Mission Planning and Analysis Division
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

IN REPLY REFER TO: 70-FM54-112

MAY 25 1970

MEMORANDUM TO: See attached list

FROM : FM5/Chief, Lunar Mission Analysis Branch

SUBJECT : RTCC requirements for Apollo 14 (H-3): Non-free return modes of the translunar midcourse correction processor - Change 1

Enclosed is Change 1 to MSC Internal Note No. 70-FM-14. This change includes the addition of the capability to compute the "DPS-monitor ΔV" for both non-free return options (options 4 and 5) of the translunar midcourse correction processor. Also included are some minor cleanup items relevant to the original documentation.

Ronald L. Berry

APPROVED BY:

John P. Mayer
Chief, Mission Planning
and Analysis Division

The Flight Software Branch concurs with the above recommendations.

James C. Stokes, Jr., Chief
Flight Software Branch

Enclosure

MPAD STANDARD INTERNAL NOTE DISTRIBUTION LIST
(Revised April 27, 1970)

AB/Deputy Director
BM63/Technical Library (2)
CF/Chief
EA2/Assistant Director for Electronic Systems
EG/Deputy Chief
EG/Assistant Chief for Engineering and Development
EA/Director of Flight Operations
EA/Deputy Director
FA/Acting Technical Assistant for Apollo
FA/Technical Assistant for Skylab
FA/Technical Assistant for Space Shuttle and Space Station
FA/Chief, Office of Program Management
FA/Chief, Advanced Planning Support Office
FC/Chief (5)
FL/Chief (2)
FS/Chief, Flight Support Division
FS/Chief, Flight Software Branch (3)
FA/Manager for LM
FD/Acting Chief (2)
FF/Chief

FM/Chief
FM/Deputy Chief
FM/Technical Assistant
FM2/Chief
FM3/Chief
FM4/Chief
FM5/Chief
FM6/Chief
FM7/Chief
FM8/Chief
FM13/Chief
FM13/NR Representative (2)
FM13/GAC Representative (2)
FM15/Report Control File (25)
FM/Author(s)
Bellcomm/K. E. Martersteck
IBM Library
TRW Library (4)
TRW/F. A. Evans (10).

Dist 5/28/70 10:50 ch
5/28/70

ADDITIONS:
IBM/J. Hoskins (5)
G. Mueller (12)
S. James (2)
P. Hofheinz
TRW/D. P. Johnson (3)
D. M. Gafford (4)
FS5/L. Dungan
E. Shinpaugh
K. Leach
FM4/E. Schiesser (5)
FM5/J. D. Yencharis
A. A. Holmes
K. T. Zeiler
R. S. Davis
R. F. Wiley
R. H. Sanders
FM6/R. Regelbrugge
W. Sullivan
FC/M. P. Frank
J. C. Bostick (2)

NASA - Manned Spacecraft Center

RELEASE APPROVAL

1. Type of Document: Change sheet to Internal note

2. Identification: 70-FM-14 dated February 16, 1970

Page 1 of 1 Pages

TO:

3. FROM:
Division: Mission Planning and Analysis
Branch: Lunar Mission Analysis
Section:

4. Title or Subject: EOC REQUIREMENTS FOR APOLLO 14: NON-FREE-RETURN MODES OF THE TRANSLUNAR MIDCOURSE CORRECTION PROCESSOR

Date of Paper: May 25, 1970

5. Author(s): Quentin A. Holmes and Kenneth T. Keller

6. Distribution

| Number of Copies | Addressees | Special Handling Methods |
|---|---|---|
| | See attached memo | |

☐ This is a change to distribution on Release Approval dated,

☐ This is an addition to distribution on Release Approval dated,

| 7. Signature of Branch Head | Signature of Division Chief | Date |
|---|---|---|
| Signature of Appropriate Assistant Director or Program Manager | | Date |
| 8. Change or Addition made by | | Date |
| 9. Location of Originals: | | |

MSC Form 199 (Rev Dec 63)

CHANGE HISTORY FOR 70-FM-14

| Change no. | Date | Description |
|---|---|---|
| 1 | 5/25/70 | Page 8: Pen-and-ink change to eliminate redundant computation.<br><br>Replace pages 15 and 23: Added a branch so that DPS ΔV can be monitored, if desired.<br><br>Add pages 24 and 25: Added appendix to present the logic for computing the velocity increment (DPS ΔV monitor) for returning the spacecraft to earth in the event of no burn at LOI on a non-free-return trajectory.<br><br>Page 26: Changed number of reference page. |

