



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

HOUSTON, TEXAS 77058

IN REPLY REFER TO: 69-FC54-8

DEC 1 1969

MEMORANDUM TO: Apollo 12 Flight Director

FROM : Retrofire Officers

SUBJECT : Apollo 12 Postflight Report

I. Problems/Resolutions.

A. Prelaunch - The V_{ET} vs γ_{ET} plot did not plot during the T-5 hr trajectory confidence run due to improper input data to the RTCC. However, the second trajectory confidence run was satisfactory.

B. Launch through Evasive - The CMC clock lost .08 sec during launch. The EPS anomaly that resulted from the lightning is considered to be the cause of this timing "glitch".

C. TLC - For manual inputs into the S/C deorbit setting of the RTCC and a specified vector fetch, the RTCC processor would use the wrong weight from the MPT. That is, it would use the weight in the MPT at GETI instead of at the vector fetch time. This problem was not serious, but it should be fixed for subsequent missions.

D. TEC/Entry.

1. The ΔV_C read +1.8 fps at MCC5 cutoff instead of the nominal 0.0 fps. Since the ΔV_C is noted for jumping when going through 0.0 fps while under low acceleration, it was considered to be functioning properly. EMS self-check tests were run and verified that it was GO.

2. The EMS ΔV_C was found to have a -.022 fps/sec bias after MCC5 analysis and the EMS self-test procedure during TEC.

a. The error for MCC7 resulting from this bias was determined to be .1 fps. Since the MCC7 was a G and N burn with the ΔV_C as a backup, we elected not to bias the PAD ΔV_C value. However, if the ΔV_C had been prime for burn control, we would have properly biased the PAD ΔV_C value.

b. For entry, the error resulting from this small bias was considered negligible, because a bias of -.022 fps/sec when compared to the entry G's (64 to 192 fps/sec) is very small.

II. Mission Narrative.

A. Prelaunch - During the CDDT, the CMC clock and the LGC clock were observed to have a drift. From KSC readouts, the drifts for the clocks were determined to be .00148 sec/hr slow for the CMC and .008 sec/hr slow for the LGC. On November 13, 1969, 1:30 CST, the CMC was biased to be .05 sec fast in order that the clock be correct at lift-off.

B. Launch through Evasive.

1. The GMT of the first motion was 16:22:00.677. The CMC lift-off was 16:22:00.68, which was input to the RTCC as GMTLO.

2. Due to a navigation error in the IU, the predicted TLI resulted in a perigee of 29145 n.m. The ΔV at 75 hrs required to return to the AOL was about 250 fps.

3. The .08 sec error in the CMC was not corrected until after TLI as it would not hinder TLI. The erasable memory dump verified that T_{EPHEM} was not destroyed during launch, and, thus, no CMC clock problems would impact TLI.

4. The confirmed TLI C/O had a resulting perigee of 29164 n.m.

5. The crew reported that the SIVB was emitting gases just prior to the SIVB evasive maneuver. The BSE confirmed that no normal vent mode was in progress.

C. TLC - Due to the high return perigee after TLI, the hybrid trajectory was not as far from free return as the premission nominal. The LOI+30-min abort chart carried by the crew was found to have resulting perigees of -400 n.m. to -500 n.m. These errors can be attributed to a different lunar approach trajectory, in addition to premission errors in the calculations of the LOI+30-min abort chart. The crew chart was updated using data computed by an iteration process in the RTCC and verified by the RTACF.

D. LOI_1/LOI_2 - Prior to LOI_1 , the RTCC SPS thrust characteristics were updated based on the MCC2 SPS burn. However, LOI_1 was non-nominal in that the burn was 6 secs shorter than predicted. The deviation was attributed to a higher thrust SPS engine. The RTCC SPS thrust characteristics were again updated before the final computations of LOI_2 and TEI_5 .

E. LM Activation through T_3 .

1. Prior to PDI, the RTCC predicted throttle down time was 6+35 using a nominal thrust of 9850 lbs. During PDI, based on an actual DPS thrust of 9850 and a GTC of 93 percent, the predicted throttle down time was 6+22 with the crew reporting the actual time as 6+23. The difference between the actual and the RTCC pre-PDI value is unexplained at this time.

2. Touchdown was recorded as 110+31+58 GET based on crew callout.

F. Lunar Stay - The ascent stage weight was about 90 lbs heavier than nominal due to the added rocks, television camera, surveyor gear, PLSS battery, etc. The weight that Control passed to us was 10789 lbs, which was approximately 40 lbs lighter than the weight SPAN reported. All agreed to use the Control's weights.

G. Ascent/Rendezvous.

1. Lift-off occurred on time at a GET = 142:03:47.
2. The APS engine seemed to be hotter than normal with the LGC verifying it by indicating a 9-sec early cutoff and a small overspeed.

H. Postdocking Lunar Orbit - Following a nominal docking, a LM crew and equipment transfer to the CSM proceeded satisfactorily. The necessary PADs for the LM deorbit burn, LM jettison, and CSM separation maneuver were computed and passed for implementation by the crew. The LM was jettisoned as planned and the CSM separation burn was nominal. The LM was in the proper attitude and counting toward the fictitious APS burn at AOS about 17 mins prior to the deorbit burn. Using the LGC DSKY readout and a stop clock, the transmission plus processing delay was determined to be 7 sec. Using the above computed delay time and a premission command delay of 2 secs, the DSKY value of ΔV_m for burn termination was computed to be 169.7 fps. A ΔV_m value of 95.5 fps was expected at 48 secs into the burn. The actual value was 98 fps, which indicated that the assumed acceleration was very close to nominal and that a timed C/O would be acceptable if TM were lost. The command to terminate the burn was sent when the DSKY ΔV_m was 170 fps, which coincided exactly with the time of 79 secs (the value for a timed C/O). The ascent stage impacted the lunar surface within 40 n.m. of the Apollo 12 landing site.

