Prelaunch
Mission Operation Report
No. M-933-71-15

MEMORANDUM

17 July 1971

TO: A/Administrator

FROM: MA/Apollo Program Director

SUBJECT: Apollo 15 Mission (AS-510)

We plan to launch Apollo 15 from Pad A of Launch Complex 39 at the Kennedy Space Center no earlier than July 26, 1971. This will be the fourth manned lunar landing and the first of the Apollo "J" series missions which carry the Lunar Roving Vehicle for surface mobility, added Lunar Module consumables for a longer surface stay time, and the Scientific Instrument Module for extensive lunar orbital science investigations.

Primary objectives of this mission are selenological inspection, survey, and sampling of materials and surface features in a pre-selected area of the Hadley-Apennine region of the moon; emplacement and activation of surface experiments; evaluation of the capability of Apollo equipment to provide extended lunar surface stay time, increased EVA operations, and surface mobility; and the conduct of in-flight experiments and photographic tasks. In addition to the standard photographic documentation of operational and scientific activities, television coverage is planned for selected periods in the spacecraft and on the lunar surface. The lunar surface TV coverage will include remote controlled viewing of astronaut activities at each major science station on the three EVA traverses and the eclipse of the sun by the earth on August 6, 1971.

The 12-day mission will be terminated with the Command Module landing in the Pacific Ocean near Hawaii. Recovery and transportation of the crew and lunar samples to the Manned Spacecraft Center will be without the quarantine procedures previously employed.

Rocco A. Petrone
Rocco A. Petrone

APPROVAL:

Dale D. Myers
Dale D. Myers
Associate Administrator for
Manned Space Flight

Report No. M-933-71-15

MISSION OPERATION REPORT

APOLLO 15 MISSION

OFFICE OF MANNED SPACE FLIGHT

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FOREWORD

MISSION OPERATION REPORTS are published expressly for the use of NASA Senior Management, as required by the Administrator in NASA Management Instruction HQMI 8610.1, effective 30 April 1971. 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.

Prelaunch reports are prepared and issued for each flight project just prior to launch. Following launch, updating (Post Launch) reports for each mission are issued to keep General Management currently informed of definitive mission results as provided in NASA Management Instruction HQMI 8610.1.

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 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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CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

APOLLO/SATURN FLIGHTS

Mission	Launch Date	Launch Vehicle	Payload	Description
AS-201	2/26/66	SA-201	CSM-009	Launch vehicle and CSM development. Test of CSM subsystems and of the space vehicle. Demonstration of reentry adequacy of the CM at earth orbital conditions.
AS-203	7/5/66	SA-203	LH_2 in S-IVB	Launch vehicle development. Demonstration of control of LH_2 by continuous venting in orbit.
AS-202	8/25/66	SA-202	CSM-011	Launch vehicle and CSM development. Test of CSM subsystems and of the structural integrity and compatibility of the space vehicle. Demonstration of propulsion and entry control by G&N system. Demonstration of entry at 28,500 fps.
APOLLO 4	11/9/67	SA-501	CSM-017 LTA-10R	Launch vehicle and spacecraft development. Demonstration of Saturn V Launch Vehicle performance and of CM entry at lunar return velocity.
APOLLO 5	1/22/68	SA-204	LM-1 SLA-7	LM development. Verified operation of LM subsystems: ascent and descent propulsion systems (including restart) and structures. Evaluation of LM staging. Evaluation of S-IVB/IU orbital performance.
APOLLO 6	4/4/68	SA-502	CM-020 SM-014 LTA-2R SLA-9	Launch vehicle and spacecraft development. Demonstration of Saturn V Launch Vehicle performance.

APOLLO/SATURN FLIGHTS

Mission	Launch Date	Launch Vehicle	Payload	Description
APOLLO 7	10/11/68	SA-205	CM-101 SM-101 SLA-5	Manned CSM operations. Duration 10 days 20 hours.
APOLLO 8	12/21/68	SA-503	CM-103 SM-103 LTA-B SLA-11	Lunar orbital mission. Ten lunar orbits. Mission duration 6 days 3 hours. Manned CSM operations.
APOLLO 9	3/3/69	SA-504	CM-104 SM-104 LM-3 SLA-12	Earth orbital mission. Manned CSM/LM operations. Duration 10 days 1 hour.
APOLLO 10	5/18/69	SA-505	CM-106 SM-106 LM-4 SLA-13	Lunar orbital mission. Manned CSM/LM operations. Evaluation of LM performance in cislunar and lunar environment, following lunar landing profile. Mission duration 8 days.
APOLLO 11	7/16/69	SA-506	CM-107 SM-107 LM-5 SLA-14	First manned lunar landing mission. Lunar surface stay time 21.6 hours. One dual EVA (5 man hours). Mission duration 8 days 3 hours.
APOLLO 12	11/14/69	SA-507	CM-108 SM-108 LM-6 SLA-15	Second manned lunar landing mission. Demonstration of point landing capability. Deployment of ALSEP I. Surveyor III investigation. Lunar surface stay time 31.5 hours. Two dual EVA's (15.5 manhours). Mission duration 10 days 4.6 hours.
APOLLO 13	4/11/70	SA-508	CM-109 SM-109 LM-7 SLA-16	Planned third lunar landing. Mission aborted at approximately 56 hours due to loss of SM cryogenic oxygen and consequent

APOLLO/SATURN FLIGHTS

Mission	Launch Date	Launch Vehicle	Payload	Description
APOLLO 13 continued				loss of capability to generate electrical power and water.
APOLLO 14	1/13/71	SA-509	CM-110 SM-110 LM-8 SLA-17	Third manned lunar landing mission. Selenological inspection, survey and sampling of materials of Fra Maura Formation. Deployment of ALSEP. Lunar Surface Staytime 33.5 hours. Two dual EVA's (18.8 man hours). Mission duration 9 days.

NASA OMSF MISSION OBJECTIVES FOR APOLLO 15

PRIMARY OBJECTIVES

- Perform selenological inspection, survey, and sampling of materials and surface features in a preselected area of the Hadley-Apennine region.
- Emplace and activate surface experiments.
- Evaluate the capability of the Apollo equipment to provide extended lunar surface stay time, increased EVA operations, and surface mobility.
- Conduct in-flight experiments and photographic tasks from lunar orbit.

Rocco A. Petrone
Rocco A. Petrone
Apollo Program Director

Date: 16 July 1971

Dale D. Myers
Dale D. Myers
Associate Administrator for
Manned Space Flight

Date: 17 July 1971

MISSION OPERATIONS

GENERAL

The following paragraphs contain a brief description of the nominal launch, flight, recovery, and post-recovery operations. For the third month launch opportunity, which may involve a T-24 hour launch, there will be a second flight plan. Overall mission profile is shown in Figure 1.

LAUNCH WINDOWS

The mission planning considerations for the launch phase of a lunar mission are, to a major extent, related to launch windows. Launch windows are defined for two different time periods: a "daily window" has a duration of a few hours during a given 24-hour period; a "monthly window" consists of a day or days which meet the mission operational constraints during a given month or lunar cycle.

Launch windows will be based on flight azimuth limits of 80° to 100° (earth-fixed heading of the launch vehicle at end of the roll program), on booster and spacecraft performance, on insertion tracking, and on lighting constraints for the lunar landing sites.

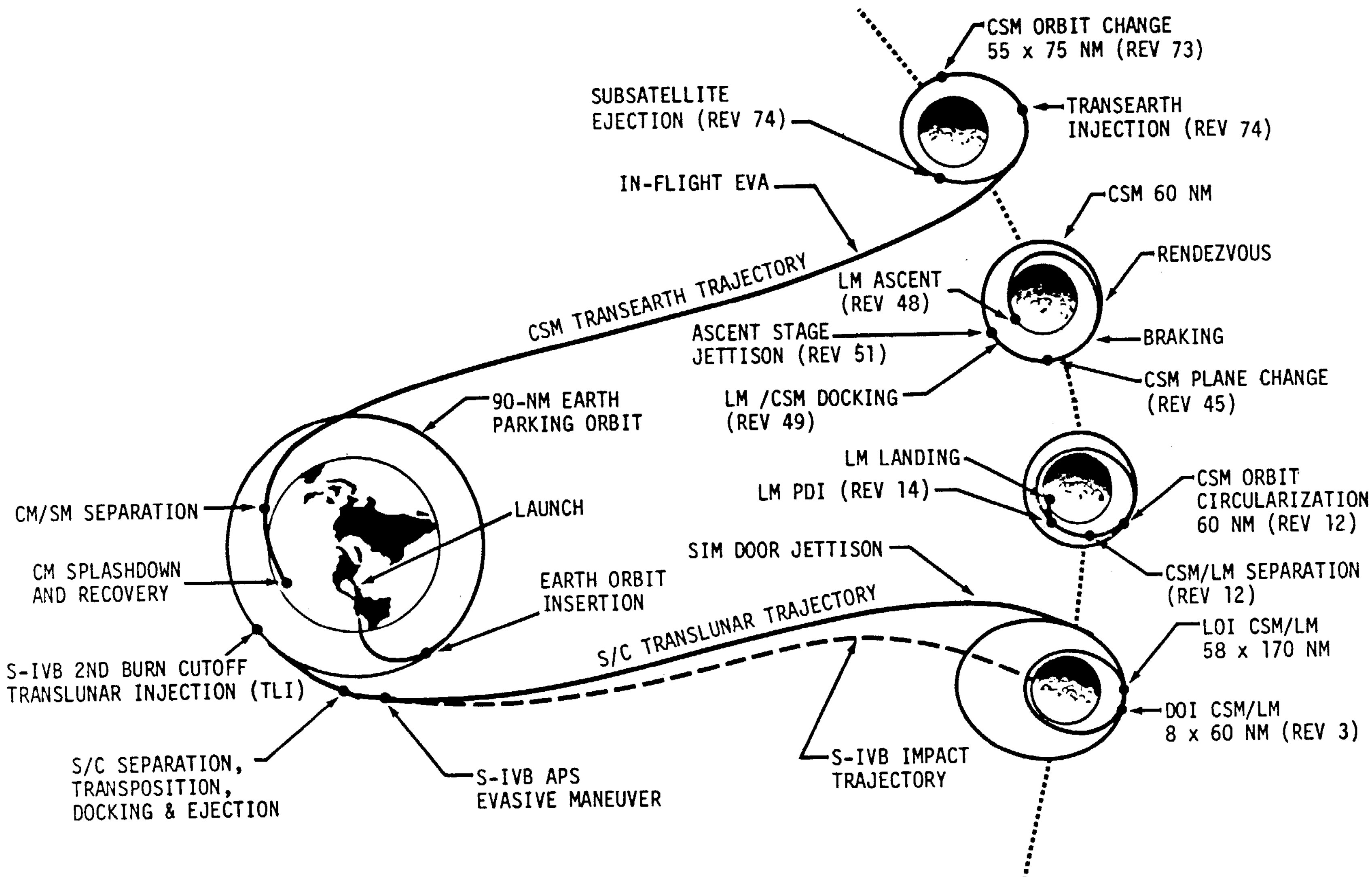
The Apollo 15 launch windows and associated lunar landing sun elevation angles are presented in Table 1.

TABLE 1

LAUNCH WINDOWS

	WINDOWS (EST)		SUN ELEVATION
LAUNCH DATE	OPEN	CLOSE	ANGLE
July 26, 1971	0934	1211	12.0°
July 27, 1971	0937	1214	23.2°
August 24, 1971	0759	1038	11.3°
August 25, 1971	0817	1055	22.5°
September 22, 1971	0637	0917	12.0°
September 23, 1971	0720	1000	12.0°
September 24, 1971	0833	1112	23.0°

APOLLO 15 FLIGHT PROFILE



M-933-71-15

Fig. 1

LAUNCH THROUGH TRANSLUNAR INJECTION

The space vehicle will be launched from Pad A of launch complex 39 at the Kennedy Space Center. The boost into a 90-NM earth parking orbit (EPO) will be accomplished by sequential burns and staging of the S-IC and S-II launch vehicle stages and a partial burn of the S-IVB stage. The S-IVB/IU and spacecraft will coast in a circular EPO for approximately 1.5 revolutions while preparing for the first opportunity S-IVB translunar injection (TLI) burn, or 2.5 revolutions if the second opportunity TLI burn is required. Both injection opportunities are to occur over the Pacific Ocean. The S-IVB TLI burn will place the S-IVB /IU and spacecraft on a translunar trajectory targeted such that transearth return to an acceptable entry corridor can be achieved with the use of the Reaction Control System (RCS) during at least five hours (7 hrs: 57 min. Ground Elapsed Time (GET)) after TLI cutoff. For this mission the RCS capability will actually exist up to about 59 hours GET for the CSM/LM combination and about 67 hours GET for the CSM only. TLI targeting will permit an acceptable earth return to be achieved using SPS or LM DPS until at least pericynthian plus two hours, if Lunar Orbit Insertion (LOI) is not performed. For this mission however, the LM DPS requirement can be met until about 20 hours after LOI.

TRANSLUNAR COAST THROUGH LUNAR ORBIT INSERTION

Within two hours after injection the Command Service Module (CSM) will separate from the S-IVB/IU and spacecraft-LM adapter (SLA) and will transponse, dock with the LM, and eject the LM/CSM from the S-IVB/IU. Subsequently, the S-IVB/IU will perform an evasive maneuver to alter it's circumlunar coast trajectory clear of the spacecraft trajectory.

The spent S-IVB/IU will be impacted on the lunar surface at 3° 39'S. and 7° 34.8'W. providing a stimulus for the Apollo 13 and 14 emplaced seismology experiments. The necessary delta velocity (ΔV) required to alter the S-IVB/IU circumlunar trajectory to the desired impact trajectory will be derived from dumping of residual LOX and burn(s) of the S-IVB/APS and ullage motors. The final maneuver will occur within about nine hours of liftoff. The IU will have an S-Band transponder for trajectory tracking. A frequency bias will be incorporated to insure against interference between the S-IVB/IU and LM communications during translunar coast.

Spacecraft passive thermal control will be initiated after the first midcourse correction (MCC) opportunity and will be maintained throughout the translunar-coast phase unless interrupted by subsequent MCC's and/or navigational activities. The scientific instrument module (SIM) bay door will be jettisoned shortly after the MCC-4 point, about 4.5 hours before lunar orbit insertion.

Multiple-operation covers over the SIM bay experiments and cameras will provide thermal and contamination protection whenever they are not in use.

A retrograde SPS burn will be used for lunar orbit insertion (LOI) of the docked spacecraft into a 58 X 170-NM orbit, where they will remain for approximately two revolutions.

DESCENT ORBIT INSERTION THROUGH LANDING

The descent orbit insertion (DOI) maneuver, a SPS second retrograde burn, will place the CSM/LM combination into a 60 x 8-NM orbit.

A "soft" undocking will be made during the 12th revolution, using the docking probe capture latches to reduce the imparted ΔV. Spacecraft separation will be executed by the service module (SM) reaction control system (RCS), providing a ΔV of approximately 1 foot per second radially downward toward the center of the moon. The CSM will circularize its orbit to 60 NM at the end of the 12th revolution. During the 14th revolution the LM DPS will be used for powered descent, which will begin approximately at pericynthian. These events are shown in Figure 2. A lurain profile model will be available in the LM guidance computer (LGC) program to minimize unnecessary LM pitching or thrusting maneuvers. A steepened descent path of 25° will be used during the terminal portion of powered descent (from high gate) to enhance landing site visibility. The vertical descent portion of the landing phase will start at an altitude of about 200 feet at a rate of 5 feet per second, and will be terminated at touchdown on the lunar surface.

LANDING SITE (HADLEY-APENNINE REGION)

The Apennine Mountains constitute the southeastern boundary of Mare Imbrium, forming one side of a triangle-shaped, elevated highland region between Mare Imbrium, Mare Serenitatis, and Mare Vaporum. In the area of the landing site, the mountains rise up to 2.5km above the adjacent mare level.

Rima Hadley is a V-shaped lunar sinuous rille which parallels the western boundary of the Apennine Mountain front. The rille originates in an elongate depression in an area of possible volcanic domes and generally maintains a width of about 1.5km and a depth of 400 meters until it merges with a second rille approximately 100 km to the north. The origin of sinuous rilles such as Rima Hadley may be due to some type of fluid flow.

Sampling of the Apenninian material should provide very ancient rocks whose origin predates the formation and filling of the major mare basins. Examination and sampling of the rim of the Hadley Rille and associated deposits are expected to yield information on the genesis of it and other sinuous rilles. If the exposures in the rille are bedded, they will provide an excellent stratigraphic section of Imbrian material.

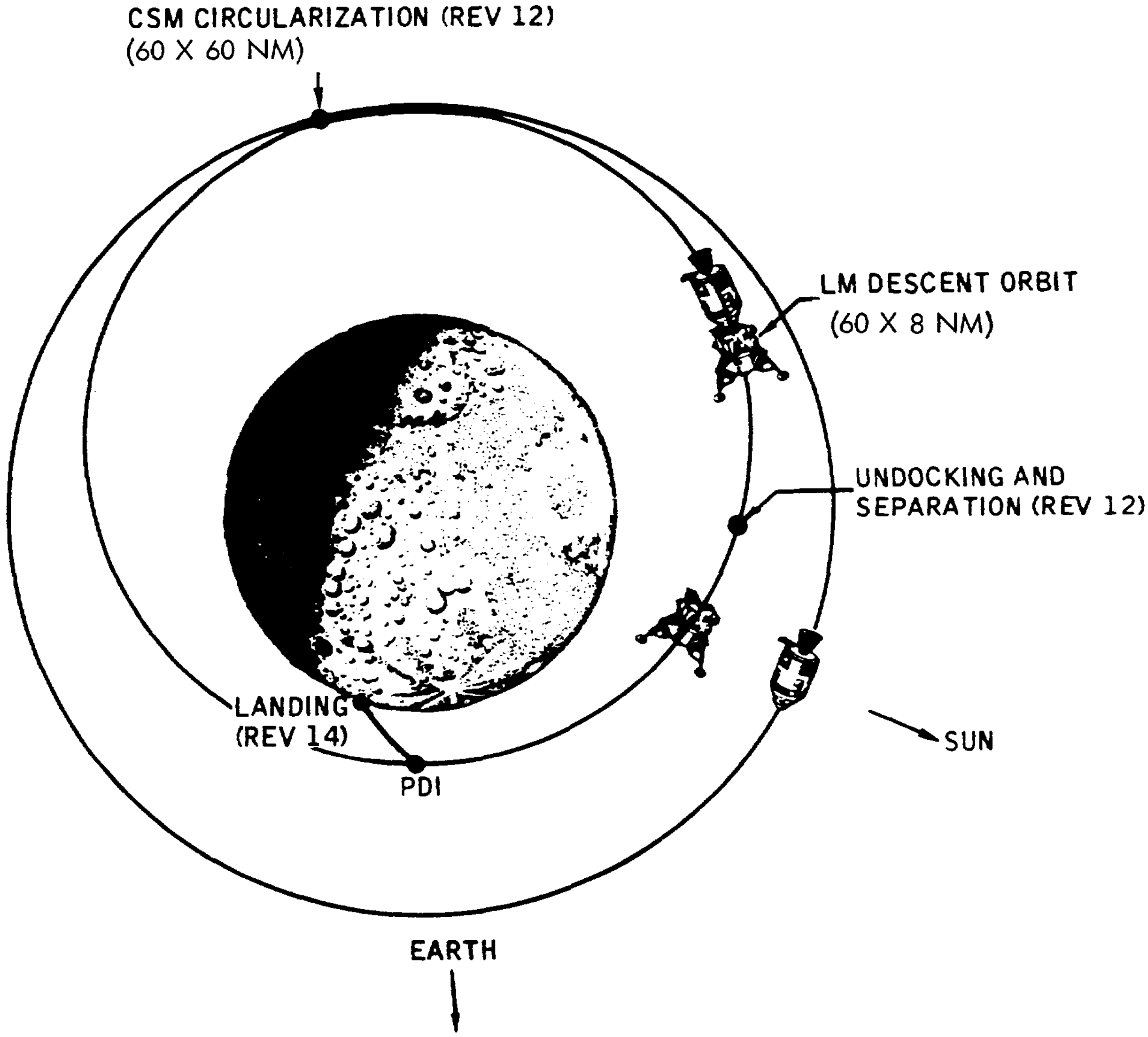

CSM CIRCULARIZATION (REV 12)
(60 X 60 NM)
LM DESCENT ORBIT
(60 X 8 NM)
UNDOCKING AND
SEPARATION (REV 12)
LANDING
(REV 14)
PDI
SUN
EARTH

Fig. 2

The planned landing point coordinates are 26°04'54"N, 3°39'30"E (Figure 3).

APOLLO 15 LANDING SITE

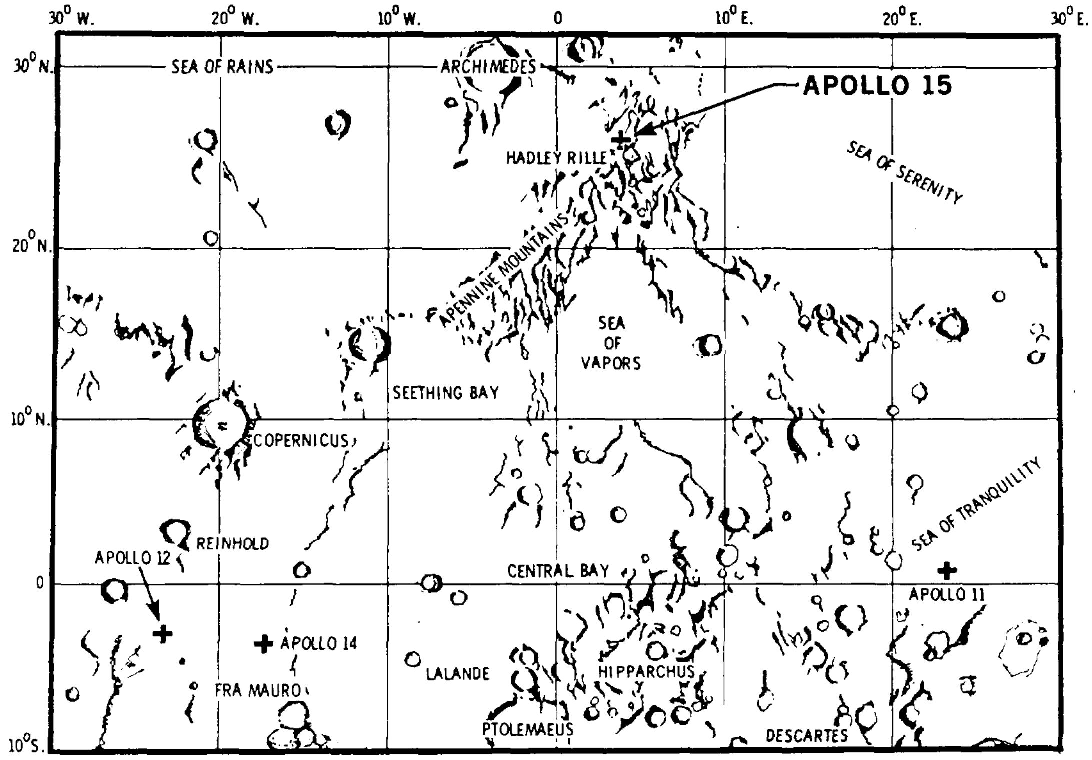


Fig. 3

LUNAR SURFACE OPERATIONS

The maximum stay time on the lunar surface is approximately 67 hours which is about double that of Apollo 14 and is a result of the addition of life support consumables in LM-10. A standup EVA (SEVA) will be performed about 1 1/2 hours after landing with the Commander (CDR) positioned with his head above the opened upper hatch for surveying the lunar surface. The SEVA will be followed by rest-work periods which provide for 3 traverse EVA's of 7-7-6 hours respectively. The LM crew will remove their suits for each rest period and will sleep in hammocks mounted in the LM cabin.

