

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) - Mission Operation Report

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.

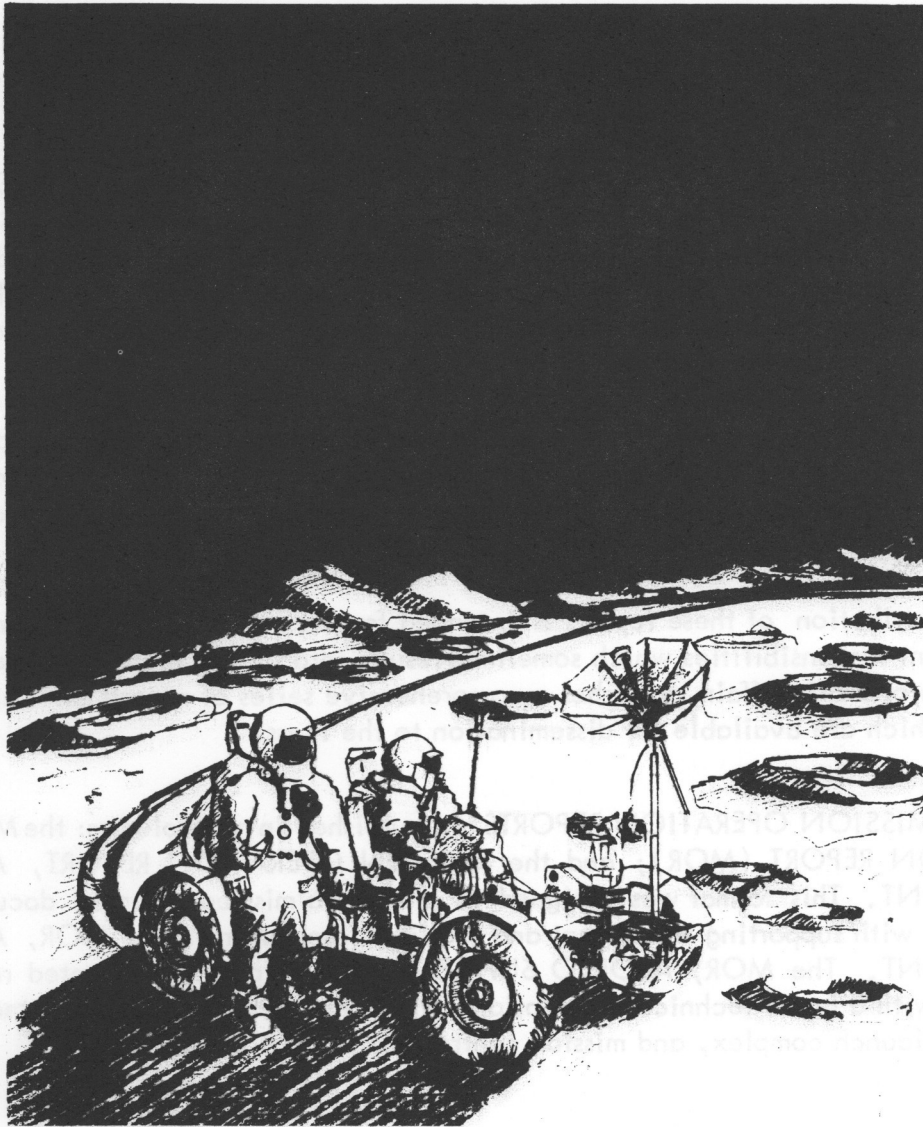
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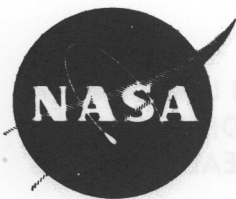
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MISSION OPERATION REPORT



APOLLO 15 MISSION



OFFICE OF MANNED SPACE FLIGHT

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MISSION OPERATION REPORT

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.

APOLLO 15 MISSION

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SUMMARYAPOLLO/SATURN FLIGHTS

<u>Mission</u>	<u>Launch Date</u>	<u>Launch Vehicle</u>	<u>Payload</u>	<u>Description</u>
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.

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APOLLO/SATURN FLIGHTS

<u>Mission</u>	<u>Launch Date</u>	<u>Launch Vehicle</u>	<u>Payload</u>	<u>Description</u>
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 cis-lunar 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

<u>Mission</u>	<u>Launch Date</u>	<u>Launch Vehicle</u>	<u>Payload</u>	<u>Description</u>
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 OPERATIONSGENERAL

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.

