

UNITED STATES GOVERNMENT

# Memorandum

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TO : FA/Director of Flight Operations

FROM : FC/Chief, Flight Control Division

SUBJECT: IM-1 Operations Team Report

DATE: FEB 21 1968

The IM-1 Operations Team Report is enclosed for your review. This report is divided into two sections as follows:

1. Flight Director's Report.
2. Flight Controller Position Reports.

*John D. Hodge*  
John D. Hodge

Enclosure

cc:  
See attached list

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## FLIGHT DIRECTOR'S REPORT

### PREMISSION OPERATIONS IM-1

My initial contact with the IM-1 Mission was through the FDSM's that occurred from August 1966 through December 1966. During this period of time, I was impressed by the quality of the personnel involved; however, I was also concerned by the lack of operational experience (depth) of the team. The majority of these meetings was devoted to discussing the "real" systems constraints and reviewing the network status and requirements. During the fifth FDSM, November 16, 1966, I concurred that we would not require an MMDB for IM-1. I believe in retrospect that this was a major error, and regarding this I would like to say a few words.

#### Modular Mission Data Book

This document, as conceived by Mr. Lunney and Mr. Harlan, was to be composed of 3 sections: Operating Constraints, Parametric Data, and the Blocks. I do not believe that we will ever be able to do our job completely until proper management and authority is put into this document. I believe that much of the problem we had on Launch and Flight Mission Rules and the hundreds of hours of argument could have been put to better usage. This problem was to become acute when we started using "Mission Rule Change Sheets." The rationale for these rules changes required a definition of a source for all limits and procedures. The "source" data varied from telecon, to test data, to "gut feeling." This caused us to repeatedly call and draft memo's to the subsystem managers requesting their review. This situation must be improved for future missions.

### Recommendations

There are many ways to manage this document; however, I believe that the FCD Systems Branches should be the technical managers of the Constraints and Parametric Data Sections, while the FCSD should manage the Building Blocks. This will provide the required motivation and technical follow-through that should guarantee the validity of the data. An alternate approach, that is preferred by the majority of the FCD personnel, is to maintain the technical control of the MMDB in the Program Office but assign greater emphasis to this effort. In this area it is possible that the mission staff engineers could provide the operational monitoring. It is mandatory that we develop, maintain, and use the MMDB (or an equivalent document) as the "Bible" for defining the systems constraints and parametric data necessary to plan and conduct a mission. This document should contain both the spacecraft systems as well as the guidance system constraints. It should address the total spacecraft.

As we studied the mission in greater detail, it became apparent that we had to assure that both the requirements and ground systems were properly defined and integrated into the mission. We started off by a page-by-page review of the FCDAR, similar to the Project Mercury OR and OD Reviews. We were able to close this part of the loop, but now we needed a man fulltime to keep it closed.

At this time, I requested MCRB to provide fulltime dedicated mission monitoring. Mr. Dunbar was assigned, and we proceeded to verify that he participate in all mission and procedural discussions. His job was to "verify that the mission requirements were compatible with the mission

plans and intended procedures." Mr. Dunbar, after several months, handed over this task to O. Lindsey and H. Stenfors. The latter two accepted the "drape" and proceeded to crosscheck our requirements from a mission standpoint. In this area, Mr. Lindsey contributed significantly in avoiding "things going down the crack." In this area, he provided weekly status reports on the FCDAR and various change request status. The only significant deficiency that existed was an in-house problem where once Mr. Lindsey identified a problem, the next persons in the chain in FCD did not feel the same urgency. This problem started to correct itself later. The prime contribution of Mr. Lindsey was his work in developing and implementing the "Flight Control Trouble Report." I must say that this activity in the MCC again paid large dividends.

#### Recommendation

Establish the position of "Mission Requirements Engineer" in the MCRB. Staff it with the best-qualified personnel. In addition, make the "Flight Control Trouble Report" a standard item for all missions. The format used for IM-1 was excellent.

In the detailed procedural reviews, we realized the utter dependence of the mission on our network equipments and procedures, and in March, 1967, started mission reviews for the Network Controller and CCATS personnel. Again, it was believed that the more personnel knew about the mission, the better our chances of success. The opinions and recommendations of these personnel was excellent, so I will not dwell on them. FSD had made some organizational and management changes that created a "204/IM-1 Test Team."

This was the first time I had heard of the Test Team, as defined in L. Dunseith's memo. I did, however, think it was a good idea. In actuality, the Test Team operation led by G. Ojalehto was excellent. The support of E. Clayton and G. LeBlanc contributed greatly to a "Can Do" atmosphere that enabled us many times to hurdle major obstacles. In all cases, we met or bettered all scheduled activity between the 501 and 204L Missions. The quality of the test effort, as well as the "dogged" pursuit of even the smallest glitch resulted in a very early ground system maturity. This confidence in the ground system and its personnel at Houston never wavered.

One minor problem that occurred on several occasions was that of scheduling. As the schedule changed on an almost daily basis, we found that we would be frequently needing scheduling answers, but the FOSO man was not in a position to give them nor commit to a new schedule within reasonable times.

### Recommendation

Continue the Test Team operations as they were performed on IM-1. Attach, or maintain, a mission-oriented FOSO man under the control of the Test Team Leader to provide more timely and proper evaluation of scheduling requirements.

After the completion of the first set of the Mission Rules and Timelines, we proceeded to initiate the development of the updates to this document. Immediately, we ran into trouble identifying the rationale behind the first set of rules and procedures. (Frequently, the key man that had defined the constraint would be missing, or we may have forgotten some of the constraints which was normally the cause.) This led us to institute the "Mission Rules Change Sheets" which would establish a rationale data base to be utilized in the future rules discussions. This effort is defined in the FCD Mission Rules Preparation" document. There are many other benefits in addition to the rationale:

- a. Expedites the review of new rules.
- b. Provides historical base for mission rule decisions that may be required many missions in the future.
- c. Reduces the number of rule changes by improving the quality of initial inputs.
- d. Allows FOD management personnel an opportunity to easily monitor the development of mission rule philosophy.
- e. Closes the coordination loop prior to the mass mission rule meetings.

f. Assures better review and understanding of the rules by all mission personnel.

In addition, in the process of mission rule development we ran across both "hard" and "soft" limits on both the systems and trajectory rules. We initiated the process of underlining all "soft" limits in order to flag to the Program Office, subsystems personnel and the manufacturer, those areas where there was agreement on the ruling, but the limit value at which the ruling would be applied was still "soft" (i.e., insufficient data, or data inconclusive). This process allows all personnel listed above to recognize the major open areas and initiate unilateral activity to obtain that data which falls in their area of responsibility.

#### Recommendation

Continue the use of the Mission Rule Change Sheets and the identification of "soft" limits by underlining. Improve the quality of the rationale behind each rule.

The mission now progressed into the detailed planning stage. With the advent of this phase of operations we had our initial sustained interface with the ASPO Mission Engineer. For the IM-1 Mission, Mr. W. McKenzie was the assigned engineer. From the very beginning, he pitched in and assumed the burden of defining, justifying, and analyzing the mission objectives. In addition, he established the delta priorities within the objectives, undertook to obtain the written engine constraint, and participated fully in all mission discussions. I believe that this interface with the Program Office, initially with McKenzie and later

with he and Tomberlin, gave us a strong interface that allowed the mission development to progress smoothly.

Recommendation

Assign 2 mission engineers to support each mission, each with equivalent capability of Mr. Tomberlin and Mr. McKenzie.

The next step in development was to develop a detailed awareness of the Mission Plan in the CCATS controllers. Wherever possible, we set up briefings for the CCATS controller on the mission systems and alternates, and stressed the need for a "perfect" ground system. During the mission testing and training, I spent several hours sitting with RTC and TIC at their consoles, and advised all flight control personnel to do likewise. I believe that many of the MOCR personnel developed a bit of "humility" when they recognized the size of the job, and the technical capabilities of the CCATS controllers. Again, the team further closed the gap between the MOCR and CCATS. The benefits were obvious, for the MOCR and CCATS reached a detailed understanding of each other's job.

Recommendation

For all future missions, the MOCR controllers should be required to spend at least 1-3 hours monitoring the CCATS operation, and thus develop a better understanding of the tasks of the CCATS controllers.

As the simulation operations progressed, we now began to recognize some problems within our network systems. These problems fall into two categories:

1. Problems relative to data validity.
2. Problems generated by remoting the network.

#### Data Validity

In addressing the first problem of data validity, it is pertinent to note that I consider this a true "safety of flight" item. Two major cases occurred several times during the IM-1 Mission. The first case is one of static data on all displays. The only way for a flight controller to note whether his data is valid is to note whether the clocks on his display are counting. In addition, all displays do not have the clocks. This is also true for the CCATS and computer controllers. In one instance, both the MOCR Guido and RTCC T/M were trapped by this display during live commanding in a pad test.

There is also a further case that is worse. If a TV channel is "flagged" that channel will stop updating, but the clocks on the TV tube adjacent to the static tube will be counting. This occurred at least 3 times during IM-1 operations. The only way to detect this case is to have selected the TV guide, and to have the display people notify the MOCR that a TV channel is static.

The previous item has been studied, traded off, deemed both adequate and inadequate by many people. In my opinion, it is a hazard to the operation and must be corrected.

#### Recommendation

Provide display invalid lights above each TV tube in the MOCR. (Also, critical SSR positions.) Further study should be applied in this area to identify other configurations that result in invalid data being displayed.



In addition, I feel that there are three problem areas that are occasioned by the fully remoted data network. The major problem area is the lack of a data reduction and analysis capability within the Control Center. To be more specific, on previous missions, we relied very heavily upon trained remote site personnel monitoring realtime analog data, and being in a position to rapidly reconfigure their site to play back high-rate analog data onto their local site recorders. This generic capability exists within the MCC; however, I now feel that this capability must be upgraded to allow a fuller analysis of the propulsion and stabilization systems operations. The voice data lines, site and Control Center patching, switching and calibration of this data must be upgraded. In addition, room within the Control Center should be provided with data tables, gerber scanners, etc., to allow the proper analysis of this data. This area should not attempt to duplicate the Building 45 capability, but should provide a practical capability of performing post-event analysis.

The IM-1 mission simulations provided sufficient indications relative to the need for significant analog data capability, in order to analyze engine, guidance, control systems operation and interaction.

#### Recommendation

FCD define the needed analog capabilities, with FSD conducting simultaneous study of analog data handling techniques.

The next problem that exists is the total lack of data in case of a CP failure anywhere in the long line of CP's from the site to the TV tube. A sustained CP outage could seriously cripple a mission. I believe the

fix could be relatively simple by incorporating a limited number of summary messages formats in the 642B computers. These summaries would be output in PCM counts vice either EV or hexadecimal, would be generated by the local site M&O, and would not be rebroadcast. The majority of the CP's around the world can be bypassed in a torn tape mode for teletype traffic. This would enable at least a "mercury" type of operation and minimal systems analysis of the outage.

#### Recommendation

Modify LSD philosophy as defined above.

The third problem cuts across many areas, and is pertinent to the display of data. At present, the basic display device is the D/TV System. This should be augmented by a balanced analog system that will enable post-pass analysis. In addition, there is a need for an adequate hard copy output. At present, the hard copy system is being improved in quality, but I still feel that this may be inadequate. I feel that there is a need for a hard copy printout, similar but faster than that which was provided to the Gemini Remote Sites (R.O.). These devices should be provided to each SSR to enable them to obtain digital printouts of data from the RTCC. Some of the utilizations of this device are listed below.

Printout of PSAT - would allow readable, reproducible printouts for mission planning. Could be used under opaque TV to reduce channel loading.

Printouts of selected and/or group parameters - This would allow the digital development of data necessary for trend plots, reduce the real time D/TV requirements, allow bypassing TV system in case of failure.

Printouts of Flight Plans, when and if such a device is ever developed.

Printouts of results of T/M Diagnostic Program - This program, incidently, worked quite well and should be continued.

In essence, as the mission operations for Apollo continue to mature, a heavier workload will be placed upon the operations personnel due to both the mission complexity and the impact of the remoted network. It is essential to develop a balanced display system that provides the necessary data in an appropriate analog or digital format, and then select the appropriate device for the display of that data.

#### Recommendation

FCD/FSD review existing display output requirements and determine ground display system functional capabilities necessary to sustain planning and operations.

As the mission became very proximate, we again had problems with the systems constraints and parametric systems data. This was to become acute in the areas of Launch Mission Rule "redline" values. I monitored the perimeter arguments and talked with J. Tomberlin frequently. In my opinion, the E&D inputs for redlines were generally the "best judgement" derived by the subsystems personnel. In most cases, adequate preparation and rationale was not provided by ASPO and E&D personnel. We (FCD) were, however, fully required to justify our "inputs". This approach became a real irritant and an extravagant waste of time, and it was difficult to maintain a semblance of interest in FCD's part during these sessions.

### Recommendation

The first recommendation is to provide the redline data in the MMDB, subsequent to that reference the MMDB values in the Launch Mission Rules (page extracts, if possible, to avoid transcription errors), and lastly, implement applicable recommendations from the MMDB and mission engineer as described previously.

In addition to the Launch Mission Rule redlines, there was a significant gap in the definition of the S/C configuration as defined in the Launch and Flight Rules. The Flight Rules are based upon the assumption that all systems have been functionally verified, are in a specific configuration at launch, and where no T/M exists and/or the systems are operating within specified limits. This configuration definition is necessary in order to establish the validity of the Flight Rules.

### Recommendation

The Launch Rules should have a configuration checklist that will define the last time the system was checked, the TCP number and date, and DR's listed against that system. It is recognized that this could become a relatively large task, and in an effort to define the "scope" of the checklist, a meeting should be established between KSC and MSC under the chairmanship of ASPO, preferably Mr. Tomberlin.

I believe that the remainder of the flight controllers reports adequately cover the more specific problems that occurred immediately prior to and during the mission.

## FLIGHT DIRECTOR'S REPORT

### IM-1 MISSION OPERATIONS

This debriefing is derived solely from the voice loop recording at the Flight Director's Console and the Flight Director's log during the countdown, launch, and orbit phases of the IM-1 Mission.

#### COUNTDOWN

The White Team initially came on duty at 0230Z at T-10:30 to pick up the command checks with the launch vehicle. At T-10 hours and 20 minutes, the command system was armed in preparation for the single word dump and sector dump commands. The launch vehicle's interface was concluded successfully at T-10 hours and 16 minutes and the command system was safed. At T-8:30, through monitoring the SRO and discussion with CVTS Test Supervisor, it was noted that two failovers of the range command transmitters had occurred during command checks with the Saturn launch vehicle. At this time, we were about 15 minutes behind in the countdown; however, the estimate to repair the range transmitters was relatively short and the countdown was continued. During this period of time, there was minimal activity from the Houston standpoint, and the White Team reviewed their Mission Rules and their countdown documentation. The White Team continued on duty until 0800Z, at which time they were relieved by the Blue Team who continued the network and the space vehicle countdown. The Blue Team shift was essentially uneventful with the exception of two major items. During one of the network data flow tests, an invalid command execute was transmitted

to the Goldstone site. This command was a CSM Nav update and was supposedly not continued in the operational command system. Network personnel continued to evaluate the source of this invalid command generation throughout the remainder of the countdown. In addition, the Redstone tracking ship computers faulted and we had no estimated time when these computers would be operational. The Redstone was a mandatory piece of network instrumentation. The network controllers and the network support team continued to work with the Redstone tracking ship throughout the remainder of the countdown. The network countdown was uneventful with the exception of minor failures on certain network sites that occurred during the countdown process. The Launch Flight Control Team arrived onstation at T-3 hours. At this time, the network was essentially in a GO configuration with the exception of the Redstone site. The countdown was resumed and continued down until T-2 hours and 30 minutes. The erasable memory load was transmitted via the pad AGE equipment and was verified by Houston. Houston completed the erasable memory initialization by transmitting a verb 34 command. At about the same time, it was noted that a GSE problem had apparently developed in the freon system and the glycol temperatures in the spacecraft were going up very rapidly. The hold duration was approximately 3 hours and 45 minutes. During this period of time, we developed procedures to work around the failure of the Redstone ship telemetry computer. The basic procedure was to determine prepass what types of data we required from the Redstone, and make a decision approximately 20 minutes prior to each pass as to whether we would have the telemetry or the command program loaded in the one operational computer. For launch, we decided

that we would load the command program in the operational computer and, if necessary, command in the blind using local site printouts to determine whether the commands had been received by the spacecraft. The countdown was resumed at T-2 hours and 30 minutes at 2018Z. At this time, I gave a GO for LH<sub>2</sub> loading, and the countdown continued. Lox loading was completed at T-2 hours and 19 minutes, and the countdown continued normally through to launch.

#### LAUNCH PHASE

Liftoff occurred at 22:48:09Z. Due to the time delays associated with the telemetry system, command (5E) was transmitted to back up the guidance reference release. These commands were transmitted to the spacecraft at T+8 seconds when the Guidance Officer did not see the auto GRR. Launch phase reporting was normal with inboard engine cutout on the SIB vehicle at 2 minutes 22 seconds. Outboard engine cutoff occurred at 2+26. Staging was confirmed, thrust was OK, and we moved into Program 12 in the IM guidance computer. The IM guidance computer issued the proper commands to open the IM water valves to initiate sublimator operation. At 04:00 minutes elapsed time, the internal status check at the Control Center indicated we were all GO. Subsequent status checks at 6 and 8 minutes indicated GO conditions also. At 09:20 GET, we moved into the Mode IV or Contingency Orbit Insertion Phase of the mission. The launch proceeded normally through to 9 minutes and 58 seconds, at which time the J2 engine on the SIVB cut off. The events, rates, and times based on the SIVB all occurred as expected; the IM guidance computer moved into Program 13; the nose cap was jettisoned;



and the abort and tumble monitors were disabled. We very rapidly got a GO condition from the FIDO and at 12 minutes and 48 seconds, obtained confirmation that our initial tracking identified that we were in an 87 by 118 n.m. orbit. During the entire course of the Launch Phase of the mission, the Range Safety Officer was reporting in on the Flight Director's loop at intervals of about 60 seconds with his status. I believe this was a good procedure that was developed in support of the 501 Mission and in essence replaces the Mercury and Gemini Range Safety Observer task. The Redstone telemetry computer was reported as having faulted during the early Launch Phase of the mission and we would not have telemetry from that site after insertion.

ORBIT PHASE  
Rev 1

The status check after insertion indicated that all spacecraft systems were GO. The spacecraft cabin pressure had stabilized around 5.5 psi. Nosecap jettison was confirmed at approximately 11:15 GET after liftoff. LOS at Bermuda occurred at approximately 13:10 GET and command handover was performed to the Redstone ship; however, no telemetry data was available at this time. At 13:30, the Booster Systems Engineer advised that they had an apparent leak in the gaseous nitrogen sphere pressure for their environmental control system, measurement #B25-601. From the lifetime standpoint, this would not influence the spacecraft system test objectives, inasmuch as separation should normally occur prior to the time that any problems in SIVB ECS might begin to constrain us. At T+14 minutes EECOM advised me that he had seen a short transient of 65A total current at approximately T+2 minutes; the prelaunch currents were



indicating 58 amps. The liftoff azimuth was 122.8 degrees, which during the powered flight, due to the platform bias, would indicate a northerly deviation. From the standpoint of our subsequent maneuvers with the IM guidance computer, this bias would tend to raise apogee, and the bias was in the preferable direction as determined by prelaunch analysis. The glycol temperature, confirmed at Bermuda LOS, was 43.8 degrees and apparently the sublimator was coming online very well, and systems temperatures were going back to normal.

#### SLA

At Canary acquisition, all spacecraft systems appeared normal; however, the Booster Systems Engineer did not see an indication of the SLA deploy physical monitor measurement via the data that was being transmitted back to Houston from the Canary Islands. At approximately 22 minutes, the Booster Engineer transmitted the SLA deploy command. At the same time the Guidance Officer indicated that he was picking up some booster attitude errors. We did not get telemetry confirmation on SLA deploy. The Booster Engineer identified that the launch vehicle attitude errors were within the deadbands of the system and the launch vehicle was nominal from an attitude control standpoint. The Mission Phase 7 timers were loaded and counting and the LGC sequencing continued normal over the Canary Island site. I requested the Booster Engineer to obtain from the Canary Island ground station all three indications relative to SLA panel deployment; these indications are SLA deploy relay "A," SLA deploy relay "B," and SLA deploy physical monitor. LOS at Canary Island occurred 24 minutes into the flight. After LOS, the BSE advised me that the SLA deploy physical monitor indicated a "one"

status bit which would indicate that the SLA had actually opened. At this particular time in the mission, I was not too concerned, inasmuch as we had another independent site that could verify the status of SLA panel deploy, namely the Coastal Sentry Quebec (CSQ) ship. In addition, if necessary, we could slip the separation maneuver until the Continental United States at the end of the first revolution in case we required any further data readouts. The total plan for no SLA deploy was contained in "Alternate D." We were still tracking down the SLA deploy status at 27 minutes elapsed into the mission, and I requested the Booster Systems Engineer to go back to the Canary Islands to determine if the physical monitor indication had been time-tagged to correlate with either the LVDC time-base command or the ground transmitted command. At approximately 30 minutes elapsed time into the mission, I was advised that our mission operations computer, the MOC, had gone down and that the computer supervisor had switched to our dynamics standby system. At this time, he was preparing to make a restart to reinitialize both systems and transfer that mission data from the dynamic standby that had been accrued so far into the mission into the other machine to maintain a redundant computer capability. I cleared him for this restart at 32 minutes into the mission. At the same time, the IU telemetry data was being played back from the Canary Islands site, and I advised the Flight Controllers that I wanted the Canary Island playback data terminated by the CSQ acquisition minus 5 minutes. One of the other factors that tended to confuse the status of our SLA deploy was that for a period of time, we lost the LVDC and IU telemetry during the Canary Island pass. Data was lost for approximately 1 minute and 40 seconds.

CYI LOS STATUS

A quick status check after Canary Island LOS indicated, from a launch vehicle standpoint, that the gaseous nitrogen sphere pressure for the environmental control system would provide us at least  $3\frac{1}{2}$  hours of cooling prior to depletion. In addition, at this time we believed the SLA panels had been deployed; the Pad message had been transmitted to the remote sites indicating the Mission Phase 7 enable times; the Guidance Officer had confirmed that the guidance reference release was generated automatically and had not been executed as a function of the (5E) command. FIDO advised that we could not use Canary Islands data as their tracking data had been rejected. Our anchor vector from an orbit standpoint was based on the Bermuda data and indicated an orbit of 87 by 119 nautical miles. All other spacecraft systems were GO at this time. EECOM advised that telemetry data quality VHF was very good and they had experienced only short dropouts during the Launch Phase and over Canary Islands. At the completion of the status check, we polled the room to see if there were any further updates to our separation criteria defined in the Mission Rules. At 37 minutes into the flight, I conducted a status check with the CSQ and Carnarvon sites and briefed them on our status to date. In addition, I hacked their Mission Phase 7 enable and separation times. At this time, we reviewed in detail the Mission Rules associated with the SLA deploy problem.

MORE ON THE SLA

The BSE advised me that, due to a ground station readout error or error in identifying the parameter desired for readout, the only

indication we could confirm on SLA deploy was the SLA deploy relay "A." At this time, I became seriously concerned relative to our SLA panel deployment. Previously, I believed that the physical monitor indication, if present, was a very reliable indication, indicating that the SLA panels had actually deployed. To obtain this indication you had two microswitches on each SLA panel (each of 4 SLA panels) rigged in a series, parallel arrangement. All four panels must deploy to get the proper limit switch indications. Therefore, if the indication were present, it truly indicated that the SLA panels had deployed fully. However, the absence of this indication did not necessarily mean that they had not deployed. The SLA deploy physical monitor instrumentation, I felt, was quite complex. As such, we had determined through our Prelaunch Mission Rules that if we had both the relay "A" and "B" indication indicating that power had been applied through the relays to deploy the SLA, or the SLA deploy physical monitor, we would continue with the separation. Now we were faced with making our GO/NO GO decision for separation based only upon the CSQ data. We had not been able at this time to get any further confirmation of the SLA deployment status from the Canary Island site. At this time, I had the Systems SSR bringing the mechanical instrumentation of SLA deploy with the associated sketches and drawings into the front room, and I also briefed the Coastal Sentry site as to what our status now was relative to SLA deploy.

#### SEPARATION

The CSQ acquired telemetry on both vehicles at approximately

47:30 GET. Immediately at acquisition, they identified that they had SLA deploy relay "A" and "B" indications and I gave them a GO to continue with Mission Phase 7. Also, during this period of time, the Coastal Sentry advised that they had intermittent telemetry on both vehicles. The CSQ site, due to their intermittent telemetry, was able to confirm only sporadic events occurring after the Mission Phase enable time of 49:54 GET. They would remain locked up for short periods of time, could confirm that we were in Mission Phase 7, and that the counters had been disabled. In addition, they were able to confirm that the RCS systems "A" and "B" had pressurized. Carnarvon (CRO) acquired the spacecraft at approximately 51:30 GET elapsed into the mission and handover from the CSQ to the CRO site was accomplished very smoothly. CRO telemetry was solid at acquisition and they were able to confirm all events thus far in the Mission Phase. At 52:30 GET, the MCC and CRO gave a GO for separation. At 53:50 GET, the Carnarvon site detected plus X translation and at 53:54 GET, confirmed separation and minimum deadbands. Rates and attitudes were good during the second 5-second plus X translation and the LGC sequenced into Program 15 (the DPS cold soak program) at 54:18. The spacecraft maneuvered to the cold soak attitudes of pitch 319 degrees, roll 328 degrees, yaw 099 degrees. After the completion of the cold soak attitude maneuver, the Carnarvon Capcomm identified that the spacecraft seemed to be holding solidly in attitude with very little RCS activity to maintain that attitude. After completion of the maneuver, we switched high-speed data formats incoming to Houston to enable the Booster Systems Engineer to monitor the SLV vents and the pitch maneuver. At this time, the Booster Engineer

identified that the SIVB was GO. The Carnarvon site was also monitoring the S-band telemetry and identified that they had minus 98 dbm from a standpoint of signal strength, and that the low power S-band data did not look as good as their VHF telemetry. At Carnarvon LOS, the Booster Systems Engineer identified that the  $LH_2$  vent had occurred normally, and the GNC Engineer at Houston advised that all of the LGC IMP commands had been issued during the separation phase. At Carnarvon LOS, all spacecraft systems were GO; the launch vehicle was proceeding normally in its timebase and had initiated its pitchover to the local horizontal. Carnarvon LOS occurred at approximately 59:00 GET into the mission; the RCS system usage during separation was normal as far as we could detect. From my position, it appeared we had used approximately 4% of our RCS quantity for separation and the initial cold soak maneuver.

#### ORBIT COAST

The post-Carnarvon tracking data indicated that we were in a 90 by 120 n.m. orbit and the Flight Controllers in the Control Center now began the development of the command plan for the Continental United States pass. During the same period of time, we were contacted by SPAN, namely Jim Tomberlin, and advised that if the fuel and oxidizer tank pressures on the ascent engine were less than 50 psi we would be required to transmit the abort stage arm command prior to going into the Mission Phase 11 DPS/FITH/APS sequence. In addition, during this period of time, the Booster Systems Engineer advised that the SIVB tape dump over the Tananarive site had started approximately 2 minutes 30 seconds earlier and stopped 3 minutes 16 seconds earlier than had been previously

predicted. The command plan for the first Continental U.S. pass had been completed by 01:10:00 GET into the mission, and included closing the fuel and oxidizer crossfeed valves with DSKY commands as well as the selection of the secondary (high-power) S-band system. At 01:10:15 I briefed the RKV ship on their upcoming pass, identified that all systems looked normal, covered the command plan for the Texas site, and subsequently identified that the playback of the S-band data from the CRO site looked very good. In addition, we informed them that we had had very marginal UHF signal strength from the spacecraft during the last half of the Carnarvon site pass. During this period of time, we were running between -100 and -109 dbm with the threshold at -99 dbm. We did feel that a good portion of this signal strength reduction was due to the spacecraft attitude as it left the Carnarvon site. As we approached the first Stateside pass, the Redstone still did not have both the telemetry and the command computer up. I elected to load the telemetry program into the one good computer onboard the Redstone for this pass inasmuch as everything seemed to be proceeding normally. The Rose Knot Victor ship acquired telemetry at about 01:34:00 GET. The UHF receiver signal strength looked good at this pass and all spacecraft and launch vehicle systems were normal. The spacecraft clocks were in sync and we acquired Guaymas telemetry at approximately 01:33:00 GET; all systems were GO; and the glycol temperature in the spacecraft was 42.6 degrees. UHF receiver signal strength started to deteriorate toward the end of the RKV pass. Texas data was acquired at approximately 01:34:00 GET, and command handover was accomplished between the RKV ship and Houston.



CONUS COMMAND ACTIVITY

At the initial Texas acquisition, the signal strength looked good and the EECOM Engineer transmitted RTC-30A, primary S-band OFF. The secondary S-band was brought online at 01:36:00 GET, through RTC-20A. After the secondary S-band system had been brought in, the Guidance Officer issued the IMP commands necessary to close the RCS crossfeed valves. The first command was the crossfeed closed, Octal 376. Approximately midway through the transmission of the RCS crossfeed reset command, we delayed the transmission of the 377 Octal until handover had been completed between Texas and MILA. During the period of time that we had power applied to the coil of the RCS crossfeed close relay, due to the peculiarity of the instrumentation associated with the Parker valve when coil power is maintained, we did not get valid telemetry indication of valve status. Therefore, during this period prior to the reset, the valve was indicating OPEN. However, as soon as the reset command had been transmitted, the valve telemetry indicated valid. We were to note this interesting instrumentation anomaly several times during the mission when commanding other Parker valves. The Continental United States command plan was completed by 01:43:00 GET, at which time we then shifted over to monitoring the SIVB vehicle. The systems on the SIVB were good and we monitored the enabling of the passivation experiment through an LVDC command. At the same time, the Booster Engineer gave me an update on the ECS sphere lifetime of 5 hours 30 minutes elapsed time. UHF signal strength continued to vary during the Stateside pass, and towards the end of the pass, the EECOM Engineer initiated work with SPAN in an attempt to define the relationship between



spacecraft attitude and our command capabilities.

ORBIT PHASE  
Rev 2

At 01:55:00 elapsed into the mission, FIDO advised me that he had committed to the DPS-1 maneuver. This maneuver was essentially perfect as contained onboard; there were no updates required in preparation for the maneuver; and FIDO subsequently initiated the detailed planning for the DPS/FITH/APS sequence. After the Canary Islands site LOS at the beginning of the second revolution, I summarized the status of the mission in discussions with the CSQ and Carnarvon Capcomm. Our SIVB ECS sphere lifetime was predicted to be at least  $5\frac{1}{2}$  hours; our APS lifetime was greater than 8 hours; the passivation experiment was enabled; and all SIVB systems appeared normal. From a spacecraft standpoint over the Continental United States, we had commanded the crossfeed valves closed; we had selected our secondary S-band transmitters; and the UHF signal strength was a bit poorer than expected. We also reviewed the change to the Mission Rules relative to the ascent propulsion system pressures. Our water, electrical, and RCS usages were normal. RCS system "A" quantity appeared to be biased about 4% los. During the first rev apparently as a result of the cold soak attitude, quad #1 temperature was running approximately 20 degrees higher than the remaining 3 quads. All other spacecraft systems were GO.

PASSIVATION

The CSQ acquired the spacecraft at 02:23:00 GET. As on their previous pass, the telemetry was broken and their UHF signal strength

was not adequate to provide command coverage. During this pass, the SIVB telemetry was also very poor. The MCC Booster Systems Engineer advised that the SIVB orientation would provide better coverage for the CRO site. The CRO site acquired both vehicles at 02:27:00 GET. They advised they had solid telemetry on both vehicles and that both vehicles were GO. The SIVB passivation experiment was initiated with Lox Dump over the Carnarvon site; the attitudes appeared to be very stable during the entire passivation experiment. During the passivation experiment, the oxidizer ullage pressure did not decrease as far as we had expected. The fuel dump and the passivation experiment were concluded at approximately 60 seconds prior to the CRO LOS at which time the  $\text{LH}_2$  vent was initiated.

#### ORBIT COAST

After the CRO pass, the MCC EECOM Engineer requested Carnarvon to play back their S-band data. This gave us an opportunity to evaluate the primary and secondary data system quality and it was determined that the secondary system was superior to the primary system.....at least during this comparison of two passes over the same site. The command plan for the Stateside pass was quite simple. The only activity was to cue PRA Sequence 5 using a forward search. This PRA sequence was cued up in case we should have a lifetime problem immediately after the fire-in-the-hole staging sequence in Mission Phase 11 and be required during this same pass to go into an APS depletion burn. PRA Sequence 5 was the nucleus of the Alternate Mission "I."

#### MORE ON PASSIVATION

Between the Hawaii and Carnarvon sites, we discussed the

passivation experiment. During passivation, the Oxuullage pressure had dropped from 24 psi to 11 psi. The fuel ullage pressure was expected to be 14 psi at AOS; however, the sensor was reading approximately .4 psi. Over Hawaii, at 2 hours and 52 minutes, the SIVB dumped the cold helium and the passivation experiment was essentially completed. The only remaining items in the SIVB timeline were the Lox and liquid hydrogen vents and the tape dumps. We continued to track the SIVB vehicle, generally once per revolution, in accordance with our premission tracking plan.

#### CONUS PASS

The spacecraft and SIVB vehicle systems were GO over Hawaii as we approached the end of the second revolution. Signal strength during the initial portions of the Hawaii pass were adequate for any command activity that should have become necessary. The RKV acquired the spacecraft at 02:57:00 GET; signal strength at that site was inadequate for command activity; all spacecraft systems were GO; and shortly thereafter, the Goldstone USB site acquired the spacecraft and transmitted its high-speed data to Houston. Houston confirmed the GO assessment identified by the RKV ship. Texas acquisition occurred at 03:06:00 GET and the handover between the RKV and Texas was accomplished, again, very smoothly. Our UHF signal strength at Texas acquisition was inadequate for commanding and handover was accomplished from Texas to Canaveral. The UHF signal strength was -106 dbm, and  $3\frac{1}{2}$  minutes after the Texas acquisition we transmitted a DCS self test command to determine our threshold for commanding. Two DCS self test commands were transmitted; both were rejected by the spacecraft. By this time, 5 minutes had elapsed since our initial command acquisition at Texas, and I advised the Guidance Officer

that we would not cue PRA 5 on this pass. At approximately 6 minutes after our acquisition at Texas, while over MILA, our signal strengths appeared to be improving and we transmitted another DCA self test command, and this time it was accepted by the spacecraft. This command was accepted at -92 dbm. With approximately 2 minutes remaining in this pass, I instructed the Guidance Officer to cue PRA Sequence 5. Immediately after obtaining the compare of PRA Sequence 5, the signal strengths again dropped off to -104 dbm. Toward the end of the MILA pass, the BSE advised that he apparently did not obtain proper operation of the Lox vent and as such he transmitted the Lox vent closed command. However, telemetry LOS on the SIVB vehicle occurred at MILA prior to the time that he obtained verification on this command. The Booster Engineer does not normally have data from Antigua, and he elected not to command this function in the blind, inasmuch as it was not a time-critical command. At about midpass, during Antigua, the UHF receiver signal strength again improved and if necessary, we could have commanded at this point.