This mission will employ the Lunar Roving Vehicle (LRV) which will carry both astronauts, experiment equipment, and independent communications systems for direct contact with the earth when out of the line-of-sight of the LM relay system. Voice communication will be continuous and color TV coverage will be provided at each major science stop (see Figure 4) where the crew will align the high gain antenna. The ground controllers will then assume control of the TV through the ground controlled television assembly (GCTA) mounted on the LRV. A TV panorama is planned at each major science stop, followed by coverage of the astronauts scientific activities.

The radius of crew operations will be constrained by the LRV capability to return the crew to the LM in the event of a Portable Life Support System (PLSS) failure or by the PLSS walkback capability in the event of an LRV failure, whichever is the most limiting at any point in the EVA. If a walking traverse must be performed, the radius of operations will be constrained by the buddy secondary life support system (BSLSS) capability to return the crew to the LM in the event of a PLSS failure.

EVA PERIODS

Approximately 1 1/2 hours after landing the CDR will perform a 30 minute SEVA. He will stand in the LM with his head above the hatch opening to observe the lunar geographical features and photograph the surrounding area. The SEVA will assist the crew in traverse planning and in selecting a site for Apollo Lunar Surface Experiment Package (ALSEP) deployment. The crew will rest after the SEVA and before the first traverse EVA. The 3 traverses planned for Apollo 15 are designed with flexibility for selection of science stops as indicated by the shaded areas on the traverse map (Figure 4).

First Eva Period

The first EVA (up to 7 hours duration) will include the following: contingency sample collection, LM inspection, LRV deployment and loading, performance of a geology traverse using the LRV, deployment and activation of the ALSEP, deployment of the laser ranging retro-reflector, and deep core sample drilling. The TV camera will be mounted on a tripod to the west of the LM early in the EVA for observation of crew activities (including LRV deployment) in the vicinity of the LM (Figure 5). The geology traverse will follow as nearly as possible the planned route shown for EVA-1 in Figure 4.

The data acquisition camera and Hasselblad cameras, using color film, will be used during the EVA to record lunar surface operations. The lunar communications relay unit (LCRU) and the ground commanded television assembly (GCTA) will be used in conjunction with LRV operations. Lunar surface samples will be documented by photography and voice description. High resolution photographic survey of rille structure and other surface features will be accomplished with the Hasselblad camera equipped with the 500 mm lens. If time does not permit filling the sample return container (SRC) with documented samples, the crew may fill the SRC with samples selected for scientific interest. Following the traverse, the crew will deploy and activate the ALSEP to the west of the LM landing point as shown in Figure 6. If time does not permit completion of all ALSEP tasks, they will be rescheduled for appropriate times in subsequent EVA's. The planned timeline for all EVA-1 activities is presented in Figure 7.

Second and Third EVA Periods

The second and third EVA's (7 and 6 hours duration respectively) will continue the extensive scientific investigation of the Hadley-Apennine region and further operational assessment of the new and expanded capability of the Apollo hardware and systems. LRV sorties are planned for exploration of the Apennine front, Hadley Rille, and other prominent features along the traverse routes as shown in Figure 4.

The major portion of the lunar geology investigation (S-059) and the soil mechanics experiment (S-200) will be conducted during the second and third EVA's and will include voice and photographic documentation of sample material as it is collected and descriptions of lurain features. The solar wind composition (S-080) will be concluded prior to termination of the third EVA and will be returned for post-flight analysis. The LRV will be positioned at the end of the EVA-3 traverse to enable remote controlled color TV coverage of LM ascent, a solar exlipse on August 6, and other observations of scientific interest. The planned timelines for EVA-2 and EVA-3 activities are presented in Figures 8 and 9 respectively. Following EVA-3 closeout the crew will make preparations for ascent and rendezvous.