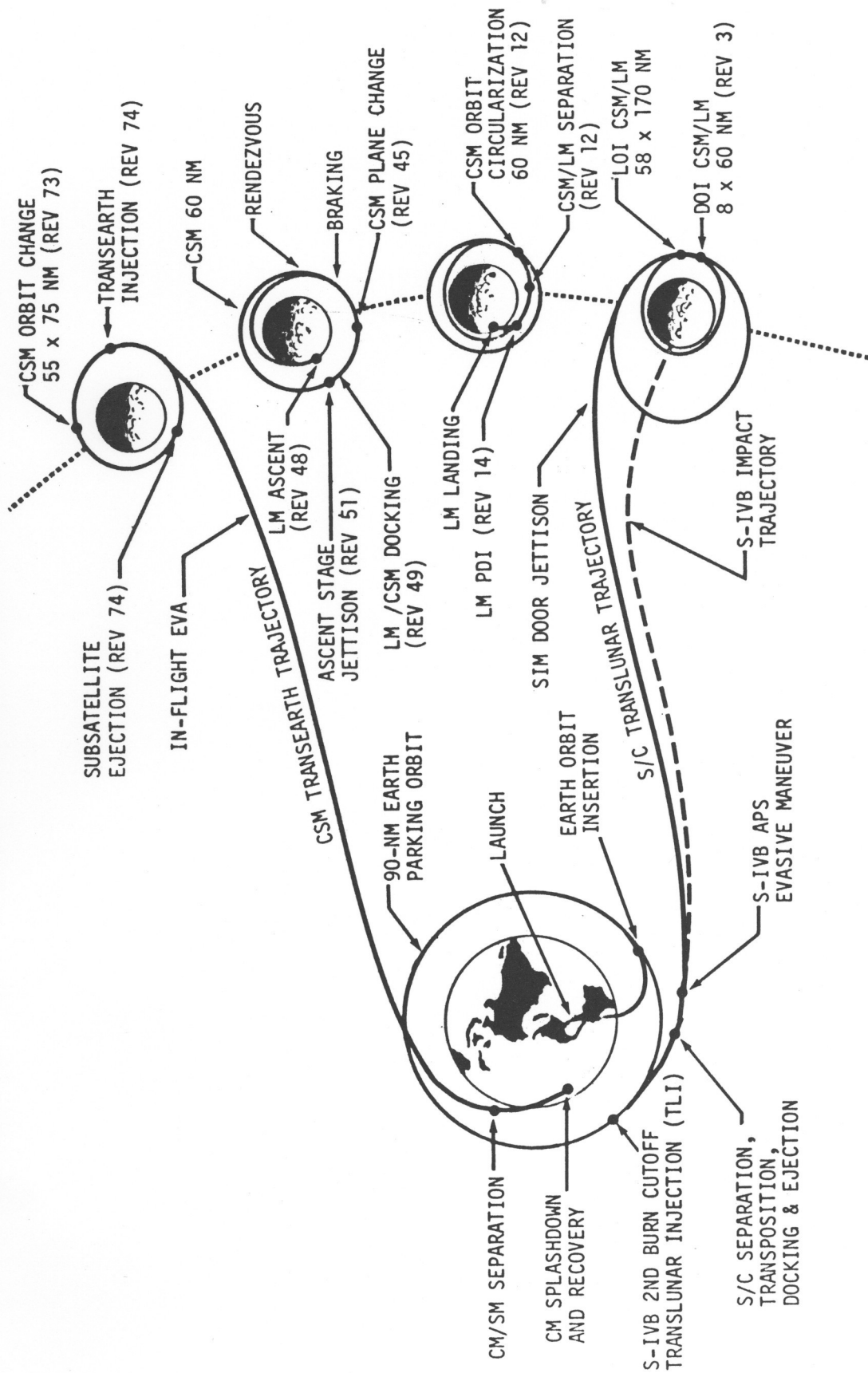
Launch windows will be based on flight azimuth limits of 80° to 100° (earth-fixed heading of the launch vehicle at end of the roll program), on booster and spacecraft performance, on insertion tracking, and on lighting constraints for the lunar landing sites.

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

TABLE 1
LAUNCH WINDOWS

LAUNCH DATE	WINDOWS (EST)		SUN ELEVATION ANGLE
	OPEN	CLOSE	
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



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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 pericyinthian 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 pericyynthian. These events are shown in Figure 2. A lunar 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.

