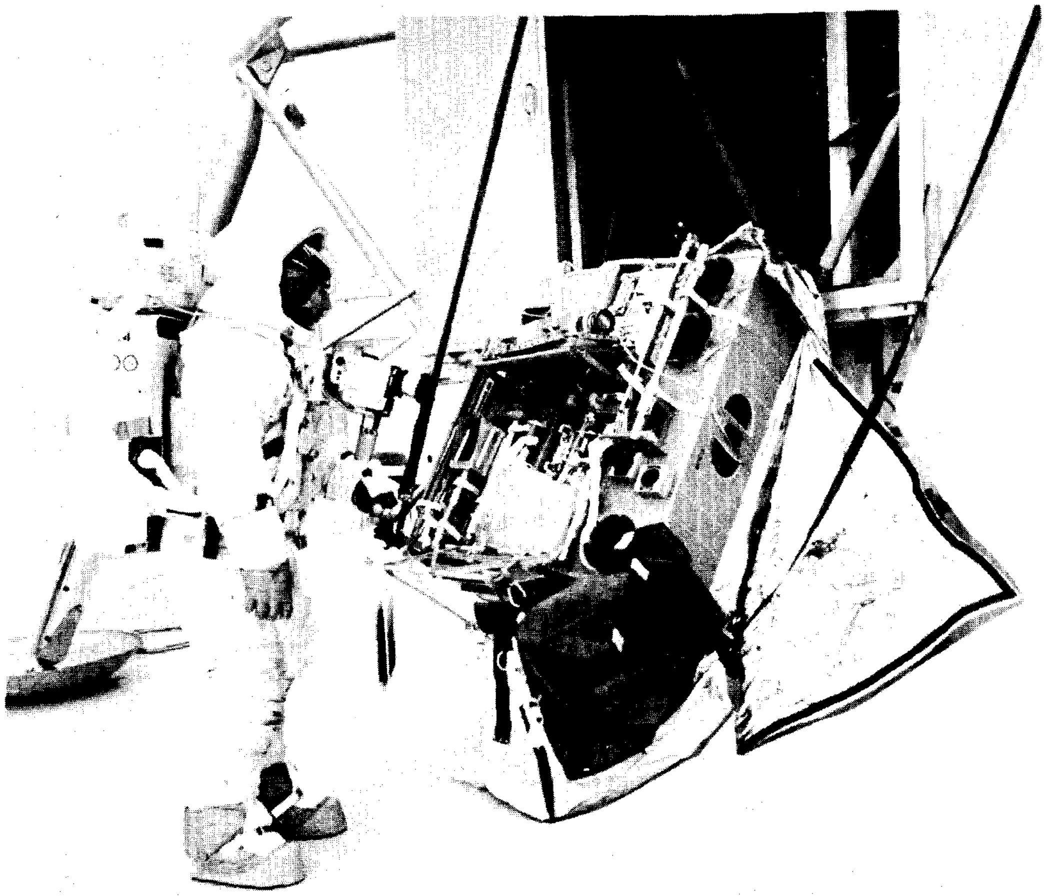


Fig. 7

The CDR will move through the hatch, deploy the Lunar Equipment Conveyor (LEC), and move to the ladder where he will deploy the Modularized Equipment Stowage Assembly (MESA), Figure 8, which initiates television coverage from the MESA. He will then descend the ladder to the lunar surface. The LMP will monitor and photograph the CDR using a 70mm and a sequence camera (16mm Data Acquisition Camera).

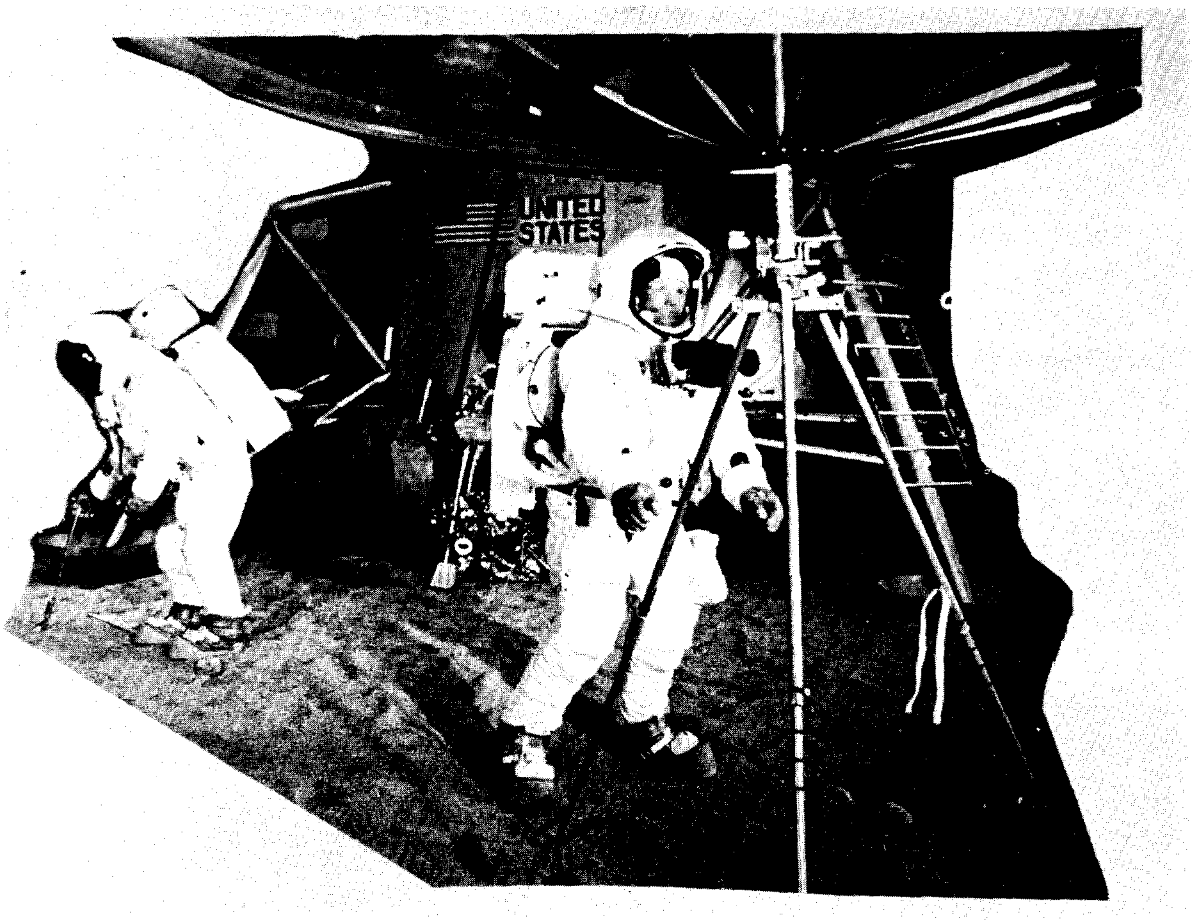


DEPLOYED MESA Fig. 8

Environmental Familiarization/Contingency Sample Collection - After stepping to the surface and checking his mobility, stability, and the Extravehicular Mobility Unit (EMU), the CDR will collect a contingency sample. This would make it possible to assess the differences in the lunar surface material between the Apollo 11 and 12 landing sites in the event the EVA were terminated at this point. The sample will be collected by quickly scooping up a loose sample of the lunar material (approximately 2 pounds), sealing it in a Contingency Sample Container, and transferring the sample in the Equipment Transfer Bag (ETB) along with the lithium hydroxide (LiOH) canisters and PLSS batteries into the LM using the LEC. The LMP will then transfer the 70mm cameras to the surface in the ETB.

Contingency Photography - The CDR will photograph the contingency sample area, deploy and photograph the color chart in the sunlight, and photograph the descent of the LMP to the surface.