EVA TRAVERSES

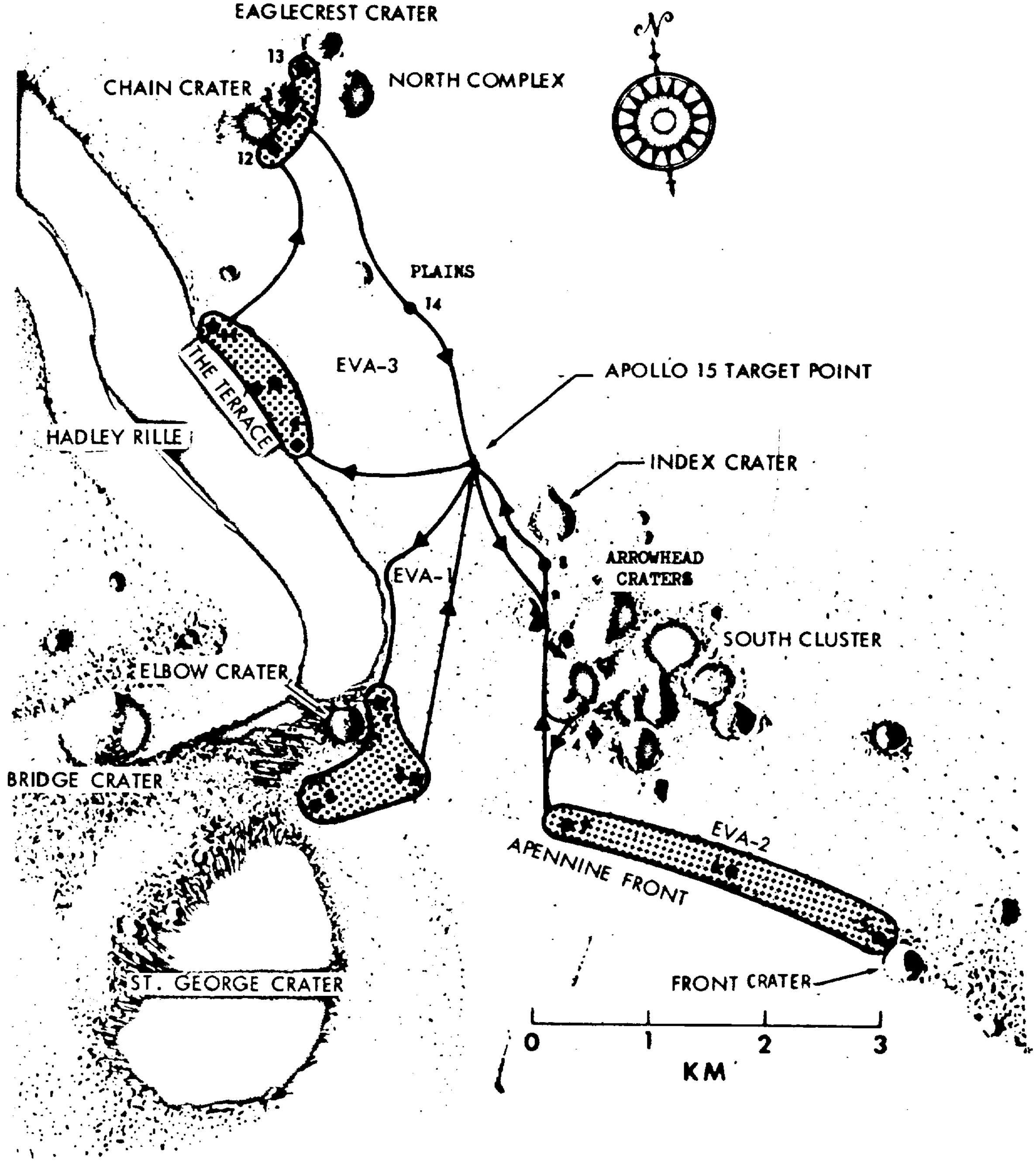


Fig. 4

NEAR LM LUNAR SURFACE ACTIVITIES

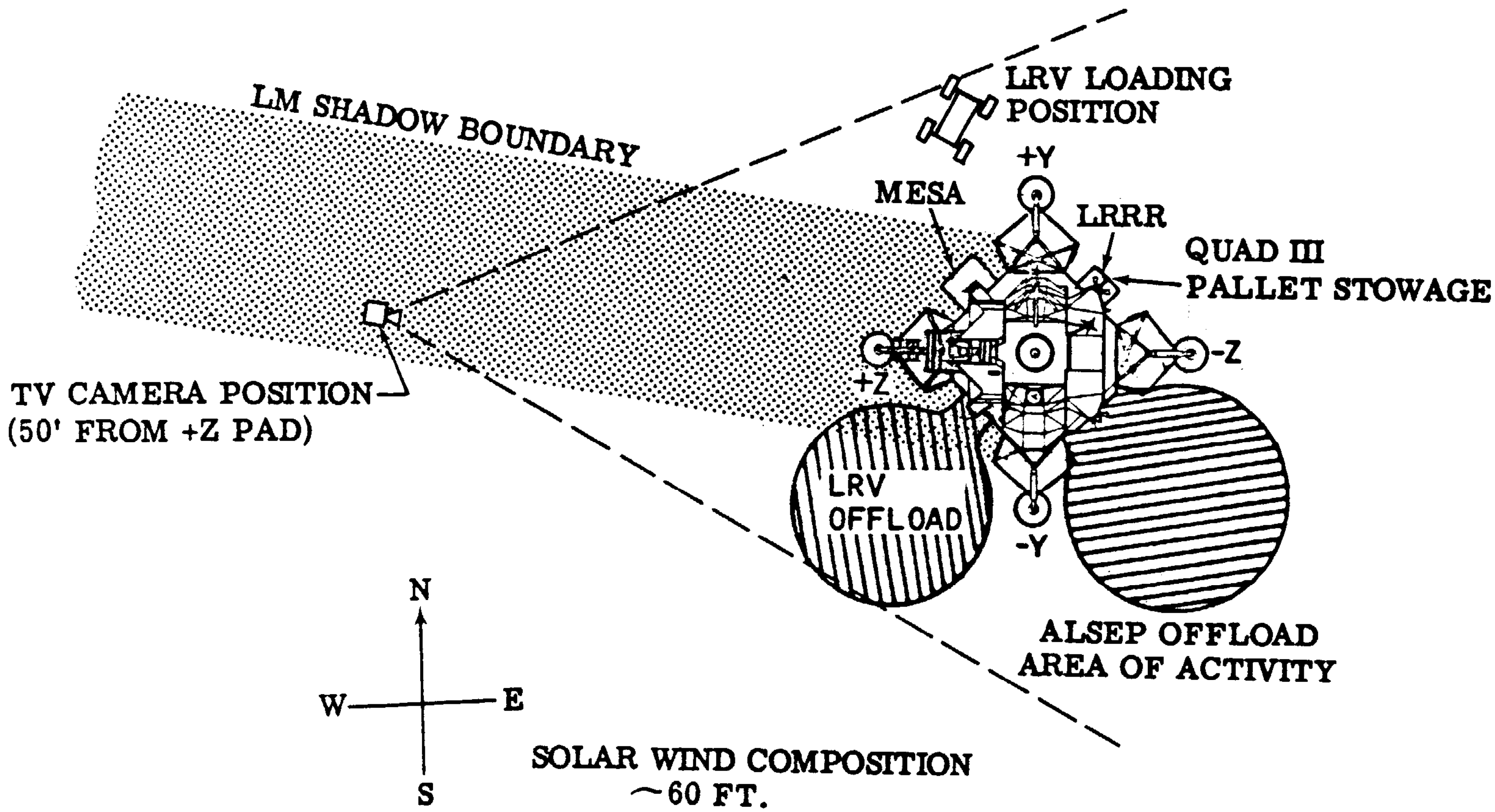


Fig. 5

ALSEP ARRAY LAYOUT

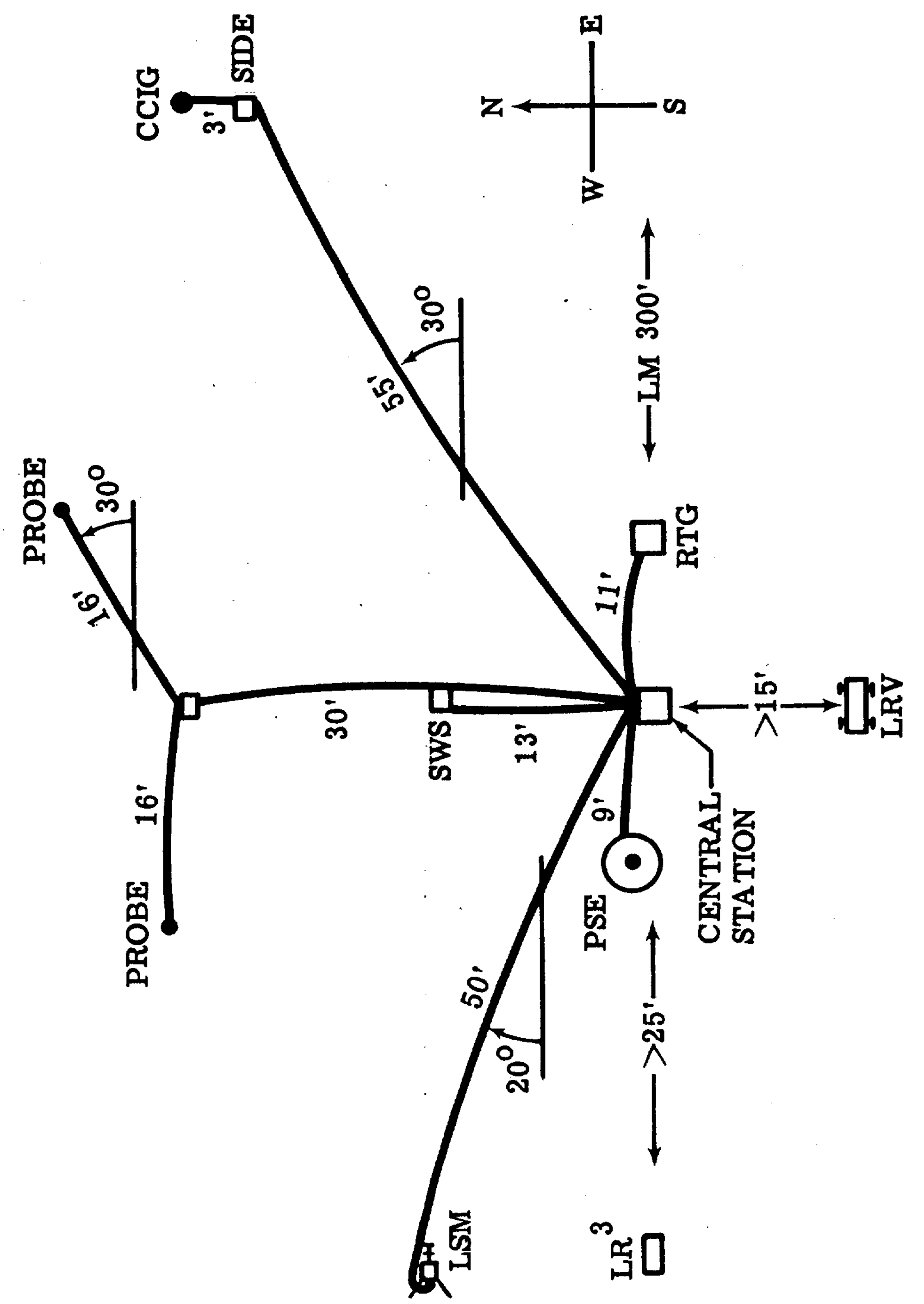


Fig. 6

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EVA-1 TIMELINE

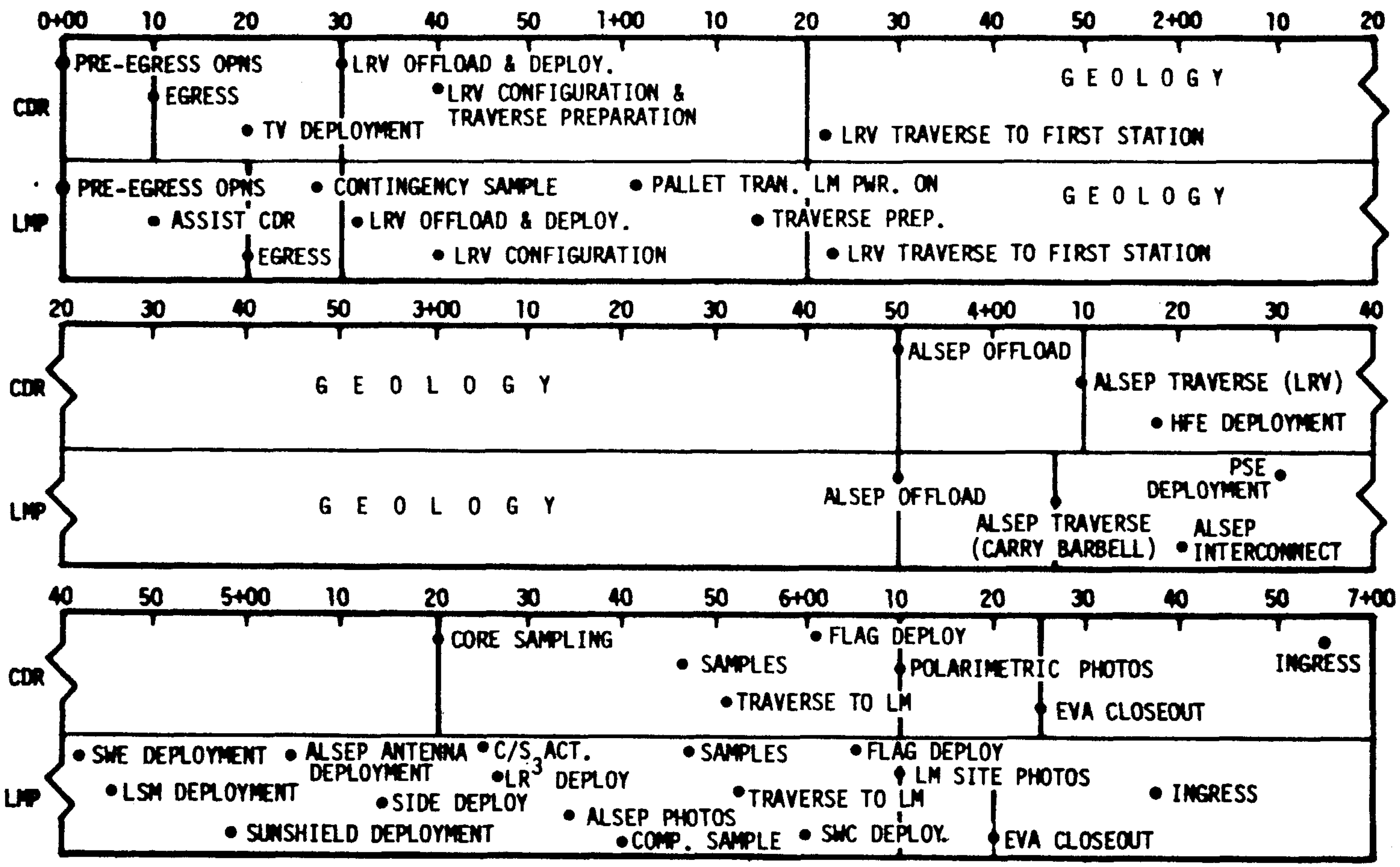

Fig. 7

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EVA-2 TIMELINE

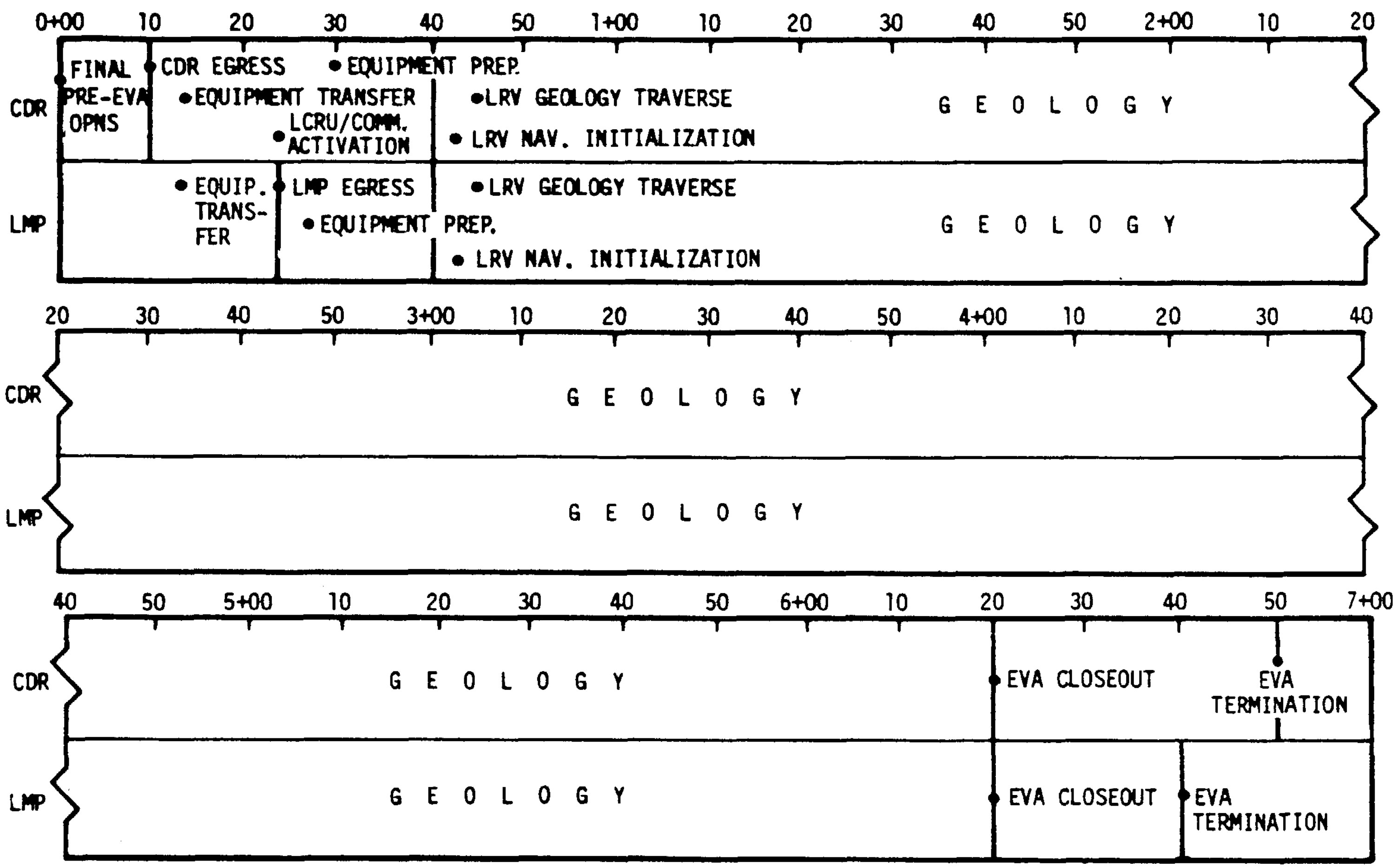


Fig. 8

EVA-3 TIMELINE

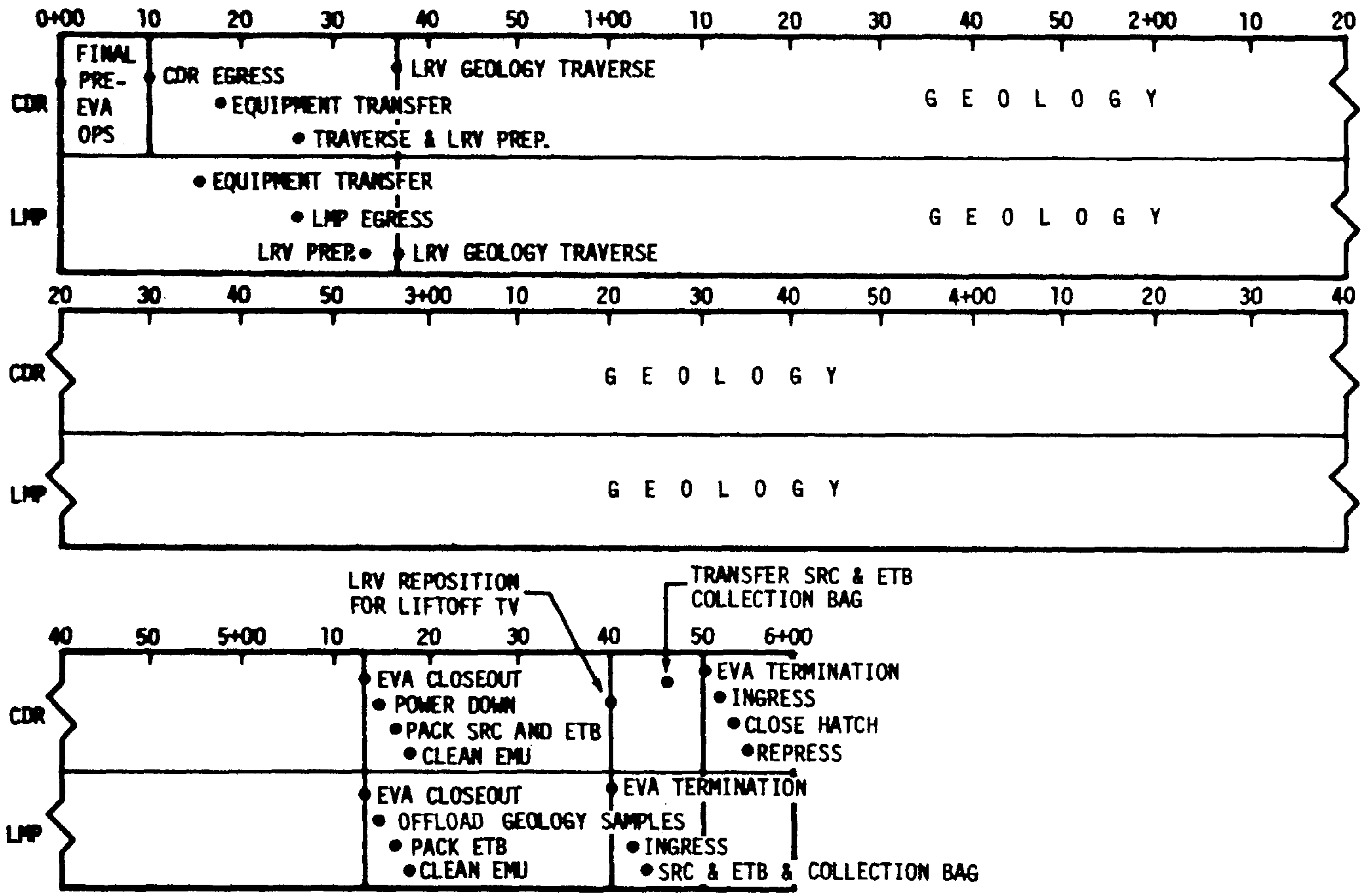


Fig. 9

M-933-71-15

LUNAR ORBIT OPERATIONS

GENERAL

The Apollo 15 Mission is the first with the modified Block II CSM configuration. An increase in cryogenic storage provides increased mission duration for the performance of both an extended lunar surface stay time and a lunar orbit science period. The new scientific instrument module (SIM) in the SM provides for the mounting of scientific experiments and for their operation in flight.

After the SIM door is jettisoned by pyrotechnic charges and until completion of lunar orbital science tasks, selected RCS thrusters will be inhibited or experiment protective covers will be closed to minimize contamination of experiment sensors during necessary RCS burns. Attitude changes for thermal control and experiment alignment with the lunar surface and deep space (and away from direct sunlight) will be made with the active RCS thrusters. Orbital science activities have been planned at appropriate times throughout the lunar phase of the mission and consist of the operation of 5 cameras (35mm Nikon, 16 mm Data Acquisition, 70 mm Hasselblad, 24 inch Panoramic and a 3 inch Mapping), a color TV camera, a laser altimeter, a gamma ray spectrometer, X-ray flourescent equipment, alpha ray particle equipment and mass spectrometer equipment.

Pre-Rendezvous Lunar Orbit Science

Orbital science operations will be conducted during the 60 x 8 NM orbits after DOI, while in the docked configuration. Orbital science operations will be stopped for the separation and circularization maneuvers performed during the 12th revolution, then restarted after CSM circularization.

The experiments timeline has been developed in conjunction with the surface timeline to provide, as nearly as possible, 16 hour work days and concurrent 8 hour CSM and LM crew sleep periods. Experiment activation cycles are designed to have minimum impact on crew work-rest cycles.

About 8 hours before rendezvous, the CSM will perform a plane change maneuver to provide the desired 60 x 60 NM coplanar orbit at the time of the LM rendezvous.

LM Ascent, Rendezvous and Jettison

After completion of lunar surface activities and ascent preparations, the LM ascent propulsion system (APS) and LM RCS will be used to launch and rendezvous with the CSM. Prior to LM liftoff, the CSM will complete the required plane change to permit a nominally coplanar rendezvous.

The direct ascent rendezvous technique initiated on Apollo 14 will be performed instead of the coelliptic rendezvous technique used on early landing missions. The lift-off window duration is about 10 seconds and is constrained to keep the perilune above 8 NM. The LM will be inserted into a 46 x 9 NM orbit so that an APS terminal phase initiation (TPI) burn can be performed approximately 45 minutes after insertion. The final braking maneuver will occur about 46 minutes later. The total time from LM liftoff to the final breaking maneuver will be about 99 minutes.

Docking will be accomplished by the CSM with RCS maneuvers. Once docked, the two LM crewmen will transfer to the CSM with lunar sample material, exposed films, and designated equipment.

The LM ascent stage will be jettisoned and subsequently deorbited to impact on the lunar surface, to provide a known stimulus for the emplaced seismic experiment. The impact will be targeted for 26° 15'N. and 1° 45'E.

Post-Rendezvous Lunar Orbit Science

After rendezvous and LM ascent stage jettison, additional scientific data will be obtained by the CSM over a two-day period. Conduct of the SIM experiments and both SM and CM photographic tasks will take advantage of the extended ground track coverage during this period.

During the second revolution before transearth injection, the CSM will perform an SPS maneuver to achieve a 55 x 75 NM orbit. Shortly thereafter, the subsatellite carried in the SIM bay will be launched northward, normal to the ecliptic plane. It is anticipated to have a lifetime of approximately 1 year.

TRANSEARTH INJECTION THROUGH LANDING

After completion of the post-rendezvous CSM orbital activities, the SPS will perform a posigrade burn to inject the CSM onto the transearth trajectory. The nominal return time will be 71.2 hours with a return inclination of 40° relative to the earth's equator.

During the transearth coast phase there will be continuous communications coverage from the time the spacecraft appears from behind the moon until shortly prior to entry. Midcourse corrections will be made, if required. A six-hour period has been allocated for the conduct of an inflight EVA, including pre- and post- EVA activities, to retrieve film cassettes from the SIM in the SM. TV, an inflight demonstration, and photographic tasks (including the solar eclipse on August 6, 1971) wil be performed as scheduled in the flight plan. SIM experiments will be continued during transearth coast.

The CM will separate from the SM 15 minutes before entry interface. Earth touchdown will be in the mid-Pacific at about 295:12 GET, 12.3 days after launch. The nominal landing coordinates are 26° 07'N. and 158°W approximately 300 miles north of Hawaii. The prime recovery ship is the USS Okinawa.

POST-LANDING OPERATIONS

Flight Crew Recovery

Following splashdown, the recovery helicopter will drop swimmers and life rafts near the CM. The swimmers will install the flotation collar on the CM, attach the life raft, and pass fresh flight suits in through the hatch for the flight crew to don before leaving the CM. The crew will be transferred from the spacecraft to the recovery ship via life raft and helicopter and will return to Houston, Texas for debriefing.

Quarantine for Apollo 15 and the remaining lunar missions has been eliminated and the mobile quarantine facility will not be used. However, biological isolation garments will be available for use in the event of unexplained crew illness.

CM and Data Retrieval Operations

After flight crew pickup by helicopter, the CM will be retrieved and placed on a dolly aboard the recovery ship. Lunar samples, film, flight logs, etc., will be retrieved for shipment to the Lunar Receiving Laboratory (LRL). The spacecraft will be off-loaded from the ship at Pearl Harbor and transported to an area where deactivation of the CM propellant system will be accomplished. The CM will then be returned to contractor facilities. Flight crew debriefing operations, sample analysis, and post-flight data analysis will be conducted in accordance with established schedules.

ALTERNATE MISSIONS

General

If an anomaly occurs after liftoff that would prevent the space vehicle from following its nominal flight plan, an abort or an alternate mission will be initiated. An abort will provide for acceptable flight crew and CM recovery.

An alternate mission is a modified flight plan that results from a launch vehicle, spacecraft, or support equipment anomaly that precludes accomplishment of the primary mission objectives. The purpose of the alternate mission is to provide the flight crew and flight controllers with a plan by which the greatest benefit can be gained from the flight using the remaining systems capabilities.

Alternate Missions

The two general categories of alternate missions that can be performed during the Apollo 15 Mission are (1) earth orbital and (2) lunar. Both of these categories have several variations which depend upon the nature of the anomaly leading to the alternate mission and the resulting systems status of the LM and CSM. A brief description of these alternate missions is contained in the following paragraphs.

Earth Orbit

In the event that TLI is inhibited, an earth orbit mission of approximately six and one-third days may be conducted to obtain maximum benefit from the scientific equipment aboard the CSM. Subsequent to transfer of the necessary equipment to the CM, the LM will be deorbited into the Pacific Ocean. Three SPS burns will be used to put the CSM into a 702 x 115 nm orbit where the subsatellite will be launched at approximately 35 hours GET. The high apogee will afford maximum lifetime of the subsatellite. The launching will be in the daylight with the spin rotation axis normal to the ecliptic to achieve the maximum absorption of solar energy. The gamma ray spectrometer will be employed to obtain data on the earth's magnetosphere. Two additional SPS burns will be performed to place the CSM into a 240 x 114 nm orbit with the apogee over the United States for photographic tasks using the SIM bay cameras. Camera cassettes will be retrieved by EVA on the last day of the mission. In addition, the alpha-particle spectrometer, mass spectrometer, and laser altimeter will be exercised to verify hardware operability. The x-ray fluorescence equipment will be used for partial mapping of the universe and obtaining readings of cosmic background data.

Lunar Orbit

Lunar orbit missions of the following types will be planned if spacecraft systems will enable accomplishment of orbital science objectives in the event a lunar landing is not possible.

CSM/LM

The translunar trajectory will be maintained within the DPS capability of an acceptable earth return in the event LOI is not performed. Standard LOI and TEI techniques will be used except that the DPS will be retained for TEI ~~unless~~ required to achieve a lunar orbit. The SPS will be capable of performing TEI on any revolution. Orbital science and photographic tasks from both the new SIM bay and from the CM will be conducted in a high-inclination, 60 NM circular orbit for about 4 days.

CSM Alone

In the event the LM is not available, the CSM will maintain a translunar trajectory within the SM RCS capability of an acceptable earth return. LOI will not be performed if the SIM bay door cannot be jettisoned. Orbital science and photographic tasks will be conducted in a high-inclination, 60 NM lunar orbit during a 4 to 6 day period.

CSM/Alone (From Landing Abort)

In the event the lunar landing is aborted, an orbital science mission will be accomplished by the CSM alone after rendezvous, docking, and LM jettison. The total orbit time will be approximately 6 days.

EXPERIMENTS, DETAILED OBJECTIVES, IN-FLIGHT DEMONSTRATIONS, AND OPERATIONAL TESTS

The technical investigations to be performed on the Apollo 15 Mission are classified as experiments, detailed objectives, or operationa tests:

Experiment - A technical investigation that supports science in general or provides engineering, technological, medical or other data and experience for application to Apollo lunar exploration or other programs and is recommended by the Manned Space Flight Experiments Board (MSFEB) and assigned by the Associate Administrator for Manned Space Flight to the Apollo Program for flight.

Detailed Objective - A scientific, engineering, medical or operational investigation that provides important data and experience for use in development of hardware and/or procedures for application to Apollo missions. Orbital photographic tasks, though reviewed by the MSFEB, are not assigned as formal experiments and will be processed as CM and SM detailed objectives.

Inflight Demonstration - A technical demonstration of the capability of an apparatus and/or process to illustrate or utilize the unique conditions of space flight environment. Inflight Demonstration will be performed only on a non-interference basis with all other mission and mission related activities. Utilization performance, or completion of these demonstrations will in no way relate to mission success. (None planned for this mission)

Operational Test - A technical investigation that provides for the acquisition of technical data or evaluates operational techniques, equipment, or facilities but is not required by the objectives of the Apollo flight mission. An operational test does not affect the nominal mission timeline, adds no payload weight, and does not jeopardize the accomplishment of primary objectives, experiments, or detailed objectives.

EXPERIMENTS

The Apollo 15 Mission includes the following experiments:

Lunar Surface Experiments

Lunar surface experiments are deployed and activated or conducted by the Commander and the Lunar Module Pilot during EVA periods. Those experiments which are part of the ALSEP are so noted.

Lunar Passive Seismology (S-031) (ALSEP)

The objectives of the passive seismic experiment are to monitor lunar seismic activity and to detect meteoroid impacts, free oscillations of the moon, surface tilt (tidal deformations), and changes in the vertical component of gravitational acceleration. The experiment sensor assembly is made up of three orthogonal, long-period seismometers and one vertical, short-period seismometer. The instrument and the near-lunar surface are covered by a thermal shroud.

Lunar Tri-axis Mangetometer (S-034) (ALSEP)

The objectives of the lunar surface magnetometer experiment are to measure the magnetic field on the lunar surface to differentiate any source producing the induced lunar magnetic field, to measure the permanent magnetic moment, and to determine the moon's bulk magnetic permeability during traverse of the neutral sheet in the geomagnetic tail. The experiment has three sensors, each mounted at the end of a 90-cm long arm, which are first oriented parallel to obtain the field gradient and thereafter orthogonally to obtain total field measurements.

Medium Energy Solar Wind (S-035) (ALSEP)

The objectives of the use of the solar wind spectrometer are to determine the nature of the solar wind interactions with the moon, to relate the effects of the interactions to interpretations of the lunar magnetic field, the lunar atmosphere, and to the analysis of lunar samples, and to make inferences as to the structure of the magnetospheric tail of the earth. The measurements of the solar wind plasma is performed by seven Faraday cup sensors which collect and detect electrons and protons.

Suprathermal Ion Detector (S-036) (ALSEP)

The objectives of the suprathermal ion detector experiment are to provide information on the energy and mass spectra of positive ions close to the lunar surface and in the earth's magnetotail and magnetosheath, to provide data on plasma interaction between the solar wind and the moon, and to determine a preliminary value for electric potential of the lunar surface. The suprathermal ion detector has two positive ion detectors: a mass analyzer and a total ion detector.

Cold Cathode Ionization Gauge (S-058) (ALSEP)

The objective of the cold cathode ionization gauge experiment, which is integrated with the suprathermal ion detector, is to measure the neutral particle density of the lunar atmosphere.

Lunar Heat Flow (S-037) (ALSEP)

The objectives of the heat flow experiment are to determine the net lunar heat flux and the values of thermal parameters in the first three meters of the moon's crust.

The experiment has two sensor probes placed in bore holes drilled with the Apollo Lunar Surface Drill (ALSD).

Lunar Dust Detector (M-515)

The objectives of the dust detector experiment is to obtain data on dust accretion rates and on the thermal and radiation environment. The dust detector has three small photoelectric cells mounted on the ALSEP central station sun shield, facing the ecliptic path of the sun.

Lunar Geology Investigation (S-059)

The fundamental objective of this experiment is to provide data for use in the interpretation of the geological history of the moon in the vicinity of the landing site. The investigation will be carried out during the planned lunar surface traverses and will utilize camera systems, hand tools, core tubes, the ALSD, and sample containers. The battery powered ALSD will be used to obtain core samples to a maximum depth of 2.5 meters.

Documented Samples - Rock and soil samples representing different morphologic and petrologic features will be described, photographed, and collected in individual pre-numbered bags for return to earth. This includes comprehensive samples of coarse fragments and fine lunar soil to be collected in pre-selected areas. Documented samples are an important aspect of the experiment in that they support many sample principal investigators in addition to lunar geology. Documented samples of the Apennine front and the drill core samples have higher individual priorities than the other activities of this experiment.

Geologic Description and Special Samples - Descriptions and photographs of the field relationships of all accessible types of lunar features will be obtained. Special samples, such as the magnetic sample, will be collected and returned to earth.

Laser Ranging Retro-reflector (S-078)

The objective of the experiment is to gain knowledge of several aspects of the earth-moon system by making precise measurements of the distance from one or more earth sites to several retro-reflector arrays on the surface of the moon. Some of these aspects are: lunar size and orbit; physical librations and moments of inertia of the moon; secular acceleration of the moon's longitude which may reveal a slow decrease in the gravitational constant; geophysical information on the polar motion; and measurement of predicted continental drift rates. The retro-reflector array on Apollo 15 has 300 individually mounted, high-precision, optical corners. Aiming and alignment mechanisms are used to orient the array normal to incident laser beams directed from earth.

Solar Wind Composition (S-080)

The purpose of the solar wind composition experiment is to determine the isotopic composition of noble gases in the solar wind, at the lunar surface, by entrapment of particles in aluminum foil. A staff and yard arrangement is used to deploy the foil and maintain its plane perpendicular to the sun's rays. After return to earth, a spectrometric analysis of the particles entrapped in the foil allows quantitative determination of the helium, neon, argon, krypton, and xenon composition of the solar wind.

Soil Mechanics Experiment (S-200)

The objective of the experiment is to obtain data on the mechanical properties of the lunar soil from the surface to depths of tens of centimeters.

Data is derived from lunar module landing dynamics, flight crew observations and debriefings, examination of photographs, analysis of lunar samples, and astronaut activities using the Apollo hand tools. Experiment hardware includes an astronaut operated self-recording penetrometer.

In-flight Experiments

The in-flight experiments are conducted during earth orbit, translunar coast, lunar orbit, and transearth coast mission phases. They are conducted with the use of the command module (CM), the scientific instrument module (SIM) located in sector I of the service module (SM), or the subsatellite launched in lunar orbit, as noted.

Gamma-ray Spectrometer (S-160) (SIM)

The objectives of the gamma-ray spectrometer experiment are to determine the lunar surface concentration of naturally occurring radioactive elements and of major rock forming elements. This will be accomplished by the measurement of the lunar surface natural and induced gamma radiation while in orbit and by the monitoring of galactic gamma-ray flux during transearth coast.

The spectrometer detects gamma-rays and discriminates against charged particles in the energy spectrum from 0.1 to 10 mev. The instrument is encased in a cylindrical thermal shield which is deployed on a boom from the SIM for experiment operation.

X-Ray Fluorescence (S-161) (SIM)

The objective of the X-ray spectrometer experiment is to determine the concentration of major rock-forming elements in the lunar surface. This is accomplished by monitoring the fluorescent X-ray flux produced by the interaction of solar X-rays with surface material and the lunar surface X-ray albedo. The X-ray spectrometer, which is integrally packaged with the alpha-particle spectrometer, uses three sealed proportional counter detectors with different absorption filters. The direct solar X-ray flux is detected by the solar monitor, which is located 180° from the SIM in SM sector IV. An X-ray background count is performed on the lunar darkside.

Alpha-Particle Spectrometer (S-162) (SIM)

The objective of this experiment is to locate radon sources and establish gross radon evolution rates, which are functions of the natural and isotopic radioactive material concentrations in the lunar surface. This will be accomplished by measuring the lunar surface alpha-particle emissions in the energy spectrum from 4 to 9 mev.

The instrument employs ten surface barrier detectors. The spectrometer is mounted in an integral package with the X-ray spectrometer.

S-Band Transponder (SCM/LM) (S-164)

The objectives of the S-band transponder experiment are to detect variations in the lunar gravity field caused by mass concentrations and deficiencies and to establish gravitational profiles of the ground tracks of the spacecraft.

