BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: Contingency Experiments for Apollo - Case 340

DATE: April 30, 1968

FROM: W. L. Piotrowski

ABSTRACT

Contingency scientific experiments for Apollo are investigated for the case where ALSEP does not fly. On the basis of minimum interference with the nominal mission, it is concluded that no active experiments to be left behind on the lunar surface are readily available. Several real-time "active" and long-term passive surface experiments are readily available, however, including:

1. a corner-reflector array for laser ranging experiments,
2. the Apollo Lunar Surface Drill,
3. the Solar Wind Composition experiment,
4. a camera with a portrait lens for detailed surface photography, and
5. an ECHO-type diffuse reflector to be deployed on the surface for site location and orbital navigation.

Two lunar orbital contingency experiments which could be carried are:

1. the 250 mm lens and additional film for the CSM camera, and
2. a multispectral photography feasibility experiment.

The ALSEP deployment time gained in certain contingency situations (> 1 1/2 man-hours) could be effectively used for deployment of the contingency experiments and for extending the Lunar Field Geologic Investigation (FGI).

In the event that additions to the CM experimental payload become possible in the contingency situation, it is suggested that high priority be given to additional sample return (∿ 44 lbs) in the two containers now carried.

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MEMORANDUM FOR FILE

I. INTRODUCTION

The initial Apollo lunar landing mission payload now includes five active lunar surface experiments with a power supply and a central station integrated into an Apollo Lunar Surface Experiment Package (ALSEP) which is carried in the LM Scientific Equipment (SEQ) bay and deployed on the lunar surface by the crew. Recent LM weight and lunar surface timeline analyses indicate that it may be necessary to exclude ALSEP from the first lunar landing mission. If ALSEP is deleted on account of weight considerations, the lunar surface EVA time assigned for the deployment of ALSEP may be available for other activities. If ALSEP is excluded because of EVA time limitations (i.e., significant shortening or deletion of the second EVA which is scheduled for ALSEP deployment) the weight and stowage volume normally used by ALSEP may be available to carry other experiments, but these experiments necessarily must require short deployment time. It is probable that the real situation will entail a combination of the two factors, i.e., some cutdown in both weight and time available.

In the contingency situation the available weight and stowage space is not necessarily limited to carrying equipment to the lunar surface. It may be possible to include experiments aboard the CM for lunar orbit environmental studies or remote sensing of the lunar surface while the LM is detached. Conceivably the available space in the LM SEQ bay could be left vacant and additional fuel added to the ascent propellant tanks. This additional return capability could then be used to return additional lunar geological samples to Earth. If a second EVA is available, it may be desirable to use some of the contingency EVA time for additional geological investigations. In this memo we consider some of these alternatives, the problems associated with each, and suggest a group of contingency experiments.

II. EXPERIMENT SELECTION

The contingency experiments can be grouped into the following categories:

1. Active Surface Experiments - The active surface experiments would be independent, deployed on the lunar surface by the crew, and might or might not return data after the LM has departed. The experiments would be carried in the LM SEQ bay ($\sim$ 15 ft^3) or the Modular Equipment Stowage System (MESS) and could weigh as much as 225 lbs. (The structural limit is 115 lbs in each compartment of the SEQ bay with a total of 195 lbs in both.) We assume that the Lunar Geologic Experiment (24 lbs and 1.5 ft^3) will be carried on the mission.

2. Passive Surface Experiments - Passive surface experiments, carried in the LM SEQ bay or MESS, and deployed on the lunar surface by the crew would be of two types:

   a. Those requiring a revisit on subsequent missions (not necessarily in the immediate future) to acquire the data. They would range from passive devices to measure dust accretion over extended time periods to experiments that determine the effect of the lunar environment on Earth-type materials.

   b. Experiments not requiring a site revisit, including devices placed on the lunar surface to be used for Earth-based or lunar orbital experiments.

3. Experiments for the CSM in lunar orbit - Orbital experiments would include photographic experiments which may require additional lenses and/or film, experiments to determine the lunar environment at orbital altitude, remote sensing experiments, and subsatellites.

4. Additional Sample Return - An additional Apollo Lunar Sample Return Container (ALSRC) could be carried in the LM SEQ bay and additional geological samples returned to Earth, or it may be possible to put more geological samples in the two ALSRC's currently scheduled for the mission. The lunar surface EVA time freed by the exclusion of ALSEP (> 1.5 man-hours) could be effectively used in conducting surface observations and in the gathering of additional geological samples. This additional sample return would require more fuel for the LM ascent stage.

