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Memorandum

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FROM : MA/Apollo Program Director

SUBJECT: Minutes of the Apollo Site Selection Board Meeting, March 30, 1967

The Apollo Site Selection Board met on March 30, 1967, to review the list of candidate sites for the first Apollo lunar landing. The agenda is attached as Enclosure A. Attendees are listed in Enclosure B.

INTRODUCTION

J. R. Sevier - Enclosure C

The list of candidate sites will determine where site survey analysis will be concentrated and will, with high probability, include the set of selected sites for the first Apollo landing.

A candidate site must be covered by Lunar Orbiter high resolution photography, in order to ensure that the surface properties can be measured. The sites have been chosen, on the basis of preliminary screening, to meet the requirements of Apollo hardware, software, and operations.

NAVIGATION AND CLOSED LOOP GUIDANCE CONSTRAINTS AFFECTING SITE SELECTION

D. C. Cheatham - Enclosure D

Guidance dispersions require a landing ellipse 26,000 ft long (down range) and 18,000 ft wide for a 99.7% probability of landing within the ellipse. Landmarks at least 1,200 ft in diameter are required near each landing site.

DECISION LOGIC FOR REDESIGNATION AND TOUCHDOWN POINT CONTROL

D. C. Cheatham - Enclosure E

The LM redesignation capability permits a change of touchdown point of 10,000 ft crosstrack and 7,000 ft downtrack at hi gate (90 fps ΔV, command at 30,000 ft down range). Visibility restrictions do not permit up-range redesignation. Preliminary examinations of the Lunar Orbiter photography indicate that this capability will be sufficient for crater avoidance.

INDEXING DATA

DATE	OPR	#	T	PGM	SUBJECT	SIGNATOR	LOC
06-26-67	HQS		M		(Above)	PHILLIPS	075-22

LUNAR SURFACE CHARACTERISTICS FOR TOUCHDOWN

H. Doiron - Enclosure F

Computer simulations, verified by scale model tests, show that the LM landing gear is adequate for a maximum topographic slope of 12°, maximum protuberances of 24 inches, and soil similar to that observed by Surveyor I. Manual landing will increase the margin of safety by reducing the probable landing velocities.

LAUNCH RECYCLE AND REPAIR CONSIDERATIONS

R. Ward - Enclosure G

The desired time between launch opportunities is 68 hours, which would allow for significant repairs to the spacecraft in addition to the minimal turn around time for recycle decisions made within 187 seconds from launch. In consideration of the lighting constraints at lunar landing, this requires that sites be spaced about 36° apart in lunar longitude. A minimal recycle requirement, allowing very little repair time, would be 44 hours. This would correspond to a spacing of about 24°.

LIGHTING AT LUNAR LANDING

J. P. Loftus - Enclosure H*

The sun during landing should be from 7° to 20° for good contrast and the use of shadows. From 14° to 20°, a dogleg of 10° to 30° would be highly desirable if other constraints would allow it. If no dogleg is possible and the high range of angles is used, the site must be known to be landable without dependence on redesignation.

TRAJECTORY AND PERFORMANCE LIMITATIONS

J. R. Elk - Enclosure I

The region of most efficient accessibility shifts from north to south over a year's time, especially in the western half of the Apollo zone. This favors sites in both the north and south in the west, permitting a choice depending on the month.

In order to avoid a communication blackout during descent, the LM will have to execute a yaw maneuver if the landing site is in the eastern part of the Apollo zone. A similar condition occurs during ascent in the west part of the Apollo zone, in some months of the year.

*Note: This talk was not presented due to time limitations.

SUMMARY OF PHOTOGRAPHIC SCREENING PROCESS

J. H. Sasser - Enclosure J

The preliminary screening of Lunar Orbiter II photography was done by systematically examining all possible landing site ellipses at medium resolution, visually selecting the most promising in terms of low crater count and smooth approach paths. An estimate of the probability of landing outside rejected areas*, called the N number, was made from the medium resolution photography. The sites with the highest N number were then examined at high resolution and the N numbers were corrected. The N numbers and coordinates of the best ellipses in the five proposed candidate sites from Mission II are as follows:

SITE	LATITUDE	LONGITUDE	N
II-P.2	2°40'N	34°00'E	.904
II-P.6	0°45'N	23°37'E	.907
II-P.8	0°25'N	1°20'W	.822
II-P.11	0°25'N	19°55'W	.851
II-P.13	1°40'N	41°40'W	.836

Photographs of these ellipses are in Enclosure J. The location of the ellipses for Set C may be changed (within each Lunar Orbiter target) as a result of further analysis. A similar screening is in progress on the Mission III sites.

GEOLOGICAL INTERPRETATIONS

J. Dietrich - Enclosure K

Although the sites selected for Apollo landing sites are somewhat dull, all being undifferentiated dark mare relatively free of craters, there is some evidence near the sites of volcanic activity and faulting. An astronaut walking will be able to investigate only a very small portion of the site.

Geologic study of the area has supported extrapolation of Surveyor I and Luna 13 tactile data to other mare, through studies of crater formation and bouncing and rolling boulders. Geologic maps of the candidate sites from Mission II are shown in Enclosure K.