CHANGE SHEET

FOR

MSC INTERNAL NOTE 70-FM-14 DATED FEBRUARY 16, 1970

RTCC REQUIREMENTS FOR APOLLO 14: NON-FREE-RETURN MODES

OF THE TRANSLUNAR MIDCOURSE CORRECTION PROCESSOR

By Quentin A. Holmes and Kenneth T. Zeiler

Change 1

May 25, 1970

Ronald L. Berry, Chief
Lunar Mission Analysis Branch

for John P. Mayer, Chief
Mission Planning and Analysis Division



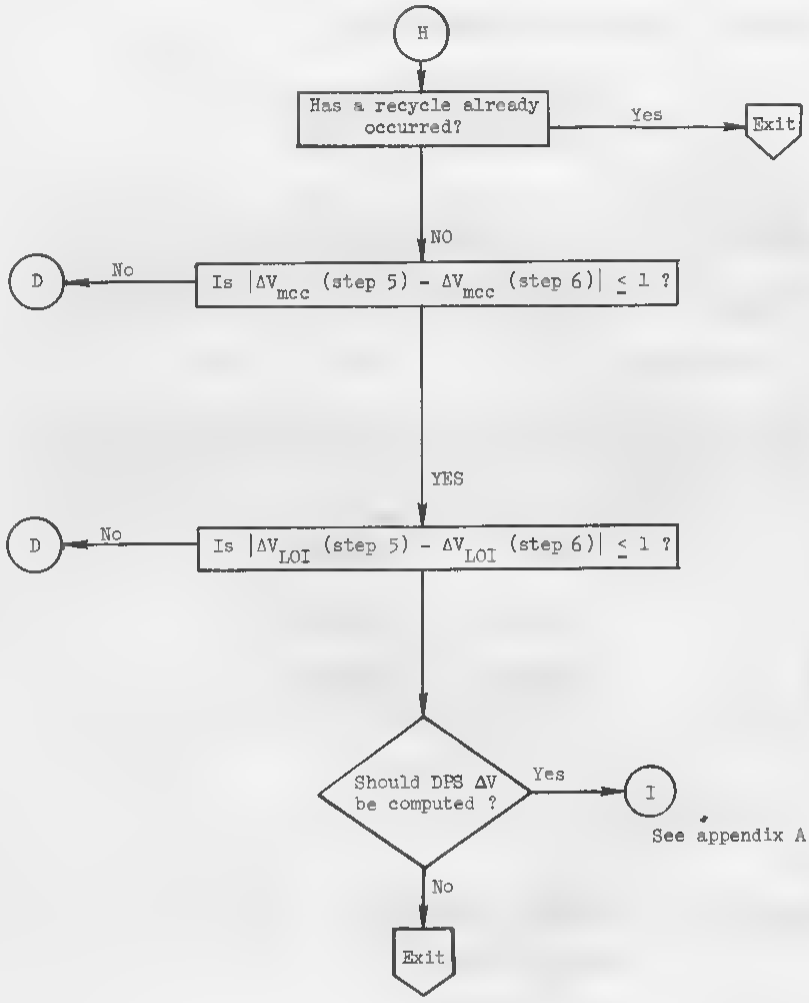
---

NOTE: A black bar in the margin indicates the area of change.

After the attached enclosures, which are replacement pages and added pages, have been inserted and after the following pen-and-ink changes have been made, place this CHANGE SHEET between the cover and title page and write on the cover, "CHANGE 1 inserted".

1. Delete from page 8 the block that reads "Compute lunar orbit plane and angular momentum vector".

2. Change number of reference page to 26.




Flow chart 1.- Concluded.

Change 1, May 25, 1970

Option 5: Free orbit non-free-return BAP

Enter with state vector and delay time to MCC

Step 1

Converge conic TLMC by use of nominal perilune state

| Independent variable | Value | Step size | Weight |
|---|---|---|---|
| Scalar velocity at perilune | [a] | $\phi$ 1564 | 512 |
| AZM at perilune | 270° | $\phi$ 1564 | 512 |
| LONG at perilune | [b] | $\phi$ 1564 | 512 |

Time of perilune MIM[MAX DPS time, MAX SEA time, $\delta(\Delta T)$] Not triggered

| Dependent variable | Minimum | Maximum | Class designator |
|---|---|---|---|
| X | Premidcourse - 0.0657 n. mi. | Premidcourse + 0.0657 n. mi. | 1 |
| Y | Premidcourse - 0.0657 n. mi. | Premidcourse + 0.0657 n. mi. | 1 |
| Z | Premidcourse - 0.0657 n. mi. | Premidcourse + 0.0657 n. mi. | 1 |