The following ground rules have been adopted for the individual experiments and/or equipment to be included:

1. The experiments shall require minimal development and minimal integration with the spacecraft mechanical or electrical system. Effectively this means that lunar orbit experiments should be carried piggy-back and that experiments for the lunar surface which were not specifically designed for that purpose are eliminated.

2. Any active lunar surface experiment, or set of experiments, must include its own power supply and data transmission system.

3. The contingency experiment should have minimal perturbation on the nominal mission planning.

4. The selection of contingency experiments is concerned only with possible uses of available weight, stowage space, and EVA time. The effects of the various contingency experiments on the LM and CM center-of-gravity are not considered.

III. ACTIVE SURFACE EXPERIMENTS

On the basis of the ground rules the only active experiments which could be deployed on the lunar surface are those developed for the Ranger, Surveyor, or Apollo Programs. None of the Ranger or Surveyor instruments are considered feasible contingency experiments for the following reasons:

1. Ranger Seismometer - This is a single-axis seismometer developed for inclusion in a self-contained capsule which was to be hard landed on the moon. Since no flight model of this instrument exists and a prototype has been scavenged for parts, a complete instrument would have to be fabricated and tested. In view of the time and costs required to obtain a flight model, which would still only be a stand-by experiment, a Ranger seismometer is not a feasible lunar surface contingency experiment.

2. Ranger Lunar Facsimile Capsule (LFC) - The LFC is a self-contained unit including a high resolution facsimile device capable of obtaining a 360 degree panoramic view of the terrain surrounding the capsule. Since the Apollo TV camera, the 16 mm Data Aquisition Camera, and the SWA Hasselblad camera will photograph approximately the same area as the LFC but with better resolution, and since no off-the-shelf hardware exists today, the LFC is not considered a useful contingency experiment.

3. Surveyor Scientific Instruments - Since none of these experiments are self-contained, it would be necessary to develop power supplies, telemetry, etc. or carry parts of a dismantled Surveyor to supply these services. For these reasons, Surveyor experiments are not feasible contingency experiments.

Therefore, on the basis of the above discussion, no previously developed active lunar surface experiments are feasible back-ups for ALSEP. However, several experiments are being developed or equipment can be readily modified to perform "active" experiments on the lunar surface. These are:

1. Apollo Lunar Surface Drill (ALSD) - The ALSD is being developed to provide a means of drilling holes for implanting temperature sensors for the ALSEP Heat Flow Experiment (HFE) and for collecting sub-surface samples. The ALSD is a self-contained rotary-percussive coring unit capable of drilling two holes up to 3 meters deep and one inch in diameter. The core samples will be collected, packaged, and returned in the ALSRC. By including the ALSD as a contingency experiment:

   a. subsurface sampling to a depth of several meters will be obtained on the first mission rather than the third or fourth,

   b. the operation of the drill on actual lunar material in its natural state can be determined, and

   c. the feasibility of utilizing an ALSD on subsequent missions with or without the HFE can be ascertained. This includes determination of of actual timelines, and seeing if holes can be cased.

   The ALSD weighs about 27 lbs and fits into the LM SEQ bay. A flyable model currently exists, and two flight models are scheduled for delivery in May, 1968. It is estimated that about 45 minutes of EVA time will be required to unload and assemble the drill, drill a 3 meter hole, and pack the core sample.

2. Portrait Lens for Hasselblad - Because of constraints imposed by the spacesuit, the hand held FGI camera will not be closer than about 1 meter to the surface. The surface resolution obtainable at this distance will be approximately 0.3 mm. By placing a portrait lens on an Electric Hasselblad or a SWA Hasselblad and