#### ORBIT PHASE

##### Rev 3

After the completion of the Antigua pass, it was determined that the reasons the SIVB commands did not get into the SIVB vehicle was that they had handed over from MILA to Antigua and the commands were radiated from Antigua prior to that station's acquisition of the SIVB vehicle, therefore indicating why the BSE had obtained 2 spacecraft rejects on the Lox vent closed commands. For the upcoming DPS 1 Mission Phase 9 maneuver, timer J2 was loaded with a mission phase enable time of 035504; pitch attitude 032 degrees, roll 355 degrees. The ground elapsed time of burn

initiate was 035941 with cutoff at 040018. The Delta T of the burn was 37 seconds, the Delta V was 145 feet per second. Preliminary estimates on the Mission Phase 11 DPS/FITH/APS sequence indicated that the onboard targets were good; we should regain throttle control at 044337; the fuel remaining at abort staging provided adequate margins, and we would not pulse the engine during the burn sequence. Telemetry was handed over from Antigua to the Redstone and the Redstone telemetry during this period was excellent, with only momentary dropouts occurring. Over the Ascension site, all spacecraft systems were GO for the DPS 1 maneuver. The CSQ and CRO sites were briefed that we had cued PRA 5; the clocks were in sync; passivation was GO, and that based on the Conus pass, it appeared that the signal strength necessary for effective commanding was -99 dbm or better. During the Gemini Program, we had essentially experienced a capability to command in any spacecraft orientation from zero degrees at acquisition to zero degrees at LOS, and our sensitivity to thresholds for commanding during this mission began to concern me considerably. The majority of our Mission Rules, from a spacecraft systems as well as from a trajectory standpoint, required considerable command support in case of any spacecraft systems or trajectory problems. In addition to this, we did not know the effects of plume attenuation of the descent and ascent engine would be on our capability to command the spacecraft. During the Stateside pass, over 7 minutes were lost from a command standpoint due to the low UHF signal strength. FIDO had continued his planning for the DPS/FITH/APS sequence and advised that at abort staging we would have 1,350 lbs. of propellant remaining and that we would not obtain the DPS low-level warning light. Also during this

period of time, the Guidance Officer identified a spacecraft peculiarity that invalidated a portion of Mission Rule 14-30. This rule related to unstable vehicle attitudes shown by a difference between actual and desired CDU's greater than 10 degrees. During the course of the mission, we had an apparent bias in these numbers and we determined that this was due to the fact that the measurements were based around the spacecraft control axis as opposed to the CDU axes. I did not fully understand this at the time and advised GNC and Guido to discuss this problem and prepare a briefing for the network. It was very difficult in the short time remaining to discuss the details of this mission rule as we now understood it, with the remote sites and as such, I advised them to delete the first section of Mission Rule 14-30 and make cutoff decisions based on rates alone. Also during this period of time, to try and improve the quality of the VHF telemetry reception at the Coastal Sentry Quebec site, the AFD, based on previous experience with the CSQ, advised the CSQ Capcomm to monitor his telemetry sync indications when he was transmitting voice from the HF ship-to-shore facility while in high-power mode. During previous missions apparently the Goddard voice communications on occasion would interfere with the downlink telemetry reception.

DPS #1

The Coastal Sentry Quebec ship acquired the spacecraft at 03:54:00 GET. Almost immediately after their acquisition, they reported the loss of their 1218 computer and as such they were unable to readout any of the LGC downlink words; thus, they were not able to verify that we had gone into the proper mission phase and programs. They were able

to verify counter disable and those events occurring within the mission phase; counters disable, deadband minimum, calc manu, and ED and DPS armed discrettes. Through these discrettes, they were able to verify that the LGC entered the mission phase at 03:55:04 GET. Shortly thereafter, the Carnarvon site acquired, and command handover was accomplished after the descent engine ARM discrete had been issued by the LGC. MCC, through monitoring the telemetry remoted from Carnarvon, was able to determine that the spacecraft was GO for the DPS 1 maneuver; pitch attitude was reading 032 degrees, roll 355 degrees, and the attitudes were perfect. The GO for the DPS 1 maneuver was given by the CSQ and Houston sites at 035904 GET. Plus X tranlation, engine ON, and 10 percent throttle was confirmed on time. Ten seconds after the DPS ON was reported by the Carnarvon site, they identified they had a PGNS caution indication which they subsequently amended to be a program caution indication. DPS OFF was confirmed by several indications about 7-10 seconds after the engine ignited. At Tig+16 the MCC Guidance Officer advised that we had gone to Program 00, Mission Idle. At Tig+45 seconds, I requested that Houston be made prime for command and we started the cleanup commanding of the spacecraft. At this time, we were reading -100 dbm on UHF S.S. and Command 34B master relay reset was delayed by approximately 60 seconds till signal strengths were adequate. The first transmission was rejected by the spacecraft; the second transmission at Tig+2:10 was also rejected by the spacecraft. On the third attempt to transmit master relay reset at Tig+2:35, the command was accepted by the spacecraft and the DPS arm discrete was removed from the prime relays. Subsequent to this, at Tig+4:00, a verb 15, noun 50 was transmitted to enable



Houston to readout the error codes. At the same time, the FIDO was starting to evaluate our alternate mission capability and the GNC advised that apparently we did not have our thrust chamber pressure build-up as rapidly as we had expected it to be. The enter for the verb 15, noun 50 was transmitted at Tig<sup>4</sup>:4:50. At this time, Guidance read out the error codes, Delta V monitor alarm, and "forget it," indicating that the LGC had commanded the engine ON, and it did not come on. The GNC and the EECOM engineers at this time were reviewing their systems to determine if there were any lifetime constraints that would prohibit going back to the nominal mission. The spacecraft systems were safe and the only LGC command requirements were for a V3<sup>4</sup> and error reset. However, due to the limited time remaining in the pass, we determined that we would delay this commanding until Hawaii. Immediately after Carnarvon LOS, we scheduled a playback of the burn data as well as getting a verbal description of the analog data acquired by Carnarvon during the pass.

#### ALTERNATE PLANNING

The MCC EECOM and GNC at Carnarvon LOS indicated they did not see any systems anomalies which would constrain us from lifetime standpoint. At Carnarvon LOS, we immediately started reviewing 3 possible alternatives. The first alternative discussed was continuing with the nominal plan by scheduling Mission Phase 9 back over the CSQ/CRO site on the subsequent revolution. The Flight Dynamics Officer advised that it would be very difficult to reschedule Mission Phase 9 over Carnarvon inasmuch as the max elevation on the Carnarvon pass on the next revolution was 2.9 degrees. This poor coverage had been anticipated in pre-mission planning and as such we concentrated on the two primary



alternates as defined in the Mission Rules. Alternate Mission "L" would continue on the nominal Mission Phase 11, culminating with a ground commanded abort staging sequence after a short DPS burn. Our other alternate mission was Mission "C" which was a PRA minimum requirements sequence.

#### SCRUB "L" OVER CONUS AND SLIP A REV

Targets were already available for Alternate Mission "L" over the Continental United States on the third revolution. Based on pre-mission planning, the Alternate "L" targets and the nav vector were ready for transmission to the Hawaii site prior to the DPS 1 maneuver to take care of this type of contingency (i.e., failure to attain DPS 1 targets). However, based on the MOCR analysis combined with inputs that were now being received from SPAN as well as the MIT support people, it had been determined that we must increase LGC wait period to allow for a longer thrust buildup. As such, we scrubbed the Alternate "L" plan for the third revolution over the States. In addition, this allowed the Flight Controllers to further evaluate the status of the DPS prior to committing to a maneuver. We wanted to verify that the apparent cause was the real cause for the shutdown. The Assistant Flight Director at this time proceeded to initiate the development of the command plan for the Hawaii site on the third revolution. At this time, I also elected to allow the prime relay reset command (34B) to remain in the spacecraft until we had determined which alternate plan we would implement. Immediately after Carnarvon LOS, the analog recorders were brought into the front room and indicated that we had actually reached

10 percent throttle, immediately prior to the DPS shutdown. At this time, we initiated a preplanned contingency checklist to go back and reverify what our lifetime remaining constraints were, what our next and best opportunities were for maneuvers, to reverify that we had a safe spacecraft configuration, and to build command plans necessary for whatever corrective action was necessary. The FIDO's recommendation at this time was to pursue the "L" Mission and develop the plan for the fourth revolution over the States. This plan included the guidance commands to clean up the LGC configuration at Hawaii as well as the new nav and target loads. FIDO then proceeded to evaluate the perigee constraints and the maximum time that the descent propulsion system would be burning prior to the time that manual abort stage command would be transmitted. During this period of time, there were no constraints on the conduct of the APS 2 burn under LGC control. At this time, I also requested the GNC controller to track down an anomaly that we had noticed once during pad testing, either plugs out or the S/C SIT, where we noticed a very long delay in throttle response.

#### EVALUATION OF ALTERNATES

With Alternates "L" and "C" in active planning, I continued the discussion of returning to the planned mission profile. We would have a 7 minute, 15<sup>0</sup> elevation pass over the Coastal Sentry Quebec ship on the next revolution. I asked FIDO for his opinion on further updates required for the DPS 2 portion of the maneuver inasmuch as he would have to perform those updates with no tracking data and limited capability of observing the IM guidance computer during this period. In addition, he advised that the CSQ would be by themselves during this maneuver and due to

their limited LGC readout capability on the ground, they would have limited access to the computer data during the period of time immediately prior to, during, and after the maneuver. As the SSR continued the planning, the MOCR now discussed the "L" and "C" Alternates as more data became available. In continuing the discussion of our secondary alternate ("C"), we evaluated the feasibility of cutting off the minimum requirements sequence after the APS 1 burn and prior to the APS 2 burn, which would allow about 24 seconds for the GO/NO GO and cutoff commands. This would allow us the capability of coming back with the IM guidance computer for the APS to depletion burn later in mission. At this time, I also discussed my concern about executing the time-critical abort staging command by RTC in Alternate "L" due to the problems we had had with the UHF receiver signal strength throughout the mission so far. FIDO advised he wanted to continue studying Alternate "L" to determine if there was a possibility of going all the way under LGC control. We now turned to discussing the "L" mission guidance update requirements for Mission Phase 11. Over the States we would uplink commands to increase the wait period for Delta V sensing after ignition, and transmit two timer updates to get the phase enable time counting down properly. I again identified my concern about the manual abort staging command with the unfavorable command situation which we had seen so far. My preference was to obtain the abort staging sequence independent of ground command activity.

#### THE HAWAII PASS

Hawaii acquisition occurred at approximately 04:24:00 GET. At

this time, Flight Dynamics Officer gave me the preferred Alternate Charlie time of 6 hours 15 minutes elapsed, and the GNC Controller recommended that we increase the Delta V monitor time and continue with the Mission Phase 9 and 11 nominal mission sequence at which time I identified again that we had very poor coverage over the CSQ and that we would have no tracking data from Carnarvon. The CSQ, although they had a long pass, had no capability of either reading out the LGC downlink capability easily or commanding the LGC if necessary. At this time, the Guidance Officer identified that the spacecraft attitude was purely retrograde for a PRA Sequence 3 and suggested that we update the spacecraft attitudes for this alternate while we had time. These updates would be performed over the States and would cause the calc maneuver routine to be executed to give us inplane posigrade attitude of 27 degrees pitch up, zero degrees roll, and zero degrees yaw. At this time, I also identified that I wanted to be in a position to execute "L" or "C" on the next revolution. After the "error reset" and Verb 34 commands had been transmitted over Hawaii, PRA 3 was cued up using a forward search.

#### EVALUATION OF RETURN TO PLANNED MISSION

At this time, the FIDO gave me the CSQ and Carnarvon AOS and LOS times for the next revolution. We were still considering returning to a nominal mission plan if it were feasible. CSQ acquisition time was 05:27:44, LOS 05:34:44, max elevation 15 degrees. The Carnarvon acq and LOS was 05:32:50, LOS 05:37:18, 3 degrees elevation max.

#### DECISION TO SCRUB THE RETURN TO NOMINAL

Towards the latter end of the Hawaii pass, I requested FIDO

to evaluate the possibility of generating targets for a nominal Mission Phase 9 and Mission Phase 11. In addition to this, I asked the EECOM to evaluate the command coverage from a theoretical standpoint for the CSQ/CRO pass. EECOM advised that he could not evaluate command coverage over the CSQ/CRO sites. I again requested him to attempt to define what our coverage would be and he initiated work with the Flight Dynamics Officer to estimate the attitudes for the maneuver. By now, the RKV had acquired and the spacecraft was now over the Goldstone site. At this time, I identified to Mr. Low that we would be very time-critical in getting all of our target, timer, and systems commands into the spacecraft over the States; that with the unfavorable T/M, command and tracking situation over the CSQ, I recommended against attempting the burn over the CSQ. I felt that once we had committed to an LGC burn, and once we had enabled our mission phase timers, we would very possibly be unable to stop the implementation of that burn. The Delta V associated with the burn could cause us very serious problems if, for any reason, we were in the wrong attitude, either due to LGC problems or the possibility of getting improper updates in due to the short period necessary to plan and implement the uplink of these updates to the spacecraft. It may be noted that ~~this~~ decision was consistent with our premission study of similar situations.

ORBIT PHASE  
Rev 4

At this time, I had to make a decision as to which series of commands would be issued to the spacecraft first. I determined to guarantee as a minimum, a good attitude (as well as good coverage from a ground

tracking and telemetry standpoint for the fire-in-the-hole sequence) in case we decided that Alternate "C" was most preferable. At this time, Mr. Kraft and I discussed the Alternate "L" and Alternate "C" plans. We identified that our prime concern should be in accomplishing our staging objective and that if we had a favorable condition between the APS 1 and APS 2 burn, to again attempt to get back under LGC control for the burn to depletion.

#### MORE ON THE NOMINAL

At this time, the Flight Dynamics Officer came back and identified another constraint to continuing with the nominal Mission Phase 9-Mission Phase 11 sequence. This was that if we were able to update all of the targets, nav vectors, and timers necessary to return back to the normal mission, the best he could do from a trajectory standpoint would be to have the DPS 2 ignition occur approximately 60 seconds prior to the RKV acquisition. This would lead to a very complex handover problem from both a telemetry standpoint as well as from a command standpoint and control during this critical phase between the Hawaii and RKV sites. In addition, he did not believe that we had adequate opportunities to transmit the necessary loads to the spacecraft to implement this plan. I advised FIDO to terminate all activity associated with the planning to return to the nominal profile.

#### CONFIGURE FOR "C" AND PLAN "L"

At this time, after the discussions with Mr. Low, I identified to the Flight Dynamics Officer that we guarantee Alternate "C" but to continue the uplink process necessary for Alternate Mission "L". Also,

at this time, I identified to the Flight Dynamics Officer my preference for continuing with the APS 2 burn under LGC control, and he stated that he did feel he could generate a satisfactory set of targets for that type of maneuver. At this time, we were in midpass over the Continental United States. All spacecraft systems were still GO and the Guidance Officer was uplinking the attitude maneuver commands. Mr. Kraft continued to discuss the Alternate "L" possibility with Mr. Low, and at this time, Mr. Low identified a preference for the Alternate "L" plan provided we could increase the DPS burn duration. The FIDO identified that the maximum burn duration would be approximately 60 seconds, 26" at 10% and 34" at 100% thrust. By this time, the Guidance Officer had completed the transmission of approximately 80 commands necessary to go to the burn attitude for Alternate "C" over the United States. The maneuver to attitude was performed very smoothly by the spacecraft, and the attitude settled down at precisely the attitudes the Guidance Officer had expected them to. He had advised that based on the impulsive maneuver, our ephemeris at the completion of the burn would be around 91 x 566 n.m. After the States LOS at the end of the third and the beginning of the fourth revolution, I identified that the spacecraft was configured for Alternate "C" minimum requirements sequence. However, we were continuing the planning and implementation for Alternate "L". I summarized for the Flight Control Team my feelings relative to the decision not to return to the nominal mission plan on the GOSS conference loop, again stating the problems associated with command, telemetry, the capability of reading out the LGC, with the two overriding factors being that once we enabled the mission phase timers, after having done much uplinking



and reinitializing of the LGC, I believed we would be locked into that plan and that we could conceivably lose control of the mission if we had any problems over the CSQ. In addition, the Mission Phase 11 Tig time occurred prior to the RKV and, as such, we would have a very unfavorable command as well as a tracking situation for both Mission Phase 9 and Mission Phase 11.

#### ALTERNATE "C" AS PRIME

At 05:05:00 GET FIDO advised that for Alternate Mission "L" we would require 4 updates, a nav load, a target load, and 2 timer update loads from the Hawaii site, which was our only opportunity for getting these commands into the spacecraft. In addition, he identified that the maneuver dipped down very low in perigee, down as low as a negative 100 n.m., and we would have to transmit the abort stage commands prior to going below our 85 n.m. perigee line in order to enable us to come back with an APS 2 burn to depletion. I identified to Mr. Faget and Mr. Low that the longer we tried to increase the DPS burn duration, the worse the situation got from the standpoint of ground coverage as well as minimum perigee. Mr. Low and Mr. Kraft again conferred on this discussion. At 05:15:00 GET, I elected to execute Alternate "C" as the primary plan.

#### ALTERNATE "C" MODIFICATIONS

Alternate "C" would be modified to terminate the PRA sequence between the APS 1 and APS 2 burns and attempt to come back for an APS depletion burn under LGC control on the subsequent revolution. Now that we had selected the minimum requirements sequence as our primary alternate

and had locked in on this plan, we started to evaluate this alternate in much greater detail. In an attempt to extend our DPS engine on time, we examined the possibility of transmitting the AGS select RTC to stop the PRA sequence and lock into the period of time that we are at 100 percent thrust during the DPS 1 maneuver. We had a 7-second period during which we could transmit this command. I discussed this with the MCC GNC and we reviewed the feasibility of this type of approach. Again, we came back to the same conclusions we had come to during our premission planning period, that with the time delays inherent in our telemetry and command systems we could not reliably extend the DPS burn duration (i.e., TM delay approximately 6 seconds, command delay approximately 2 seconds). Again, I passed this to Mr. Kraft, who passed it to Mr. Low. Similarly, I instructed the Assistant Flight Director to identify the constraints on cutoff during the minimum requirements sequence between the APS 1 and APS 2 maneuvers and identify those cases from a systems and trajectory standpoint for which we would not terminate the maneuver. Simultaneously, the Guidance Officer in preparing for the APS 2 maneuver, was developing a plan to start his initial series of updates to start the mission phase timers counting down to a Mission Phase 13 and as such, he could increment about this time, which somewhat reduced the time to uplink all of the necessary Nav, Target, and Timer updates. This would make it procedurally simpler for him to move into Mission Phase 13, the APS to depletion burn. The Ascension site had problems acquiring during this pass and we could not immediately determine what the problem was. However, we did have reports from an ARIA aircraft in the vicinity of Ascension that the aircraft was able to lock up and

maintain track. It was reported subsequently that the problem with the Ascension site had been the pointing data they had been supplied.

#### FINAL PLANNING FOR "C" AND LGC APS 2

The final Alternate "C" plan was committed to the FIDO and the rest of the Flight Control Team at approximately 05:30:00 GET. During this discussion, the Assistant Flight Director had reviewed the predicted site acquisition tables (PSAT) and identified that if we conducted the minimum requirements sequence at 05:15:00 GET, we would have very low elevation angles at the Texas and the ETR sites. He recommended that the time for this sequence be planned earlier. The time for the initiation of PRA Sequence 3 was selected to be 06:10:00 GET, which corresponded to a time approximately 60 seconds after White Sands acquisition, and provided good 2-site FITH coverage. This also allowed C-band radar tracking from the initiation to completion of the maneuver. The Guidance Officer, by this time, had prepared the two timer updates necessary for Mission Phase 13 and had transmitted them to the CRO site. CSQ acquired about 05:35:00 GET and identified they had fluctuations in UHF signal strength at acquisition. Command handover was accomplished as soon as possible from the CSQ to the CRO site and further handover was accomplished to Houston for the LGC commanding. There were minor breaks in the Mission Phase 13 timer uplink process due to the UHF signal strength; however, by midpass at CRO, the Mission Phase 13 timer was loaded and started to count down. The spacecraft systems were GO at LOS at CRO. We were now reviewing the UHF command predictions and site AOS-LOS times for the Mission Phase 13 (APS 2) commanding with the

appropriate Nav, Mass, and Target updates. It became apparent at this time that we might run into problems with the updates during the Continental United States pass due to the relatively low elevation angles. In addition, however, with the raising of the apogee due to the MRS sequence, we felt we would have a relatively long Carnarvon pass during which many of the required updates could be transmitted. We therefore considered that it might be necessary to delay the APS 2 burn until as late as an 090000-093000 GET; however, we continued on the assumption that we would be able to transmit all the loads within 1 rev. At this time, the spacecraft systems lifetimes were at minimum 13 hours, and we were constrained only by the network in the execution of Mission Phase 13. While the Flight Dynamics Officer continued to iterate these two plans now for Mission Phase 13, the Assistant Flight Director had been working on the command plan and the GO/NO GO criteria that would be implemented between the APS 1 and APS 2 burns during the PRA MRS. The final command plan for the execution of PRA MRS was developed while the spacecraft passed over Guam. Guam saw the spacecraft RF but was unable to lock up on the data and pass the data through to Houston.

#### FINAL PREP FOR MRS

The final MOCR review of the command plan had been completed by 05:50:00 GET. At this time, we spent about 5 minutes reviewing our ground rules for the conduct of the GO/NO GO in the 24 seconds between the APS 1 and APS 2 burn. The first ground rule was that we would continue the sequence into APS 2 if the minimum perigee during the MRS decreased to below 85 n.m. The FIDO was instructed that if he had any

doubt as to his data quality during this burn, we would continue to burn into the APS 2 portion of the MRS. Similarly, the GNC Controller was briefed to allow the burn to continue if there were any APS or RCS problems that would constrain the lifetime to less than 3 hours after completion of APS 1. EECOM was advised to give his GO/NO GO based on the glycol and electrical power status after the completion of APS 1. GUIDO would monitor for any potential or incipient gimbal lock problems during the course of the burn. If a gimbal lock problem existed, we would want to continue into the APS 2 portion of the burn under PRA control. All clocks in the Control Center and at the Rose Knot Victor site were synchronized to count down to PRA start time of 06:10:00 GET.

#### PRA CUTOFF TECHNIQUE

During the process of development of the command plan, it was essential to determine which technique would be used for cutting off the burn between the APS 1 and APS 2 sequence. The two prime techniques that we considered were the transmission of the "Guidance Select AGS" (RTC 40B) or the "Prime Relay Reset" (RTC 34B). Each had its inherent advantages and disadvantages. The primary technique that was chosen was the "Guidance Select AGS" which would put the PRA into essentially a hold mode and if, after cutoff, we determined we wanted to continue with the PRA APS 2 burn, we could transmit the PRA "Start" command, then continue with the APS 2 burn.

#### EXECUTION OF ALTERNATE "C" MRS

Initial command activity after Hawaii acquisition was delayed approximately  $2\frac{1}{2}$  minutes due to low UHF signal strength and the "prime

relay off" command ~~was~~ transmitted twice over the Hawaii site with no effect. At this time, we were slightly below our threshold for effective commanding. With 3 minutes remaining in the Hawaii pass, the prime relay off command was transmitted, and this time it was accepted by the spacecraft. Subsequently, we commanded the ascent battery 5 to the backup feed path and then transmitted the "Master Arm" command which brought the pyro batteries online. A communications check was performed with the RKV at approximately 06:05:00 GET and they were advised that the prime relays were "set," battery 5 ~~gas~~ on the backup feed path, and the pyro batteries were online. In addition, they were advised per the Mission Rules that this PRA sequence was a time-critical sequence and they should be prepared to back up by RTC all spacecraft functions as listed in the Mission Rules. The UHF receiver signal strength at RKV acquisition was excellent. Approximately 60 seconds after acquisition, they transmitted the AGS select command and the vehicle switched to and was very stable in AGS mode. Goldstone data was remoted to Houston at approximately 06:09:00 GET. The data was initially broken; however, when solid telemetry was acquired, all spacecraft systems were GO. The telemetry quality at both sites was excellent. The PRA start command was transmitted by the RKV site at precisely 06:10:00 GET. Compare and clock pulses were issued indicating that the PRA had received that command. Plus X translation was detected and the sequence was proceeding normally. The DPS arm command was monitored approximately 35 seconds into the sequence and 10 percent thrust was noted 39 seconds after sequence start. The thrust chamber pressure was reported GO; the rates were good; and at 01:05 into the sequence, the DPS throttle went to

100 percent. DPS 1 was complete approximately 1 minute 20 seconds into the sequence; subsequently, the second plus X translation and DPS 2 ignition was monitored by both Houston and the RKV sites. Handover from RKV to Texas was accomplished at approximately 2 minutes and 10 seconds into the sequence. Fire-in-the-hole staging and the APS 1 burn was initiated on time. White Sands track, as reported by the Flight Dynamics Officer, was solid and apogee was continuing to increase. During this period of time, the spacecraft attitudes were approaching very closely to the gimbal lock attitudes. Apogee was continuing to increase and the spacecraft approached within 8 degrees of gimbal lock. Immediately after APS 1 cutoff, the Trajectory, Guidance, EECOM, and GNC Officers indicated that their sequences and systems were all GO.

#### CONUS ACTIVITY, RCS DEPLETION B SYSTEM

The PRA was stopped approximately 23 seconds after the APS 1 cutoff. Subsequent to this time, the PGNS select command and the prime relay reset commands were transmitted to save the spacecraft systems as well as to attempt to regain PGNS control and avoid gimbal lock. The Guidance Officer indicated that his initial command activity would be an attitude counter update. Simultaneously, the GNC Officer indicated that we were using RCS propellant quantity at a relatively rapid rate. This was attributable to the fact that we had not updated the spacecraft mass and that we were still operating in minimum deadbands. As the RCS continued to decrease, I instructed the GNC Controller to transmit the RCS Main "A" closed command. This command was transmitted at an elapsed time of approximately 06:17:20 GET, at which time we had 30 percent RCS



remaining in the "A" system. The Guidance Officer was meanwhile continuing his updates to the IM guidance computer in preparation for the Mission Phase 13 under LGC control. With the counter update complete, the next item was the mass update to be performed by the Guidance Officer, which would have corrected the high RCS usage. At 06:19:00 GET, we had telemetry LOS. About 40 seconds later, MILA had reacquired telemetry and subsequently had LOS around 40 seconds later. We feel this was attributable to the relatively low elevation angles we were not tracking. The GNC advised me that the "B" system was very rapidly running toward depletion; however, at this time, we were expecting reacquisition of telemetry at Antigua and I was still assuming we could get the vehicle mass updated. (After the flight, we were to determine that this vehicle mass update would not become effective until the spacecraft computer went into an average G routine.) Our ephemeris at the completion of the MRS was 92 n.m. perigee, by 532 n.m. apogee. It may be noted that the impulsive computation of our ephemeris for the minimum requirements was very close to that which was obtained during the maneuver. Antigua acquired at 06:21:20 GET and the UHF receiver strength was very good. The Guidance Officer during the Antigua pass was generating the update for the vehicle mass. Simultaneously during the process of generating this load, he had initiated the transmission of the navigation update for Mission Phase 13. At approximately 06:24:45 GET, data was dropping in and out, and our signal strength dropped off very rapidly. We did believe that by LOS we had gotten the complete nav load into the spacecraft.

ORBIT PHASE  
Rev 5

APS 2 ALTERNATES

At 06:26:00 GET, I identified I wanted to develop 2 alternates in preparation for the Hawaii pass. There was a good possibility that due to the depletion of the RCS B system, we might be in gimbal lock by the time we reached CRO and were able to complete the mass update. Therefore, the development of two simultaneous command plans was initiated; one for the use of PRA Sequence 5 over Hawaii, the other one for the Mission Phase 13 updates to the IM guidance computer. With 30 percent RCS remaining in system "A", RCS propellant would be relatively low for PRA Sequence 5 since it required 2 plus X ullage maneuvers totalling 32 seconds in duration. At this time, I again asked Mr. Kraft to query the Program Office on whether they would prefer one long APS burn during PRA Sequence 5, or a 60-second burn with a 10-second coast followed by an APS relight and a burn to depletion. After the update on the orbit due to the 500 n.m. apogee, the pass time was approximately 10 minutes in duration. The targeting for the APS 2 maneuver under LGC control indicated that we would acquire an apogee of around 1500 n.m. during the maneuver.

CRO COMMAND PLAN

The initial command plan for the Carnarvon site required a mass update and after that update we would bring the "A" RCS system online. In addition, we would transmit a Verb 63 update to initialize the digital autopilot, open the RCS crossfeed valves to reduce the possibility of a jet abort during the LGC maneuver, and transmit IMP commands to

go back to maximum deadband. Simultaneously, on the backup command plan for PRA Sequence 5, we had determined to send an engine start override command after the initiation of the first ascent propulsion burn in that sequence. This would provide one continuous burn to depletion of the ascent propulsion system. The ascent propulsion system #2 targets that were to be loaded for the burn provided significant improvements in the network ground coverage. This maneuver would regain our coverage over the United States and allow us to continue into the post-mission testing, as well as give us good coverage for the burn to depletion. The Assistant Flight Director had reviewed the command histories from the Stateside pass to verify that the command plan/spacecraft configuration was right for the burn. During this review, he felt that the time history for the commanding after APS 1 may have allowed us to burn the plus X thrusters and thus account for some of the high RCS usage. We were briefed by the SPAN team to increase the number of passes through the Delta V counter to 60 seconds (30 passes) such that we could not run into a repeat of the same problem that we had had on the DPS 1 maneuver. At the time, it became apparent that for the APS 2 maneuver that we would have a break in coverage of approximately 1 minute and 25 seconds, between HAW and RKV. The Watertown ship had been placed in this gap to provide tracking as well as telemetry coverage for this type of contingency and a status check at the Watertown indicated that their telemetry recording status was GO.

#### THE CSQ/CRO PASS

CSQ acquired the spacecraft at approximately 06:50:00 GET;

however, they were unable to lock up on the VHF. The first 3 minutes of the pass, CSQ was unable to acquire solid lock; however, Carnarvon acquired solid telemetry at about 4 minutes after the CSQ acquisition and VHF signal strength at Carnarvon acquisition was very good. The mass update was completed by about 2 minutes after the Carnarvon site acquisition; then in sequence, the RCS main B closed and closed reset, RCS main A open and open reset commands were transmitted. This was then followed by prime relay off at approximately 4 minutes into the Carnarvon pass. The Guidance Officer then proceeded to open the RCS crossfeed valves via IMP commands. Dropouts were occurring during the RCS crossfeed IMP commanding, and spacecraft rejects resulted in slowing down the Guidance Officer's command activity. The crossfeed valves were opened and it was then noted that the oxidizer pressure in both System "A" and "B" had decreased significantly. Crossfeed reset command was accomplished at approximately 6 minutes after Carnarvon acquisition. The Guidance Officer, with broken data, continued the EMU update #2 which should put us in max deadband and give us 60 seconds on the Delta V counter. We were now approximately 60 seconds from LOS and had the APS 2 target and the GET timer updates still to get in in order to be able to accomplish the LGC APS 2 maneuver. CRO LOS occurred prior to the time of the update of the APS 2 target in the GET timer update.

