T 72-15796 NATIONAL AERONAUTICS AND SPACE ADMINISTRATION MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058

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Distribution

JUN 29 1972

FROM: PA/Chief, Apollo Data Priority Coordination Mannes Spacecraft Center SUBJECT: Mission Techniques for Apollo 17, Lunar Orbit and Ascent

DOI 1 is the same as Apollo 16 as far as monitoring techniques and "go" for DOI are concerned. As a result of DOI 2, the trim rules are changed in that we will also trim underburns to 1 fps as we did overburns on 16. The engine usage is the same, RCS if less than 10, and SPS if greater than 10. If we go into DOI 1 under SCS control then the EMS is loaded normally (V_C) ; but, under G&N control we load ΔV total to make trimming easier. G&N failures during DOI 1 are cause for termination, not SCS completion.

The CIRC/DOI 2 combination needs a little more looking at. What we want is a Hohmann transfer for DOI 2, CIRC before DOI 2 by about 2 minutes, CIRC into an orbit that is 60 circular at TPI, enough time between P24 and CIRC, and some room to move the combination in real time if it's required. MPAD will look into this some more.

It takes an overburn of 1.7 seconds at DOI 1 to put us on a trajectory requiring bailout and the monitoring/execution procedures (shutdown on PAD burn time) virtually precludes that. However, MPAD will prepare a canned bailout assuming 1.7 second overburn for execution at AOS plus 12 minutes. Enclosure 1, shown by D. Scheffman (MPAD), describes the trajectory behavior for various overburns.

Since there ain't hardly no way to need a bailout, we will not go to the bailout attitude for AOS after DOI. Instead we will be in attitude to do the J-2 landmark tracking (OJT). If the initial ground data indicates we need a bailout then we will hustle over to the bailout attitude. Both the landmark tracking and bailout attitude will permit higain comm. The voting for bailout is unchanged. One ground vote saying bailout is enough.

The conditions making us no go for DOI 2 are the same as those making us no go for SEP. The biggest concern seems to be in the VHF comm area in that the CMP must confirm he has done CIRC before we do DOI 2. However, with the redundancy in the VHF and the fact that it's checked out before SEP and used after LOS and leading to CIRC, there should be no surprise. Failures late require reconfiguring the VHF to get comm back. C. Lewis (CPD) will look into this for both vehicles. A question coming out of this is "how late can DOI 2 be?" Obviously a minute or so is okay. MPAD will give us the penalty in hover time for being late.

If we allow a radial component in DOI 1 the SPS EOM reserves are increased by about 35 fps. We are certainly "go" for a radial component in DOI 1. The savings is a result of making LOI 1 more efficient.

B. Wollenhaupt (MPAD) showed us some preliminary landmarks he would like to track in order to tie photography from earlier missions to Apollo 17. The specific landmarks can't really be done yet because the final trajectory is not known. However, we were able to give him some guidelines.

- REVS 13 and 50 can contain landmark tracking at no penalty since they already contain tracking
- We are willing to track some landmarks during one rev during EVA 2. More than that is too much penalty on SIM BAY OPS.

We'll stand by for Wollenhaupt.

We scrubbed the rev 14 LM visual tracking. The sun location allows photography of areas not photographed on Apollo 15 so we need to run the SIM BAY on rev 14. The lunar sounder must be checked out for EMI on rev 15 so it's not available. The tradeoff turned out to be SIM BAY photography of new areas versus <u>another</u> solution for LM position and SIM BAY wins! The other operational tracking is unchanged from 16.

Enclosure 2 was shown by W. Presley (FCD) to bring the crew up to speed on the care and feeding of "JET ON MONITOR," no changes from 16.

Ken Lindsay (GCD) presented the results of the wide deadband SIM BAY pointing improvement procedures we did on Apollo 16. (See Enclosure 3). The performance was very much improved like Ken and Ed Kubiak said it would be. For Apollo 17, we will do the docked control like 16 and go 2.5° (instead of 3.0°) for CSM alone to further rescue pointing errors. Narrow deadband is unchanged. By the way, Ken and Ed have written an Internal Note (MSC-EG-72-1) which describes this effort and the results in detail so you all watch for it. It's still in the signoff mill and should be published shortly.

On Apollo 16, we turned off the LGC and the MET to save power which did away with all the LM sources for GET. There was no need to turn off the MET since only the display lights draw any appreciable power

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Let's not turn off the MET again. However, if we turn off the LGC and the MET fails then the crew needs a way to establish GET. Since the crews set their watches to CST, and we can assume they know the day and whether it's morning or afternoon, all they need is a single relationship between CST and GET. At the bottom of the "LIFTOFF TABLE" card we will put GET XXX:XX:XX = CST ZERO, DEC X, at midnight. This will allow establishing GET to a minute or so and that's acceptable for the block data lunar surface aborts. N36 is used to write in the new GET. Thank W. Presley and C. Deiterich for working this out.

