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

REPLY TO ATTN OF: FM73 (71-214)

July 21, 1971

MEMORANDUM

TO: FA/Chairman, Apollo Spacecraft Software Control Board

FROM: FM/MPAD Representative to Apollo Spacecraft Software Control Board

SUBJECT: MPAD Action Items from Apollo 15 FSRR

Reference is made to memorandum FA-114, "Action Items Resulting from the Apollo 15 FSRR," dated June 22, 1971.

The intent of this memorandum is to close specific action items from the referenced memorandum and to relay the status of the remaining open items. The subject action items are as follows:

1. There is some question as to just how much docked DPS testing has been done on the final LUMINARY program with the Apollo 15 spacecraft characteristics. MPAD, along with FSD, was requested to review the testing to determine how thoroughly it has been done and, if necessary, to recommend additional tests.

2. MPAD was requested to review all of the testing that has been done on the AGS to make sure that:

a. It will work correctly if the PGNS is broken

b. If the PGNS fails in mid-rendezvous, the crew will be able to successfully switch from the automatic to a manual mode of rendezvous radar updating.

c. There is no PGNS failure that can somehow feed through the wires and foul up the AGS.

The following action has been taken in response to the above action items:

1. The only docked DPS case run at MIT was a LOI abort case where the CSM was fully loaded. This case did not simulate fuel slosh and vehicle bending. Additional testing was requested of MIT.

Enclosure #1 presents the additional testing and the following is a summary of the tests and their results:

a. Three docked DPS runs (CSM full, half full, empty) with fuel slosh and vehicle bending. The tests have been completed and no difficulties found.

b. Case #3 of Enclosure #1 calls for a docked APS run (LOI abort). This case cannot be run at MIT as it requires both AGS and PGNS capability. GAC has been requested to perform this test on the FMES. The test is scheduled for July 20th and this is still an open item.

c. Case #2 of Enclosure #1 requests a CSM alone LOI run. This was requested in support to an alternate mission. This case has been completed and no difficulties found.

2. A thorough review of the testing performed for the AGS program has been completed. There are two soft areas in the testing which we felt required additional testing.

a. TRW has no responsibility to demonstrate the guidance and control interactions in their routine testing. This generally is done independent of TRW by Lockheed and GAC.

b. TRW has no PGNS simulation to demonstrate AGS capability in the monitoring mode. Consequently, TRW cannot simulate a dynamic switch-over from the PGNS to the AGS. The GAC facility is the only one in existence (to my knowledge) that can demonstrate this capability.

As a result of these two soft areas we defined an AGS test plan which we felt would demonstrate the total AGS system capability. This test plan also includes cases which will further verify the manual radar input mode as well as the AGS capabilities independent of the PGNS. The test cases are defined in Enclosure #2. It was requested that they be executed on the FMES with TRW (in addition to GAC) evaluating the results. The tests were run the week of July 5th and everything performed as expected. TRW is writing a memorandum reporting on the testing.

The third part of Action Item II (PGNS failures that foul up AGS) is a difficult one to answer. There probably are some hardware failures which could foul up the AGS but nobody, as yet, has identified any specific problems. I don't anticipate that this action item will be closed prior to July 26th.

A potential problem has been identified as a result of the AGS testing on the FMES. The problem is not one of program deficiencies (PGNS or

AGS) but rather the consequences of a failed LM RR. One of the test cases simulated a broken interface between the RR shaft and trunnion CDU's and the LGC. The crew expects large N49's from the initial marks after insertion. If the interface is broken between either the shaft or trunnion and the LGC, the initial acceptance of the data could degrade both the PGNS and AGS state vectors. Had the AGS been updating manually in this case, i.e., getting equivalent shaft and trunnion angles from vehicle attitude and not the RR, it would have retained a good state vector. This problem is being investigated by GAC and the MPB of MPAD and further information should be forthcoming. As I understand it, the probability of such occurence is small, however, we should understand it as much as possible. The ground has the vehicle in sight (after insertion) for a sufficient length of time to monitor the RR and verify its proper operation.

