UNITED STATES GOVERNMENT

# *Memorandum*

TO : M/Associate Administrator for Manned Space Flight DATE: 11 NOV 1968

FROM : MA/Apollo Program Director

SUBJECT: Apollo 8 Mission Selection

The purpose of this memorandum is to obtain your approval to fly Apollo 8 on an open-ended lunar orbit mission in December 1968.

My recommendation is based on an exhaustive review of pertinent technical and operational factors and also on careful consideration of the impact that either a success or a failure in this mission will have on our ability to carry out the manned lunar landing in 1969.

THE APOLLO 8 C' LUNAR ORBIT MISSION:

Attachment I to this memorandum contains a detailed description of the Apollo 8 lunar orbit mission. Significant features of this mission plan are:

Planned Schedule:

Launch: 0750 EST, 21 December 1968
Translunar Injection: 1040 EST, 21 December 1968
Lunar Orbit Insertion:
$LOI_1$ Initiate: (60X170 NM Orbit) 0457 EST, 24 December 1968
$LOI_2$ Initiate: (60 NM Circular Orbit) 0921 EST, 24 December 1968
Transearth Injection: 0105 EST, 25 December 1968
Landing: 1053 EST, 27 December 1968

Alternate Schedule:

Monthly Launch Windows: 21-27 December 1968 or as soon thereafter as possible.
Daily Launch Windows: Approximately 5 hours duration.

Open-Ended Mission Concept:

A large number of abort and alternate mission options are provided for in the Mission Plan and associated Mission Rules. Noteworthy examples of the way in which this open-ended concept could operate in this mission are the following:

A low earth orbital mission in the event of a "no go" in earth orbit prior to translunar injection.

Early return to earth in event of certain malfunction conditions during translunar coast.

A circumlunar mission in event of a "no go" during checkout prior to the lunar orbit insertion burn.

APOLLO 8 MISSION SELECTION:

On August 19, 1968, we announced the decision to fly Apollo 8 as a Saturn V, CSM-only mission. The basic plan provided for Apollo 8 to fly a low earth orbital mission, but forward alternatives were to be considered up to and including a lunar orbital mission. Final decision was to be reserved pending completion of the Apollo 7 mission and a series of detailed reviews of all elements of the Apollo 8 mission including the space vehicle, launch complex, operational support system, and mission planning.

Apollo 7 Mission Results:

An important factor in the total decision process leading to my recommendation has been and continues to be the demonstrated performance of the Apollo 7 Command and Service Module (CSM) subsystems, and the compatibility of the CSM with crew functions, and the Manned Space Flight Network. Comprehensive understanding of all Apollo 7 flight anomalies and their impact on a lunar mission is fundamental to arriving at a proper decision. Attachment II to this memorandum provides a recap of the Apollo 7 flight anomalies, their disposition, and a statement of any known risk remaining on the proposed Apollo 8 mission together with the actions proposed.

Apollo 4 and Apollo 6 Results:

The results of the Apollo 4 and Apollo 6 missions, in which the performance of the SO1 and SO2 Saturn V launch vehicles was tested, have been carefully analyzed. All flight anomalies have been resolved. In particular, the two most significant problems encountered in Apollo 6--longitudinal oscillation or "POGO" effect in the first stage of the Saturn V and the rupture of small propellant lines in the upper stages--have been corrected and the solutions verified in extensive ground tests.

Meetings and Reviews:

The decision process, resulting in my recommendation, has included a comprehensive series of reviews conducted over the past several weeks to examine in detail all facets of the considerations involved in planning for and providing a capability to fly Apollo 8 on a lunar orbit mission. The calendar for and purpose of these meetings are presented in Attachment III. An important milestone

was achieved with successful completion of the Design Certification Review on November 7, 1968. A copy of the signed Design Certification is appended as Attachment IV.

Pros and Cons of a Lunar Orbital Flight:

My objective through this period has been to bring into meaningful perspective the trade-offs between total program risk and gain resulting from introduction of a CSM-only lunar orbit mission on Apollo 8 into the total mission sequence leading to the earliest possible successful Apollo lunar landing and return. As you know, this assessment process is inherently judgmental in nature. Many factors have been considered, the evaluation of which supports a recommendation to proceed forward with an Apollo 8 open-ended lunar orbit mission. These factors are:

PROS:

Mission Readiness:

- The CSM has been designed and developed to perform a lunar orbit mission and has performed very well on four unmanned and one manned flights (CSM's 009, 011, 017, 020, and 101).