The experiment data is obtained by analysis of the S-band Doppler tracking data for the CSM and LM in lunar orbit. Minute perturbations of the spacecraft motion are correlated to mass anomalies in the lunar structure.

Mass Spectrometer (S-165) (SIM)

The objectives of the mass spectrometer experiment are to obtain data on the composition and distribution of the lunar atmosphere constituents in the mass range from 12 to 66 amu. The experiment will also be operated during transearth coast to obtain background data on spacecraft contamination.

The instrument employs ionization of constituent molecules and subsequent collection and identification by mass unit analysis. The spectrometer is deployed on a boom from the SIM during experiment operation.

Bistatac Radar (S-170) (CSM)

The objectives of the bistatic radar experiment are to obtain data on the lunar bulk electrical properties, surface roughness, and regolith depth to 10-20 meters. This experiment will determine the lunar surface Brewster angle, which is a function of the bulk dielectric constant of the lunar material.

The experiment data is obtained by analysis of bistatic radar echos reflected from the lunar surface and subsurface, in correlation with direct downlink signals. The S-band and VHF communications systems, including the VHF omni and S-band high-gain or omni antennas, are utilized for this experiment.

Subsatellite

The subsatellite is a hexagonal prism which uses a solar cell power system, an S-band communications system, and a storage memory data system. A solar sensor is provided for attitude determination. The subsatellite is launched from the SIM into lunar orbit and is spin-stabilized by three deployable, weighted arms. The following three experiments are performed by the subsatellite:

S-Band Transponder (S-164) (Subsatellite) - Similar to the S-band transponder experiment conducted with the CSM and LM, this experiment will detect variations in the lunar gravity field by analysis of S-band signals. The Doppler effect variations caused by minute perturbations of the subsatellite's orbital motions are indicative of the magnitudes and locations of mass concentrations in the moon.

Particle Shadows/Boundary Layer (S-173) (Subsatellite) - The objectives of this experiment are to monitor the electron and proton flux in three modes: interplanetary, magnetotail, and the boundary layer between the moon and the solar wind.

The instrument consists of solid state telescopes to allow detection of electrons in two energy ranges of 0-14 kev and 20-320 kev and of protons in the 0.05 - 2.0 mev range.

Subsatellite Magnetometer (S-174) - The objectives of the subsatellite magnetometer experiment are to determine the magnitude and direction of the interplanetary and earth magnetic fields in the lunar region.

The biaxial magnetometer is located on one of the three subsatellite deployable arms. This instrument is capable of measuring magnetic field intensities from 0 to 200 gammas.

Apollo Window Meteoroid (S-176) (CM)

The objective of the Apollo window meteoroid experiment is to obtain data on the cislunar meteoroid flux of mass range 10^{-12} grams. The returned CM windows will be analyzed for meteoroid impacts by comparison with a preflight photomicroscopic window map.

The photomicroscopic analysis will be compared with laboratory calibration velocity data to define the mass of impacting meteoroids.

UV Photography - Earth and Moon (S-177) (CM)

The objective of this experiment is to photograph the moon and the earth in one visual and three ultraviolet regions of the spectrum. The earth photographs will define correlations between UV radiation and known planetary conditions. These analyses will form analogs for use with UV photography of other planets. The lunar photographs will provide additional data on lunar surface color boundaries and fluorescent materials.

Photographs will be taken from the CM with a 70mm Hasselblad camera equipped with four interchangeable filters with different spectral response. Photographs will be taken in earth orbit, translunar coast, and lunar orbit.

Gegenschein from Lunar Orbit (S-178) (CM)

The objective of the gegenschein experiment is to photograph the Moulton point region, and analytically defined null gravity point of the earth-sun line behind the earth. These photographs will provide data on the relationship of the Moulton point and the gegenschein (an extended light source located along the earth-sun line behind the earth). These photographs may provide evidence as to whether the gegenschein is attributable to scattered sunlight from trapped dust particles at the Moulton point.

Other Experiments

Additional experiments assigned to the Apollo 15 Mission which are not a part of the lunar surface or orbital science programs are listed below.

Bone Mineral Measurement (M-078)

The objectives of the experiment are to determine the occurrence and degree of bone mineral changes in the Apollo crewmen which might result from exposure to the weightless condition, and whether exposure to short periods of 1/6 g alters these changes. At selected pre- and post-flight times, the bone mineral content of the three Apollo crewmen will be determined using X-ray absorption technique.

The radius and ulna (bones of the forearm) and os calcis (heel) are the bones selected for bone mineral content measurements.

Total Body Gamma Spectrometry (M-079)

The objectives of this experiment are to detect changes in total body potassium and total muscle mass (lean body mass), and to detect any induced radioactivity in the bodies of the crewmen. Preflight and postlaunch examination of each crew member will be performed by radiation detecting instruments in the Radiation Counting Laboratory at MSC. There are no inflight requirements for this experiment.

DETAILED OBJECTIVES

Following is a brief description of each of the launch vehicle and spacecraft detailed objectives planned for this mission.

Launch Vehicle Detailed Objectives

Impact the expended S-IVB/IU on the Lunar surface under nominal flight profile conditions.

Post-flight determination of actual S-IVB/IU point of impact within 5 km, and time of impact within one second.

Spacecraft Detailed Objectives

Collect a contingency sample for assessing the nature of the surface material at the lunar landing site in event EVA is terminated.

Evaluate Lunar Roving Vehicle operational characteristics in the lunar environment.

Demonstrate the LCRU/GCTA will adequately support extended lunar surface exploration communication requirements and obtain data on the effect of lunar dust on the system.

Assess EMU lunar surface performance, evaluate metabolic rates, crew mobility and difficulties in performing lunar surface EVA operations.

Evaluate the LM's landing performance.

Obtain SM high resolution panoramic and high quality metric lunar surface photographs and altitude data from lunar orbit to aid in the overall exploration of the moon.

Obtain CM photographs of lunar surface features of scientific interest and of low brightness astronomical and terrestrial sources.

Obtain data to determine adequate thermal conditions are maintained in the SIM bay and adjacent bays of the service module.

Inspect the SIM bay, and demonstrate and evaluate EVA procedures and hardware.

Determine the effects of SIM door jettison in a lunar environment.

Obtain data on the performance of the descent engine.

Record visual observations of farside and nearside lunar surface features and processes to complement photographs and other remote-sensed data.

Obtain more definitive information on the characteristics and causes of visual light flashes.

Inflight Demonstration

None planned for this mission.

OPERATIONAL TESTS

The following significant operational tests will be performed in conjunction with the Apollo 15 mission.

Gravity Measurement

Performance of the gravity measurement will be by ground control. Following lunar landing, the IMU and platform will remain powered up. Flight controllers will uplink the necessary commands to accomplish gravity alighments of the IMU. Subsequent to the data readouts, the crew will terminate the test by powering down the IMU. This is the only crew function required, and crew activities are not restricted by the test. If the test is not completed in the short period after landing, it may also be conducted during the powered-up pre-liftoff operations.

Acoustic Measurement

The noise levels of the Apollo 15 space vehicle during launch and the command module during entry into the atmosphere will be measured in the Atlantic launch abort area and the Pacific recovery area, respectively. The data will be used to assist in developing high-altitude, high-Mach number, accelerated flight sonic boom prediction techniques. MSC will condust planning, scheduling, test performance, and reporting of the test results. Personnel and euipment supporting this test will be located aboard secondary recovery ships, the primary recovery ship, and at Nihoa, Hawaii.

VHF Noise Investigation

On-board audio recordings and VHF signal strengths from spacecraft telemetry will be reviewed and analyzed to attempt resolution of VHF noises and less-than-predicted communications performance experienced on previous Apollo missions. The crew will note any unusual VHF system performance, and signals will be recorded in the LM before ascent when the CSM is beyond the line of sight.

MISSION CONFIGURATION AND DIFFERENCES

MISSION HARDWARE AND SOFTWARE CONFIGURATION

The Saturn V Launch Vehicle and the Apollo Spacecraft for the Apollo 15 Mission will be operational configurations.

CONFIGURATION	DESIGNATION NUMBERS
Space Vehicle	AS-510
Launch Vehicle	SA-510
First Stage	S-IC-10
Second Stage	S-II-10
Third Stage	S-IVB-510
Instrument Unit	S-IU-510
Spacecraft-LM Adapter	SLA-19
Lunar Module	LM-10
Lunar Roving Vehicle	LRV-1
Service Module	SM-112
Command Module	CM-112
Onboard Programs	
Command Module	Colossus 3
Lunar Module	Luminary 1E
Experiments Package	Apollo 15 ALSEP
Launch Complex	LC-39A

CONFIGURATION DIFFERENCES

The following summarizes the significant configuration differences associated with the AS-510 Space Vehicle and the Apollo 15 Mission. Additional technical details on the new hardware items described below and contained in the Mission Operations Report, Apollo Supplement.

SPACECRAFT

Command/Service Module

Added third cryogenic H_2 tank with modified heating	Increased electrical power capability for extended mission duration.
Relocated third cryogenic O_2 tank isolation valve and plumbing	Eliminated potential single failure point.

Added Scientific Instrument Module (SIM) in Sector IV of Service Module	Increased in-flight science capability by addition of experiments, a sub-satellite, cameras, and laser altimeter (see experiments section).
Added Scientific Data System	Provided complete scientific experiment data coverage in lunar orbit with capability for realtime data transmission simultaneously with tape recorder playback and transmission of data recorded on the lunar far side.
Modified CM environmental control system for in-flight EVA capability	Provided for in-flight retrieval of film from SIM cameras by adding third O_2 flow restrictor; EVA control panel; and EVA umbilical with O_2, bioinstrumentation, and communications links with the EVA crewman.
Lunar Module	
Enlarged descent stage propellant tanks	Provided for longer powered descent burn to permit increased LM landing weight and landing point selection.
Modified descent engine nozzle by adding a ten-inch extension with quartz liner	Increased descent engine specific impulse.
Added GOX tank, water tank, and descent stage battery	Extended lunar surface stay time from 38 to 68 hours.
Modified quadrant I for LM-LRV interface	Provided for LRV stowage and deployment to increase lunar surface mobility.
Crew Provisions and Lunar Mobility	
New spacesuits for crewmen	Provided in-flight EVA capability for CMP and increased lunar surface EVA time for CDR and LMP. All suits have improved mobility. CDR and LMP suits have increased drinking water supply and 175 calorie fruit bars for each EVA.

Lunar Roving Vehicle	Provided increased lunar surface mobility for astronauts and equipment. Provided for transport and power supply for LCRU and GCTA on EVA traverses.

Launch Vehicle

S-IC

Modified LOX vent and relief valve	Additional spring increased valve closing force and improved reliability.
Increased outboard engine LOX depletion delay time	Increased payload capability approximately 500 pounds.
Removed four of the eight retro-rocket motors	Saved weight and cost and increased payload capability approximately 100 pounds.
Reorificed the F-1 engines	Increased payload capability approximately 600 pounds.

S-II

Removed four ullage motors	Eliminated single failure points and increased payload capability approximately 90 pounds.
Delayed time base 3 (S-II ignition) by one second	Maintained same S-IC/S-II stage separation as was previously achieved with S-IC retro-rockets.
Replaced LH2 and LOX ullage pressure regulators with fixed orifices	Increased payload capability approximately 210 pounds by providing hotter ullage gases. Eliminated several single point failures
Added a G-switch disable capability	Decreased the probability of an inadvertent cutoff due to a transient signal.
Changed engine pre-cant angle from 1.3° to 0.6°	Reduced probability of collision with the S-IVB stage in an engine out condition during second plane separation.

S-IVB

Added filter in J-2 engine helium pneumatic control line	Decreased probability of valve seat leakage and a possible restart prolem.

IU

Added redundant +28 volt power for ST-124 stabilized platform system	Improved power supply reliability.
Modified launch tower avoidance yaw maneuver by reducing the time from command to execute	Reduced launch wind restrictions and increased assurance of clearing the tower.
Modified Command Module Computer Cutoff program to provide spacecraft computer cutoff of S-IVB TLI burn	Increased accuracy of TLI burn cutoff in event of IU platform failure.

TV AND PHOTOGRAPHIC EQUIPMENT

Standard and special purpose cameras, lenses, and film will be carried to support the objectives, experiments, and operational requirements. Table 2 lists the television and camera equipments and shows their stowage locations.

TABLE 2

TV AND PHOTOGRAPHIC EQUIPMENT

NOMENCLATURE	STOWAGE LOCATION				
	CSM AT LAUNCH	LM AT LAUNCH	CM TO LM	LM TO CM	CM AT ENTRY
TV, COLOR, ZOOM LENS (MONITOR WITH CM SYSTEM)	1	1			1
CAMERA, 35MM NIKON	1				1
LENS - 55MM	1				1
CASSETTE, 35MM	4				4
CAMERA, DATA ACQUISITION, 16MM	1	1			1
LENS - 10MM	1	1			1
- 18MM	1				1
- 75MM	1				1
FILM MAGAZINES	10				10
CAMERA, LUNAR SURFACE, 16MM BATTERY OPERATED		1			
LENS - 10MM		1			
MAGAZINES	8		8	8	8
CAMERA, HASSELBLAD, 70MM ELECTRIC	1				1
LENS - 80MM	1				1
- 250MM	1				1
- 105MM UV (4 BAND-PASS FILTERS)	1				1
FILM MAGAZINES	6				6
FILM MAGAZINE, 70MM UV	1				1
CAMERA, HASSELBLAD, 70MM LUNAR SURFACE ELECTRIC		3			
LENS - 60MM		2			
- 500MM		1			
FILM MAGAZINES	13		13	13	13
CAMERA, 24-IN. PANORAMIC (IN SIM)	1				
FILM CASSETTE (EVA TRANSFER)	1				1
CAMERA, 3-IN. MAPPING STELLAR(SIM)	1				
FILM MAGAZINE (EVA TRANSFER)	1				1

FLIGHT CREW DATA

PRIME CREW (Figure 10)

COMMANDER: David R. Scott (Colonel, USAF)

Space Flight Experience: Colonel Scott was one of the third group of astronauts selected by NASA in October 1963.

As Pilot for the Gemini 8 Mission, launched on March 16, 1966, Colonel Scott and Command Pilot Neil Armstrong performed the first successful docking of two vehicles in space. Gemini 8, originally scheduled to continue for three days, was terminated early due to a malfunctioning attitude thruster.

Subsequently, Colonel Scott was selected as Command Module Pilot for the Apollo 9 Mission which included lunar orbit rendezvous and docking simulations, crew transfer between CM and LM, and extravehicular activity techniques.

Colonel Scott has flown more than 251 hours in space.

COMMAND MODULE PILOT: Alfred M. Worden (Major, USAF)

Space Flight Experience: Major Worden is one of 19 astronauts selected by NASA in April 1966. He served as a member of the astronaut support crew for Apollo 9 and backup command module pilot for Apollo 12.

Worden has been on active duty since June 1955. Prior to being assigned to the Manned Spacecraft Center, he served as an instructor at the Aerospace Research Pilots School.

LUNAR MODULE PILOT: James Benson Irwin (Lieutenant Colonel, USAF)

Space Flight Experience: Lieutenant Colonel Irwin was selected by NASA in 1966. He was crew commander of Lunar Module Test Article - 8 (LTA-8). LTA-8 was used in a series of thermal vacuum tests. He also served as a member of the support crew for Apollo 10 and as backup LM pilot for Apollo 12.

Irwin has been on active duty since 1951. Previous duties included assignment as Chief of the Advanced Requirements Branch at Headquarters, Air Defense Command.

APOLLO 15 PRIME CREW

BACKUP CREW

COMMANDER: Richard F. Gordan (Captain, USN)

Space Flight Experience: Captain Gordan was assigned to NASA in October, 1963. He served as the backup pilot for Gemini 8, backup CM pilot for Apollo 9 and served as CM pilot for Apollo 12, the second lunar landing mission.

Captain Gordan's total space time exceeds 315 hours.

COMMAND MODULE PILOT: Vance D. Brand (Civilian)

Space Flight Experience: Mr. Brand has served as an astronaut since April, 1966. He was a crew member for the thermal vacuum test of the prototype CM 2TV-1. He was also a member of the Apollo 8 and 13 support crews.

LUNAR MODULE PILOT: Harrison H. Schmitt, PhD (Civilian)

Space Flight Experience: Dr. Schmitt was selected as a scientist astronaut by NASA in June, 1965. He completed a 53 week course in flight training at Williams Air Force Base, Arizona. Dr. Schmitt has also been instrumental in providing Apollo flight crews with detailed instruction in lunar navigation, geology and feature recognition.

MISSION MANAGEMENT RESPONSIBILITY

TITLE	NAME	ORGANIZATION
Director, Apollo Program	Dr. Rocco A. Petrone	OMSF
Mission Director	Capt. Chester M. Lee (Ret)	OMSF
Saturn Program Manager	Mr. Richard G. Smith	MSFC
Apollo Spacecraft Program Manager	Col. James A. McDivitt	MSC
Apollo Program Manager, KSC	Mr. Robert C. Hock	KSC
Director of Launch Operations	Mr. Walter J. Kapryan	KSC
Director of Flight Operations	Mr. Sigurd A. Sjoberg	MSC
Launch Operations Manager	Mr. Paul C. Donnelly	KSC
Flight Directors	Mr. Gerald D. Griffin	MSC
	Mr. Eugene F. Kranz	MSC
	Mr. Glynn S. Lunney	MSC
	Mr. Milton L. Windler	MSC

ABBREVIATIONS AND ACRONYMS

AGS	Abort Guidance System
ALSEP	Apollo Lunar Surface Experiments Package
AOS	Acquisition of Signal
APS	Ascent Propulsion System (LM)
APS	Auxiliary Propulsion System (S-IVB)
ARIA	Apollo Range Instrumentation Aircraft
AS	Apollo/Saturn
BIG	Biological Isolation Garment
BSLSS	Buddy Secondary Life Su... System
CCATS	Communications, Command, and Telemetry System
CCGE	Cold Cathode Gauge Experiment
CDR	Commander
CPLEE	Charged Particle Lunar Environment Experiment
CM	Command Module
CMP	Command Module Pilot
CSI	Concentric Sequence Initiation
CSM	Command/Service Module
DAC	Data Acquisition Camera
DDAS	Digital Data Acquisition System
DOD	Department of Defense
DOI	Descent Orbit Insertion
DPS	Descent Propulsion System
DSKY	Display and Keyboard Assembly
ECS	Environmental Control System
EI	Entry Interface
EMU	Extravehicular Mobility Unit
EPO	Earth Parking Orbit
EST	Eastern Standard Time
ETB	Equipment Transfer Bag
EVA	Extravehicular Activity
FM	Frequency Modulation
fps	Feet Per Second
FDAI	Flight Director Attitude Indicator
FTP	Fixed Throttle Position
GCTA	Ground Commanded Television
GET	Ground Elapsed Time
GNCS	Guidance, Navigation, and Control System (CSM)
GSFC	Goddard Space Flight Center
HBR	High Bit Rate
HFE	Heat Flow Experiment
HTC	Hand Tool Carrier
IMU	Inertial Measurement Unit
IU	Instrument Unit
IVT	Intravehicular Transfer
KSC	Kennedy Space Center
LBR	Low Bit Rate
LCC	Launch Control Center
LCRU	Lunar Communications Relay Unit
LDMK	Landmark
LEC	Lunar Equipment Conveyor
LES	Launch Escape System
LET	Launch Escape Tower
LGC	LM Guidance Computer
LH_2	Liquid Hydrogen
LiOH	Lithium Hydroxide
LM	Lunar Module
LMP	Lunar Module Pilot
LOI	Lunar Orbit Insertion
LOS	Loss of Signal
LOX	Liquid Oxygen
LPO	Lunar Parking Orbit
LR	Landing Radar
LRL	Lunar Receiving Laboratory
LRRR	Laser Ranging Retro-Reflector
LSM	Lunar Surface Magnetometer
LV	Launch Vehicle
MCC	Midcourse Correction
MCC	Mission Control Center
MESA	Modularized Equipment Stowage Assembly
MH_z	Megahertz
MOCR	Mission Operations Control Room
MOR	Mission Operations Report
MPL	Mid-Pacific Line
MSC	Manned Spacecraft Center
MSFC	Marshall Space Flight Center
MSFEB	Manned Space Flight Evaluation Board
MSFN	Manned Space Flight Network
NASCOM	NASA Communications Network
NM	Nautical Mile
OMSF	Office of Manned Space Flight
OPS	Oxygen Purge System
ORDEAL	Orbital Rate Display Earth and Lunar
PCM	Pulse Code Modulation
PDI	Powered Descent Initiation
PGA	Pressure Garment Assembly
PGNCS	Primary Guidance, Navigation, and Control System (LM)
PLSS	Portable Life Support System
PSE	Passive Seismic Experiment
PTC	Passive Thermal Control
QUAD	Quadrant
RCS	Reaction Control System
RR	Rendezvous Radar
RLS	Radius Landing Site
RTCC	Real-Time Computer Complex
RTG	Radioisotope Thermoelectric Generator
S/C	Spacecraft
SEA	Sun Elevation Angle
SEVA	Stand-up EVA
S-IC	Saturn V First Stage
S-II	Saturn V Second Stage
S-IVB	Saturn V Third Stage
SIDE	Suprathermal Ion Detector Experiment
SIM	Scientific Instrument Module
SLA	Spacecraft-LM Adapter
SM	Service Module
SPS	Service Propulsion System
SRC	Sample Return Container
SSB	Single Side Band
SSR	Staff Support Room
SV	Space Vehicle
SWC	Solar Wind Composition Experiment
TD&E	Transposition, Docking and LM Ejection
TEC	Transearth Coast
TEI	Transearth Injection
TFI	Time From Ignition
TLC	Translunar Coast
TLI	Translunar Injection
TLM	Telemetry
TPF	Terminal Phase Finalization
TPI	Terminal Phase Initiation
T-time	Countdown Time (referenced to liftoff time)
TV	Television
USB	Unified S-Band
USN	United States Navy
USAF	United States Air Force
VAN	Vanguard
VHF	Very High Frequency
ΔV	Differential Velocity

GPO 915-012

Post Launch
Mission Operation Report
No. M-933-71-15

16 August 1971

TO: A/Administrator

FROM: MA/Apollo Program Director

SUBJECT: Apollo 15 Mission (AS-510) Post Launch Mission Operation Report No. 1

The Apollo 15 Mission was successfully launched from the Kennedy Space Center on Monday, 26 July 1971 and was completed as planned, with recovery of the spacecraft and crew in the mid-Pacific Ocean recovery area on Saturday, 7 August 1971. Initial review of the mission indicates that all mission objectives were accomplished. Further detailed analysis of all data is continuing and appropriate refined results of the mission will be reported in the Manned Space Flight Centers' technical reports.