#### PRA 5 SELECTED

During the Carnarvon pass, it was noted that with both RCS systems manifolded together, the RCS oxidizer pressure did not increase equivalent to the fuel pressure. In addition we again seemed to be

going into a high duty cycle and high usage rates on the "A" RCS system. I did not understand this at the time because I had believed that the DAP enabling and the mass update should have corrected the RCS usage problem. I did feel that the low oxidizer pressure may have been a result of a failure in the "B" system; however, the only way to correct the spacecraft configuration at that time consisted of a series of DSKY commands to again close the crossfeed valves. This was not practicable in the time remaining in the Carnarvon pass. In addition, we had managed to get the majority of the updates into the LGC to prepare it for the APS 2 maneuver and I did not want to go to a spacecraft configuration, where again we were faced with a probability of an RCS jet abort during an LGC maneuver. We wanted all 16 thrusters online connected to the RCS "A" system for the APS 2 burn. Due to the fact that we were unable to condition the LGC for the APS 2 maneuver, and with the RCS problems we had indicated at CRO LOS, I elected to use the PRA Sequence 5 over the Hawaii site. In addition, it became evident that we would not have sufficient RCS propellant in the system to provide the plus X ullage necessary for the propellant settling prior to the APS 2 maneuver as well as for providing attitude control during the 2-minute period we would be burning the APS prior to the time that the ascent feed valves were opened. Therefore, we changed our command plan for the Hawaii site to allow sufficient time to open the ascent feed interconnects to provide propellant for the RCS thrusters. I did, however, request the FIDO Officer to evaluate the feasibility of using the targets that were presently in the spacecraft, but initiating the burn at a later time during the Hawaii pass through the transmission of the mission phase

timer update of plus zero. This would cause the Mission Phase 13 to be enabled simultaneously with the receipt of the mission phase timer plus zero update. Over Guam, the RCS "A" system propellant was essentially depleted; however, the vehicle was still holding attitude with very small rates noticeable. While over the Guam site, the Flight Dynamics Officer advised me that with the targets that were presently in the spacecraft, we could not delay initiation time of Mission Phase 13. In addition, we still had a sizeable amount of command activity during the early portion of the Hawaii pass, and the command plan was now updated to include the IMP commands 176/074 and 076. This would configure the ascent feed valves as discussed previously. In addition, we decided to transmit the RCS main B open command in an effort to utilize the differential pressure between the ascent propellant tanks and RCS system to trap within the RCS manifolds and lines as much APS propellant as possible. Due to the large amount of command activity associated with the Hawaii pass in preparation for PRA Sequence 5, I instructed the Guidance Officer to start PRA Sequence 5 as soon as possible after the completion of all preceding command activity. Hawaii acquired the spacecraft at approximately 07:38:00 GET. Signal strength was good at acquisition and commanding was initiated immediately to open the ascent feed valves. As soon as the ascent feed valves were opened, RCS manifold pressures came up to normal, and I asked the GNC whether he believed we could go one more revolution on the RCS system. He responded in the affirmative. As soon as I saw a good RCS, I again wanted to attempt to get back to an LGC controlled APS 2 maneuver and see if we could slip the maneuver by one revolution. However, the Hawaii site was the only

site from which we could uplink the commands for an LGC controlled maneuver. We had essentially run out of network coverage for execution of any LGC controlled maneuvers. I instructed the Guidance Officer then to continue the sequence and to cue PRA Sequence 5 for the APS depletion burn. The AGS select command was transmitted after receipt of the PRA compare pulse. PRA Sequence 5 was first attempted at 07:43:19 GET; However, the UHF signal strength was not adequate, we received no clock and compare pulses, and we had a spacecraft reject indication. The command was retransmitted approximately 30 seconds after the first attempt and this time the command was successful. The engine start override command was transmitted as soon as the APS was burning. The AGS select command was transmitted at approximately 07:45:00 GET to avoid resetting the ascent feed valves and losing RCS control of the spacecraft; however, the MCC data had gone static by that time and the Hawaii site had brought down their carrier. At this time, it is estimated that the AGS select command was transmitted at approximately 12 seconds after Hawaii site LOS and was not received by the spacecraft. The RKV site acquired the spacecraft approximately 45 seconds after Hawaii LOS and about 15 seconds prior to the time that the ascent feed valves closed. Immediately upon the closing of the ascent feed valves, the RCS A and B systems pressures within the manifolds went to near zero and spacecraft rates increased to values greater than 25 degrees per second. Fortunately during this period of time, the RKV still retained telemetry lock. The pitch and roll rate indications were reading off scale high, and the spacecraft had gone into gimbal lock. Gimbal lock occurred at approximately 07:48:00 GET. Immediately prior to gimbal



lock, pitch attitude was 260 degrees, roll 100, and yaw 103 degrees. TCP dropped off and the APS fuel and Ox inlet pressures were reading 75 and 25 psi respectively, indicating that we had actually accomplished the APS fuel depletion test. GYM data was acquired at approximately 07:51:00 GET. Spacecraft systems status, based on the Guaymas telemetry data indicated we had depleted both RCS A and B systems as well as our APS propellant. The Guaymas data was solid for approximately 60 seconds. Final LOS occurred at approximately 07:52:15 GET, and we immediately initiated command planning for the Hawaii acquisition on the following revolution if we should see the spacecraft. However, at that time it was my belief that we would not see the spacecraft again. The initial attitudes at the beginning of the burn were essentially retrograde. There was a possibility that due to the loss of attitude control during the burn, the thrust vector orientation might be such that we would not reenter. It may be noted that UHF receiver signal strength during the period of time after loss of attitude control was excellent. With apparent C-band LOS during the maneuver, we instructed all sites to go to a skin-track mode. There was no C-band acquisition after the completion of the maneuver, and the EECOM advised that due to the rates we possibly might have indications that we had lost the C-band beacon and would be unable to track it. Maximum elevation angle during the Guaymas pass was approximately one degree. We had only two tracking sites at this time, Pretoria and Hawaii, that would be able to track during the next several revolutions. The Blue Team then assumed shift duties; however, they were unable to acquire the spacecraft.

In addition to my comments relative to premission operations, there are three subjects that have not been sufficiently covered so far. These items reflect upon many of our real-time decisions and should be discussed.

1. RCS System Operations. Throughout the entire premission preparation period, much of our work in the development of mission rules and flight control procedures was devoted to the RCS System management.

Special attention was devoted to this system due to the following items:

- a. Malfunction history of Parker valves.
- b. Significance of RCS-DAP interface.
- c. Flexibility of the systems.
- d. Gemini thruster problems.

Therefore, when we developed high usage rates due to the mass error, we were able to isolate a system, later use the crossfeeds, and finally use ascent feeds when necessary with complete confidence in the procedures and system response. In large part, this system confidence was due to the outstanding cooperation and assistance of Mr. W. Karakulko (PPD-Auxiliary Propulsion) in the development of the operating constraints and procedures for this system. Mr. Karakulko's confidence in his system was a key item in the flight control team's activity during that last revolution, for we were able to use pre-established procedures that had been completely reviewed and that we were confident would work. Thus, we were able to devote the majority of our time and attention to the other problems that faced us.

2. Mission Objective Priorities. In a similar fashion, Mr. W. McKenzie participated in all of the flight control premission activity. He was fully aware of all of the operational constraints as well as the priorities and details of the objectives. His work with us premission brought every flight controller into a detailed awareness of the mission objectives. The alternate missions were developed to provide the maxi-

imum objectives consistent with the system or trajectory capability.

During the entire plus time of the IM-1 Mission, it was again apparent that this interface had paid off, for in all cases, the team consistently planned for maximum objectives, yet also maintained a "safety valve" for the backup. It is unfortunate that the prime alternates could never be implemented, and in all cases, we selected the backup. Again it was with confidence that the backup plans were utilized, for we believed that, if successful, we would satisfy the "man rating" requirement desired from IM-1.

3. Simulation Operations. There are two significant aspects of the simulation operations: the quality of the IM-1 math model and the excellence of the Sim Ops personnel led by G. Griffith.

The IM-1 model was consistently improving throughout the training period; the time spent on the system was about 90% of that scheduled; and all of the scheduled time was productive. This model should be an excellent generic base for future IM models.

The Sim Ops personnel had followed us through every step of mission development. Their thought-provoking simulations caused the redefinition of many of our rules and procedures and gave us confidence in the others. Most of all, they taught us the necessity for precision planning for each pass, as well as the development of "fail safe" procedures. Through their gradual escalation of the pressure during the simulations (most sims were 10-12 hours) we learned to work for sustained periods and yet maintain a consistent quality of effort.

The final comment pertinent to this report is relative to the IM Operations Team itself.

The team performance during the real time portion of the mission was excellent. It was truly a pleasure to be associated with this team during the many months of preparation that culminated in team readiness, allowing us to handle the many problems that faced us. I believe all personnel felt both a sense of accomplishment as well as one of dissatisfaction when the mission was concluded at T+8 hours. We recognized that we had accomplished the minimum requirements, but had been unable to regain LGC control for the APS 2 burn. The latter was difficult to accept, especially since we came so close.

For a long time we spoke of the Flight Control Team, but this was too parochial, and we coined the term "IM Operations Team" to include all personnel from all areas that contributed to this mission. This was truly a total effort, and only in this way could we have been successful.

  
Eugene F. Kranz

APOLLO 5  
FLIGHT CONTROL  
FINAL MISSION REPORT  
FEBRUARY 2, 1968

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Perry L. Ealick



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Charles R. Lewis

Assistant Flight Directors  
Apollo 5

## 1.0 Preface

The Apollo 5 (AS-204/LM-1) Mission, launched from Kennedy Space Center Complex 37 on January 22, 1968, was controlled from the Mission Control Center - Houston (MCC-H) at the Manned Spacecraft Center, Houston, Texas. This report is primarily concerned with countdown and real time mission activities. Those premission activities which directly affected the conduct of the mission will be discussed briefly.

Those portions of the report concerning mission control are based solely on real time observations. They may or may not agree with post mission data reduction.

## 2.0 Premission Problem Areas

### a. Documentation

#### (1) Flight Control Operations Handbook (FCOH)

Following the Apollo 204 accident, all areas of operations, including operational documentation, were subjected to detailed review by an FOD Safety Panel, and many changes were recommended. One of the areas most drastically affected was the FCOH. This was especially true for the content of that document. All procedures implemented by a single console were to be deleted. In an effort to conform to this guideline many procedures were deleted, or were not documented, without adequate alternate documentation. One example of this was the Reaction Control System contingency procedures. Another was the DCS patching test. These particular procedures were reinstated prior to the mission.

#### (2) Operational Trajectory (OT)

The Operational Trajectory was extremely late in publication. It was not generally available to all flight controllers even during the mission. There were extenuating circumstances, such as last minute changes of targets, etc., but it is still a valuable document for mission planning. I am sure portions of it were available much earlier, and should have been published in parts, if necessary.

#### (3) Flight Mission Rules

The Flight Mission Rules were being updated even after lift-off. The data for these revisions was available earlier, but was not made available. This indicates inadequate review by those responsible.

There was also much confusion over revisions. This was caused primarily because unsigned review copies were distributed for use during simulations, and the personnel receiving them assumed them to be advance distribution of the formal revision. In the future each page of such review copies should be clearly marked as such. It should be pointed out that if proper use had been made of the Mission Rules Change forms such preliminary copies would not have been necessary. Instead of submitting changes as soon as the need was recognized, there was a tendency to hold them until a formal review had been scheduled. This normally occurred immediately prior to simulations.

#### (4) Launch Mission Rules

The Launch Mission Rules for this mission were very poorly handled. It was nearly impossible to update them, or to insure that updates had been coordinated. This was caused, in part, by two reorganizations; one at the Manned Spacecraft Center, and one at the Kennedy Space Center. In both instances responsibility for parts of this document were passed to other elements of the same organization.



A second factor in this problem was the late promulgation of input due dates by KSC. On at least two occasions the input schedule was revised after inputs had been made. This caused confusion as to exactly what had and had not been changed. It is felt that KSC should have published revisions to the preliminary document, if they did not desire to publish the final.

A third problem area in this document was the establishment of redlines and mandatory items. This item can be further subdivided into three elements:

(a) Responsibility for the establishment of redlines was not clearly defined at MSC. It has since been determined that only those redlines to which both ASPO and FOD agree will be submitted to KSC. A further improvement which could be made would be to make use of the Mission Staff Engineer for all such coordination.

(b) The problem of the definition of mandatory items centered about the termination of mandatory requirements. This is being taken care of by the establishment of a third column in the LMRD. It will be used to note those items which are required for evaluation of detailed test objectives as opposed to inflight data requirements. All such Detailed Test Objective mandatory items will revert to highly desirable after automatic launch sequence start, unless specifically designated as effective to a later time.

(c) The third problem area was the value of redlines. It was previously the practice to state redlines as absolute values defined by the operating limits of the system, or values showing an operational system. When the KSC added on instrumentation and display tolerances to insure these were not exceeded, some parameters would have been no-go when operating normally. Redlines are now stated in KSC display values. This requires that ASPO be aware of all KSC display limitations, and be willing to accept some risk in assessing redlines based upon them. This should be further evaluated.

#### (5) Operations Checkout Procedures

Most deficiencies in the area of Operations Checkout Procedures can probably be attributed to the fact that this was a "first-of-a-kind" vehicle, and a new contractor was involved. Generally speaking the launch vehicle procedures were no problem. Spacecraft procedures, however, are another matter. Seldom did MSC inputs get into the document in the way they were stated even after the third or fourth iteration. This was true even after visits were made by the flight controllers for the specific purpose of coordination.

Realizing that deviations cannot be avoided, Operations Directive 26 notwithstanding, a better method of getting them into the hands of the flight controllers must be found. On one occasion the

procedures for a test were received after the test had been run because bad weather had caused the aircraft carrying them to be diverted to Los Angeles. Those deviations made immediately prior to tests, or during them, were not all passed to the MCC-H. On at least one occasion one of the deviations required the Flight Director's concurrence prior to taking action. Those deviations transmitted by LDX were generally illegible scrawled. During the CDDT there were several lengthy deviations which had to be passed by voice because KSC did not have an LDX operator on duty. One of these deviations was a series of MCC-H commands to the LGC.

(6) Transmission of Documentation Between KSC and MCC-H

As noted in the previous paragraph there was a problem in getting data from KSC to MCC-H. There was a similar problem in getting data from MCC-H to KSC. This was especially a problem in sending Flight and Launch Mission Rules updates to the Program Director and the Mission Director. It is recommended that we consider making the LDX a two way system for future missions.

(7) Network Operations Directive (NOD) and Mission Supplements

FCD was unable to support the NOD review and input cycle because of late delivery of review copies. Our inputs were made to FSD (Network Controller) within a week of receipt of them.

Other than the usual duplication of material in the NOD and the FCOH, and the usual resulting confusion when there were apparent conflicts, the AFD did not personally note any major deficiencies. Judging by remote/remoted sites Queries and RIC's; however, there was much to be desired in the instrumentation area, particularly in the unified S-Band and telemetry patching areas. (Refer to the Operations and Procedures Officer's report for a breakdown of ISI's and RIC's written against specific sections.)

b. Pad Safety

The MCC-H became deeply involved in pad safety problems from a command safety viewpoint. Because of the unique configuration of the spacecraft (all systems armed during the countdown, without the normal launch vehicle interlocks) it was necessary to impose more restrictive command system control procedures than normally required. Attachment 1 provides a brief summary of MCC support of pad safety.

### 3.0 Training

Reference the Operations and Procedures Officer's report for mission training.

### 4.0 MCC Pad Support

This section will be restricted to those significant problems in ground support which were detected during the pad test cycle. Detailed descriptions of vehicle systems problems will not be discussed unless they require a change in support procedures or software. The CDDT will not be discussed here. It is covered in more detail in Section 5.0, Mission Support, since it was really a part of the LM countdown.

#### 4.1 Launch Vehicle MCC Interface Test 1 (LV SIT 1)

##### a. LV SIT 1, Phase 1

The Launch Vehicle SIT 1 was run on November 29, 1967. The initial problem was that no one really knew what the T-O for the pad test was. Network had a T-O for the end of the support count. Some people thought T-O for the test was our first support. Others were using T-O for the simulated mission liftoff. This caused the BSE SSR personnel to be an hour late for support. This caused no real problem, however, since the pad was not on schedule. We started using a "Support O", and "On Station" time and noted the first support on subsequent schedules.

Delays were experienced due to improper configuration of the CIF. Improper program decks were loaded. Initially, there was no input to the MCC ETR clock, then the clock readouts did not agree with KSC. The problem was isolated to the CIF.

BSE experienced command panel light logic problems. He could not precondition or select either the Setup or CMD mode; however, RTC verified proper operation based on his HSP outputs. Resolution of this problem was procedural control of the number of TM parameters CCATS/TIC had called up simultaneously. It was believed the TM readouts were loading CCATS and not permitting DDD updates to the BSE command panel.

Several procedural problems were noted which caused delays, most of which were support and software, indicating poor preparation prior to testing.

BSE transmitted a LH2 vent command and received a S/C reject although KSC verified receipt of command. BSE retransmitted and all indications were normal. Receiving S/C rejects and at the same time having confirmation that the commands were received by the S/C occurred several times. The problem was later isolated to the 642B command computer/PCM ground station interface and was corrected. No further discussion will be made on this problem although it was encountered in later tests before corrective action was taken.

b. LV SIT 1, Phase 2

BSE reported losing data at one point and CCATS reported solid data. BSE was utilizing SLV time in time base and GRR clocks on MSK 1405 and 1409 which stopped counting. However, MSK 1401 clocks were updating and all other data appeared to be processing normally. This was not resolved.

A 642B command history problem was encountered. Several histories requested that contained erroneous data and also data omission. Also, one End-of-File was ignored during command history printouts. Several hardware checks were made and the tape was changed; however, this did not correct the problem and it was left open. The DCS 1218 "Red" program was utilized for command histories.

4.2 LM-1 MCC Interface Test 1 (LM-1 SIT 1)

The LM-1 SIT 1 test was conducted on December 6, 1967.

a. LM-1, SIT, Phase 1

KSC briefed MCC on a PCA prime relay failure (End Stop O/R) and noted that a request had been made to replace the LM-1 PCA with one from LM-2. This affected the LGC and PRA Eng. Stop O/R function and not the RTC capability.

Twice during KSC's loading of K-Start tape to prepare the LGC for GRR, the LGC switched to AGS. MCC was requested to transmit the PNGS Select (41B) RTC. No resolution.

b. LM-1, SIT 1, Phase 2

A special interface test was conducted between the RKV and the LM-1 S/C. Primary objectives of this test were to determine the phase error and frequency deviation thresholds of the UHF command system. The results were as follows:

(1) With a signal strength of -70 dbm, the LM-1 will accept commands with up to, but not including, phase differences of +35 and -38 microseconds between the 1 and 2 KC signals.

(2) With zero 1 and 2 KC phase difference, LM-1 will accept commands with carrier deviations from 30 to 70 KHZ.

4.3 Space Vehicle Overall Test (Plugs-Out)

The Plugs-Out Test was conducted on December 15, 1967. There were no significant MCC problems noted during this test. Several hardware problems at KSC delayed testing periodically. Several times, data inconsistencies were noted such as MAPS after the command system

was "SAFE"; the MAPS were not confirmed by KSC. Also, ED ARM and STAGE RELAY ARM A and B event lights had spurious inputs. These were attributed to MCC input patching problems. A glycol pump switch-over was noted. Later, it was discovered that official documentation had deleted the measurement (GW 5158); however, the measurement remained valid. GNC reported the DPS throttle pulsing (GQ 6806) and a delay of 18 seconds to reach maximum throttle. Normally, the delay is 1 second. Later, it was determined that KSC was conducting a calibration run which accounted for the delayed pulsing.

#### 4.4 Launch Vehicle MCC Interface Test (LV SIT 2)

LV SIT 2 was conducted on December 19 and 20, 1967. The total test was scheduled to be completed on December 19, but MILA FRW-2 transmitter problems precluded conducting Phase 1 until December 20. No significant support or procedural problems were encountered except as noted on the FRW-2.

#### 4.5 LM-1 MCC Interface Test (LM-1 SIT 2)

The LM-1 SIT 2 was conducted on December 27, 1967.

Phase I testing commenced at 11:00:00 GMT and was completed at 16:09:00 GMT. No significant problems were noted with the exception of an attempted command execute for PRIME RELAY RESET (34B). The command execution was transmitted from the MCC but not received in the MILA 642B command computer input buffer. This problem was not resolved and was probably rejected due to designed error code protection against transmission noise, data transfer, etc. No other problems were encountered.

#### 4.6 MCC Support of Flight Readiness Test (FRT)

The FRT was conducted on December 22, 1967, with a T-0 at 1600 GMT.

MCC command support was to commence nominally at T-4:40:00. CVTS requested MCC support at T-5:25:00. The Guidance Officer was not prepared and MCC command support was delayed approximately 30 minutes from T-5:25:00 to T-4:55:00 although still in advance of the nominal T-4:40:00. The delay was due to late receipt of several deviations to the TCP which impacted the Guidance Officer commands and required updating and review before commenting to support of the test.

At approximately T-00:37:00, the BSE SECTOR DUMP command was transmitted and no CRP was received; however, BSE telemetry indicated the command was received. BSE transmitted TERMINATE followed by SECTOR DUMP again and all indications were normal. This problem was not isolated, but the cause was suspected to be a momentary loss of SLV telemetry into the 642B command computer.



At 161137 GMT, the count was picked up at T-00:15:00 and continued until the recycle time. CVTS reported a problem with the HOLD FIRE/KILL sequence which apparently damaged the IU Flight Computer Software. Subsequently, CVTS reported that a rerun of the HOLD FIRE/KILL sequence would not be made. At 171800 GMT, CVTS reported the count would be picked up at T-01:00:00 at approximately 181800 GMT. From this time through the remainder of the FRT, the AFD position was not manned.

#### 4.7 General Comments and Recommendations

Reference paragraph 2.a(5) and 2.a(6) for comments on OCP documentation. In addition, MCC support positions contained in the OCP's were all identified as HFLT. It is recommended that henceforth the support position which is prime to interface with KSC for commanding or other active support items be specifically designated. For example, HGDO for GUIDANCE, HGNC for GNC, and so forth. This would have alleviated some confusion during the SIT's particularly and also provided KSC personnel with a means of identifying the specific position with whom they are interfacing.

The ATIWG representative is responsible for providing MCC inputs to KSC and also for receiving updates (deviations) from KSC. He should also be responsible to provide the necessary technical support here and at KSC for transmission and receipt of OCP revisions and reproduction, if required. The ATIWG representative should develop written procedures for this support to insure that errors in transmissions are precluded and timely distribution is made.

Specific objectives should be specified by the MOCR support personnel for each pad test. That is, what portions of a pad test do they desire to monitor and whether MOCR and SSR personnel both are required or only MOCR personnel. This would preclude to some degree overstaffing during portions of pad testing. Also, it would provide a means of designing the MCC/Network support count to provide pad data when specifically desired by MOCR positions.

### 5.0 Mission Support

#### 5.1 CDDT

Mission support for the LM-1 mission actually began with the CDDT. The spacecraft systems were, for all practical purposes, closed out during the CDDT. MCC support started at 0600Z, January 18, 1968. The following is a summary of significant items noted in the AFD log for the CDDT.

0812Z Six spacecraft TCP deviations affecting MCC-H support were relayed by voice to the AFD. LDX copies of the deviation were transmitted for verification later.

1100Z Picked up the count at T-23:30:30.

1131Z Spacecraft command receivers were turned on.

1152Z Spacecraft command receivers were turned off. It was confirmed by telemetry of spacecraft received signal strength, MAP pattern, and the setting of alarm 1106 in the LGC. (The latter was characteristic of LM-1 only. The DCA output spurious bits to the LGC when turned off.)

1229Z KGNL transmitted a +0.1 second update to the LGC to compensate for the predicted LGC clock drift prior to liftoff. The clock did not respond in the manner in which KSC expected. The problem was in the arithmetic convention for determining the sign of the update. It should have been GMT - LGCT. KSC used LGCT - GMT. The proper sign was used and the update completed satisfactorily.

1330Z PBT hangup in CP A. Cleared by recycling. Restored by 1337Z.

1331Z Conducted closed loop command checks with CNV, GBI, and ANT. Completed by 1350Z.

1351Z K-Start tape loaded. One serious problem. KSC had assumed that a Verb 36 Enter (Fresh Start) was on the beginning of the tape. It was not. As a result, the timers were enabled and an LMP command was left in the LMP history buffer. The status of other portions of the LGC was unknown, but believed safe. MCC-H GUIDO and Software Support discussed the problem with KGNL. The K-Start tape, preceded by a Verb 36 Enter, was reloaded at 1418Z.

1436Z Computer Supervisor reported continuous machine checks in the MOC. Apparent hardware problem. Switched to the DSC.

1510Z Transferred command loads to MILA for EMU update portion of the DSKY checks.

1533Z ETR command carrier on. MILA armed.

1538Z Spacecraft command receivers on.

1539Z EECOM transmitted the DCA self test command. GUIDO starting DSKY checks. Completed at 1551Z. During the EMU 1 check one more MAP was received than was expected according to the TCP. The command system was safed at 1546Z while investigating the possibility of a spurious command. It was confirmed that this was



normal. The EMU load has an Enter command after the data block. KSC was not aware of this and had not accounted for it. The same thing occurred in the EMU 2 test.

1551Z Command system safed.

1556Z Spacecraft receivers off.

1610Z CVTS reported a possible problem with a VCO in the DFI instrumentation.

1611Z MCC-H gave a Go for cabin closeout.

1623Z CVTS reported there would be a 1 hour delay while replacing the DFI VCO.

1815Z Completed BDA and RED command and telemetry interface tests.

1853Z Received message from GSFC stating that all network open items reviewed at the FRR have been corrected and that there are no problems which would constrain the launch (DTG 18/1845Z).

2004Z Restarting MOC and DSC. MOC back on line at 2008Z. DSC had a problem with the restart. DSC back on the line at 2037Z.

2046Z SLA batteries installed.

2030Z Count jumped to T-12:00:00.

2153Z CP PBT hangup. Cleared by 2155Z by reinitializing.

2206Z CP PBT hangup. CP's recycled. System A on line with 4 Stop tape. System A brought up without 4 Stop tape.

2211Z CP B PBT hangup. Determined to be a hardware problem. Both CP's on line at 2257Z, without 4 Stop tape.

2220Z Local IU command carrier up, IU receivers on for KSC tests.

2252Z CVTS requested MCC-H status for SLV command checks. Estimated ready in 30 to 45 minutes.

2334Z MCC-H ready to support SLV command checks.

2336Z MILA armed.

2339Z MILA safed.

2342Z IU receivers on.

2343Z ETR command carrier on.

2344Z MILA armed.

2348Z Launch vehicle command checks. Completed at 2349Z.

2349Z MILA safed.

2355Z ETR command carrier down.

19/0032Z Possible IU ambient temperature problem. MCC-H BSE did not confirm from his data.

0120Z CVTS advised that the launch vehicle is approximately 1 hour behind, and will probably be behind 2 hours by the time the built-in hold is reached. MCC-H has no further support requirements until T - 03:30:00.

0200Z Holding at T - 07:00:00 for replacement of IU battery.

0240Z Both CP's down for executive routine problem.

0256Z CLTC requested an additional 1 hour hold.

1157Z The launch vehicle experienced a "revert" during the 8 percent LOX fill. Caused by AGE valve (redundant) cycling closed.

1224Z The launch vehicle had another "revert." Not certain whether failure was a valve or micro-switch failure. Crew sent to the pad to investigate at 1238Z.

1239Z EECOM observed a momentary Glycol Low discrete. Confirmed by KECL.

1359Z On line CP PBT hangup. Cause unknown. Possible hardware problem.

1433Z Experiencing GSFC CP faults. Cause unknown at this time, but isolated to one area of the software.

1435Z Started Mission Rules review.

1551Z Count picked up at T - 03:30:00.

1552Z Command system armed, ETR carrier on.

1553Z Spacecraft receivers on.

1555Z Started GUIDO DSKY command checks. Completed at 1601Z.

1600Z GUIDO uplinking accelerometer bias update. (ADIX 1447/74462). Completed at 1603Z.

1604Z Command system safed.

1605Z Command carrier down.

1606Z Starting EMU verification.

1812Z Stopped LH2 loading. Indications of free oxygen in the SIVB. Apparently false indication.

1906Z Launch vehicle ECS H<sub>2</sub>O valve is open. ECS circuit breakers are open. Personnel going to boatail area to reset.

1945Z RCA 110A power supply failure. Personnel sent to the pad to investigate. New regulator hooked up.

2215Z KSC lost D/TV data because of a short at the generator. MCC-H requested to monitor critical parameters.

2231Z Started SIVB LOX flow. LH2 loading estimated to start in 1 hour.

2326Z Holding at T - 00:50:00. Estimated pick up in 1 hour.

2350Z Possible problem in freon boiler flow rate.

20/0038Z MILA armed.

0047Z Booster command checks. Completed at 0048Z.

0049Z MILA safed.

0055Z Indication of LH2 leak on the service tower. Not confirmed by TV. Continuing count.

0057Z Command carrier off for SLV local command checks.

0102Z Command carrier on. MILA armed.

0103Z Momentary hold at T - 00:20:00.

0105Z GUIDO transmitted "all zeroes" and Error Reset.

0106Z GUIDO transmitted Verb 34 Enter to enable readout of LGC error codes.

0106Z PRA sequence VII cued. Compare pulse received.

0107Z MILA safed.

0109Z Holding at T - 00:20:00 for completion of SIVB LOX loading.

0117Z KSC reports Relay Safe light out. (GY0122X System B Staging Relay Open). Indication lasted about 5 seconds. EECOM did not confirm. No indication during tape playback at MCC-H.

0122Z Experienced another glitch on GY0122X System B Staging Relay Open. No confirmation from EECOM.

0124Z GUIDO reports that we will have a key release when Verb 6 is sent because the Verb 34 Enter was not transmitted after completion of the K-Start tape, and the LGC has an error code to display, and can't access the DSKY.

0132Z AGCS (RCA 110A) is down. Power supply failure. The CDDT is scrubbed. Draining launch vehicle propellants.

0137Z Glitch on GY0122X. EECOM does not confirm.

0147Z GUIDO transmitted Verb 34 Enter.

0148Z PRA sequence XVI and Reverse Search transmitted to put the PRA at start of tape.

0148Z Command system safed.

0150Z Spacecraft receiver off. MCC-H support terminated.

## 5.2 Countdown

MCC-H support of the countdown started at 0130Z, 22 January, 1968. At this point, the spacecraft was essentially closed out with only final command checks, erasable memory verification, and systems monitoring remaining. Most of the countdown activities were concerned with launch vehicle preparation. The following is a listing of significant countdown activities and status, as condensed from the Assistant Flight Director's log, and voice recordings from the AFD console.

<u>Time</u>	<u>Description</u>
013600Z	Local IU command carrier and IU receiver/decoder coming on.
013800Z	Recycling CP's. Standby CP went down with an executive buffer fault. ETO 15 minutes.
013900Z	MOC and DSC down to load "day zero."
015400Z	IU receivers on, proceeding with functional test.
015500Z	Starting CASTS/CASRS test.
015800Z	MOC and DSC up.
021000Z	SPAN reported that a discrepancy in DPS supercritical helium pressure noted prior to picking up support was due to data flow test data being mistaken for valid data. There is no readout discrepancy.
022600Z	BSE site selected to MILA.
022700Z	MILA armed, ETR carrier coming on.
022800Z	CLTC estimates 10 minutes for command check pickup. MILA safed.
023200Z	BSE deselected.

023300Z CLTC reports that he is unable to run the IU receiver functional checks with the ETR carrier up. ETR carrier coming down.

023700Z IU functional checks completed.

023800Z BSE site selected to MILA, MILA armed. ETR carrier coming up.

024101Z BSE attempted initiation of Single Word Dump command while in Setup.

024124Z Single Word Dump transmitted and verified.

024136Z Sector Dump transmitted and verified.

024200Z MILA safed.

024300Z IU receiver/decoder off. ETR carrier coming down.

035900Z ETR carrier failed over to backup transmitter during the DSRC checks.

040200Z ETR carrier failed to secondary transmitter again.

043300Z ETR carriers brought down for trouble shooting. All vehicle receivers are off. SRO advised that carrier would be coming up and down periodically during the tests.

044500Z ETR transmitter number 1 now checks satisfactorily, problem was bad verification receiver. (Report of cause not received until 0600Z.)

074000Z REDSTONE telemetry computer is Red. ETO unknown. (This item continues throughout the mission and will not be noted again. MCC-H elected to precede with the mission. REDSTONE will load either the command or telemetry program as directed prepass.)

084500Z Start SLA closeout.

093000Z Start 6-hour built-in hold at T - 03:30:00.

094000Z SCS constants transmitted to remote sites.

101300Z DSC being loaded with ORACT program.

101700Z Hardcopy system A is down. Possible problem in the video switching matrix. No ETO. Affects all MOCR positions except Network Controller. System B is available to the SSR's.

105700Z Start ORACT testing. Pad data will be lost for approximately 3 hours during ORACT.

111200Z Hardcopy system A is green.

130300Z Started LOX system preparations.

132300Z Switched CP's to trouble shoot possible problem.

133000Z Discussion with CVTS on Liftoff report on Black 2. (Used as a cue for sending backup GRR command to the LGC.) CVTS had intended to announce liftoff at approximately T + 5 seconds. It was pointed out that this is much too late. Two commands, 5 Enter, must be sent prior to T + 10 seconds. CVTS agreed to make the announcement by T + 3 seconds. This is marginal, but acceptable.

140000Z Having problems with GYM timing. Intermittent updates on the day of the month. Will cause possible rejection of GYM summaries.

140500Z Starting FIDO trajectory run. Completed at 1427Z.

145000Z KSTC reported that all mandatory measurements, except GBO522 (DFI measurement, one of two mandatory), are green.

150300Z Clearing pad.

151200Z Recycling MOC and DSC into prelaunch. Completed by 1517Z.

152100Z Confirmed that MILA is safed, all consoles deselected, all consoles in setup, and that flight controllers are ready for command support.

153000Z Picked up the count at T - 03:30:00.

153100Z Internal command checklist completed.

153158Z MILA armed.

153252Z ETR command carrier is on.

153412Z Spacecraft command receiver is on.

153517Z DCA Self-Test transmitted.

153528Z LGC cleanup commands being transmitted. (All zeros, Verb 34 Enter). Completed by 153606Z.

153617Z Start DSKY command checks. Completed at 154058Z.



154122Z MILA safed, all consoles deselected and in setup.

154320Z Local spacecraft command transmitter is on.

154320Z ETR command carrier down. Starting EMU load and verification.

162357Z EMU verification complete. ETR carrier up, MILA armed. GUIDO transmitting Verb 34 Enter to clear DSKY for display of error codes. Completed at 162420Z. MILA safed and ETR carrier brought down.

163700Z Holding at T - 02:30:00 for GSE problem. Freon boiler had an increase in outlet pressure and a decrease in flow rate. Shortly afterward, it returned to normal. Spacecraft glycol and PIPA CAL MOD Temps. confirmed problem. Problem isolated to one rack of freon equipment at 1752Z and replaced. CVTS reported that it would take the launch vehicle approximately 1 hour to get back to the T - 02:30:00 point, because of LOX replenishment.

180100Z Clearing pad.

180700Z Starting LOX flow.

180910Z Starting ETR command checks. Completed at 1814Z. Checks are go.

193300Z Pad is having problems with launch vehicle data. Appears to be an AGCS (RCA 110A) power supply problem. ETO 1945Z.

201100Z Estimated pickup in 15 minutes. AGCS power supply replaced.

203600Z Cutting a type B restart tape in the RTCC. Completed at 2038Z.

204100Z ETR command carrier coming up for ELSIE and EGADS checks. Confirmed that MILA is safed.

204500Z Setting up for FIDO confidence run. T - 0 will be 2058Z.

204900Z Flight Director raised CYI command and telemetry categories to mandatory until REDSTONE telemetry computer problems are resolved.

205800Z Running FIDO confidence run. Run completed at 2112Z. The IP computer faulted during the run. No reason. Test was re-run with no problem.

- 210700Z Texas FRW2-A is red for a defective modulator. ETO  
1 hour.
- 211200Z REDSTONE telemetry computer is up and cycling. M&O  
reports that he has some small degree of confidence.  
(Telemetry computer faulted again at approximately 2139Z,  
and remained red until after liftoff, near the end of  
REDSTONE's passes.)
- 212200Z LOM reported that the preferred hold points from now  
on were T - 50:00, 40:00, and 20:00.
- 212500Z Confirmed that CVTS will make the liftoff callout  
on Black 2 by T + 3 seconds.
- 212700Z Confirmed that all consoles are deselected, in setup,  
and that MILA is safed.
- 213400Z Verified that consoles were preconditioned in  
accordance with Attachment 2 to the Overall Countdown.  
The following changes were made to the list:
- BSE - Added Switch Selector Command 3,  
Auxiliary Hydraulic Pump Flight  
Mode Off.
  - GNC - Added Prime Relay Reset (34B).
- 214300Z CVTS requested MCC-H status for terminal count,  
approximately 10 minutes early. Launch vehicle  
is ahead of the count.
- 215900Z MILA armed, BSE site selected to MILA. Gave CVTS  
a go for command checks.
- 220300Z BSE reports that the IU receiver/decoder is on. No  
report from CVTS. ETR carrier is on.
- 220500Z LM on internal power and go.
- 220539Z Single Word Dump transmitted and verified.
- 220609Z Sector Dump transmitted and verified.
- 220646Z MILA safed. BSE deselected and in setup.
- 221200Z Gave CVTS go for SIVB chilldown. (REDSTONE  
telemetry computer was still red. Command program  
loaded in the command computer.)