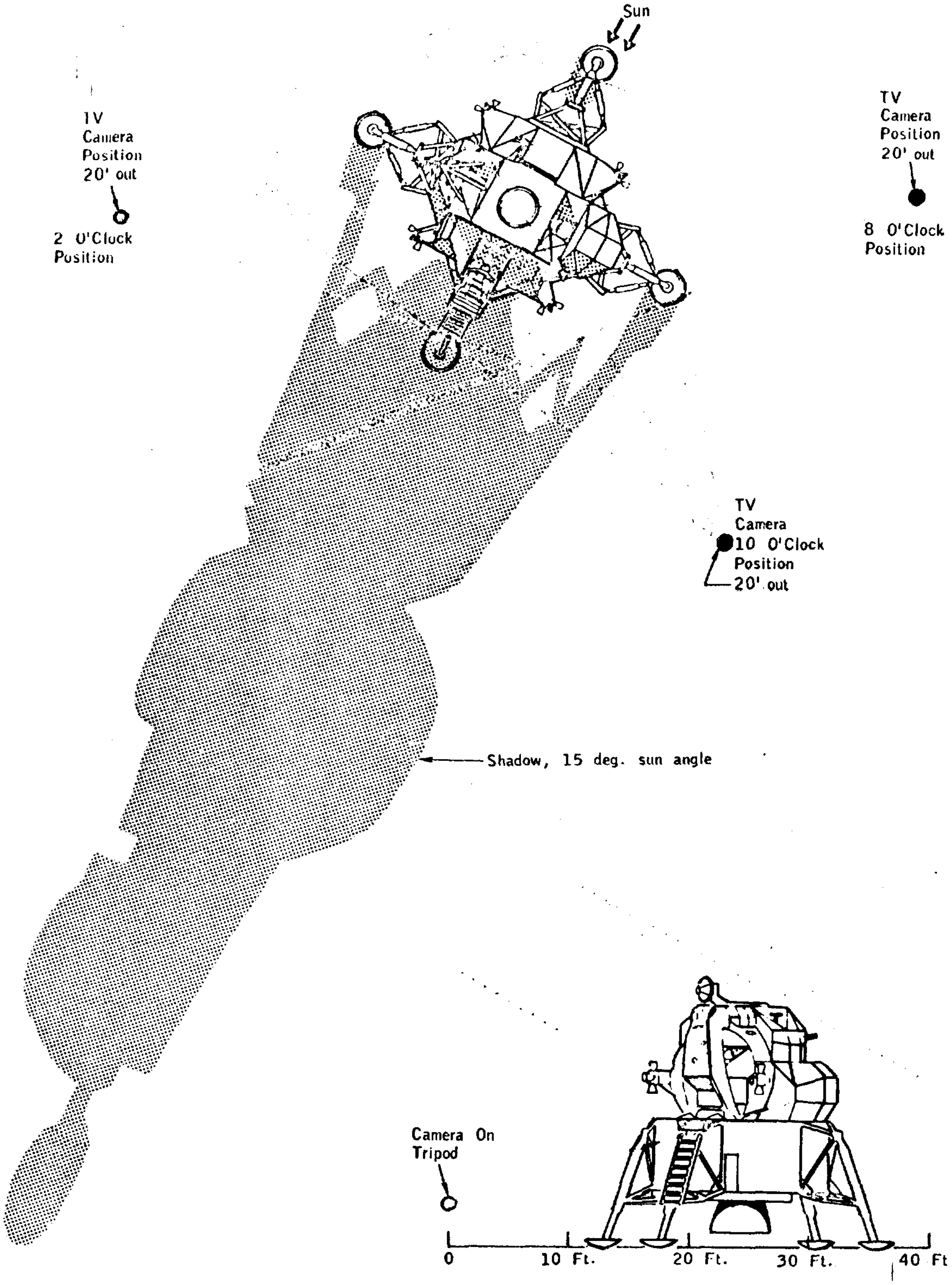
S-band Antenna Deployment - The S-band antenna will be removed from the LM and carried to the site where the CDR will erect it as shown in Figure 9, connect the antenna cable to the LM, and perform the required alignment.



DEPLOYED S-BAND ANTENNA Fig. 9

Flag Deployment - The CDR will then unstow the American flag and carry it to the deployment site and implant it in the lunar surface.

Lunar TV Camera Deployment - While the CDR deploys the S-band antenna, the LMP will unstow the TV camera and deploy it on the tripod approximately 20 feet from the LM in the 10 o'clock position (Figure 10). The LMP will then obtain TV panorama and special interest views after which he will point the camera at the S-band antenna/flag deployment/MESA area.



APOLLO 12 DEPLOYED TV CAMERA POSITIONS

Fig. 10

Solar Wind Composition Deployment - The LMP will next unstow and deploy the Solar Wind Composition (SWC) experiment which uses a 4-square foot aluminum foil area for entrapment of solar wind particles. It will be carried to the deployment site where the foil will be unfurled and the staff implanted in the lunar surface. As in the Apollo 11 Mission, the SWC detector will be brought back to earth by the astronauts. However, on Apollo 12 the detector will be exposed to the solar wind flux for approximately 17 hours instead of 2 hours and will be placed a sufficient distance away from the LM to protect it from lunar dust kicked up by astronaut activity.

LM Inspection - After repositioning the TV to view the Scientific Equipment Bay door area, the LMP will inspect and photograph the LM footpads and quadrants (QUAD's) I, II, III, and IV with his 70mm camera. Concurrently the CDR will obtain panorama and close-up photographs.

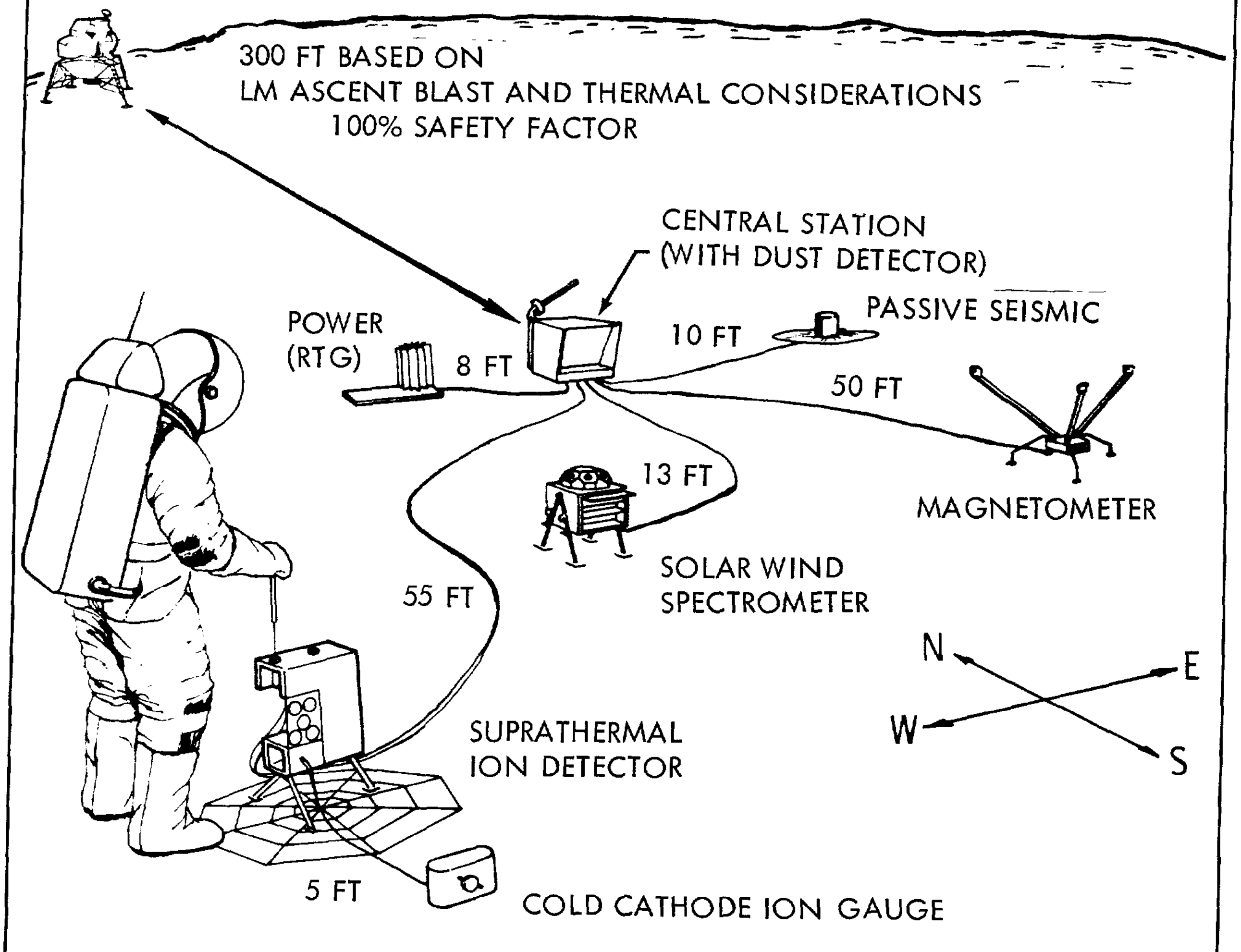
ALSEP Deployment - Both crew members will offload, deploy, and activate the Apollo Lunar Surface Experiments Package (ALSEP) which will obtain scientific data consisting of lunar physical and environmental characteristics and transmit the data to earth for determination of (1) the magnetic fields at the moon, (2) the lunar atmosphere and ionosphere and the lunar seismic activity, and (3) the properties of the solar wind plasma as it exists at the lunar surface. The ALSEP is stowed and offloaded in two subpackages. The fuel cask (part of the electrical power subsystem) is attached to the LM.

