



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
MANNED SPACECRAFT CENTER  
HOUSTON, TEXAS 77058

RECEIVED

MAY 18 1970

P. G. FELLEMAN

IN REPLY REFER TO: 70-FS55-100

MEMORANDUM TO: FS5/Head, Apollo Guidance Program Section

FROM : FS5/Head, Program Support Group

SUBJECT : Apollo 13 Postflight Report - AGC

1. Apollo 13 AGC personnel on console 37 were as follows:

- a) John R. Garman
- b) John W. Jurgensen
- c) James A. Martin
- d) C. David Sykes
- e) Robert Covelli (MIT)
- f) Tony Cook (MIT)

and continuous console support was supplied from T-10 hrs. until splash-down.

2. Included as enclosures to this report are the following:

- a) Encl. 1 - Apollo 13 EMOD's (1 page)
- b) Encl. 2 - Apollo 13 uplinks (2 pages)
- c) Encl. 3 - MCC-2 CMC Burn Data (1 page)
- d) Encl. 4 - MCC-FR LGC Burn Data (1 page)
- e) Encl. 5 - PC 2 LGC Burn Data (1 page)
- f) Encl. 6 - MCC7(AGS) LGC Burn Data (1 page)
- g) Encl. 7 - 6:00 GET P23 Data (2 pages)
- h) Encl. 8 - 31:00 GET P23 Data (2 pages)
- i) Encl. 9 - P52 Data, CMC & LGC (1 page)

3. The CMC was flown with Flight Program Manche 72, Rev. 3; and an erasable load as previously published but altered as follows. There were no late changes to the K-START tape necessary. At liftoff, the CMC automatically updated TEPHEM to reflect time of liftoff, 19:13:00.65 GMT. It then had value 2,460,678,065 cs, with corresponding octal 00011,05253,33661 in addresses 1706, 1707, and 1710. at GET 6:10, the crew reloaded the P23 W-matrix initialization parameters as per Flight Plan page 3-7.

WMID POS	80,000 ft.	addr 3000	octal 01372
WMIDVEL	7 ft./sec.	addr 3001	octal 00535

At GET 31:10, the crew reloaded the P23 W-matrix initialization parameter as per Flight Plan page 3-25.

WMIDPOS	45000 ft.	addr 3000	octal 00659
WMIDVEL	0.6 ft./sec.	addr 3001	octal 00035

At GET 32:03, the following IMU compensation parameters were updated.

NBDX	0.6 meru	addr 1460	octal 00114
NBDY	-1.2 meru	addr 1461	octal 77456
NBDZ	-3.0 meru	addr 1462	octal 77201

At GET 140:40 the splash point target was updated.

LAT (SPL)	21.66 deg South	addr 3400,01	octal 76046, 47254
LNG (SPL)	165.37 deg West	addr 3402,3	octal 61231, 72366

At GET 142:46, the following IMU compensation parameter was updated.

PBIASZ	-0.0547 ft./sec.	addr 1456	octal 72123
--------	------------------	-----------	-------------

4. The LGC was flown with Flight Program LM131A, Rev. 1; and an erasable load as previously published with alterations as follows. There was one late change to the K-START tape that was hand loaded prelaunch:

DELQFIX	200 ft.	addr 2520	octal 00000
		2521	01717

(this was a change to the least significant portion only)

It was then decided that DELQFIX should be 400 ft., with corresponding octal 00000, 03637. Because this parameter concerns the landing radar, this change was never incorporated. At GET 59:25, TEPHEM was updated to reflect time of actual liftoff.

TEPHEM 2,460,678,065 cs	addr 1706	octal 00011
(GET 19:13:00.65)	1707	05253
	1710	33661

DKDB, address 3011, was changed from its padload of 1/1.4° (200 octal) to 1/5° (44 octal) at 74:30 GET. It was returned to its padload value at 78:25.

5. The following narrative is intended to list only those major problems associated with CMC or LGC software and hardware as well as console operating and interfacing problems.

a. Prelaunch

(1.) CMC Erasable Memory Dump (EMOD) when first run in the RTCC did not contain compare data. This had happened previously during simulations.

