

UNITED STATES GOVERNMENT

Memorandum

TO :Flight Director, Apollo 11

DATE: AUG 4 1969

FROM :Retrofire Officers

SUBJECT: Apollo 11 Postflight Report

1. Prelaunch.

a. During the CDDT, the CMC clock and LGC clock were observed to have a drift. From KSC readouts, the drifts for the clocks were determined to be .00086 sec/hr fast for the CMC, and .00067 sec/hr fast for the LGC. On July 14, 1969, 21:30 CDT, the CMC was biased to be .04 sec slow in order that the clock would be correct at lift-off.

b. Seven hrs prior to launch, Recovery reported that the weather in the earth orbit target areas was satisfactory.

c. The T-5 hr trajectory run was not acceptable because the DSC did not receive all the data input to the MOC. The second trajectory run was satisfactory.

d. The ACR wind data for Mode I aborts proceeded smoothly.

e. The prelaunch weights for the SIVB and LM were verified with a small change of about 14 lbs gained in the LM dry weight. The CSM weight was computed correctly, except for the waste water. The RTCC calibration curves were based on zero "g" conditions, however, under one "g" these curves are invalid. About T-3 hrs, the EECOM agreed that the one "g" value from ASPO was correct, and by T-2:20 new L/D's and SPS c.g. curves were loaded based on the best prelaunch data, and confirmed by the ACR in the form of SPS trims and aerodynamics.

2. Launch.

a. The GMT of first motion was 13:32:00.600. The CMC lift-off was 13:32:00.78, which was input to the RTCC as GMTLO.

b. The launch phase trajectory was nominal with an insertion orbit of 102.5 n.m. by 99.7 n.m.

3. Earth Orbit.

a. The "carry-on" earth orbit block data was checked and found to require no update after insertion.



b. The SIVB weight predicted at 2:30:00 GET was received from BSE and input to the RTCC as 198,720.

c. At GET 32:00, GMTLO was sent to all remote sites.

d. The TLI + 10-min pitch angle was computed by the ACR to be 223° .

e. The TLI + 90-min abort pad with the TLI + 4-hr data in the comments was verified onboard during the first U.S. pass.

4. TLI - The TLI trajectory appeared to be nominal, however, the SIVB burned 3 secs longer than predicted.

5. TLC.

a. The TLI + 90-min and the TLI + 4-hr abort data required no update after the evasive maneuver.

b. The TLI + 11-hr block data was verified onboard at 6:12:00 GET.

c. The TLI + 25, 35, 43, and 53-hr abort data was verified onboard at 11:00:00 GET, assuming no MCC. The free-return flight path angle at 15:00:00 was -48.3° .

d. MCC₂ was executed nominally.

e. The TLI + 35, 43, and 53-hr abort data were sent to the crew reflecting MCC₂ at 30:10:00 GET.

f. The LOI - 5-hr flyby pad was verified onboard at 35:15:00 GET.

g. The CMC clock was updated at 51:11:00 GET by -.06 sec in order to be correct at LOI.

h. The gimbal angles for the LOI + 15-min abort chart were computed and passed to the crew. The other abort data was satisfactory.

6. Lunar Orbit.

a. LOI₁ and LOI₂ were executed nominally with the exception that the gas pressure for one² set of SPS ball valves indicated a leak.

b. The lunar orbit block data was sent as indicated in the flight plan and required no non-nominal updates.

c. The CMC clock was updated at 83:20:00 GET by -.02 sec to be correct during the landmark tracking procedure.

d. The weight of the SPS propellant after LOI became a controversy due to the non-nominal propellant flow rates and usage during LOI. The

SPS c.g.'s were recomputed for the various configurations, i.e., three men bottom of tanks, one man bottom of tanks, and one man top of tanks (for docked DPS burns).

