APOLLO 15 EXPERIMENTS

The Apollo 15 mission will conduct in-flight experiments, lunar surface experiments, and other experiments. These three groups of experiments and a description of lunar EVA activities are defined in the following paragraphs.

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 from the SIM while in lunar orbit. Orbital science(s) activities are scheduled at appropriate times throughout the lunar orbit phase of the mission.

After the SIM door is jettisoned by pyrotechnic charges and until completion of lunar orbital science tasks, selected RCS thrusters may 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.

Pre-Rendezvous Lunar Orbit Science

For the nominal mission, orbital science operations will be conducted during both the 60 x 170-NMI lunar orbits after lunar orbit insertion (LOI) and the 60 x 8-NMI orbits after descent orbit insertion (DOI), while in the docked configuration. Orbital science operations will be stopped for the separation and circularization maneuvers performed during the twelfth revolution, then restarted after the CSM circularization. In the case of a T-24 launch, the additional day in 60 x 8-NMI orbit prior to lunar landing will also be used for orbital science.

Launching of the subsatellite will occur after circularization, during the twelfth orbit. The subsatellite will be spin stabilized by three deployable, weighted arms. Time of activating the subsatellite in its lunar orbit will be scheduled to avoid interference with other mission operations. Subsatellite tracking and data collection requirements will be planned to avoid conflict with other orbital experimental requirements.

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 orbital timeline will be planned 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 during the lunar orbit science phase. Experiment activation cycles will be planned to have minimum impact on crew work-rest cycles.

Conduct of orbital experiments and photographic tasks will be planned in consideration of: mass spectrometer and gamma-ray spectrometer boom extend/retract requirements; outgassing, stand-by, warm-up, and operational periods; mapping and panoramic camera field-of view limitations; experiment field-of view limitations; CSM attitude tolerances; and MSFN data collection requirements.

Post-Rendezvous Lunar Orbit Science

During the second revolution after rendezvous, the LM ascent stage will be jettisoned and 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.

List of In-Flight Experiments

1. 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 a defined energy spectrum. The instrument is encased in a cylindrical thermal shield which is deployed on a boom from the SIM for experiment operation.

2. 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 degrees from the SIM in SM sector IV. An X-ray background count is performed on the lunar darkside.

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

4. S-Band Transponder (CSM/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.

5. 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 a defined mass range. 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.

6. 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 echoes 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.

7. 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 impacting meteoroids.

8. 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 (UV) 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, trans-lunar coast, and lunar orbit.

9. 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.

10. 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.

11. Partical 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 defined energy ranges and of protons in one energy range.

12. 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.

LUNAR SURFACE EXPERIMENTS

Lunar surface experiments are deployed and activated or conducted by the lunar module (LM) crewmen during extravehicular activity (EVA) periods. Those experiments which are part of the Apollo lunar surface experiments package (ALSEP) are thus noted in the following list.

1. Lunar Passive Seismology (S-031) (ALSEP). The objectives of this 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.

2. Lunar Tri-Axis Magnetometer (S-034) (ALSEP). The objectives of this 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 ninety-centimeter (cm) long arm, which are first oriented parallel to obtain the field gradient and thereafter orthogonally to obtain total field measurements.

3. 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 are performed by seven Faraday cup sensors which collect and detect electrons and protons.

4. Suprathermal Ion Detector (S-036) (ALSEP). The objectives of this 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.

5. Cold Cathode Ionization Gauge (S-058) (ALSEP). The objective of this experiment, which is integrated with the suprathermal ion detector, is to measure the neutral particle density of the lunar atmosphere.

6. Lunar Heat Flow (S-037) (ALSEP). The objectives of this 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).

7. Lunar Dust Detector (S-059). The objective of this experiment is to obtain data on dust accretion rates and on the thermal and radiation enrivonment. The dust detector has three small

photoelectric cells mounted on the ALSEP central station sunshield, facing the ecliptic path of the sun.

8. 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 a comprehensive sample of coarse fragments and fine lunar soil to be collected in a pre-selected area. 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 activites 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.

9. Laser Ranging Retro-Reflector (S-078). The objective of this 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 retroreflector 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 retroreflector 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.

10. Solar Wind Composition (S-080). The purpose of this 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.

11. Soil Mechanics Experiment (S-200). The objective of this experiment is to obtain data on the mechanical properties of the lunar soil from the surface to depths of ten 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.

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.

1. Bone Mineral Measurement (M-078). The objectives of this 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.

2. Total Body Gamma Spectrometry (M-079). This experiment is assigned to Apollo 15 subject to elimination of quarantine requirements. The objective of this experiment is to detect changes in total body potassium, total muscle mass (lean body mass) and to detect any induced radioactivity in the body of the crewmen. Preflight and postlaunch examination of each crew member will be performed by radiation detecting instruments in the Radiation Counting Laboratory as MSC. There are no inflight requirements for this experiment.

FIRST SURFACE EVA

The first surface EVA (up to seven hours) 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 Apollo Lunar surface experiments package (ALSEP), and laser ranging retro-reflector deployment. Television will be deployed as soon as possible in this period for observation of lunar surface activities. The data acquisition camera and Hasselblad camera 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. Collected 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 millimeter (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 their scientific interest. If time does not permit completion of all ALSEP tasks, they may be carried over to appropriate points in subsequent EVA's.

SECOND AND THIRD SURFACE EVA'S

Traverses in the second and third surface EVA's (up to seven hours each) will be planned both to maximize scientific returns at the selected site and to obtain operational assessments of new and expanded capability hardware and systems. LRV sorties will be planned with flexibility for selecting stops and conducting experiments. Consumables usage rates will be closely monitored on earth to assist in real-time traverse planning.

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 surface EVA's and will include voice and photographic descriptions of lurain features and documentation of sample material as it is collected. The LRV will be used for the planned scientific traverses, carrying both astronauts, experiment equipment, and the LCRU used with both high- and low-gain S-band antennas. Earth-controlled color TV monitoring will be conducted through use of the GCTA mounted on the LRV. The Hasselblad and data acquisition cameras will also be used to record the lunar surface operations. Black and white film will generally be used for Hasselblad photography, including the rille surveys with the 500 mm lens. The solar wind composition (S-080) will be concluded prior to termination of the third surface EVA, and will be returned for post-flight analysis.

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