APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD
- PROGRAM CHANGE REQUEST -

No. 551
(Completed by FS

1.0 COMPLETED BY ORIGINATOR

1.1 ORIGINATOR: R. F. Stengel
DATE: 9/3/68

1.2 ORGANIZATION: MIT/IL
APPROVAL: [signature] DATE: 9-16

1.3 EFFECTIVITY: LUMINARY (NOT COLOSSUS)

1.4 TITLE OF CHANGE: Rotational Hand Controller Scali

1.5 REASON(S) FOR CHANGE:
a) Maximum commanded rate of ACA normal scaling is too high for manual lu landing.
b) Normal and fine scaling of ACA are too high for manual CSM-docked contro

1.6 DESCRIPTION OF CHANGE:
a) Reduce normal maximum commanded rate from 20°/sec to 14°/sec.
b) Reduce normal and fine scaling by a factor of 7 for the CSM-docked case.

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

2.1 ☐ APPROVED ☐ 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:

3.5 MIT COORDINATOR: ______
DATE: ______

4.0 SOFTWARE CONTROL BOARD ACTION

4.1 ☐ IMPLEMENT AND PROVIDE DETAILED CHANGE EVAL. ☐ PROVIDE DETAILED CHANGE EVALUATION ☐ DISAPPROVED

4.2 REMARKS:

4.3 SOFTWARE CONTROL BOARD SIGN OFF: ______
DATE: ______

5.0 MIT DETAILED PROGRAM CHANGE EVALUATION

5.1 MIT COORDINATOR: George W. Cherry
DATE: 9/16/68

5.2 MIT EVALUATION:

6.0 SOFTWARE CONTROL BOARD DECISION ON MIT DETAILED PROGRAM CHANGE EVALUATION

6.1 ☐ START OR CONTINUE IMPLEMENTATION ☐ DISAPPROVED OR ST IMPLEMENTATION

6.2 REMARKS:

6.3 SOFTWARE CONTROL BOARD SIGN OFF: ______
DATE: ______

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

-DATA AMPLIFICATION SHEET -

PROGRAM CHANGE REQUEST NO. ________	PREPARED BY: ________ DATE: ________	ORGANIZATION:

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

The maximum commanded rates of the Lunar Module hand controller are presently scaled at 20°/sec (normal) and 4°/sec (fine). The commanded rate is quantized at $.476^{\circ}$/sec (normal) and $.0952^{\circ}$/sec (fine), as the Attitude Controller Assembly (ACA) output is incremented in 42 steps.

The results of flight evaluations with the Lunar Landing Research Vehicle (LLRV) and at the Lunar Landing Research Facility (LLRF), summarized in Reference 1, indicate that normal scaling of 14°/sec produces better handling qualities at the lunar landing control power of about $10-12^{\circ}/sec^2$. As shown in the accompanying figures from Reference 1, this combination lies further within the "Acceptable Contour" and provides greater contingency control in the event of reaction jet or trim gimbal failure.

In Reference 2, attitude rocket propellant consumption of the LLRV is given as a function of stick scaling and rate deadband. In the figure from Reference 2, it can be seen that reduced stick scaling results in reduced propellant consumption. In view of current concern over control jet impingement, reduced stick scaling is again suggested by these data.

In the CSM-Docked case, automatic maneuver rates are limited to $.5^{\circ}$/sec or less. With fine scaling, this is 12.5 percent of full scale. When the quantization level of nearly $.1^{\circ}$/sec is also considered, it seems unlikely that precise manual control can be achieved with the present fine scaling.

REMARKS

APOLLO SPACECRAFT SOFTWARE CONFIGURATION CONTROL BOARD

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It is suggested that 2 scaling changes be made in the uprated hand controlle now being developed. The first is that normal scaling be changed to 14^{o}/sec., subject to further refinement after handling qualities simulation. This change can be made immediately with no additional LGC coding. It is also proposed that both scale factors be divided by 7 in the CSM-Docked manual control mode, giving maximum commanded rates of 2 and .57^{o}/sec, granularity of .0476 and .0136^{o}/ sec. Additional coding amounting to approximately 6 instructions is required and can be accomplished immediately.