220500Z GUIDO transmitted LGC clean-up commands (all zeros, Verb 34 Enter). Completed at 222131Z.

222153Z Transmitting EMU update to enable auto GRR in the LGC (1.1 g's). Completed at 222439Z.

222457Z Cuing PRA Sequence VII. Completed at 222457Z. Compare pulse received.

222500Z MILA safed.

222600Z All consoles in setup. GUIDO and GNC site-selected to MILA.

222800Z CLTC reported a glitch in IU power at first switch to internal power. Possible inverter problem. Cut-off will be requested if observed again at T - 28 seconds.

223200Z O&P/MSFN voice and status checks. All go.

223300Z Flight Director gave KSTC a clear to stop monitoring GF9998U, Glycol Temp., at T - 03:43 (Auto Launch Sequence Start).

224200Z All consoles site-selected to MILA.

224232Z MILA armed.

224306Z GUIDO transmitting Verb 6. Completed at 224314Z.

224332Z Prime Relay Off (35B) transmitted and verified. KSTC confirmed function.

224526Z Automatic Launch Sequence Start (T - 02:43). No problems in the automatic launch sequence. No IU power glitch at final switch to internal power.

### 5.3 Plus Time Operations

Liftoff occurred at 22:48:09Z on 22 January, 1968. The following paragraphs are a summary of the mission as observed from the AFD's console. All data, except where specifically noted, is based on real time observations as noted in the AFD console log, console voice recordings, and command histories. All times are given in Ground Elapsed Time (GET) unless noted otherwise.

#### 5.3.1 Launch Through Canary Islands LOS

Liftoff occurred at 22:48:09Z. All vehicles were in a nominal configuration and GO at launch. Data delays precluded the Guidance Officer from seeing the spacecraft Guidance Reference Release. He transmitted the remainder of the backup GRR commands, the keycodes for 5 and Enter (at 00:00:06 and 00:00:07 respectively).

The Max q region was reached at 00:01:18. All systems were GO at the 00:02:00 pre-staging status check. The Retrofire Officer reported receipt of PRA Clock and Compare Pulses at 00:02:15. These were apparently caused by telemetry dropouts.

The Booster Systems Engineer reported Inboard Engine Cutoff, followed shortly by Outboard Engine Cutoff at 00:02:20. J-2 Ignition was reported at 00:02:34.

The LM ECS water valves opened at 00:03:00 as programmed. All systems were GO at the four minute status check. EECOM reported that the cabin had stabilized at 5.5 PSIA at 00:04:30.

At 00:05:00 the REDSTONE reported that their telemetry data processor would not stay up. The command computer was up and all other systems were green.

All systems were GO at the six minute status check. At 00:07:20, the start of the Fixed Time Abort region, command was handed over to Bermuda. At 00:07:45 the Booster Systems Engineer reported Step Press.

All systems were GO at the eight minute status check. At 00:09:05 the Booster Systems Engineer reported nominal engine mixture ratio. At 00:09:10 the Guidance Officer reported a predicted cutoff of 00:09:59. Actual cutoff occurred at 00:09:57. The vehicle was inserted into an 87 by 119 nautical mile orbit.

The launch vehicle post-cutoff vents were as programmed, and all launch vehicle and spacecraft systems were GO. The Range Safety Officer safed the S-IVB at 00:10:42.

The Booster Systems Engineer reported Nose Cap Jettison at 00:10:54. He reported a leak in the ECS GN2 sphere, measurement D25-601, at 00:14:00. This was later confirmed at Canary Islands. There was, however, no lifetime constraint on the primary mission.

At 00:16:00 EECOM reported that the maximum launch phase battery currents were 65 amps. This had occurred at 00:02:00. The maximum prelaunch currents were 58 amps.

Canary Islands acquired telemetry on both vehicles at 00:16:59. Deployment of the SLA panels was not observed at 00:19:58, when programmed (only the physical monitor, not the deploy relays, are on the HSD format). It was still unconfirmed at 00:21:14 and the Booster Systems Engineer sent the command at that time. Command verification was received, but there was still no telemetry confirmation of the event. At this time the Guidance Officer reported that the S-IVB was picking up attitude errors. The Booster Systems Engineer confirmed that the error was approximately one degree, which is within the dead-band. SLA deploy was not verified by Canary Islands LOS at 00:24:20.

### 5.3.2 Canary Islands LOS through LM/SLA Separation

Prior to Canary Islands LOS the Booster Systems Engineer had requested a TM station readout of the SLA panel physical monitor discrete. At 00:25:37 it was reported that there was a "1" in that bit position, indicating that the panels had deployed. It was later learned that the wrong measurement number had been given to the M and O, and that the measurement readout was SLA Deploy Relay A, not the SLA deploy physical monitor discrete. Attempts to verify this function by tape playback at Canaries proved unsuccessful.

The Coastal Sentry Quebec (CSQ) acquired IU telemetry at 00:48:00. They were able to confirm both SLA Deploy Relay A and B had actuated, but that the SLA deploy physical monitor discrete was not set. Based on the two out of three indications, the Flight Director elected not to call a NO-GO for separation. Pre-mission discussion had lead to the conclusion that the physical monitor was a positive indication of panel status if the discrete was set.

The CSQ was reporting intermittent LM telemetry from the LM at 00:48:48. At 00:49:11 telemetry from both vehicles was reported as intermittent. (Later during the mission the CSQ CAPCOM reported that part of the telemetry problem was apparently caused, in part, by RFI from the ship's ground communications equipment. The Brave teletype channel was turned down during acquisition to alleviate the problem.)

At 00:50:01 the CSQ reported that the counters were disabled and they still had intermittent sync. Mission Phase 7, Program 14 was confirmed at 00:50:23:00. The RCS pressurization sequence was nominal. CSQ reported ED Arm at 00:54:00, and RCS pressurization completed at 00:50:52.

At 00:51:26 CSQ reported that GET lead by 1 second. This was not confirmed by MCC-H display of Delta LGCT at Carnarvon (CRO).

Carnarvon acquired telemetry at 00:51:47. CSQ brought their command carrier down and gave a GO for separation at 00:52:00. CRO also confirmed that both SLA deploy relays had actuated. At 00:52:47 EECOM and GNC gave a GO for separation. The separation sequence was nominal, with LM/SLA separation occurring at 00:53:54 (23:42:03Z). Rates were reported as steady, with little RCS attitude. The maneuver to cold soak attitude was good. CRO noted that UHF received signal strength started out at - 87 dbm immediately after separation, and appeared to be decreasing throughout the pass. The reading was 30 PCM counts (approximately - 100 dbm) at LOS. CRO also reported that their S-Band data was not as good as VHF telemetry.

CRO reported that RCS A seemed to be depleting somewhat faster than system B. It was later confirmed that there was a four percent low bias in the system A quantity measurement. GNC felt that the sensor was a little erratic.

The Guidance Officer reported that the timers were loaded and counting at 00:57:02. HSD format number 2 was selected to give the Booster Systems Engineer data. The S-IVB venting was normal.

A procedural tape playback was executed after CRO LOS to review the separation sequence, and to evaluate S-Band data in the low power mode. S-Band data was confirmed as good, but not as good as VHF. S-Band received signal strength was approximately - 98 dbm.

### 5.3.3 Carnarvon LOS through end of Revolution 1

At 01:16:30 the BSE reported that the Tananarive tape dump had started 2 minutes and 30 seconds early and terminated 3 minutes and 16 seconds early. Later; however, Tananarive reported that the report was in error. What they had observed was data dropouts. The dump actually started 1 minute 12 seconds early and ended 8 seconds late. This is within tolerance.

Upon completion of the Carnarvon playback, generation of the command plan for the CONUS pass was started. Since there had been no anomalies to this point, other than the varying UHF received signal strength, the only commands required were the procedural commands for switching to the secondary S-Band system to get into the high power mode, and the LMP commands for insuring that the RCS crossfeed valves were closed. The flight controllers were requested to review and concur in the plan.

The Flight Director reminded all personnel that the REDSTONE telemetry computer was still not reliable, and that all command activity should be completed prior to Bermuda LOS. It was then decided that we would prefer to have the telemetry program loaded into the command computer at the REDSTONE, if this would not interfere with their trouble shooting. The flight controllers were advised that we would receive format 2, and the Network Controller was requested to inform the REDSTONE.



The RKV acquired the LM at approximately 01:28:16. UHF received signal strength was fluctuating around -65 dbm. It should be noted that throughout the mission the RKV was the only MSFN site with consistently solid telemetry and command capability (The latter being based on UHF received signal strength). The CAPCOM reported that all clocks were in sync. GT0993E, S-Band Transmitter Power Out, was reported as erratic, and reading about 46 PCM counts. Since this measurement was known to be erratic pre-mission, EECOM informed the Flight Director that it was good. The RKV also reported reception of intermittent booster data.

At approximately 01:29:00 Guaymas acquired LM data. The systems engineers reported that the vehicle looked good. Glycol temperature was reading 42.6 degrees. The UHF received signal strength was observed to drop to about -95 to -100 dbm at RKV LOS minus 1 minute.

At 01:31:20 Guaymas reported that the IU signal was fading from the vehicle. Houston TM confirmed that the data received was very noisy.

Texas data was acquired at 01:32:00. All systems were GO based on Texas data. At 01:32:24 the Flight Director informed the RKV that Houston was prime for command, and the RKV brought their command carrier down. Texas was slow in bringing up their command carrier. It was not up until 01:32:54. When the carrier came up signal strength was good, and EECOM started the S-Band command sequence. The primary S-Band Off command, 30A, was sent at 01:33:12. Secondary S-Band On, RTC 20A, was transmitted at 01:33:28.

Following the switching of S-Band systems, GUIDO started the command sequence to close the RCS crossfeed valves (LMP 376 load 2502) at 01:34:17. The final command was transmitted at 01:35:35. Refer to the Command Support Position's report for the specific time of each command in the sequence. At completion of the close command GNC reported that he had a crossfeed valve open indication that he had not seen prior to the command. This caused some momentary concern until it was remembered that the instrumentation for all RCS valves was not reliable until power was removed from the coils. GNC; however, did not concur with this explanation initially. He did agree later.

The Guidance Officer started the crossfeed valve close reset commands (LMP 377, load 2602) from Texas at 01:36:01. It was completed over MILA at 01:38:19. At that time the proper TM confirmation was received.

At 01:39:58 the BSE was queried about the Guaymas tape dump. The dump had been received, but the site was unable to lock up on the data.

#### 5.3.4 Revolution 2

Bermuda acquired data at 01:41:00. BSE reported that we were go for the Passivation Experiment and the experiment was enabled.



REDSTONE acquisition was at approximately 01:46:40. Again the UHF signal strength was marginal. The Flight Director requested EECOM to evaluate the data available and to try to predict the command coverage for the burns. The problem appears to be related to attitude.

At approximately 01:49:50 GNC reported to SPAN that RCS Quad 1 temperature was running about 20 degrees higher than the others.

At 01:51:00 the BSE reported that the SLV APS lifetime was predicted to be good to 08:00:00.

At 02:05:00 the GNC reported that RCS system A quantity and usage were nominal. He confirmed that there was a four percent low bias in the quantity readout.

At 02:15:00 the Flight Director conducted a systems status briefing on the GOSS Conference loop. This procedure had been used on only one previous mission. The advantage of doing it this way as opposed to an MCC internal briefing followed by a network summary briefing is that the remote site flight controllers have the opportunity to query the control center personnel as each item is discussed. It also insures that the sites are briefed as soon as possible, rather than immediately prior to acquisition.

The LM status as summarized during this briefing was as follows:

- a. UHF received signal strength is running lower than expected. Varying between - 61 to - 109 dbm. No explanation other than possible attitude affect.
- b. The vehicle is on secondary S-Band data. S-Band data is good.
- c. The RCS crossfeed valve commands were transmitted during the CONUS pass. The crossfeed valve open indication was received as long as power was applied to the valve coil, which is a known condition.
- d. RCS system A quantity is reading four percent low.
- e. Water, electrical, and RCS usage rates are normal.
- f. RCS Quad temperatures are as follows:
  - (1) Quad 1 - 156 degrees
  - (2) Quad 2 - 137 degrees
  - (3) Quad 3 - 138 degrees
  - (4) Quad 4 - 148 degrees
- g. RCS Quad 1's high temperature was believed to be caused by solar heat soak.

h. The LGC was performing nominally.

The S-IVB up to this point had been following a nominal time line. The only anomalies were the ECS GN2 sphere leak, which had no effect on the mission, the poor telemetry received, and the fact that the fuel ullage pressure was reading zero. The latter was apparently caused by more fuel vaporizing and venting than had been expected. The vehicle was Go for the Passivation Experiment, which was enabled. The GN2 sphere lifetime was predicted to 05:30:00.

At about the same time as the briefing was being held the Flight Director was informed that the ASPO had determined that the APS tank pressures which would require premature APS pressurization should be 50 PSIA, rather than the 80 PSIA presently in the mission rules. A Mission Instruction message updating mission rule 16-9 to the new value was sent to the MSFN.

At about this time also, the Flight Dynamics Officer reported that he had committed to the DPS 1 maneuver. No updates were required. Subsequently he started the detailed DPS/FITH/APS sequence planning.

At 02:21:00 the CSQ reported acquisition of S-IVB telemetry. The quality of data was reported as very poor. This continued to at least 02:22:25. The MCC BSE acknowledged that this was what had been expected, and that the vehicle would be in a better attitude for reception of telemetry at Carnarvon.

Carnarvon reported acquisition of LM telemetry at 02:24:23, and acquisition of both vehicles at 02:24:41. CSQ/CRO command hand-over was completed at 02:24:56. At 02:25:10 BSE reported that the S-IVB was Go.

At 02:26:00 both vehicles were Go. Lm telemetry was momentarily intermittent. At 02:26:19 Carnarvon reported that the booster was showing FCC Burn Mode On (start of passivation). LOX dump initiate was reported one second later. At 02:27:41 Carnarvon reported FCC Burn Mode Off. LOX dump terminate was reported at 02:28:27. 10 Seconds later the LH2 dump started. At 02:29:04 Carnarvon reported that the Oxidizer ullage pressure had not relieved as much as expected. The LH2 dump terminated at 02:31:27. Nominal LH2 and LOX venting was reported at 02:31:51. Attitudes were nominal and steady during passivation.

At 02:48:25, some three minutes early, Hawaii reported AOS. We were; however, unable to sync on the data. Whether this was actual acquisition of the signal due to multipath, or whether it was RFI, was not determined. Actual Hawaii AOS occurred at 02:51:00. The S-IVB cold helium dump was initiated at 02:52:38. The dump sequence was nominal. The RKV had acquisition at 02:58:47. The Hawaii command hand-over went smoothly, and was completed at 02:59:16.

The RKV reported their initial UHF received signal strength as - 105 dbm. LGCT was reported as lagging 1 second with excursions to 10 seconds. This had not been reported by any other site, and was not confirmed at Guaymas. The RKV probably had intermittent loss of LGC sync.

The handover from the RKV to Texas was executed at 03:05:45. UHF signal strength was poor. The EECOM was concerned that the signal strength calibration curve had shifted. Since we had no command problems to this point, he wanted to transmit the DCS Self Test Command for verification. EECOM also reported that if this were a true reading we would have adequate signal strength by 03:09:00. The only planned command activity for this CONUS pass was the cuing of PRA Sequence V, No DPS/FITH/APS to Depletion, which would be required in the event of lifetime constraints or trajectory problems after the DPS 1 burn. The Flight Director elected to postpone EECOM's DCA Self Test until after the predicted signal strength improvement, immediately prior to cuing PRA Sequence V.

Command handover from Texas to MILA was accomplished at 03:09:12. UHF received signal strength was - 106 dbm. EECOM transmitted two DCA Self Test Commands (03:10:12 and 03:10:26). Spacecraft Rejects were received on both. Flight advised GUIDO that we would not cue PRA Sequence V this pass. At 03:12:58 the UHF received signal strength was up to - 92 dbm and another DCA Self Test command was transmitted. This time the command was accepted. GUIDO was directed to cue the PRA. This was completed by 03:13:52. The Compare Pulse was received at 03:14:40.

### 5.3.5 Revolution 3

At 03:14:49 the BSE reported that the LOX vent valve was open. The LOX Vent Valve Closed command was transmitted at 03:15:05. The command was not accepted. Apparently the command was sent after MILA LOS and prior to Antigua AOS.

At this time the Flight Director instructed the Network Controller to have the REDSTONE load the command program in the command computer for the next pass.

The Retrofire Officer reported intermittent PRA Clock and compare pulses at 03:25:03. They were apparently invalid, caused by noisy data. RETRO conducted a clock sync check with the CSQ and Carnarvon CAPCOM's at 03:26:00.

At 03:33:30 FIDO reported that the DPS 2 burn would not achieve propellant depletion. Approximately 1,393 pounds would be left.

The Flight Director conducted a status review of the mission after Ascension Island LOS. There were no new problems above those discussed at the last review. The Guidance Officer had; however, noted that

the CDU actual and desired readings were not agreeing because the CDU desired was in spacecraft axes, while the CDU actual was in INU axes. This caused deletion of the part of mission rule 14-30 which used those cues.

After the site briefing on mission status, the AFD's discussed the possible causes of the CSQ's relatively poor telemetry reception. The CSQ had had a history of interference caused by keying the GOSS Conference loop. The CSQ CAPCOM said that he had been watching that, but there appeared to be no problem. He did; however, report that part of the problem was caused by their outgoing teletype traffic, and requested to terminate the B (summary message) channel. Permission was granted.

The CSQ had acquisition at 03:54:24 and immediately reported that the 1218 RSDP was down. This would prevent their confirmation of LGC program, phase, and DSKY data. They were still able to monitor directly driven events and analogs.

Based on the CSQ's reports of preburn events it was confirmed that the LGC had entered mission phase 9 at the nominal time of 03:55:04. At 03:57:30 the Guidance Officer reported that predicted time of ignition for DPS 1 was 03:59:40.

Carnarvon acquired data at 03:57:58. Command handover was delayed, as planned, until after DPS Arm at 03:58:42. At that time a Go for DPS 1 was given by both the CSQ and MCC.

DPS 1 ignition occurred at 03:59:40.6, based on Carnarvon's strip chart recorders. At 03:59:57, immediately after reporting 10 percent throttle, Carnarvon reported a PGNS Caution, which they later changed to a Program Caution, and Program 00. The DPS engine was commanded off at 03:59:44.8 by the LGC. Carnarvon was directed to make Houston prime for command at 04:00:30. EECOM reported poor signal strength immediately after the handover.

UHF received signal strength read - 99 dbm when the Prime Relay Reset command, 34B, was transmitted twice (04:01:18 and 04:01:39). Approximately one minute later, at 04:02:19, the Prime Relay Reset command was again transmitted. This time it was accepted and the DPS ARM discrete was removed. The Guidance Officer recommended transmission of Verb 15, Noun 50 to enable display of the error codes. The command sequence was started at 04:03:34, and completed at 04:04:26 (reference the Command Support report for the times of each command). The error codes received were Delta V monitor Alarm, and FORGETIT. These indicated that the LGC had commanded shutdown of the DPS because of failure to sense adequate acceleration.

Carnarvon was requested to provide DPS on/off times and the history of thrust chamber pressure from their chart recorders. The results are tabulated below:

Time GMT	Time GET	Readout
02:47:49.6	03:59:40.6	DPS ON discrete
02:47:50.5	03:59:41.5	TCP deflection on recorder
02:47:52.2	03:59:43.5	TCP = 09 PCM counts
02:47:53.5	03:59:44.5	TCP = 18 PCM counts
02:47:53.8	03:59:44.8	DPS OFF discrete
02:47:54.5	03:59:45.5	TCP = 00 PCM counts

The above history shows a slower rise in TCP than would have been expected. This may have been due to a combination of the ullage pressures and the 1.3 second time delay between the ignition signal and DPS pressurization.

At 04:06:50 EECOM and GNC reported that there were no systems problems which would affect vehicle lifetime. The Flight Dynamics Officer recommended that we wait until next rev before starting an alternate mission. The two prime alternates for this type failure are C and L. There are targets for L at Hawaii, if they are required for execution this pass over the states. They are based on prelaunch nominal data with no DPS burn, and may not be valid. If used, a manual abort stage may be required.

The Flight Director concurred in FIDO's recommendation. He further requested that we evaluate the possibility of retargeting DPS 1 for the next CSQ/CRO pass. This possibility had been rejected pre-mission because of the limited coverage available from those sites during revolution 4. Since there was some DPS burn the trajectory may have been able to tolerate it. FIDO verified that the coverage would be roughly what had been predicted, and this alternate was discarded. It was discussed again several times before it was finally rejected.

Following Carnarvon LOS the command plans for Hawaii and the CONUS pass were started. The only commands required for Hawaii were the LGC Error Reset command, and the cuing of PRA Sequence III for alternate mission C. The Prime Relay Reset command, 34B, was to be left in the spacecraft until just prior to going into an alternate mission. This was done to insure the vehicle was in a safe condition. At this time the cause of the failure was still undefined. (See the Command Support report for the times of the Hawaii commands.)



The discussion of which alternate mission to follow (C or L) continued from Carnarvon LOS to Hawaii AOS the next revolution. Alternate mission L was not desirable from the point that we were unable to retarget it in such a way that a manual abort stage could be avoided. The maximum DPS burn time available would have been 60 seconds. This did not satisfy the ASPO's desire for a long DPS burn. Further, if the manual abort stage were not effective, the DPS would fuel deplete while below the minimum perigee limit. Since we had had severe commanding problems, attempting alternate L with a manual abort stage would jeopardize not only the abort stage, but the APS burn to depletion and RCS/Ascent feed test. This was not immediately apparent, and as previously stated, the discussion continued until immediately prior to Hawaii's pass during revolution 4.

Following Hawaii LOS during revolution 3, the Guidance Officer pointed out that the attitude for PRA III would be retrograde. He then recommended using the LGC to establish an optimum attitude during the CONUS pass. The command sequence started at 04:41:47 and ended at 04:51:30. (See the Command Support Plan for the times of the individual commands.) The LM went to attitudes as commanded at completion of commanding.

#### 5.3.6 Revolution 4

Still going on the assumption that we would be able to execute alternate mission L, the Guidance Officer transmitted the updates for mission phase 13 from Carnarvon. The update was completed at 05:35:01.

The Flight Dynamics Officer recommended an initiate time of 06:15:00 for PRA Sequence III, if used. The AFD's were directed to determine the reasons for which we would not terminate PRA Sequence III after APS 1. This was a deviation from the alternate mission C. The reason for the deviation was that the LGC was still good. If we were able to interrupt the PRA prior to reaching the APS depletion burn, it could be done under LGC control the next revolution. In doing the check requested, it was noted that if the PRA sequence were started at 06:15:00 the abort stage would occur near LOS of both the RKV and Texas. It was then recommended that initiate time be moved up to 06:10:00, and that the sequence be terminated no later than 06:13:32. The latter time was approximately 7 seconds prior to getting into the plus X translation for the APS to depletion burn.

At Hawaii, revolution 4, the pre-sequence commands were sent for PRA sequence III. Signal strength was very poor initially. Spacecraft rejects were received for the first two attempts at the Prime Relay Off command, 35B, sent at 05:59:22 and 05:59:31. Signal strength improved and the third attempt at 05:59:37 was accepted. Battery 5 was commanded to the alternate feed path at 06:00:28. ED Batteries were commanded on line at 06:00:46.

The RKV commanded the LM to the AGS mode at 06:05:34. (The DCS retransmit switch was at zero per SOP and direction of the AFD). The

RKV CAPCOM commanded PRA Start at 06:10:00 and the sequence proceeded normally. The MCC was monitoring the sequence through Goldstone and Guaymas. Rates were good. The RKV reported the DPS 1 burn had ended with the throttle at less than 100 percent, but later retracted the report. The sequence continued nominally. Abort stage occurred at 06:12:21.

After the APS 1 cutoff the Flight Director started a quick status report to determine whether we should continue with the APS depletion burn part of the sequence. GNC, EECOM, GUIDO, and FIDO reported that we were in good condition both systems and trajectory wise. We had approached within about eight degrees of LGC gimbal lock, but had come back out. Based on that Flight directed that the AGS Select command, 40B, be sent to stop the sequence before any further commands were executed by the PRA. The first command was transmitted at 06:13:40 by the GNC. GUIDO initiated the same command one second later. Both commands were accepted. The clean up commands, PGNS Select, 41B, and Prime Relay Reset, 34B, were sent at 06:14:03 and 06:14:15 respectively. Shortly afterward GNC reported an extremely high RCS usage rate. This was thought to have been caused by the fact that we were in PGNS control and the Digital Auto Pilot was using the full vehicle mass for its thruster command calculations. This had been discussed pre-mission, and was expected. GUIDO was preparing mass update loads for this problem. They were not available for immediate transmission because the mass values required would have been a function of the vehicle state, and how far we had gone into the PRA III sequence.

The AFD noted that according to his log data the PRA stop function may have been executed after the start of the plus X translation for the APS 2 burn. If so, there would have been some 36 seconds of plus X translation, which would have accounted for some of the high RCS usage. The command histories confirmed that this was probable. GNC; however, did not feel this was the case. RCS usage was as expected until the time the PGNS mode was selected.

After the RKV LOS the RKV CAPCOM reported that a review of the analog recording of thrust chamber pressure during the PRA DPS 1 and DPS 2 burns showed that there had been a delay in reaching 10 percent thrust, similar to that observed during the abortive first DPS burn. The delays were 2.4 and 4.0 seconds respectively.

Post flight evaluation of RCS quantities confirmed that there was no plus X translation. Either the RKV or Texas command histories or both must have been rounded off to the nearest second in the right direction.

Since the LGC had been commanded to attitude for the PRA burn, the Guidance Officer had to send an EMU update to reenable the LGC KALKMANU routine, if we were to do any further LGC controlled burns. This



was started at 06:16:47, and completed by 06:17:43. (See the Command Support report for the times of each command).

During the attitude counter update discussed in the preceding paragraph, GNC recommended that RCS system A be closed off to conserve some attitude hold capability, rather than depleting both systems. The RCS Main A Closed command, 44A, was transmitted at 06:17:09. At 06:23:20 GNC reported that system B was depleting and recommended that we go to the AGS mode to conserve RCS. Flight vetoed this request because he wanted to insure that we did not get into an LGC gimbal lock condition. That would have precluded using the LGC for the APS burn to depletion.

Meanwhile, the Guidance Officer had had a navigation update load generated based on post cutoff data. He started uplinking the load from MILA at 06:24:47. The final Enter was transmitted through Antigua at 06:25:58. A verification was received, but LOS occurred prior to LGC telemetry verification that the load had been accepted. It was confirmed at Carnarvon later.

### 5.3.7 Revolution 5

At 06:28:10 the network was advised that we would either go with PRA Sequence V or LGC mission phase 13. The starting point for either of them would be Hawaii. In either case the APS depletion burn would not be completed until the RKV. There was a one minute gap between Hawaii and the RKV, but the WATERTOWN, which had been called up on an engineering evaluation basis, would cover the gap. The WATERTOWN had been receiving data during it's previous passes.

At this point we still needed the mass update, target update, and a timer update for mission phase 13. In addition an update to lengthen the LGC acceleration sample period was highly desirable. The exact cause of the DPS 1 problem was still unresolved. If we were unable to complete the maneuver as planned because of a similar problem, there was little range coverage left for subsequent attempts. Further, since we expected to lose attitude control when RCS system B depleted, we intended to open system A and the RCS crossfeeds as soon as possible after the mass update was completed. Since tracking data confirmed that we were in a 91 by 532 nautical mile orbit, there would be a fairly long pass at Carnarvon, but time available for all the updates would be critical.

The CSQ acquired broken telemetry at 07:01:30. Their telemetry for that pass remained fairly poor throughout. Part of the problem was apparently caused by a failure of a PCM station power supply. This prevented the CSQ from cuing PRA V as planned.

The first command transmitted from Carnarvon was RCS Main A Closed Reset, 45A, at 07:08:06. The Guidance Officer started uplink of the mass update (EMU 1, load 3701) at 07:08:50. It was completed by

07:09:41. Immediately thereafter GNC started configuration of the RCS main shutoff valves. RCS Main B Closed (54A), RCS Main B Closed Reset (55A), RCS Main A Open (50A), and RCS Main A Open Reset (51A), were transmitted by 07:10:57. (See the Command Support report for the time of each command).

The next activity at Carnarvon was to get the RCS crossfeed valves opened. The first command, Prime Relay Off, 35B, was sent at 07:11:07. GUIDO started uplink of the crossfeed open commands (LMP 374) at 07:11:20. The sequence was completed by 07:12:22. The reset commands (LMP 375) were started at 07:13:05 and completed at 07:14:05. (See the Command Support report for the times of the individual commands.)

After opening the crossfeed valves the Guidance Officer initiated EMU 2 (load 3801) to increase the sampling period for the Delta V Monitor Routine, and to get the Digital Auto Pilot into maximum deadband. He was unable to get the data in via the load messages because of intermittent drops in UHF received signal strength. He then attempted the load through DSKY commands. The load was still not completed by LOS.

During the EMU load attempt Carnarvon reported high thruster activity and occasional high rates. GNC confirmed. Further, GNC reported that the RCS oxidizer pressures were low. He felt that this was the cause of the problem. After the mission it was learned that the mass update previously transmitted did not restore normal Digital Auto Pilot operation. The current mass is ignored until the LGC was in an average routine. It could have been forced, if the problem had been known. Based on his feelings on the oxidizer status (which was also unexplainable in real time) GNC recommended opening the ascent feed valves prior to executing any burn sequence.

After Carnarvon LOS the mission status was reviewed. If an LGC controlled burn were to be used we still needed to get timer and target updates in. In either case the ascent feed valves had to be opened. Three LMP commands were required for that function. There was not enough time to get in all the required commands prior to time for ignition. Consideration was given to slipping the APS burn to depletion one more revolution. Unfortunately this would have required generating new timer and target updates, which could not have been done at Hawaii. There were no other sites available to uplink LGC commands again until Hawaii the next pass. We would have been essentially in the same position.

The Flight Director requested FIDO to find out what would happen if the phase were enabled after time for ignition. FIDO replied that he could not tell. The computer would navigate to target, but what it would do in getting there was unpredictable. The affect on the

guidance equations was indeterminate. Based on this input PRA Sequence V, No DPS/FITH/APS to Depletion, was selected as the prime alternate. There was still a significant amount of commanding left prior to initiating the sequence. We would be unable to get ignition at the desired point.

The RKV was advised that the vehicle would come over the horizon burning, and that we couldn't predict where we would be in the sequence. The PRA sequence would not be executed in the nominal manner. ASPO had expressed a preference to have one long APS burn instead of the one short and one long burn on the tape. This required that an Engine Start Command be sent after the APS 1 burn had started. Further, since the RCS system required APS propellants for attitude, the AFD queried Flight about interrupting the sequence before reaching the end of the ascent feed test. The Flight Director requested ASPO advice. They replied that they concurred, but that they wanted to let the sequence proceed until the RCS system was in the normal configuration for the feed test (both main shutoff valves closed, ascent feeds and crossfeed valves open).

Hawaii acquired the LM at 07:38:00. UHF received signal strength was good (approximately - 80 dbm). GUIDO started the command sequence to open the ascent feed valves at 07:38:31 (LMP's, 176,074 and 076). Ascent feeds were opened at 07:42:14. (See the Command Support report for the times of the individual commands.)

Immediately after opening the ascent feed valves the Guidance Officer started cuing PRA Sequence V. This was completed, and the compare pulse received at approximately 07:42:38.

At 07:42:57 GNC transmitted the RCS Main B Open Command, 60A, to trap as much propellant in the RCS system as possible, in the event we were unable to get the sequence stopped before the ascent feed valves were closed.

We then entered the command sequence to start the PRA burn. The times of the commands are listed below:

Guidance Select AGS	07:43:07	
PRA Start (Not Accepted)	07:43:19	Delay in sending second command to verify not accepted.
PRA Start (Accepted)	07:43:54	
Engine Start	07:44:15	
	07:44:18	
	07:44:21	

The burn was normal, attitudes were steady. At the time the ascent feed and RCS valves were confirmed to be in the normal configuration for the ascent feed test, GNC transmitted Guidance Select AGS, 40B. Hawaii

had had LOS and the command did not reach the spacecraft. It was missed by approximately 12 seconds. If the first PRA Start command had been accepted confirmation would have been made in time.

The RKV acquired at 07:46:48. Twelve seconds later the last ascent feed valve closed. The burn continued with good attitude stability until approximately 07:47:45. At that time rates started going off scale high and low in all axes. The RKV maintained solid telemetry until LOS. The burn continued until depletion. The RKV reported approximately 5 PCM counts on the APS TCP even after cutoff.

The vehicle structure apparently held during the entire burn. Cabin pressure was reported as 52 PCM counts at RKV LOS. Two commands were transmitted in the blind from Texas, hoping to put the vehicle in a usable condition for the post mission test plan.

The vehicle was never reacquired after Guaymas. That station had a maximum elevation of 1.0 degrees. Several sites reported possible contact, but could not confirm it. The MSFN continued to search for the vehicle until approximately 11:00:00Z.

LM-1 Pad Safety

Approximately two years ago FCD recommended spacecraft configuration changes to provide control over spacecraft relays that would allow complete safing of the LM system. Approximately one year ago the subject was again addressed at FCD's insistence, and the Program Office organized a meeting at the Cape to review this problem. The major safing effort at that time was directed toward providing a capability via hardline for controlling the spacecraft received decoders. A secondary effort was directed at providing a capability to inhibit the outputs of the prime relays again via hardline. The former effort was successful, however, due to the major spacecraft redesign necessary for the latter, the requirement was dropped. At that time that adequate safeguards existed either via procedures or within the spacecraft that no single failure could cause operations of prime relays. During the terminal testing of the LM spacecraft, starting approximately March of last year, certain EMI problems were noted that could cause spurious activations of the Program Reader Assembly and also between the DCA/LGC interface. If these facts had been known at the time of the discussion relative to the provision of the capability to inhibit the prime relays, this capability would have been pursued more vigorously.

FCD on March 1967 initiated a very detailed study of the effect of inadvertent command radiation and its influence upon spacecraft systems both through the prime and ground (RTC) relays. This led to the development of the "inadvertent command relay matrix". In August this matrix was initially transmitted to KSC for their review and comment. A meeting was held at KSC to review this matrix with NASA/GAEC spacecraft checkout personnel. It was FCD's contention at the meeting that radiated commands were not the only source of input that could cause an inadvertent closure of these relays, and FCD recommended strongly that a similar study be made by spacecraft checkout personnel. During this meeting discussions were conducted about the control capabilities that exist within KSC AGE (DCS test set) to apply preventative and corrective actions necessary to recover from a potentially catastrophic situation. At this same time, FSD personnel presented a technical discussion of the operation of our ground command systems and the procedures that we would use to assure maximum safety during our pad test period.