*10 meter craters or larger

PHOTOGRAMMETRIC ANALYSIS TECHNIQUES

D. Esten - Enclosure L

Due to the relatively primitive calibration of the Lunar Orbiter photographic subsystem, the best that one can do in estimation of slope over a 10 km baseline is approximately 1° (1σ). In view of the present landing radar requirement, this is not adequate for assurance of safety.

STATUS OF PHOTOGRAMMETRIC AND PHOTOMETRIC TASKS

J. H. Sasser - Enclosure M

The proposed candidate sites from Mission II and Mission III meet the requirements of the Apollo program for three launch opportunities in any month for a full year. Further intensive analysis will be performed before Set C is selected to ensure that the preliminary ranking is correct, to identify all problem areas, and to prepare for further analysis of the Set C sites.

All DOD (photogrammetric) and USGS (geologic) products are due by August, 1967. At MSC, a photometric computer program will be used to achieve a more objective estimate of the percentage of random landings that would encounter hazardous conditions.

PHOTOMETRIC COMPUTER ANALYSIS TECHNIQUES

N. W. Naugle - Enclosure N

The MSC program for computer analysis of Lunar Orbiter photographs is about to enter the validation stage. When operational, it will be used to derive hazard statistics and maps, to evaluate the landing hazards in candidate areas, and to define the type of hazards which occur.

This quantitative evaluation will be used to reconsider the relative ranking and actual location of landing ellipses for Set C.

ACTION BY THE BOARD

The following proposals by Mr. O. E. Maynard (Enclosure O) were approved by the board:

1. The Candidate Sites (Set B) for the first Apollo lunar landing mission are in the following Lunar Orbiter target areas:

II-P.2	II-P.11	III-P.9
II-P.6	II-P.13	III-P.11
II-P.8		III-P.12

Continued detailed evaluation will concentrate on these sites.

2. The Selected Sites (Set C) for the first Apollo lunar landing mission will be proposed to the board after August 1, 1967. Set C will be selected from Set B to meet the operational requirements of the first Apollo mission for a launch in any month, in a period of one year after the first possible launch.

3. Although further data from Lunar Orbiters D and E will be requested, the photography already received from Orbiters I, II, and III meets the minimal requirements of the Apollo Program for site survey for the first lunar landing.

Samuel C. Phillips
Major General, USAF
Apollo Program Director

Enclosures
a/s

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RAYTHEON/AUTOMETRIC - MSC

R. D. Esten

JET PROPULSION LABORATORY

V. C. Clarke

ENCLOSURE A

A G E N D A

Apollo Site Selection Board Meeting

March 29, 1967

1:00	Introduction	J. R. Sevier
1:20	Navigation and Closed Loop Guidance Constraints Affecting Site Selection	D. C. Cheatham
	Decision Logic for Redesignation and Touchdown Point Control	D. C. Cheatham
2:30	Lunar Surface Characteristics for Touchdown	H. Doiron
2:50	Launch Recycle and Repair Considerations	R. Ward
3:10	Lighting at Lunar Landing	J. P. Loftus
3:30	Trajectory and Performance Considerations	J. R. Elk
4:00	Summary of Photographic Screening Process	J. H. Sasser
4:30	Geological Interpretations	J. Dietrich
4:50	Photogrammetric Analysis Techniques	D. Esten
5:10	Status of Photogrammetric and Photometric Tasks	J. H. Sasser
5:20	Summary and Recommendations	O. E. Maynard
5:40	Discussion	
	Photometric Computer Analysis Techniques (time permitting)	N. W. Naugle

ENCLOSURE B

ATTENDEES

Board Members and Delegates

J. H. Turnock/MA for S. C. Phillips/MA (Chairman)
L. Reiffel/MA
O. E. Maynard/MSC-ASPO
J. M. Eggleston/MSC-TA
R. J. Allenby/SM for E. M. Cortright/SD
N. C. Costes/MSFC-R-RP for E. Stuhlinger/MSFC
W. D. Moody/KSC/DG for Matthews/KSC-DG

Other Attendees

C. J. Byrne/Bellcomm
V. S. Mummert/Bellcomm
G. L. Bush/Bellcomm
O. R. Pardo/Bellcomm
F. N. Schmidt/Bellcomm
D. B. James/Bellcomm
A. G. Griffin/KSC-HD
R. M. Schulherr/HQ-MAO
R. B. Sheridan/MAO
A. T. Young/LRC-LOPO
R. P. Bryson/SL
K. L. Wadlin/SL
W. C. Hittinger/Bellcomm
I. M. Ross/Bellcomm
G. B. Trousoff/Bellcomm
C. H. Eley/Bellcomm
F. Heap/Bellcomm
R. D. Esten/Raytheon/Autometric
D. Cheatham/MSC-EG
J. R. Elk/MSC/MPAD
E. Svrcek/MSC/MPAD
H. H. Doiron/MSC/SMD
R. J. Ward/MSC/ASPO
H. B. Allen/MF
J. D. Stevenson/MO
N. W. Naugle/MSC/CAAD
J. E. Dornbach/MSC/TH3
A. T. Strickland/SL
S. L. Whitley/MSC/TF2
J. H. Sasser/MSC/TH3
D. D. Lloyd/Bellcomm
W. H. Shirey/SL
J. W. Dietrich/MSC/TH2
W. T. O'Bryant/SL
J. R. Sevier/MSC/PM
M. W. Krueger/MLA
W. B. Taylor/MLA