I. TEI - The TEI burn was nominal. The post-trimming residuals were $V_{gx} = 0.0$, $V_{gy} = +.7$, and $V_{gz} = +.1$.

Summary of TEI

Condition	V_{400K}	γ_{400K}	h_p
TEI Entry Targets	36116	-6.50	20.3
Trajectory Update prior to TEI	36116	-6.40	21.8
Confirmed TEI Maneuver	36116	-6.69	+17.6

J. Transearth Coast/Entry.

1. MCC5 was executed 1 hr later than nominal to allow the crew a longer rest period. A 2-fps maneuver was executed at 188:27:14 GET to decrease the entry angle from an unacceptable -7.85° to -6.49° at 400K ft.

2. The tracking data prior to the nominal time of MCC6 indicated a 1-fps burn for MCC6 and 4 fps for MCC7. However, the quality of this data was questionable due to uncoupled RCS attitude maneuvers and S/C vents. MCC6 was not executed because 1 fps is about as small a maneuver that can be performed with confidence, in addition to the fact that the vector was based on radar data following unmodeled maneuvers.

3. A 2-fps MCC7 was executed at EI-3 hrs to increase the entry angle from -6.22° to -6.49° . This MCC was not mandatory in that MCC5 insures an entry within a safe corridor. However, MCC7 placed the trajectory on the corridor target line, thus, minimizing G and N dispersions during entry and making entry monitoring task as easy as possible, i.e., nominal entry conditions.

4. The entry was nominal. The recovery ship reported the impact point as 15.81S and 165.17W, which was the target given to the CMC.

Summary of Conditions

	EI-5-hr update (assuming MCC7)	EI-45 mins	EI
GET _{400K}	244:22:18	244:22:18	244:22:18
V _{400K}	36116 fps	36116 fps	36116 fps
γ_{400K}	-6.49°	-6.48°	-6.51°
EMS Range	1167.3 n.m.	1166.3 n.m.	1170.4 n.m.
MAX G	6.1 g's	6.1 g's	6.1 g's

K. General.

1. Mass properties were computed for the first time in an offline computer by the RTCC controllers in lieu of the RTACF. This operation was smooth, and, with the assistance of Mr. Ted Turner of MPAD, no major problems developed. The SPS trim values computed were in good agreement (less than $.1^{\circ}$) with the onboard postburn values for CSM alone and docked configurations. The mass properties were run prior to each maneuver. The entry aerodynamics were computed at a GET of 237 hrs based on actual stowage of lunar samples and equipment.

2. The onboard clocks (CMC, LGC, AGS) drift rates premission and real time were observed as follows:

Clock	Premission	Real Time
CMC	-.00148 sec/hr (30-hr data span)	-.00143 sec/hr (244-hr data span)
LGC	-.0008 sec/hr (20-hr data span)	-.0008 sec/hr (32-hr data span)
AGS		+.014 sec/hr (4 1/2-hr data span)

The clocks were maintained within the operational limits with only the CMC requiring updates due to drift. Below is a table of the timing updates.

Summary of Clock Updates

CMC		
GET of update	ΔT of update	Reason for update
6:00	+0.08	to correct for the glitch during launch
79:10	+0.12	to have the CMC correct for LOI
88:23	+0.03	to have the CMC correct for the T+106 landmark tracking
131:32	+0.09	to have the CMC correct for the T+165 landmark tracking
244:53	+0.11	to have the CMC correct during entry
LGC		
105:58	-0.20	to sync the LGC to GET
AGS K-Factor		
106:15	100:00:00.73	to properly reference the AGS to the LGC
140:26	140:00:00.33	to properly reference the AGS to the LGC

III. Recommendations.

A. The verification and/or computation of the LOI+30-min abort chart should be done in a computer other than the Mission Operation Computer (MOC). During Apollo 12, the chart was computed in the MOC at a GET of 51 hrs. This proved to be cumbersome and lengthy due to several factors. To compute the chart, many inputs to the RTCC are needed for the several iterations. Four hrs were needed to compute the LOI+30-min abort chart, because the MOC was required by other controllers in addition to the normal information flow through the RFO position. The updated chart was not checked in the RTCC at a GET of 74 hrs. as planned, because the FDO was having problems with LOI₁ computations. However, the chart was checked in the RTACF and found to be satisfactory. In the future, complete verification/generation of the LOI abort charts in the MOC is necessary as the RTACF will not have this capability. Accomplishment of this task will be enhanced if two definite periods during TLC are set aside for this explicit function. Two periods are required, because many times preliminary data are accurate and only need to be checked during the second period of time.

B. The mass property function of the RFO and the offline computer was acceptable. The major task in the setup of the computer runs was the definition of miscellaneous weights and their respective c.g. The handling of the mass properties as utilized in the RTCC should be more flexible, because now only one set of c.g.'s each for the CSM and LM (fuel in either bottom or top of tanks) can be loaded, thus, the burn configurations are limited. In the future, the RTCC should have the capability of storing all c.g. tables, and, thus, all configurations would be available to the Flight Controllers.

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