A second meeting was held at KSC to review the results of procedural activities in applying preventative and corrective actions for inadvertent closures. The results of this meeting were similar to the first and it appeared that insufficient attention had been devoted to this task, and that no hardware or software capabilities were being developed to provide a KSC preventative and/or corrective action capability.



Throughout this entire period of time, however, a strong interface was being developed through the spacecraft Test Conductors in the development of the OCP's to reduce or mitigate the effect of any command transmission. The OCP's were developed in such a fashion and procedures established such that two relays must be closed prior to the occurrence of any catastrophic event. Control procedures were established during the countdown to assure that both the receiver decoders were powered down and that the Houston command system was mechanically safed at the appropriate update buffers (point closed to the antenna). A unilateral study was initiated in late October to readdress the corrective/remedial actions necessary to recover from any inadvertent relay closures. The intent was to provide the basis for development of standardized recovery procedures wherever possible. This included listings of cause, effect, verification, delta T, criticality, and preventative and corrective actions. The results of this study led to the three following conclusions:

1. LGC - any inadvertent operation of the LGC resulting from a premature Guidance Reference Release (GRR) was not potentially catastrophic until the period of time where the abort monitor routine would be enabled, after which a single further relay closure could conceivably cause an engine ignition. The abort monitor routine is not enabled until approximately 2 1/2 minutes after the Guidance Reference Release and it was felt that KSC in this case would have sufficient time to apply preventative/corrective actions through the DCS test set, in coordination with the SRO. (It would be necessary to bring down the range carrier.)

2. PRA - In order to provide a redundant means of initiating suborbital sequences during launch phase, the FCD intended to cue PRA sequence IV prelaunch. However, in reviewing the potentially catastrophic results of an inadvertent activation of this sequence (first +X translation occurs four seconds after sequence start), it was decided that PRA VII (RCS insulation) would be cued prelaunch. This eliminates any catastrophic events that could be caused by inadvertent PRA operation.

3. Real Time Commands - There is no way of protecting against multiple real time command transmissions to the spacecraft. There were several combinations of real time commands that could cause catastrophic events on the pad.

It was believed at this time that adequate safeguards exist within the command system and within the MSC/KSC OCP's to protect against inadvertent command radiation throughout the majority of the pad test cycle. Similarly it will require a minimum of two different real time commands prior to a catastrophic occurrence. The design of the command system implemented for Apollo is significantly different from that associated with the Gemini system. At no time during the Apollo testing operations have multiple, different commands been radiated. In one instance a single command was radiated inadvertently as a result of a ground system problem. (This system design deficiency was corrected for LM-1.) Procedures to provide maximum possible speed in inhibiting command transmission if they should occur, and to minimize the time that the command system is "armed" during hazardous OCP's.

Subsequently, meetings between Mr. S. Simpkinson, ASPO Flight Safety Office and FOD were established to review the safeguards or protection against inadvertent command transmissions that were designed into the CCATS, GSFC C.P. and 642B systems. Also, the MCC command support procedures were reviewed in detail with emphasis on command system configuration control.

Telecon conference between G. Page/KSC and FOD personnel on December 28, 1967 reviewed in detail the MCC nominal, backup and contingency command support procedures which would be utilized for the CDDT and launch countdown. The agreements reached during this discussion were subsequently documented in the TCP's. The contingency command procedures were primarily a result of insufficient hardline control over critical LM systems.



FEB 1 1968

PROCEDURES

POSTMISSION REPORT TO THE FLIGHT DIRECTOR

204/LM-1

- I       PREMISSION TRAINING AND TESTS
- II       ACTIVITY LOG
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ENCLOSURE 1: PLANS POSTMISSION REPORT

ENCLOSURE 2: COMMAND SUPPORT POSTMISSION REPORT

ENCLOSURE 3: TM SUPPORT POSTMISSION REPORT

ENCLOSURE 4: RCC POSTMISSION REPORT

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H. RUSSELL GOODWIN

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LAWRENCE L.D. ARMSTRONG

# I. Premission Training and Tests

## A. Simulations

- |                   |         |  |
|-------------------|---------|--|
| 1. Aug. 9, 1967   | 4 hrs.  | FIDO Trajectory Runs   |
| 2. Sept. 11, 1967 | 6 hrs.  | SIM Ops Checkout<br>(nominal run through MP-11)  |
| 3. Sept. 13, 1967 |         | Launch Sims<br>(scrubbed due to CCATS command problem)   |
| 4. Sept. 14, 1967 | 10 hrs. | Launch Sims (six runs)<br><br>a. Nominal run thru CRO rev 1.<br>b. Emergency sep. procedure<br>(primary and secondary)<br>c. COI case<br>d. Terminated due to CP problems.<br>e. One rev, alternate B over U.S.<br>f. SOS case                   |
| 5. Sept. 20, 1967 | 8 hrs.  | LM Systems SIM (two runs)<br><br>a. 4 hrs. Checkout of LGC<br>Mission Phases.<br>b. One run thru Sep.<br>c. Approx. 3 hrs. Lost due to<br>building problems.   |
| 6. Sept. 29, 1967 | 10 hrs. | Sim Net Sim (two runs)<br><br>a. First run near nominal APS<br>He 2 pressure failure, APS engine<br>start failure.<br>b. Second run 1 rev, used PRA<br>seq 1 for emergency sep.<br>c. One hr. delay in picking up<br>due to simulation problems. |
| 7. Oct. 3, 1967   | 8 hrs.  | Gemini SRS Sims (eight cases)<br><br>a. Two sep cases<br>b. Two DPS 1 cases<br>c. Two DPS 2 cases<br>d. Two APS 2 cases  |
| 8. Nov. 20, 1967  |         | Sim Net Sim (scrubbed due to CP<br>problems, time was used for<br>system debug)  |

- a. First run was fast time thru Mission Phases.
  - b. Second run - Launch Abort
  
- 9. Nov. 22, 1967      10 hrs.      Sim Net Sim (two runs)
  - a. First run nominal.
  - b. Second run, fast time thru CRO/U.S. pass, ran alternate C.
  - c. First L/O delayed one hr. for CP/RTCC interface.
  
- 10. Nov. 28, 1967      10 hrs.      Flight Control Sim (two runs)
  - a. Run 1, COI case, toggle switch not held long enough for command to get in. Used PRA SOS as backup to LGC COI.
  - b. Run 2, nominal thru DPS 1. DPS 2 violated perigee limit. Burn was cutoff, tried PRA 15 next rev over U.S.
  - c. First L/O delayed 3 hrs. for RTCC/GSSC/Bld. 422 interface.
  
- 11. Dec. 1, 1967      10 hrs.      Flight Control Sim (four runs)
  - a. Run 1, Launch abort case, had choice of Mode III or PRA 4 due to Mission Rule procedural conflict. SLV Abort was transmitted late, could not cue PRA 4 due to command system problem.
  - b. Run 2, SOS case, cutoff at 8+20, backed up one RTC during sequence.
  - c. Run 3, Sim Net Sim, many problems, SLV APS Lifetime less than 1 1/2 hrs. executed PRA 7 because of Parker Valve problem. Sep with PRA 1 at CRO. Closed interconnect with PRA 16 over U.S. rev 1. Executed PRA 3 over U.S. rev 2, had to cutoff for perigee violation, executed PRA 16 to close interconnect. Backed up many RTC's during all sequences.
  - d. Run 4, trajectory deviation, tried PRA 4, command handover error caused loss of VERs. Multiple Reverse Search commands were

transmitted.

e. First L/O delayed 2 hrs.  
for APCU hardware problem.

12. Dec. 12, 1967

8 hrs.

Launch Aborts (six runs)

a. COI case, did not get COI  
ignition, executed PRA 4.

b. COI case

c. COI case, did not get SLA  
panels deployed with SLV Abort  
command, waited until in time  
base and tried PRA 4.

d. FTA for two descent batt.  
failure.

e. LGC SOS case.

f. No J-2 ignition, PRA 4.

13. Dec. 13, 1967

10 hrs.

Sim Net Sim (two runs)

a. CES power fail, emergency sep  
with PRA 1, MRS over U.S. APS 2  
violated perigee limits. Tried  
some systems tests prior to re-  
entry.

b. Nominal thru MP-11, Lots of  
systems problems.

14. Dec. 18, 1967

10 hrs.

Launch Sims (nine runs) delayed  
start 1 hr. for APCU loading  
problem.

a. COI case, early J-2 cutoff.

b. Coolant flow failure starting  
at about T+4 min, executed SOS  
over Redstone.

c. Held 40 min for building power  
failure. Had S IVB hydraulic  
failure, cut off at TFF Limit Line.  
Executed abort, went thru VHF  
blackout before much else accom-  
plished.

d. SLV pitch down, SOS case.

e. COI, did not make orbit,  
executed PRA 15 but forgot to  
reset Engine Stop override.

f. PRA SOS

g. Cutoff with high gamma and low  
velocity. Executed SOS and ended  
up in orbit.

- h. Many transducer failures and systems problems, MODE III.
- i. FTA for loss of two descent batteries.

15. Dec. 20, 1967 15 hrs.

Sim Net Sim (three runs)

- a. Mission Phases 9 and 11 from LMS (monitor only).
- b. Mission Phase 13 from GSSC followed by extended mission test plan. Extended mission terminated due procedural error causing RCS depletion.
- c. Extended mission test plan. Ran well thru completion of all tests.

16. Dec. 21, 1967 10 hrs.

Sim Net Sim (two runs)

- a. Many instrumentation problems, electrical systems problems, CES AC failure. Stayed with nominal mission.
- b. Picked up at T+3:30 ran till T+6:00. Low TCP on DPS 1, loss of attitude control on DPS 2, performed manual abort stage.

17. Dec. 23, 1967 10 hrs.

Sim Net Sim (two runs)

- a. Minor systems problems, procedural problem in commanding caused MP-11 to time out early, corrected at CRO, slipped MP-9 1 rev. much commanding.
- b. Launch thru CRO, sublimator breakthrough.

18. Dec. 26, 1967 10 hrs.

Sim Net Sim (run delayed 3 hrs, were trying to run with CP-C had to switch to A and B before we ever got off)

- a. Did not sep at CRO, separated at second sep opportunity over U.S. Slipped MP-11 one rev. Manually staged off descent engine burning at 10 %. Tried PRA 5 could not get APS engine on. Configured for extended mission test plan.

19. Dec. 28, 1967	10 hrs.	<p>Flight Control Sim (three runs)</p> <p>a. Booster Pitch up, transmitted SLV Abort, Nose Cap Jett and SLA panel deploy. COI did not get in while abort monitor was still enabled. Sent PRA 4 at CYI. Had gimbal lock indications at CSQ.</p> <p>b. RCS system A leak, DPS 1 nominal did not get staging after DPS 2, executed PRA 15 and staged, re-targeted APS 2, tried to clean up after APS 2 but could not get commands in. Had many ground problems throughout the sim.</p> <p>c. COI case.</p>
20. Jan 5, 1968	10 hrs.	<p>Launch Aborts (nine runs)</p> <p>a. GSSC Problems caused loss of all data.</p> <p>b. COI case.</p> <p>c. SOS case.</p> <p>d. COI case.</p> <p>e. SOS case.</p> <p>f. Lost Booster attitude control tried LGC SOS could not get command in, went PRA 4.</p> <p>g. PRA 4, SOS.</p> <p>h. COI case.</p> <p>i. SOS case.</p>
21. Jan. 6, 1968	8 hrs.	<p>Network Exercise</p> <p>First exercise with entire network, mission was near nominal, comm was bad, many procedural errors around the network in command handover, starting Sim tapes, etc.</p>
22. Jan. 11, 1968	8 hrs.	<p>Network Sim (held 30 min for RKV communications)</p> <p>Mission near nominal, still had problems starting tapes at right time, several CP failures, procedures overall much better.</p>
23. Jan. 15, 1968	15 hrs.	<p>Sim Net Sim and Launch Aborts</p> <p>a. Near nominal mission thru</p>

extended mission test plan.

b. COI case.

c. SOS case.

d. GSSC problems caused run to terminate before any action.

24. Jan. 16, 1968

8 hrs.

Network Sim

near nominal thru APS 2.

B. Pad Tests

1. Nov. 27, 1967

Launch Vehicle Software Integration  
Test Dry Run

2. Nov. 29, 1967

Launch Vehicle Software Integration  
Test Phase I

3. Nov. 30, 1967

Launch Vehicle Software Integration  
Test Phase II

4. Dec. 2, 1967

Spacecraft Software Integration  
Test Dry Run Phase I

5. Dec. 6, 1967

Spacecraft Software Integration  
Test Phase I and II

6. Dec. 15, 1967

Overall Test Plugs Out

7. Dec. 19/20, 1967

Launch Vehicle Software Integration  
Test Phase I and II. Phase II was  
scrubbed on Dec. 19, due to FRW-2  
command transmitter problem at MILA.  
Phase II was completed Dec. 20.

8. Dec. 22, 1967

Flight Readiness Test

9. Dec. 27, 1967

Spacecraft Software Integration  
Test Phase I and II.

10. Jan 18/19, 1968

Countdown Demonstration Test, was  
scrubbed at T-20 min due to RCA 110  
power supply. All test objectives  
were satisfied.



## II. Procedures Officer's Activity Log

GMT	Action
0400	At T-9:00 hrs Jan 22, 1968 Procedure's Officer on station. Network count holding at T-10 hrs.
0415	Start Console check list per console handbook.
0500	Completed console checklist. All items checked OK.
0610	Black No. 1 Comm Loop inoperative, turned over to Telco No ETO.
0707	Starting Pad Clearing.
0711	Gave "go" to CVTS for Safe and Arm Connections and pad clearing. The network is Green at this time.
0739	The pad has been cleared for safe and arm connections.
0745	0745 Redstone TM CDP Red. ETO 0900 mandatory item, keeps faulting.
0800	Network Count Picked at T-10:00 hrs and counting.
0911	The IU Doors are closed.
0930	At T-3:30 Jan 22, 1968 started six hour built-in-hold.
0945	Redstone TM Computer still faulting. New ETO 1042.
0951	Redstone TM Computer still faulting.
1050	Redstone TM Computer is now green.
1051	Hardcopier "A" System inoperative No ETO.
1230	WHS-CAL 1218 computer Red. No high speed radar capability at this time No ETO.
1341	Redstone TM Computer faulting again. No Go at this time, No ETO.
1345	Hardcopier "A" system now operative
1350	ETO for Redstone TM computer is now 1443.
1406	Starting Fido trajectory Run.
1412	WHS, CAL 1218 now Green can support High Speed Radar Data.
1450	Fido Traj Run completed and all systems functioning properly.

GMT	Action
1510	Guido transferring loads for T-3:30 DSKY command checks.
1526	HFLT gave go for picking up count. Redstone TM computer is still Red. ETO 1700.
1530	Pick up count from six hour built-in hold at T-3:30.
1534	Command System configured for DSKY command checks.
1609	Redstone TM computer still Red ETO 1700.
1619	KSTC Reported freon problem. EECOM reports water boiler No. 2 has gone bad.
1622	CVTS is stopping LOX loading at T-2:46 to clear LM personnel to examine problem. KSC is going to hold at T-2:30. No estimate.
1623	Guido transmitting V34E.
1630	Holding count at T-2:30, No estimate LM problem.
1720	Still holding No estimate.
1744	New Redstone TM computer ETO 1815.
1804	Starting LOX loading again. Estimate one hour before picking up count at T-2:30.
1836	Redstone ETO now 1900.
1850	LOX loading approaching 60%.
1852	CVTS estimates pick up of count at 1930.
1859	Slow fill on S IVB started.
1912	Planning the best way to utilize Redstone with its faulting TM computer. Decided to load the good computer in real time with either command or telemetry programs dependent upon what was needed most during the Redstone's pass based on mission status. Decided that no High Speed inputs were to be made to the TM computer to switch formats.
1943	New estimate on picking up the count of 2000.
2018	Picking up count at T-2:30.

GMT	Action
2049	FLT made CYI command and telemetry mandatory until such time as the Redstone problem is fixed.
2136	CAL high speed radar Red. ETO 2200.
2143	FLT gave go to CVTS for start of terminal count.
2154	Recycling CP's.
2217	Briefed Redstone on the configuration MCC wants for launch phase and also how configuration requirements would be handled pre-pass.
2219	Command system configured for final command checks.
2228	Started voice and status check with MSFN.
2233	Completed status check. All stations voice was go. All stations equipment was go with the exception of the Redstone's TM computer.
2242	All doors locked. All consoles preconditioned and site selected and MILA armed.
2243	Verb six and master relay reset transmitted.
2245	Automatic sequence started.
2248	Lift-off LM GRR 22:48:08.96 Clocks set to 22:48:09.
Plus Time	
Hrs:Mins:Sec.	
GET	
00:05:00	GET clock 1 second fast - Display corrected.
00:42:46	Tried to get an IU TM playback from CYI. CYI's telemetry computer kept faulting. Did not have time prior to CSQ AOS to get this playback. Local PCM readouts were used to verify SLA Deploy.
00:54:54	Changed from High Speed format three at CRO to format two per nominal time line.
01:00:00	Start LM Telemetry playback of S-Band from CRO data for evaluation of the S-Band telemetry quality.
02:28:00	Started LM S-Band telemetry playback from CRO for further S-Band data quality evaluation.
03:05:54	RTC had to tell TEX M and O to bring up command carrier. TEX

GET  
Hrs:Min:Sec

Action

did not follow command handover procedure.

04:11:34 Started VHF LM Telemetry playback from CRO to further evaluate mission phase nine data for possible indication of premature DPS cutoff.

04:23:06 Terminated CRO telemetry playback.

05:33:00 At CRO AOS the data still had the playback bit set from the previous playback M and O forgot to reset it. TIC caught this very quickly and corrected it so MCC only lost 10 seconds of real time data.

07:00:00 Recycling CP's. All command panels re-preconditioned FC/M and O switch cycled.

07:43:55 Got RTA 5 started for time in PRA sequence Number 5 and Display made an operator error and had clock configured to count down vice up. This was corrected at 2 mins into the sequence.

07:52:21 GYM AOS.

07:53:30 Lost data at GYM. From this time on all sites predicted to have contact with the LM tried S-Band, VHF, C-Band and skin track to make contact. No stations reported solid lock.

11:48:00 Terminated mission support all stations.

### III. Documentation

#### A. RIC Breakdown by site

##### Site RIC's Processed

ACN	13
BDA	8
CAL	2
CNB	10
CRO	22
CSQ	16
CYL	14
GBM	2
GDS	22
<del>GEM</del>	17
GYM	9
HAW	20
MIL	13
RKV	5
TAN	5
TEX	16
ANG	10
WHS	1
RED	17
MA <sup>D</sup>	5
WTN	25
ARIA	<u>3</u>
TOTAL	255

#### B. ISI Breakdown by subject

##### 1. NOD Basic Document

a. RSDP	- 5
b. Station operating procedures	-13
c. Scheduling	- 2
d. Effective pages	- 1
e. Telemetry	- 1
f. VHF acquisition Sys.	- 1
g. USB	- 7
h. Ship support	- 2
i. Reporting	- 2
j. Data handling	- 1

##### 2. NOD 204/LM-1 Supplements

a. Communications	-10
b. Command	- 5
c. RSDP	- 5
d. VHF Acquisition Sys.	- 3
e. Radar	- 3

f. USB	- 5
g. Computer support	- 2
h. Displays	- 3
i. Ship support	- 2
j. Telemetry	- 4
k. ARIA	- 2
l. Data Handling	- 6
m. MSFN	- 5
3. NASCOP	- 5
4. Mission Status	- 5
5. Engineering Instruction	-11
6. Systems Test	- 5
7. Erratas	- 3
8. Remoted Sites SRT	- 3
9. Misc.	<u>-14</u>
TOTAL	136

Twenty ISI's were issued changing or deleting previous ISI's

C. Query Status by Site

<u>CSQ QUE NBR.</u>	<u>SUBJECT</u>	<u>ANSWERED BY</u>
1.	MSFN FCDAR	ISI
2.	MSFN FCDAR	ISI
3.	Calibration data	
4.	Rebroadcast Summaries	
5.	Mission Rules	DCI
6.	NOD Supps	
7.	NOD Supps	ISI
8.	TM Alpha Numeric listings	
9.	LM-1 Measurement and Configuration data GAEC document LED 360-316	
10.	ISI 52	ISI
11.	LED 360-316	DCI
12.	NOD Supps and ISI 42	ISI
13.	(no subject, que was issued to keep site que numbers in order)	
14.	Operational Trajectory	
15.	TM alpha numeric listing and LED 360-316	

16. Rebroadcast Summaries  
17. Mission Rules

DCI

CRO QUE NBR

SUBJECT

ANSWERED BY

1.	DCS Operational Tape	
2.	Operational Trajectory	
3.	Ground Station Address	
4.	DCI 6 (Systems Handbook)	DCI
5.	DCI 7 (Mission Rules)	DCI
6.	DCI 6 & 10 (Systems Handbook)	DCI
7.	DCI 7 (Mission Rules)	
8.	CSQ QUE 6	
9.	DCI 6, 10 and CRO QUE 6 (Systems Handbook)	DCI
10.	Operational Trajectory	
11.	DCI 6, 10, and 15 (Systems Handbook)	DCI

CNB QUE NBR

1.	DCI 1 (FCOH)	DCI
2.	DCI 7 (Mission Rules)	

RKV QUE NBR

1.	Summary Overlays	DCI
2.	IRIG Channel Deviation	
3.	MSFN FCDAR	ISI
4.	Correction to RKV QUE 3	
5.	Cancelled	
6.	TM Alpha Numeric listing	
7.	DCI 7 (Mission Rules)	DCI
8.	RKV QUE's 3 and 4	
9.	LED 360-316	DCI
10.	Summary Messages	
11.	Extended Mission Procedures	
12.	TM Alpha Numeric listing	
13.	CSQ QUE 13	

GDS QUE NBR

1.	Cancelled	
2.	Mission Rules	DCI
3.	Mission Rules	

MCC QUE NBR

1.	TM Patching Script	
2.	LED 360-316	



# D. DCI Breakdown

<u>DCI NUMBER</u>	<u>SUBJECT</u>	<u>COMMENTS</u>
1.	FCOH Rev. A	Issued to update Remote Site Flight Controller's preliminary copies of Rev. A, to the final published copy of Rev. A
2.	LM Systems Handbook	EECOM Changes since Rev. D
3.	Summary Overlay Update	Answered RKV QUE 1
4.	Gemini Sites FCDAR	Included changes in Rev. I of FCDAR which was published after F/C Deployment
5.	Calibration Curves	Late calibration changes entered into RTCC
6.	LM Systems Handbook	GNC Changes to Systems Handbook since Rev. D.
7.	Rev. A to Mission Rules	
8.	Rev. A to FCOH, Remoted Sites	Updated Sites which had not received Rev. A in mail with changes affecting Remoted Sites answered CNB QUE No. 1
9.	Mission Rules	Corrections to DCI No. 7
10.	LM Systems Handbook	Updated DCI No. 6
11.	Calibration Curves	
12.	GAEC Document, LEED 360-316 LM-1 Measurement Requirements and configuration data	Updated through Rev. C of subject document answered RKV QUE No. 9 and CSQ Que. 11
13.	LM Systems Handbook	EECOM Changes since Rev. D
14.	LM Systems Handbook	GNC changes since Rev. D
15.	LM Systems Handbook	GNC changes to DCI 6 and DCI 10
16.	Calibration curves	
17.	Rev. B FCOH	Updated Remote & Remoted Sites with latest changes to the SOPs.

- 18. Mission Rules Rev. C
- 19. Mission Rules Rev. C
- 20. LM Systems Handbook Changed DCI's 6, 10 and 15
- 21. Mission Rules Correction to DCI 18
- 22. Mission Rules Rev. D

E. MRR's - See Requirements Change Control Report (Enclosure 4) for Breakdown of MRR's.

F. FSR's - 101 FSR's were issued for 204/LM-1

#### IV. PROBLEMS AND RECOMMENDATIONS

**Problem:** As in all missions, when launch day comes the Control Center is overrun with persons who are not required in support of the mission, but want to see what goes on and gain some real time mission experience. Mission day is not the time to come sit at a console and get experience. These persons are not familiar with the consoles, display systems, communications discipline, or normal Control Center procedures. This lowers the safety factor and disrupts operational person's work schedules to answer questions for these people. Also, people cannot help but raise the noise level of the operations room above that which is encountered during simulations.

**Recommendation:** No persons should be badged for access to the Control Center after F-6 days except those having a real time mission support or management responsibility. Persons wanting training should get this during simulations, not on mission day. Persons having a real time job cannot act as policemen during a mission, therefore, management must take corrective measures premission to preclude this problem.

**Problem:** The KSC Test Checkout Procedures (TCP's) are not received properly and on a timely schedule to make corrective inputs to the ATIWG representative prior to the actual test. Too many people waited until the 24 hour briefing to look at the TCP's. In some cases, this was due to the late arrival of the TCP's.

##### Recommendations:

- (1) The ATIWG representative must insure that procedures are established and enforced for receipt of TCP's and that last minute changes are Data-faxed in a timely manner.
- (2) A tighter control must be placed on accepting TCP corrections past the input cutoff date. Flight controllers must review and make inputs prior to the 24 hour briefing. The 24 hour briefing should be a briefing on how the TCP will be run, not a time to make TCP corrections.

**Problem:** Extensive voice interface was required between the Display Controller and the Procedures Officer in setting up times in RTA's 5 and 6. This resulted from the Display Controller having the capability input times into the RTA's and the Procedures Officer having the clock "start" and "stop" capability.

**Recommendation:** If RTA's 5 and 6 are to be used as much during future missions as they were on LM-1, it is highly recommended that complete control of the clocks be located on the Procedures Officer's console.

UNITED STATES GOVERNMENT

# Memorandum

TO : Flight Director, Mission AS-204L

FROM : Mission Requirements Support Engineer

SUBJECT: Recommendations for future missions

DATE:

Experience gained in support of Mission AS-204L in the integration and implementation of requirements is as follows:

a. A problem existed in the interface between the flight controllers and the implementors in that flight controllers were spending a disproportionate amount of time in attempting to resolve hardware and software discrepancies. Complaints were frequently badly defined, misdirected, or redundantly submitted resulting in poor accountability and vague status determination.

b. A first attempt was made (unsuccessfully) to resolve the problem by defining more clearly to the flight controller the use of the MRR and the DR.

c. The second, and more successful, move was to institute a "Flight Controller's Trouble Report" form which achieved the following:

(1) Made it easy, timely, and convenient for a flight controller to define his problem completely (time, date, console, type of exercise in progress, data sources, etc.).

(2) Relieved the flight controller of "follow-up" activity and responsibility and of responsibility for MRR/DR decision.

(3) Provided to MCRB a document which could be reproduced "as is" and handed immediately to the Network Controller for DR action or which could be handed to the MCRB RCC Group if research and/or MRR action seemed to be indicated.

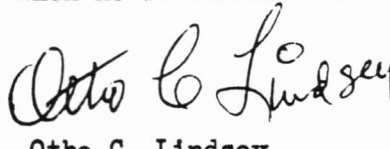
(4) Provided to the Mission Support Engineer (MCRB) a log of complaints from which it was easy to summarize closed and outstanding items for Flight Director support. It also placed control at a single point.

d. Post-mission meetings inside MCRB point to optimization of this service in the future by continuance of the FCTR and placement of status reporting and follow-up in the RCC Group (as previously done) rather than transferring this function to the Support Engineer, thus, enabling them to work in parallel rather than in series and providing the Support Engineer with more time for test requirements development, test review, test and simulation monitoring. The MCRB Support Engineer by his presence would



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become a convenient real-time point of contact for trouble reporting and expediting of action. He can also contribute to speed of implementation by his real-time knowledge of days when no simulations or testing are scheduled.

A handwritten signature in cursive script, reading "Otho C. Lindsey". The signature is written in dark ink and is positioned above the printed name.

Otho C. Lindsey

TO: E. F. Kranz

9 February 1968

FROM: W. J. McKenzie

SUBJECT: Apollo 5 (204/LM-1) Mission Staff Engineer's Post  
Mission Report

Pre-mission planning activities were extensive and time consuming due to the complexity of the mission and the fact that this mission was to be the initial flight of the Lunar Module. The initiative, cooperation, knowledge of spacecraft systems and the team spirit of the flight control personnel were major factors in the success of this mission. Their performance during the conduct of the mission, under adverse conditions, was exemplary and emphasized the skill, knowledge and devotion of these personnel.

Some personal observations concerning the Apollo 5 pre-mission planning activities are contained in the following paragraphs. Some of these same observations, I am sure, have been made by other members of the Apollo 5 team. A few of these observations were developed from the keen sense of "hind sight" which seems to accompany the post mission "let down".

Planning activity associated with the development of Flight Mission Rules would be greatly expedited if spacecraft systems constraints could be identified in the early stages of flight mission rule development. These constraints could be developed through special efforts of ASPO, E&D and the spacecraft contractors. It is especially important that the developers of the constraint understand how the constraint is to be used by FCD for contingency and alternate mission planning. Realistic constraints would be provided if this approach was employed to the fullest extent. Greater participation by ASPO, E&D and spacecraft contractors in the early development of flight mission rules is the only solution to this problem.

The compatibility of spacecraft systems interfaces should be investigated thoroughly. Mathematical models should be used when necessary to determine interactions between systems with "off nominal" conditions.

PGNCS software inflexibility and the long lead time required for changes dictates the requirement for more exacting and earlier mission planning. More flexible software or shorter lead times for changes would alleviate some of the pressure on mission planning.

Last minute changes to the trajectory, consumables loading, launch mission rules should be avoided if at all possible. Changes in these items tend to have a "snow balling" affect on mission planning.

Contingency planning and alternate mission provisions must be keyed to percent of mission objectives achievement. This was accomplished very well in the Apollo 5 Mission. In retrospect, I can think of only one additional contingency provision that should have been provided; a long DPS burn in a PRA sequence.

In bringing this report to a conclusion, I would like to say that I have enjoyed my relationship with you, an extremely capable flight director, and the capable members of your well organized team. I am proud to have been a member of the Apollo 5 team.



W. J. McKenzie  
Associate Mission Staff Engineer  
Apollo 5 (204/LM-1)



UNITED STATES GOVERNMENT

# Memorandum

*Enc 1*

TO : Flight Director, AS-204/LM-1  
Attention: Operation and Procedures Officer

DATE:

FROM : Requirements Change Controller

SUBJECT: Postmission report of requirements change control activities during the AS-204L mission

1. Procedures and priorities as directed by FCD Office and MCRB policies and responsibilities as outlined by previous Requirements Change Controllers (RCC's) were used as guidelines in conducting the RCC activities during the AS-204L mission. The activities performed are as follows:

a. A master copy of the AS-204L MCC-H FCDAR was maintained throughout the premission and mission periods.

b. RCC provided liaison between operations personnel and the implementing organizations.

c. Changes to the ground system were submitted to RCC in the form of Mission Reconfiguration Requests (MRR's) which were evaluated to determine if they were within operational, system, and cost constraints.

d. RCC maintained a status log of all MRR's that were initiated.

e. In addition, RCC assisted the operation personnel by developing and writing new requirements considered necessary for mission support.

2. During the period from February 3, 1967, to January 17, 1968, a total of 265 MRR's were issued by RCC.

3. A general classification of MRR's versus the organization responsible for initiating the request is shown in Enclosure 1.

*James E. Wallace*  
for James E. Wallace  
Requirements Change Control  
Mission Control Requirements Branch

Enclosures 2

cc:

FC/D. H. Owen

FC/J. L. Cole

E. F. Kranz

C. E. Swearingen

H. R. Goodwin

L. A. DeLuca

FC7:JEWallace:ss



AS-204/LM1

## Classification of MRR's Versus Organization

	FCD	FSD	PHO M&O	ASTD	LRD	ASPO	TOTAL
Label and Color Changes	20	16					36
Programing and Label Changes	26	15					41
Gross Connect (or Patching) and label changes (events, meters, recorders and/or PBI's)	11	3	1				15
Documentation changes (MCC-H FCDAR)	5						5
Communication Changes	33	52	1				86
TLM Data Flow	6						6
D/TV Program Change	7						7
Group Display (label changes, delete drivers)	6	4					10
MSFN FCDAR update, patching and label changes	5						5
MSFN DRUL Command and Record	1						1
Miscellaneous	10	6					16
Requiring E.O. Action	2	2				1	5
Superceded by other document	1	2		1			4
Cancelled	16	11			1		28
Total	149	111	2	1	1	1	265

UNITED STATES GOVERNMENT

# Memorandum

TO : Apollo 5 Flight Director

DATE: January 26, 1968

FROM : Apollo 5 Network Controller

SUBJECT: End of Mission Quick Look Report

1. This report will be covered in five parts as follows:

- a. Telemetry
- b. Command
- c. Track
- d. Communications
- e. Communications Processor

2. Telemetry

a. Redstone telemetry computer red from before liftoff until a GET of 05:42:00. Problem is still under investigation. The one green computer was loaded as a command computer for launch phase and as a telemetry computer for Revs 2 and 3.

b. On Rev 3, GWM high speed telemetry was not received at MCC. A GSFC Communication Line Terminal (CLT) could not lock up on GWM data. We suspect a bad CLT. CLT's were switched shortly after the pass and static data was again received at MCC.

c. After Rev 3, all sites were experiencing noisy downlink from the LM on both VHF and USB links.

3. Command

a. The GM10 load plus S-IVB history request apparently caused both 642B computers at CYI to fault. Problem is under investigation. The faulting occurred after the CYI pass with no data loss. Computers were reloaded for the next pass.

b. Only five executes out of a total of 378 uplink requests for the spacecraft and launch vehicle were lost. One execute loss is attributed to a CP Polynomial Buffer Terminal (PBT) hangup. Three other execute losses are attributable to a failover from one 40.8 line to a backup. One execute loss still unexplained. We feel, however, that this loss (5 out of 378) is quite remarkable and that the high speed command system functioned extremely well.



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c. Several executes sent produced spacecraft rejects. This is attributed to the weak and fluctuating signal strength in the spacecraft receiver

4. Track

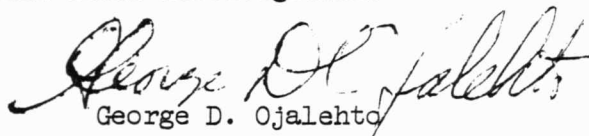
The only significant problem was the generation of acquisition messages. RTCC advised that at one time they had used a telemetry vector to anchor the ephemeris. This vector is assumed to have been erroneous. As a result, sites received erroneous acquisition messages. This resulted in ACN not locking up on Rev 3 and CAL locking up late on Rev 2. The problem is still under investigation.