- We have learned all that we need in earth orbital operation except repetition of performance already demonstrated.

- The extensive qualification and endurance-type subsystem ground testing conducted over the past 18 months on the CSM equipments has contributed to a high level of system maturity, as demonstrated by the Apollo 7 flight.

- Performance of Apollo 7 systems has been thoroughly reviewed, and no indication has been evidenced of design deficiency.

- Detailed analysis of Apollo 4 and Apollo 6 launch vehicle anomalies, followed by design modifications and rigorous ground testing gives us high confidence in successful performance of the Apollo 8 launch vehicle.

- By design all subsystems affecting crew survival (Environmental Control System, Electrical Power System, Reaction Control System, and Guidance and Navigation System) are redundant and can suffer significant degradation without crew or mission loss. The sole exceptions are the injector and thrust chamber of

the Service Propulsion System. These two engine components are of simple, rugged design, with high structural and thermal safety margins. (See Attachment V.)

- Excellent consumables and performance margins exist for the first CSM lunar mission because of the reduction in performance requirements represented by omitting the weight of the lunar module. An example of the predicted spacecraft consumables usage is provided below to illustrate this point:

| Consumable | Total Usable | Total Used | Reserve |
|---|---|---|---|
| Service Module Reaction Control System Propellant (Pounds) | 1140 | 294.5 | 845.5 |
| Command Module Reaction Control System Propellant (Pounds) | 231.2 | 29.4 | 201.8 |
| Service Propulsion System Propellant (Pounds) | 40,013 | 28,987 | 11,026 |
| Cryogenic Oxygen (Pounds) | 640 | 410 | 230 |
| Cryogenic Hydrogen (Pounds) | 56 | 40 | 16 |

PROS:

Effect on Program Progress:

The lunar orbit mission will:

- Provide valuable operational experience on a lunar CSM mission for flight and ground and recovery crews. This will enhance probability of success on the subsequent more complex lunar missions by permitting training emphasis on phases of these missions as yet untried.

- Provide an opportunity to evaluate the quality of MSFN and on-board navigation in lunar orbit including the effects of local orbit perturbations. This will increase anticipated accuracy of rendezvous maneuvers and lunar touchdown on a lunar landing mission.

- Permit validation of Apollo CSM communications and navigation systems at lunar distance.

- Serve to improve consumables requirements prediction techniques.

- Complete the final verification of the ground support elements and the onboard computer programs.

- Increase the depth of understanding of thermal conditions in deep space and lunar proximity.

- Confirm the astronauts' ability to see, use, and photograph landmarks during a lunar mission.

- Provide an early opportunity for additional photographs for operational and scientific uses such as augmenting Lunar Orbiter coverage and for obtaining data for training crewmen on terrain identification under different lighting conditions.

CONS:

Mission Readiness:

- Marginal design conditions in the Block II CSM may not have been uncovered with only one manned flight.

- The life of the crew depends on the successful operation of the Service Propulsion System during the Transearth Injection maneuver.

- The three days endurance level required of backup systems in the event of an abort from a lunar orbit mission is greate than from an earth orbit mission.

CONS:

Effect on Program Progress:

- Validation of Colossus spacecraft software program and Real Time Computer Complex ground software program could be accomplished in a high earth orbital mission.

- Only landmark sightings and lunar navigation require a lunar mission to validate.

Impact of Success or Failure on Accomplishing Lunar Landing in 1969:

A successful mission will:

- Represent a significant new international achievement in space.

- Offer flexibility to capitalize on success and advance the progress of the total program towards a lunar landing without unreasonable risk.

- Provide a significant boost to the morale of the entire Apollo program, and an impetus which must, inevitably enhance our probability of successful lunar landing in 1969.

A mission failure will:

- Delay ultimate accomplishment of the lunar landing mission.

- Provide program critics an opportunity to denounce the Apollo 8 mission as precipitous and unconservative.

RECOMMENDATION:

In conclusion, but with the proviso that all open work against the Apollo 8 open-ended lunar orbit mission is completed and certified, I request your approval to proceed with the implementation plan required to support an earliest December 21, 1968, launch readiness date.

Sam C. Phillips
Lt. General, USAF

Attachments