References

1. Hewes, D.E., Interim Report on Flight Evaluations of Lunar Landing Vehicle Attitude Control Systems, AIAA Flight Test, Simulation, and Support Conference, Cocoa Beach, Feb. 6-68, 1967.

2. Jarvis, C.R., Flight Test Evaluation of an On-Off Rate Command Attitude Control System of a Manned Lunar-Landing Research Vehicle, NASA TND-3903, Washington, April, 1967.

REMARKS

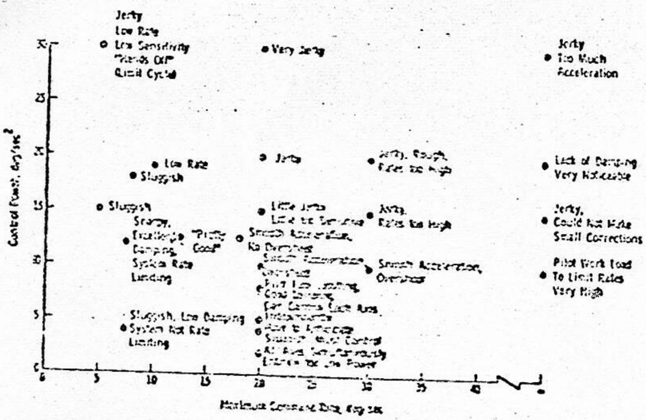


Figure 4.- Plot of pitch control system test points and pertinent comments for the LLRF Vehicle.

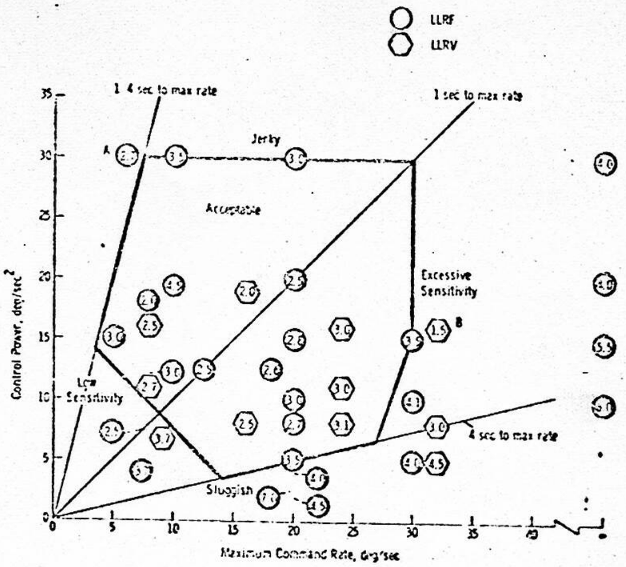


Figure 7.- Summary plot of LLRF and LLRV averaged pilot ratings for pitch control system showing tentative boundary for ratings of 3.5 and better.