5. Communications

No significant problems to report

6. Communications Processor

The only significant problem was the PBT hangups. These occurred throughout the day and had to be manually cleared resulting in momentary drops of data. Problem is still under investigation.

  
George D. Ojalehto

FS: GDO: cd

UNITED STATES GOVERNMENT

# Memorandum

TO : AS-204/LM-1 Operations and Procedures Officer

DATE: JAN 2 1968

FROM : FC25/James L. Kitchen

SUBJECT: Addendum to postmission report for FD SSR Command Support Console

Reference is made to paragraph 2, mission activities. To expound upon the GMTLO problem, it should be noted that the LM Command History was received at CYI and processed and returned to the MCC. Subsequent to that, an SIVB Command History was requested; and as it was being processed, the MCC transferred the GMTLO load to all sites. CYI received six high speed GMTLO loads and one low speed GMTLO. This, for some undefined reason, put both the command and telemetry computer in a loop that took a reinitialization of both computers to correct. The SIVB Command History was not written on a magnetic tape as a result. Another interesting point is that six other prime sites did not receive the low speed GMTLO but did receive one high speed load. It is not known if there is any significance to this or not.

The six high speed loads at CYI was noticed during the mission by the TTY high speed validations returned but was not confirmed until postmission.

  
James L. Kitchen

FC25:JLKitchen:jrh



## 204/LM1 Telemetry Support Post Mission Report

Flight Control Division participation in 204/LM1 program testing began during the SIT's. During launch vehicle SIT's LM systems personnel manned all consoles and tested event lights, chart recorders, and D/TV using the AC-8 tape as a data source. Launch vehicle personnel performed the same tests during LM SIT's. This procedure allowed an earlier than usual look at the AC-8 data at no increase in computer time. Numerous program and/or hardware discrepancies were found (on the order of fifteen (15) plus discrepancies). Earlier than normal discovery allowed most of these discrepancies to be corrected. At liftoff, one bi-level word on rebroadcast summary 65 was invalid. This affected eight parameters, but was not corrected as it was not discovered until T-3 days. No explanation for failure to catch this error is presently available. One error on SLV summary 51 was also not corrected. This was minor and only appeared on remote site generated summaries. All personnel were advised of these discrepancies.

FCOB and MCRB personnel monitored the FCD network validations, obtaining hardcopies and history printouts. These were checked for data content and validity. No errors were found at this time in the MOC Program; however, six errors were found in the TSPAP history program. These were corrected.

A four hour FCD data flow test was held on T-10 with launch vehicle personnel. FCOB personnel checked LM data and obtained history printouts. These were checked and then reviewed with LM system engineers. They felt that this was a valid test and no additional testing was needed.

During testing and simulations it became evident that LM redundant parameters were not programmed from the same TLM slot in high speed and

low speed data. If all redundant parameters should be programmed from the same slot a requirement should be generated. There were no such requirements for 204/LM1.

No plus time support was required from this position other than verifying that SLA deploy operated properly during network validation. These indications were among those verified bit by bit from ALDS and RSDP programs.

  
Edwin B. Beatty



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# Memorandum

*Enc. 2*

TO : AS-204/LM-1 Operations and Procedures Officer

DATE:

FROM : FC25/James L. Kitchen

SUBJECT: Postmission report for FD SSR Command Support Console

## 1. Premission activities:

a. Premission activities; in so far as the command support position was concerned, consisted of delineating what was really desired in the way of support from that position. This was clarified after the fourth or fifth simulation. Since the Vehicle Systems SSR could not keep the Command Matrix up in anything except post pass, we requested control and operation of the Command Matrix to facilitate real-time accomplishment. The request was granted, and it was felt that the real-time display of the Relay Matrix helped establish mission confidence during simulations.

b. During simulations, we were able to aid in the correction of certain command area discrepancies such as RTCC transferring loads with sequence numbers of zero because the RSDP would not accept or process them, not requesting more than one Command History at a time because it aborts the one in progress, high speed loads being transferred but no English Translation (ET), and notifying the AFD or O&P that the Flight Controllers were not announcing commanding on the same communication network as per the direction of the Flight Director. The latter continued to be a problem throughout the premission phase. This made MOCR command coordination difficult, and it was impossible to keep up the Command Matrix in real time, especially when commands are sent and not announced at all as was sometimes the case.

c. Post-APS 2 simulations went very well. None of the anomalies experienced in paragraph b existed during the post-APS 2 simulation.

## 2. Mission activities:

The mission activities went much smoother than the simulations. Very few command-related discrepancies were noted. The problems noted in 1.b. were almost non-existent with the exception of the ET, especially on the GMTLO. CRO, ACN, GYM, GDS, TEX, and HAW did not get the low speed GMTLO and only in one small sequence did the Flight Controller doing the commanding forget to announce the commanding on the network. In the case of the ET, CCATS is aware of the problem and corrective action will be taken.

## 3. Conclusions:

The mission was nominal from a command support standpoint. Methods to smooth mission operations are covered in recommendations.



5010-108

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#### 4. Recommendations:

a. The decision of the Flight Director to discuss commanding and organize the command plan on the Flight Director's loop and to perform the actual commanding on the RTC loop was a good decision but during simulations, few Flight Controllers responded to the decision. This is why the command plan and the Relay Matrix did not reflect the correct status in real time in some cases. That is also the reason the Command Support Console requested to take control of the Relay Matrix because the other SSR's did not have all of the communication loops that the other Flight Controllers were using.

It does not make any difference what communication loop the commanding is announced on as long as it is announced and on a communication loop that all consoles have.

It is recommended that all positions needing access to commanding information have the RTC loop installed and that any Flight Controller commanding announce what command he is sending on that communication loop specified by the Flight Director. If it is necessary to command on another loop, Master Access should be used so that the RTC loop and the other loop can be used.

b. Delete the command support position. If paragraph a. above is implemented, the Relay Matrix can be accomplished in real time by the Vehicle Systems SSR as before. The other command support functions are superfluous to the CCATS command consoles. The same support can be provided by that console. They have more and better facilities to accomplish the same objectives. They are more closely associated with the programs (both CCATS and RSDP) and are in closer contact with IST/NST for answers to questions outside the MCC. To sum it up, it is a CCATS command function. Let them do it.

  
James L. Kitchen

FC25:JLKitchen:jrh

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# Memorandum

*Enc. 1*

TO : AS 204/LM-1 Operations and Procedures Officer      DATE: Jan. 30, 1968

FROM : FC261/Harley L. Weyer/Axel M. Larsen, Jr.

SUBJECT: Plans Position Post Mission Report

1. Premission activities

a. Overall, the premission activities went smoothly. All messages that were received were given prompt attention and logged and filed.

b. We received 46 queries of which two queries were cancelled. We sent 44 query answers. We originated two queries and received six query answers in response from the manned sites. The longest delay in answering a query was six days and three hours. The shortest delay was one hour and 40 minutes. The average delay was 33 hours. At times the status of query answers were hard to determine because more than one person had taken some action on them.

Recommendation: One person should have the responsibility of knowing the status of all queries. He should direct the action to be taken. No one else should take action without his knowledge. An action log should be kept by the one responsible person. It should contain:

- (1) The DTG and the source of the message requiring an answer.
- (2) The action to be taken on the message.
- (3) The DTG of all outgoing messages even if they do not answer other messages.
- (4) A serial number that will be placed on the message going out. The action log could be updated by a second person with the delegated responsibility to do so.

c. Some concern was expressed by the RKV CapCom that messages being sent to his station were not coming from a valid source. I suspect that other remote sites had the same concern.

Recommendation: Every message going out from and coming to the MCC should have "from" and "to" lines. An example follows.

(CALL SIGNS)

FM: GNC/CARLTON

TO: RKV CAPCOM

OPN - OP NR OOL - TEXT



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The serial number in the above message is the same as recommended in paragraph b(4) above. This type of header would insure that:

- (1) The recipient knows exactly where the information came from.
- (2) The proper person receives the message.
- (3) The coordinator has seen the message and approved it.

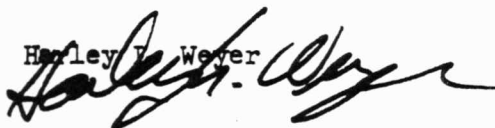
## 2. Mission activities

a. The Site Activity Plan (SAP) form was used during the mission. It was used for logging the configuration of the remote and remoted sites which have command capability. During periods of heavy commanding, it was necessary to take the SAP off channel 61 so that an additional command plan could be shown.

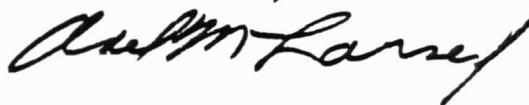
b. The Command Plan form was used and updated during the mission. Writing individual commands on slips of paper and laying them on the form rather than writing directly on the form facilitated quick changes in command plans in real time.

c. Some difficulty was encountered in getting hardcopies of a valid Predicted Site Acquisition table. This was due to the large deviations from the nominal trajectory and the frequent use of the table by the Flight Dynamics Officer. As a result, we had difficulty in supplying the Procedures Officer with valid pass time and LOS of last site in the CONUS pass after the third revolution.

Harley V. Weyer



Axel M. Larsen, Jr.



FC261:HLWeyer:AMLarsen:wlb

UNITED STATES GOVERNMENT

# Memorandum

TO : Apollo 5 Flight Director

DATE: FEB 9 1963

FROM : Flight Dynamics Officer

SUBJECT: Postmission report

Date: January 22, 1968

1330Z Preliminary console check performed. No discrepancies were seen. WHS and CAL sites were red with ETO for support of one hour each. The problems were in the onsite 1218 computers.

1340Z Lemon-1-Alpha reported that the IP was in a one-computer configuration at that time but would support the first FIDO trajectory run. The insertion IRV would be passed as was discussed in the CDDT.

1345Z RED reported that the onboard TM computer was red with an ETO of one hour.

1350Z Conditioned the RTCC for actual launch. Both the MOC and the DSC were up for support. TRK reported that BDA, RED, DATA CORE, and the IP would support the first FIDO trajectory run. RED would not be able to ship TM data however.

1400Z First FIDO trajectory run was initiated. Good transmission of all data was established. Received telemetry tapes from DATA CORE and BDA. Received radar tapes from IP and RED. Run was good. Select did report however, that some real-time data was received during the run. Further investigation revealed this data to be USB test data from the ETR.

1430Z Received the IRV from Lemon-1-Alpha via voice loop.

1435Z Established voice contact with the RSO on Cape 111, PL, and Flight Director's loop. Good voice communication on all loops.

1500 CAL radar is reported green and go as was WHS. It was noted at this time that the ACR vector transfer procedure during the first trajectory run had gone awry and two subsequent attempts had met with limited success. This problem was noted to be corrected. The ACR was checking the hardware at that time.

1530Z Both IP computers were up and ready to support as reported by Lemon-1-Alpha. No CAL boresight test was to be done. Hold began here.



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1600Z RED is red for the TM computer with no ETO. Received RED and WTN coordinates from Network and relayed them to ACR and Select.

1603Z Gave ACR the targets that were onboard.

1620Z Flight advised all stations of hold due at T-2+30. Also received the CSQ and RKV coordinates from TRK which were relayed to the RTCC and ACR. Requested flight that we be allowed to take the MOC back to orbit phase to check the ACR vector transfer procedure again.

1740Z Flight gives the OK to go into orbit phase again. Input nominal insertion vector and good transfer was established. Original problem was hardware and was corrected.

1746Z Began MOC recycle.

1758Z Another one hour of hold was announced by Flight.

1852Z COM SUPE made a restart tape in DSC as hold continued. Retro support advised that the SSR Plotboard No. 1 was red for hardware problem with ETO of 1 hour.

1854Z B-Restart tape completed and MOC and DSC announced up and processing.

1901Z AFD requested AOS/LOS data for ETR sites.

1921Z AFD received AOS/LOS data from FIDO.

1926Z RETRO SUPPORT confirmed that the SSR plotboard was repaired and up.

2013Z Voice check with RSO revealed that the CAPE 111 loop was bad. No contact was possible on that loop. Network was advised of this problem. PL voice communication was good.

2048Z CAPE 111 loop was still bad. Problem was determined to be at the Cape. RTCC was conditioned for simulated launch. TRK advises all stations would support.

2058Z FIDO trajectory run No. 2 began. Full support was attained. At 8+36 into the test, the IP data dropped completely out. TRK advised that the dropout was a hardware problem at the IP and that they requested another run. RED data came in good but dropped out near end of run. Problem was not known.

2110Z FIDO advised Flight of the problem and requests rerun of trajectory run after IP inhouse run. Flight granted request and run was planned.



2113Z IP complex informed track that they would "lift-off" at 21+25+00Z.

2115Z Redstone data problem was reported to have been caused by patch board mixup or CP problem.

2125Z Lost RSO FL and reported same to Network. Cape 111 still good.

2130Z Lift-off of IP rerun. All data looked good and FIDO informed Flight that we were go for launch.

2155Z FIDO was advised by Track that the CAL radar was "RED".

2155Z FIDO began target quantity check with dynamics and trajectory (completed at 2159).

2203Z CAL reported "green".

2206Z Requested COMPUTER SUPERVISOR condition the RTCC for launch phase.

Launch Phase Summary:

224808Z Immediately after lift-off indications, the Guidance Officer commanded GRR. Lift-off data source was IP smooth and Flight was informed of same. During first stage flight, the LGC telemetry vectors seemed to "lag" (in flightpath  $\phi$ ) the IP and IU sources. It was at first thought that a possibly late GRR was the cause but Guidance later, in first stage flight, confirmed that the LGC had indeed sensed 1.1g and had released the platform automatically. Almost coincidental with this report, the LGC lag began to "catch up" with the IU and IP. Staging source was the LGC and the report of  $q < 1$  came shortly thereafter. As soon as the trajectory confirmed staging, comparison of the sources confirmed that the only remaining biases were due to differential system time delays between the radar and telemetry data processing. At this time, the SIVB cutoff event switch was placed in the normal position. As the plotboards entered third scale, a downward deviation (in  $\gamma$ ) away from the nominal was noted. This trend slowly but definitely was corrected back to nominal at about the time of MODE IV capability. (It is interesting to note that the GSSC had always flown this type of trajectory and when it was called to their attention, they confirmed that they were flying the MSFC timeline in their generation of trajectory data. They were able to generate the "nominal", however, by moving the time of the final PU shift a little earlier than nominal. Thus, if the AS-204 booster was indeed late in PMR shift, it would seem to verify the resultant trajectory effects.)

~ 9+22 As the h vs. d and V vs.  $\gamma$  plots confirmed MODE IV capability, Flight and the RSO were informed same.



9+40 The RSO reported African overflight.

9+55 J-2 cutoff occurred early, from a time standpoint, and this was later thought to be caused by the slow PMR shift.

The IU telemetry was used as the third scale cutoff source.  $IP_R$  indicated a  $\gamma$  difference of  $0.00^\circ$  and a velocity difference of  $+2$  fps. The LGC differed from the IU by  $-3$  fps (slower) and a  $-0.05^\circ$  (lower) in  $\gamma$ .

The RSO was requested to "SAFE" the booster and this event was verified to the Flight.

The insertion orbit was  $87.4 \times 118.2$  n.m. and was verified by BDA at  $87.6 \times 119.5$ .

#### Mission Timeline:

10+42 Monitored a normal nosecon jettison and Guidance report of "cutoff +50".

12+56 Requested Dynamics to input time of SEP maneuver as 54+00.

14+41 Passed ALT L ignition times to ACF (4+40+00 and 6+15+00).

16+56 BDA DC's confirmed insertion orbit at  $87.6 \times 119.5$  and  $i = 31.63^\circ$ . At this time J-2 cutoff was confirmed to be 9+53 and dynamics was instructed to change time of SEP to 53+55.

20+13 Could not make any display requests at all, yet TV channels were not red.

22+00 Flight still unable to confirm SLA deploy.

22+30 GSFC sent Post SEP vector.

25+00 CYI TM readout of A and B relays position indicated SLA deploy but the physical monitor could not be verified.

26+00 Had to reject Redstone data.

29+49 Track was requested to change tracking configuration of CRO. CRO had been scheduled to come up tracking the LM but in that SLA deploy could not be confirmed, it didn't seem advisable to induce the possible C-Band radiation problem that we had heard so much about regarding the SLA PYRO's.

(As soon as separation was confirmed, Track instructed CRO to track the LM beacon.)

- 32+00 CYI data was rejected. Track mentioned something about the IU beacon triggering the IM beacon but the CYI problem was later found to be a misalignment of the FINE range encoder.
- 35+00 COM SUPE began an A restart tape.
- 38+00 ACF began generating ground track data for recovery.
- 39+00 Network called down and requested time of J-2 cutoff and insertion for the SRO?
- 49+00 CSQ confirmed SIA A and B relays indicating deploy but no physical monitor.
- 49+50 TAN confirmed  $87.5 h_p \times 119.2 h_a$  n.m. orbit and an inclination of  $31.63^\circ$ .
- 50+00 Requested Select to go to H/S trajectory processing through separation and requested Track to switch CRO beacon to IM as soon as separation was verified.
- CRO TM vector indicated  $92.3 h_p \times 117.7 h_a$  and an inclination of  $31.99^\circ$  until the next S/C integration cycle indicated  $93.4 \times 117.5$  n.m. and inclination was  $31.9^\circ$ . Although CRO H/S C-Band was noisy, the inclination was holding at  $31.63^\circ$ .
- 1+03+36 CRO C-Band low speed data confirmed the separation orbit to be  $89.8 \times 119.5$  and the inclination at  $31.64^\circ$ .
- 1+04+00 Requested dynamics for the time of  $100^\circ W$  longitude in the FOD for revolution number 1. This time was 1+34+40 and would have been used as an ALT C execution time should it have been needed.
- 1+05+23 AFD given postseparation orbit of  $90 \times 120$ .
- 1+13+ The RFO computed  $T_{DI}$  to be 4+00+19 and MP-11 enable to be 4+32+49. This  $T_{DI}$  time was input to the RTCC for the initial calculations if the DPS No. 1 maneuver. The critical maneuver parameters are listed below:

$$T_{ig} = 3+59+40.4$$

$$T_{c/o} = 4+00+17.8$$

$$R_M = 345.0^\circ$$

$$P_i = 39.9^\circ$$

$$\Delta T_B = 37.5 \text{ SEC}$$

$$R_P = 21969619.0$$

1+13+20 Select informed FDO that he had a format 68 TLM vector from CAN. This vector was checked for validity in the DSC and then transferred to the MOC where the DPS No. 1 maneuver was recomputed as summarized below:

$$T_{ig} = 3+59+40.8$$

$$T_{C/O} = 4+00+17.9$$

$$R_M = 366.0^\circ$$

$$P_i = 32.3$$

$$\Delta T_B = 37.0$$

As can be seen, the agreement between vectors (TLM and TRK) was very good and any difference can probably be explained by the launch azimuth alignment of the LGC.

The orbit as predicted by the CAN TM vector was  $88.9 \times 116.8$  with an inclination of  $32.02^\circ$ .

1+16+00 RFO instructed dynamics of a weight update with an indicated  $\Delta$  of about 34 pounds.

1+21+23 Reinput of CRO C vector to recheck DPS No. 1 after the weight update showed no change in DPS No. 1.

1+26+ Results of DPS No. 1 double integration showed  $h_{p-MIN}$  to be 91.8 n.m. The ACF computation of ignition was  $3+59+40.9$  and cutoff was  $4+00+18.2$ .

~ 1+30+ Select was instructed to go to H/S in an attempt to receive CAL and WHS data. In that the WHS data was "Off-TRACK", Select requested to go back to low speed and then back to high speed. No data was received.

1+41+40 The H/S MIA radar data was coming in and looked good. Short arc data from MIA confirmed the orbit at  $89.8 \times 122.0$  with an inclination  $31.62^\circ$ . At this time, we returned to L/S processing and input  $4+32+49$  as enable for mission phase II.

1+42+20 The ACF passed the following information for ALT L:

$$T_{ig} = 4+38+28.7 \quad CPT_6 \quad X = +0.24045200$$

$$\text{Recommended } T_{C/O} = 4+39+27.2 \quad Y = -0.50321364$$

$$R_M = 326 \quad Z = +0.83003543$$

$$P_i = 282$$

$$h_{aResult} = 122.9$$

$$h_{pResult} = 89.9$$

- 1+43+00 Track informed FIDO that he suspected PAT was tracking IU.
- 1+46+56 Based on the CRO C-Band data, the DPS No. 2 maneuver iterated 103 times, regained throttle control at 4+43+07, spent 6+11 under throttle control, and:

$$T_{ig} = 4+36+56.7$$

$$T_{C/O} = 4+49+18.0 \text{ (APS No. 1)}$$

$$R_M = 340$$

$$P_i = 301.6$$

$$M_{DPS} = 919 \text{ lb.}$$

- 1+49+35 The ACF began passing additional ALT L data as follows:

$$T_{ig} = 6+14+07.5 \quad CPT_6 \quad X = +0.16473225$$

$$\text{Recommended } T_{C/O} = 6+15+06 \quad Y = -0.58478910$$

$$R_M = 12.24^\circ \quad Z = 0.79428266$$

$$P_i = 179.5$$

$$h_{aResult} = 156.64 \quad h_{pMIN} = 80.3$$

$$h_{pResult} = 85.74$$

- 1+50+30 Select was requested to input the BDA telemetry vector to the DSC. This was done. Dynamics noted that the engine pulsed during DPS No. 2 prior to recomputing the engine on algorithm. The vector was then transferred to the MOC and the DPS No. 1 and No. 2 maneuvers were recomputed.

- 1+55+45 Based on the BDA TM vector, the DPS No. 1 maneuver was as follows:

$$T_{ig} = 3+59+40.9$$

$$T_{C/O} = 4+00+17.9$$

$$R_M = 354.8$$

$$P_i = 32.4$$

$$\Delta T_B = 37.0$$

- 1+57+00 The ACF completed the PAO data and it was sent to PAO.

- 2+03+49 Select had completed DC's on CRO, CNB, WHS, MLA and BDA, and updated. Based on these DC's and the BDA telemetry vector, the ACF was instructed to perform DPS No. 1 double integration.
- 2+16+ Results of double integration indicated an  $h_{DMIN}$  of 91.4 n.m. Therefore no navigation update would be needed. Further, the middle gimbal angle was acceptable and the time of ignition was inside CRO ACQ; therefore, no target update would be necessary. This information was later relayed to Flight. The DPS No. 2 maneuver was recomputed based on the BDA tracking and was also acceptable.
- 2+21+43 The Com Supe requested permission to write a restart tape when we got past WOM.
- 2+25+25 (CRO 0° ACQ)
- 2+34+44 The CRO telemetry vector was input to the DSC where it again caused pulsing of the DPS No. 2 maneuver prior to recomputing the ignition. This was expected.
- 2+40+00 The DPS No. 2 maneuver information was passed to FD as follows:  
 $T_i = 4+37+31$ ,  $T_{C/O} = 4+49+26$ ,  $R_M = 341$ ,  $P_i = 301$ ,  $M_{DPS} = 1353$ ,  $120/4+43+37/5+49$ .
- 2+45+00 The Com Supe was given a go for the restart tape.
- 2+47+00 Restart tape complete.
- 2+48+00 Updated on CRO @ telemetry.
- 2+48+30 Requested the time of 100°W in revolution number 2. Time was 3+07+42 (based on telemetry).
- 2+51+41 Requested BSE to reset his telemetry events to remove the erroneous telemetry indication of J-2 thrusting.
- 2+53+36 CRO C-Band data verified the DPS No. 1 and DPS No. 2 maneuvers would still be acceptable should a navigation update be required.
- 3+02+33 Still no CAL tracking data in H/S. At this time, RED and MLA reported, through track, that their IRV's were bad. The RTCC was instructed to go to low speed processing and "force" new IRV's to MLA and RED.
- 3+05+20 RTCC went back into H/S. WHS data looked terrible.
- 3+14+09 Track indicated that previous CRO and PAT IRV were off. (At this time, it is suspected that the IRV's were generated on telemetry vectors and this may explain the bad IRV's.)
- 3+16+13 ACF received SIVB post-passivation vector.

- 3+28+00 "Maneuver" informed FIDO that should the DPS No. 1 maneuver overburn, such that the resultant apogee was  $\approx 185$  n.m., the DPS No. 2 maneuver would begin to encounter gimbal-lock problems.
- 3+37+34 The DPS No. 1 maneuver was placed in the DMT and the ephemeris was updated based on ANT 33.
- 3+45+00 DPS No. 2 was recomputed and was OK.
- 3+47+47 GSFC computer down with a 10-minute estimate.
- 3+51+40 Yaw informed FIDO that he was site-selected to CRO.
- 3+52+40 Track informed FIDO that the CAL 1218 radar computer was "RED" and had an ETA of 3+08+00. No reason was given.
- 3+55+14 The RTCC was placed into H/S mode.
- 3+5 + LGC predicted  $T_{ig} = 3+59+40$ .
- 3+59+ LGC went to P00 and "forget it" following an early cutoff. Planned orbit was  $115.5 \times 174.1$ . The short burn placed us in a  $100 \times 119$  orbit as predicted by H/S data.
- 4+02+14 CRO low speed C-Band data confirmed the cutoff orbit as  $91.5 \times 119.1$ .
- 4+03+00 Instructed Dynamics to delete DPS No. 2.
- 4+0 ACF was immediately requested to recompute ALT L with a  $T_{ig}$  of 6+15+00.
- Requested  $100^\circ$ W REV No. 3 in the FOD. Time was 4+40+58 and would have been valid for ALT C execution on REV No. 3. ALT C execution time for next revolution was noted as 6+15+00 (same as ALT L  $T_{ig}$ ).
- 4+28+00 A need for a posigrade attitude for any stateside maneuvering was noted and dynamics was instructed to put a separation maneuver into the DMT to find gimbal angles representing this posigrade attitude for the ALT C time of 4+40+58. The following gimbal angles were passed to Guidance.  $R_M = 7.8^\circ$ ,  $P_i = 213.6$ ,  $Y_o = 50.9$ .
- These gimbal angles were then reinput to the DMT for a time of execution of 6+15+00 to insure that they would still be valid if ALT C needed to be executed at a later time. The angles were good and would result in a local pitch attitude of  $+27.4^\circ$ .
- 4+30+00 The above "separation" maneuvers were deleted and the CSQ and CRO acquisition times were noted in order to begin evaluation if a complete rescheduling of MF-9 and MF-11 for a one-REV later execution.

The elevation angle at CRO was  $3.8^\circ$  with a  $4m+22s$  pass ( $0^\circ$  to  $0^\circ$ ).  
The maximum elevation angle at the CSQ was  $15.7^\circ$  with ACQ at  $5+27+44$  and LOS at  $5+34+44$ .

The DPS No. 1 maneuver was reinput direct to the DMT and was as follows:

$$T_{ig} = 5+32+21.9$$

$$T_{C/O} = 5+32+58.8$$

$$R_M = 351.9$$

$$\Delta T_B = 37.1 \text{ SEC}$$

The second DPS maneuver was directly input and came out as follows:

$$T_{ig} = 6+04+35.3$$

$$T_{C/O} = 6+17+44$$

$$R_M = 357.6$$

$$M_{DPS} = 600 \text{ lbs}$$

The resulting RKV acquisition time was  $6+05+24$ .

In order to support this plan, two timer updates for DPS No. 1 would have to be made and a timer update would also have to be made for DPS No. 2. A navigation update would not be needed.

( $4+43+00$ ) The FD was informed of the above maneuver plan.

At this point the ACF recomputed ALT L targets and maneuver quantities were passed to the FDO. They were as follows:

$$T_{ig} = 6+14+13.8$$

$$\text{Recommended } T_{C/O} = 6+15+12.3 \quad (\text{time of arrival at } 85 \text{ n.m. } h_p)$$

$$\Delta T_B = 58.5 \text{ SEC}$$

$4+50+00$  Guidance reported that the S/C had completed the maneuver to the desired attitude.

$4+56+26$  WHS C-Band confirmed the orbit at  $91.6 \times 118.9$ .

$5+24+00$  At this time the Flight informed the FDO that we would initiate ALT C at  $6+10+00$ . This would make the previously computed pitch attitude of  $+27.4$  come to  $\approx 7^\circ$  at burn initiate. The



Flight wanted to know whether or not APS No. 2 could be retargeted following termination of PRA sequence No. 3 after the first APS burn.

He was informed that this could and would be done.

A quick look at the intended maneuver in the GPM showed an impulsive postmaneuver orbit of 82 x 545.

The FTDO asked Flight to review how the PRA sequence could be reinitiated should tracking not be able to confirm a "go" orbit at burn termination.

6+03+41 CAL, WHS, GYM, TEX and MLA were configured to provide H/S tracking data.

6+07+00 RTCC was placed in the H/S tracking mode.

6+07+36 RKV sent AGS select.

6+09+ No track yet available.

6+10+ +X on reported from RKV

GYM S-Band data looked good--confirmed the maneuver as raising apogee and perigee. The Flight was continually informed of the trajectory status (GO).

6+11+ Switched tracking sources to WHS and it continued to agree that we had a "go" orbit. Many data dropouts were experienced but every time restart was complete we still had a "go" orbit.

6+13+36 APS engine cutoff was confirmed and WHS short arcs indicated a 93.4 x 526.4 orbit.

6+15 Guidance was instructed that there wouldn't be time to process DC's for a vector for a navigation update and that the short data was all that was available. This navigation update was to be sent from ANT.

6+16+ FDO immediately set to generating APS No. 2 targets. These initial computations were complete prior to ANT LOS.

+ + The upcoming HAW AOS was 7+38+34 with LOS at 7+45+25.

6+46+ The APS No. 2 maneuver details were as follows:

$$T_{ig} = 7+38+59.5$$

$$R_M = 321.2^\circ$$

$$P_i = 294.2$$

$$M_{APS} = 518$$

This maneuver was verified by the ACF as having an  $h_{pMIN}$  of 87.9.

(~ 7+00+) Requested Flight verify whether he wanted to burn APS No. 2 on the upcoming HAW pass or subsequent one. Flight indicated that we would attempt to burn on the upcoming HAW pass.

7+ + RFO was requested to generate "POS MAX" and "GET" timer loads for Guidance.

7+ + A request was made to generate posigrade altitudes valid for the upcoming CRO pass. They were:

$$R_M = 36.0$$

$$P_i = 351.6 \quad LVLH = 0,0,0 \text{ at a Get of } 7+07+00$$

$$Y = 320.3$$

7+10+00 RTCC to H/S to verify LGC had received navigation vector update from ANT. It had!

7+20+00 Necessary timer and target loads did not get in at CRO. Flight requested what would happen if burn was initiated late. A quick check of the guidance in the RTCC with a later ignition time confirmed that the guidance equations could handle this late ignition but there was no way of knowing the minimum perigee, also, the time of ignition would have to be later than the target arrival time! Should the burn have been initiated later, no real-time site would be able to see the end of the burn.

The FD was given this information.

7+35+00 The FD decided to do PRA SEQ 5 over HAW REV 5. The Flight Dynamics team recommended IGN time of 7+39+00 or ASAP after AOS. The RFO reported an estimated 6400 pounds of APS fuel onboard (based on GNC data).

(7+38+00) Flight instructed Guidance not to send PRA SEQ 5 and asked us to start generating a new plan based on performing an LGC controlled APS depletion burn for next pass over HAW (REV 6).

Flight was informed that the upcoming pass over HAW was the last command site prior to the next HAW pass and if a burn was to be initiated, all targets would have to be generated and loaded at HAW immediately.

7+42+00 Flight then decided to go ahead with PRA SEQ 5 this pass over HAW, but make first burn go to depletion.

7+43+55 PRA SEQ 5 was initiated and confirmed by the Guidance Officer. The following is an approximate list of the event times associated with PRA SEQ 5.

+X on at 7+44+04 GET

APS on at 7+44+15 GET

+X off at 7+44+20 GET

GNC commanded engine start override approximately 16 seconds after APS IGN<sup>2</sup>

+X on at 7+45+14 GET

+X off at 7+45+30 GET

APS depletion as reported by RKV approximately 7+50+30.

In an attempt to simulate the PRA burn in the RTCC, the following attitudes (gimbal angles) were recorded from Guidance Officer reports

$\approx$  7+44+00 GET  $p = 92^\circ$ ,  $R = 0^\circ$

$\approx$  7+46+00 GET  $p = 0^\circ$ ,  $R = 13^\circ$

Also, the RKV reported an attitude readout of  $p = 260^\circ$ ,  $R = 100^\circ$  with estimated tumbling rates of  $20^\circ$ - $25^\circ$ /SEC. Based on these attitude reports and unavailability of tracking data, we were unable to simulate an effective maneuver to update the current ephemeris. NOTE: No high speed tracking was available to monitor the PRA SEQ 5 burn and real time low speed data from HAW was lost at 7+45+51 GET.

7+53+00 Track reported possible loss of C-Band beacon. FIDO then asked EECOM if he had any indications of C-Band or S-Band beacon problems; he reported negative. Then suspected tumbling was probable cause of any beacon tracking problems.

7+55+00 FIDO then instructed Track to configure all the expected Network sites for the next two REV's for attempting S/C tracking, with the following immediate plan: ASC, REV 6, should beacon track with their S-Band system and skin track with the C-Band radar. REV 6 PRE and TAN should both use their C-Band radar to beacon track since neither was capable of skin tracking.

Shortly thereafter FDO received a request from EGL, through Track, to attempt tracking of S/C on next REV. Approved request and asked Track to provide all necessary data.

8+15+00      Contacted NORAD through Flight Dynamics SSR ACF chief to determine if they had any post PRA SEQ 5 vectors--received negative report. NST Trinidad radar reported, to track, tracking 37 pieces at 6+25+00, which may have been the descent stage.

After HAW REV 5, no valid trajectory data on the ascent stage was established during the next two REVS. The only known ascent stage trajectory data after this time was unusable. The low speed C-Band watertown tracking data received between 7+43+56 and 7+52+32 GET proved to have large ranging and angle errors. And, the one low speed TM vector received from GYM at 7+54+59 was useless because the LGC did not know where it was as a result of the PRA SEQ 5 maneuver.

11+11+00      The Flight released the Flight Control team after a final unsuccessful attempt to track the ascent stage at HAW during the previous 15 minutes.

Later analysis and queries confirmed that as of 1/26/68, no valid trajectory data for the ascent stage after PRA SEQ 5 had been established.

#### Conclusions and Recommendations:

The excellent support experienced by FDO throughout the mission from the RTCC, the ACF, CCATS Track, GSFC, the IP Complex, and all other interface personnel was most gratifying.

A significant point to be made is, however, that in future missions more attention must be placed on the interface with the "instrumentation tracking controller". "Track" has an important series of tasks to perform in order to properly configure and reconfigure the tracking network, especially during real time mission planning and maneuver monitoring.