(2) CMC Erasable loading sequence was performed twice due to repeating Saturn Dap tests.

b. Launch and TLI

- (1) No software CMC problems during launch or TLI.
- (2) Liftoff was detected (i.e. clock zeroed) at a CMC clock time of 43:13:00.65 (which, with TEPHEM, corresponds to April 11, 1970 at 19:13:00.65 GMT). The insertion orbit calculated by the CMC was 102.8 x 100.0.
- (3) See enclosure 9 for all P52 data. The TLI cutoff CMC  $V_I$  was 35,560 fps.

c. CIS - Lunar

- (1) During the P23 sightings that began at 6:00 GET, a (what has been termed) "very low probability" flagbit problem that appeared on Apollo 12, also appeared on Apollo 13. It is being fixed for Apollo 14, and the following is a write-up made by R. Covelli in real-time:

GET 9:00

Another manifestation of the optics problem described by Jack Garman during Apollo 12 occurred today.

The crew did a V37 during the final 0.2 seconds of an optics zero delay which destroyed the waitlist call that would reset bits 1-3 of OPTMODES.

Due to the fact that the V37 hit in the interval from 16.0 to 16.2 seconds after the optics zero, the CMC initiated optics zero command (bit 1 of channel 12) had been removed, so that the optics fail indication that occurred in Apollo 12 did not occur. The optics were still usable, and the only problem is that an OCDU fail would not light the TRACKER light, and consequently could go undetected by the crew.

This problem is the subject of Program Note A 1.2.1-b, where the recovery procedure is to reset bit 1 if OPTMODES and to cycle the optics zero switch. After studying the program, it was decided that this procedure would result in a program alarm (code 116), and the following procedure was recommended to the Guidance Officer: reset bits 1-3 of OPTMODES. This procedure completes all of the work that the aborted waitlist task would have done. The procedure is as follows:

V25N7E 1331E7EE

The procedure was read to the crew and performed, and all is now well.

(2) P52 measurements indicated a sign changed (polarity reversal) on the X-gyro free drift compensation (NBDX). At GET 17:00 MIT recommended a minimum update (because the value of the shift term had to be assumed as 1 meru for lack of data on the gyro). At 21:00 MIT obtained some data on the actual GYRO and found that the X-gyro shift term ( $\Delta D$ ) had been measured as zero. This led to their changing their recommendation to  $\pm .9$  meru. The next P52 after the NBD had been updated showed a return to the original sign of NBDX, suggesting that MIT's original recommendation might have been correct. The SM problem prevented further analysis.

(3) Beginning at about 15:00 the optics long-term trunnion? oscillation appeared on Apollo 13 as it had on previous flights.

(4) The only CMC manifestation of the SM electrical problem (O<sub>2</sub> tanks) was a hardware restart (the first not due to software in Apollo - along with many other firsts in Apollo) at 55:55. An erasable memory Dump at 57:22 was never received, but the EMOD at 140:24 verified no E-memory destruction. The IMU was powered down at 58:16, CMC at 58:17.

(5) The LAC was powered up at about 57:50 with initializations and docked coarse align complete by 58:14. An 1105 alarm residual was present when LGC data was first received. Included in later LGC initializations were:

- (a) Torquing the IMU (usual docked align procedure) at 58:46 with  $+.33$ ,  $+2.48$ ,  $-1.51$ .
- (b) V55 clock delta of  $-88:59:32.74$  at 59:13.
- (c) EMOD at 59:14, verified at 60:00.
- (d) Normal uplinks

(6) There was quite a bit of debate on whether or not the first docked DPS burn (at 61:30) was to be done P40-PGNCs, P47-PGNC's, or AGS. The concern was that of Guidance Officers over the inaccuracies of Cis-Lunar LGC integration (and, of course, giving the PGNCs full control via an (untried) procedure). Our (AGC) advice was to time-tag the LGC vector at average-G time to bypass integration, and to use P40 in the normal (designed for this case) docked autopilot mode. As pointed out by J. L. Norton, the P47-PGNC's mode wouldn't really work anyway since only P40 enables the autopilot to drive the DPS gimbal (not driving would, among other problems, cause a heavy use of RCS fuel). Despite our advice, the Flight Director was given a recommendation of burning P40-PGNC's only if MIT got a hybrid run completed. We received no hybrid results prior to the burn, but were able to

convince all that the burn should be P40-PGNC's, regardless of simulation/testing status.