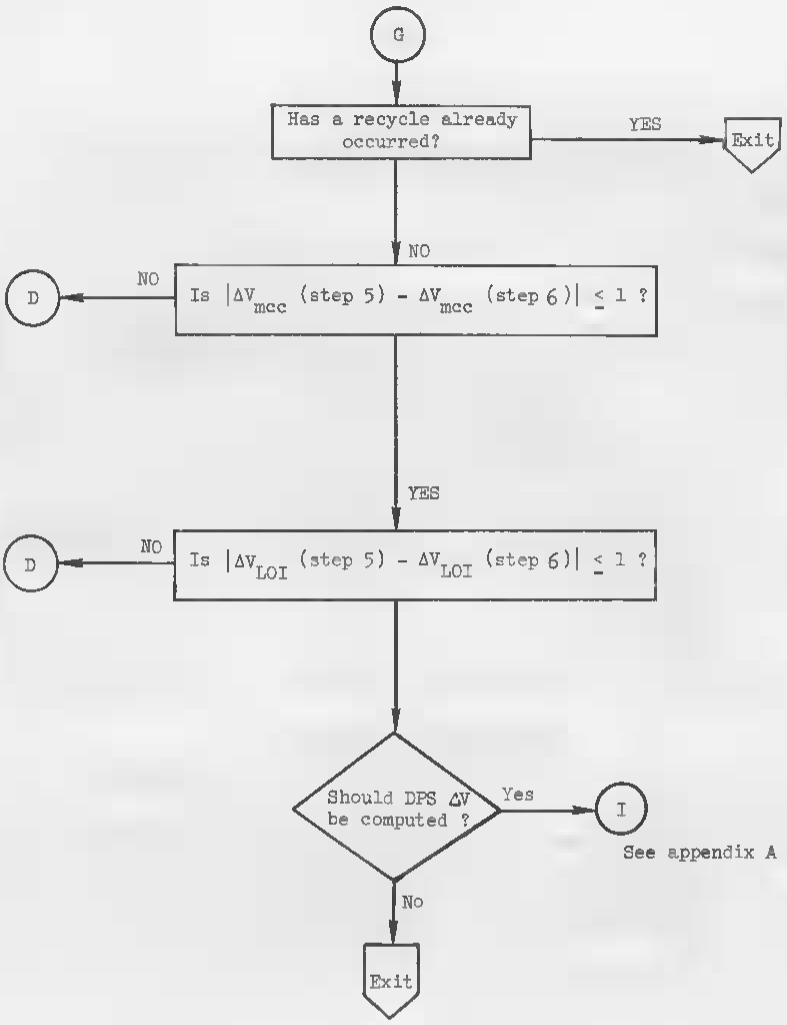
A

[a]Computed as $\nu = \sqrt{.18406305 + .5530824/r_{pc}} - .0022(\delta T)$

$-13.5(\lambda_{pfd} - 180°)$

[b]Computed as $\lambda = 3.1 - 0.25(\delta T)$

Flow chart 2.- Free orbit nonfree return BAP.




Flow chart 2.- Concluded.

Change 1, May 25, 1970

APPENDIX A

DPS ΔV MONITOR


Enter with delay time from perilune to DPS abort and pick up non-free-return perilune state from completed non-free-return midcourse computation (options 4, 5, or 1).

Step 1

Select and optimize (200 iterations maximum) a conic transearth trajectory

| Independent variable | First guess | Step size | Weight |
|---|---|---|---|
| ΔV at TEI | 0 | $2^{-21}$ | 8 |
| Δ flight-path angle at TEI | 0 | $2^{-21}$ | 8 |
| ΔAZM at TEI | 0 | $2^{-21}$ | 1 |

| Dependent variable | Minimum | Maximum | Class | Weight |
|---|---|---|---|---|
| HT of entry | 64.096513 n. mi. | 67.566513 n. mi. | 1 | -- |
| INCL of return | 0° | 40° | 2 | 1 |
| Characteristic velocity at TEI | 0 | 0 | 3 | -- |