Late in the Apollo 16 preparation, D. Thorson (FCD) and friends developed an onboard gyro compensation chart which required a lot less arithmetic to use, however, it was too late for 16. We took a look at this and reviewed the need to have the chart and decided we didn't need it at all. The crew will do the last P52 in time for the ground to compute the new compensations and besides we have yet to update them on a LM prior to PDI

C. Tillman (GAC) has run the descent yaw profile on the FMES and said that so far it looks okay in that the LR locked on okay and provided good data. He wants to do some more work before having a final opinion. He also ran DOI 2 on the FMES and said -X thrusters are better than +X based on the amount of attitude control firings. -X had essentially none and +X many. -X took 26 seconds and +X 35 seconds.

The plane change for ascent will occur at 6 hours \pm 30 minutes prior to liftoff. We won't know exactly until the OT is done. We want it to occur on the front side and if both opportunities are in coverage we want the early one.

S. Grega (CPD) presented a chart (Enclosure 4) for use in rendezvous after SEP. The LM uses the chart to tell the CSM what to do. The chart allows the sequence to begin anywhere in the football for about anyAt between beginning the rendezvous and station keeping. Beginning the sequence at max separation is most efficient, however beginning 30 minutes prior to closest approach is least sensitive and this should be the onboard nominal. The football trajectory is perturbed by the accuracy of SEP execution, especially in the cross axis components. The P24 pads are also degraded. The name of the game is to do SEP as well as we can. The ground can start them at the most efficient point based on range at closest approach. The CSM should always be active if possible because line of sight control is tough with the descent state on. This is not the final chart and Steve can tell you how to use it much better than I.

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T. Holloway and E. Pippert (CPD) showed us several timelines for Apollo 17 and they are in Enclosure 5. I will discuss them one at a time. The undocking to PDI timeline has to be changed for two reasons, DOI 2 and 15 minutes from AOS to PDI, so the changes are as follows.

- Delete LPD cal because it's just not required
- Include DOI 2
- Call P63 at PDI 8 min (vice 10 on 16) to allow the ground 7 minutes for lockon and LM updates. This normally takes 5 minutes but we need some pad

The moving of P63 call should result in doing some jobs, like DPS check and cockpit configuration checks, before P63. CPD will rework this timeline for review.

We will plan to normally read the Backup RLS data in case we have trouble commanding, then if the commanding is not successful by PDI - 7 minutes, the crew will enter the bakcup RLS. GDO is responsible for determining success since he is commanding. In the past when the ground has to uplink state vectors and RLS, and has not had high bit rate (LGC data) we have read the data to the crew for DSKY entry. A better way to do this is for us to command in the blind and read the data. Then the crew only has to verify and correct if required. The crew would tell us when they see P27 (the uplink is in progress) and when they see NO2 (the uplink is complete). After verification, they would do the V3E. This should save quite a bit of time. PDI - 5 minutes is the absolute latest time we should call P63 and P63 must follow entry of state vectors or Backup RLS. If we use Backup RLS, a V47 to ship the PNGS vector to the AGS is not required unless the AGS vector has degraded since the last V47 but an early altitude update may be, depending on errors. Remember that Backup RLS is used when we can't get the vectors in.

We made a small change in the ascent prep timeline to allow the LM systems guys to watch the IMU for a while before we started shaking the LM by donning suits and jettisoning gear. We'll powerup the PNGS before eating and do the first P57 after eating.

We will plan to do P22/P24 and the sightings on four stars for postflight LM position and gravity deflection, however, these get scrubbed for problems as they did on Apollo 16.

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The post docking timeline is unchanged from 16 except for deletion of a LM S.Y. update to the CSM. It's not used or required. I would remind you that this SEP can be delayed at least 30 minutes with no problem if the crew has trouble getting ready. The 2 fps posigrade maneuver is nice.

W. Lamey (MPAD) showed us Enclosure 6 which shows the yaw required for ascent to maintain steerable coverage. We must yaw right 30° at lift-off plus 1 minute. This requirement may also be valid for descent aborts but we must check it. The 30° yaw will be maintained for TWEAK. It also looks like the LM will have to stay heads up for pre-TPI tracking to maintain steerable coverage.

The procedures we tried on 16 (No N49 after 5 marks) to see if a post insertion LM vector to the CSM was required didn't work. The line of sight was too close to the sun. Therefore, if there is any question in the FDO's mind about the CSM's version of the LM trajectory we will send a vector. We've sent one every time so far.