(7) At 63:53 an LGC alarm 1106 was noted by AGC personnel (due to opening D.U.A. breaker, common occurrence in LM). The problem, however, was that the crew did not see it and much discussion finally led to the conclusion that systems people had forgotten that that CB configuration left DSKY lights (not numerics) unpowered. Our concern was that the crew couldn't see the Gimbal Lock Warning light but hadn't known that. The decision was to make sure the crew understood the situation and to power-up the DSKY lights during any extended period of time the ground wouldn't be able to monitor telemetry (such was the case soon after, and the lights were enabled).

(8) At 73:50 a short procedure for widening the autopilot dead-band was read to the crew. This excellent idea had been initiated by MIT via SPAN in order to save fuel during PTC. There seemed to be no MOCR (Guidance and Control) impetus to implement it, however, until we finally wrote it up ourselves and personally talked with both positions.

(9) We also had some coordination difficulties with the star check procedures to be used for verifying that the IMU alignment was still good enough for the PC+2 maneuver. The initial procedure called for a V49 maneuver to ground calculated gimbal angles which would put the star on the AOT cross-hairs. We pointed out that simply selecting P52 and inputting the desired starcode would not only be procedurally simpler (that's the normal 3rd star; check method after a P52) but would also save fuel by not constraining attitude about the star LOS (i.e. VECPOINT versus 3-axis maneuver).

After this was read to the crew and despite our explanations, the FAO gave CAPCOM the gimbal angles he thought the LGC should come up with. This was done off the loops and so we suddenly heard the angles being read up. We engaged; in a few more minutes lively debate leading to the CAPCOM having to tell the crew to ignore the angles he had read up (since VECPOINT output angles are a function of the starting attitude, the chances of even similar comparison would be slim).

(10) The LGC was finally powered down at 82:20 following the PC+2 maneuver and sleep preps. The LGC was not powered up for the subsequent MCC (at 105:10) and, in fact, was not powered up again until 133:37 for MCC7; and entry procedures.

d. Transearth through Re-entry

(1) Most significant AGC work during the period of flight following PC+2 until entry prep's was concerned with generating special procedures and advising at the numerous meetings that led to the final entry procedures. Significant contributions were made to the formulation of the following procedures:

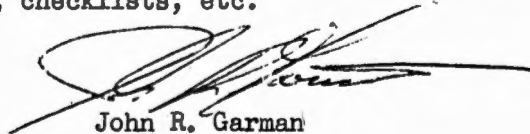
- (a) CMC alignment technique (for no stars and one set of marks constraints). This was the backwards docked-align technique used for re-entry but not in its entirety since it turned out that the coarse alignment portion gave him just enough auto optics capability to barely see, but mark, on stars.
  - (b) At about 124:00 GET we finally straightened out exactly which E-load constants were necessary for re-entry and the corresponding uplink loads that might have been sent. The initial list of constants received from Cambridge matched our initial list, both of which were proved wrong after a (Norton and Garman) review of the subject (MIT concurrence obtained at 130:00).
  - (c) LGC control procedure of establishing a CM roll rate if CM RCS were failed. MIT also provided an automatic procedure.
  - (d) We generated a procedure for bringing up the LGC and aligning the IMU with minimum capability and work for MCC7. This was incorporated into the LM checklist and the LGC was brought up.
  - (e) Numerous other minor procedures relating to both "nominal" and contingency situations.
- (2) LGC data was first received at 133:37 and the IMU came on at 133:41. At 1106 alarm occurred when the crew enabled the D.U.A. at about 134:27.
- (3) There were no major problems with the IMU alignment except for the very large NO5 which is still unexplained (sun-moon gave  $-1.12^\circ$ ). The alignment was performed by coarse aligning, then releasing the IMU at an earth reference attitude, then doing a P52 option 1 to the MCC7 alignment using the sun and moon to mark on.
- (4) There is an (as yet) unexplained attitude error needles problem that lead to some confusion about what burn attitude was for MCC7. In addition, Control was requesting AGS control for the burn and some MOCR personnel were confused over telemetry CDU angles versus the desired FDAI angles read up on the burn pad. Also, the crew inadvertently called P40 (vice P41) for the MCC which we all quickly caught.
- (5) SM sep was performed following MCC7 with the LGC in P47 with a final N83 of  $-.9, -.1, -.5$ .
- (6) At 138.17 the CMP was to power up the CMC then put it into standby. We had made the procedure as carefully worded as possible, but it didn't get to the CMP that way. First, he ended up in the post-restart portion of PO6. Then, he couldn't get the CMC into standby, so we suggested holding the PRO button for 10-15 seconds - it worked.