Attached is the Mission Director's Summary Report for Apollo 15 which is submitted as Post Launch Mission Operation Report No. 1. Also attached are the NASA OMSF Primary Objectives for Apollo 15. The Apollo 15 Mission has achieved all the assigned primary objectives and I judge it to be a success.

Rocco A. Petrone

Rocco A. Petrone

APPROVAL:

Dale D. Myers

Dale D. Myers
Associate Administrator for
Manned Space Flight

NASA OMSF MISSION OBJECTIVES FOR APOLLO 15

PRIMARY OBJECTIVES

- Perform selenological inspection, survey, and sampling of materials and surface features in a preselected area of the Hadley-Apennine region.
- Emplace and activate surface experiments.
- Evaluate the capability of the Apollo equipment to provide extended lunar surface stay time, increased EVA operations, and surface mobility.
- Conduct in-flight experiments and photographic tasks from lunar orbit.

Rocco A. Petrone
Rocco A. Petrone
Apollo Program Director

Date: 16 July 1971

Dale D. Myers
Dale D. Myers
Associate Administrator for Manned Space Flight

Date: 17 July 1971

ASSESSMENT OF APOLLO 15 MISSION

Based upon a review of the assessed performance of Apollo 15, launched 26 July 1971 and completed 7 August 1971, this mission is adjudged a success in accordance with the objectives stated above.

Rocco A. Petrone
Rocco A. Petrone
Apollo Program Director

Date: 11 August 1971

Dale D. Myers
Dale D. Myers
Associate Administrator for Manned Space Flight

Date: August 16, 1971

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO ATTN OF: MAO

7 August 1971

TO: Distribution

FROM: MA/Apollo Mission Director

SUBJECT: Mission Director's Summary Report, Apollo 15

INTRODUCTION

The Apollo 15 Mission was planned as a lunar landing mission to: perform selenological inspection, survey, and sampling of materials and surface features in a preselected area of the Hadley-Apennine region of the moon; emplace and activate surface experiments; evaluate the capability of Apollo equipment to provide extended lunar surface stay time, increased EVA operations, and surface mobility; and conduct photographic tasks. Flight crew members were Commander (CDR) Col. David R. Scott (USAF), Command Module Pilot (CMP) Maj. Alfred M. Worden (USAF), and Lunar Module Pilot (LMP) Lt. Col. James B. Irwin (USAF). Significant detailed mission information is contained in Tables 1 through 13. Initial review indicates that all primary mission objectives were accomplished (reference Table 1). Table 2 lists the Apollo 15 achievements.

PRELAUNCH

The space vehicle prelaunch operations were nominal and the final countdown was exceptionally smooth.

LAUNCH AND EARTH PARKING ORBIT

The Apollo 15 space vehicle was successfully launched on time from Kennedy Space Center, Florida, at 9:34 a.m. EDT, on 26 July 1971. The S-IVB/IU/CSM/LM combination was inserted into an Earth Parking Orbit (EPO) of 91.5 x 92.5 nautical miles (NM), about 11 minutes 44 seconds after liftoff. The planned EPO was 90 NM circular.

During EPO, a navigation correction for the Translunar Injection (TLI) maneuver was uplinked to the Instrument Unit (IU), all major Command Service Module (CSM) and S-IVB systems were verified, and preparations were completed for the S-IVB engine restart for TLI. The restart was initiated at 2:50:02 GET and a nominal TLI was achieved at 2:56:03 Ground Elapsed Time (GET).

The CSM separated from the LM/S-IVB/IU at 3:22:24 GET. Onboard color television (TV) was initiated as scheduled to cover the docking of the CSM with the Lunar Module (LM). Hard docking was completed at 3:33:49 GET followed by CSM/LM ejection at 4:18:00 GET. The S-IVB Auxiliary Propulsion System (APS) evasive maneuver was performed nominally and within a few seconds of the prelaunch plan.

The first S-IVB APS burn to achieve lunar impact was initiated at 5:47:53 GET. The second S-IVB APS burn was initiated at 10:00:00 GET, about 30 minutes later than planned. The late burn provided additional tracking time to compensate for any trajectory perturbations introduced by liquid oxygen (LOX) and liquid hydrogen (LH_2) tanks venting. Preliminary targeting for S-IVB lunar impact was 3°39'S and 7°39'W.

The spacecraft trajectory was so near nominal that midcourse correction (MCC)-1, scheduled for 11:55:33 GET, was cancelled.

Shortly after docking, telemetry data indicated that the solenoid valve drivers in the Service Propulsion System (SPS) were on. This condition indicated an electrical short to ground in the circuitry. The crew reported the Entry Monitor System Delta V thrust light was on in the cabin. Troubleshooting appeared to isolate the problem to the Delta V thrust A switch or adjacent wiring. Additional procedures were prepared to further diagnose the problem during the SPS engine burn at MCC-2.

The MCC-2 maneuver was performed with the SPS engine at 28:40:30 GET. The burn time of 0.72 second produced a Delta V of 5.3 feet per second (fps). The maneuver was conducted with SPS bank A in order to provide better analysis of the apparent intermittent short. SPS engine checkout procedures were developed and simulations were conducted on the ground prior to passing the procedures up to the crew. The method employed for the firing isolated the intermittent short to an area of Delta V thrust switch A downstream of a necessary SPS valve function for bank A. Because power could still be applied to the valve with a downstream short, SPS bank A could be operated satisfactorily in the manual mode for subsequent firings. The redundant bank B system was nominal in all respects and could be used for automatic starting and shutdown.

At approximately 33:47:00 GET, a temporary loss of communication was experienced due to a power amplifier failure at the Goldstone wing site tracking station. Communications were restored after switching to the Goldstone prime site.

The LM crew entered the LM at 33:56:00 GET for checkout, approximately 50 minutes earlier than scheduled. LM communications checks were performed between 34:21:00 and 34:45:00 GET. Good quality voice and data were received even though Goldstone was not yet configured correctly during the initial portion of the down-voice backup checks. Approximately 15 minutes later, the downlink carrier lock was lost for approximately a minute and a half; however, other stations that were tracking reduced the data loss to a few seconds.

TV of the CSM and LM interiors was broadcast between 34:55:00 and 35:46:00 GET. Camera operation was nominal, but the picture quality varied with the lighting of the scene observed. During checkout of the LM, the crew discovered the range/range rate exterior cover glass was broken, removing the helium barrier. Subsequent ground testing qualified the unprotected meter for use during the remainder of the mission in the spacecraft ambient atmosphere.

IVT/LM housekeeping began at 56:26:00 GET, approximately an hour and a half earlier than scheduled. The crew vacuumed the LM to remove broken glass from the damaged range/range rate meter. LM checkout was completed as planned.

MCC-3, scheduled for 56:31:00 GET, was not performed since the spacecraft was very close to the planned trajectory.

At 61:13:00 GET, during preparations for water chlorination, a water leak developed in the chlorination septum gland in the command module (CM). The leak was attributed to insufficient torque on the nut which compresses the septum washers in the gland. Procedures were read up to the crew for tightening the insert in the injector port. The leak was stopped and the water was absorbed with towels.

The CSM/LM entered the moon's sphere of influence at 63:55:20 GET.

Based on the MCC-2 burn test data, which indicated that SPS bank A could be safely operated manually, it was decided to perform all SPS maneuvers except Lunar Orbit Insertion (LOI) and Transearth Injection (TEI) using bank B only. LOI and TEI would be dual bank burns with modified procedures to permit automatic start and shutdown on bank B. The procedures to be used for these maneuvers were relayed to the crew.

MCC-4 at 73:31:14 GET was performed with the SPS engine, bank B. The burn time of 0.92 second produced a Delta V of -5. fps with no trim required since the residuals were zero.

SIM door jettison occurred at 74:06:47 GET. The LMP photographed the jettisoned door and visually observed it slowly tumbling through space away from the CSM and eventually into a heliocentric orbit.

LUNAR ORBIT INSERTION

LOI was performed using both banks of the SPS. The nominal maneuver, initiated at 78:31:46 GET, placed the CSM/LM in a 170 x 58-NM elliptical orbit around the moon. The burn time of 400.7 seconds produced a velocity change of -3000.1 fps. Bank A was shut down 32 seconds before planned cutoff to obtain performance data on bank B for future single bank burns.

S-IVB IMPACT

The S-IVB/IU impacted the lunar surface at 79: 24:42 GET (4:58:43 p.m. EDT), approximately 11 minutes later than the prelaunch prediction. The impact point was 1.0°S and 11.87°W, which is 188 kilometers (km) northeast of the Apollo 14 landing site and 355 km northeast of the Apollo 12 landing site. The energy from the impact traveling through the lunar interior arrived at the Apollo 14 passive seismometer 37 seconds after impact and at the Apollo 12 seismometer 55 seconds after impact.

DESCENT ORBIT INITIATE

The DOI burn at 82:39:48 GET was nominal and the spacecraft was inserted in a 58.5 x 9.2 NM orbit. The single bank SPS burn duration was 24.5 seconds and resulted in a velocity change of -213.9 fps.

LUNAR ORBIT PRELANDING ACTIVITIES

Because the orbital decay rate was greater than anticipated, and RCS DOI trim burn of 21.2 seconds at 95:56:42 GET was executed on Revolution 10, producing a velocity change of 3.1 fps. The maneuver changed the orbit from 59.0 x 7.1 NM to 59.9 x 9.6 NM.

During the 12th lunar revolution on the far side of the moon at about 100:14:00 GET, the CSM/LM undocking and separation maneuver was initiated; however, at Acquisition of Signal (AOS), the commander reported that undocking did not occur. The crewmen and ground control decided that the probe instrumentation LM/CSM umbilical was either loose or disconnected. The CMP went into the tunnel to inspect the connection and found the umbilical plug to be loose. After reconnecting the plug and adjusting the spacecraft attitude, undocking and separation was achieved approximately 25 minutes late at 100:39:30 GET. The CSM circularization burn of 3.59 seconds was performed as planned at 101:38:58 GET and produced a Delta V of plus 68.3 fps. The SPS single bank burn was nominal with a resulting orbit of 64.7 x 58.0 NM.

POWERED DESCENT

LM powered descent was initiated at 104:30:09 GET. The descent-to-landing performance was nominal. Touchdown occurred at 104:42:29 GET. The crew reported that they had landed at Hadley near Salyut Crater. Based on landmark bearings during SEVA and sightings from the CSM, ground crew analysis indicated the LM landing point to be about 600 meters north northwest of the planned target. The LM landing coordinates were 26°05'N and 3°39'E.

LUNAR SURFACE

The stand-up extravehicular activity (SEVA) to observe and photograph the landing site and surrounding area began at 106:42 :49 GET (cabin depressurization). The CDR opened the upper hatch, stood on the ascent engine cover with his head out the hatch, and described and photographed the features of the area. SEVA termination occurred at 107:15:56 GET for a total of 33 minutes 7 seconds.

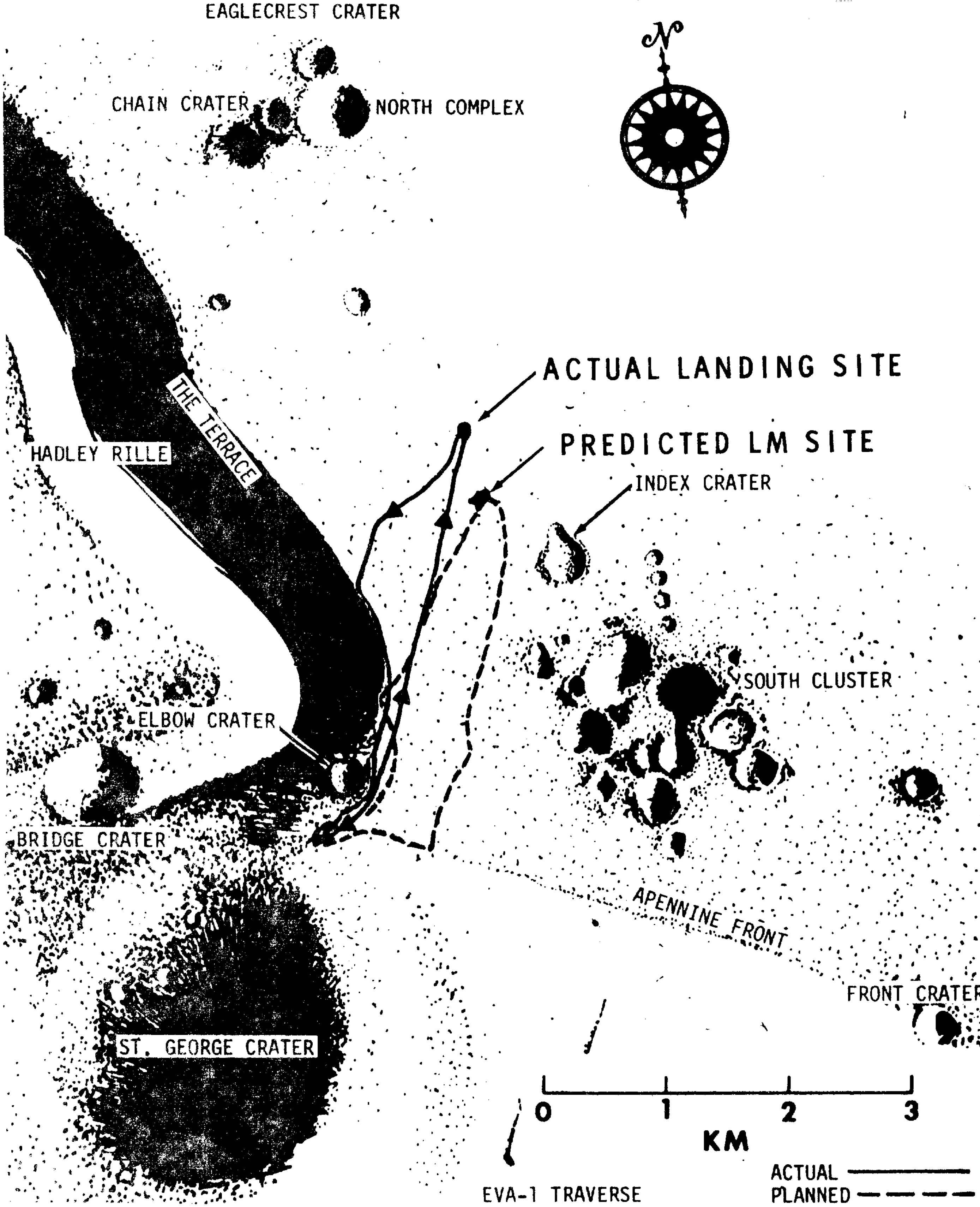
EVA-1 commenced at 119:30:10 GET at LM cabin depressurization. At 119:45:30 GET, the LMP experienced difficulty with the feedwater pressure in his Portable Life Support System (PLSS). The pressure reading was off-scale high, but this was attributed to gas bubbles in the feedwater and allowed the EVA to be continued. The CDR egressed the LM, and part of the way down the ladder he deployed the Modularized Equipment Stowage Assembly (MESA). The TV in the MESA was activated and the pictures of the CDR's remaining descent to the lunar surface were excellent. The LMP then egressed the LM to the lunar surface. While the CDR removed the TV camera from the MESA and deployed it on the tripod, the LMP collected the contingency sample.

The Lunar Roving Vehicle (LRV) was deployed with some difficulty by both astronauts. During checkout of the LRV, it was found that the LRV's front steering mechanism was inoperative. Additionally, there were no readouts on the LRV battery #2 ampere/volt meter. After minor troubleshooting of these problems, a decision was made to perform EVA-1 without the LRV front wheel steering activated. The troubleshooting determined that LRV battery #2 was carrying its share of the load.

The crew mounted the LRV and proceeded on the traverse (Figure 1) for EVA-1 at 121:44:56 GET. During the traverse, the crew obtained rock samples and photographs at the various stations. TV transmission during the stops was excellent.

At the end of the traverse, the ALSEP was deployed; however, the second coring operation for the heat flow experiment was not completed. This portion of ALSEP deployment was rescheduled to be completed during EVA-2. LM cabin repressurization terminated the EVA at 126:11:59 GET. The EVA duration was 6 hours 32 minutes 49 seconds, as compared to the 7 hours originally planned. This was occasioned by higher than anticipated O_2 usage by the CDR.

Since the LMP's PLSS was recharged 30° from the required vertical position, it was decided to vent and recharge the PLSS. A non-vertical recharge could cause gas bubbles as apparently experienced during EVA-1; the PLSS operation was nominal during EVA-2. During communications checks, the CDR reported that the LMP's PLSS antenna was broken. After powering down the EMU, the antenna was taped onto the Oxygen Purge System (OPS) and communications checks were satisfactorily completed.


EAGLECREST CRATER
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PREDICTED LM SITE
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ELBOW CRATER
BRIDGE CRATER
APENNINE FRONT
FRONT CRATER
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0
1
2
3
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ACTUAL
PLANNED
EVA-1 TRAVERSE

Fig. 1

EVA-2 commenced at 142:14:48 GET. The LRV was powered up, and the circuit breakers were cycled. The LRV steering was then found to be completely operational, as opposed to EVA-1 when the front steering mechanism was inoperable. The crew started the EVA-2 traverse at 143:11:00 GET. The trip included stops at Spur Crater, Dune Crater, Hadley Plains, and between Spur and Window Craters (see Figure 2). During the traverse, the crew obtained numerous samples and photographs. TV transmission was very good. Following termination of the traverse, the crew completed the heat flow experiment which was initiated on EVA-1 and collected a core sample. The drill core stems were left at the ALSEP site for retrieval during EVA-3. The crew returned to the LM and deployed the United States flag. The sample container and film were stowed in the LM. Crew ingress followed, and EVA-2 was terminated with LM repressurization at 149:27:02 GET. The total EVA duration was 7 hours 12 minutes 14 seconds.

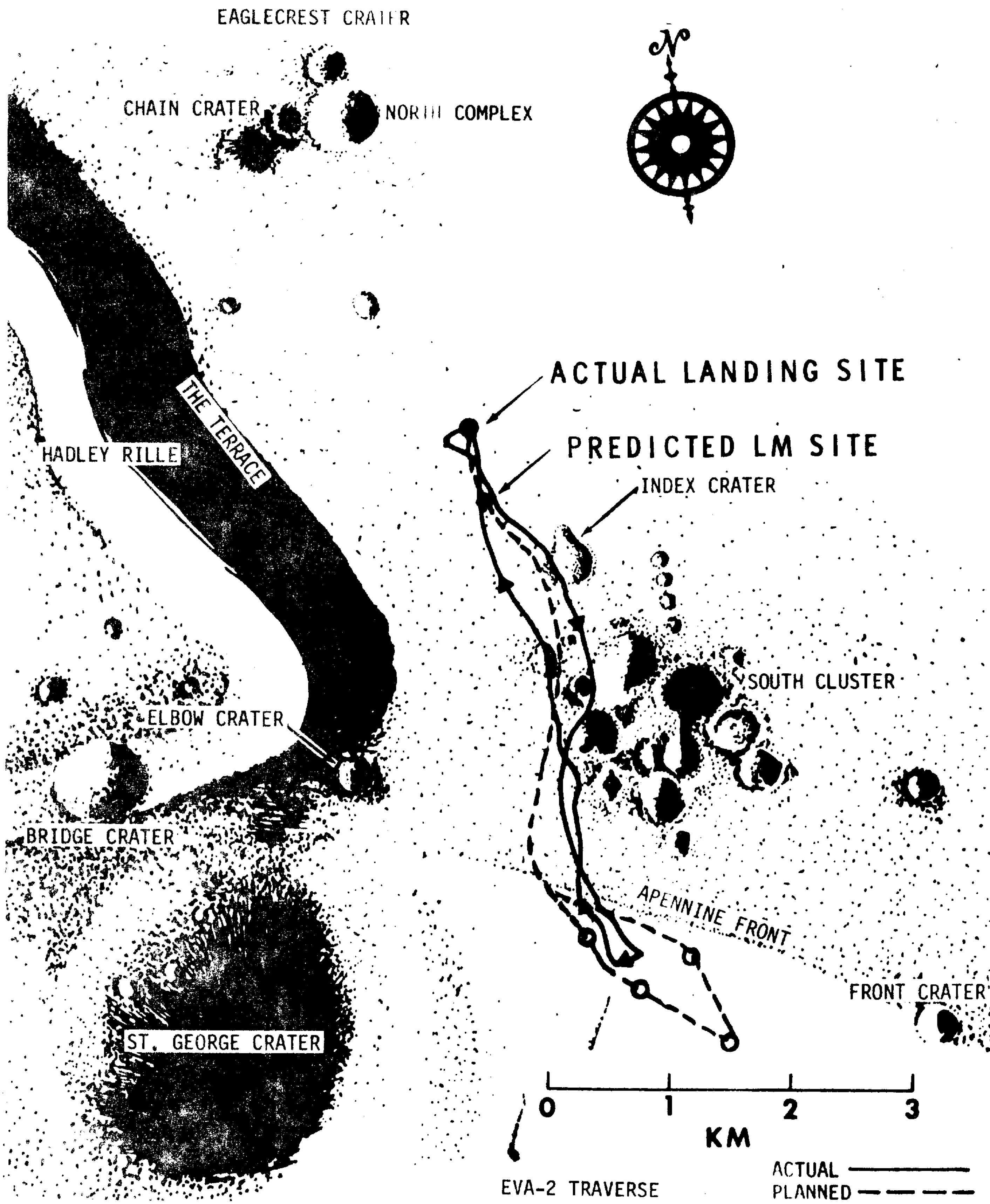
EVA-3 commenced at 163:18:14 GET, about 1 hour 45 minutes later than the nominal flight plan time due to cumulative changes in the surface activities timeline. The late start and the requirement to protect the nominal liftoff time required shortening the EVA. An alternate EVA plan was devised, and the traverse was made in a westerly direction from the LM to Hadley Rille (see Figure 3). The first stop was near the ALSEP site to retrieve the drill core stem samples left behind on EVA-2. Two of the sections of the drill core stem were removed and stowed in the LRV. The drill and the four remaining sections of the drill core stem could not be separated and were left for later retrieval. The remaining stops were Scarp Crater, "The Terrace" near Rim Crater, and Rim Crater. The return route was generally the same as the outbound route. Samples were obtained and documented and photographs were taken of various lunar surface features. During the sample collecting, the CDR tripped over a rock and fell, but experienced no difficulty in getting up.

Upon reaching the ALSEP area, the crew again attempted to disassemble the drill core stem. They managed to separate one more section, but the remaining three sections were returned still assembled.