After offloading the ALSEP packages, the Radioisotope Thermoelectric Generator (RTG), which provides the ALSEP electrical power, will be fueled (Figure 11), the ALSEP subpackages will be attached to a one-man carry bar for traverse in a "barbell" mode, as shown on the cover, and the TV will be positioned to view the ALSEP site.

RADIOISOTOPE THERMOELECTRIC GENERATOR FUELING

Fig. 11

The LMP will then carry the ALSEP subpackages in the "barbell" mode to the deployment site approximately 300 feet from the LM while the CDR carries a subpallet of ALSEP. Upon arriving at the deployment site they will survey the site and determine the desired location for the experiments. The following individual experiment packages will then be separated, assembled, connected to the ALSEP cabling, and deployed to their respective sites (Figure 12).



DEPLOYED ALSEP I

Fig. 12

Passive Seismic Experiment (Figure 13) - This experiment is designed to monitor seismic activity and affords the opportunity to detect meteoroid impacts and free oscillations of the moon. It may also detect surface tidal deformations resulting in part from periodic variations in the strength and direction of external gravitational fields acting upon the moon.

Solar Wind Spectrometer Experiment (Figure 14) - This experiment will measure energies, densities, incidence angles, and temporal variations of the electron and proton components of the solar wind on the surface of the moon.

Lunar Surface Magnetometer Experiment (Figure 15) - This experiment will measure the magnitude and temporal variations of the lunar surface equatorial field vector.

Suprathermal Ion Detector (Lunar Ionosphere Detector) Experiment (Figure 16) - This experiment will measure the flux, number, density, velocity, and energy per unit charge of positive ions in the vicinity of the lunar surface.*

Cold Cathode Ion Gauge (Lunar Atmosphere Detector) Experiment - This experiment will determine the density of any lunar ambient atmosphere including variations either of a random character or associated with lunar local time or solar activity. In addition, the rate of loss of contaminants left in the landing area by the astronauts and the Lunar Module will be measured.*

Lunar Dust Detector Experiment - This experiment will obtain data for the assessment of dust accretion on ALSEP to provide a measure of the degradation of thermal surfaces.

Following the deployment of experiments, the ALSEP will be activated, data receipt by MSFN confirmed, and the ALSEP site and deployed experiments photographed. The ALSEP site will also be photographed from the LM area.

Selected Sample Collection - During the return traverse to the LM, both crewmen will collect a selected sample of geologically interesting material, including rock samples and fine-grained fragmental material, which will be carried in a side bag on each crewman. Approximately three-fourths of the quantity will be rock samples with the remaining one-fourth fine-grained material. The samples and the immediate sample site will be photographed.

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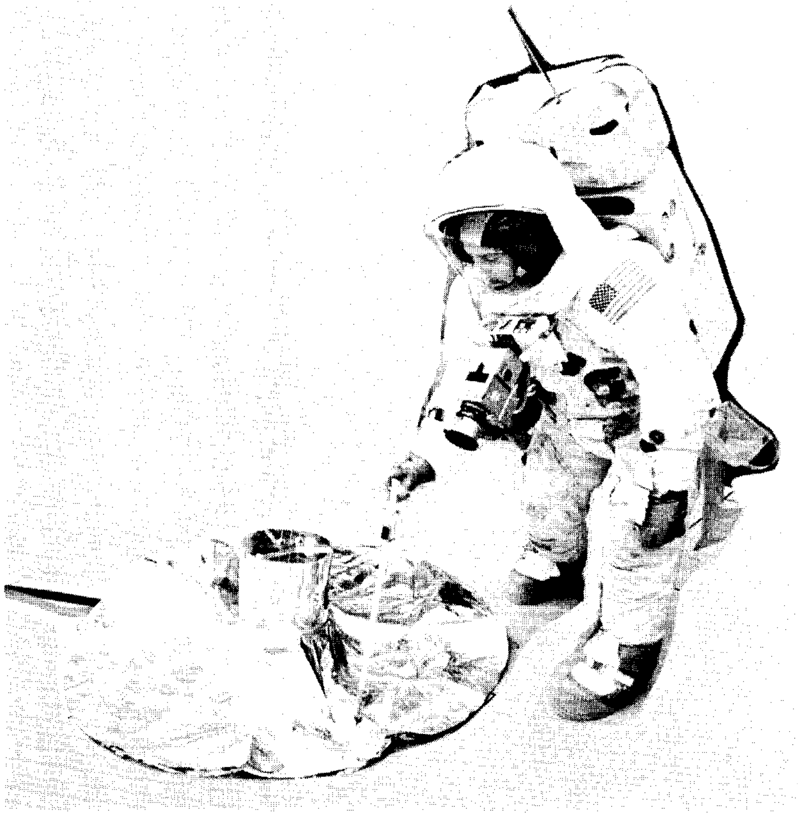
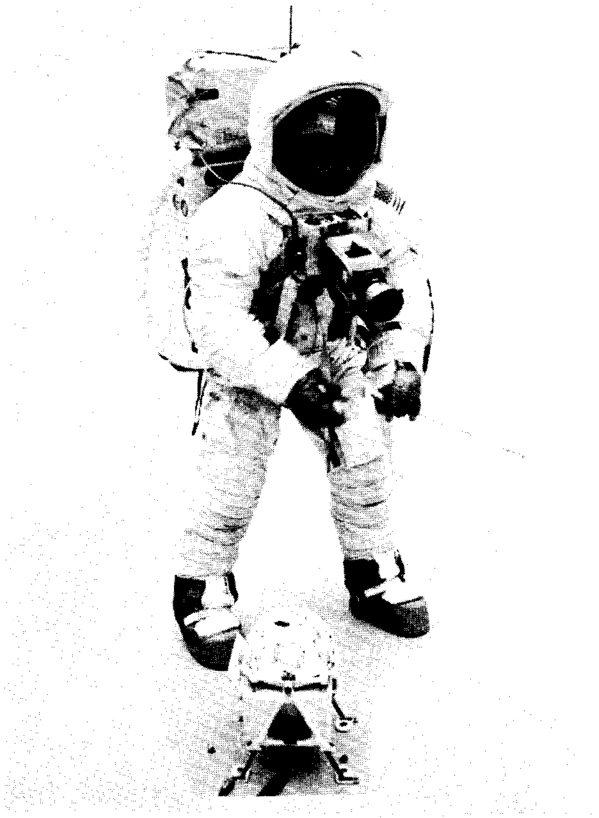
* On ALSEP I, the suprathermal ion detector and cold cathode ion gauge will be integrated together in one experiment system.