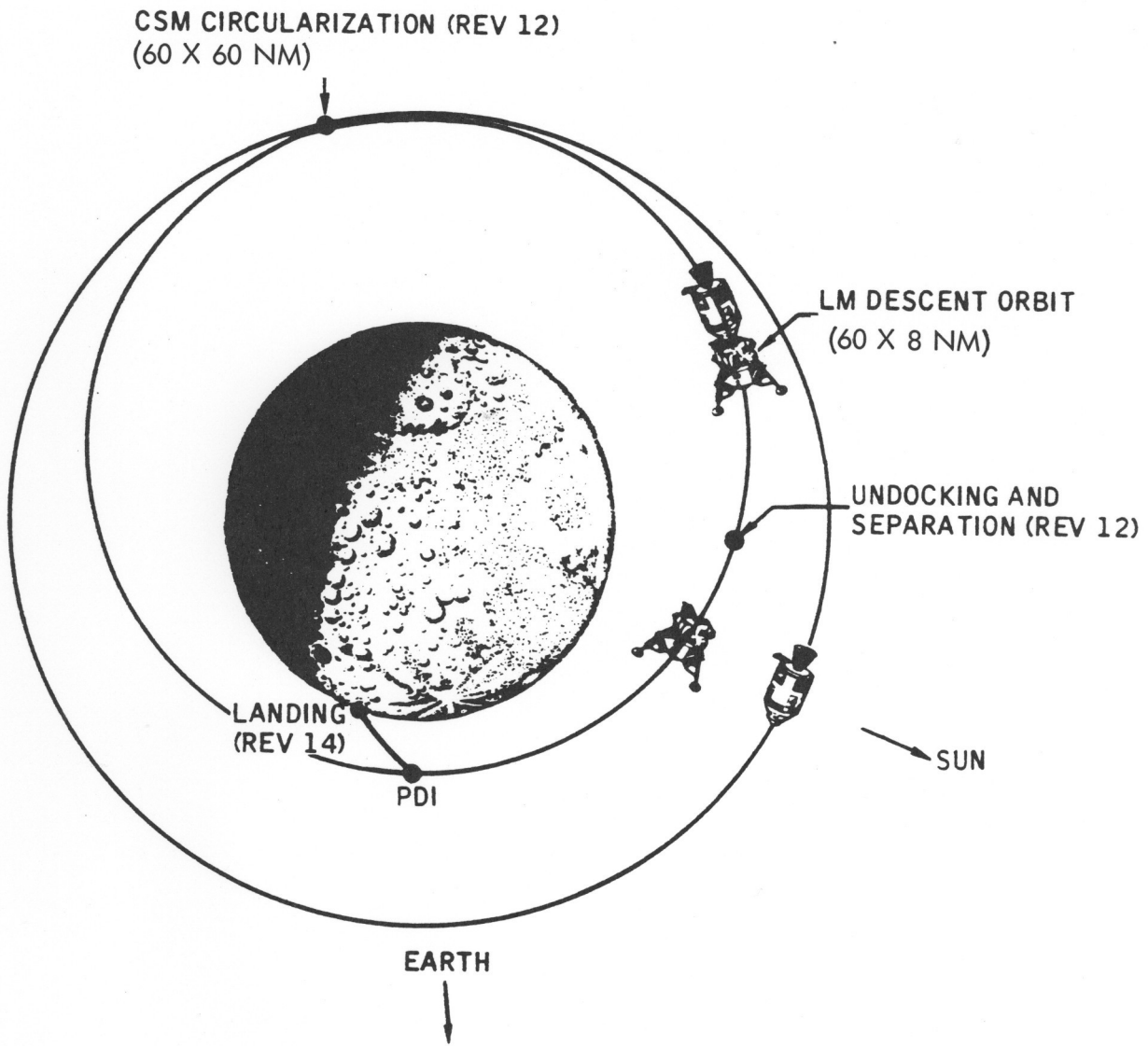


Fig. 2

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

APOLLO 15 LANDING SITE

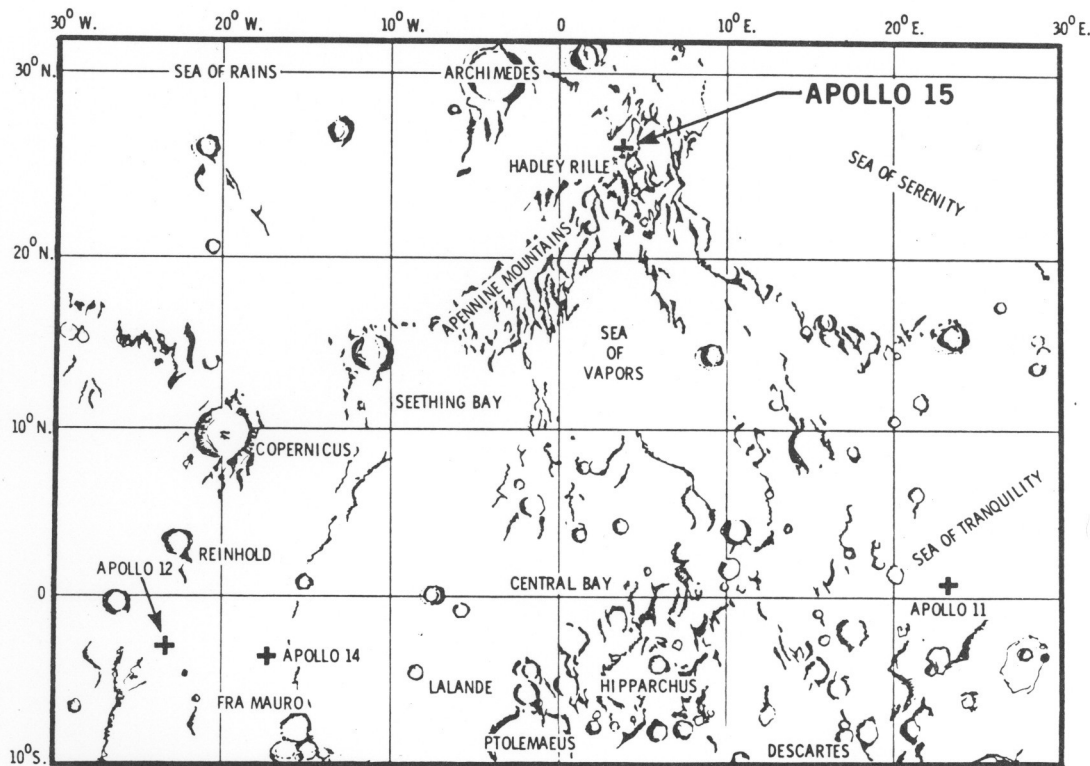


Fig. 3

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 lunar 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 eclipse 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

