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LM MEMORANDUM

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From: C. Tillman MA&S

To: G. Smith
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Subject: Simulating the RR-CDU Interface When the RR is in the SLEW or AUTO (not LGC) Mode in The FMES/FCI Laboratory.

References: 1. LAV-500-940; Clint Tillman; Program Alarms in Powered Descent-Apollo-11.

2. MIT/IL Letter AG#370-69; George Cherry; Exegesis of the 1201 and 1202 Alarms Which Occurred During the Mission G Lunar Landing.

Summary:

A study has been performed by the FCI Laboratory staff to find a way to reproduce, without an actual radar pedestal, the RR-CDU interface condition that exists when the RR is moded to SLEW or AUTO. A setup has been devised, using a Resolver Circuit Tester (Apollo GSE) borrowed from AC Electronics, that causes the CDU's to slew at essentially 6.4 KC. This setup was enabled during a nominal G Mission descent simulation using the LUMINARY 1A Flight Program. The alarm conditions experienced by Apollo 11 were essentially reproduced.

The software performance of this simulation was analyzed and it is concluded that this input to the RR CDU's should permit a valid verification of the fix (PCR 848) in LUMINARY 1B. Further, we believe that this run also provides hybrid simulator confirmation of the diagnosis of the alarm condition in Apollo 11.

Discussion:

Along the lines of the recommendation in Reference 1 several possibilities for injecting signals into the front ends (A/D) of the RR CDU channels were evaluated to induce the CDU's to output at effectively slew speeds (6.4 KC). This investigation concluded that use of a resolver would be the best arrangment. A Resolver Circuit Tester, a piece of Apollo Ground Support Equipment, was borrowed from the AC Electronics Site Support group and this equipment was connected to the RR CDU's and to ATCA power. Monitoring of the CDU's on the DSKY (V16N72) showed a rapid, erratic variation of the shaft and trunnion angles. In order to get a better look at the effect an EMemory loaded special downlist was utilized. This program is prepared following the format of the so-called 70 word list used in the IMU Performance Test K START Tapes (-K00081). In this case it displays an ID word, 6 DP words each containing shaft and trunnion CDU counters, and two words of channels. In this way essentially a 20 ms (the interval between downlink transmissions) monitor on the angles is obtained. Examination of some printout of this list (Quick Look) showed total excursions of about 13 deg. almost entirely at 6.4 KC. It is estimated that the reversals which were at slow rate resulted in an average 15% pulse loss

compared to a continuous 6.4 KC slewing. However, it is felt that this is representative of the condition in the vehicle. Converting to central processor time loss from both CDU channels this is 13% instead of 15%.

A nominal descent was simulated using this setup to provide inputs to the RR CDU's. No attempt was made to reproduce exactly the Flight's initial conditions or to follow exactly the trajectory (flight path). The plan was to call up the V16N68 monitors normally, leaving them on a while to see if an alarm condition was induced. If one occurred the monitor would be re-established. The spare location - #26 - in the Descent and Ascent downlist was patched to display ALMCADR so that it could be determined which Job was being called at overflow.

The performance of this run, summarized in TABLE 1, was in significant agreement with the Apollo 11 landing on the moon based on data we have seen to date.

No alarm occurred in the first V16N68 monitor for a period longer than the 12 sec in the flight so V57E was executed. Thereafter, 1202 alarms came after V16N68's were entered in P63. The last monitor started in P63, overlapped into P64 and a 1201 occurred. A second 1201 came in P64 without DSKY entry as in the flight. Finally, there was one more 1202, but unlike the flight this was in P66.

There were no so-called multiple alarms-that is, one right on top of another or in fast succession, say at the rate of SERVICER (every 2 sec.). There were no 1203's. The RR CDU Fail indication, Ch30B07, was present throughout the run. This should be, if the resolver setup is working properly. Trajectory performance data has not been reviewed, but the Software Restarts did not cause any other perturbations noticeable to the Pilot and the landing seemed nominal.

Conclusions:

1. The Resolver Circuit Testor setup provides an input to the RR CDU's that adequately simulates the vehicle configuration when the panel control is in SLEW or AUTO.
   This arrangement should be used to verify the fix (PCR 848) in Luminary 1B.

2. The diagnosis of the alarm problem in Apollo 11 has been verified in the FMES/FCI Laboratory and the results agree quite well with the flight results.

CT/sjd

cc: J. Marino, J. Devaney, B. Sidor, J. Coursen, H. Wright, D. Markarian, L. Tucker, R. Schindwolf, P. Hoffman, H. Sperling, M. Rimer, S. Greene, M. Solan, R. Steele, W. Nufer, F. Chen, L. Russo, P. Chow, S. Berg, V. Sabella, R. Hong

TABLE I SUMMARY OF RUN

TIME FROM ENGINE ON (PDI) SEC.	TIME INTERVAL OF INTEREST	EVENT	CONTENTS OF AIMCADR	MACHINE ADDRESS AND GENERAL AREA OF CALLING PROGRAM	JOB CALLED AND TYPE	PROG. NO.
0		ENGINE ON				63
314.31		LRALT LITE OFF				
	34	V16N68E Release Monitor				
		V57E (Set F11B08, LRINH)				
360.22 368.23	8	V16N68E AC1202	03457 76000	37,3457, READACCS	SERVICER (FINDVAC)	
386.23 440.22	54	V16N68E AC1202	02654 20000	10,2654 GODSPRS1	MAKEPLAY (NOVAC)	
450.22 464.22	14	V16N68E AC1202	03457 76000	37,3457 READACCS	SERVICER (FINDVAC)	
480.22 488.22	8	V16N68E AC1202 (V74E)*	03311 62000**	41,3311 MONREQ (Pinball)	MONDO (NOVAC)	
502.21		V16N68E				63 64
504.21 512.24 532.23	30 28	LR in Pos. 2 AC1201 (V74E)	03457 76000	37,3457 READACCS	SERVICER (FINDVAC)	
582.63	50	AC1201 (V74E)	03457 76000	37,3457 READACCS	SERVICER (FINDVAC)	64 66
612.87 664.86 676.86	64	V16N68E AC1202 (V74E)	02654 20000	10,2654 GODSPRS1	MAKEPLAY (NOVAC)	66
728.10		(V74E)				68

* EMemory Dumps taken after these points.
** EXECUTIVE only stores FBANK.