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Memorandum

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TO : AD/Deputy Administrator
Office of the Administrator

DATE: July 18, 1967

FROM : M/Associate Administrator
for Manned Space Flight

SUBJECT: Lunar Mapping and Survey System (LMSS)

REF : Your memo, subject as above, dated July 13, 1967

This memorandum is in response to your questions asked in the reference.

Reference question 1 - Lunar orbital photography would help determine the status of equipment used in a lunar landing in assessing the physical configuration and any structural deformations suffered during the landing, and in determining the LM orientation with respect to the local terrain. These would require the best possible ground resolution.

Before answering specifically what ground resolution is required, I believe a few comments should be made regarding what ground resolution is. Ground resolution is a dimension, in this case on the surface of the moon, of a target photographed under many stated assumptions including film contrast, target shape, lighting conditions and spacecraft dynamics. Usually Military Standard 150-A is used in defining the target geometry. Ground resolution is a dimension of a detectable object - something appears in the film grain pattern that is not part of the macro grain structure. The ground object must be larger than this detectable size before it can be identified on film - e.g. whether the object in question is a cone or hemisphere, concave or convex. In the lunar case, even under ideal lighting conditions on object must be at least two or three times the detectable size (ground resolution) before it can be identified.

A typical resolution requirement can be based on a typical accident mode. Let us assume a broken or collapsed LM landing pad. (See enclosure for basic LM dimensions). First the pad itself. Its diameter is approximately 2.5 feet. Under good lighting the pad could be detected from orbital photography if the photographic system had a ground resolution (detection) capability of 2.5 feet. At this resolution, the pad would need to be at least five feet in diameter before the photo interpreter could make any judgment regarding the identification of the imaged object as a LM pad versus a rock. It would be difficult even with one-foot ground resolution to make any judgments regarding the status of the truss structure supporting the pad.

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Although it is obvious that one would want the best possible resolution for assessment of surface equipment, it is concluded that ground resolution (detection size) of at least one foot would be required for useful evaluation of equipment status on the lunar surface to answer typical questions such as status of LM pad deployment and extent of major structural deformations. Ground resolutions of several feet could be of value for some accident modes analysis, but this quality would not provide a high probability of satisfying fundamental questions in many situations.

Reference question 2 -

a. Resolution capabilities of the LM&SS are available in separate classified documents. Ground resolution for the LM&SS has usually been stated for 30 n.m. altitude, but better performance could be achieved by flying lower. Orbital altitudes of as low as 5 nautical miles are feasible for photographic operations.

b. The extended capability LM&SS would use the same survey camera as in the baseline configuration.

c. Hand-held cameras in the CSM could obtain resolutions as high as 15-20 feet using telephoto lenses, but not consistently because of motion induced blurring and other problems. Stereo cannot be achieved systematically. A small photographic system utilizing longer focal length catadioptric optics, with automated image motion compensation, and a window mount could be developed, but it probably would not be feasible to design such a necessarily compact system to obtain ground resolutions in the one-foot range even from very low orbital altitudes.

d. CSM mounted equipments planned for APP-A and APP-B (highest quality) - The only candidate equipment is the metric camera for APP-B. This system would have a ground resolution under optimum conditions of no better than 12 feet from an altitude of 30 n.m.

Reference question 3 - In order to have any system available for an investigative lunar orbital flight it would be necessary to bring both photographic system hardware and software up to a flight readiness state. It would probably take several months before the orbital portion of a previous mission could be re-flown. It would appear not to be feasible to have a Saturn V specifically assigned as back-up photographic lunar orbital mission to support each launch. It would be valuable to have the capability of changing the mission of the next scheduled Saturn V.

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Reference question 4 - The consideration of investigatory techniques and approaches that have been considered in the event of difficulties on a lunar landing attempt is too broad for treatment in this memo. It includes telemetry of critical parameters, abort provisions, redundancy and voice communications as well as possible orbital photography. With respect to the latter, it has been part of the general LM&SS planning to have flight hardware and software available during the time period when LM landings are planned. The LM&SS could be scheduled for a low orbital altitude photographic mission as soon as a problem developed and prior to subsequent landing missions. If photographic hardware and software were not available for a mission, and if this mission were deemed necessary prior to another landing attempt, a hiatus in surface operations of eighteen months or more would result while such a capability were developed.