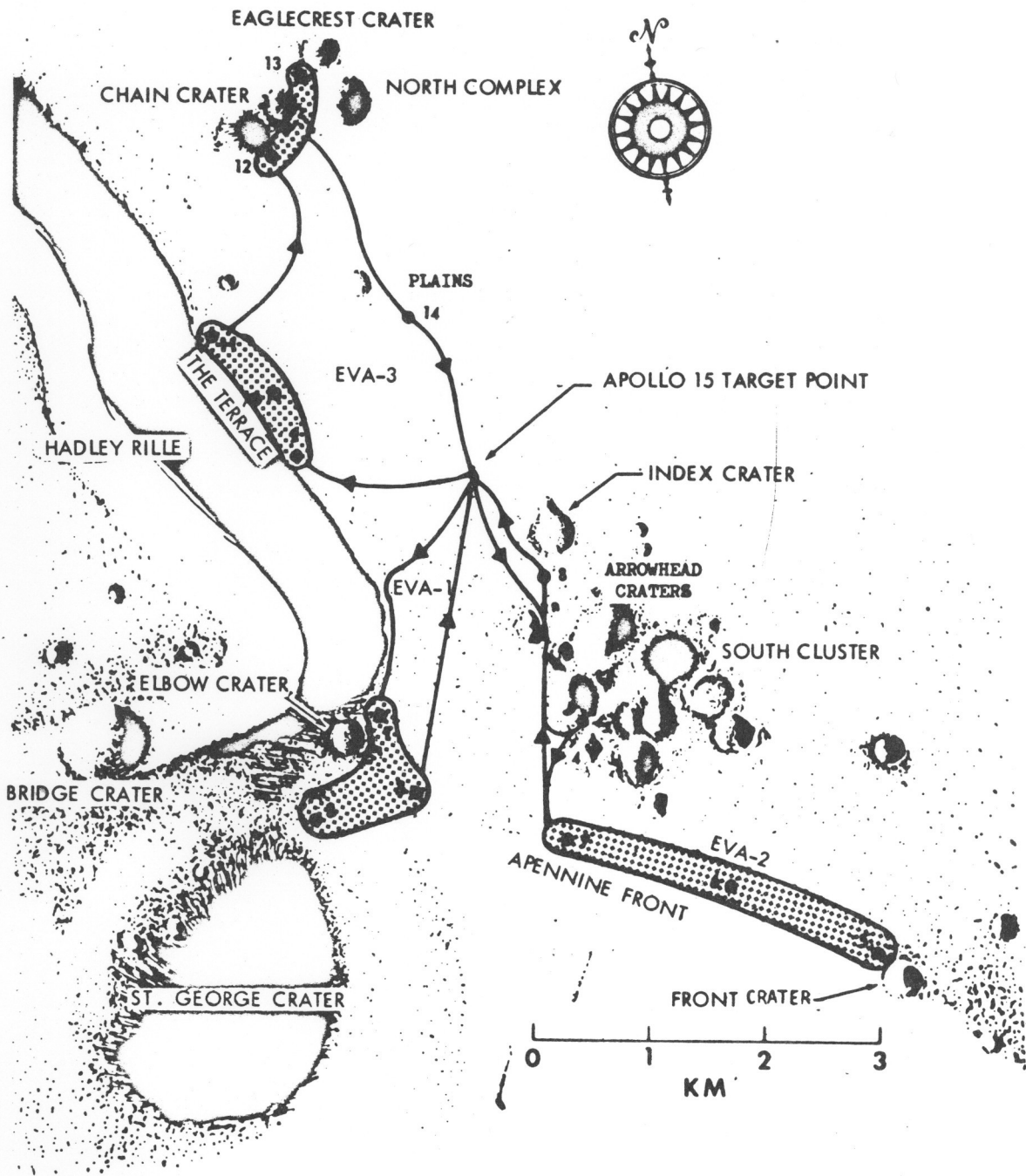
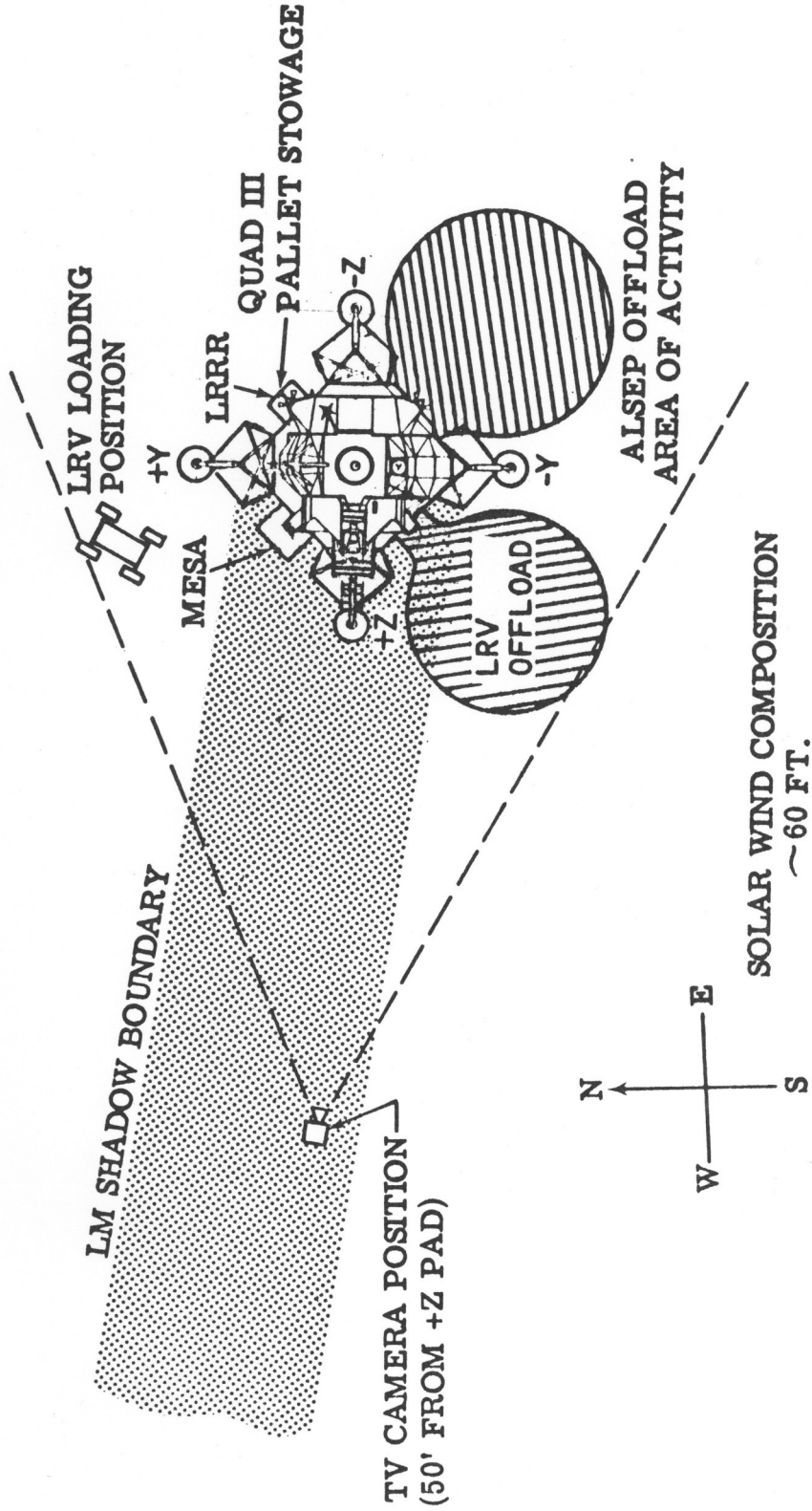