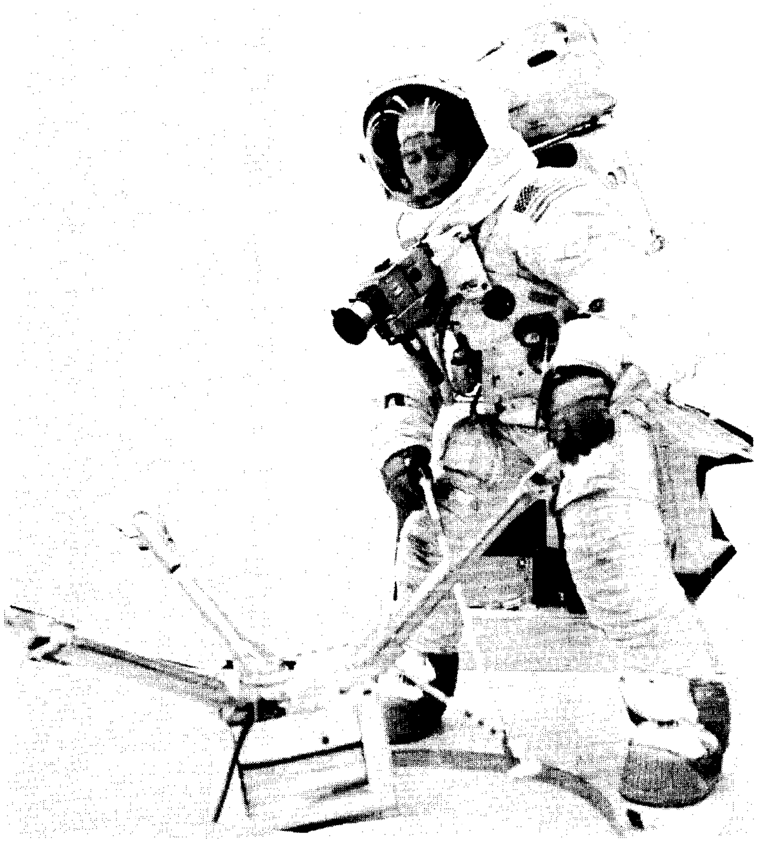
DEPLOYED PASSIVE SEISMIC EXPERIMENT

Fig. 13



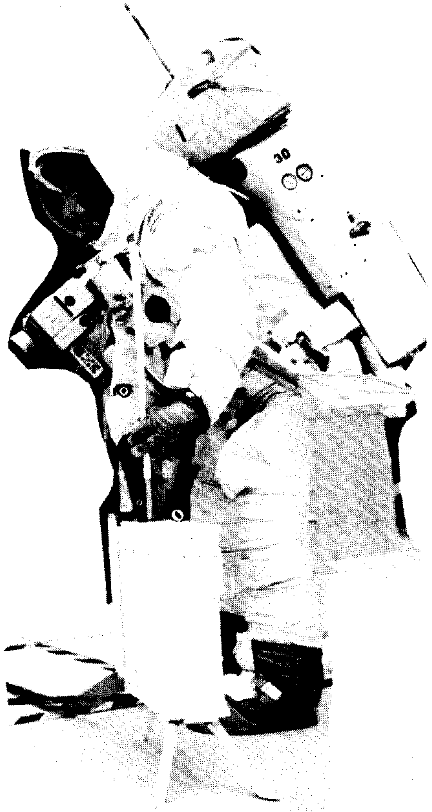
DEPLOYED SOLAR WIND SPECTROMETER EXPERIMENT

Fig. 14



DEPLOYED LUNAR SURFACE
MAGNETOMETER EXPERIMENT

Fig. 15



DEPLOYED SUPRATHERMAL ION DETECTOR/
COLD CATHODE ION GAUGE EXPERIMENT

Fig. 16

The LMP will carry the TV back to the LM area and position it to view the MESA and surrounding area from the 2 o'clock position shown in Figure 10. The LMP will then assemble the core tube and handle, and collect a core sample. After collecting the core sample, the sample will be capped and stowed in Sample Return Container (SRC) 1.

Upon return to the LM, the CDR will unstow the selected SRC, attach the scale to the MESA, finish filling the CDR and LMP side bags with loose material, seal the organic control sample, pack the samples, and seal the SRC.

After helping the CDR with the selected sample collection, the LMP will clean his EMU, ingress the LM, check LM systems, switch to the erectable S-band antenna, and make a communications check. The CDR will attach the LEC to the SRC 1 and transfer it into the LM with the assistance of the LMP.

Post-EVA 1 Operations

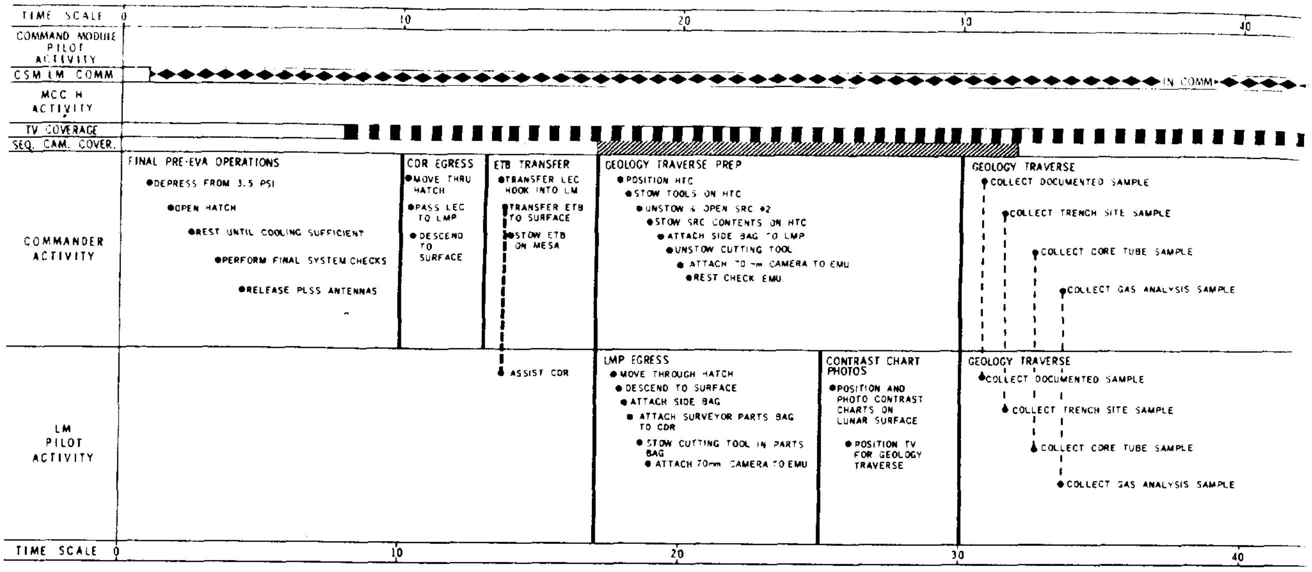
After configuring the LM systems for post-EVA 1 operations, the PLSS's will be recharged. This includes filling the oxygen system to a minimum pressure of 875 psi, filling the water reservoir, and replacing the battery and LiOH cannister. The PLSS's and OPS's will be doffed and stowed, followed by an eat period, a 9-hour rest period, and another eat period.

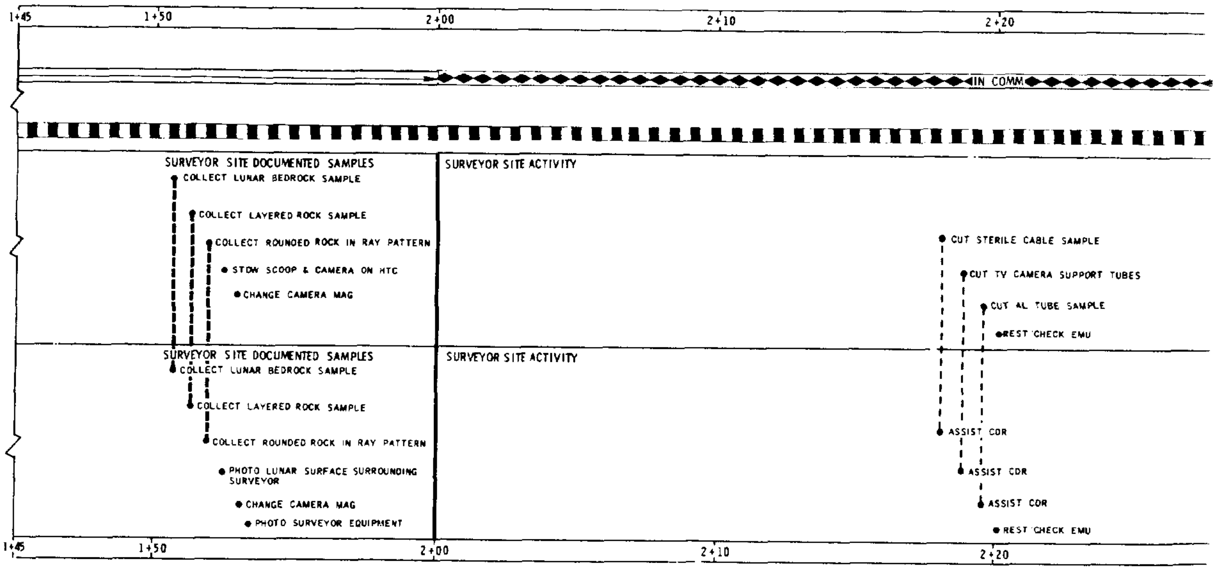
EVA 2

After pre-EVA configuring of the EMU's and LM systems, the cabin will be depressurized from 3.5 psi and the CDR will descend to the surface for EVA 2 (Figure 17). Upon transferring the 70mm Lunar Surface Cameras to the surface using the ETB and LEC (Figure 18), and turning on the 16mm Data Acquisition Camera (Sequence Camera) in the LM, the LMP will descend to the surface.