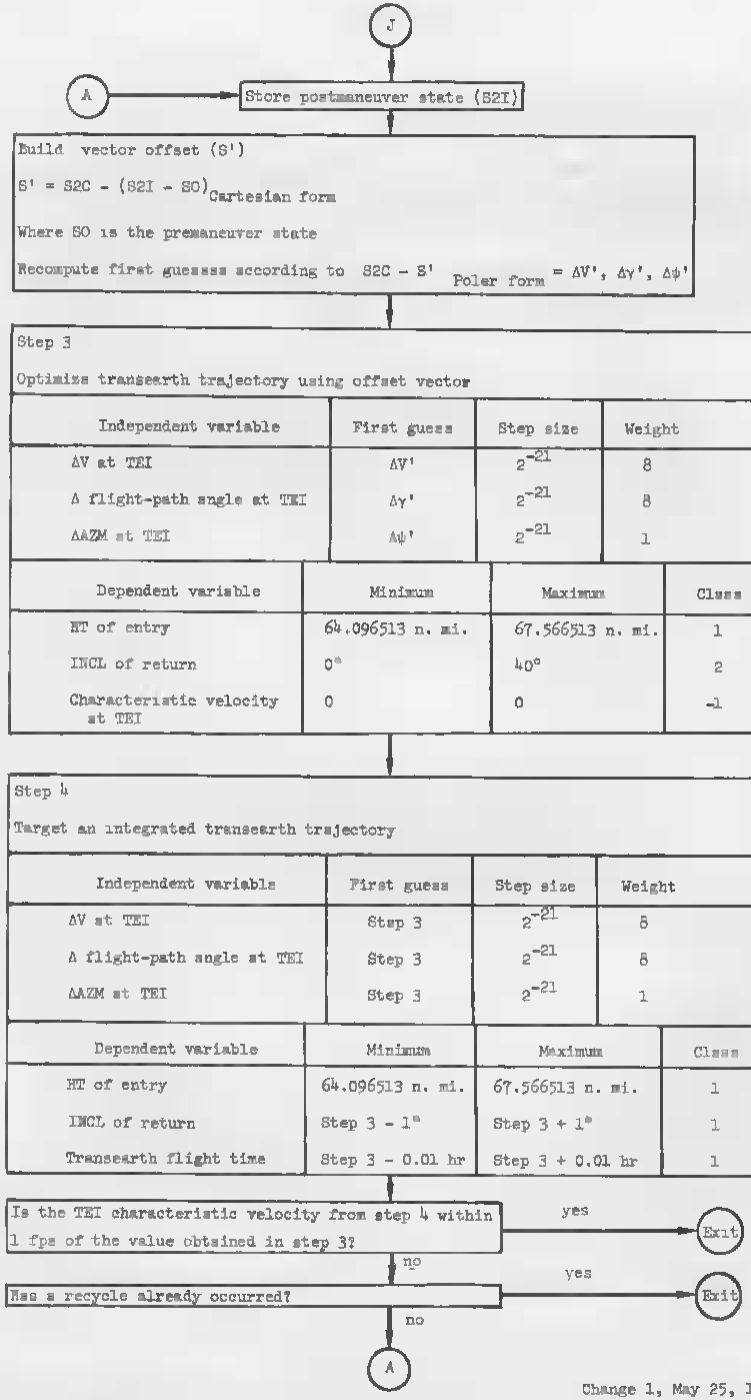
Store postmaneuver state (S2C)

Step 2

Select an integrated transearth trajectory to the end conditions obtained in step 1

| Independent variable | First guess | Step size | Weight |
|---|---|---|---|
| ΔV at TEI | (Step 1 - 100 fps) | $2^{-21}$ | 8 |
| Δ flight-path angle at TEI | Step 1 | $2^{-21}$ | 8 |
| ΔAZM at TEI | Step 1 | $2^{-21}$ | 1 |

| Dependent variable | Minimum | Maximum | Class | Weight |
|---|---|---|---|---|
| HT of entry | 64.096513 n. mi. | 67.566513 n. mi. | 1 | -- |
| INCL of return | Step 1 - 1° | Step 1 + 1° | 1 | -- |
| Transearth flight time | Step 1 - 0.01 hr | Step 1 + 0.01 hr | 1 | -- |




Change 1, May 25, 1970

## REFERENCES

1. Zeiler, K. T.: Lunar Accessibility of the Hybrid Mission. MSC memo 69-FM52-223, June 28, 1968.

2. Morrey, B. F.; McCaffety, B. O.; and Morrey, A. E.: RTCC Requirements for Mission G: The Translunar Midcourse Correction Processor. MSC IN 68-FM-193, August 9, 1968.

3. Sears, G.; and Redwine, W.: Optimum Translunar Flight Times for Premature TLI Shutdown. IOC 3423.8-25, April 20, 1967.