Fig. 4

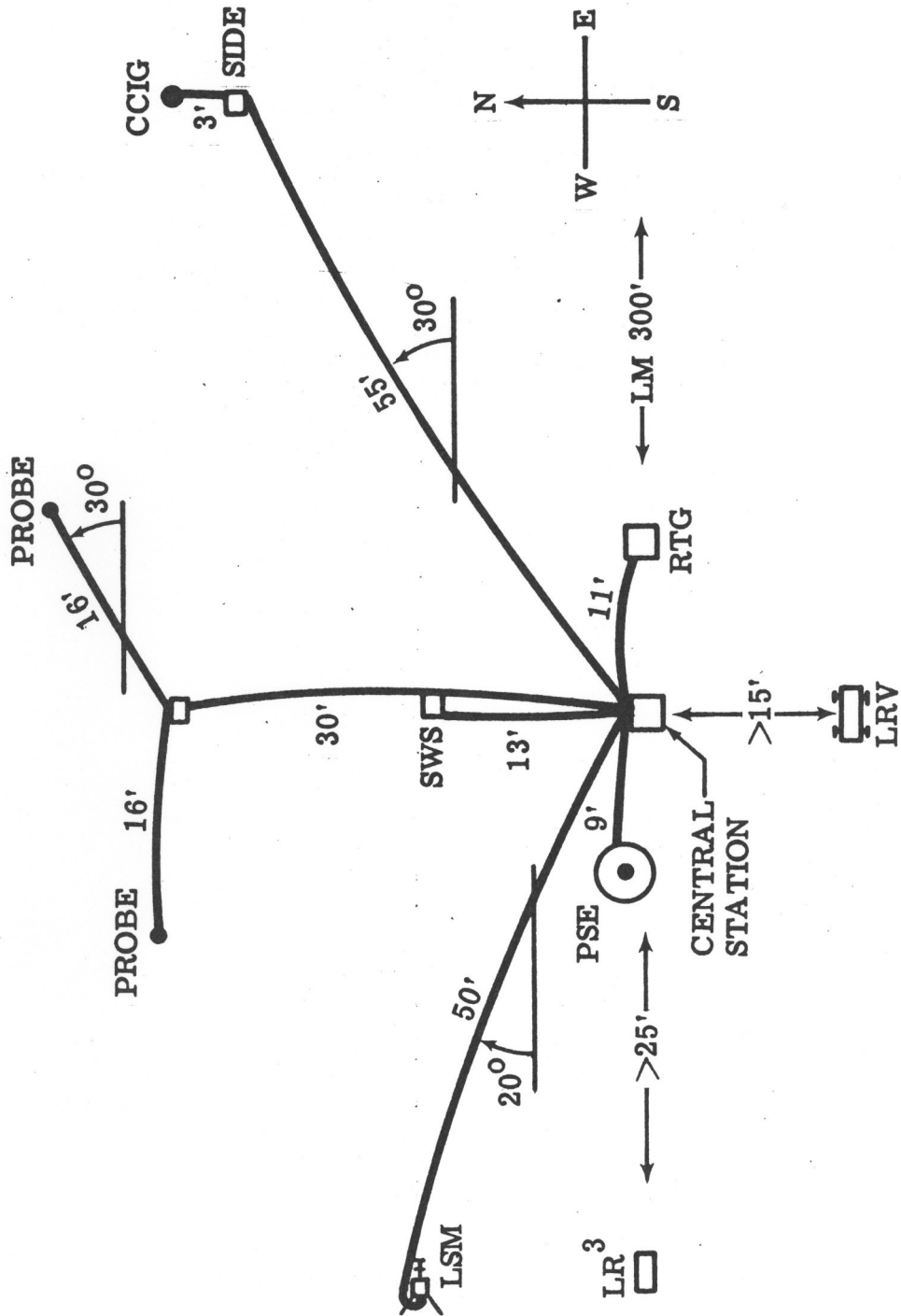
NEAR LM LUNAR SURFACE ACTIVITIES



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Fig. 5

ALSEP ARRAY LAYOUT