(7) The CMC was powered up at 140.21 (receipt of data) and the IMU at 140:30. Uplinking, alignment, etc., went nominally, except for a 220 alarm (first and last alarm in mission) because he forgot to set the flags, and he used stars for the P52 option 1; although those chosen by the CMC weren't bright enough, so he used ground supplied numbers. The CMC clock had to be updated twice because we all computed off of low bit rate the first time (thinking we were in HBR).

(8) Gimbal lock warning occurred a couple times during LM Jettison which was done at 141:30 with the CMC in P47.

(9) We lost LGC data with a final LGC clock value of 142:38:04.97. We lost CMC data in P63 with its clock at 142:39:25.65.

6. Any questions concerning this report should be directed to John R. Garman at ext. 2111. Further data and information are available at that extension in the AGC log, hardcopy file, checklists, etc.



John R. Garman

Enclosures 9

cc:

TRW/J. Norton

R. Harwood

MIT/P. Felleman

EG/J. Hanaway (2)

T. Lawton (MIT)

CFK/F. Hughes

CF/T. Kaiser

J. Monroe

FC/W. Fenner

E. Kranz

FS/L. Dunseith

J. Stokes

J. Williams

T. Price

G. Sabionski

T. Keeton

J. Martin

J. Jurgensen

C. Sykes

T. Cook (MIT)

R. Covelli (MIT)

FS55:JRG:csc

## Apollo 13 Erasable Memory Dumps (EMOD's)

### I. CMC

- A. T-24 hr, countdown (4/10/70, 4:49 am CST)
- B. T-17 hr, repeat of "A" (4/10/70, 10:05 am CST)
- C. 12:20 GET (1st night)
- D. 36:48 GET (2nd night)
- E. 57:22 GET - never received (SM problem)
- F. 140:24 GET (re-entry)

### II. LGC

- A. During CDDT prior to final LGC power-down.
- B. 60:00 GET (LM activation after SM problem)
- C. 135:17 GET (re-entry and MCC7)

ENCL. 1

FLIGHT DIR MISSION LOG		DAY	REV	PG
UPLINKS		APOLLO 13	APOLLO 13	P. 1 of 2
SITE/ACQ/LOS	FLIGHT EVENTS/HISTORY/BRIEFING			
GET OF UPLINK	TIME TAG OF VECTOR	LOAD NO.		V66
147:23	2:24	0002	CSM SV to CMC	Yes
04:59:00	REFSMMAT	1201	REFSMMAT	N/A
04:59:00	—	—	Zerolmann Bias	N/A
10:12:15	10:30:00.0	0004	SV	Yes
48:51	30:30:00.00	0005	S.V.	Yes
28:52	—	1001	XDELV MCC	N/A
32:08	—	—	NBDX, XZ	N/A
34:05	10:00:00.00	0006	SM SV	Yes
47:43	54:00:00.00	0007	CSM SV	Yes
<del>63:49</del>	<del>79:27:10.13</del>	<del>2003</del>	<del>LM SV</del>	<del>Yes</del>
59:23	<del>REFSMMAT</del>	2301	MCC REFSMMAT	
60:53		2202	XDV for MCC	
60:53		2401	CLOCK UPDATE	
60:53	61:29:12.84	2002	LGC/LM NAV	YES
63:49	79:27:10.13	2003	LGC/LM NAV	YES
75:41	79:27:10.07	2007	LGC/LM NAV (PL+2)	YES
75:41		2204	XDV for PL+2	
78:21	79:27:08.30	2008	LGC/LM NAV	YES
78:23		2205	XDV for PL+2	
134:34		2305	actual REFSMMAT	
134:36		2306	MCC REFSMMAT	
134:30		2402	LGC CLOCK UPDATE	
134:31	134:40:00.00	2017	LGC/LM NAV	YES
136:15		2206	LGC XDV for MCC	