Lunar Field Geology Experiment - Both crewmen will participate in the conduct of the Lunar Field Geology Experiment, which is to provide data for use in the interpretation of the geologic history of the moon. A team of earth-based geologists will be available to advise the astronauts in real-time.

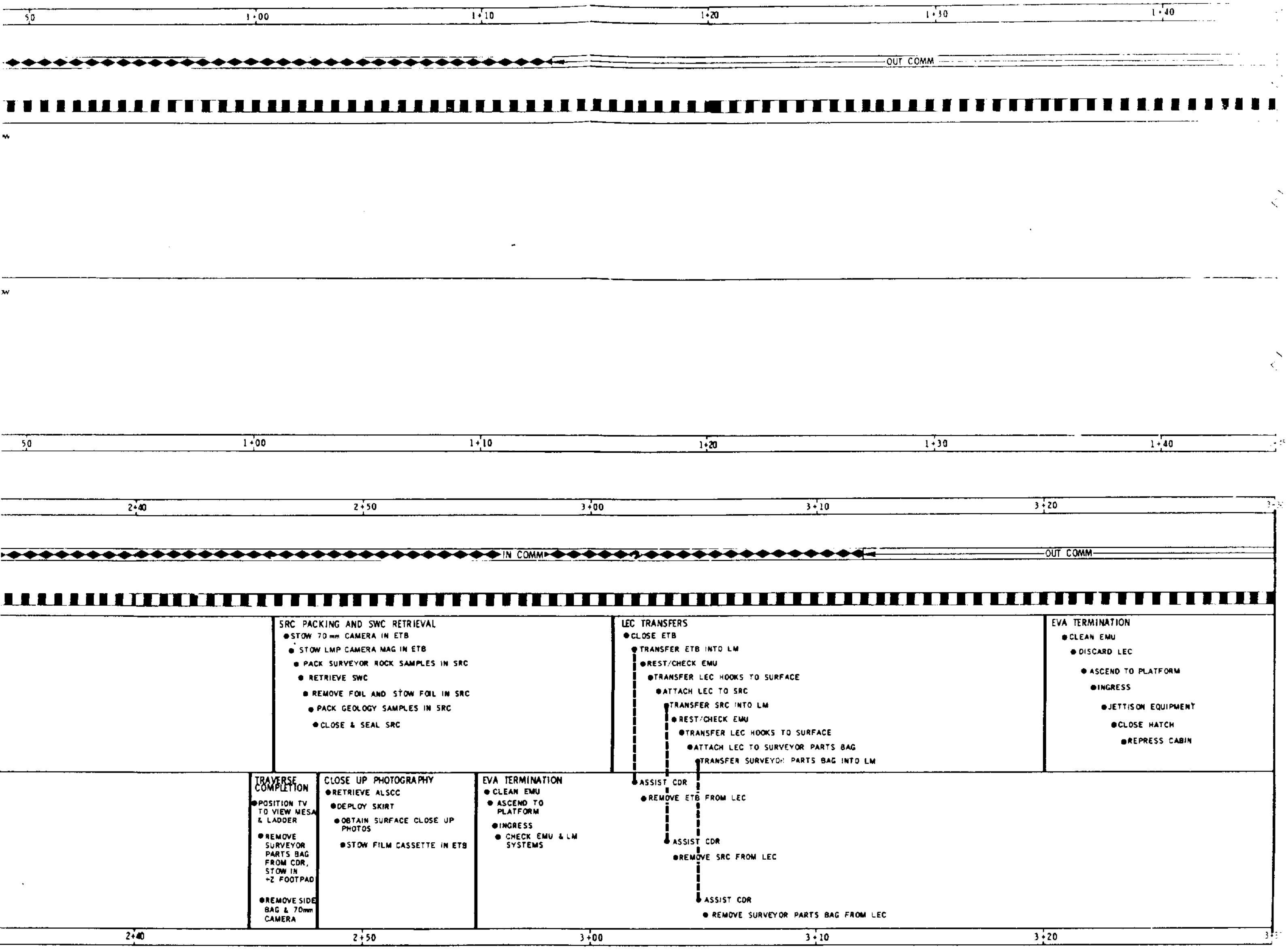
Geology traverse preparations will include stowing several contrast charts, a hammer, an extension handle, a small and a large scoop, core tubes and caps, sample bag dispenser, and a gnomon on the Hand Tool Carrier (HTC) (Figure 19); attaching side bags; stowing the cutting tool in the CDR's Surveyor parts bag; attaching a 70mm Lunar Surface Camera to each EMU; tethering tongs to the CDR's EMU; deploying contrast charts; and repositioning the TV for geology traverse.


TIME SCALE
0
10
20
30
40
COMMAND MODULE PILOT ACTIVITY
CSM LM COMM
IN COMM
MCC H ACTIVITY
TV COVERAGE
SEQ. CAM. COVER.
COMMANDER ACTIVITY
FINAL PRE-EVA OPERATIONS
●DEPRESS FROM 3.5 PSI
●OPEN HATCH
●REST UNTIL COOLING SUFFICIENT
●PERFORM FINAL SYSTEM CHECKS
●RELEASE PLSS ANTENNAS
CDR EGRESS
●MOVE THRU HATCH
●PASS LEC TO LMP
●DESCEND TO SURFACE
ETB TRANSFER
●TRANSFER LEC HOOK INTO LM
●TRANSFER ETB TO SURFACE
●STOW ETB ON MESA
GEOLOGY TRAVERSE PREP
●POSITION HTC
●STOW TOOLS ON HTC
●UNSTOW & OPEN SRC #2
●STOW SRC CONTENTS ON HTC
●ATTACH SIDE BAG TO LMP
●UNSTOW CUTTING TOOL
●ATTACH 70mm CAMERA TO EMU
●REST CHECK EMU
GEOLOGY TRAVERSE
●COLLECT DOCUMENTED SAMPLE
●COLLECT TRENCH SITE SAMPLE
●COLLECT CORE TUBE SAMPLE
●COLLECT GAS ANALYSIS SAMPLE
LM PILOT ACTIVITY
●ASSIST CDR
LMP EGRESS
●MOVE THROUGH HATCH
●DESCEND TO SURFACE
●ATTACH SIDE BAG
●ATTACH SURVEYOR PARTS BAG TO CDR
●STOW CUTTING TOOL IN PARTS BAG
●ATTACH 70mm CAMERA TO EMU
CONTRAST CHART PHOTOS
●POSITION AND PHOTO CONTRAST CHARTS ON LUNAR SURFACE
●POSITION TV FOR GEOLOGY TRAVERSE
GEOLOGY TRAVERSE
●COLLECT DOCUMENTED SAMPLE
●COLLECT TRENCH SITE SAMPLE
●COLLECT CORE TUBE SAMPLE
●COLLECT GAS ANALYSIS SAMPLE
TIME SCALE
0
10
20
30
40


1+45
1+50
2+00
2+10
2+20
IN COMM
SURVEYOR SITE DOCUMENTED SAMPLES
●COLLECT LUNAR BEDROCK SAMPLE
●COLLECT LAYERED ROCK SAMPLE
●COLLECT ROUNDED ROCK IN RAY PATTERN
●STOW SCOOP & CAMERA ON HTC
●CHANGE CAMERA MAG
SURVEYOR SITE ACTIVITY
●CUT STERILE CABLE SAMPLE
●CUT TV CAMERA SUPPORT TUBES
●CUT AL TUBE SAMPLE
●REST CHECK EMU
SURVEYOR SITE DOCUMENTED SAMPLES
●COLLECT LUNAR BEDROCK SAMPLE
●COLLECT LAYERED ROCK SAMPLE
●COLLECT ROUNDED ROCK IN RAY PATTERN
●PHOTO LUNAR SURFACE SURROUNDING SURVEYOR
●CHANGE CAMERA MAG
●PHOTO SURVEYOR EQUIPMENT
SURVEYOR SITE ACTIVITY
●ASSIST CDR
●ASSIST CDR
●ASSIST CDR
●REST CHECK EMU
1+45
1+50
2+00
2+10
2+20

URFACE ACTIVITY TIMELINE-EVA 2

M-932-69-12



*NOTE: IN THE EVENT AN EXTENSION OF THE EVA TO 4.0 HOURS IS DESIRED, THE ADDITIONAL 0.5 HOURS WILL BE ADDED TO THE "GEOLOGY TRAVERSE" TIME BLOCK ABOVE.

