R. Larson

Mission Techniques Memo #29B

TO: Distribution
FROM: Malcolm W. Johnston
DATE: July 14, 1969
SUBJECT: "G" Descent Aborts

1. Various descent abort criteria have been presented, primarily in the Lunar Descent Mission Techniques document. Some of these are: FTP equal to 160% ± 10% (P4.16), P63 to 64 transition at TGO = 60-62 secs (P4.20), throttle recovery (MTM #28D, item #3), LR ΔH limits (MTM #28D, item #2), attitude and attitude rate limits (MTM #28D, item #4). MIT concurs! (Throttle recovery rule has been re-appraised). In addition, if actual throttle-up (FTP) occurs more than 10 secs. later than the LGC computed throttle-up time.... abort! Also, A. Klump still feels his "impact prediction" scheme might provide more straight-forward monitoring.

2. Certain CSM rescue situations require multiple CSI-type maneuvers. Can onboard CSI solutions be obtained for inputs of up to N=8?

   Ans. Yes! TPI time must be compatible.

3. Landing abort anomoly #77, concerning possible loss of guidance for up to 163 secs following an abort (P70) or an abort stage (P71), is described in AG #306-69. The rope has been fixed!

4. PGNCS/LEAR/AGS monitoring techniques and fail limits have been reviewed and independent error analyses exercised. As mentioned in MTM #28D, item #5, a continual dialogue has been maintained with MSC and general agreement has been reached. MIT associates a slightly lower probability of success (avoiding lunar contact) when using MSC's velocity residual redlines for aborts from 13K altitude. This can be attributed to the use, by MIT, of more conservative instrument accuracies. A memo discussing the latter, and summarizing this effort, will be published to augment a recent MIT report E-2427, "Mission G-G&N Error Analysis." (See also

MTM #9, item #1 and MTM #29A, item #1).

5. The pre-PDI suncheck procedures are outlined in the enclosed crew procedures change request LSD-13. (See also MTM #28D, item #1 and MTM #32, Item 1).

6. Enclosed Mission Development Staff memo #7 discusses recently discovered descent guidance peculiarities (oscillations, etc.).

7. How does the PGNCS react to a GDA failure?

   Ans. The GDA fail indication is ignored until the GDA is turned off, then the LGC stops sending steering signals. If the GDA is turned back on, the steering resumes.

8. In P12, 70, and 71 a second thrust level threshold (approximating 60% thrust of a full DPS configuration) is included in the LGC guidance logic. Steering commands will not be issued when the thrust is below this threshold, instead attitude hold will be commanded. (See MTM #29A, item 11). Guidance equation scaling restricts this threshold presently, though it could be reduced in future programs.

9. Paragraph 3.2 on Page 3.2 of the June 30, 1969 revision of this Mission Techniques document mentions a manual guidance scheme that is available to back-up a PGNCS and APS failure. Currently this only provides a back-up for ascents from the lunar surface. A simple extension of the scheme could (and should - I think) be developed for aborts during descent. (Utilizing a chart plotting different pitch angles as a function of time of abort, etc.)

10. On Page 3.3, manual throttle advance is suggested for aborts. A precaution should be noted.....the manual throttle should be kept at a minimum in the Auto mode in P63, 64, 65 or 66. Advancing the throttle in these situations can cause the LM to invert.

11. The second paragraph of Page 3.8 should be changed to read V06 N63.

12. Page 3.10, paragraph 3.5.1 indicates that post-insertion residuals are trimmed before determining if the PGNCS has degraded. Should'nt logic be reversed? Also, on page 3.5, paragraph 3.3.2, the attitude and attitude rate limits could momentarily be exceeded nominally. (See MTM #28D, item #4).

13. The following comments summarize MIT's position on the "Notes" appearing in the Mission Techniques document. In most cases, when a GNCS (PGNCS)/MCC-H tolerance is specified, MIT can only indicate the expected contribution of the GNCS (PGNCS) to the total tolerance.

Notes A, B, C, and E

Comment - All O.K.!

Note D - PGNCS Gyro Drift $> 0.3^{\circ}$/sec (fail PGNCS)

Comment - This threshold should be used to update gyro drift compensation, rather than to fail gyro. Also, the threshold could be lowered....not to the normal 0.075°/hr level (due to short time between alignments) but to some intermediate value like 0.15°/sec. Same comment applies to the post-insertion compensation for a standard launch (P5.13 in the Lunar Orbit Activities document).

Malcolm W. Johnston

Malcolm W. Johnston

CREW PROCEDURES CHANGE REQUEST Sheet 1

INITIATED BY	ORGANIZATION	DATE
C. O. Lewis	Flight Crew Support Division	June 16, 1969

CHANGE NUMBER	S/C EFFECTIVITY	
LSD-13	G & SUBS	

DOCUMENT AFFECTED

TITLE	DOCUMENT NO.	PAGE NO.	BASIC OR CHANGE DATE	TIME OR STEP NO.
LM Descent/Ascent Summary Document	MSC-CF-P-69-16	11	22 May 1969	

DETAIL CHANGE IN EXACT WORDING

Incorporate check of IMU pitch alignment between DOI and PDI, by sighting on the sun. Procedure is to call P52, specify sun as first star, and readout difference in commanded pitch gimbal angle and actual angle obtained by centering AOT on sun. If delta angle exceeds .25°, the IMU is NO GO for PDI.

See Sheet 2 for detail procedure

REASON:

Present procedures do not provide for a good drift check on the IMU platform. This drift check will increase confidence that alignment is good enough to support powered descent and aborts.