[illegible]

ST 30 34 35  
ST 40 41 47

# MANEUVER

BURN ☐ WT 6.2  
PROP/GUID ☐

CMC (PRE)  
LM WT + \_\_\_\_\_  
CSM WT + \_\_\_\_\_  
PTRM 00  
YTRM 00  
USED ☐

GROUND  
+ 5 1 1 1 1  
+ 1 1 1 1 1  
1 0 0 1 1  
- 0 0 0 2 1

CMC (POST)  
WT + 6.2  
PTRM + 0 0 0 1 1  
YTRM - 0 0 0 2 1

TIG  
+ 0 0 3 0  
+ 0 0 0 1  
+ 0 1 7 0 0

$\Delta V_{LV}$   
- 0 0 2 1  
- 0 0 0 1 7  
- 0 0 0 8 0

## ATTITUDE

DMT  
ROLL  
PITCH  
YAW  
+ 1 9 1  
+ 1 6 4 3  
+ 1 6 3

CMC (PRE)  
+ 7 9 9 8  
+ 1 6 4 2 8  
+ 1 2 6 3 2

CMC (POST)  
+ \_\_\_\_\_  
+ \_\_\_\_\_  
+ \_\_\_\_\_

VG  
(THU)

DMT  
- 1 8 2  
- 1 3 2  
- 5 5

CMC (PRE)  
- 1 8 2  
- 1 3 2  
- 5 5

CMC (POST)  
- 1  
- 2  
- 2

VGBODY (POST)  
- 2  
- 2  
- 2

DMT Ha  
Hp

ORB Ha  
DIG Hp

CMC Ha  
Hp

MC  
STARCHK  
N92 ☐ ACTUAL ☐

PRE MINUS POST  
 $\Delta V_x$  - 1 8 2  
 $\Delta V_y$  - 1 3 2  
 $\Delta V_z$  - 5 5  
Tc/O  
TIGN  
BT

$\Delta V_T$  + 0 0 2 3 2  
BT 0 0 0 3  
 $\Delta V_C$  1 0 1 1 5  
SXTS 1 1  
SFT + 1 3 5 9 0  
TRN + 2 8 1 0 0

LAT SPL  
LNG SPL  
RTGO  
VIO  
T.O.SG

PRETHRUST 30 32 33 34 THRUST 40 41 42 BURN 11KCT

T-  
LOADED ☐

+	0	0	0	6	1
+	0	0	0	3	9
+	0	4	2	8	4

TIG  
(TPI)

+	0	0			
+	0	0	0		
+	0				

$\Delta V_{LV}$

-	0	0	2	1	3
+	0	0	0	4	1
-	0	0	3	1	2

$\Delta V_R$   
BT  
R<sub>FDAI</sub>  
P<sub>FDAI</sub>  
Y<sub>FDAI</sub>

+	0	0	3	8	0
	0	3	1		
+	1	2	0		
+	2	9	8		
+					

(32 ONLY)  
H<sub>A</sub>  
H<sub>P</sub>

+					

33 ALL

LGC

$\Delta V_{AGS}$

-	0	0	2	1	3
+	0	0	0	4	1
-	0	0	3	1	2

R<sub>TRM</sub> + 05.86  
Y<sub>TRM</sub> + 06.75

	LGC (INIT)	GROUND	LGC (PRE)	LGC (POST)
LMWT +	33731			33413
CSMWT +	63396			

ATTITUDE THRT  $\Rightarrow$  5 sec 10%, then 40%  
DMT TRIM ☐ U11 2 jet 10 sec  
LGC (PRE)

	DMT	LGC (PRE)	LGC (POST)
YAW +	92.6		
PITCH +	178.2		
ROLL +	4.5		

LGC (POST)

+	15.7
+	178.4
+	359.5

VG (IMU)

-	37.89
+	2.96
-	1.21

LGC (PRE)

-	37.89
+	2.96
-	1.21

LGC (POST)