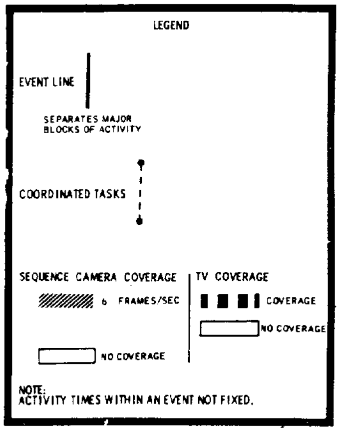
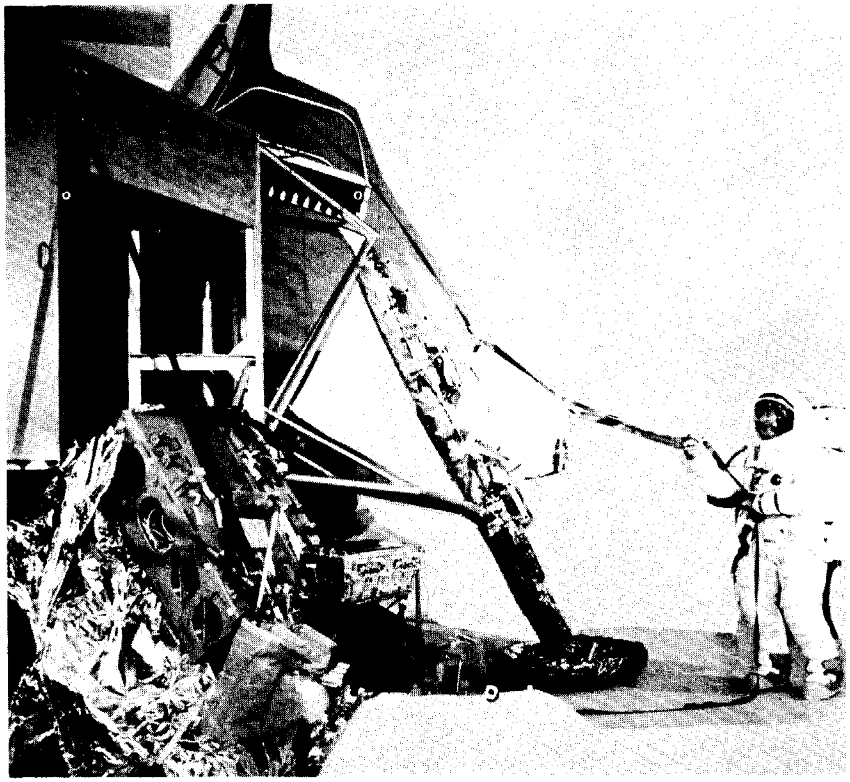


Fig. 17



EQUIPMENT TRANSFER BAG/
LUNAR EQUIPMENT CONVEYOR

Fig. 18

HAND TOOL CARRIER

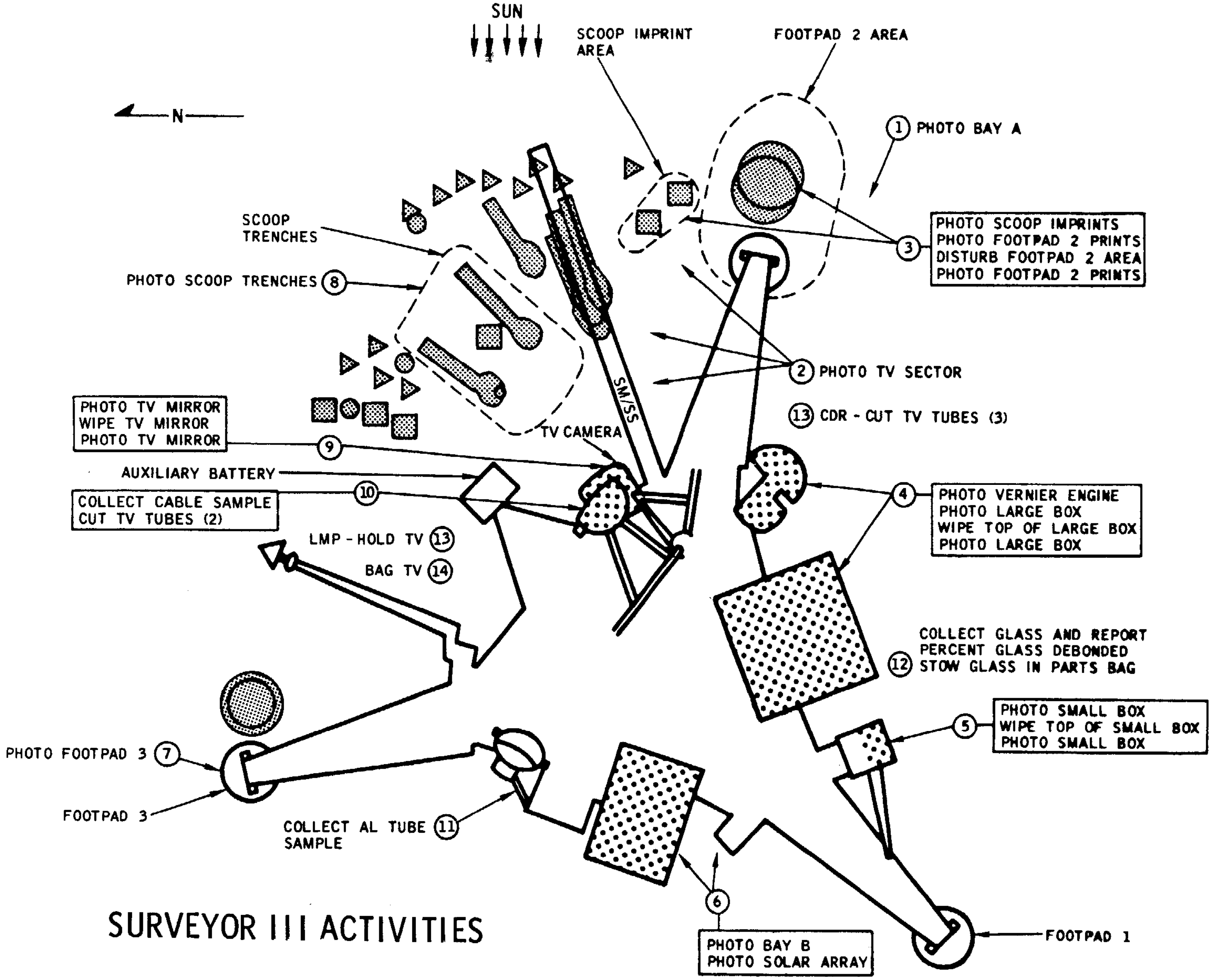
Fig. 19

The geology traverse for this experiment will consist of documented sample collection, core tube sample collection, trench site sample collection, and gas analysis sample collection. A typical documented sample collection will include photographing the sample and its site and describing and stowing the sample in a sample bag. A typical core tube sample collection will include photographing the sample site cross sun, driving the core tube into the surface and photographing the core tube down sun, and pulling and capping the core tube. Trench site sample collection will include digging a trench along the sunline, filling the special environmental sample container with surface material and sealing it, photographing the trench both down and up sun, collecting a core sample from the trench, and stowing the samples in the HTC. Gas analysis sample collection will include photographing the sample both cross and down sun, collecting the sample using tongs, and placing it in and sealing the gas analysis sample container which will be stowed in the HTC.

Surveyor site and vehicle investigation will precede the geology return traverse.