The crew then returned to the LM, off-loaded the LRV, and stationed it for TV coverage of the LM liftoff. The CDR selected a site slightly closer to the LM than originally planned in order to take advantage of more elevated terrain for better LM liftoff TV coverage. The CDR ingressed the LM, and the EVA was terminated at 168:08:04 GET for a total duration of 4 hours 49 minutes 50 seconds.

ASCENT, RENDEZVOUS, AND DOCKING

Ascent stage liftoff from the lunar surface occurred on time at 171:34:22.4 GET, and the initial movement off the descent stage was televised by the Ground Controlled Television Assembly (GCTA). The ascent stage was inserted into a nominal lunar orbit and no tweak burn was required. The TPI burn was executed on time at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PREDICTED LM SITE
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SOUTH CLUSTER
ELBOW CRATER
BRIDGE CRATER
APENNINE FRONT
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EVA-2 TRAVERSE
ACTUAL
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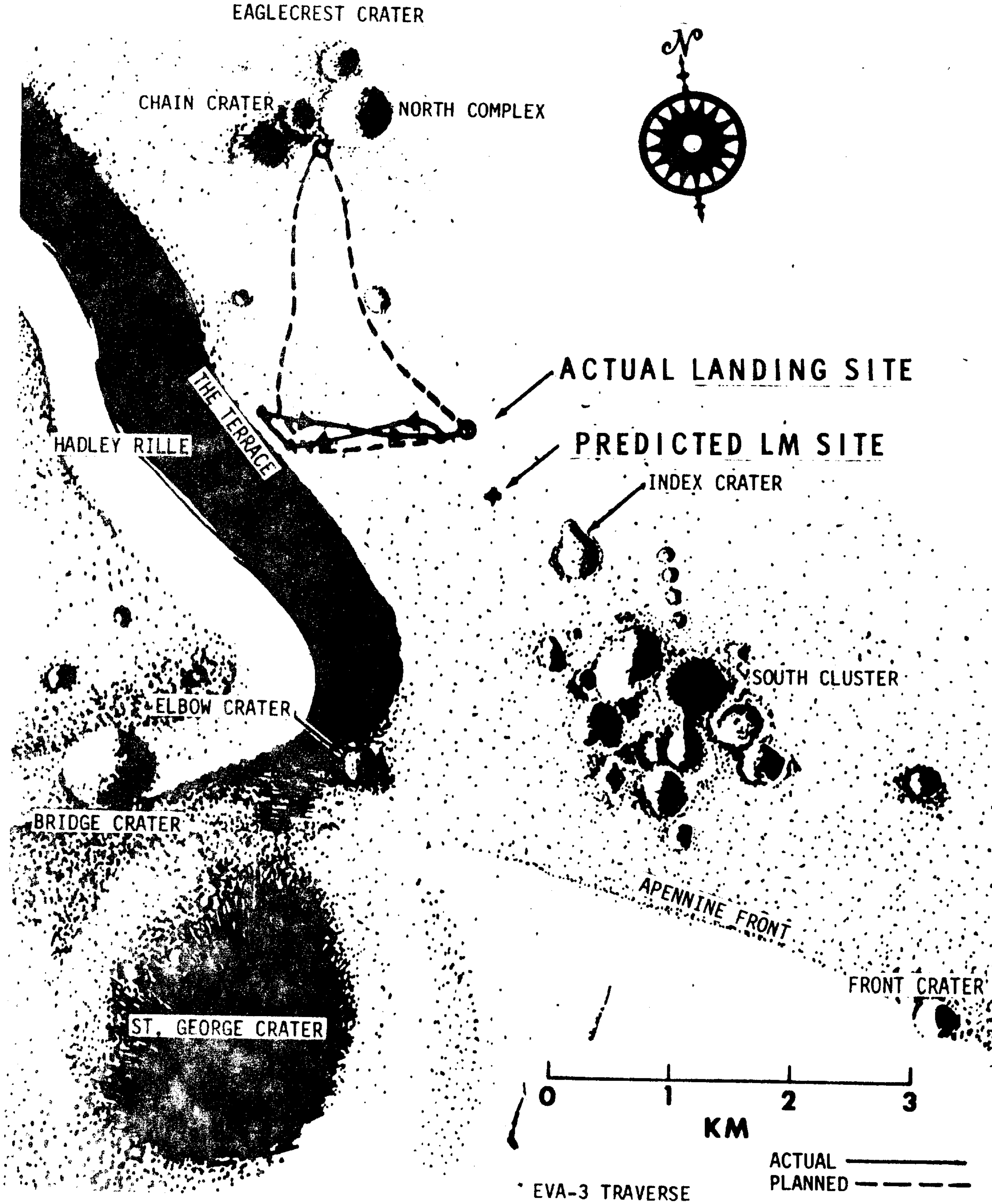
Fig. 2



EVA-3 TRAVERSE

Fig. 3

172:20:39 GET, with a nominal Delta V of 73 fps. The ascent stage performed a nominal braking maneuver for rendezvous with the CSM. Hard docking occurred at 173:35:47 GET. After CSM/LM docking, the CDR and LMP transferred the samples and other equipment to the CM for return to earth.

POST RENDEZVOUS

Following CDR and LMP IVT to CM, LM jettison and CSM separation were delayed one revolution in order to verify that the CSM and LM hatches were completely sealed. LM jettison occurred at 179:30:14 GET. The CSM was to perform a separation maneuver of 1 fps five minutes after LM jettison, but the delay in LM jettison caused the relative positions of the two spacecraft to be off-nominal, requiring a 2 fps Delta V posigrade burn which was accomplished at 179:50:00. The ascent stage deorbit burn (also delayed one revolution) occurred at 181:04:19. The spent LM ascent stage impacted the lunar surface at 26° 22'N and 15'E at 181:29:36 GET, 93 km west of the Apollo 15 ALSEP site, 23.6 km from the preplanned target. The impact was recorded on the Apollo 12, 14, and 15 Passive Seismometers.

The orbit shaping maneuver for the subsatellite launch was performed during the 73rd lunar orbit revolution (rev) at 221:20:47 GET. The 3.3 second burn produced a Delta V of 66.4 fps, with a resultant orbit of 76 x 54.3 NM. At 22:39:19 GET, the subsatellite was launched into a 76.3 x 55.1 NM orbit. The launching produced a velocity of 4 fps for the subsatellite relative to the CSM.

TRANSEARTH INJECTION AND COAST

The transearth injection maneuver was performed at 223:48:45 GET. The Service Propulsion System (SPS) burn of 141.2 seconds resulted in a Delta V of 3047 fps and a flight path angle of -6.69 degrees at entry interface.

Since the spacecraft trajectory was near nominal, MCC-5 was not performed. The predicted Delta V was 0.3 fps.

The CMP performed the in-flight EVA at 241:57:57 GET to retrieve the Panoramic (Pan) and Mapping Camera film cassettes from the Scientific Instrument Module (SIM) located in the SM. Three excursions were made to the SIM bay. The film cassettes were retrieved during trips one and two. The third trip to the SIM bay was used to observe and report the general condition of the instruments; in particular, the Mapping Camera. The CMP reported no evidence of the cause for the Mapping Camera extend/retract mechanism failure in the extended position and no observable reason for the Pan Camera velocity/altitude sensor failure. He also reported the Mass Spectrometer Boom was not fully retracted. The 38 minute 12 second EVA was completed at 242:36:09 GET.

MCC-6 scheduled at 272:58:20 was canceled since the requirement was less than one fps. MCC-7 was performed at 291:56:48 GET. The 24.2 second maneuver produced a Delta V of 5.6 fps.

ENTRY AND LANDING

The CM separated from the SM at 294:44:00 GET, 15 minutes before entry interface (EI) at 400,000 ft. Drogue and main parachutes deployed normally; however, one of the three main parachutes partially closed during descent and subsequently caused a harder landing than planned. Landing occured at 295:11:53 GET in the mid-Pacific Ocean, at approximately 158°09'W longitude and 26°07'N latitude. The CM landed in a stable 1 position, about 5.5 NM from the prime recovery ship, USS Okinawa, and about 1 NM from the planned landing point.

Weather in the prime recovery area was as follows: visibility 12 miles, wind 10 knots, scattered cloud cover 2,000 ft., isolated showers, and wave height 3 feet.

ASTRONAUT RECOVERY OPERATIONS

Following CM landing, the recovery helicopter dropped swimmers who installed the flotation collar and attached the life raft. Fresh flight suits were passed through the hatch for the flight crew. The post landing ventilation fan was turned off, the CM was powered down, the crew egressed, and the CM hatch was secured.

The helicopter recovered the astronauts and flew them to the recovery ship. After landing on the recovery ship, the astronauts proceeded to the Biomed area for a series of examinations. Following the examinations, the astronauts departed the USS Okinawa the next day, were flown to Hickam Air Force Base, Hawaii, and then to Ellington Air Force Base, Texas.

COMMAND MODULE RETRIEVAL OPERATIONS

After astronaut pickup by the helicopter, the CM was retrieved and placed on a dolly aboard the recovery ship. All lunar samples, data, and equipment will be removed from the CM and subsequently returned to Ellington Air Force Base, Texas. The CM will be offloaded at San Diego where deactivation of the CM propellant system will take place.

SYSTEMS PERFORMANCE

The Saturn V stages performed nominally.

The spacecraft systems were also near nominal throughout the mission with the exception of the intermittent short circuit in the Delta V thrust switch A (downstream of a necessary SPS valve function for bank A), the CSM/LM failure to undock at 100:14:00 GET, and an increase in CM tunnel pressure subsequent to the cabin integrity check preceding LM jettison.

All anomalies were rapidly analyzed and either resolved or workaround procedures developed to permit the mission to safely continue.

All anomalies are listed in Table 9 through 13.

FLIGHT CREW PERFORMANCE

The Apollo 15 flight crew performance was excellent throughout the mission.

All information and data in this report are preliminary and subject to revision by the normal Manned Spaceflight Centers' technical reports.

C M Lee
C. M. Lee

IN-FLIGHT SCIENCE

The first Command and Service Module Orbital Science Payload commenced operation after successful door jettison and Lunar Orbit Insertion. Although there was a problem with the Panoramic Camera V/H Sensor and the Laser Altimeter, all the major photography objectives using the service module cameras were achieved. All of the other orbital experiments operated as designed. The subsatellite was successfully placed in lunar orbit, and its experiments all operated as planned.

EXPERIMENTS

Gamma-Ray Spectrometer

The Gamma-Ray Spectrometer performs a remote compositional survey of the upper 30 cm of the lunar surface by detecting the gamma rays emitted during the radioactive decay of the naturally occurring radioisotopes (40_k, 238_U, 232_{Th}, and their daughter products) and of the radioisotopes produced by cosmic ray bombardment of lunar surface materials (0, Mg, Al, Si, Fe). The instrument measures the number of gamma rays emitted from the lunar surface in each of 512 energy increments between 0.10 and 10 Mev. The instrument is mounted on a 25-ft. boom to remove it from the gamma ray background caused by radioactive materials on the CSM and by secondary gamma rays due to cosmic ray bombardment of the CSM.

The instrument performed particularly well both in lunar orbit and during Transearth Coast (TEC). All commands to the instrument via the crew were implemented, including gain changes and charged particle rejections.

During operating periods prior to CSM/LM undocking, gamma rays from the ALSEP Radioisotope Thermoelectric Generator (RTG) dominated the gamma ray spectrum and several RTG gamma ray line spectra were identified. After undocking a significant decrease in the gamma ray background was observed at boom extension. Fifty-two hours of prime gamma ray data (minimum background configuration) were obtained during the lunar orbital phase and the data is 100% useful. Although detailed analysis of the data is required before the chemical composition of a particular region can be identified, on the basis of real-time data, several lunar features have been identified which have an above average Th concentration. In addition, the total gamma ray activity was found to be slightly higher on the backside than on the frontside.

The spectrometer was also operated for 50 hours during TEC to obtain background data necessary for the detailed analysis of the lunar data, to perform a galactic gamma ray survey, and to examine particular galactic gamma ray sources. Significant gamma ray activity was observed at this time, but the real time data displayed in the Mission Control Center was insufficient to identify the line spectra.

The instrument was also operated in lunar orbit for 58 hours in various nonminimum gamma ray background configurations. In addition to providing significant lunar gamma ray information, these data will determine the actual effect of the various background sources on the prime data and may allow a relaxation of the constraints on instrument operation on Apollo 16.

X-Ray Spectrometer

The X-ray Spectrometer performs a compositional survey of the topmost lunar surface by detecting secondary fluorescent X-rays emitted by the constituent elements when they are bombarded by solar X-rays.

The instrument performed exceptionally well both in lunar orbit where over 100 hours of data were acquired and during TEC where 50 hours of galactic data including seven discrete- X-ray sources were acquired.

During TEC the recently discovered X-ray Pulsar CX-1 was observed continuously for 30 minutes, the first time a galactic X-ray source has been observed this long continously. Simultaneously, with the Apollo observations of CX-1, the source was also monitored by the Soviet observatory in the Cremea (Crimean Astrophysical Observatory) with a 100-inch optical telescope. The Apollo X-ray data and the Soviet visual observations will be used to derive a model consistent with both sets of data.

The data acquired is 100% useful. Since the count rate is higher than predicted, the data can be compiled in shorter time intervals permitting compositional maps with improved spatial resolution.

Preliminary analysis of the data acquired on rev 16 between 95°E and 40°E shows a definite correlation of Al concentration and Mg/Al ratios with lunar features. Over both Mare Smithii and Mare Crisium a depletion of Al and an enhancement of Mg was found over that observed in the adjacent highlands.

Alpha-Particle Spectrometer

The Alpha-Particle Spectrometer seeks to locate cracks or fissures in the lunar surface by detecting the alpha particles emitted by the decay of two of the isotopes of the inert radioactive gas radon. In addition to providing data on radon, the instrument also corroborates the data from the Gamma-Ray Spectrometer by detecting alpha particles emitted during the decay of U, Th, and their daughter products.

The instrument was operated for over 100 hours in lunar orbit and about 90-95% of the data are useful. Two of ten detectors were intermittently noisy at high temperatures, but this noise can be removed by later detailed analysis.

Preliminary analysis of the data indicates that the rate of radon evolution on the moon is at least one thousand times less than that on the earth.

Background data were also acquired for 50 hours during TEC.

Mass Spectrometer

The Mass Spectrometer (MS) measured the composition and density of neutral molecules present in the lunar atmosphere at 60 NM. Due to outgassing and venting from the CSM, the MS is mounted on a 24-ft. boom.

Operation of the instrument was nominal, but an apparent problem with the boom retraction mechanism resulted in the decision not to ext end the MS during one scheduled data acquisition period, and the crew failed to turn the instrument on during a second scheduled data acquisition period. However, the subsequent experiment timeline was modified to include additional MS operating periods, and over 46 hours of useful data were acquired including 7 hours of background data. In addition, the instrument was operated for 50 hours during TEC with the boom extended various distances from the CSM to determine spacecraft venting and outgassing levels. A preliminary analysis of the data indicates the presence of several constituents which may be native to the lunar atmosphere. Agron mass 40, varies in constituents from approximately 2×10^5 particles/CM^3 on the dark side to about 6×10^5 particles/CM^3 in sunlight, while Argon 36 varies similarly from 6×10^4 to 2×10^5 particles/CM^3. Short intense bursts of several gases including CO_2 as well as masses 36 and 56 have been observed on the backside, but detailed analysis is required before these can be attributed to either the CSM or to lunar phenomena.

S-Band Transponder

S-band Doppler tracking of the CSM during inactive periods and of the LM during unpowered descent occurred over the three largest known lunar gravitational anomalies (Mare Imbrium, Mare Crisium, and Mare Serenitatus).

Preliminary data from Apollo 15 at an altitude of 15 km corroborates the mascon data obtained from Lunar Orbiter from an altitude of 200 km over these features. The gravitational profile has been compared with the Laser Altimeter data acquired over these same features, and some interesting correlations have been observed. However, further reduction of the data is required in order to remove the topographic effect and to determine the size and depth of the mascon.

The S-band Transponder onboard the Subsatellite (described below) will be tracked for approximately one year as the altitude decays from its present orbit and eventually impacts the lunar surface. Repeated overflights of the regions between 28°N and 28°S at these varying altitudes will permit an accurate detailed gravitational profile of the frontside between these latitudes and also permit an estimate of the gross gravitational anomalies on the backside.

Subsatellite Magnetometer and Charged Particles Detectors

The Subsatellite was successfully deployed from the CSM into a 76.3 x 55.1 NM lunar orbit with an inclination of -28.7°. Scientific data with the particle detectors and magnetometer is being obtained.

The particle experiment uses five curved plate particle detectors and two solid state telescopes to study the boundary layer of the solar wind plasma interaction with the moon and with the earth's geomagnetic tail. This interaction region extends outward from the lunar surface to $\sim$100 km and is characterized by the properties of the plasma as well as those of the moon. These data will yield information on the external plasma, the lunar interior, the lunar surface electrical charge, and the lunar ionosphere.

The magnetic field experiment employs a biaxial fluxgate magnetometer to measure the magnetic field at orbital altitudes. In addition to providing data in the interaction of the solar wind with the moon, the magnetometer data will be correlated with surface magnetic field measurements made by the Apollo 12 and 15 ALSEP/LSM's. These simultaneous measurements will lead to a determination of the electrical conductivity of the deep interior.

Bistatic Radar Experiment

The Bistatic Radar Experiment was conducted using the onboard CSM S-band and VHF communications systems. Two complete dual-frequency frontside passes were conducted on revs 17 and 28, respectively. In the dual-frequency mode, the S-band high gain antenna and the VHF omni antenna were used, and a spacecraft maneuver was performed to maintain the proper geometry between the HGA, the lunar surface, and the earth. The S-band data was received by the 210' Goldstone antenna and the VHF by the 150' antenna at Stanford University. A VHF only bistatic radar operational period, consisting of six complete frontside passes, was conducted during the crew sleep period from 180 hours GET to 193 hours GET. During the VHF only mode the CSM remains in the SIM down attitude, and data collection by the SIM experiments was not impacted in any way.

Although considerable processing of the received signal is required before the experimental data can be analyzed, a first look indicated strong received signals with good data potential for determination of the bulk dielectric constant and near surface roughness along the spacecraft track.

The spacecraft ground track during both the dual-frequency and VHF-only portions of the bistatic radar experiment intersected the ground tracks of the Apollo 14 bistatic radar experiment. This should permit a cross correlation of the Apollo 14 and 15 bistatic data with a common reference point.

UV Photography--Earth and Moon

The UV photography experiment was conducted from the CM using a 70 mm Hasselblad camera with a 105 mm UV transmitting lens and four spectral filters centered at 2600 Å, 3250 Å, 3750 Å, and 5000 Å respectively. The filters were sequentially rotated over the camera lens and the film exposed. The photographs were taken through the CM right hand side window which is of a special double pane quartz construction.

The purpose of the UV photography of earth is to determine if there is a correlation between the observed UV radiation and known meteorological conditions. If a correlation is shown to exist, it will then be possible to extrapolate by planetary analogs to the atmospheres of Mars and Venus.

Photographs of the earth were taken in each of the 4 spectral regions, from earth orbit, from 1/4, 1/2 and 3/4 of the lunar distance during TLC, from lunar orbit, and from 2/3, 1/2, and 1/4 of the lunar distance during TEC.

UV photographs of the moon were also taken and will be used to extend the earth-based calorimetric work and to search for lunar UV fluorescence.

Gegenschein Photography

The Gegenschein experiment used a 35 mm Nikon camera in the CM to take 12 exposures (~90 sec each) of a region encompassing the Moulton Point and the anti-solar point of the earth. Since the Gegenschein is a very faint glow, it is necessary to have a minimum of scattered light in the vicinity of the camera. The Gegenschein photography conducted on Apollo 15 took advantage of the CSM operating in the darkest region of the universe accessible to man--the "double umbra" behind the moon where the CSM was shielded from both sunlight and earthshine.

In addition to providing a dark photographic point, the unique geometry offered by the "double umbra" permitted photography of the region surrounding the Moulton Point from 15° off the earth-sun line. Analysis of these photographs then will determine whether a relationship exists between the Gegenschein and the Moulton Point (i.e., whether the Gegenschein is due to dust particles trapped at the Moulton Point or whether the observed light comes from the cosmic dust of the zodiacal light).

CM Window Meteoroid

The experiment takes advantage of the CM windows as meteoroid collectors for particles with masses $\geq 10^{-12}$ gms and will use the data to investigate the degradation of surfaces in the space environment due to such bombardment. The windows are examined optically postmission to accurately locate all impacts. On the basis of the crater diameter, the meteoroid material may also be present in the impact crater diameter, the meteoroid mass can be calculated. Sufficient meteoroid material may also be present in the impact crater to permit an analysis of the meteoroid composition.

CSM Photographic Tasks

SM Camera System

Panoramic Camera - The objective for the panoramic camera was to obtain high resolution (approximately 2 meters) photography for all areas overflown by the spacecraft in daylight. Priorities for coverage were:

- Landing site, pre-and post-EVA
- Several areas considered as possible candidates for Apollo 17 landing site
- LM impact point
- Near terminator areas
- General coverage

Telemetry from the first camera pass on rev 4 indicated that the V/H automatically resets to a nominal 60-NM altitude. For the remainder of the mission the sensor ocillated between off scale and nominal. It is expected that 80% of the photography will be high quality and 20% degraded. All critical areas have been phtographed with good pictures.

Mapping Camera – The objective of the mapping camera was to obtain cartographic quality photography for all areas overflown by the spacecraft in daylight. To assist in data reduction, a stellar photograph and a laser altitude measurement were to be made in synchronism with each mapping camera photograph. Mapping camera operation was desired on all pan camera passes and on selected dark side passes where the laser altimeter was operating. Mapping camera functioning was nominal throughout the mission, and it is expected that the associated stellar camera was operating, although there is no telemetry data for that system to confirm its operation. On rev 38 the laser altimeter ceased to operate. All subsequent dark side passes with the mapping camera for altitude data (no mapping imagery) were deleted from the flight plan.

On rev 50, the mapping camera was turned off during the pan camera pass over the landing site to check the remote possibility that pan camera malfunctioning might be related to mapping camera operation. There was no effect on pan camera operation, and deletion of the mapping camera pass resulted in an insignificant loss in coverage.

Changes in planned photo passes occasioned by the delay in LM jettison caused a small decrease in sidelap between rev 50 and rev 60. This will cause a slight weakness in data reduction in this area.

Loss of laser altimeter data will also cause a decrease in accuracy of the lunar control network established from the mapping camera photographs. The objective was ± 15 meters, and this may be reduced to approximately ± 30 meters.