-	21
-	06
-	27

VGBODY (POST)

+	2
+	0
+	3

PRE min: POST

TC/OB	8:17.07	$\Delta V_x$	-37.68
TIGN	8:42.84	$\Delta V_y$	+3.02
BT	8:34.23	$\Delta V_z$	-0.93

COAS  
AZ  
EL


	DMT (PRE)	ORB DIG. (POST)	LGC (POST)
H <sub>A</sub> +			
H <sub>P</sub> +			

ENCL. 4

7/15/69

LOG TIME OVER PRETHRUST 30 32 33 34 THRUST 40 41 42 BURN PC+2

TJ

+	0	0	0	7	9
+	0	0	0	2	7
+	0	3	8	3	0

TIG (TPI)

+	0	0			
+	0	0			
+	0				

ΔV<sub>LV</sub>

+	0	8	3	3	0
-	0	0	5	0	9
-	0	2	1	3	9

LOADED →

→ (32 ONLY)

→ 33 ALL

ΔVR  
BT  
R<sub>FOR</sub>  
P<sub>FOR</sub>  
Y<sub>FOR</sub>

+	0	8	6	1	5
+	4	2	4		
+	2	7	2		
+	0	8	1		
+	0	6	0		

LGC

HA + N/A  
Hp + 0 0 2 0 5

ΔV<sub>ASS</sub>

+	0	8	3	4	0
-	0	0	5	0	9
-	0	2	0	9	9

LGC (INIT)	GROUND ✓	LGC (PRE)	LGC (POST)
LM WT + 33413	+ 33452	+ 33449	+
CSM WT + 62396	+ 62480	+ 62479	+

U11 2jet 10.5sec, 5sec at min, 2 at max

ATTITUDE DMT TRIM ☐ DB collapsed to 1.4°  
LGC (PRE)

YAW	PITCH	ROLL	LGC (PRE)	LGC (POST)
+ 271.0	+ 353.0	+ 330.3	+ 264.87	+ 263.84
			+ 353.02	+ 354.30
			+ 330.33	+ 330.00

VG (IMU)	DMT	LGC (PRE)	LGC (POST)	VG BODY (POST)
+743.08	+743.08	+743.08	+ .75	+ 1.0
-426.42	-426.42	-426.42	- .51	+ 0.3
+90.84	+90.85	+90.85	- .19	+ 0.0

PRE HIGH POST

L AVE off ⇒ 0.57 -0.54 -0.19

TC/OT 32:02.12	ΔV <sub>x</sub> +742.13
TIGN 7:38.30	ΔV <sub>y</sub> -425.91
BT 4:23.82	ΔV <sub>z</sub> +91.04

COHS  
AZ  
FL


DMT (PRED)	ORB DIG. (POST)	LGC (POST)	ENCL. 5
L +	+	+	
Hp +	+	+	

7/15/69

RTGO: 1163.5 T.059 142:39:22

# LGC MANEUVER

PRETHRUST 30 32 33 34

THRUST 40 41 42

BURN

MCC7/AGS

TIG

+	0	0	1	3	7
+	0	0	0	3	4
+	0	4	8	3	4

TIG

(TPI)

+	0	0			
+	0	0			
+	0				

$\Delta V_{LV}$

-	0	0	0	3	1
+	0	0	0	0	0
+	0	0	0	0	1

LOADED

☐

☐ (32 ONLY)

☐ 33 ALL

$\Delta V_R$

+	0	0	0	3	1
---	---	---	---	---	---

BT

	0	2	3		
--	---	---	---	--	--

R<sub>FEAR</sub>

+	0	0	8	2	
---	---	---	---	---	--

P<sub>FEAR</sub>

+	3	5	8	7	
---	---	---	---	---	--

Y<sub>FEAR</sub>

+	3	5	9	8	
---	---	---	---	---	--

LGC

$\Delta V_{AGS}$


LGC (INIT)

GROUND

LGC (PRE)

LGC (POST)

LMWT + \_\_\_\_\_

+ 25181

+ 25187

+ 25177

CSMWT + \_\_\_\_\_

+ 62468

+ 62470

+ 62470

used

ATTITUDE

TRIM

no

☐

DMT

LGC (PRE)