mounting the camera on a short tripod detailed photography of the lunar surface at 1:1 could be obtained. (The surface resolution would be three or four times better than without the portrait lens and tripod, although the field of view would be smaller.) This improved resolution would be of significant scientific value since it would show the detailed structure of the lunar surface material in its natural state, and photography of the same small area at various sun angles during the EVA periods (~ 12 hours apart) would contribute to the knowledge of the local lunar photometric function. Detailed photography of the regions immediately adjacent to, and at varying distances from the LM landing pads and in the directions normal and parallel to the motion of the LM pads on the surface, would contribute to an improved understanding of the lunar soil mechanics properties. Undulations in the surface due to weathering by mass transport might also be visible with the improved resolution. A photograph of the surface both before and after a shallow ditch has been dredged by the astronaut using the LGE scoop or hammer would enable one to infer various soil mechanics properties. In addition, the astronaut could scoop up some lunar dust and from a height of about 1 meter slowly drop it to the surface; a detailed photograph of the way the dust is distributed will indicate some properties of the dust. By hard mounting a camera on a short tripod, these experiments could be performed independent of the FGI camera. The field of view would be known in relation to the legs of the tripod so that the only preparation for photography would be positioning the tripod over the region to be photographed, determining the exposure, and snapping the picture.

The total experiment weight would be about 7 lbs of which one film magazine (200 exposures) weighing .97 lbs would be returned to Earth.*

3. Solar Wind Composition Experiment (SWC) - The SWC experiment consists of a 4.5 ft^2 aluminum foil which will be exposed on the lunar surface to direct solar wind impingement where the energetic solar wind particles will be trapped in the foil. The exposed foil will be returned to earth, vaporized in an ultrahigh vacuum system, most of the reactive gases removed by gettering action, and the remaining gases (mostly noble gases) subjected to mass spectroscopic analysis. The principal investigator hopes to determine the elemental and isotopic composition and relative abundances of the noble gases and other

*Assuming a separate camera. Addition of a portrait lens to the existing camera would add only ounces to the current camera weight.

selected elements in the solar wind. The relative isotopic abundances at the Moon can then be compared with the relative abundances in the solar corona.

The threshold sensitivity of the analysis is determined by the contamination level of the foils with terrestrial noble gases. Based on estimates of particle fluxes and experimental results on trapping probabilities, a one hour exposure of the foil on the lunar surface would permit the determination of the solar wind isotopic abundances of $He^{3,4}$, $Ne^{20,21,22}$, $Ar^{36,38}$, and perhaps Ar^{40}. Longer exposures would be required to ascertain the isotopic abundances of Kr^{82-86} (2 hour exposure), Kr^{80} (4 hour exposure), and $Xe^{129,131-136}$ (12 hour exposure).

The SWC is currently under development and is awaiting flight assignment (a prototype has been delivered to MSC). In the contingency situation with two EVA's, two SWC foils would be deployed on the lunar surface, one of which would be retrieved at the end of the first EVA ($<$ 2 hour exposure) and the second retrieved at the end of the second EVA ($\sim$ 15 hour exposure). The outbound weight of a SWC foil is .94 lbs and the return weight is .125 lbs. Consequently, the addition of two SWC foils in the contingency situation will add 1.88 lbs to the landed payload and 0.25 lbs to the return weight. The deployment time is estimated to be 3 min/foil.

IV. PASSIVE SURFACE EXPERIMENTS

Passive lunar surface experiments fall into three categories: 1) those currently under development for Apollo, 2) those considered for Surveyor, or 3) those which have been suggested as possible back up for ALSEP. Some of these possibilities are:

1. Laser Ranging Retro-Reflector (LR^3) - The lunar surface retro-reflector array, consisting of $\sim$ 90 uncoated cube-corner reflectors, will be deployed on the lunar surface, positioned on a tripod, and aimed at the center of the earth's libration pattern. The array will be used to reflect an earth based laser beam for ranging experiments. The objectives of the experiment are to determine more accurately the lunar physical librations, to determine the lunar size and orbit, and to obtain variations in the earth's

rotational rate. The corner reflector array is currently under development and is awaiting flight assignment. The package is entirely self contained, weighs about 17 lbs, and will require about 20 minutes for deployment. A flight model can be expected by May, 1969. This experiment would be an attractive standby experiment for ALSEP.

2. ECHO-Type Landing Site Marker - The placement of an ECHO-type diffusely reflecting sphere on the lunar surface at the LM landing site (visible with the aid of a telescope from the CSM) would assist in the real time positioning of the LM relative to various topographic features and could also be used to determine the Apollo orbit relative to the landing site. A 5 meter diameter diffusely reflecting aluminized mylar sphere had been recommended as a Surveyor Landing Aid for Apollo and would have been carried collapsed inside a spherical canister which, upon command, would open. An inflation system would erect the sphere. The total experiment was estimated to weigh 16 lbs. A 5 meter sphere would be visible from the CSM in lunar orbit with a 28 power telescope (Ref. 1). Assuming that the marker has an albedo 10 times that of the surrounding terrain, the diffuse sphere would be readily visible in photographs of the surface taken from the CSM with the Electric Hasselblad using the 250 mm lens; the marker may also be visible in photographs of the surface taken with the 16 mm Data Aquisition camera.