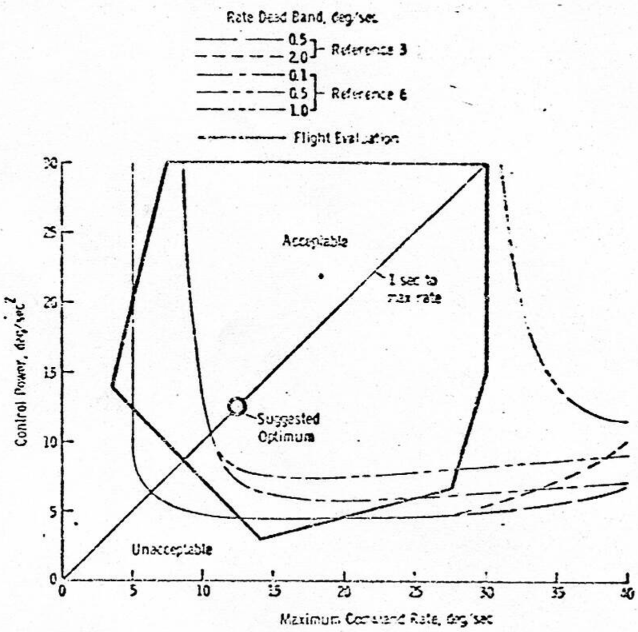
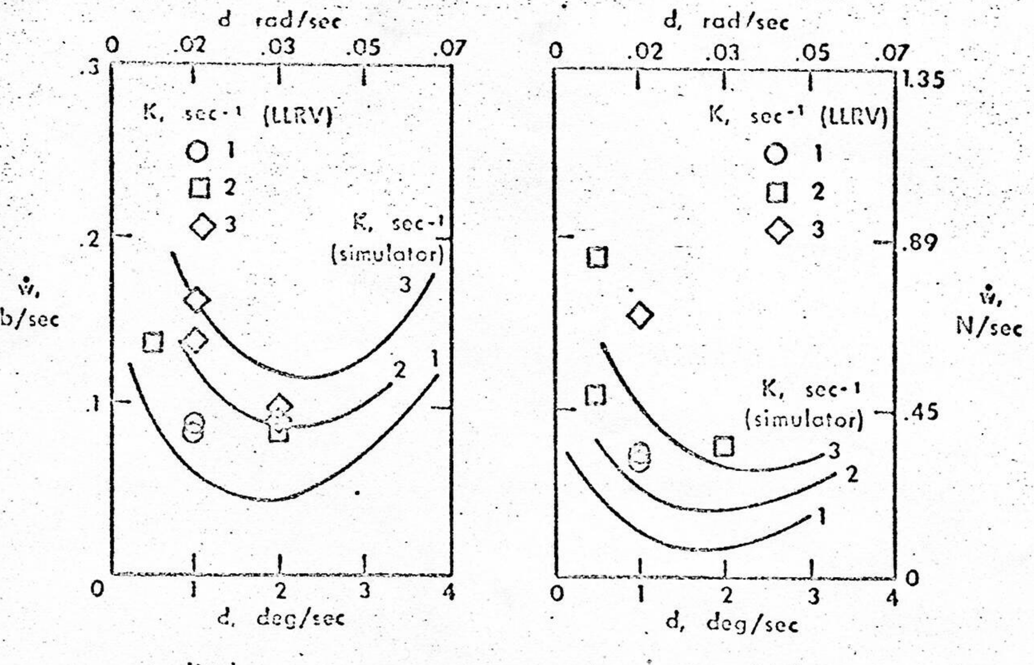


Figure 8.- Comparison of acceptable pilot rating boundaries established by use of the LLRF and the LLRV pitch control systems.

TABLE I.- COOPER PILOT-OPINION RATING SYSTEM

Operating conditions	Adjective rating	Numerical rating	Description	Primary mission accomplished	Can be landed
Normal operation	Satisfactory	1	Excellent, includes optimum	Yes	Yes
		2	Good, pleasant to fly	Yes	Yes
		3	Satisfactory, but with some mildly unpleasant characteristics	Yes	Yes
Emergency operation	Unsatisfactory	4	Acceptable, but with unpleasant characteristics	Yes	Yes
		5	Unacceptable for normal operation	Doubtful	Yes
		6	Acceptable for emergency condition only[1]	Doubtful	Yes
No operation	Unacceptable	7	Unacceptable even for emergency condition[1]	No	Doubtful
		8	Unacceptable - dangerous	No	No
		9	Unacceptable - uncontrollable	No	No
	Catastrophic	10	Motions possibly violent enough to prevent pilot escape	No	No

From Reference 2



(a) Pitch (b) Roll.

Figure 22.– Comparison of LLRV lunar-simulation attitude-rocket propellant consumption from flight-test data with fixed-base simulator results. $\ddot{\theta}$ = 10 deg/sec^2 (0.18 rad/sec^2); $\ddot{\phi}$ = 11 deg/sec^2 (0.21 rad/sec^2).

K, sec^{-1}	Max Comm. Rate, °/sec
1	8
2	16
3	24