YAW + 25181  
PITCH + 358.7  
ROLL + 8.2

+ 0.04  
+ 1.04  
+ 7.88

LGC (POST)

+ \_\_\_\_\_  
+ \_\_\_\_\_  
+ \_\_\_\_\_

VG (IMU)

DMT

+ 3.02  
+ 0.44  
+ 0.07

LGC (PRE)

+ 3.02  
+ 0.44  
+ 0.07

LGC (POST)

- 0.04 (-0.06)  
- 0.17 (-0.23)  
- 0.05 (-0.08)

VG BODY (POST)

+ 0.0  
+ 0.1  
+ 0.0

PRE minus POST

TC/O  
TIGN  
BT

:	:	:
:	:	:
:	:	:

$\Delta V_x$   
 $\Delta V_y$   
 $\Delta V_z$

+ 3.06  
+ 0.61  
+ 0.12

during  
maneuver  
to smap  
COAS  
AZ  
EL


DMT (PRED)

ORB DIG. (POST)

LGC (POST)

ENCL. 6

Ha + \_\_\_\_\_  
Hp + \_\_\_\_\_

+ \_\_\_\_\_  
+ \_\_\_\_\_

+ \_\_\_\_\_  
+ \_\_\_\_\_

7/15/69

# P23 DATA

BIAS - .003

ID	TIME	ΔR	ΔV	SHFT	TRUN	CDUX	CDUY	CDU
STAR 33 N88	6:10:10.24	39.6	0.2	478.15	38.783	158.93	297.33	359.2
(E) N H M (F) L	6:11:19.73	1.6	0.3	278.04	38.849	158.83	297.22	359.2
	6:12:29.52	1.4	0.7	278.01	38.912	158.55	297.04	359.2

BIAS - .003

ID	TIME	ΔR	ΔV	SHFT	TRUN	CDUX	CDUY	CDU
STAR (221) + 39954	6:18:21.40	13.4	2.6	102.50	34.523	159.11	297.36	359.47
N88 26599 - 14003	6:18:57.82	53	1.2	102.49	34.492	159.16	297.29	359.47
(E) (N) H M F L	6:19:34.07	3.2	.9	102.50	34.462	159.19	297.21	359.47

BIAS .

ID	TIME	ΔR	ΔV	SHFT	TRUN	CDUX	CDUY	CDU
STAR 125 - 12136	6:22:49.81	7.6	.3	290.52	34.636	159.53	298.62	357.2
N88 34223 - 12133	6:23:33.53	1.4	.1	290.30	34.615	159.49	297.87	357.2
(E) N H M (F) L	6:24:11.53	0.7	.1	289.91	34.102	159.54	297.74	357.2

BIAS .

ENCL. 7

# P23 DATA

BIAS .

ID	TIME	ΔR	ΔV	SHFT	TRUN	CDUX	CDUY	CDU
STAR 40	6:28:14.13	26.6	11.0	161.99	34.004	162.44	302.47	357.4
N88	6:30:51.82	30.3	12.4	161.84	33.973	163.02	302.03	357.4
(E) (N) H M F L	6:32:09.04	0.5	0.2	162.81	33.949	162.48	301.89	357.7
	6:33:04.23	0.3	0.2	162.44	33.935	162.69	301.84	357.7

BIAS .

ID	TIME	ΔR	ΔV	SHFT	TRUN	CDUX	CDUY	CDU
STAR 42	6:39:18.12	4.3	4.3	21.72	25.285	162.49	291.01	359.4
N88	6:39:59.30	23.1	6.7	21.54	25.307	162.72	291.06	359.2
(E) (N) H M F L	6:41:21.98	23.7	8.7	21.98	25.340	162.92	291.06	359.6
	6:41:55.64	6.1	2.5	21.61	25.315	162.52	290.95	359.4

BIAS .

ID	TIME	ΔR	ΔV	SHFT	TRUN	CDUX	CDUY	CDU
STAR	: : .	.	.	.	.	.	.	.
N88	: : .	.	.	.	.	.	.	.
E N H M F L	: : .	.	.	.	.	.	.	.

BIAS .