/Signed/

George E. Mueller

Enclosure

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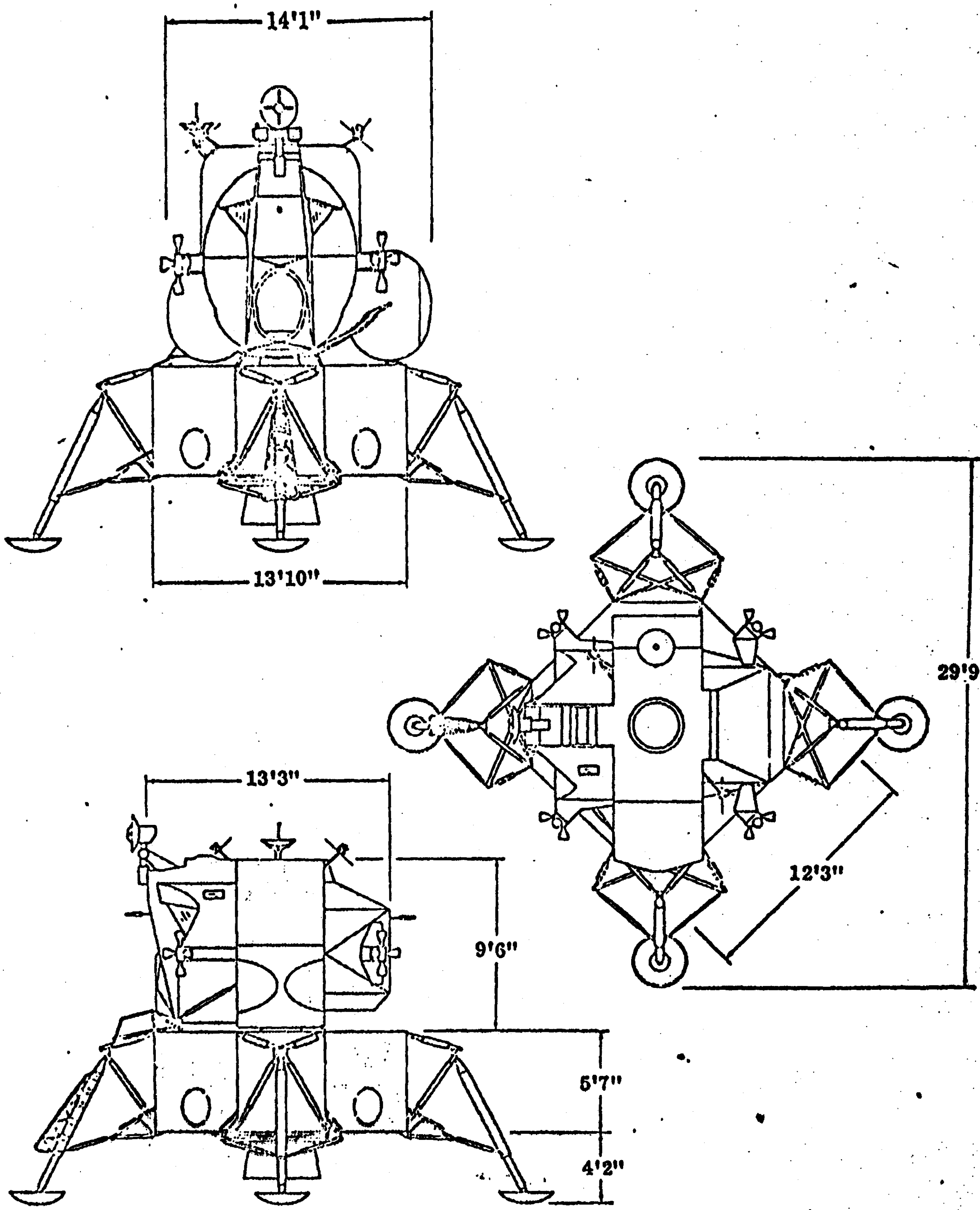

Figure 3-2 Existing Lunar Landing LEM Configuration