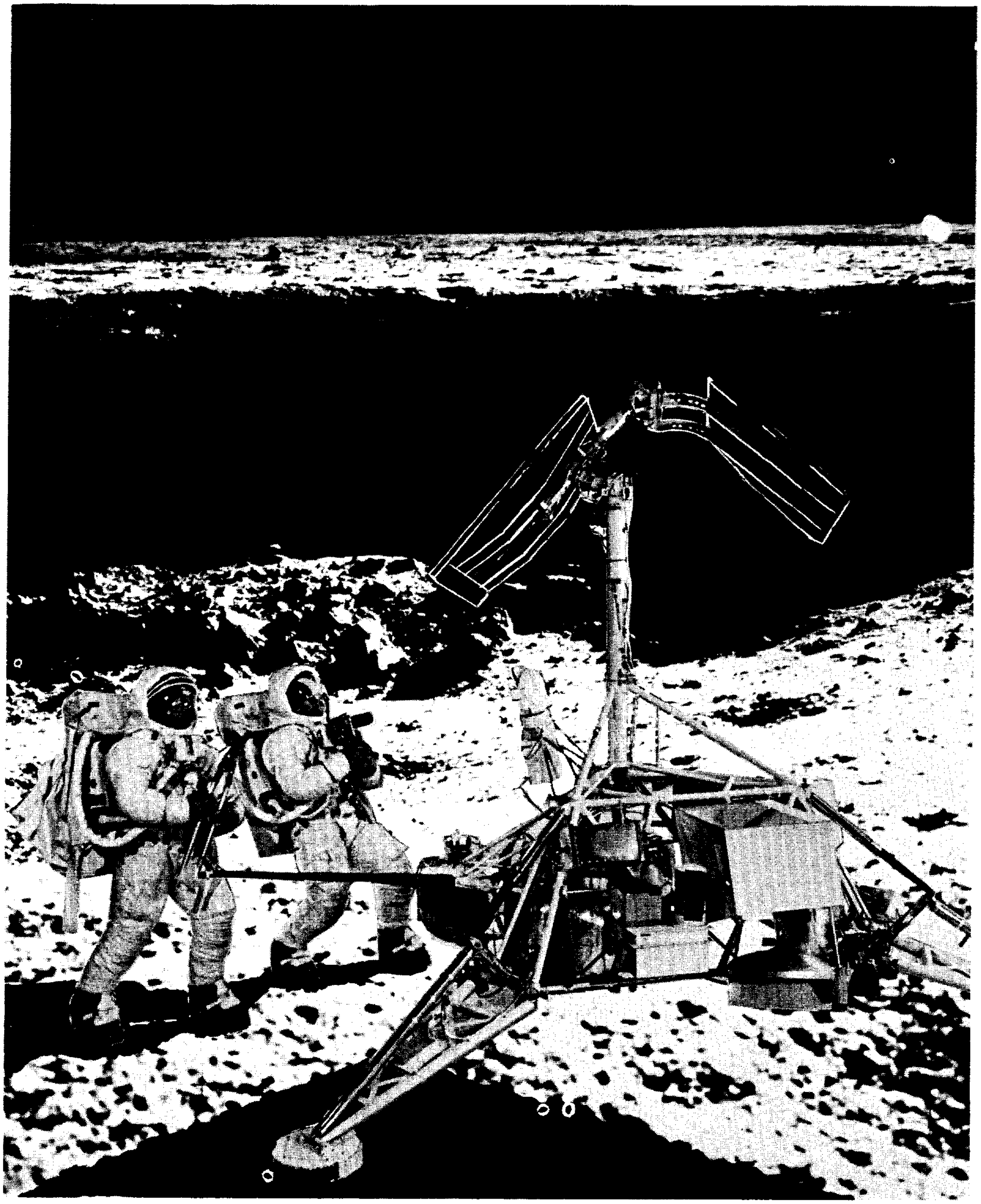
Surveyor Site Activity - As a secondary objective, it is planned that the CDR and LMP will walk to the Surveyor III site for an investigation of the site and the Surveyor vehicle (Figure 20). The CDR and LMP will descend into the crater containing the Surveyor III and collect samples of lunar material including lunar bedrock, layered rock, and rounded rocks in ray patterns. The LMP will obtain photographs of lunar material in the vicinity of and deposited on the Surveyor III spacecraft as well as several photographs of the Surveyor spacecraft equipment (Figure 21). The CDR will read the LMP's checklist during the LMP's photography and then cut the TV camera, a piece of the TV camera electrical cable which will be dropped untouched into the special environmental sample container, and a polished aluminum tube from the Surveyor using the cutting tool. The LMP will assist the CDR in the cutting task and will stow the equipment in the Surveyor parts bag on the CDR's PLSS. In addition, if feasible and safe, the CDR and LMP will collect pieces of glass from the Surveyor III spacecraft mirrors and report on the extent of debonding.

Post-Geology Activity - After completion of the geology return traverse, the TV camera will be repositioned to view the MESA and the ladder; the SWC will be retrieved and stowed in the SRC; the 70mm lunar surface cameras will be stowed in the ETB; the side bag samples, the core tubes, special environmental sample container, gas analysis sample container, and documented samples will be transferred in the SRC (Figure 22); and the LMP will obtain surface close-up photographs with the Apollo Lunar Surface Close-up Camera (Figure 23). After both EMU's have been checked and cleaned, the LMP will ingress the LM and assist the CDR in transferring the SRC, ETB, and the Surveyor parts bag into the LM.



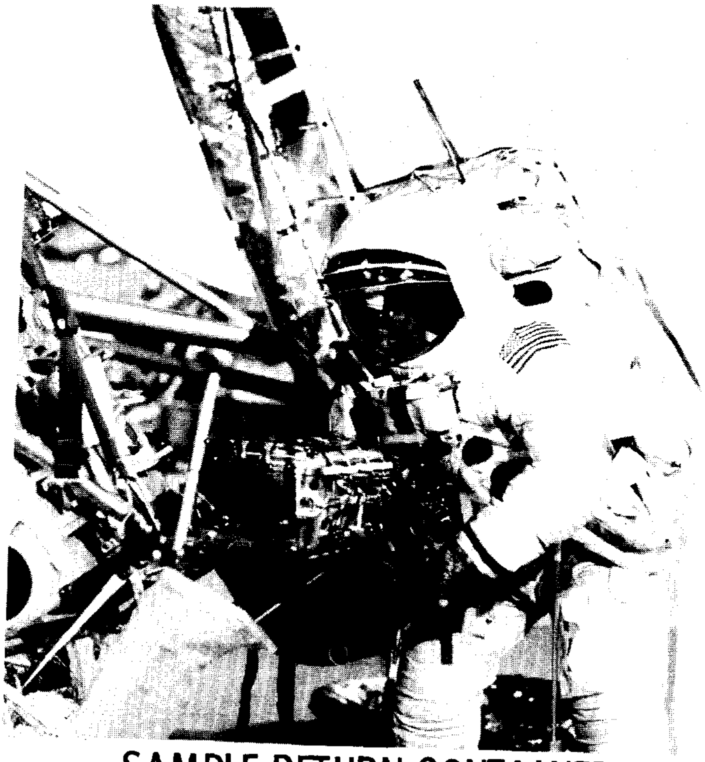
SURVEYOR III ACTIVITIES

Fig. 20



SURVEYOR III

Fig. 21



SAMPLE RETURN CONTAINER

Fig. 22

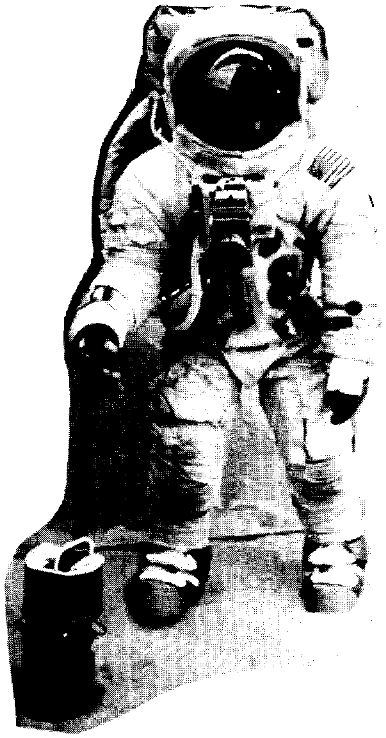


Fig. 23

LUNAR SURFACE CLOSE-UP CAMERA

EVA-2 Termination - After completing equipment transfer to the LM, the CDR will clean his EMU, ascend the ladder and ingress into the LM. Expendable equipment will be jettisoned and the cabin repressurized terminating the second EVA.