Also, during simulations, we had a number of occasions to receive (via TWX) vectors from the IP Complex, NORAD, and GSFC. With the exception of GSFC, these vectors were not compatible with the requirements of the direct input MEDS of the RTCC. In the future, it would seem that the direct vector input capability of the RTCC should be expanded to accomodate, not only IP and NORAD standard vector formats, but the WTRs as well.

#### Team Members:

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*W. David Reed*

UNITED STATES GOVERNMENT

# Memorandum

TO : LM-1 Flight Director

DATE: FEB 9 1968

FROM : LM-1 Guidance Officer

SUBJECT: AS-204L Post Mission Report

1. Included in this report is a summary of the Guidance Officer's participation in the various pad test and the LM-1 mission. Also included in the enclosure is a summary of all the command loads generated and a complete command history of all the commands transmitted throughout the flight.

2. The Guidance Officers participated in the following pad tests, primarily for command support prior to beginning CDDT and terminal count operations:

Software Integration Test #1 - OCP KL-0024

Plugs Out - OCP KL-0016

Flight Readiness Test - OCP KL-0005

Software Integration Test #2 - OCP KL-0026

3. CDDT and terminal count support was as follows:

## CDDT

1/18/68	12:24:00Z	LGC clock alignment was performed with a 10 centi-second negative bias based on an anticipated positive drift between alignment and actual liftoff.
	13:00:00Z	LGC E-Memory loading started using the following tapes:  Mission tape - REV B F06L001-K00068-02 1/08/68 Launch tape - REV F F06L001-K00067-06 1/08/68
	13:32:00Z	Mission and Launch tape loading completed and gyrocompassing started.



5010-108

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13:51:00Z It was noted that a V36E (fresh start) had not been executed prior to starting the above tape loadings. As a result, the timers were enabled, verify bit was set, and LMP 3 was setting in the LMP 0 output register.

13:52:00Z KSC was informed of the procedural error noted above and made an immediate decision to reload the memory using the proper procedure.

14:30:00Z Second LGC E-Memory loading was completed using tapes specified in 13:00:00Z procedure.

15:40:00Z MCC DSKY command checks were performed per T-18:50:00 procedure in OCP KL-0006.

1/19/68 11:00:00Z Considerable discussion had occurred concerning the possibility of updating the ADIAX compensation quantity at T-3:30:00 in the CDDT from the value inserted during the initial E-Memory loading. More background on this subject is given later in the countdown activities.

11:34:00Z It was noted that the outer gimbal (that controlled by CDUX and affected by ADIAX) had increased in value from a 1/18/68 19:41:00Z reading of  $121.79^{\circ}$  to a 1/19/68 11:10:00Z reading of  $123.15^{\circ}$ . The initial ADIAX compensation was still in use by the computer at that time ( $-71$  meru/G).

16:04:00Z KSC G&N personnel provided a new ADIAX parameter and requested it be uplinked at T-3:30:00 in the CDDT. The new value was  $-67$  meru/G, octal 75562 and was provided verbally over BLK 3 (KSTC comm channel). It was successfully uplinked per the procedure in OCP KL-0006. The DSKY check at T-3:30:00 in OCP KL-0006 had been completed just prior to the above update.

16:15:00Z LGC E-Memory verification was performed by KSC with three expected "error stops" noted. The two addresses containing GLIFTOFF, which was set to POSMAX at initial E-Memory loading, and ADAIX, which was changed at KSC's request per the 16:40:00Z sequence.

17:27:50Z It was discovered at DCS turn-off after E-Memory verification that the LGC had not been left in suitable configuration to monitor program alarm error codes should they occur. This resulted because "Key release" of the DSKY wasn't performed and thus prevented use of the DSKY displays by the LGC should it desire to display a monitor verb/noun and associated error codes. MSC recommended that KSC deviate the terminal count procedures and perform a V34E at the end of final E-Memory verification to prevent a similar situation. Each DCS turn-off gave error code 1106 (Uplink too fast) as expected.

1/20/68 01:39:00Z The CDDT was scrubbed at T-00:20:00. All T-00:24:00 commands had been performed per OCP KL-0006. The system was safed at KSC request with the following commands V34E, PRA SEQ 16 TIME WORD, and REVERSE SEARCH.

#### 4. TERMINAL COUNT

1/21/68 22:00:00Z The following was discussed concerning launch criteria for the outer gimbal (CDUX) which was exhibiting considerable instability. It was determined from dispersion analysis that the instantaneous minimum perigee during DPS 2 and APS 2 was protected if the outer gimbal was always bias in a southerly direction, which would mean a value greater than the desired  $122.05^{\circ}$ . Analysis also proved that a smaller northerly bias could be tolerated. Based on the above information and a desired value of  $122.05^{\circ}$ , the following "red line" launch limits were set on CDUX alignment. Maximum northerly tolerance was  $121.2^{\circ}$  and southerly was  $123.9^{\circ}$ . These variations incorporated



pad alignment uncertainty (quoted as  $0.15^\circ$ ) and instantaneous peak to peak variation of the angle. It's the opinion of the Guidance Officers that enough emphasis was not put on the possibility of the azimuth problem in pre-mission readiness reviews. The facts seem to become available very late in the launch countdown activities.

1/22/68	14:40:00Z	Latest information gave outer gimbal (CDUX) reading of $122.77^\circ$ , somewhat biased in the desired southerly direction.
	15:32:00Z	Performed DSKY command checks per OCP KL-0006. Check was successful.
	16:05:00Z	Final LGC E-Memory verification was completed. Verification was successful with three non-verifies as expected. GLIFTOFF (still at POSMAX value) and ADIAX (changed in CDDT).
	16:21:00Z	Performed a V34E (per our recommendation at 17:27:50Z in the CDDT) to perform "Key Release" of the DSKY.
	22:24:00Z	Performed command sequence per OCP KL-0006. This included setting GLIFTOFF to the proper value.
	22:43:00Z	Performed command sequence per OCP KL-0006.
	22:47:43Z	Outer gimbal (CDUX) was reading $122.8^\circ$ at T-25 seconds.

##### 5. LAUNCH PHASE

Guidance reference release times were recorded as follows:

GMT IUGRR (Occurrence of event 0747 at KSC)	22:48:03.03
GMT S/CGRR (TEUENT in S/C DOWNLINK)	22:48:08.86

This mission also provided the first opportunity to test the hardline method of receiving IUGRR direct from the pad via ALDS. It should be noted that the prime method for receipt of the time was by voice from KSC based on event 0747 (Guidance Reference Release). It was known premission that the hardline was connected to event 0360 (LVDA firing commit enable) which could occur later than 0747 by 300-500 milliseconds. This time received via hardline was GMT IUGRR 22:48:03.47.

Immediately after liftoff the backup S/C GRR commands "5" and "enter" were transmitted based on the no indication by liftoff plus 5 second mission rule. The commands were transmitted at 22:48:15Z and 22:48:17Z respectively and correspond to a liftoff of 22:48:09Z. It was confirmed shortly thereafter that S/C GRR had occurred by onboard sending of acceleration, and not by ground command. Telemetry data delays may be attributed to implementing the mission rule.

At approximately 60 seconds after liftoff an LGC navigation error in the crossrange plane was detected. The actual trajectory in this plane was nominal however, the LGC divergence was such that the LGC believed it was north of the actual trajectory. The divergence continued throughout both stages of flight and by orbital insertion it represented approximately 400 fps of northerly navigation error in the crossrange trajectory plane.

The above described error had been expected due to the misalignment of the outer gimbal (CDUX) in the southerly direction (see prelaunch operations for more information on this subject) at liftoff. Rough pre-liftoff calculations assuming a misalignment of approximately 1° at liftoff indicated the navigation error could be as much as 400-500 fps. No estimation of further errors that might be contributed by acceleration loads during ascent phase were incorporated in the above calculation. Launch vehicle and LGC guidance, navigation, and sequencing was nominal throughout both stages of flight, with exception of the previously mentioned LGC crossrange error.

The S-IVB cutoff time was slightly earlier than nominal. Actual cutoff time was at a ground elapse time of 09:53.0, whereas the pre-liftoff nominal was 09:58. This earlier time can be attributed to a slightly delayed engine mixture ratio shift causing more flight time at the high thrust level during the S-IVB stage, but is well within expected uncertainty tolerances.

## 6. ORBIT PHASE

### REV 1

- 10:00 The LGC entered MP6 (P13) upon sensing S-IVB C/O as expected.
- 19:35 Booster had problem confirming SLA deploy and qured me to stand by to possibly stop the LGC sequencing. But CYI and CSQ confirmed the SLA was deployed.
- 21:52 Upon completion of Mission Phase 6, the timers were enabled and timer #1 was loaded and started counting down to MP7. The attitude comparison between the LGC CDU angles and the IU attitudes were in good agreement.

- 52:08 Upon acquisition of LM at CRO, a quick check of the LGC and platform confirmed the Guidance system was "GO" for separation and so indicated to FLT. The separation sequence went as planned and time #4 was loaded to countdown to MP8 (DPS COLD SOAK).
- 54:25 Upon entering MP8 the LGC maneuvered to the cold soak attitude. The attitudes from the LGC agreed exactly with a set that had been computed by the ACF. The attitudes were Pitch  $319.7^{\circ}$ , Roll  $328.5^{\circ}$ , and Yaw  $99.4^{\circ}$ . Upon completion of MP8, Timer #2 was loaded and started counting down to start MP9 (DSP 1).
- 01:38:00 The LMP loads #2502 and #2602 were generated and loaded in MILA and TEX. The LMP commands were 376<sub>8</sub> (RCS X-FEED CLOSE) and 377<sub>8</sub> (RCS X-FEED CLOSE RESET). The loads were pre-mission SOP's.
- 1:34:00 After checking the Guidance system status, uplinking of the two LMP loads was started at Texas. Load #2502 was completed and part of load #2602 was done at Texas. The remaining part of load #2602 was completed at MILA. No problems were encountered while uplinking the loads. One thing was noted while the initial command was in to close the prime relay and prior to the reset command, the telemetry indicated the X-FEED valve open. Once the reset command was entered the telemetry had the proper indication of valve closure.

## REV 2

During the Redstone, CYI, CRO, and HAW passes the Guidance system status was checked. The LGC was checked to see if all its computer status words were correct and Timer #2 was checked to insure still counting down to the same start time of MP9. In addition the LM attitudes were checked to insure within the deadbands using MSK 253 and MSK 254. MSK 254 had three analog traces indicating the difference between the actual and desired CDU angles. It was noted that the attitude differences were outside the  $\pm 5^{\circ}$  deadband limits. Discussions were entered into with the MIT personnel in the SSR as to why the difference were greater than the deadband limits. It was determined that the DAP controls attitude about the body axis and not the gimbal angle axis, which caused the errors about the gimbal axis' to be larger than the deadband limits. This was pointed out to FLT and resulted in the deletion of part of mission rule 14-30 which dealt with actual and desired differences  $> 10^{\circ}$ .

- 3:06:00 During the second Texas pass it was planned to que PRA SEQ #5. Due to signal strength problems, queing the sequence was delayed until the MILA pass.

3:14:00 PRA SEQ 5 was queued successfully at MILA, getting the compare pulse at 3:14:35 approximately 43 seconds after the forward search command was sent.

### REV 3

3:48:00 FLT deleted first portion of Rule 14-30 discussed previously

3:56:00 Upon receiving CRO data and checking the LGC setup for the DPS 1 burn FLT was given a "GO" for the maneuver. A comparison of the ground predicted and LGC actual attitude at ignition are as follows:

	<u>DMT</u>	<u>LGC</u>
PITCH	32.4°	31.8°
ROLL	354.8°	355.6°

The yaw angle is not part of the guidance computation. The ground predicted ignition time was 3:59:41 and the LGC's ignition time was 3:59:40. The total velocity to be gained also showed good agreement, ground, 146 fps and LGC, 145 fps.

3:59:40 The LGC commanded the engine on as expected at 3:59:40 and approximately 4-6 sec later commanded it off. It has been verified that CH 11 BIT 13 was set indicating LGC commanded the engine on and then off again looking at CH 11 BIT 14. After commanding the engine off, the LGC went to Program 00 and also set Bit 11 DISTAB +11 D (Program alarm).

3:59:48 FLT was informed of PNGS caution indication..

4:01:00 Due to the alarm codes associated with the program alarm not being displayed. FLT was told V15N50 would allow readout of the alarm codes on the DSKY.

4:04:26 V15N50E was uplinked and alarm codes 1405 and 315 were read-out. Alarm 1405 indicates LGC commanded the engine on and it did not come on. Alarm 315 is the forget it alarm which is set prior to the LGC going to P00.

Prior to issuing alarm 1405 and commanding the engine off, the LGC looks at the acceleration level measured by the PIPA's to be  $>0.225 \text{ m/sec}^2$  or 4 m/sec. If after looking for this acceleration level during 2 computer cycles of 2 seconds each and the acceleration is not above this level, the LGC commands the engine off. The number of computer cycles the LGC looks for this thrust level was set at 2, but could have been set at any number of cycles desired to extend the wait

time. It was recommended to FLT to update this parameter to a larger number if further guided LGC burns were executed. The number could be changed due to being in erasable memory.

4:27:30 During the Hawaii pass the following commands were sent to the LGC:

1. Error Reset - Cleared alarm codes from DSKY
2. V34E - Released the DSKY for internal program use

4:28:33 3. PRA #3 Callup

Between CRO and CONUS the alternate mission that would be used were discussed. FLT recommended Alternate Mission C or Alternate Mission L be performed on the subsequent states pass. Alternate C called for execution of PRA sequence #3 and Alternate L called for an LGC controlled DPS 2 burn. Flight was informed if the LGC attitude at DPS #1 shutdown was maintained and PRA #3 executed over the states the  $\Delta V$  was enough to cause the LM to re-enter due to being in a retro attitude. It was recommended to FLT to do an attitude maneuver update to put the LM in a posigrade attitude. FLT concurred and said to do the update this states pass.

4:35:00 The desired attitudes were obtained from FIDO for PRA SEQ #3 execution at 6:15:00.

	<u>DMT</u>		<u>ACE</u>
PITCH	213.6°	(OCTAL)	45761
ROLL	7.8°	(OCTAL)	01306
YAW	50.9°	(OCTAL)	11031

Once the attitudes were obtained from FIDO they were passed to the ACF for conversion to octal.

4:41:30 Upon receipt of Texas telemetry and a command carrier, uplinking the attitude maneuver was started. The following commands were sent.

1. Update to set bit 12 of Flagword 2 to a zero (no final yaw bit). Allows three axis attitude maneuver V21 NO1 E  
V21NO1E  
76E (Address of Flg Wd 2)  
60025 E (Desired configuration of Flg Wd 2)

2. Set up small program to execute attitude maneuver routine in LGC.

4:41:27 V25 N26 E  
 04001 E  
 02067 E  
 70063 E

3. Loaded three desired CDU angles

V21 N01 E  
 01631 E (Address of CDUZ)  
 11031 E (CDUX Desired)  
 E 1632 E (Address of CDUY)  
 45761 E (CDUY Desired)  
 E 1633 E (Address of CDUZ)  
 01306 E (CDUZ Desired)

4. Sent final command to start attitude maneuver.

4:51:30 V30 E

The final command was sent from ANT at 4:51:30. At the completion of commanding the LGC started the attitude maneuver and completed it just prior to ANT LOS. After performing the maneuver the DAP remained in the minimum deadband.

#### REV 4

Between States LOS and CRO AOS continued to work on 2 alternates. One in support of Alternate L calling for a DPS #2 maneuver and one in support of Alternate C calling for PRA #3. The following is a description and the planning for the two alternates.








#### Alternate L

1. Generated command loads necessary to do LGC DPS #2 maneuver on Rev 4.
  - a. DPS #2 retargeting was being done by FIDO
  - b. Generated and loaded into CRO navigation vector with time tag of 5:35:00 (Load #2001)
  - c. Mission Phase and Timer Update to start MP 11 generated and loaded into CRO and HAW (Load #3303)



- d. Needed GET Timer update to start MP11 at proper time.

Alternate C

- a. Alternate called for using PRA #3 across states Rev 4
- b. Coordinating with GNC and FLT, came up with the following command plan
  1. Prime Relay off 
  2. Master Arm 
  3. AGS Select 
  4. PRA START - was to be sent at 6:15:00, which corresponded to desired attitudes
  5. AGS Select  Would be sent 3 min 32 sec after start of sequence between 2 APS burns. In addition would stand by to start PRA again or call sequence #5 for immediate execution.
  6. Prime Relay Reset 
  7. Guidance Select PNGS 
  8. Prime Relay Off 

In addition, the attitudes loaded into the LM were passed to the ACF for conversion to LVLH attitudes at 6:15:00 and 5:35:00 for EECOM. EECOM was trying to determine if any signal strength problems would exist during the burn. Also, a discussion as to what to do if the PRA #3 was executed over states and stopped. It was suggested performing the APS #2 burn with the LGC during the next states pass. In support of this, a mission phase and timer update with 4:30:00 was loaded into CRO and HAW (Load #3401)

- 5:30:00 Just prior to CRO AOS FLT decided to go with PRA #3, this state pass and APS #2 on next pass. Asked for go ahead to uplink MP and Timer Update to start LGC counting to to MP13. Got go ahead.
- 5:33:28 Started uplinking Load #3401 into LGC, and completed loading at 5:35:01. Upon completion of load, timer #2 started counting to start MP13 in 4:30:00 or timer would zero at GET of 10:05:01. Between CRO and HAW a lengthy discussion was



entered into on how to stop the PRA during Sequence #3. GNC suggested sending prime relay on ~~34B~~ due to it inhibiting use of the prime relays. Guidance suggested using AGS select ~~40B~~ due to it stopping the PRA and it would also be required prior to queing another sequence in any case. In addition, should the prime relay reset ~~34B~~ get in and not be able to remove it, another sequence couldn't be executed. Flight decided that the AGS select ~~40B~~ command would be used to stop the PRA and it would be executed by Guidance, who was to watch the middle gimbal angle (CDUZ). In addition, it was decided to start the sequence at 6:10:00 instead of 6:15:00.

- 5:59:00 During the HAW pass the first few commands in Plan #2 were executed by GNC and EECOM.
- 6:06:00 The RKV transmitted the AGS select ~~40B~~ command at 6:06:00. Once in AGS the LM attitudes began to drift, due to the poor attitude control of rate damping.
- 6:10:00 The RKV started the PRA at 6:10:00. The LM attitudes at burn initiation were approximately pitch  $210^{\circ}$ , Roll  $0.6^{\circ}$ , and Yaw  $43^{\circ}$ . Once the burn started the attitudes continued to diverge at a steady rate. Approximately 3 min into the burn the middle gimbal angle went to  $300^{\circ}$  and informed FLT of such. The attitude then started back up again and informed FLT again that we were coming back out of the gimbal lock region. At APS shutdown FLT asked how attitudes were and informed him they were "GO." At 6:13:40 AGS select ~~40B~~ was sent to stop the sequence. FLT then said we would not continue burn.
- 6:14:03 GNC returned LM to PNGS control
- 6:14:30 Informed FLT in order to do an APS #2 controlled by the LGC the following updates would be required:
1. ATT CDR UPDATE
  2. MASS UPDATE
  3. NAVIGATION UPDATE
  4. TARGET UPDATE
  5. GET TIMER UPDATE
- 6:16:47 Started loading ATTCADR update into LGC. This update was required due to having executed the attitude maneuver in the LGC by update. The ATTCADR update allows the LGC to perform

future attitude maneuvers automatically. The following commands were uplinked:

V21N01E





372E

OE

- 6:23:40 At completion of ATTCADR update, a navigation update (Load #2003) was generated for 6:23:00 and loaded into MILA.
- 6:24:47 Started loading the navigation update into LGC. Finished the loading at 6:25:58 just at ANT LOS.
- 6:26:00 Started working on getting mass to put into LGC. Got three different masses prior to getting final mass (9170#) to use from GNC. Once the mass was obtained, it had to be passed to the ACF for scaling into octal.

#### REV 5

Between ANT LOS and CRO entered into discussion of problem associated with not having updated mass. Informed Flight the LGC would be able to control attitude even with wrong mass in the computer. Flight informed me RCS system B had been depleted and RCS System A had been closed. At the time it was felt if the mass had been updated, the LGC would have been able to control the attitude more efficiently. It was pointed out after the flight that this was wrong. The DAP only uses the mass when in average "G" and continually updates the acceleration constants used in attitude control. Once in coast phase, the DAP uses the last set of acceleration constants it had prior to exiting average "G" and does not recompute new values until entering average "G" again. Therefore, updating the mass would not have done any good, unless average "G" was forced on by another lengthy update. It should also be noted that we were still in minimum deadband as a result of the earlier ground commanded attitude maneuver. Once the mass was scaled into octal an EMU #1 update was generated and loaded into CRO. FLT requested that an update plan be formulated. The following plan was provided:

1. EMU #1 (Mass Update)
2. RCS system B close  54A
3. RCS system B close reset  55A
4. RCS system A open  50A
5. RCS system A open reset  51A
6. RCS X-feed open (Prime relay command 374g)

7. RCS X-feed open reset (Prime Relay command 375<sub>g</sub>)
8. EMU #2
  - a. Set DV CNTR to 35 (60 seconds)
  - b. Set deadband to maximum
9. APS #2 target update
10. GET timer update to start MP13

Setting the DV CNTR in EMU #2 would have eliminated the problem that had caused the LGC to shutdown the DPS #1 burn. Setting the counter to 30 would cause the computer to cycle 30 times or approximately 60 seconds prior to turning the engine off due to lack of thrust.

Once FLT concurred with the plan the following loads were generated and transferred to CRO and HAW.

1. EMU #1 (Load #3701)
  2. APS #2 (Load #2301)
  3. GET Timer (Load #3001)
  4. EMU #2 (Load #3801)
- 7:08:49 Upon acquiring CRO telemetry and a command carrier, the following was uplinked.
1. EMU #1
  2. Part of EMU #2

While uplinking EMU #2 UHF signal strength started fluctuating and upon executing the first address data line (01377E/00035) only, 0335 got into the LGC. A "clear" command was executed and the remainder of the loading was done using the DSKY. The loading of the new DVCNTR number and only the address for setting the max deadband were completed prior to CRO LOS. Due to not getting the APS #2 targets and GET timer updates into the LGC, the possibility of performing APS #2 across the states was eliminated. Therefore, it was decided to call up and execute PRA SEQ #5 at HAW.

Between CRO and HAW it was decided to open the ascent feed using part of SOP 13-XV and to execute PRA #5 as soon as possible after the ascent feed was opened.

7:38:31 Upon HAW acquisition the three LMP commands; LMP 176 (ASC FEED ARM), LMP 74 (ASC Feed A Open ) and LMP 76 (ASC Feed B Open) were loaded into the LGC. The PRA sequence #5 was then queued up. At 7:43:07 the AGS Select ~~40B~~ command was sent and at 7:43:54 the PRA SEQ #5 was started. Once the APS engine came on the attitudes began to drift from their initial values and eventually once attitude control was lost due to the APS interconnect being closed by the PRA forced the MGA past  $85^{\circ}$  which caused gimbal lock and ISS warning. The ISS warning caused automatic switchover to AGS control, therefore after APS depletion control could not be returned to PNGS.

8:00:00 Team 2 relieved the mission team for the next two revs in hopes of acquiring the LM again, to perform some of the extended mission tests.

Enclosure

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## COMMAND LOG

### COMMAND HISTORY

~~SITE~~

~~REV~~

~~CET AOC 00~~

204/LM-1

MSC Form 1933A (May 67) (OT)

[illegible]

AS-204L

Post-Mission Comments, Command System

Observations:

1. The volume of commands sent from the MOCR DSKY exceeded any known premission estimates.
2. Some of the automation provided (EMU) was by-passed in favor of manual entry via DSKY. The reason stated was a sudden lack of confidence when it appeared, temporarily, that a command had been "garbled" in the uplink and had entered as an unintended keycode.
3. It was observed that manual DSKY commanding was slowed down seriously (the sequence over Carnarvon in preparation for the last burn was not completed before the end of the pass) by the intermittent nature of the MOCR D/TV display of TM data.

Interpretation of Observations:

1. While AS-204L had the highest visible potential for Ground Commanding, we must not assume that future missions will have minimal Ground Commanding because of:

- a. Small numbers of CSM/LM RTC's ~~XX~~
- b. Presence of astronauts.

I feel we (FCD) must be prepared to take unlimited action via the uplink in the case of -

- (1) Onboard DSKY failure
- (2) Human failure.

The ground support (MOCR) personnel must, therefore, be in possession of contingency AGC/LGC input procedures at least equal to those normally used by the astronauts.

2 and 3. A study of the apparent "garbling" in the uplink should be made. If found to have actually occurred, corrective systems design is indicated; if not, further training of personnel and/or study of system capabilities toward optimization of the man-spacecraft interface is required.

I believe it can be stated now, that with a totally remoted network, and with the capability for data delays and dropouts between the sites and MCC, a closer look at eye-ball versus onsite computer verification of uplinked data is in order. It may be that, in addition to performing a bit-by-bit comparison, we may need to have the capability, upon occasion, to authorize the entering of the data by the onsite computer.



MCRB Requirements Integration Function

(By O. Lindsen)

The MCRB Requirements Integration Function is seen to be composed of the following elements, to be described below:

- a. Flight Control Team (mission) Support -
  - (1) MCC-H Configuration Control
  - (2) Network Configuration Control
  - (3) Simulation Real-Time Support
  - (4) Test Real-Time Support
  - (5) Mission Rules and Procedures Development Support
  - (6) Mission Real-Time Support.
- b. Test Development Support -
  - (1) Test Requirements Generation
  - (2) Test Review.
- c. End-to-End Requirements Verification -

-----  
a. Flight Control Team Support:

The concept of utilizing, by the Flight Director, of MCRB engineers as members of the Flight Control Team, as demonstrated for Mission AS-204/LM-1, produced two significant improvements in flight control efficiency. First, the flight controller, during the simulation, pad test, and launch phases was relieved of the burden of solving MCC-H configuration problems. Second, the MCRB engineers assigned to the Mission were able, by interfacing between the flight controllers and the MCC-H implementers, to more accurately define the problems and institute the corrective action. In addition, the MCRB engineers were the position to accumulate and feed back implementation status and to advise implementers of priorities as implementation time, always hard to come by, became available.

(1) MCC-H Configuration Control:

Attachment I portrays the method recommended for processing MCC-H configuration discrepancies discovered by flight controllers. These discrepancies discovered by flight controllers. These discrepancies fall into three categories:

- (a) Obvious console hardware faults (such as burned-out lamps)
- (b) Changes, corrections, or additions to stated requirements
- (c) Items whose implementation was performed in disagreement with the requirement.

The flight controller has only one decision to make. If case "a" is apparent, he enters the fault in the console discrepancy log; if case "b" or "c" is apparent, or if there is any doubt as to whether case "a" is apparent, he fills out a Flight Control Trouble Report (attachement II) which he then gives to the MCRB engineer or the O&P officer.

(2) Network Configuration Control:

Network Configuration Control, while minimized by remotng the network, is performed by the same process when errors are detected by flight controllers.

(3) Simulation Real-Time Support:

MCRB engineers provide immediate communication of discrepancies (except those relatively few cases where impact is major) to the implementers. He is also able to evaluate, through careful monitoring, the performance of the system and the adequacy of procedures and mission rules.

(4) Test Real-Time Support:

Test Real-Time Support by MCRB engineers provides a monitoring of system operation with a degree of detachment not available to participating

flight controllers. He has an opportunity at this time to further evaluate overall performance of hardware, software, and procedures.

(5) Mission Rules and Procedures Development Support:

In this area the MCRB engineers apply their specialized knowledge of requirements and operation.

(6) Mission Real-Time Support:

This area has not been fully developed, but it seems logical to say that there is no visible reason for not using, during the real mission, the skills and experience of these members of the team.

b. Test Development Support:

The MCRB engineers, through their intimate knowledge of requirements are qualified to recommend testing, to input test requirements, and to review the finished test procedures.

c. End-to-End Requirements Verification:

End-to-End Requirements Verification is a broad term which underlines most of the MCRB engineer's action. He is concerned with the satisfaction of the intent as well as the letter of the requirements, and evaluates implementation as to its ability to satisfy the ground support task.

# FLIGHT CONTROLLER TROUBLE REPORT

Please attempt to supply all information relevant to your problem

1. Name of Flight Controller \_\_\_\_\_ Date of Occurrence \_\_\_\_\_

2. System/s Affected:

Circle one: Hardware      Software  
            Circle: CCATS      RTCC      DTV      Ground Station  
                         Recorder      DDD      CIM      Comm      Other \_\_\_\_\_

3. Exercise in progress when failure observed (Circle)

Simulation      Data Flow      SIT  
FRT      Plugs Out      CDDT      Other \_\_\_\_\_

4. Data Source (Circle)

AC Tape      LM  
ALDS      SLV  
GSSC      HSD (Format NR \_\_\_\_\_)  
CSM      Other \_\_\_\_\_

5. Console NR \_\_\_\_\_ Module NR \_\_\_\_\_ Site \_\_\_\_\_

6. Event Failure

Nomenclature \_\_\_\_\_ Light \_\_\_\_\_  
Data Source \_\_\_\_\_  
Pertinent Details (Logic inverted, etc.) \_\_\_\_\_

7. MSK Faults:

MSK NR \_\_\_\_\_ Parameter \_\_\_\_\_  
Nomenclature \_\_\_\_\_  
Pertinent Details \_\_\_\_\_

8. Recorder Faults:

I.D. \_\_\_\_\_ Pen NR \_\_\_\_\_  
Nomenclature \_\_\_\_\_  
Pertinent Details \_\_\_\_\_

FOR MCR USE ONLY:

Date received from Flight Controller \_\_\_\_\_  
Disposition : MRR      FSR      DR  
Date delivered to CCB or FSD \_\_\_\_\_  
Estimated implementation date \_\_\_\_\_



1/26/68

## 2. Command Support Postmission Report

The following is a list of commands versus Ground Elapsed Time (GET) including vehicle, command function, octal, and console originating the command sent during NGC 722 mission. The prelaunch commanding will not be time tagged as GET on Command Histories prior to launch is all zeros.

All commanding was accomplished by the MCC through the remoted sites with the exception of:

RKV, Rev. 4

AGS Select 40B

PRA 3 Start

CRO, Rev. 5

RCS Main A Closed Reset 45A

There was one case where two controllers were commanding the S/C at the same time. Over TEX, Rev. 4, Guido and G&C both sent AGS Select 40B . Later in the same pass while Guido was uplinking DSKY commands, G&C sent RCS Main A Closed 44A .

There were 41 RTC sent to S/C after launch, 32 of which had MAPS and 9 without MAPS. Two RTC were sent from TEX, Rev. 5, with TEX command carrier down.

There were 232 DSKY commands sent to the S/C after launch, 221 of which had MAPS and 11 without MAPS.

There were 9 loads sent to the S/C after launch, 8 of which had MAPS and 1 without MAPS.

There were 3 commands sent to SIVB. The SLA deploy command sent over CYI on Rev. 1 was not confirmed by command history as the history was lost due to computer hang-up. The other two commands were not verified.