3. Passive Engineering Package - A passive engineering package would consist of various terrestrial materials and surfaces which would be deployed and exposed to the lunar environment for long time periods. In order to determine the effects of the lunar environment on these materials, a return visit to this initial Apollo site would be required. Such a return visit now appears unlikely for several years and, therefore, it would seem that the contingency capability should be put to a use which would permit a quicker return of data. In the event that a return visit is eventually made, the LM descent stage and the scientific equipment left on the surface should provide a large amount of information on the effect of the lunar environment on terrestrial materials and surfaces. Therefore, a passive engineering package is not recommended as a stand-by experiment for the first Apollo mission.

V. ADDITIONAL SAMPLE RETURN

The return to Earth of additional lunar samples is an attractive proposition for a contingency situation. This could be accomplished either by putting more lunar samples in the two sample return containers already onboard or by including an additional Apollo Lunar Sample Return Container (ALSRC). An additional pound of ascent propellant will be required for each additional pound of lunar samples returned. The SM currently has the capability of ejecting 45 lbs of additional payload from lunar orbit (Ref. 2) and the capability exists to add about 116 lbs of propellant to the ascent tanks. The additional EVA time gained in certain contingency situations could be very effectively used in collecting additional samples.

1. Additional Samples in ALSRC - The ALSRC will have a usable volume of about 1,350 cu in. Assuming that the lunar samples will have an average density of .108 lb/in^3 (3.0 gm/cc) and that the packing efficiency will be 33%, one container will hold approximately 48 lbs of samples (the current allocation is 26 lbs). Thus, by judiciously packing the two containers about 44 lbs of additional lunar samples could be accommodated. (The ALSRC has the structural integrity to accommodate this weight). For return to Earth this would require an additional 44 lbs of ascent propellant. No additional stowage space would be required in the LM ascent stage or CM. However, the following questions arise: a) does the LM have the structural integrity to accommodate an additional 44 lbs at the stowage location of the ALSRC's? b) does the CM have the structural integrity to accommodate the additional weight during deboost for Earth entry? and, c) do the main parachutes have the capability to safely lower this additional weight to Earth? Until the structural limits of the LM and CM are determined and until the weight limits on the main parachutes are ascertained, it would seem unwise to totally exclude additional samples in the onboard ALSRC's as a contingency experiment.

2. Inclusion of a Third ALSRC - An additional ALSRC, weighing 13.5 lbs, could be carried to the lunar surface in the LM SEQ bay and 40 lbs of additional propellant added to the LM ascent stage. This would permit the return of 26 lbs of additional lunar samples. In addition to the questions regarding the structural integrity of the LM and CM and the question regarding the capability of the main parachutes, the following problems arise:

    a. There is no stowage space in the LM ascent stage for an additional sample container. (The sample container might be strapped to the floor - this problem is being investigated by MSC in order to allow an ALSRC to be loaded into the LM prior to the end of the mission.)

b. There appears to be sufficient stowage space in the CM for the container but apparently not above hard points.

Therefore, on the basis of the above problems, the inclusion of an additional ALSRC does not appear to be a feasible contingency experiment.

If the LM and CM have the structural integrity to safely accommodate additional sample return and if additions to the CM return experimental payload can be handled by the main parachutes, the return of additional lunar samples should rate high in priority for the contingency situation. If this is the case, then 44 lbs of additional propellant should be added to the ascent tanks and up to 22 lbs of additional lunar samples should be packed in each container.

VI. USE OF EVA TIME

The present lunar surface EVA schedule is rather crowded (Ref. 3) and in fact, does not allow for a significant Field Geologic Investigation. The additional time freed in certain contingency situations can be profitably utilized:

1. In deploying contingency experiments;

2. In an extended Field Geologic Investigation;

3. In real-time performance of tasks suggested by Earth-based scientists who have digested the results of the first surface excursions and the preliminary geological sampling;

4. In additional photography from the lunar surface of the Milky Way, the gegenschein, the zodiacal light, and star fields; and

5. In psychological and physiological observations of the astronauts. This will be the first time that man has been on the Moon and, consequently, the astronauts can be expected to desire a maximum of initial observing time.