In spite of the above losses, all major objectives were met.

Laser Altimeter – The objectives for the laser altimeter were to provide an altitude measurement in synchronism with each mapping camera exposure on the light side, and to provide independent altitude measurements on the dark side to permit correlation of topographic profiles with gravity anomalies.

Altimeter operation was nominal through rev 24. On rev 27 it was noted that some altitude words were clearly in error, and this situation became progressively worse on revs 33, 34 and 35. The errors were associated with a rise in cavity temperature. The mapping camera altimeter was left extended, but not operating, for the dark side pass on rev 38, it was determined that the altimeter had failed completely.

The altimeter was deleted from all subsequent dark side passes, but it was operated with all mapping camera passes.

On rev 63 an attempt was made to correct the altimeter operation by a switch operation routine conducted by the CMP, but it was not successful. Only about half of the total planned altimeter data was obtained. Although correlation of topography with gravity can be done on the light side using elevation data obtained from eventual reduction of the mapping photographs, the ability to do this on the dark side will be reduced to those areas where valid telemetry was obtained.

Command Module Photography

Lunar surface photography from the Command Module was planned to complement the SM photography. This included:

- Oblique photography of special targets using the electric Hasselblad camera with the 80 mm and 250 mm lenses using both BW and CEX film. All scheduled targets were taken as planned except for the following cases:

- Target 25 was scheduled on rev 16 and was taken on rev 33. The delay was caused by VHF check on REV 16.

- Target 14 and 12 which were scheduled on revs 58 and 59 respectively were deleted due to the delay in LM jettison and subsequent shift of the rest cycle.

. Near-terminator photography using high speed BW film. Two targets scheduled on rev 58 (farside and nearside) were deleted for same reason; near-terminator photography was taken on rev 63 (farside only).

. Earthside photography on rev 34 was completed as planned.

Visual Observations from Lunar Orbit

The objective of "visual observation from lunar orbit" was implemented for the first time on Apollo 15. The CMP was asked to make and record observations of special lunar surface areas and processes. Emphasis was placed on characteristics which are hard to record on film and could be delineated by the eye, such as subtle color differences between surface units. All of the scheduled targets were accomplished, and the CMP relayed to the ground results of his careful and geologically significant observations such as:

. The discovery of fields of cinder cones made by volcanic eruptions on the southeast rim of Mare Serenitatis (Littrow area) and southwest rim of the same Mare basin (Sulpicius Gallos area)

. The delineation of a landslide or rock glacier on the northwest rim of the crater Tsiolkovsky on the lunar farside

. Interpretation of the ray-excluded zone around the crater Proculus on the west rim on Mare Crisium as due to the presence of a fault system at the west rim of the crater

. The finding of layers on the interior walls of several craters which were interpreted as volcanic collapse creaters of "calderas" in the maria

CM Astronomical Photography

Several tasks of astronomical photography were carried out using very high speed black and white film in the 35 mm Nikon, the 70 mm Hasselblad, and the 16 mm Data Acquisition Cameras as appropriate. These included three sets of photographs of the solar corona, one set each of zodiacal light and lunar libration point L_4, a set of the moon as it entered full eclipse and another set as it exited, and four sets of star field photos using the sextant. Although data quality cannot be assessed until the recovered film has been processed, all operational procedures were carried out as planned, and crew reports on film usage indicated the expected values.

The Apollo flights provide two unique conditions necessary for the performance of some of these tasks - the long earth-moon baseline for parallax shift in studying concentrations of dust-like micrometeoroids reflecting sunlight compared to the background star field and also the extremely dark conditions of the moon's double umbra. The eclipse photography is simply a chance opportunity to study reddening of the lunar disk as a known reflectance target for spectral scattering and transmittance effects of the earth's atmosphere. Stellar field sextant photos will indicate the future usefulness of that system for comet and stellar photography during translunar and transearth coast periods.

Visual Light Flash Phenomenon Test

The Apollo 15 visual light flash phenomenon test was successfully completed as scheduled.

The test consisted of three separate observation periods of approximately one hour duration for each period. The first session was conducted during translunar coast (51:37-52:33 GET), the second during lunar orbit (197:00-198:00 GET), and the final session during transearth coast (264:35-365:35 GET).

During the observation sessions, crew members wore eyeshields (blindfolds) to prevent light from entering their eyes, and reported by voice communications to ground each time a light event was perceived. This report was followed by comments pertaining to the characteristics of the individual light flashes. These descriptive comments were recorded on CM tape in lieu of real-time voice communication, for subsequent playback to the Mission Control Center.

Voice data obtained have been tabulated and are being evaluated. Preliminary assessment of the frequency data reported by crew members reveal the average frequency of occurrence of light flashes to range from a high of about one light flash event every two minutes (reported during translunar coast) to a low of about one light flash event every seven minutes (reported during transearth coast). Final assessment of the data stored on tapes and reporting of results will be made available to the Principal Investigators.

SURFACE SCIENCE

The first Apollo 15 surface science event was the impact of the S-IVB stage at 79:24:41 GET. The impact point was 1.0°S and 11.87°W, approximately 188 km northeast of the Apollo 14 site and 355 km east of the Apollo 12 site. The seismometers at both sites recorded the impact, and preliminary analysis indicates that the lunar subsurface east of the instruments is similar to the subsurface to the west and south where previous impacts have taken place. The distance of the impact from the seismometers will facilitate analysis of the subsurface to depths of 50-100 km. Previous impacts extended our subsurface knowledge to a depth of approximately 30 km.

The debris and particle cloud created by the impact was recorded by the Apollo 12 Solar Wind Spectrometer, and Suprathermal Ion Detector. At the Apollo 14 site the Charged Particle Lunar Environment Experiment, Suprathermal Ion Detector, and the Cold Cathode Ionization Gauge detected the event. Analysis of the data is now continuing.

Approximately two hours after landing, CDR Scott commenced the stand-up EVA (SEVA). Bearings were taken of known lunar features to assist in the landing point determination. A photographic panorama of twenty-two frames of 70 mm photos was completed as well as a number of 500 mm photos. A detailed verbal description was made of both distant and near field objects. Trafficability for the LRV was considered to be good, and a usable deployment site for the ALSEP was felt to be present to the west. Rock fragments larger than 8 inches were not observed near the LM. The surface appeared smooth and rounded with many more 8--10 meter craters present than anticipated. Lineaments were seen on the slopes of Hadley Delta, but no flows or landslides could be seen. One dark black fragment 6--8 inches long was observed; all other fragments were light colored.

The crew commenced the 1st EVA traverse aboard the LRV at 121:44:56 GET. Traverse route was direct to Station 1 (Elbow Crater), omitting the first check point. Crew observations of the craters, rock fragments, and lurain conditions were made while the LRV was underway. Hadley Rille rim was encountered north of Station 1 and followed toward the sourth until arrival at Elbow Crater. Documented samples and a radial sample were collected. The traverse continued south to Station 2, on the flank of St. George Crater. Documented samples, a comprehensive sample, and 500 mm photos were taken. From Station 2 the crew returned directly to the LM, omitting Station 3. ALSEP deployment occupied the remainder of the EVA. All experiments were commanded on before EVA termination at 126:11:59 GET.

To provide adequate geological exploration at the Apennine front and accomodate ALSEP closeout activities at the end of EVA-2, changes were made to the nominal plan. The traverse commenced at 143:10, proceeding south to the front. Descriptions were made of the secondary crater cluster as the crew drove by and observations made of the front. The crew continued up the front toward Spur Crater and noted that rocks were more abundant here than on the flank of St. George and were especially abundant on the rim of Spur. A stop was made east of Spur (Station A). Documented samples, some of which were breccias, single core, special environmental sample, and soil samples were collected. A panorama and 500 mm photos were taken. The soil was described as more powdery than seen earlier. A trench was also dug and sampled. The crew then turned southwest to sample a large (3M on a side) boulder (Station B). The boulder was layered and consisted in part of breccia with a thick, green colored layer. Communications became noisy at this station, and crew voice was relayed thru the LM which was within sight but approximately 5 km away. Spur Crater was sampled next, and the crew believed they collected a large fragment of anorthositic rock. Light green to gray rocks and breccias were also collected and documented. A comprehensive sample was also taken. From Spur the crew returned to Dune Crater, one of the secondary craters, and sampled the west rim. A comprehensive sample and documented samples were collected. Returning to the LM the crew completed deployment of the Heat Flow Experiment and ALSEP documentation. Station 8 activities were carried out near the ALSEP. A trench was dug and sampled, and 6 penetrometer readings made. At the end of the EVA, a 7' 4" core was drilled but not extracted from the ground.

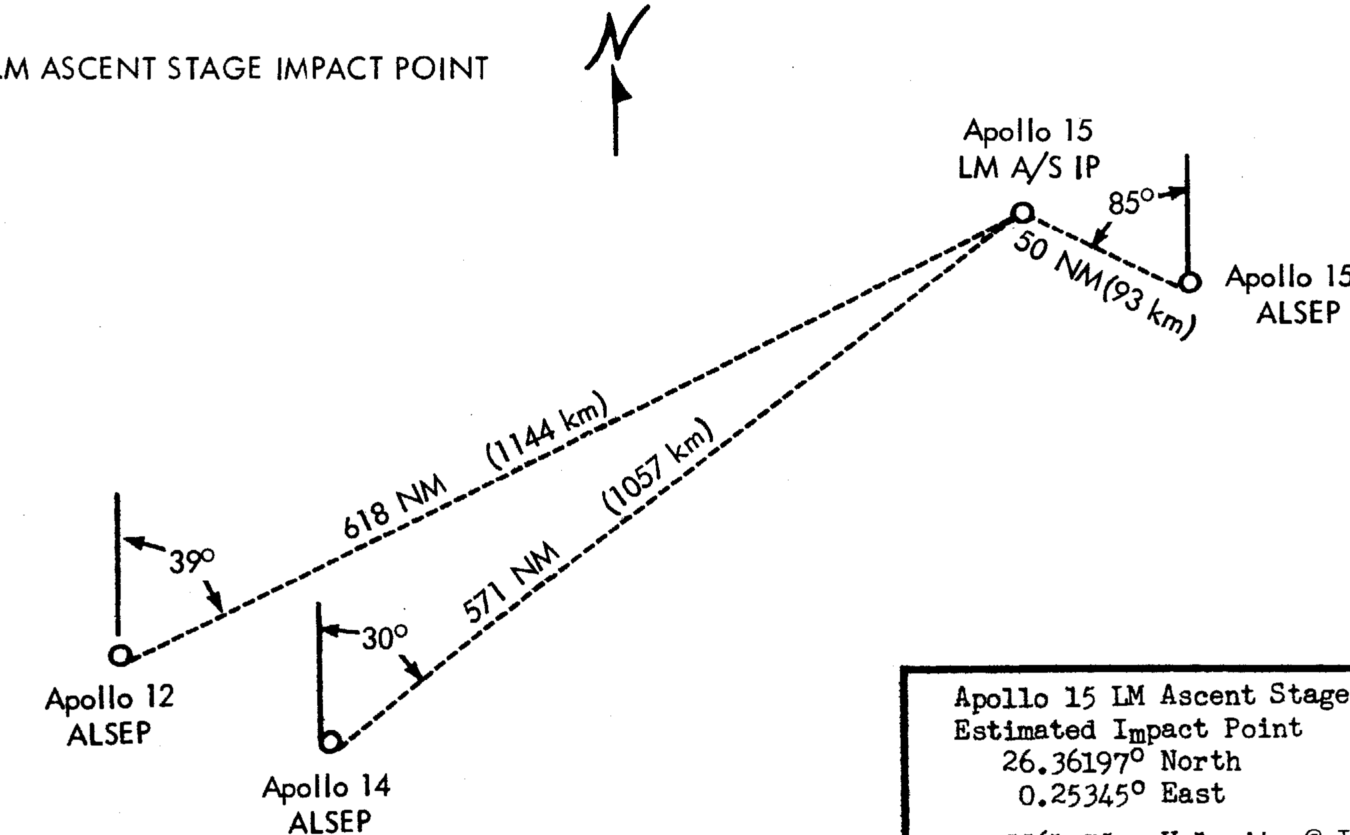
The beginning of the crew sleep period was delayed between EVA-2 and EVA-3, neccessitating a shortening of the final EVA. The crew started the 3rd EVA at 163:18:14 GET and extracted the core sample. The crew then proceeded westward to the rille. Documented samples, a comprehensive sample and bedrock samples were collected. Pans and 500 mm pictures were also taken. North complex stations were omitted, and the crew returned directly to the LM. The core was separated and stowed. The Solar Wind Composition Experiment, deployed at the end of the 1st EVA, was retrieved after 41 hours 8 minutes of exposure. The LRV was parked east of the LM for liftoff and post liftoff TV pictures. Samples and camera magazines were transferred to the LM, and the 3rd EVA terminated at 168:08:04 GET. Total samples collected during all three EVA's is estimated to be between 170--180 pounds.

After LM jettison, the LM was deorbited and impacted west of the Apollo 15 landing site at 26.3° N and 9.25°E. All three seismometers recorded the impact, which was 93 km west of Apollo 15, 1057 km north of Apollo 14, and 1144 km north of Apollo 12 (see Figure 4; also Experiment Description).

TV panoramics were taken throughout all the surface activities.

On August 4 a final TV panorama was taken of the Hadley Apennine area. The higher sun angle revealed lineations on the front which were previsously poorly defined or unobserved.

LM ASCENT STAGE IMPACT POINT



Apollo 15 LM Ascent Stage
Estimated Impact Point
26.36197° North
0.25345° East

5561.75 - Velocity @ Impact
-3.222° = Impact Angle
283.86 = Impact Azimuth
5259 lbs = Impact Weight

181:29:36.24 GET = Impact Time

Missed Realtime Target By
12.7 NM (23.6 km)

Fig. 4

Apollo Lunar Science Experiments

The Apollo Lunar Science Experiments (ALSEP) package was deployed on EVA s-1 and -2 and the antenna on the central station was properly aligned. The Radioactive Thermoelectric Generator (RTG) continues to supply 74 watts of electric power and the downlink telemetry signal strength is -136 db.

The Passive Seismic Experiment

The Passive Seismic Experiment (PSE) was leveled on command to 0.2" arc, and the sensor reached equilibrium at 126°F. The Apollo 15 PSE, along with Apollo 12 and 14, constitute a network of widely spaced stations simultaneously recording seismic signals. The S-IVB/IV impact was recorded by the Apollo 12 and 14 PSEs, and the Apollo 15 LM impact was recorded by all three instruments. These five new data points, plus the earlier data, indicate that a major increase in velocity could occur at a depth of about 25 km . Such an increase at this depth would indicate a change of composition in the lunar material. A depth of 25 km is not considered sufficient to produce a change in velocity with change in pressure alone. The higher velocity indicated by these new data is on the order of 7.5 km/sec which is equivalent to velocities in the earth's mantle.

The recording of the Apollo 15 LM impact at great distances (see Figure 4) will be valuable in calibrating long-range characteristics of the moon.

Seismic signals generated by the LRV during EVA-2 and -3 traverses vary smoothly in amplitude according to the distances between LRV and PSE. These data will help us understand the physical properties of near surface lunar materials to depths of 1-2 km.

The Lunar Surface Magnetometer

The Lunar Surface Magnetometer (LSM) completed its one-time site survey sequence. The site survey data are now being analyzed. The internal (remanent) magnetic field at the Apollo 15 site appears to be much lower than at Apollo 12 and Apollo 14 sites. The Principal Investigator suggests that this difference may be associated with the proximity of Apollo 15 site to one of the mascons. The Apollo 15 LSM, along with the Apollo 12 LSM, gives us two magnetometers functioning on the moon. In addition, data is being recorded simultaneously with the magnetometer on the Apollo 15 subsatellite. From analysis of this data it will be possible to determine the interior electrical conductivity and calculate the temperature profile to the center of the moon.

The Solar Wind Spectrometer

The Solar Wind Spectrometer (SWS) began recording science data shortly after LM liftoff. The Apollo 12 SWS, as well as the Apollo 15, are now both functioning nominally. Since the moon is now in the magnetospheric tail of the earth, no solar wind data is being recorded. Science data will begin August 9, 1971, when the moon comes back into interplanetary space (see Figure 5).

The Suprathermal Ion Detector Experiment and Cold Cathode Gauge Experiment

The Suprathermal Ion Detector Experiment (SIDE), which measures the lunar ionosphere, and Cold Cathode Gauge Experiment (CCGE), which measures the pressures of the ambient lunar atmosphere, both were deployed and turned on for an initial checkout. After 28 minutes, they were commanded to standby, i.e., instruments are on, but high voltage turned off. The instruments were commaned "ON" to record the LM cabin depress and LM impact. They are now in standby until lunar sunset August 13, 1971. Three SIDE's are operating simultaneously (Apollo 12, 14, 15) and two Cold Cathode Gauges (Apollo 14, 15) (see Figure 5).

Heat Flow Experiment

The two heat flow probes are deployed in the lunar subsurface. Their deployment was not nominal due to the shallow boreholes drilled. The investigators are confident that, despite the shallow depth of the probes, valid measurements of the net heat flow from the moon can be obtained over relatively long periods of time. The net heat flow will be based on thermal gradient and thermal conductivity measurements. Thermal gradient measurements are taken from both the bridge sensors and ring sensors on the probe giving a total of eight data points on each reading. A thermal conductivity measurement will be run within the 45-day period of real-time support. Initial data shows a temperature drop of over 100°C in the first 80cm (32 in.) and a slight increase (a few hundredths of a degree) in the next meter. This indicates that the lunar material has extremely low thermal conductivity. During the four-hour period of the eclipse the thermocouple on the lunar surface registered a drop from +87° C to -128° C and then returned to +87° C. This data will help determine the thermal conductivity of lunar surface materials.

Laser Ranging Retroflector

The Laser Ranging Retroflector (LR^3) was acquired by McDonald Observatory subsequent to LM liftoff . Good quality signals are now being received from all three LR^3's (Apollo 11, 14, and 15).

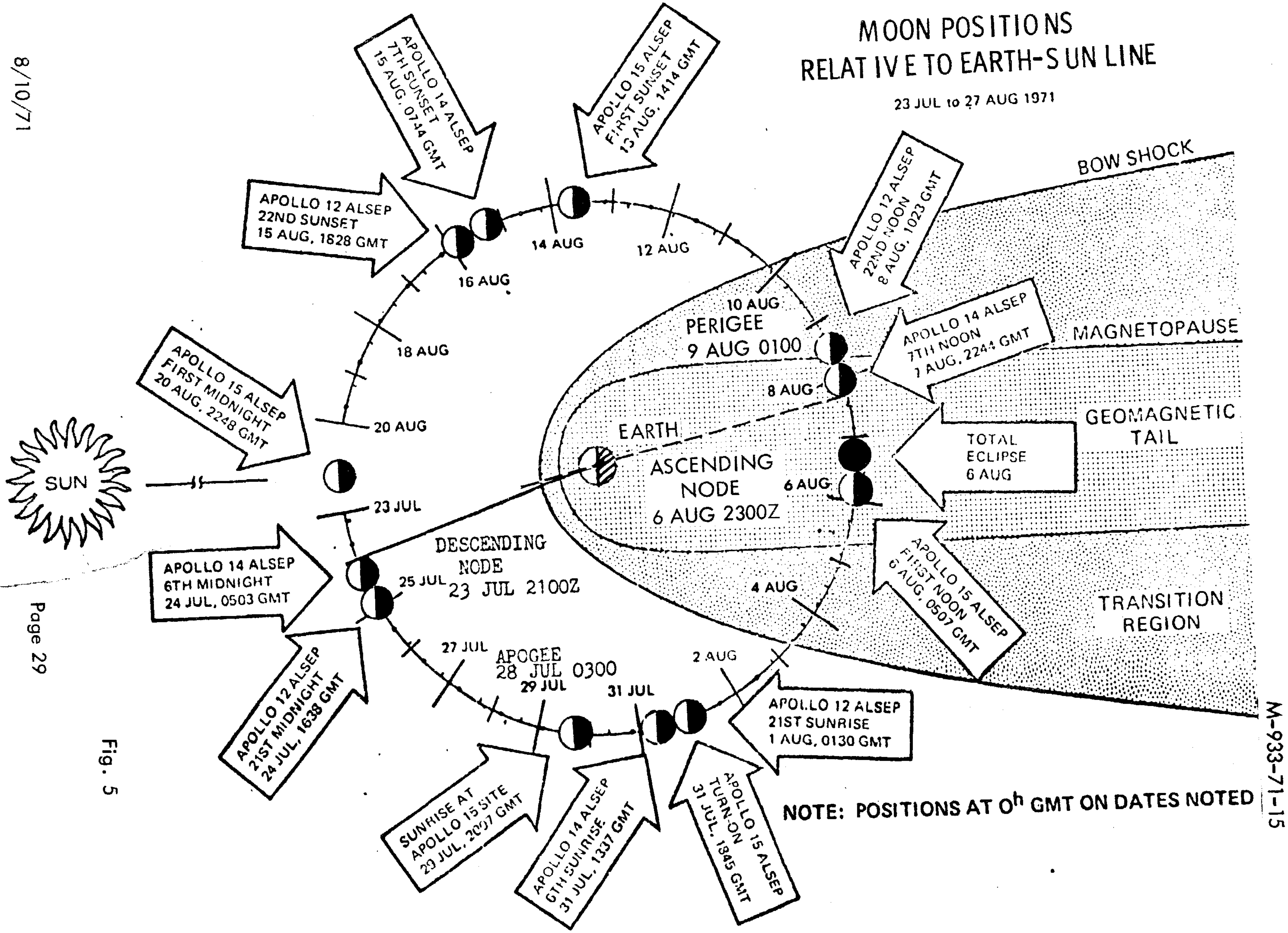

MOON POSITIONS
RELATIVE TO EARTH-SUN LINE
23 JUL to 27 AUG 1971
BOW SHOCK
MAGNETOPAUSE
GEOMAGNETIC TAIL
TRANSITION REGION
SUN
EARTH
ASCENDING NODE
6 AUG 2300Z
DESCENDING NODE
23 JUL 2100Z
PERIGEE
9 AUG 0100
APOGEE
28 JUL 0300
23 JUL
25 JUL
27 JUL
29 JUL
31 JUL
2 AUG
4 AUG
6 AUG
8 AUG
10 AUG
12 AUG
14 AUG
16 AUG
18 AUG
20 AUG
APOLLO 14 ALSEP 7TH SUNSET 15 AUG, 0744 GMT
APOLLO 15 ALSEP FIRST SUNSET 13 AUG, 1414 GMT
APOLLO 12 ALSEP 22ND SUNSET 15 AUG, 1828 GMT
APOLLO 12 ALSEP 22ND NOON 8 AUG, 1023 GMT
APOLLO 14 ALSEP 7TH NOON 7 AUG, 2244 GMT
TOTAL ECLIPSE 6 AUG
APOLLO 15 ALSEP FIRST NOON 6 AUG, 0507 GMT
APOLLO 15 ALSEP FIRST MIDNIGHT 20 AUG, 2248 GMT
APOLLO 14 ALSEP 6TH MIDNIGHT 24 JUL, 0503 GMT
APOLLO 12 ALSEP 21ST MIDNIGHT 24 JUL, 1638 GMT
SUNRISE AT APOLLO 15 SITE 29 JUL, 2037 GMT
APOLLO 14 ALSEP 6TH SUNRISE 31 JUL, 1337 GMT
APOLLO 15 ALSEP TURN-ON 31 JUL, 1845 GMT
APOLLO 12 ALSEP 21ST SUNRISE 1 AUG, 0130 GMT
NOTE: POSITIONS AT 0^h GMT ON DATES NOTED
M-933-71-15

Fig. 5

TABLE 1

APOLLO 15 OBJECTIVES AND EXPERIMENTS

PRIMARY OBJECTIVES

The following were the NASA OMSF Apollo 15 Primary Objectives:

- Perform selenological inspection, survey, and sampling of materials and surface features in a preselected area of the Hadley-Apennine region.
- Emplace and activate surface experiments.
- Evaluate the capability of the Apollo equipment to provide extended lunar surface stay time, increased EVA operations, and surface mobility.
- Conduct in-flight experiments and photographic tasks from lunar orbit.