REMARKS:

☐ APPROVED ☐ DISAPPROVED	COORDINATOR'S SIGNATURE	DATE
	DJL	

FINAL DISPOSITION

☒ APPROVED ☐ DISAPPROVED	FCOD SIGNATURE	DATE SIGNED	SUSPENSE DATE
	[signature]		

MSC Form 482 (Rev Jun 68) (Previous editions are obsolete)

Mac 6/20/69 Joyce 6/23/69

CREW PROCEDURES CHANGE REQUEST Sheet 2

INITIATED BY	ORGANIZATION	DATE

CHANGE NUMBER	S/C EFFECTIVITY	

DOCUMENT AFFECTED

TITLE	DOCUMENT NO.	PAGE NO.	BASIC OR CHANGE DATE	TIME OR STEP NO.

DETAIL CHANGE IN EXACT WORDING

CB/AC BUS A: AOT LAMP - CLOSE
AOT DETENT - F/0.0°
V37E 52E
F0406 00001 00003 (REFSMMAT)
PRO
F5025 00015
ENTR
F0170 00546 (SUN)
PRO
F5018 R,P,Y ANGLES
MODE CONTROL (PGNS) - AUTO
PRO
0618
F5018 PLEASE TRIM
MODE CONTROL (PGNS) - ATT HOLD
V76E
V06 N 20 (ICDU ANGLES)
CENTER RETICLE (PITCH) ON SUN
ENTR

REASON:

RECORD R2 _____ Δ R2 _____
N22E
RECORD R2 _____
REPEAT N20, SIGHTING, N22 SEQUENCE 3 TIMES
AVE. Δ R2 < 0.25° (CONFIRM)
V34E
CB/AC BUS A: AOT LAMP - OPEN
AOT DETENT - CL

REMARKS:

☐ APPROVED ☐ DISAPPROVED	COORDINATOR'S SIGNATURE	DATE
	DDL	

FINAL DISPOSITION

☐ APPROVED ☐ DISAPPROVED	FCOD SIGNATURE	DATE SIGNED	SUSPENSE DATE

MSC Form 482 (Rev Jun 68) (Previous editions are obsolete)

Sent FCOD 6/23/69

M. Johnston

Massachusetts Institute of Technology
Instrumentation Laboratory
Cambridge, Massachusetts

Mission Development Staff Memo #7

TO: F. H. Martin
FROM: J. L. Nevins and B. Kriegsman
DATE: July 14, 1969
SUBJECT: Telecom Between the Authors and Floyd Bennett and Willis Bolt of MPAD.

SUMMARY

This telephone conference was concerned with a proposed Apollo 11 prime crew meeting (MIT and MPAD) to discuss guidance transients that the crew might expect during P63 and P64 with altitude errors of 3 to 4,000 ft. above nominal (2-3σ). The various possible transients and the affected mission rules were discussed with the MPAD personnel. It was the opinion of the MPAD personnel that these matters had been already brought to the attention of the prime crew and that the proposed meeting was not in order. We explained that the proposed meeting was recommended by Tom Gibson at the Apollo 11 Luminary FSRR meeting following the presentation of Bernie Kriegsman's descent studies. Since, MPAD's decision in effect closed the action requested by Tom Gibson we requested that Floyd Bennett make a formal record of this telephone conversation. This he agreed to do.

DETAILED DISCUSSION

1. First we apologize for MIT dropping the communication ball by not bringing MPAD into the discussion.

2. For program P63 it was pointed out that with trajectories 3-4,000 feet higher than nominal (2 - 3σ) the crew could expect to have the spacecraft pitch-back following the first 3 - 4 landing-radar updates. It was also pointed out that this pitch-back could repeat itself and that the magnitude could be as large as 20° (4 out of 60 runs and 5 - 10° for 10% of the runs). It was also pointed out that this pitching oscillation magnitude was strongly influenced by the altitude at which landing-radar updates started, being much worse for our

L. R. model because we didn't start to get updates as late as 28-29,000 feet; and, that if the crew got L. R. data early (39-41,000 feet) the pitch-back effect would be much smaller ($< 5^{o}$).

This conversation also brought out the fact that MPAD's L. R. model has data lock up around 39,000 feet, whereas our model could be as late as 28-29,000 feet.

3. For program P64 with the same conditions described in (2) above that the crew might see the engine throttle up to full throttle for 5 to 10 sec. The throttle would then come back to the nominal value.

4. We also pointed out that effects from the terrain models we had been given indicated that the guidance effects would be small.

5. Landing site redesignation.
   a. Lateral: we indicated that with 15% redesignation the guidance could be expected to overshoot.
   b. Forward redesignations of 20% could be done safely.

6. We indicated that the discussions for items (2) and (3) would also review L. R. dropouts boundaries that could be expected with these nominal trajectories.

7. Mission Rules - Final dated May 16, 1969.

   We pointed out that the spacecraft might violate the following mission rules.
   a. 5-90 G - No throttle recovery by P63/P64 program switch plus 15 sec. We pointed out that engine could have throttled down and then per item (3) throttled back-up at the beginning of P64.
   b. 3-84 B1 - Unstaged LM.
      Attitude excursions greater than or equal to 5^{o}. We pointed out that item (2) might possibly violate this constraint. On checking Rev. A dated June 20, 1969, Floyd Bennett could not find this mission rule. He was going to look into this one further.

cc: R. Ragan, D. Hoag, R. Battin, N. Sears, W. Marscher, M. Hamilton, W. Widnall, T. Fitzgibbon, P. Felleman, R. Larson, D. Gustafson, T. Gibson FS5, S. Mann FM7, F. Bennett FM6, M. Johnston