Therefore, the more than 1.5 man-hours of lunar surface EVA time freed in certain situations by the exclusion of ALSEP can be profitably utilized in various activities which will contribute to our scientific knowledge.

VII. ORBITAL EXPERIMENTS

On the basis of the ground rules established for this study (i.e., no major integration with the spacecraft electrical or mechanical systems) all active lunar orbital experiments for the CSM are eliminated. Experiments which meet the ground rules and which could be carried on the CSM are primarily photographic or environmental. These are:

1. Additional lenses and film for the CSM Electric Hasselblad - The current photographic complement of the CSM contains an Electric Hasselblad with an 80 mm lens and three magazines of film (200 exposures each). From a 60 n mi altitude, this system would have a surface resolution of about 12 meters, insufficient to unambiguously identify the LM or the LM shadow (3-4 resolution elements are required for identification). Consequently, the LM landing point cannot be determined with this system. By including the 250 mm lens (2.057 lbs) for the Hasselblad (removed from the CSM photographic complement in late 1967 in a weight reduction program), a surface resolution of about 4 meters would be possible and the LM shadow could be identified on photographs taken from the CSM. In addition, scientists working with Lunar Orbiter photographs have identified numerous lunar surface features that would benefit significantly from photography at a resolution of 5 meters or better. The inclusion of the 250 mm lens and an additional magazine of film (200 exposure) for experimental scientific photography would add 3.03 lbs to the CSM.

   The inclusion of a 500 mm f/8 lens (∿ 4 lbs) for the Hasselblad would enable the CSM crewman to photograph lunar surface features at a resolution of about 2 meters if IMC could be obtained by rolling the spacecraft. However, to reduce jitter the camera must be hard mounted at the spacecraft window, and this necessarily requires a mounting bracket. Since installation of bracket may require enlarging existing screw holes in the spacecraft structure, it could not be installed on short notice. As in the case of the 250 mm lens, numerous areas on the lunar surface can be identified that scientists would like photographed at a ground resolution of 2 meters.

   Other photographic experiments from the CSM using the 80 mm, 250 mm, and 500 mm lenses for the Hasselblad and special film are suggested elsewhere (Ref. 4).

2. Orbital Multispectral Photography Experiment - Telescopic observations from Earth and pictures from Surveyor indicate that the Moon does not possess

the wide range of color differences as does the Earth and, consequently, a multispectral photographic experiment for geochemical sensing has been relegated to a low priority on an early lunar orbital mission. However, a feasibility experiment which is simple, lightweight, and uses existing flight-tested instrumentation does seem possible in the contingency situation. The experiment essentially would consist of a four unit set of ganged Electric Hasselblad cameras (with the 80 mm lenses) mounted together in a frame, boresighted and electrically slaved by a wiring harness. The spectral region available to each camera would be determined by the lens filter/film combination. A preliminary analysis (Ref. 5) has shown that such an experiment is feasible using the CM windows as a viewing port, although the UV and IR coatings on the windows limits the study to the spectral region from 4,200 Å to 7,800 Å. The area photographed in this experiment will depend more on when the time budget and the sun angle will permit photography than on any particular site although regions on the front side are preferred since data from Earth-based studies (e.g., IR, UV) will be available or can be obtained. The regions photographed should include a mare, a highland area, and a rayed crater with the sun angle varying between 20° to 70° and the viewing angle varying from vertical to about ± 30° off vertical. For this particular experiment, an orbital height of 100 km, and film with 50 lines/mm, a surface resolution of about 25 meters would be possible. This would be more than sufficient to indicate the feasibility of the technique. One film magazine per camera (200 exposures per magazine) should be sufficient for the experiment. The total experiment weight would be less than 25 lbs of which 4 lbs of film would be returned and the camera unit transferred to the LM and left in lunar orbit. The experiment would require a stowage volume of about 300 in^3 and would be unstowed and mounted at the CM window after LM descent.