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Fig. 6

EVA-1 TIMELINE

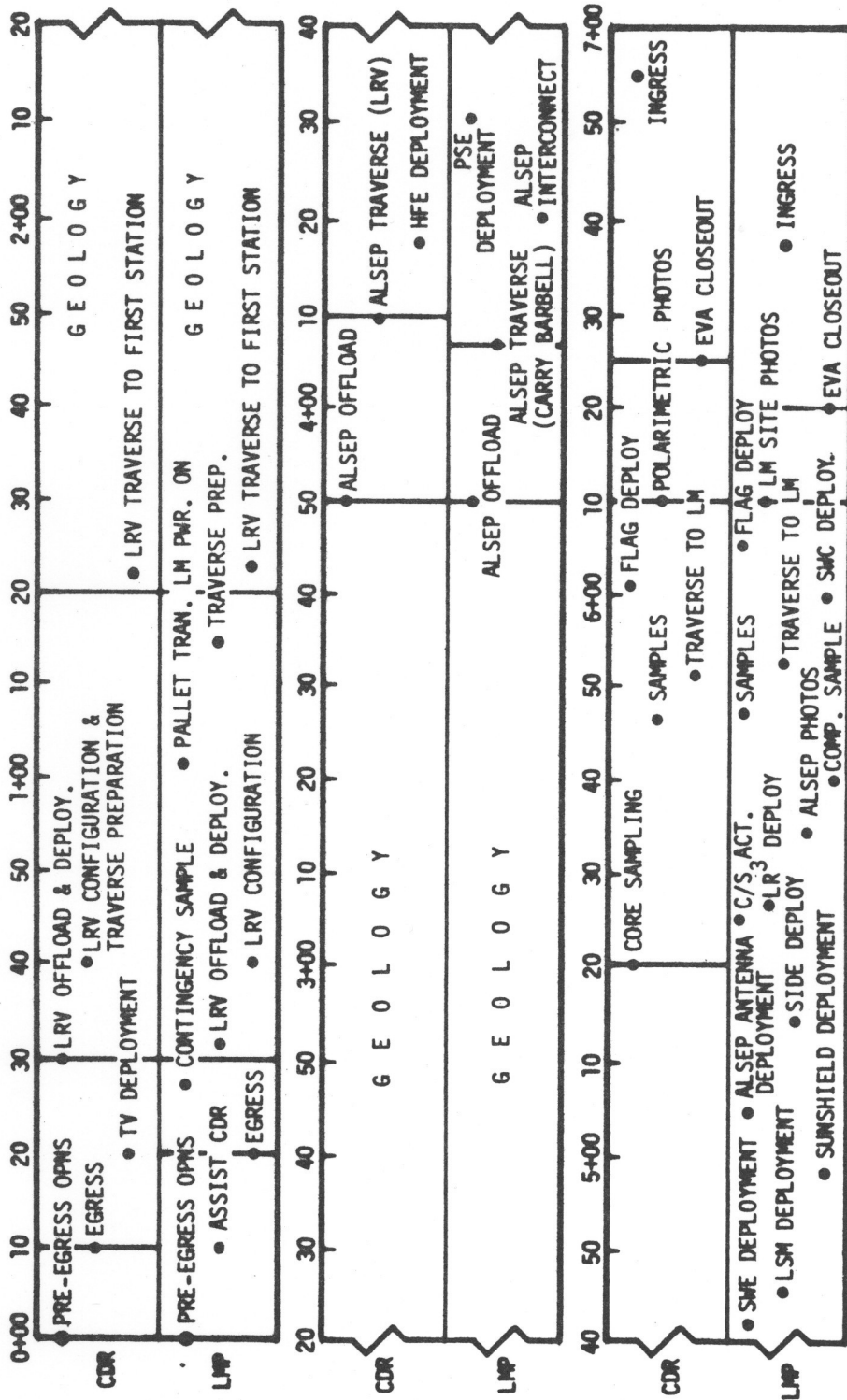
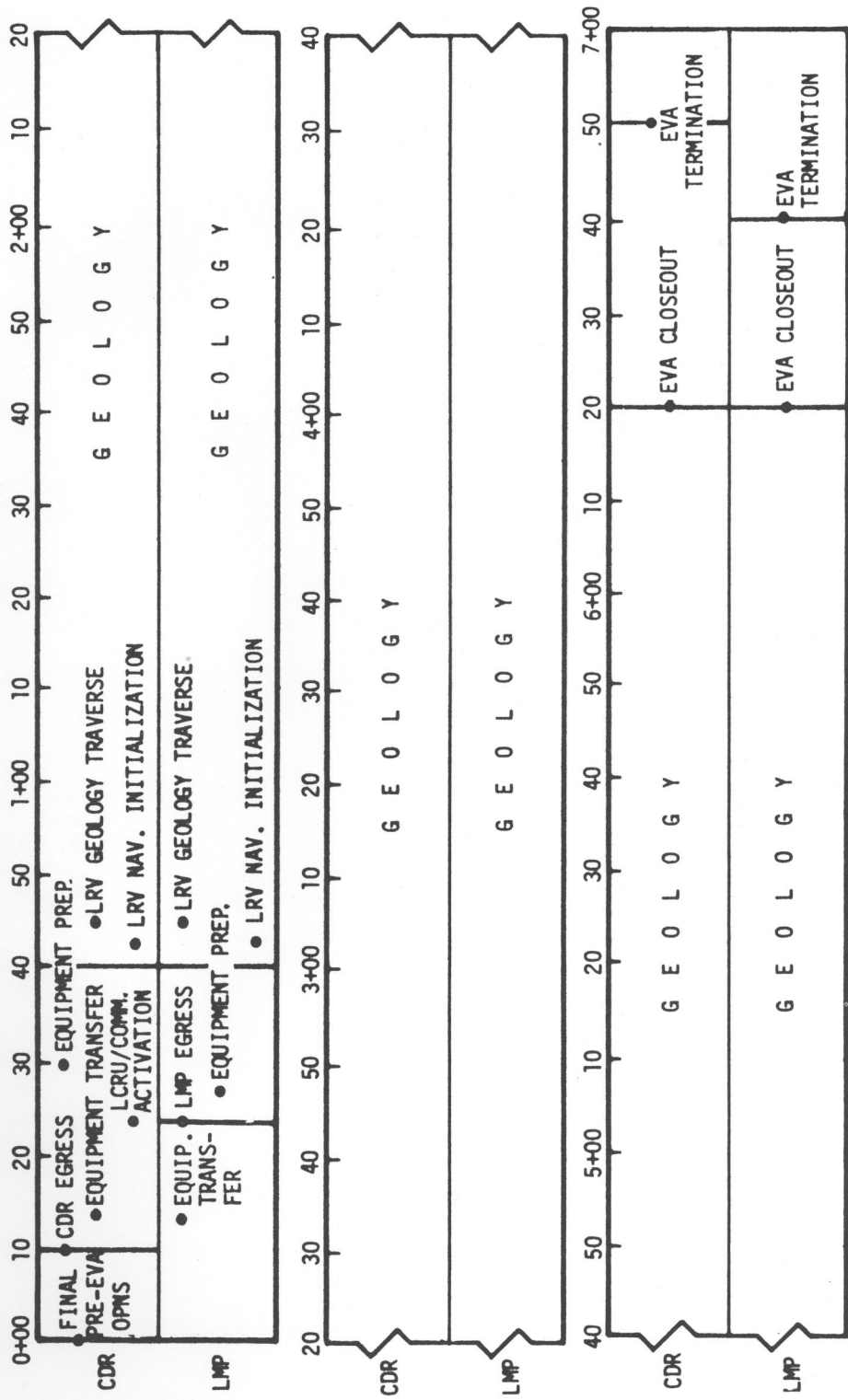