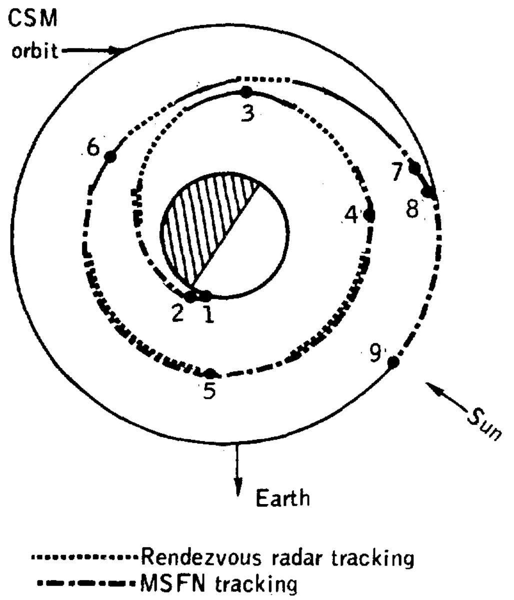
CSM Lunar Orbit Operations

Lunar Multispectral Photography

During the period of lunar surface operations, the Command Module Pilot (CMP) will obtain simultaneous multispectral photographs of the lunar surface at three widely separated wavelengths. This photography will provide data on lunar surface color variations (at an order of magnitude higher resolution than obtainable from earth) which will be useful in geologic mapping. For example, the sharpness of the color boundaries will give a good indication of the compositional differences. In addition, it will provide data for correlation with the spectral reflectance properties of the returned lunar samples from Apollo 11 and thus will allow possible extrapolation of compositional information on other areas of the moon on which no landings will occur. Finally, it will define areas of interest for future correlation with the returned samples.

Lunar Module Ascent

The LM ascent (Figure 24) will begin after a lunar stay of approximately 31.5 hours. The Ascent Propulsion System (APS) powered ascent is divided into two phases. The first phase is a vertical rise which is required to achieve terrain clearance, and the



EVENT
1. LIFTOFF
2. INSERTION
3. CSI
4. PLANE CHANGE
5. CDH
6. TPI
7. BEGIN BRAKING*
8. STATION KEEPING
9. DOCKING

* A TOTAL OF 4 BRAKING MANEUVERS ARE PLANNED.

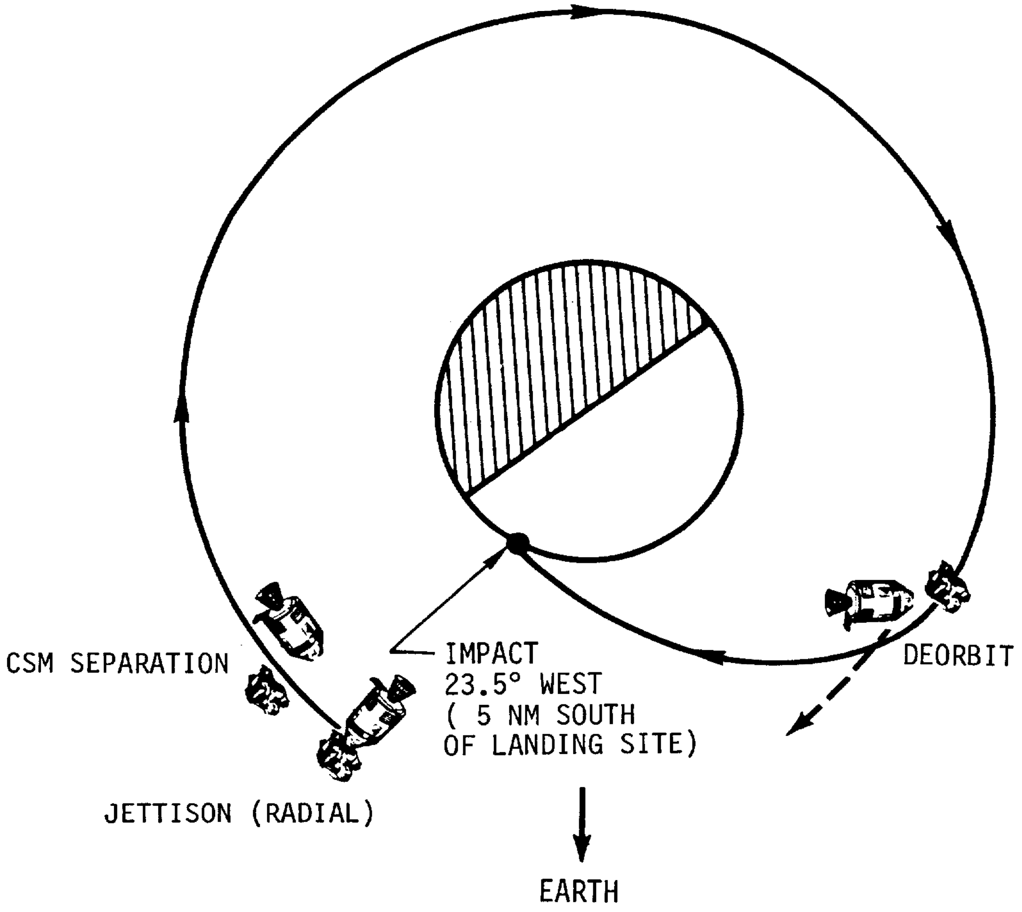
LM ASCENT THROUGH DOCKING

Fig. 24

second phase is orbit insertion. After orbit insertion the LM will execute the coelliptic rendezvous sequence which nominally consists of four major maneuvers: concentric sequence initiation (CSI), constant delta height (CDH), terminal phase initiation (TPI), and terminal phase finalization (TPF). A nominally zero plane change maneuver will be scheduled between CSI and CDH, and two nominally zero midcourse correction maneuvers will be scheduled between TPI and TPF; the TPF maneuver is actually divided into several braking maneuvers. All maneuvers after orbit insertion will be performed with the LM RCS. Once docked to the CSM, the two crewmen will transfer to the CSM with equipment, lunar samples, Surveyor III parts, and exposed film. Decontamination operations will be performed, jettisonable items will be placed in the Interim Stowage Assembly and transferred to the LM, and the LM will be configured for deorbit and lunar impact.

LM Ascent Stage Deorbit

The ascent stage will be deorbited for lunar surface impact near the newly deployed ALSEP, rather than sent into solar orbit, to provide a known perturbation for the seismic experiment (Figure 25). The CSM in a heads-up attitude will be separated



LM ASCENT STAGE DEORBIT

Fig. 25

radially from the ascent stage with a Service Module (SM) RCS retrograde burn approximately 2 hours after docking to the CSM. Following the LM jettison maneuver, the CSM will perform a pitchdown maneuver. The LM deorbit maneuver will be a retrograde APS burn initiated by ground control and the LM will be targeted to impact the lunar surface approximately 5 NM south of the Apollo 12 landing site. The ascent stage jettison, ignition, and impacted lunar surface area will be photographed from the CSM.

CSM Orbit Operations

Photography of Candidate Exploration Sites

After ascent stage deorbit the CSM will execute an orbital plane change for approximately 11 hours of lunar reconnaissance photography. Stereoscopic and sequence photographs in high resolution will be taken of Descartes, Fra Mauro, Lalande, and other candidate sites, as feasible, prior to transearth injection.

Transearth Injection and Coast

The SPS will be used to inject the CSM onto the transearth trajectory. The return flight duration will be approximately 72 hours (based on a 14 November launch) and the return inclination (to the earth's equator) will not exceed 40 degrees. Midcourse corrections will be made as required, using the MSFN for navigation.

Entry and Recovery

Prior to atmospheric entry, the CSM will maneuver to a heads-up attitude, the Command Module (CM) will jettison the SM and orient to the entry attitude (heads down, full lift). The nominal range from entry interface (EI) at 400,000 feet altitude to landing will be approximately 1250 NM. Earth landing will nominally be in the Pacific Ocean at 16°S latitude and 165°W longitude (based on a 14 November launch) approximately 244.6 hours after liftoff. Immediate recovery is planned.

Quarantine

Following landing, the Apollo 12 crew will don the flight suits and face masks passed in to them through the spacecraft hatch by a recovery swimmer wearing standard scuba gear. The flight suit/oral-nasal mask combination will be used in lieu of the integral Biological Isolation Garments (BIG's) used on Apollo 11. The BIG's will be available for use in case of an unexplained crew illness. The swimmer will swab the hatch and adjacent areas with a liquid decontamination agent. The crew will then be carried by helicopter to the recovery ship where they will enter a Mobile Quarantine Facility (MQF) and all subsequent crew quarantine procedures will be the same as for the Apollo 11 Mission.