e. After the CSM was sent a DAP load for possible rescues, a discrepancy in the RTCC values of SPS trims was discovered. The ACR was asked to verify a second time the values sent to the CSM. Feeling confident the crew had the proper data, the Retro and the Trajectory Chief compared the RTCC trims with tables for each configuration, whereupon, it was found the RTCC had loaded one man top of the tank c.g.'s. The manner in which the RTCC happened to be in error is as follows: The Mission Operations Computer (MOC) was properly loaded with one man bottom of tank c.g.'s. The Dynamic Standby Computer (DSC) was improperly loaded with one man top of the tank c.g.'s. At a later time, the MOC was dropped and the DSC became the MOC with its improper c.g.'s. This incident points out that the Flight Controller should check this kind of thing when changing RTCC's.

f. The LGC clock was determined to be .033 sec slow at 97:00:00 GET. After uplinking .03 sec, the LGC appeared to be .01 sec slow, but well within our tolerance. The AGS K-factor was computed to be 90:00:00.15 which worked very well during descent.

g. The LM DAP load was verified onboard at 98:24:00 and subsequently loaded into the LGC.

h. All the pads and command loads were sent prior to PDI as per the flight plan.

7. Descent.

a. Prior to PDI, throttle down was predicted into RTCC to be PDI + 6:28. Based on the actual thrust of 9820 lbs and a premission curve of time from GTC = 93 percent to throttle down versus thrust, throttle down was predicted to be PDI + 6:25 which was passed to the crew. The crew reported throttle down at the predicted time.

b. The landing radar was incorporated 55 secs after its initial reading.

c. Touchdown was recorded as 102:45:41 based on crew callout.

d. After the T2 stay, the RTCC was loaded with the T3 ascent weight and an ascent pad was prepared and passed to the crew.

e. The FDO and RFO computed the TPI and LO times for T4 through T7. The RFO prepared the lunar surface block data pad and the LM DAP load which were confirmed onboard at 104:24:00 GET.

8. Lunar Stay.

- a. The EVA was initiated early and went smoothly.
- b. The weight of the samples to be added to the ascent stage became questionable, thus, we finally went with nominal values.
- c. The surface block data, T8 through T12, was passed to the crew prior to their sleep period.
- d. Due to the ball valve anomaly during LOI, it was decided to use one set of ball valves for rescue planning, but to use two sets for TEI.

9. Ascent.

- a. The LGC clock was in sync for LM lift-off. The CMC clock was .02 sec fast, but no update required or desired in this high activity period.
- b. The AGS K-factor for ascent was determined to be 119:59:59.923 which passed to the crew.
- c. Prior to lift-off, only one APS propellant pressurization system appeared to work, general consensus was that it was a transducer failure.
- d. The ascent burn was smooth and nominal, with $h_a = 47$ n.m. and $h_p = 9.2$ n.m.
- e. The rendezvous was nominal, except for some minor attitude excursions during docking.

10. LM jettison and TEI.

- a. Predicted weight and configuration of the CSM for TEI was used to compute the proper c.g.'s for SPS trims. The SPS engine model was updated for TEI using engine data determined from LOI.
- b. The LM was closed out about 2 hrs early, and at AOS of rev 28, the CSM/LM was in LM jettison attitude with the AGS in attitude hold. The nominal attitude for LM jettison is CSM pitched up $\approx 45^\circ$ from the earth-moon line to allow LM communication and to give a CSM retrograde ΔV using SM minus X thrusters at AOS + 5 min. The LM systems engineers became concerned that the LM coolant loops would be off for 2 hrs prior to LM jettison and recommended early jettison. The RFO advised the Flight Director that the jettison must result in a retrograde ΔV for the CSM with respect to the LM for recontact avoidance at TEI. Since the inertial attitude could not be changed, the jettison had to occur within 45° of central angle of travel after AOS + 5 min (one revolution prior to nominal jettison), to avoid the application of any retrograde ΔV to the LM. The LM was jettisoned

at 130:09:47 which resulted in a radial attitude with the LM receiving about 2 fps upward. The crew was advised to execute no separation burn in this attitude, but to standby for an updated evasive maneuver. The ΔV imparted to the LM would cause it to go above and fall behind the CSM initially, but to return to the CSM position one revolution later. The crew was given a maneuver pad and command load for a pure retrograde burn at 130:30:00 using the standard P41 -X translation procedure. This maneuver caused the CSM to go below and continually move ahead of the LM. At TEI, the CSM was about 20 miles ahead of the LM and continued to pull away after TEI.

c. TEI was nominal with residuals, after trimming, of $V_{gx} = .1$, $V_{gy} = .9$, $V_{gz} = .1$. The confirmed maneuver had a flight path angle at entry of -5.51° and an $MCC_5 = 1.4$ fps. The DC vector based on 24 mins of data after AOS had $MCC_5 = 7$ fps.

