

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
PROGRAM CHANGE REQUEST **MIT-PCN**

NUMBER (Completed by FSB)

731

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR G. CHERRY	DATE 2/4/69	1.2 ORGANIZATION MIT	APPROVAL <i>J.W.P.</i>	DATE 2/4/69
------------------------------------	-----------------------	--------------------------------	---------------------------	-----------------------

1.3 EFFECTIVITY LUMINARY1A	1.4 TITLE OF CHANGE Modify the Lunar Landing Guidance Equations to Compensate for Computation, Throttle, FINDCDUW, & Attitude Control Lags.
--------------------------------------	---

1.5 REASON(S) FOR CHANGE
See attached sheet.

1.6 DESCRIPTION OF CHANGE
See attached sheet.

2.0 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH
DECISION FOR VISIBILITY IMPACT ESTIMATE BY MIT

2.1 <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED	2.2 REMARKS:
2.3 SOFTWARE CONTROL BOARD OR FLIGHT SOFTWARE BRANCH SIGN OFF	
DATE	

3.0 MIT VISIBILITY IMPACT EVALUATION:

3.1 SCHEDULE IMPACT	3.2 IMPACT OF PROVIDING DETAILED EVALUATION
3.3 STORAGE IMPACT	3.4 REMARKS: <i>Co-ordinated with T. Price of the FSB</i>
3.5 MIT COORDINATOR <i>G. W. Cherry</i>	
DATE 2/4/69	

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 <input type="checkbox"/> IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. <input type="checkbox"/> PROVIDE DETAILED CHANGE EVALUATION <input type="checkbox"/> DIS-APPROVED	4.2 REMARKS
4.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR	5.2 MIT EVALUATION
DATE	

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT
DETAILED PROGRAM CHANGE EVALUATION

6.1 <input type="checkbox"/> START OR CONTINUE IMPLEMENTATION <input type="checkbox"/> DISAPPROVED OR STOP IMPLEMENTATION	6.2 REMARKS:
6.3 SOFTWARE CONTROL BOARD SIGN OFF	
DATE	

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 2 OF 3PROGRAM CHANGE
REQUEST NO. 731PREPARED BY: G. Cherry
DATE: 2/4/69ORGANIZATION:
MITCONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)1.5 Reason for Change:

Attitude oscillations have been observed during the terminal part of automatic landings. It appears that the observed oscillations are wholly or partly due to the lags between state vector time and the realization of the guidance commands by the two control systems, the engine throttle servo and the attitude control system. (The oscillations were observed with negligible LR errors and no terrain slopes or irregularities.)

1.6 Description of Change:

Modify the guidance equations to allow the guidance commands to be projected forward to compensate for the system lags. The following equations should be programmed.

$$T_{go}^* = T_{go} - \tau$$

$$R = T_{go}^* / T_{go}$$

$$\underline{a}_G = R(3R - 2)(12/T_{go}^2)[\underline{r}_D - (\underline{r}_O + T_{go}\underline{v}_O)] - R(4R - 3)(6/T_{go})(\underline{v}_D - \underline{v}_O) + [1 + 6R(R - 1)]\underline{a}_{DG}$$

where \underline{r}_O , \underline{v}_O , and T_{go} are the position, velocity and time-to-go at the last PIPTIME, $t = t_O$. (See LUMINARY Memo #63 for derivation.) Place the quantity τ into erasable memory. It will be about 3 seconds.

It is also desirable to phase the FINDCDUW output command before the throttle output command because the two control systems, (FINDCDUW + DAP) and throttle servo do not have the same time constants. FINDCDUW output commands should be computed before the throttle output command.

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PAGE 3 OF 3

PROGRAM CHANGE REQUEST NO. <u>731</u>	PREPARED BY: <u>G. Cherry</u> DATE: <u>2/4/69</u>	ORGANIZATION: <u>MIT</u>
--	--	--------------------------

CONTINUATION SECTION (REFER TO BLOCK NUMBER AND TITLE
ON PROGRAM CHANGE REQUEST FORM)

1.6 Continued

At some value of T_{go} (TBD), the guidance law should be changed from the above equation to a simple velocity-nulling law.

$$\underline{a}_{TC} = (\underline{v}_D - \underline{v}_o) / \tau_1$$

thereby relaxing the positional constraint when it becomes impractical to maintain it. This modification, then, represents a minimum change from the current program design. The value of T_{go} at which the guidance law is changed will be established in an erasable register.

REMARKS

TP#21812