ENCL. 7

BIAS-.003

FCS DATA

ID	TIME	ΔR	ΔV	SHFT	TRUN	CDUX	CDUY	CDU
STAR 37	31:16:22.69	2.2	0	294.90	23.885	136.13	306.97	000
N88	31:17:14.96	3.3	0	295.19	23.885	136.12	307.09	000
(E) N H M (F) L	31:17:47.98	.5	0	295.27	23.890	136.96	307.14	0

BIAS .

ID	TIME	ΔR	ΔV	SHFT	TRUN	CDUX	CDUY	CDU
STAR 221 39954	31:20:43.17	0.5	0.0	117.95	17.205	135.77	307.50	000
N88 26599 14005	31:21:26.69	.3	0	118.18	17.202	135.62	307.57	0
(E) (N) H M F L	31:22:03.22	1.3	0	118.36	17.196	135.49	307.64	04

BIAS .

ID	TIME	ΔR	ΔV	SHFT	TRUN	CDUX	CDUY	CDU
STAR 212 + 03605	31:24:33.75	1.0	0	302.74	31.773	135.43	307.95	04
N88 43220 - 24881	31:25:14.77	.8	0	302.86	31.776	135.79	308.02	07
(E) N H M (F) L	31:26:03.31	.5	0	303.02	31.779	135.13	308.11	0

BIAS .

ENCL. 5

# FLS DATA

BIAS .

ID	TIME	ΔR	ΔV	SHFT	TRUN	CDUX	CDUY	CDUZ
STAR <u>44</u>	31:28:45.85	3.7	.0	162.38	35.377	135.77	308.95	1.2
N88 .	31:29:32.33	3.6	.0	162.16	35.377	135.86	308.88	1.2
(E) (N) H M F L	31:31:07.93	2.1	.0	161.55	35.366	136.13	308.72	1.2

BIAS .

ID	TIME	ΔR	ΔV	SHFT	TRUN	CDUX	CDUY	CDUZ
STAR <u>212</u>	31:34:19.68	1.5	.0	301.77	31.801	135.85	307.39	1.2
N88 .	31:35:10.15	.8	.0	301.42	31.806	136.04	307.19	1.2
(E) (N) H M (F) L	31:35:52.41	.2	.0	301.21	31.814	136.23	307.05	359.9

BIAS .

ID	TIME	ΔR	ΔV	SHFT	TRUN	CDUX	CDUY	CDUZ
STAR <u>77</u> +03986	31:41:54.48	0.6	0.0	309.84	31.968	136.78	306.97	359.4
N88 <u>41062</u> -28249	31:42:38.89	1.4	0.0	309.83	31.965	137.00	306.88	359.4
E N H M F L	31:43:35.78	.1	.0	309.65	31.976	136.83	306.84	359.2

BIAS .

ENCL. 8

MARK TIME 1 = TORQUE TIME

FLIGHT DIR MISSION LOG		DAY	REV	PL				
		CMC	P52'S	APOLLO 13				
SITE/ACQ/LOS	FLIGHT EVENTS/HISTORY/BRIEFING							
GET (TORQ)	S1	S2	N05	N93 x	y	z	OPTN	TQ
43:59.57	26	33	00	-0.067	-0.000	+0.162	3	Y
05:24:23.93	35	44	01	+0.175	+0.172	-0.012	(P <sub>1</sub> ) 1	Y
10:22:07.02	20	27	00	-0.123	-0.113	+0.092	3	Y
23:46:43.73	31	36	+0.01	-0.283	-0.161	+0.403	3	Y
28:59:05.77	30	32	+0.01	-0.084	-0.075	+0.146	3	Y
49:07:42.54	23	32	<u>00</u>	+0.285	+0.011	+0.131	3	Y
140:52:30.47	36	40	.00	-1.253	+0.358	+3.263	1	Y
LGC ————— LGC ————— LGC —————								
58:46	DOCKED	ALIGN	+0.33	+2.48	-1.51	"3"	Y	
135:04:25	Sun	H <sub>1</sub>	-1.12	-1.713	-3.278	-1.395	1	Y
ENCL. 9								

MSC FORM 1441 (APR 66)

FLIGHT DIRECTOR'S MISSION LOG