Richard O. Nobles

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APPROVED BY:

John P. Mayer
Chief, Mission Planning
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2 Enclosures

cc:
(See attached list)

FM7/RONobles:ssc:7-21-71:x4581

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ENCLOSURE 1

Case No. 1 DPS TEI with CSM Half Full

Launched July 26, 1971 13 hrs 34 mins 00 secs

Ignition State Vector

GET 88 hrs 13 mins 17.476 secs

X	19.283468 n.m.	
Y	-727.22782 n.m.	
Z	-675.00252 n.m.	MCI
DX	-5118.7035 fps	Selenocentric Coordinates
DY	805.99447 fps	
DZ	-1103.0074 fps	

Mass 74811.0 lbs

P30 Targets	VX	2793.5130 fps
	VY	-424.8087 fps
	VZ	-103.0840 fps

REFSMMAT	IMUX	-.88894521,	.44150806,	-.12184857
	IMUY	-.40323516,	-.62826046,	.66534969
	IMUZ	.21720462,	.64059304,	.73652069

Gimbal Angles	IGA	0.0 deg
	MGA	0.0 deg
	OGA	0.0 deg

ΔVMAG	2827.5081 fps
BTIME	595.976 secs

EI Conditions

GET 195 hrs 16 mins 31.053 secs

V	36068.081 fps
γ	-7.6677 degs
LAT	23.6422 degs
LON	165.8033 degs
INC	29.8050 degs

Case No. 2 CSM Alone LOI

Launched July 26, 1971 13 hrs 34 mins 00 secs

Ignition State Vector

GET 74 hrs 54 mins 48.836 secs

X	-837.64552 n.m.	
Y	-362.68995 n.m.	
Z	-355.15300 n.m.	MCI
DX	-4288.1950 fps	Selenocentric Coordinates
DY	6274.3785 fps	
DZ	3688.9929 fps	

Mass 65289.871 lbs

P30 Targets	VX	-3243.3502 fps
	VY	2257.5475 fps
	VZ	1407.1573 fps

REFSMMAT	IMUX	.50490387, -.85932463, .08144504
	IMUY	-.34139406, -.11214172, .93320648
	IMUZ	-.79279392, -.49898441, -.34998911

Gimbal Angles	IGA	0.0 degs
	MGA	0.0 degs
	OGA	0.0 degs

ΔVMAG	4194.7504 fps
BTIME	330.029 secs

LPO Conditions (Burnout)

HA	170.01 n.m.
HP	58.94 n.m.
INC	122.7116 degs
RA	-178.8150 degs

Case No. 3 APS Part of LOI Abort

Launched July 27, 1971 13 hrs 37 mins 00 secs

Ignition State Vector

GET 81 hrs 51 mins 33.290 secs

X	-526.62648 n.m.	
Y	5452.7686 n.m.	
Z	3679.7934 n.m.	MCI
DX	812.12916 fps	Selenocentric Coordinates
DY	3549.8216 fps	
DZ	2200.9137 fps	

Mass 65909.5 lbs

P30 Targets	VX	-353.4941 fps
	VY	-258.1518 fps
	VZ	-585.7035 fps

REFSMMAT	IMUX	-.58566617,	.78781439,	.19064011
	IMUY	.47383404,	.52358954,	-.70805036
	IMUZ	-.65762942,	-.32434937,	-.67994195

Gimbal Angles	IGA	0.0 deg
	MGA	0.0 deg
	OGA	0.0 deg

ΔVMAG	731.2069 fps
BTIME	415.225 secs

EI Conditions

GET 146 hrs 44 mins 13.70 secs

V	36171.83 fps
γ	-6.51 degs

Case No. 4 DPS TL Abort with Empty CSM

Launched July 26, 1971 13 hrs 34 mins 00 secs

Ignition State Vector

GET 47 hrs 0 mins 00 secs

X	-138978.57 n.m.	
Y	-58834.650 n.m.	
Z	-40621.467 n.m.	ECI
DX	1753.5863 fps	Geocentric Coordinates
DY	-69.229159 fps	
DZ	49.619957 fps	