The trim, tweak, bailout limits are unchanged from the final 16 criteria.

Trim X < 2 all insertions Any tweak > 5 in X, Z - execute it.

Only minutes: seconds of TIG will be passed.

One of the things that cause a lot of work for the flight planners is the varying Δt between insertion and TPI for the different launch opportunities. We will use the nominal (= 48 minutes for DEC 7) for all months and opportunities. This means that TPI occurs at sunrise - 16 ± 2 minutes for all "nominals." For the same reasons we will use two times for surface aborts, 40 minutes and the nominal. The one providing a TPI closest to sunrise -16 minutes will be used.

The remainder of the items on the agenda which are not called out in these minutes are unchanged from Apollo 16.

Open items are:

٥.	CIRC/DOI 2 Planning	MPAD
ь.	Hover time penalty for Late DOI 2	MPAD
c.	VHF Reconfiguration for Last Comm @ DOI 2	ĊPD
d,	Minimum at - LNOMRK TRK TO CIRC	CPD/CB

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e.	DOI Ballout Maneuver	MPAD
f.	Landmarks for Mapping Calibration	MPAD
g.	Undock to PDI Timeline	CPD
h.	LM yaw for Steerable - Descent Aborts	MPAD
1.	Head Orientation for Pre-TPI Track	MPAD
j.	Requirement for V47 if Backup RLS Used	TRW/Shook

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Philip C. Shaffer

PCS:bjb



ENCLOSURE Z.

EMP 523: JET-ON MONITOR

FUNCTION

• Compare DAP attitude error with selected DAP attitude deadband once every second. If attitude error exceeds the deadband by more than a specified tolerance, the software issues the master alarm by setting the ISS varning light (Ch 11 Bit 1). DISTING WINED FROM REAL ISS FAIL BY ABSENCE OF PROGRAM ALARM

ACTIVATION

- Establish P2O, opt 5.
- Insure CMC Mode is Auto or Hold and SC Control is CMC.
- Ground uplink three P27 command loads.
- Ground uplink V31 E.
- Verify operation by monitor of VHF CNT in downlink or DSKY display of N45 ($R_1 \times B$ yy).

TERMINATION

• Select another program via V37 E XXE (if P20 rotation is to be continued, select P30 then reselect P20).

· Zero N26 R.1

RECOVERY

- . Initiate corrective procedures to regain control authority.
- Reset Ch 11 Bit 1 (V25 NO 7 E, 11E, 1E, E).
- · Reset Haster Alarm.

• Emp is CMC restart protected.

EACLOSURE 3

FLIGHT TEST RESULTS

RESULTS AGREED CLOSELY WITH PRE-FLIGHT
 PREDICTIONS

CSM/LM_DOCKED

JET FIRINGS PER ORBIT REDUCED FROM
 100-200 FOR APOLLO 15 TO ABOUT 40

BIAS POINTING ERRORS REDUCED ABOUT 3 DEG IN ROLL AND 2.5 DEG IN COMBINED PITCH/YAW

<u>CSM_ALONE</u>

- JET FIRINGS PER ORBIT REDUCED FROM
 28 FOR APOLLO 15 TO 23
- BIAS POINTING ERRORS REDUCED ABOUT
 3 DEG IN ROLL AND 2.5 DEG IN
 COMBINED PITCH/YAW

PRELIMINARY RECOMMENDATIONS FOR APOLLO 17

SM/LM DOCKED

• WIDE DEADBAND

• BIAS P20 POINTING VECTOR 2 DEG AS IN APOLLO 16 ($\delta' = 86.74^{\circ}$, $\rho = 52.20^{\circ}$, $\Theta = -1.55^{\circ}$)

NARROW DEADBAND

16

USE .5 DEG DEADBAND AND NO P20 POINTING BIAS ($\delta = 90^{\circ}$, $\rho = 52.25^{\circ}$, $\Theta = 0^{\circ}$)

PRELIMINARY RECOMMENDATIONS FOR APOLLO 17 - - continued

- <u>CSM ALONE</u>
 - WIDE DEADBAND
 - USE 2.5 DEADBAND AND NO P20
 POINTING BIAS
 - NARROW DEADBAND
 - USE .5 DEG DEADBAND AND NO P20
 POINTING BIAS
- WIDE DEADBAND RECOMMENDATIONS SUBJECT
 TO CHANGE IF MASS PROPERTIES ARE
 SIGNIFICANTLY DIFFERENT FROM APOLLO 16



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TPI SOLUTIONS





TPI SOLUTIONS

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END DATE FILMED JUL 3