Fig. 7

EVA-2 TIMELINE



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Fig. 8

EVA-3 TIMELINE

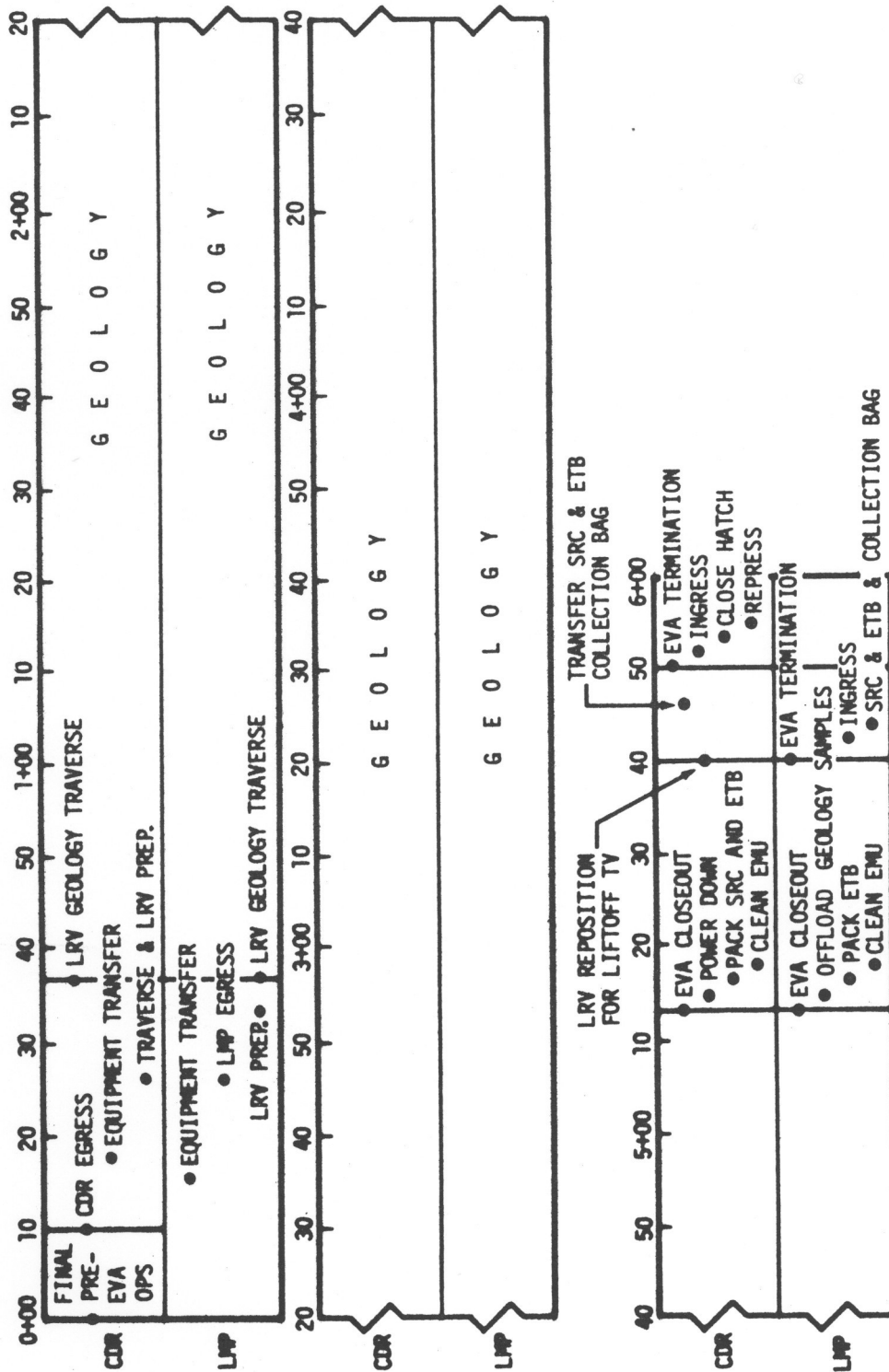


Fig. 9

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 fluorescent 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 braking 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) will 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 Magnetometer (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 ALSA, and sample containers. The battery powered ALSA 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 trans-earth 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.

Bistatic 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 alignments 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 conduct planning, scheduling, test performance, and reporting of the test results. Personnel and equipment 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 DIFFERENCESMISSION HARDWARE AND SOFTWARE CONFIGURATION

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

CONFIGURATIONDESIGNATION 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.

SPACECRAFTCommand/Service Module

Added third cryogenic H₂ tank with modified heating

Increased electrical power capability for extended mission duration.

Relocated third cryogenic O₂ 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 O₂ flow restrictor; EVA control panel; and EVA umbilical with O₂, 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 problem.