APPROVED EXPERIMENTS

The following experiments were performed:

Apollo Lunar Surface Experiments Package (ALSEP)

S-031	Lunar Passive Seismology
S-034	Lunar Tri-Axis Magnetometer
S-035	Medium Energy Solar Wind
S-036	Suprathermal Ion Detector
S-158	Cold Cathode Ionization Gauge
S-037	Lunar Heat Flow
M-515	Lunar Dust Detector

Lunar Surface

S-059	Lunar Geology Investigation
S-078	Laser Ranging Retro-Reflector
S-080	Solar Wind Composition
S-200	Soil Mechanics

In-Flight

S-160	Gamma-Ray Spectrometer (SIM)
S-161	X-Ray Fluorescence (SIM)
S-162	Alpha-Particle Spectrometer (SIM)

In-Flight (Cont)

S-164	S-band Transponder (CSM/LM) (Subsatellite
S-165	Mass Spectrometer (SIM)
S-170	Bistatic Radar (CSM)
S-173	Particle Shadows/Boundary Layer (Subsatellite)
S-177	UV Photography - Earth and Moon (CM)
S-178	Gegenschein from Lunar Orbit (CM)
	Visual Observations from Lunar Orbit
	Visual Light Flash Phenomena

Other

M-078	Bone Mineral Measurement
M-079	Total Body Gamma Spectrometry

DETAILED OBJECTIVES

The below-listed detailed objectives were assigned to and accomplished on the Apollo 15 Mission:

- Contingency Sample Collection
- LRV Evaluation
- EVA Communications with LCRU/GCTA
- EMU Assessment on Lunar Surface
- LM Landing Effects Evaluation
- SM Photographic Tasks
- CM Photographic Tasks
- SIM Thermal Data
- SIM Bay Inspection during EVA
- SIM Door Jettison Evaluation
- Visual Observations from Lunar Orbit
- Visual Light Flash Phenomena
- Impact S-IVB on Lunar Surface
- Postflight Determination of S-IVB Impact Point

SUMMARY

Fulfillment of the Primary Objectives qualifies Apollo 15 as a successful mission. The Experiments and Detailed Objectives which supported and expanded the scientific and technological return of this mission were successfully accomplished.

TABLE 2

APOLLO 15 ACHIEVEMENTS

- Fourth Manned Lunar Landing
- Largest Payload Placed in Earth Orbit (309,330 lbs.)
- Largest Payload Placed in Lunar Orbit (74,522 lbs.)
- First SIM Bay Flown and Operated on an Apollo Spacecraft
- First LM Descent Using Steepened 25° Approach
- Longest Lunar Surface Stay Time (66 Hours 55 Minutes)
- Longest Lunar Surface EVA (18 Hours 34 Minutes)
- Longest Distance Traversed on Lunar Surface (27.90 KM on LRV Odometer)
- First Use of Lunar Roving Vehicle (Manned)
- First Use of a Lunar Surface Navigation Device
- First Use of Lunar Communications Relay Unit for Direct Voice, EMU Telemetry, and TV From Distant Traverse Stations Without LM Relay
- First Use of Ground Controlled Remote Operation of TV Camera on the Moon
- First Subsatellite Launched in Lunar Orbit
- First EVA From CM During Transearth Coast
- First Standup EVA with Astronaut's Head Positioned Above the Opened Upper Hatch (Lunar Surface)
- Largest Amount of Lunar Samples Returned to Earth (Approximately 180 lbs.)
- Longest Lunar Orbit Time (74 Orbits)

TABLE 3

APOLLO 15 POWERED FLIGHT SEQUENCE OF EVENTS

EVENT	PRELAUNCH PLANNED (GET) HR:MIN:SEC	ACTUAL (GET) HR:MIN:SEC
Guidance Reference Release	-17.3	-17.5
Liftoff Signal (TB-1)	0	0
Pitch and Roll Start	11.0	11.0
Roll Complete	23.0	23.0
S-IC Center Engine Cutoff (TB-2)	2:15.5	2:15.5
Begin Tilt Arrest	2:35.2	2:35.2
S-IC Outboard Engine Cutoff (TB-3)	2:38.4	2:39.0
S-IC/S-II Separation	2:40.1	2:40.7
S-II Ignition (Command)	2:40.8	2:41.8
S-II Second Plane Separation	3:10.1	2:10.7
S-II Center Engine Cutoff	7:58.4	7:59.0
S-II Outboard Engine Cutoff (TB-4)	9:09.0	9:08.5
S-II/S-IVB Separation	9:10.0	9:09.5
S-IVB Ignition	9:10.1	9:09.6
S-IVB Cutoff (TB-5)	11:38.6	11:34.3
Insertion	11:48.4	11:44.1
Begin Restart Preps (TB-6)	2:40:17.9	2:40:24.2
Second S-IVB Ignition	2:49:55.9	2:50:02.6
Second S-IVB Cutoff (TB-7)	2:55:52.3	2:55:53.3
Translunar Injection	2:56:02.1	2:56:03.1

Prelaunch planned times are based on MSFC Launch Vehicle Operational Trajectory.

TABLE 4

APOLLO 15 MISSION SEQUENCE OF EVENTS

EVENT	PLANNED (GET) HR:MIN:SEC	ACTUAL (GET) HR:MIN:SEC
Liftoff 00:09:34.6 EDT, July 26	00:00:00	00:00:00.6
Earth Parking Orbit Insertion	00:11:48.4	00:11:44.1
Second S-IVB Ignition	02:49:55.9	02:50:02.6
Translunar Injection	02:56:02.1	02:56:03.1
CSM/S-IVB Separation, SLA Panel Jettison	03:20:54	03:22:24
CSM/LM Docking	03:30:54	03:33:49.5
Spacecraft Ejection From S-IVB	04:16:00	04:18:00
S-IVB APS Evasive Maneuver	04:39:01	04:39:38
Midcourse Correction-1	11:55:53.9	Not Performed
Midcourse Correction-2	30:55:53.9	28:40:30
Midcourse Correction-3	56:31:14.7	Not Performed
Midcourse Correction-4	73:31:14.7	73:31:14
SIM Door Jettison	74:01:14.7	74:06:47
Lunar Orbit Insertion (Ignition)	78:31:15	78:31:45.9
S-IVB Impact	79:13:26	79:24:41.5
Descent Orbit Insertion (Ignition)	82:39:32	82:39:48.3
CSM/LM Undocking	100:13:56	100:39:30
CSM Separation	100:13:56	100:39:30
CSM Circularization	101:34:55	101:38:58
Powered Descent Initiate	104:28:55	104:30:09
LM Lunar Landing	104:40:57	104:42:29
Begin SEVA Cabin Depress	106:10:00	106:42:49
Terminate SEVA Cabin Repress	106:47:00	107:15:56
Pegin EVA-1 Cabin Depress	119:50:00	119:39:10
Terminate EVA-1 Cabin Repress	126:50:00	126:11:59
Begin EVA-2 Cabin Depress	141:10:00	142:14:48
Terminate EVA-2 Cabin Repress	148:10:00	149:27:02
Begin EVA-3 Cabin Depress	161:50:00	163:18:14
CSM Plane Change (LOPC)	165:12:51	165:11:32
Terminate EVA-3 Cabin Repress	167:50:00	168:08:04
LM Liftoff	171:37:24	171:37:22
LM Tweak Burn	171:47:39	Not Performed
Terminal Phase Initiate Maneuver	172:29:39	172:29:39
LM/CSM Docking	173:30:00	173:35:47
LM Jettison	177:20:45	179:30:14
CSM Separation	177:25:45	179:50:00
Ascent Stage Deorbit	179:08:26	181:04:19
Ascent Stage Lunar Impact	179:31:41	181:29:36
Shaping	221:25:52	221:20:47
Subsatellite Launch	222:36:13	222:39:19
Transearth Injection	223:46:06	223:48:45
Midcourse Correction-5	240:48:24	Not Performed
CMP EVA Depress	242:00:00	241:57:57
CMP EVA Repress	242:48:00	242:36:09
Midcourse Correction-6	272:58:20	Not Performed
Midcourse Correction-7	291:58:20	291:56:48
CM/SM Separation	294:43:20	294:44:00
Entry Interface (400,000 ft)	294:58:20	294:58:54
Landing	295:11:46	295:11:53

TABLE 5

DATE: 7 August 1971

APOLLO 15 TRANSLUNAR MANEUVER SUMMARY

MANEUVER	GROUND ELAPSED TIME (GET) AT IGNITION (HR:MIN:SEC:)			BURN TIME (SECONDS)			VELOCITY CHANGE (FEET PER SECOND - FPS)			GET OF CLOSEST APPROACH / HT (NM) CLOSEST APPROACH		
	PRE-LAUNCH PLAN	REAL-TIME PLAN	ACTUAL	PRE-LAUNCH PLAN	REAL-TIME PLAN	ACTUAL	PRE-LAUNCH PLAN	REAL-TIME PLAN	ACTUAL	PRE-LAUNCH PLAN	REAL-TIME PLAN	ACTUAL
TLI* (S-IVB)	02:49:58	02:50:00.6	02:50:00.6	356	353.4	353.4	10 421	10414.7	10414.7	78:35:00.5 / 68.0	78:35:02 / 79	78:31:21 / 139
CSM SEP	03:20:54	03:10:51	03:22:24	3			0.5			78:35:00.5 / 68	-	78:31:21 / 139
CSM DOCK	03:30:54	03:33:54	03:33:49	NA	-	-	NA	-	-	78:35:00.5 / 68	-	78:31:21 / 139
LM EJT	04:16:00	04:16:00	04:18:00	3	3	4.6	0.3	0.3	0.5	78:35:00.5 / 68	-	78:31:20 / 126
S-IVB EVASIVE	04:39:01	04:39:38	04:39:38	80.2	5.1	5.1	10.1	9.6	9.7	79:14:35.4 / 0	78:28:26 / 0	78:28:55 / 0
MCC-1 (SPS)	11:55:53.9	-	NP	0	-	NP	0	-	NP	78:35:00.5 / 68	-	NP
MCC-2 (SPS)	30:55:53.9	28:40:00	28:40:30	0	0.85	0.72	0	4.8	5.3	78:35:00.5 / 68	78:35:01 / 68	78:35:17 / 63
MCC-3	56:31:14.7	-	NP	0	-	NP	0	-	NP	78:35:00.5 / 68	-	NP
MCC-4	73:31:14.7	73:31:14	73:31:14	0	0.92	0.92	0	5.4	5.4	78:35:00.5 / 68	78:35:06 / 68	78:35:06 / 68
SIM DOOR JETT	74:01:14.7	74:01:00	74:06:47	NA			NA			NA	-	-

NP - Not Performed
* - S-IVB Ignition

8/10/71

DATE: 7 August 1971

TABLE 6

APOLLO 15 LUNAR ORBIT SUMMARY

MANEUVER	GROUND ELAPSED TIME (GET) AT IGNITION (HR:MIN:SEC:)			BURN TIME (SECONDS)			VELOCITY CHANGE (FEET PER SECOND - FPS)			RESULTING APOLUNE/PERILUNE (N. MI.)		
	PRE-LAUNCH PLAN	REAL-TIME PLAN	ACTUAL	PRE-LAUNCH PLAN	REAL-TIME PLAN	ACTUAL	PRE-LAUNCH PLAN	REAL-TIME PLAN	ACTUAL	PRE-LAUNCH PLAN	REAL-TIME PLAN	ACTUAL
LOI	78:31:15	78:31:45.9	78:31:45.9	392.0	400.7	400.7	3000	3000.1	3000.1	170/58.3	169.6/58.4	170.1/57.7
S-IVB IMPACT	79:13:26	79:22:57	79:24:42	NA			NA			NA		
DOI	82:39:32	82:39:48.3	82:39:48.3	22.9	24.5	24.5	207.6	213.9	213.9	58.4/9.6	58.4/9.2	58.5/9.2
UNDOCKING	100:13:56	100:38:00	100:39:30	NA			NA			NA		
CSM SEP	100:13:56	100:38:00	100:39:30	3.3	6.54	7.2	1.0	1.0	1.1	59.8/8.4	60.8/8.9	60.9/9.0
CSM CIRC	101:34:55	101:38:58	101:38:58	3.9	3.59	3.59	70.8	68.3	68.3	64.7/54.3	64.9/54.3	64.7/53
PDI	104:28:55	104:30:08	104:30:09	722.1	718.6	740.0	6697.6	6694	6694	0		
LANDING	104:40:57	104:42:07	104:42:29	NA			NA			NA		
CSM LOPC	165:12:51	165:11:32	165:11:32	16.5	18.1	18.1	308.6	330.9	330.9	59.8/59.2	64.5/53.2	64.5/53.6
ASCENT	171:37:24	171:37:22	171:37:22	435.2	436.7	436.7	6055.5	6059	6059	45.6/9	42.5/9.0	42.5/9.0
TWEAK	171:47:39	NP		0.0	NP		0.0	NP		45.6/9		NP
TPI	172:29:39	172:29:39	172:29:39	2.6	---	---	73.7	74.2	72.7	61.5/43.9	64.4/39.9	64.4/38.7
DOCKING	173:30:00	---	173:35:47	NA			NA			---	---	64.1/53.8
LM JETT	177:20:45	177:20:33	179:30:14	NA			NA			NA		
CSM SEP	177:25:45	177:25:33	179:50:00	6.4	6.3	12.6	1.0	1.0	2.0	59.8/58.6	63.7/53.4	66.2/52.6
ASC DEORB	179:05:48	179:06:22	181:04:19	85.2	86.5	86.5	201.2	200.3	200.3	NA		
ASC IMPACT	179:31:41	181:29:23	181:29:35	NA			NA			NA		
SHAPING	221:25:52	221:20:47	221:20:47	3.4	3.3	3.3	64.2	66.4	66.4	77.6/57.5	76.1/54.3	76/54.3
SAT JETT	222:36:13	222:39:27	222:39:19	NA			NA			77.3/57.7	76.5/55.1	76.3/55.1

M-933-71-15

8/10/71

TABLE 7

APOLLO 15 TRANSEARTH MANEUVER SUMMARY

DATE 7 August 1971

MANEUVERS	GROUND ELAPSED TIME (GET) AT IGNITION (HR:MIN:SEC:)			BURN TIME (SECONDS)			VELOCITY CHANGE (FEET PER SECOND - FPS)			GET ENTRY INTERFACE (EI) VELOCITY (FPS) AT EI FLIGHT PATH ANGLE AT EI		
	PRE-LAUNCH PLAN	REAL-TIME PLAN	ACTUAL	PRE-LAUNCH PLAN	REAL-TIME PLAN	ACTUAL	PRE LAUNCH PLAN	REAL-TIME PLAN	ACTUAL	PRE-LAUNCH PLAN	REAL-TIME PLAN	ACTUAL
TEI (SPS)	223:46:06	223:48:45	223:48:45	137.8	141.2	141.2	3049.7	3046.8	3047.0	294:58:20 36 097.2 -6.5	294:58:05 36097.2 -6.5	294:57:45 36097. -6.69
MCC-5	240:48:24	NP		0.0	NP		0.0	NP		294:58:20 36 097.2 -6.5		
MCC-6	272:58:20	NP		0.0	NP		0.0	NP		294:58:20 36 097.2 -6.5	N/P	
MCC-7	291:58:20	291:56:48	291:56:48	0.0	24.2	24.2	0.0	5.6	5.6	294:58:20 36 097.2 -6.5	294:58:55 36096.4 -6.49	294:58:55 36096.4 -6.49
CM/SM SEP	294:43:20	294:41:55	294:44:00	NA			NA			NA NA NA		
ENTRY	294:58:20	294:58:55	294:58:54	NA			NA			294:58:20 36 097.2 -6.5	294:58:55 36096.4 -6.49	294:58:55 36096.4 -6.49
SPLASH	295:11:46	295:12:23	295:11:53	NA			NA			NA NA NA		

NP--Not Performed

TABLE 8

APOLLO 15 CONSUMABLES SUMMARY
END OF MISSION

DATE: 7 August 1971

CONSUMABLE		LAUNCH LOAD	FLIGHT PLANNED REMAINING	ACTUAL REMAINING
CM RCS PROP (POUNDS)	U	208.6	122.0	122.0
SM RCS PROP (POUNDS)	D	1220.0	427.0	396.0
SPS PROP (POUNDS)	TK	40497.0	1379.0	1509.0
SM HYDROGEN (POUNDS)	U	82.1	22.7	20.9
SM OXYGEN (POUNDS)	U	944.5	380.0	391.0
LM RCS PROP (POUNDS)	U	532.7	119.1**	190.0**
LM DPS PROP (POUNDS)	U	19412.0	627.3*	1087.0*
LM APS PROP (POUNDS)	U	5175.2	203.8**	216.0**
LM A/S OXYGEN (POUNDS)	T	4.8	3.7**	4.6**
LM D/S OXYGEN (POUNDS)	T	87.1	46.5*	34.6*
LM A/S WATER (POUNDS)	T	85.0	23.5**	73.8**
LM D/S WATER (POUNDS)	T	423.0	27.2*	36.0*
LM A/S BATTERIES (AMP-HOURS)	T	592.0	181.0**	137.0**
LM D/S BATTERIES (AMP-HOURS)	T	2075.0	327.0*	595.8*

D	-	DELIVERABLE QUANTITY
U	-	USABLE QUANTITY
TK	-	TANK QUANTITY
T	-	TOTAL QUANTITY

* At LM Ascent Stage Liftoff
** At LM Ascent Stage Impact
N/A Not Available

TABLE 9

SA-510 LAUNCH VEHICLE DISCREPANCY SUMMARY

- IU state vector error limits exceeded during EPO. Open
- Intermittent talk back on S-IVB LH_2 prevalve closed position during second start preparation. Open
- Venting from S-IVB/IV after APS-1 burn. Open
- Reported S-IVB propulsion disturbances at time base-5 and time base-6. Open

TABLE 10

COMMAND/SERVICE MODULE 112 DISCREPANCY SUMMARY

- Leakage observed at water panel injection port. Open
- Service module reaction control system quads B and D isolation valves closed sometime during boost and closed again at S-IVB/spacecraft separation. Open
- Service propulsion system thrust light on entry monitor system came on. Open
- Circuit breaker 33 panel 226 (integral lighting) found to be open at GET 33:34 (AC main bus B under voltage alarm indicated problem). Open
- At approximately 81:25 GET the battery relay bus read 13.66 volts (CC0232) instead of 32.00 volts. Open
- Tunnel pressure increased subsequent to integrity check preceding LM jettison. Open
- AC-2/main bus B glitches from GET 195:33 to GET 201:41 occurred 11 times and were later identified as nominal electrical signals for vacuum cleaner operation. Closed
- Mission timer on panel 1 inoperative and stopped at 124:47:37 GET. Reset digits to zero at 125:52:26 GET and timer started. Open
- Tape recorder tape deterioration during transearth coast on front portion of tape. Open
- One main parachute partially closed after deploy. Open

TABLE 11

LUNAR MODULE 10 DISCREPANCY SUMMARY

- Broken glass on range/range rate meter (tapemeter). Open
- Variations in pump Delta P (GF2021) reading while operating on pump #1 just after cabin depressurization for second extravehicular activity (142:18 GET). Open
- Bacteria filter for lunar module water gun is broken. Open
- AGS fail alarm at 180:55 GET. Open

TABLE 12

LUNAR ROVING VEHICLE DISCREPANCY SUMMARY

- Difficulty removing deployment saddle from lunar roving vehicle following deployment. Closed
- No volts or amps on rover battery 2 readout. Open
- No rover front steering (EVA-1). Cycling breaker and switch at start of second extravehicular activity restored front steering. Open
- Automatic closing of one of the rover battery thermal covers did not operate properly. Closed

TABLE 13

APOLLO 15 CREW/EXPERIMENT EQUIPMENT DISCREPANCY SUMMARY

- Panoramic camera velocity/altitude sensor erratic. Open
- Suit water separator speed decreased to below master alarm level (800 rpm). Open
- Lightweight headset failed: Fell apart when removed from stowage the first time. Open
- Tone warning on lunar module pilot (intermittently). The warning was caused by air compressed in the water line which resulted during water charging operations. Closed
- Drill stem stuck to drill (would not release). Open
- Mass spectrometer boom talkback indicates half gray on "extended" and full barber pole on "retract." Open
- Lunar module pilot's oxygen purge system antenna broken. Open
- Lunar module pilot's and commander's retractable tethers failed. Open
- Lunar surface 16mm magazine inoperative. Open
- Sample return container handle would not latch. Open
- Elevation control of TV control unit erratic. Open
- Unable to separate drill core tube sections. Open
- Failed 70mm camera. Open
- Suit integrity check unsuccessful on initial attempt prior to LM jettison. Open
- Laser altimeter not providing altitude data. Open
- Lunar surface TV LCRU FM downlink lost at 211:30:06 GET. Open
- Water in suit hose during lunar orbit. Open
- Mapping camera did not retract at 228:00 GET. Open