Mass 62622.0 lbs

P30 Targets	VX	-7.1612 fps
	VY	0.0 fps
	VZ	1957.1625 fps

REFSMMAT	IMUX	.88748177,	.37944333,	.26153177
	IMUY	-.04409626,	-.49498272,	.867,8318
	IMUZ	.45872825,	-.78167432,	-.42255611

Gimbal Angles	IGA	0.0 deg
	MGA	0.0 deg
	OGA	0.0 deg

ΔVMAG	1957.1755 fps
BTIME	366.824 secs

EI Conditions

GET 89 hrs 12 mins 24.753 secs

V	36108.150 fps
γ	-6.5235 degs
LAT	3.6266 degs
LON	312.3495 degs
INC	29.8496 degs

Case No. 5 DPS Abort at PCY+2 Hrs with Full CSM

Launched July 26, 1971 13 hrs 34 mins 00 secs

Ignition State Vector

GET 80 hrs 31 mins 29.554 secs

X	-544.66966 n.m.	
Y	3908.5843 n.m.	
Z	4489.0581 n.m.	MCI
DX	959.61770 fps	Selenocentric Coordinates
DY	2741.9003 fps	
DZ	3550.4756 fps	

Mass 102817.0 lbs

P30 Targets	VX	-21.5326 fps
	VY	-1325.0885 fps
	VZ	-307.0301 fps

REFSMMAT	IMUX	.14992487. .88118554, -.44836882
	IMUY	.98033782, -.07364470, .18306887
	IMUZ	.12829765, -.46699949, -.87490068

Gimbal Angles	IGA	0.0 deg
	MGA	0.0 deg
	OGA	0.0 deg

ΔVMAG	1360.3641 fps
BTIME	428.369 secs

EI Conditions

GET 146 hrs 53 mins 57.409 secs

V	36180.891 fps
γ	-6.6218 degs
LAT	27.9000 degs
LON	167.4860 degs
INC	39.9774 degs

ENCLOSURE 2

DESCENT CASES

1. PGNS prime to PDI +≃250. AGS monitor. AGS Abort on DPS. PGNCS monitor.

2. PGNCS prime to PDI + 598. AGS monitor. AGS abort on DPS. Stage to APS. PGNCS monitor.

3. PGNCS prime to hover. AGS monitor. Switch to AGS ATT HOLD. Fly for 10 sec. Switch back to auto. AGS abort on APS. PGNCS monitor.
   Run AGS Concentric Rendezvous (with plane change) through MCC1. Manual radar input to AGS.

ASCENT CASES

1. PGNCS prime to L/O + 12 sec (middle of pitchover). Switch to AGS. PGNCS monitor. Nominal AGS alignment and initialization procedures. Direct rendezvous with manual RR inputs to AGS. Run through point of closest approach.

2. Nominal AGS all way. Alignment and initialization of AGS independent of PGNCS. PGNCS monitor. Terminate at insertion.

RENDEZVOUS CASES

1. Nominal rendezvous (direct) on PGNCS initialized at insertion. Auto RR input to AGS for 6 marks with lots of restarts. Go manual RR inputs to AGS for 6 marks. Switch to auto RR inputs to AGS and continue to TPI. Compare AGS to PGNCS TPI solution.

2. Nominal rendezvous initialized at insertion. Auto RR to AGS with RR shaft and trunnion failure separately.

3. Nominal PGNCS rendezvous with 7 auto RR input marks to AGS. Fail PGNCS (unplug computer). Continue rendezvous on AGS.

4. Repeat #3 but go to P00 at "unplug" point.