Summary of TEI conditions.

<u>CONDITION</u>	<u>V_{400K}</u>	<u>γ_{400K}</u>	<u>$\frac{h}{p}$</u>
TEI ENTRY TARGETS	36194	-6.51°	+20.4
TRAJECTORY UPDATE PRIOR TO TEI	36194	-5.84°	+29.3
CONFIRMED TEI MANEUVER	36194	-5.51°	+33.2
PRE- MCC_5 VECTOR	—	—	+66.0

11. TEC and Entry.

a. Prior to MCC_5 , the trajectory was not entering (perigee = 66 n.m.) and required 4.8 fps at MCC_5 . Since the trajectory was out of the corridor and a safe entry could be guaranteed with three sigma execution, MCC_5 with a ΔV of 4.8 fps was performed.

b. Subsequent MCC 's were not required, and the flight path angle at entry was -6.50° or $.01^\circ$ different from the nominal.

c. The CM stowage was updated by the crew due to the fact that several items normally left in the LM were brought back. The entry aerodynamics were computed in the ACR several times before the stowage was finalized. The L/D sensitive items such as waste and portable water were varied to see the amount of allowable change to maintain a satisfactory L/D.

d. Sixteen hours prior to entry, Recovery reported that the weather in the recovery area would be unacceptable. At this time, it is better to change the entry range to avoid weather than to do an SPS maneuver. An entry range of 1500 n.m. provided acceptable weather, was consistent with EMS ranging, and insured P65 (to avoid confusion in prediction of entry program sequence). To provide a constant "g" entry mode that would

be clear of the weather, several procedures were checked by the Reentry Studies Section of MPAD and astronaut Ken Mattingly. As a result, a constant "g" profile was derived to give a range of about 1500 n.m. The procedure is as follows:

(1) Fly the nominal constant "g" procedure, i.e., full lift to maximum g then modulate bank angle to keep "g" = 4g's.

(2) After RETV^{CIRC} is reached, roll to 45° roll angle to extend the entry range to 1500 n.m.

e. The final entry pad was passed about EI - 48 min. The crew reported that the EI - 30 min horizon check (performed at this point to have a lighted horizon) was not good. Upon advice from the ground, the crew made the check a second time at the proper GET and reported it to be very good.

f. The CMC was given a target of 13:19N and 169:10W. The G and N data prior to blackout agreed exactly with that predicted in the RTCC. The entry was nominal with splash at 195:18:28. At splash, the carrier reported the CM 13 miles away. However, the ship reported its location as 13:26.6N and 168:58.7W. The CMC indicated 13:18N and 169:09W. The carrier reported 13:14.9N and 169:10W as the recovery point.

Summary of conditions:

	<u>EI - 4 HR UPDATE</u>	<u>EI - 45 MIN UPDATE</u>	<u>EI</u>
GET _{400K}	195:03:06	195:03:06	195:03:06
V _{L/00K}	36194 fps	36194 fps	36194 fps
γ_{400K}	-6.45°	-6.48°	-6.50°
EMS RANGE	1404.5 n.m.	1403.3 n.m.	1403/3 n.m.
MAX G	6.4 g's	6.3 g's	6.3 g's

12. General.

a. The weight and c.g. difficulties, although not serious, caused more work for all concerned than should be necessary. The CM stowage should be handled with more foresight in that the SODB was in disagreement with the crew checklist. Equipment transfer from the LM should be more definite.

b. All support areas performed well and the cooperation from these areas was excellent and is appreciated.

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