3. Environmental Experiments (nuclear emulsion stacks and micrometeoroid collection plates) - The environmental experiments are desired on a manned lunar orbital mission primarily because of the requirements of long exposure at large distances from the Earth and return of the plates to Earth for analysis. The nuclear emulsion stacks would detect the primary cosmic radiation outside the Earth's magnetosphere, and the micrometeoroid collection plates would collect

micrometeoroid primaries and lunar secondary ejecta. However, these environmental experiments require either EVA (not desirable) or a CM Airlock. The Apollo Experiments Airlock, developed for deployment of experiments outside the CM, weighs about 15 lbs and must be installed prior to the final CM vacuum test (∿ 4 months before the flight). The micrometeoroid collection plates would weigh about 6 lbs and would have a volume of .07 ft^3; a nuclear emulsion stack would weigh about 18 lbs and occupy a volume of .02 ft^3. The total return weight for the environmental experiments would be about 39 lbs (including the Airlock). Although experiment stowage would not be a problem, there are presently no allowances for additional experimental weight in the CM. In the event that additions to the return CM experimental payload do become possible, the environmental experiments would be second in priority to additional sample return.

4. Independent Orbital Spacecraft - In the contingency situation, in addition to ALSEP, 225 lbs of fuel could be off-loaded from the LM ascent stage and about 450 lbs of equipment could be carried piggy-back to lunar orbit and deployed. In this situation an attractive alternative is to deploy active experiments in lunar orbit to obtain data on the lunar environment or about the Moon itself. For minimal interference with the spacecraft, this equipment would necessarily require its own power, communications, and attitude control subsystem - i.e., a complete spacecraft in its own right. Any independent subsatellite carried piggy-back to lunar orbit would require the development of an ejection mechanism for the stowage bay. This is by no means a trivial problem and would require considerable changes to the LM SEQ bays or Sector I of the SM. Therefore, a lunar orbital spacecraft carried piggy-back is not a feasible contingency experiment.

VIII. SUGGESTED CONTINGENCY EXPERIMENTS

On the basis of the above discussion the following list of contingency experiments are suggested as back-ups for ALSEP:

1. Surface Experiments	Landed Wt.	Return Wt.
Corner-Reflector Array	17 lbs	--
Apollo Lunar Surface Drill	27 lbs	--
Solar Wind Composition Experiment	2 lbs	.25 lbs

Additional Sample Return *	44 lbs	44 lbs
Hasselblad with Portrait Lens	7 lbs	0.97 lbs
ECHO-type Reflector	16 lbs	--

2. Orbital Experiments

Multispectral Photography Feasibility	25 lbs	4 lbs
250 mm Lens and Film for Hasselblad	3.3 lbs	.97 lbs

If only one lunar surface EVA is available, the ALSD and one SWC experiment should be deleted from the above contingency experiments.

In suggesting these contingency experiments to be taken to the lunar surface and to lunar orbit, the effect on the LM center of gravity is not considered. This problem may require some reconsideration of the results of this study.

IX. CONCLUSIONS

Contingency experiments for Apollo have been considered in the event that ALSEP is not available. Three "active" surface experiments - the ALSD, a Hasselblad with a portrait lens for detailed surface photography, and two Solar Wind Composition experiments, are feasible. (If only one EVA is avaiable, the ALSD and one SWS experiment would not be carried.) A passive engineering package is deemed undesirable because of site revisitation requirements. A lunar corner-reflector array which would be carried in the LM SEQ bay or MESS and deployed on the Moon for Earth-based laser ranging experiments and an ECHO type diffuse reflector for determining the CSM orbit relative to the landing site are suggested for the contingency situation. These experiments would have minimal impact on the nominal mission.

Environmental experiments for the CM in lunar orbit are not feasible since the CM does not presently have the capability to return additional experimental payloads to Earth. However, a multispectral photography feasibility study is suggested for lunar orbit since the weight returned to Earth will be only about 4 lbs. The addition of the 250 mm lens and additional film for the CSM Hasselblad would permit photography of the lunar surface at a resolution of 5 meters and would permit the determination of the LM landing point.

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*The suggested inclusion of additional sample return assumes that the main parachutes will have the capability to return an additional 44 lbs to Earth or that some equipment (e.g., sleeping bags) can be jettisoned before Earth entry.

The return to Earth of additional lunar geologic samples may not be feasible since the CM main parachutes may not be capable of returning an additional 44 lbs safely to Earth. If, however, after study, additions to the CM experimental payload become possible, it is suggested that in a contingency situation high priority be given to additional sample return.

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W. L. Piotrowski

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