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 LENS - 55MM CASSETTE, 35MM	1 1 4				1 1 4
CAMERA, DATA ACQUISITION, 16MM LENS - 10MM - 18MM - 75MM FILM MAGAZINES	1 1 1 1 10	1 1			1 1 1 1 10
CAMERA, LUNAR SURFACE, 16MM BATTERY OPERATED LENS - 10MM MAGAZINES	8	1 1	8	8	8
CAMERA, HASSELBLAD, 70MM ELECTRIC LENS - 80MM - 250MM - 105MM UV (4 BAND-PASS FILTERS) FILM MAGAZINES FILM MAGAZINE, 70MM UV	1 1 1 1 6 1				1 1 1 1 6 1
CAMERA, HASSELBLAD, 70MM LUNAR SURFACE ELECTRIC LENS - 60MM - 500MM FILM MAGAZINES	13	3 2 1	13	13	13
CAMERA, 24-IN. PANORAMIC (IN SIM) FILM CASSETTE (EVA TRANSFER)	1 1				1
CAMERA, 3- . MAPPING STELLAR(SIM) FILM MAGAZINE (EVA TRANSFER)	1 1				1

FLIGHT CREW DATAPRIME 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

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Fig. 9

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

<u>TITLE</u>	<u>NAME</u>	<u>ORGANIZATION</u>
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	MCC	Midcourse Correction
ALSEP	Apollo Lunar Surface Experiments Package	MCC	Mission Control Center
AOS	Acquisition of Signal	MESA	Modularized Equipment Stowage Assembly
APS	Ascent Propulsion System (LM)	MHz	Megahertz
APS	Auxiliary Propulsion System (S-IVB)	MOCR	Mission Operations Control Room
ARIA	Apollo Range Instrumentation Aircraft	MOR	Mission Operations Report
AS	Apollo/Saturn	MPL	Mid-Pacific Line
BIG	Biological Isolation Garment	MSC	Manned Spacecraft Center
BSLSS	Buddy Secondary Life Support System	MSFC	Marshall Space Flight Center
CCATS	Communications, Command, and Telemetry System	MSFEB	Manned Space Flight Evaluation Board
CCGE	Cold Cathode Gauge Experiment	MSFN	Manned Space Flight Network
CDR	Commander	NASCOM	NASA Communications Network
CPLEE	Charged Particle Lunar Environment Experiment	NM	Nautical Mile
CM	Command Module	OMSF	Office of Manned Space Flight
CMP	Command Module Pilot	OPS	Oxygen Purge System
CSI	Concentric Sequence Initiation	ORDEAL	Orbital Rate Display Earth and Lunar
CSM	Command/Service Module	PCM	Pulse Code Modulation
DAC	Data Acquisition Camera	PDI	Powered Descent Initiation
DDAS	Digital Data Acquisition System	PGA	Pressure Garment Assembly
DOD	Department of Defense	PGNCS	Primary Guidance, Navigation, and Control System (LM)
DOI	Descent Orbit Insertion	PLSS	Portable Life Support System
DPS	Descent Propulsion System	PSE	Passive Seismic Experiment
DSKY	Display and Keyboard Assembly	PTC	Passive Thermal Control
ECS	Environmental Control System	QUAD	Quadrant
EI	Entry Interface	RCS	Reaction Control System
EMU	Extravehicular Mobility Unit	RR	Rendezvous Radar
EPO	Earth Parking Orbit	RLS	Radius Landing Site
EST	Eastern Standard Time	RTCC	Real-Time Computer Complex
ETB	Equipment Transfer Bag	RTG	Radioisotope Thermoelectric Generator
EVA	Extravehicular Activity	S/C	Spacecraft
FM	Frequency Modulation	SEA	Sun Elevation Angle
fps	Feet Per Second	SEVA	Stand-up EVA
FDAI	Flight Director Attitude Indicator	S-IC	Saturn V First Stage
FTP	Fixed Throttle Position	S-II	Saturn V Second Stage
GCTA	Ground Commanded Television	S-IVB	Saturn V Third Stage
GET	Ground Elapsed Time	SIDE	Suprathermal Ion Detector Experiment
GNCS	Guidance, Navigation, and Control System (CSM)	SIM	Scientific Instrument Module
GSFC	Goddard Space Flight Center	SLA	Spacecraft-LM Adapter
HBR	High Bit Rate	SM	Service Module
HFE	Heat Flow Experiment	SPS	Service Propulsion System
HTC	Hand Tool Carrier	SRC	Sample Return Container
IMU	Inertial Measurement Unit	SSB	Single Side Band
IU	Instrument Unit	SSR	Staff Support Room
IVT	Intravehicular Transfer	SV	Space Vehicle
KSC	Kennedy Space Center	SWC	Solar Wind Composition Experiment
LBR	Low Bit Rate	TD&E	Transposition, Docking and LM Ejection
LCC	Launch Control Center	TEC	Transearth Coast
LCRU	Lunar Communications Relay Unit	TEI	Transearth Injection
LDMK	Landmark	TFI	Time From Ignition
LEC	Lunar Equipment Conveyor	TLC	Translunar Coast
LES	Launch Escape System	TLI	Translunar Injection
LET	Launch Escape Tower	TLM	Telemetry
LGC	LM Guidance Computer	TPF	Terminal Phase Finalization
LH ₂	Liquid Hydrogen	TPI	Terminal Phase Initiation
LiOH	Lithium Hydroxide	T-time	Countdown Time (referenced to liftoff time)
LM	Lunar Module	TV	Television
LMP	Lunar Module Pilot	USB	Unified S-Band
LOI	Lunar Orbit Insertion	USN	United States Navy
LOS	Loss of Signal	USAF	United States Air Force
LOX	Liquid Oxygen	VAN	Vanguard
LPO	Lunar Parking Orbit	VHF	Very High Frequency
LR	Landing Radar	ΔV	Differential Velocity
LRL	Lunar Receiving Laboratory		
LRRR	Laser Ranging Retro-Reflector		
LSM	Lunar Surface Magnetometer		
LV	Launch Vehicle		