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## GUIDANCE AND NAVIGATION

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**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**

E-1398  
Comments on the Lunar  
Landing Mission Design Plan  
of 15 April 1963  
by  
John Dahlen  
John Suomala  
August 1963

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# INSTRUMENTATION LABORATORY

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E-1398

COMMENTS ON THE LUNAR  
LANDING MISSION DESIGN PLAN OF  
15 APRIL 1963

ABSTRACT

This report provides comments and recommendations for changes to the Project Apollo - Lunar Landing Mission Design Plan, MSC, 15 April 1963 and justification for any recommendations for change.

by John Dahlen

John Suomala

August 1963

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COMMENTS ON THE LUNAR  
LANDING MISSION DESIGN PLAN OF  
15 APRIL 1963

INTRODUCTION

This report is the result of a comprehensive review of the Project Apollo - Lunar Landing Mission Design Plan, MSC, 15 April 1963 conducted at the Instrumentation Laboratory. The review of this document was coordinated with all cognizant groups within the Apollo Guidance and Navigation Program at this laboratory.

This report provides comments and recommendations for changes to the Design Plan. Where a change to the Design Plan is recommended, appropriate justification is also included. A previous edition of the Lunar Landing Mission Design Plan dated 15 October 1962 was reviewed by the laboratory and extensive comments compiled. These comments were informally transmitted to MSC/SSI (R. Battey, J. Sevier) on January 11, and 12, 1963. Before these comments were published, a revised version of the 15 October document was received. A number of these comments were incorporated in the present edition of the Mission Design Plan.

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The information in this report is current, as of 1 July 1963, and may be updated, if required.

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REVIEW RECOMMENDATIONS

Reference: Page 4-4, Section 4.2.2 - Earth Parking  
Orbit, Factor c.

Recommendation: Change Factor c. to read:  
Degradation of launch vehicle inertial  
guidance system accuracy with time due to  
gyro drift.

Justification: Spacecraft guidance and navigation system  
is periodically realigned by on board  
procedures.

Reference: Page 4-7, Section 4.2.3.2 - Injection  
Velocity, Third paragraph

Recommendation: Delete first and last sentence.

Justification: For any lunar mission there is a  $\Delta V$   
requirement of approximately 300 fps. for  
midcourse corrections for both trans-lunar  
and trans-earth passes.

Reference: Page 4-12, Section 4.2.5.2 - Descent to Surface

Comment: Braking, flare, translation and touchdown maneuvers are currently under study at MSC, MIT, and GAEC. The specific details cited in the section should be considered as reasonably approximations only.

Reference: Page 4-15, Section 4.2.6.1 - Ascent and Orbit Transfer

Recommendation: Delete and change to read:  
The probable technique for Lunar Excursion Module launch from the moon is to lift off in an essentially vertical flight from the local surface, then pitch to cut-off at 50,000 feet on an ascent trajectory which will intercept the CSM.

Justification: Hohmann transfers do not appear practical according to work already done. They are practical only if coplanar ascent conditions exist. For the equatorial landing sites



designated, coplanar ascent conditions are not probable for any CSM orbit other than the equatorial orbit of zero inclination.

For the 6 to 24 hour surface time mission, small non-coplanar conditions will exist at launch ( $0.5^{\circ}$  to  $2^{\circ}$  for  $10^{\circ}$  inclined CSM orbits), and the  $180^{\circ}$  Hohmann transfer type ascent could not be used. Ascent trajectories will typically cover central angles of  $150^{\circ}$  to  $180^{\circ}$ .

Reference: Page 4-17, Section 4.2.6.2 - Launch Window, Second paragraph

Recommendation: Delete first sentence.

Justification: Refer to comments on Section 4.2.6.1

Reference: Page 4-18, Section 4.2.7 - Lunar Orbit Rendezvous, First paragraph, third sentence

Recommendation: Delete, "Hohmann".

Justification: Refer to comments on Section 4.2.6.1

Reference: Page 5-3, Section 5.2.1 - First Stage, S-IC

Recommendation: Delete third sentence.

Justification: Time zero is not provided for the AGC by any system interface.

Reference: Page 5-4, Section 5.2.2 - Second Stage,  
S-II

Recommendation: Add to the end of the fifth sentence: by the MSFC provided system located in the instrument unit atop the S-IVB.

Justification: To be consistent with section 5.2.3

Reference: Page 5-7, Section 5.5.1 - Midcourse  
Corrections

Recommendation: Change first sentence to read: Midcourse  
corrections require manual star sightings.

Justification: Correction, IMU Alignment is automatic,  
therefore not to be included under conditions  
stated in 5.0, third sentence.

Reference: Page 5-9, Section 5.7.1 - Orbit Ephemeris  
Determination

Recommendation: Delete "LEM" from second sentence.  
Change second sentence to read:  
Orbit ephemeris about the moon is  
determined as accurately as possible using  
the CM Navigation and Guidance Systems and  
the GOSS.

Justification: MIT does not presently envision using the  
LEM G&N System to determine lunar orbit  
ephemeris.

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Reference: Page 5-10, Section 5.7.2 - Landing Area  
Observation

Recommendation: Change second sentence to read:  
Detailed surveillance of the landing area is  
made from within the spacecraft.

Justification: The best resolution of landing area surface  
detail is had by observation through the SXT  
in the CM. The SCT is also available for  
wider field viewing with small magnification.

Reference: Page 5-10, Section 5.7.6 - Preparation for  
Equal Orbit Injection

Recommendation: Delete, "and verified by the CM system",  
from the end of this sentence.

Justification: MIT has not determined that this verification  
is necessary.

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Reference: Page 5-12, Section 5.10 - LEM Equal Period Orbit

Recommendation: Delete second sentence.

Justification: The full LEM orbit from perilune to perilune complicates the guidance problem and does not appear to accomplish much. As stated earlier, reconnaissance of the landing site from the CM using the SXT should be adequate.

Reference: Page 5-14, Section 5.11.2 - Flare Maneuver

Recommendation: Change second sentence to read:  
Part of the control is transferred to pilot while part remains automatic, landing site is confirmed, and final descent is initiated.

Justification: Descent is likely to be semi-automatic rather than fully manual.

Reference: Page 5-16, Section 5. 13 - Lunar Launch

Recommendation: Delete the last sentence of the last paragraph.

Justification: "Radar tracking" is desirable for a long range ascent trajectory correction which will be achieved after launch cut-off.

Reference: Page 5-17, Section 5.14.2 - LEM Orbit Alignment

Recommendation: Delete second sentence. Change third sentence to read:  
A velocity increment of several hundred ft/sec is applied to the LEM so that its orbit is essentially identical to that of the CSM.

Justification: The 200 ft/sec increment cited is optimistic.

Reference: Page 5-19, Section 5.18.1 - Midcourse  
Corrections

Recommendations: Add sentence:

The last correction will be made 1-2 hours  
before entry,

Reference: Page 7-17, Section 7.3.7 - Lunar Surface  
Abort

Comment: Abort trajectories recommended to be of  
same nature as normal launch, therefore,  
the same comment about circular parking  
orbits and Hohmann Transfers as made  
under Ref. 4-15 applies.

The 50,000 foot circular places a difficult  
guidance requirement on the LEM. A small  
error in flight path angle at cut-off reduces  
the pericyynthion altitude below 50,000 feet.  
The low velocity magnitude associated with  
the 50,000 foot orbit aggravates this difficulty.

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