PRELAUNCH PRIOR TO 1547Z

<u>VEH</u>	<u>COMMAND FUNCTION</u>	<u>OCTAL</u>	<u>VER</u>	<u>CONSOLE</u>
LM	DCA SELF TEST	35140000	M	EECOM
	ALL ZERO	31400000	M	GUIDO
	ERROR RESET	31623310	M	
	VERB	31613504	M	
	THREE	31437014	M	
	FOUR	31446620	M	
	ENTER	31740760	M	
	3701 (EMU 1)		M	
	ENTER	31740760	M	
	3701 (EMU 1)		M	
	ENTER	31740760	M	
	VERB	31613504	M	
	ZERO	31603700	M	
	ONE	31417404	M	
	NOUN	31770174	M	
	ZERO	31603700	M	
	ONE	31417404	M	
	ENTER	31740760	M	
	ZERO	31603700	M	
	ONE	31417404	M	
	THREE	31437014	M	
	FIVE	31456424	M	
	ONE	31417404	M	
	ENTER	31740760	M	
	3801 (EMU 2)		M	

<u>VEH</u>	<u>COMMAND FUNCTION</u>	<u>OCTAL</u>	<u>VER</u>	<u>CONSOLE</u>
LM	ENTER	31740760	M	
(cont'd)	3801 (EMU 2)		M	
	ENTER	31740760	M	
LM	VERB	31613504	M	GUIDO
	ZERO	31603700	M	
	ONE	31417404	M	
	NOUN	31770174	M	
	ZERO	31603700	M	
	ONE	31417404	M	
	ENTER	31740760	M	
	ONE	31417404	M	
	THREE	31437014	M	
	FIVE	31456424	M	
	ONE	31417404	M	
	ENTER	31740760	M	
	VERB	31613504	M	
	THREE	31437014	M	
	FOUR	31446620	M	
	ENTER	31740760	M	
PRIOR TO 22/1652Z				
LM	VERB	31613504	M	GUIDO
	THREE	31437014	M	
	FOUR	31446622	M	
	ENTER	31740760	M	
PRIOR TO 22/1814Z				
LM	DEAD BAND LMP	3375	M	GNC
	DEAD BAND MIN	3374	M	GNC

<u>VEH</u>	<u>COMMAND FUNCTION</u>	<u>OCTAL</u>	<u>VER</u>	<u>CONSOLE</u>
PRIOR TO 2207Z				
SIVB	SINGLE WORD DUMP	630	AC	BOOSTER
		057	AC	
		100	AC	
		151	AC	
SIVB	SECTOR DUMP	626	AC	BOOSTER
		107	AC	
		072	AC	
PRIOR TO 22/2248Z				
LM	DCA SELF TEST	35140000	M	EECOM
	ALL ZEROS	31400000	M	GUIDO
	ERROR RESET	31623310	M	
	VERB	31613504	M	
	THREE	31437014	M	
	FOUR	31446620	M	
	ENTER	31740760	M	
	VERB	31613504	M	
	TWO	31427210	M	
	FOUR	31446620	M	
	NOUN	31770174	M	
	ZERO	31603700	M	
	ONE	31417404	M	
	ENTER	31740760	M	
	ONE	31417404	M	
	SEVEN	31476034	M	
	SIX	31466230	M	

<u>VEH</u>	<u>COMMAND FUNCTION</u>	<u>OCTAL</u>	<u>VER</u>	<u>CONSOLE</u>
LM	FOUR	31446620	M	GUIDO
	ENTER	31740760	M	
	TWO	31427210	M	
	FIVE	31456424	M	
	FOUR	31446620	M	
	SIX	31466230	M	
	THREE	31437014	M	
	ENTER	31740760	M	
	ZERO	31603700	M	
	SIX	31466230	M	
	THREE	31437014	M	
	ONE	31417404	M	
	FIVE	31456424	M	
	ENTER	31740760	M	
	PRA SEQ 7	36714000	M	
	PRA FWD SEARCH	36002000	M	
	VERB	31613504	M	
	SIX	31466230	M	
	PRIME RELAY OFF	3335	M	GNC

## AFTER LAUNCH

GMTLO 22/22:48:09

VEH	COMMAND FUNCTION	OCTAL	VER	GET	CONSOLE
LM	FIVE	31456424	M	000:00:06	GUIDO
	ENTER	31740760	M	000:00:07	
CYI SIVB	SLA DEPLOY		—	NO CMD HIST	BOOSTER
TEX, REV 1	PRI S-BND OFF	3430	M	001:33:12	EECOM
	SEC S-BND ON	3420	M	001:33:29	EECOM
	VERB	31613504	M	001:34:17	GUIDO
	SIX	31466230	M	001:34:25	
	SEVEN	31476034	M	001:34:33	
	ENTER	31740760	M	001:34:41	
	2502 X FEED CLD	376	M	001:34:54	
	VERB	31613504	M	001:35:09	
	THREE	31437014	M	001:35:18	
	THREE	31437014	M	001:35:26	
	ENTER	31740760	M	001:35:35	
	VERB	31613504	M	001:36:01	
	SIX	31466230	M	001:36:09	
	SEVEN	31476034	M	001:36:25	
MIL	REV 1 AND 2				
LM	ENTER	31740760	M	001:37:34	GUIDO
	2602 X FEED C/D RESET	377	M	001:37:46	
	VERB	31613504	M	001:37:58	
	THREE	31437014	M	001:38:05	
	THREE	31437014	M	001:38:12	

VEH	COMMAND FUNCTION	OCTAL	VER	GET	CONSOLE
LM	ENTER	31740760	M	001:38:19	
MIL	REV 2 AND 3				
LM	DCA SELF TEST	35140000	N	003:10:12	} VERIFICATION OF COMMAND CAPABILITY
	DCA SELF TEST	35140000	N	003:10:26	
	DCA SELF TEST	35140000	M	003:12:58	
	PRA SEQ 5	36734000	M	003:13:46	GUIDO
	PRA FWD SEARCH	36002000	M	003:13:52	
SIVB	SS LOX VENT CLOSED	624	--	003:15:05	BOOSTER
	CL	624	--	003:15:17	
CRO	REV 3				
LM	PRIME RELAY RESET	3334	N	004:01:18	GNC
	PRIME RELAY RESET	3334	N	004:01:39	
	PRIME RELAY RESET	3334	M	004: : (TIME GARBLED ON HISTORY)	
	VERB	31613504	M	004:03:34	} GUIDO ENABLE DISPLAY OF ERROR CODES
	ONE	31417404	M	004:03:41	
	FIVE	31456424	M	004:03:49	
	NOUN	31770174	M	004:03:57	
	FIVE	31456424	M	004:04:11	
	ZERO	31603700	M	004:04:18	
	ENTER	31740760	M	004:04:26	
HAW	REV 3				
LM	ERROR RESET	31623310	M	004:27:31	} GUIDO CLEAR ERROR CODES
	VERB	31613504	M	004:27:42	
	THREE	31437014	M	004:27:49	
	FOUR	31446620	M	004:27:58	
	ENTER	31740760	M	004:28:06	

VEH	COMMAND FUNCTION	OCTAL	VER	GET	CONSOLE
LM	PRA SEQ 3	36754000	M	004:28:26	GUIDO
	PRA FWD SEARCH	36002000	M	004:28:33	
TEX, REV 3					
LM	VERB	31613504	M	004:41:27	GUIDO
	TWO	31427210	M	004:41:36	ESTABLISH
	ONE	31417404	M	004:41:42	ATTITUDES
	NOUN	31770174	M	004:41:47	FOR PRA
	ZERO	31603700	M	004:41:54	SEQUENCE
	ONE	31417404	M	004:42:01	
	ENTER	31740760	M	004:42:08	
	SEVEN	31476034	M	004:42:17	
	SIX	31466230	M	004:42:21	
	ENTER	31740760	M	004:42:29	
	SIX	31466230	M	004:42:37	
	ZERO	31603700	M	004:42:40	
	ZERO	31603700	M	004:42:43	
	TWO	31427210	M	004:42:47	
	FIVE	31456424	M	004:42:53	
	ENTER	31740760	M	004:43:00	
	VERB	31613504	M	004:43:21	
	TWO	31427210	M	004:43:28	
	FIVE	31456424	M	004:43:31	
	NOUN	31770174	M	004:43:36	
	TWO	31427210	M	004:43:42	
	SIX	31466230	M	004:43:47	
	ENTER	31740760	M	004:43:58	



VEH	COMMAND FUNCTION	OCTAL	VER	GET	CONSOLE
MIL	REV 4				
LM	ZERO	31603700	M	004:44:35	GUIDO
	FOUR	31446620	M	004:44:37	
	ZERO	31603700	M	004:44:39	
	ZERO	31603700	M	004:44:41	
	ONE	31417404	M	004:44:44	
	ENTER	31740760	M	004:44:51	
	ZERO	31603700	M	004:44:59	
	TWO	31427210	M	004:45:01	
	ZERO	31603700	M	004:45:02	
	SIX	31466230	M	004:45:04	
	SEVEN	31476034	M	004:45:06	
	ENTER	31740760	M	004:45:13	
	SEVEN	31476034	M	004:45:23	
	ZERO	31603700	M	004:45:25	
	ZERO	31603700	M	004:45:26	
	SIX	31466230	M	004:45:28	
	THREE	31437014	M	004:45:30	
	ENTER	31740760	M	004:45:37	
	VERB	31613504	M	004:46:14	
	TWO	31427210	M	004:46:18	
	ONE	31417404	M	004:46:19	
	NOUN	31770174	M	004:46:26	
	ZERO	31603700	M	004:46:30	
	ONE	31417404	M	004:46:33	
	ENTER	31740760	M	004:46:41	

VEH	COMMAND FUNCTION	OCTAL	VER	GET	CONSOLE
LM	ONE	31417401	M	004:47:44	GUIDO
	SIX	31466230	M	004:47:45	
	THREE	31437014	M	004:47:47	
	ONE	31417404	M	004:47:48	
	ENTER	31740760	M	004:47:57	
	ONE	31417404	M	004:48:04	
	ONE	31417404	M	004:48:06	
	ZERO	31603700	M	004:48:08	
	THREE	31437014	M	004:48:10	
	ONE	31417404	M	004:48:12	
	ENTER	31740760	M	004:48:46	
	ENTER	31740760	M	004:49:02	
	ONE	31417404	M	004:49:11	
	SIX	31466230	M	004:49:12	
	THREE	31437014	M	004:49:13	
	TWO	31427210	M	004:49:14	
	ENTER	31740760	M	004:49:40	
	FOUR	31446620	M	004:49:50	
	FIVE	31456424	M	004:49:51	
	SEVEN	31476034	M	004:49:53	
	SIX	31466230	M	004:49:54	
	ONE	31417404	M	004:49:57	
	ENTER	31740760	M	004:50:02	
	ENTER	31740760	M	004:50:09	
	ONE	31417404	M	004:50:18	
	SIX	31466230	M	004:50:19	

VEH	COMMAND FUNCTION	OCTAL	VER	GET	CONSOLE
LM	THREE	31437014	M	004:50:21	GUIDO
	THREE	31437014	M	004:50:22	
	ENTER	31740760	M	004:50:31	
	ZERO	31603700	M	004:50:37	
	ONE	31417404	M	004:50:39	
	THREE	31437014	M	004:50:40	
	ZERO	31603700	M	004:50:45	
	SIX	31466230	M	004:50:46	
	ENTER	31740760	M	004:50:52	
	VERB	31613504	M	004:51:14	
	THREE	31437014	M	004:51:20	
	ZERO	31603700	M	004:51:23	
	ENTER	31740760	M	004:51:30	
CRO	REV 4				
LM	VERB	31613504	M	005:33:28	GUIDO
	SEVEN	31476034	M	005:33:37	
	TWO	31427210	M	005:33:39	
	ENTER	31740760	N	005:33:48	
	ENTER	31740760	M	005:34:07	
	TWO	31727210	M	005:34:18	
	ENTER	31740760	M	005:34:26	
	3401 MISSION PHASE 13 TIMER NO 2		M	005:34:38	
	VERB	31613504	M	005:34:48	
	THREE	31437014	M	005:34:51	
	THREE	31437014	M	005:34:54	
	ENTER	31740760	M	005:35:01	

VEH	COMMAND FUNCTION	OCTAL	VER	GET	CONSOLE
HAW	REV 4				
	PRIME RELAY OFF	3335	N	005:59:22	GNC
	PRIME RELAY OFF	3335	N	005:59:31	
	PRIME RELAY OFF	3335	M	005:59:57	
	BATT 5 BACKUP	3436	M	006:00:28	EECOM
	MASTER ARM ON	3364	M	006:00:46	
RKV	REV 4				
LM	AGS SELECT	3440	M	006:05:34	RKV
	PRA 3 START	36000400	M	006:10:00	RKV
TEX	REV 4				
LM	AGS SELECT	3340	M	006:13:39	GNC
	AGS SELECT	3340	M	006:13:40	GUIDO
	PNGS SELECT	3341	M	006:14:03	GNC
	PRIME RELAY RESET	3334	M	006:14:15	
	VERB	31613504	M	006:16:47	GUIDO
	TWO	31427210	M	006:16:54	
	ONE	31417404	M	006:16:55	
	NOUN	31770174	M	006:17:02	ATTITUDE
	ZERO	31603700	M	006:17:04	COUNTER
	ONE	31417404	M	006:17:06	UPDATE TO
	RCS MAIN A CLOSED	3444	M	006:17:09	GNC ENABLE
	ENTER	31740760	M	006:17:12	GUIDO KALKMANU
	THREE	31437014	M	006:17:20	
	SEVEN	31476034	M	006:17:21	
	TWO	31427210	M	006:17:23	
	ENTER	31740760	M	006:17:30	

VEH	COMMAND FUNCTION	OCTAL	VER	GET	CONSOLE
LM	ZERO	31603700	M	006:17:36	GUIDO
	ENTER	31740760	M	006:17:43	
MIL	REV 5				
LM	VERB	31613504	M	006:24:47	GUIDO
	SEVEN	31476034	M	006:24:56	
	SIX	31466230	M	006:24:57	
	ENTER	31740760	M	006:25:03	
	2003 LM NAV UPDATE		M	006:25:38	
	VERB	31613504	M	006:25:46	
	THREE	31437014	M	006:25:51	
	THREE	31437014	M	006:25:52	
	ENTER	31740760	M	006:25:58	
CRO	REV 5				
LM	RCS MAIN A CLOSED RESET	3445	M	007:08:06	CRO
	3701 (EMU 1)		M	007:08:50	GUIDO
	ENTER	31740760	M	007:08:59	
	3701 (EMU 1)		M	007:09:09	MASS UPDATE
	ENTER	31740760	M	007:09:19	
	3701 (EMU 1)		M	007:09:30	
	ENTER	31740750	M	007:09:41	
	RCS MAIN B CLOSED	3454	M	007:10:14	GNC
	RCS B CLOSED RESET	3455	M	007:10:30	
	RCS MAIN A OPEN	3450	M	007:10:53	
	RCS MAIN A OPEN RESET	3451	M	007:10:57	
	PRIME RELAY OFF	3335	M	007:11:07	

VEH	COMMAND FUNCTION	OCTAL	VER	GET	CONSOLE
LM	VERB	31613504	M	007:11:20	GUIDO
	SIX	31466230	M	007:11:22	
	SEVEN	31476034	M	007:11:23	
	ENTER	31740760	M	007:11:30	
	THREE	31437014	M	007:11:40	
	SEVEN	31476034	M	007:11:41	X FEED OPEN
	FOUR	31446620	M	007:11:43	
	ENTER	31740760	M	007:11:50	
	VERB	31613504	M	007:12:00	
	THREE	31437014	M	007:12:01	
	THREE	31437014	N	007:12:02	
	ENTER	31740760	M	007:12:22	
	VERB	31613504	M	007:13:05	
	SIX	31466230	M	007:13:13	
	SEVEN	31766034	M	007:13:14	
	ENTER	31740760	M	007:13:22	
	THREE	31437014	M	007:13:31	
	SEVEN	31476034	M	007:13:32	} X FEED OPEN RESET
	FIVE	31456424	M	007:13:33	
	ENTER	31740760	N	007:13:42	
	VERB	31613504	M	007:13:55	
	THREE	31437014	M	007:13:56	
	THREE	31437014	M	007:13:58	
	ENTER	31740760	M	007:14:05	
	3801 (EMU 2)		M	007:14:22	
	ENTER	31740760	M	007:14:31	} LENGTHEN AV MONITOR FOR IGNITION

YEH	COMMAND FUNCTION	OCTAL	VER	GET	CONSOLE
LM	3801 (EMU 2)		M	007:14:49	GUIDO
	CLEAR	31760370	M	007:15:26	DID NOT GET IN COMPLETELY
	ONE	31417404	N	007:15:42	
	THREE	31437014	N	007:15:44	
	THREE	31437014	N	007:15:45	
	SEVEN	31476034	M	007:15:48	
	CLEAR	31760370	M	007:16:12	
	ONE	31417404	N	007:16:22	
	THREE	31437014	M	007:16:39	
	THREE	31437014	M	007:16:40	
	SEVEN	31476034	M	007:16:41	
	ENTER	31740760	M	007:16:50	
	THREE	31437014	M	007:16:56	
	FIVE	31456424	M	007:16:58	
	ENTER	31740760	M	007:17:16	
	ENTER	31740760	M	007:17:24	
	THREE	31437014	N	007:17:32	
	SEVEN	31476034	N	007:17:34	
	FIVE	31456424	M	007:17:59	
	ENTER	31740760	M	007:18:07	
	CLEAR	31760370	N	007:18:20	
HAW	REV 5				
LM	VERB	31613504	M	007:38:31	GUIDO
	SIX	31466230	M	007:38:39	ASCENT FEED ARM, A & B FEED
	SEVEN	31476034	M	007:38:40	
	ENTER	31740760	N	007:38:47	



VEH	COMMAND FUNCTION	OCTAL	VER	GET	CONSOLE
LM	ENTER	31740760	M	007:39:09	GUIDO
	ONE	31417404	M	007:39:19	
	SEVEN	31476034	M	007:39:21	
	SIX	31466230	M	007:39:23	
	ENTER	31740760	M	007:39:31	
	VERB	31613504	M	007:39:39	
	THREE	31437014	M	007:39:46	
	THREE	31437014	M	007:39:48	
	ENTER	31740760	M	007:39:55	
	VERB	31613504	M	007:40:05	
	SIX	31466230	M	007:40:08	
	SEVEN	31476034	M	007:40:09	
	ENTER	31740760	M	007:40:16	
	SEVEN	31476034	M	007:40:25	
	FOUR	31446620	M	007:40:28	
	ENTER	31740760	M	007:40:35	
	VERB	31613504	M	007:40:45	
	THREE	31437014	M	007:40:46	
	THREE	31437014	M	007:40:47	
	ENTER	31740760	M	007:40:55	
	VERB	31613504	M	007:41:05	
	SIX	31466230	M	007:41:08	
	SEVEN	31476034	M	007:41:10	
	ENTER	31740760	M	007:41:25	
	SEVEN	31476034	M	007:41:35	
	SIX	31466230	M	007:41:37	

VEH	COMMAND FUNCTION	OCTAL	VER	GET	CONSOLE
LM	ENTER	31740760	M	007:41:44	GUIDO
	VERB	31613504	M	007:41:58	
	THREE	31437014	M	007:42:01	
	THREE	31437014	M	007:42:02	
	ENTER	31740760	M	007:42:14	
	PRA SEQ 5	36734000	M	007:42:30	
	PRA FWD SEARCH	36002000	M	007:42:38	
	RCS MAIN B OPEN	3460	M	007:42:57	GNC
	AGS SELECT	3340	M	007:43:07	
	PRA START	36000400	N	007:43:19	GUIDO
	PRA START	36000400	M	007:43:54	
	ENG START <del>XXXXXXXX</del>	3314	M	007:44:15	GNC
	ENG START	3314	M	007:44:18	
	ENG START	3314	M	007:44:21	
TEX	REV 5				
	PRIME RELAY RESET	3334	N	007:55:26	GNC
	PNGS SELECT	3341	N	007:58:09	GNC

# MCCH EXECUTES

REV	STA	CMD.	SR VER	S/C RJ	SVD RJ	GMT	F/C	REMARKS
PRE	HIL	SINGLE WORD DUMP #1	X			15 34 41.34.7	BSI	
		SECTOR DUMP	X			15 34 41.36.3	BSI	
		DCA SELF TEST	X			15 35 12.5	FLCON	
		ALL ZEROS	X			33.4	END	
		ERROR RESET	X			36.9		
		V	X			45.0		
		3	X			53.5		
		4	X			59.9		
		E	X			15 36 06.3		
		FMU #1	X			18.6		
		E	X			28.5		
		ADDRESS/ DATA	X			36.4		
		E	X			43.1		
		V	X			56.2		
		0	X			15 37 03.6		
		1	X			10.3		
		N	X			16.7		
		0	X			24.7		
		1	X			32.1		
		E	X			38.5		
PRE	HIL	0	X			47.9	END	

# MCCH EXECUTES

REV	STA	CMD	SB VER	S/C RJ	GVD RJ	GMT	F/C	REMARKS
PRE	DIL	SINGLE WORD DUMP #1	X			22 01 41 24.7	BSI	
		SECTOR DUMP	X			02 41 36.13	BSI	
		DCA SELF TEST	X			15 35 12.5	FROM	
		ALL ZEROS	X			53.4	EWD	
		ERROR RESET	X			36.9		
		V	X			45.0		
		3	X			53.5		
		4	X			59.9		
		E	X			15 36 06.3		
		EDU #1	X			18.0		
		E	X			28.5		
		ADDRESS/DATA	X			36.4		
		E	X			42.1		
		V	X			56.2		
		C	X			15 37 03.6		
		I	X			10.3		
		N	X			16.7		
		C	X			24.7		
		I	X			32.1		
		E	X			38.5		
PRE	MIL	C	X			47.9	EWD	

# MCCH EXECUTES

REV	STA	CMD.	SK VER	S/C RJ	GVD RJ	GMT	F/C	REMARKS
PRE	MIL	V	X			15 40 40.3	GUID	
		3	X			15 40 46.3		
		4	X			52.12		
		Q E	X			55.6		
		V	X			16 23 56.6		
		3	X			16 34 03.24		
		4	X			16.5		
		1	X			E = 30.5	GUID	
		SINGLE WORD DP <sup>H</sup> )	X			22:05:38.8	BSE	
		SECTOR DUMP	X			06:08.6	BSE	
		DCA SELF TEST	X			20:41.8	EECOM	
		ALL ZEROS	X			20:54.8	GUID	
		ERROR RESET	X			21:02.5		
		V	X			21:10.6		
		3	X			21:17.4		
		4	X			21:25.1		
		E	X			21:31.1		
		V	X			21:52.0		
		2	X			21:59.7		
		4	X			22:22:07.0		
PRE	MIL	N	X			22:13.8	GUID	

# MCCH EXECUTES

REV	STA	CMD.	SP VER	S/C RJ	GVD RJ	GMT	F/C	REMARKS
PRE	MIL	0	X			22:22:21.9	Guid	
		1	X			29.2		
		E	X			35.6		
		1	X			41.9		
		7	X			49.6		
		6	X			56.9		
		4	X			22:23:02.8		
		E	X			09.2		
		2	X			16.1		
		5	X			23.3		
		4	X			31.4		
		6	X			39.6		
		3	X			47.6		
		E	X			55.8		
		0	X			22:24:04.7		
		6	X			11.1		
		3	X			17.9		
		1	X			25.2		
		5	X			31.6		
		E	X			39.7		
PRE	MIL	PRA SEQ #7	X			49.5	Guid	

# MCCH EXECUTES

REV	STA	CMD.	SA VER	S/C RJ	GVD RJ	GMT	F/C	REMARKS
PRE	MIL	FWD SEARCH	X			22:24:57.2	GUID	
		V	X			22:43:05.9		
		6	X			14.8	GUID	
PRE	MIL	PRIME RLYN OFF	X			33.0	GNC	
		LIFT OFF				22:48:09.0		
1	MIL	5	X			15.1	GUID	
1	MIL	E	X			16.4	GUID	
1	CYI	SLA DEPLOY	X			23:09:21.7	BSE	
1	TEX	PRI. S-BND OFF	X		23:00:21:22.0	EECOM		
		SEC. S-BND ON	X			38.3	EECOM	
		V	X			00:22:26.7	GUID	
		6	X			34.8		
		7	X			42.9		
		E	X			51.0		
		LMP#1 2502	X			00:23:02.6		
		V	X			18.3		
		3	X			27.7		
		3	X			35.8		
		E	X			44.7		
		V	X			00:24:10.8		
1	TEX	6	X			18.9	GUID	



110011 LAKEVIEW

REV	STA	CMD.	SR VER	S/C RJ	GVD RJ	GMT	F/C	REMARKS
1	TEX	7	X			00:24:34.7	GUID	
2	MIL	E	X			25:43.4	GUID	
2	MIL	LMP#2-2602	X			25:53.6		
		V	X			26:06.8		
		3	X			14.0		
		3	X			21.0		
2	MIL	E	X			27.9	GUID	
3	MIL	DCA SELF TEST		X		01:58:20.7	EECOM	LM UHF SIGNAL STRENGTH FLUCTUATING.
3	MIL	DCA SELF TEST		X		01:58:34.8	EECOM	LM UHF SIGNAL STRENGTH FLUCTUATING
3	MIL	DCA SELF TEST	X			02:01:07.5	EECOM	
		PRA. SEG #5	X			54.6	GUID	
	MIL	FWD SEARCH	X			02:02:01.5	GUID	
3	ANT	SS LOX VNT. CLSD		X		02:03:14.3	BSE	MIL HAD TLM L.O.S.
	ANT	<del>SS LOX VNT. CLSD</del>		X		<del>26.3</del>	<del>BSE</del>	NOTE: NO I.U. DATA 40.8 FROM ANT.
3	ANT	SS LOX VNT. CLSD		X		02:03:26.3	BSE	SAME AS ABOVE

# MCCH EXECUTES

REV	STA	CMD.	SE VER	S/C RJ	GND RJ	GMT	F/C	REMARKS
3	CRO	PRIM RLY RST.		X		02:49:26.0	GNC	LM UHF SIGNAL STRENGTH FLUCTUATING.
3	CRO	PRIM RLY RST.		X		47.7	GNC	SAME AS ABOVE.
		PRIM RLY RST.	X			02:50:24.8	GNC	
		V	X			51:42.5	GUID	
		1	X			49.7		
		5	X			57.8		
		N	X			52:05.6		
		5	X			20.0		
		0	X			30.5		
3	CRO	E	X			35.4		
3	HAW	ERR RESET	X			03:15:40.6		
		V	X			51.3		
		3	X			58.9		
		4	X			03:16:07.5		
		E	X			15.6		
		PRA. SEQ #3	X			35.6		
3	HAW	FWD. SEARCH	X			42.4		
	TEX	V	X			03:29:36.9		
	TEX	2	X			45.3	GUID	

# MCCH EXECUTES

REV	STA	CMD.	SK VER	S/C RJ	SVD RJ	GMT	F/C	REMARKS
3	TEX	I	X			03:29:51.7	GUID	
		N	X			56.4		
		O	X			03:30:04.0		
		I	X			11.0		
		E	X			18.2		
		7	X			26.7		
		6	X			31.0		
		E	X			38.7		
		6	X			46.8		
		O	X			49.4		
		O	X			52.8		
		2	X			56.6		
		5	X			03:31:03.0		
		E	X			09.9		
		V	X			30.3		
		2	X			37.5		
		5	X			41.0		
		N	X			45.2		
		2	X			52.0		
		6	X			56.3		
3	TEX	E	X			03:32:07.9	GUID	

110011 LAECUVED

REV	STA	CMD.	SK VER	S/C RJ	GVD RJ	GMT	F/C	REMARKS
4	MIL	0	X			03:32:44.6	GUID	
		4	X			46.4		
		0	X			48.0		
		0	X			49.8		
		1	X			52.8		
		E	X			03:33:00.0		
		0	X			08.0		
		2	X			09.9		
		0	X			11.6		
		6	X			13.4		
		7	X			15.0		
		E	X			22.3		
		7	X			31.6		
		0	X			34.2		
		0	X			35.5		
		6	X			37.2		
		3	X			38.9		
		E	X			46.2		
		V	X			03:34:22.8		
		2	X			26.7		
4	MIL	1	X			28.4	GUID	

REV	STA	CMD.	SK VER	S/C RJ	GVD RJ	GMT	F/C	REMARKS
4	MIL	N	X			03:34:35.6	GUID	
		0	X			39.5		
		1	X			42.5		
		E	X			49.7		
		1	X			52.7		
		6	X			54.5		
		3	X			56.2		
		1	X			57.5		
		E	X			03:36:06.5		
		1	X			12.9		
		1	X			15.0		
		0	X			17.6		
		3	X			19.4		
		1	X			21.0		
		E	X			54.9		
		E	X			03:37:11.0		
		1	X			20.0		
		6	X			20.9		
		3	X			22.2		
		2	X			23.0		
4	MIL	E	X			49.0	GUID	

# MCCH EXECUTES

REV	STA	CMD	SA VER	S/C RJ	GND RJ	GMT	F/C	REMARKS
4	MIL	4	X			03:37:58.9	GUID	
		5	X			03:38:00.2		
		7	Y			01.9		
		6	X			03.3		
		1	X			05.9		
		E	X			11.4		
		E	X			18.3		
		1	X			27.7		
		6	Y			28.6		
		3	X			29.8		
		3	X			31.0		
		E	X			39.7		
		0	X			46.5		
		1	X			47.8		
		3	X			49.0		
		0	X			54.2		
		6	X			55.5		
		E	X			03:39:01.0		
		V	X			23.6		
		3	X			28.7		
		0	X			32.6		
4	MIL	E	X			39.0	GUID	



# MCCH EXECUTES

REV	STA	CMD.	SA VER	S/C RJ	SND RJ	GMT	F/C	REMARKS
4	CRO	V	X			04:21:37.0	GUID	
		7	X			46.0		
		2	X			48.2		
		E		X		56.7		LM UHF SIGNAL STRENGTH FLUCTUATING.
		E	X			04:22:15.9		
		2	X			27.0		
		E	X			34.7		
		MPT #2 - 3401	X			44.0		
		V	X			57.3		
		3	X			59.8		
		3	X			04:23:02.4		
	CRO	E	X			09.7	GUID	
	HAW	PRIME RLY OFF		X		04:47:32.0	GNC	LM UHF SIGNAL STRENGTH FLUCTUATING
		PRIME RLY OFF		X		04:47:41.0	GNC	SAME AS ABOVE
		PRIME RLY OFF	X			04:48:06.6	GNC	
		BATT #5 B/U	X			37.3	EEDOM	
	HAW	MASTER ARM ON	X			55.6	EEDOM	
4	TEX	AGS SEL	X			06:01:48.7	GNC	



MCCH EXECUTES

REV	STA	CMD	SA VER	S/C RJ	GND RJ	GMT	F/C	REMARKS
4	TEX	AGS SEL	X			05:01:49.5	GUID	
		PGNS SEL	X			05:02:12.7	GNC	
		PRIME RLY RESET				17.0	GNC	PBT HANG UP MCCA
		PRIME RLY RESET	X			25.2	GNC	
		V	X			05:04:59.7	GUID	
		2	X			05:05:07.7		
		1	X			05.0		
		N	X			11.8		
		0	X			13.9		
		1	X			15.2	GUID	
		RCS MAIN A CLSD	X			18.8	GNC	
		E	X			21.7	GUID	
		3	X			29.8		
		7	X			31.0		
		2	X			32.4		
		E	X			39.7		
		0	X			45.6		
4	TEX	E	X			52.9		
5	MIL	V	X			05:12:56.4		
1	1	7	X			05:13:05.0		
5	MIL	6	X			06.3	GUID	

# MCCH EXECUTES

REV	STA	CMD	SD VER	S/C RJ	GND RJ	GMT	F/C	REMARKS
5	MIL	E	X			05:13:12.3	GUID	
		LM NAV - 2003	X			18.2		
		V	X			55.7		
		3	X			05:14:00.4		
		3	X			01.7		
	MIL	E	X			07.7		
	CRO	EMU#1 - 3701	X			05:56:58.0		
		E	X			05:57:07.8		
		A/D	X			15.8		
		E	X			27.5		
		A/D	X			36.3		
		E	X			50.2	GUID	
		RCS MAIN B CLSD	X			05:58:23.2	GNC	
		RCS MAIN B CLSD RST	X			39.4		
		RCS MAIN A OPEN	X			05:59:02.4		
		RCS MAIN A OPEN RST	X			06.2		
		PRIME RLY OFF	X			16.0	GNC	
		V	X			29.0	GUID	
		6	X			30.4		
		7	X			31.7		
5	CRO	E	X			39.0	GUID	

MCCH EXECUTES

[illegible]

# MCCH EXECUTES

REV	STA	CMD.	SK VER	S/C RJ	SVD RJ	GMT	F/C	REMARKS
5	CRO	3	X			06:02:06.8	GULD	
		E	X			14.3		
		EMU #2 - 3801	X			29.4		
		E	X			39.8		
		A/D	X			55.8		
		CLEAR	X			06:03:34.8		
		1	X	X		50.5		
		3		X		52.7		
		3		X		54.0		
		7	X			56.5		
		CLEAR	X			06:04:20.8		
		1		X		30.6		
		3	X			48.0		
		3	X			48.5		
		7	X			49.4		
		E	X			58.8		
		3	X			06:05:04.7		
		5	X			06.5		
		E	X			24.8		
		E	X			32.4		
5	CRO	3		X		41.0	GULD	

# MCCH EXECUTES

EV	STA	CMD.	SK VER	S/C RJ	GVD RJ	GMT	F/C	REMARKS
5	CRO	7		X		06:05:42.7	Gold.	
		5				43.6		
		5	X			06:06:07.8		
		E	X			15.5		
	CRO	CLEAR		X		28.7		
	HAW	V	X			06:26:40.8		
		6	X			48.9		
		7	X			49.8		
		E		X		57.0		
		E	X			06:27:18.3		
		1	X			29.0		
		7	X			30.7		
		6	X			32.4		
		E	X			40.9		
		V	X			49.0		
		3	X			55.9		
		3	X			57.2		
		E	X			06:28:04.8		
		V	X			14.7		
		6	X			17.6		
5	HAW	7	X			18.9	Gold	

# MCCH EXECUTES

EV	STA	CMD.	SK VER	S/C RJ	GVD RJ	GMT	F/C	REMARKS
5	HAW	E	X			06:28:25.8	GUID	
		7	X			35.0		
		4	X			38.0		
		E	X			45.0		
		V	X			54.3		
		3	X			55.6		
		3	X			56.5		
		E	X			06:29:05.0		
		V	X			15.3		
		6	X			17.4		
		7	X			19.5		
		E	X			34.5		
		7	X			45.0		
		6	X			46.8		
		E	X			54.0		
		V	X			06:30:07.7		
		3	X			10.3		
		3	X			12.0		
		E	X			23.5		
		PRA. SEQ #5	X			39.3		
5	HAW	FWD SEARCH	X			47.9	GUID	



**MCHH EXECUTES**

REV	STA	CMD	SA VER	S/C RJ	GND RJ	GMT	F/C	REMARKS
5	HAW	RCS MAIN B OPEN	X			06:31:07.0	GNC	
		AGS SEL	X			16.9	GUID	
		PRA. START		X		22.8	GUID	
		PRA. START	X			06:32:04.2	GUID	
		ENG. START	X			24.8	GNC	
		ENG. START	X			27.8		
5	HAW	ENG. START	X			30.4	GNC	
5	TEX	PRIME RLY RST			X	06:43:35.4	GNC	TEX U.H.F. CMD CARR NOT UP.
5	TEX	PGNS SEL		X		06:46:18.6	GNC	TEX NOT IN ACQ.
7	HAW	SEC S-BND OFF		X		09:50:53.0	EECOM	TRANSMIT IN THE BLIND
		PRIM S-BND ENABLE		X		59.5		SAME AS ABOVE
		PRIM S-BND OFF		X		09:51:30.7		SAME AS ABOVE
7	HAW	SEC S-BND ON		X		42.4	EECOM	SAME AS ABOVE



RETROFIRE OFFICER

MISSION REPORT

LM-1

January 22, 1968

18 January 1968

12:23:22Z

PRELAUNCH PHASE

LGC clock aligned to Range Time (GMT)

12:24:34Z

LGC clock misaligned..101 sec behind Range Time to compensate for known drift rate so as to have no observable error at predicted liftoff.

22 January 1968

14:05:00Z

TERMINAL COUNT

Participated in first FDO trajectory run. IP's were obtained for an IP check with the RTACF for comparison between RTACF and RTCC.

16:05:00Z

Monitored final EMU load verification to ascertain that values for which RFO was responsible had been loaded correctly.

17:41:30Z

Participated in Vector Transfer test for vector transfer capability between RTCC and RTACF.

20:58:00Z

Participated in second FDO Trajectory run. Fault developed in MILA IP computer. FDO requested a rerun.

21:30:00Z

Participated in third FDO Trajectory run. No repeat of MILA IP computer problem.

21:53:00Z

Communication check with SRO

21:58:00Z

Input to RTCC and RTACF the following weights:

APS USABLE PROP	5024 lbs.
DPS USABLE PROP	17446
RCS USABLE PROP	549
TOTAL LM WEIGHT	31528
SIVB INSERTION WEIGHT	37813
TOTAL COMBINED INSERTION WEIGHT	69341

22:08:00Z

Performed status check with Retro Support and RTACF. Informed FDO they are GO.

22:25:00Z

Confirmed a Compare Pulse to GDO for cueing of PRA SEQ VII.

22:36:00Z

Provided the following information to

(1) RTCC - Predicted GMTLO	22:48:08.1
Predicted GMTZS	22:48:08.1
(2) RTACF - Predicted GMTGRR	22:48:08.0
Predicted GMTLO	22:48:08.1

22:37:00Z Requested RTACF compute cold soak attitude for MP=8.

22:38:00Z Was "GO" on final status check by the Flight Director.

22:42:00Z Received cold soak attitudes from RTACF.

T=0

MISSION TIMELINE (All times hereafter in GET)  
LIFTOFF

Obtained from SRO first motion time of 22:48:08.355.  
S/C GMTGRR = 22:48:08.86 which was input into RTCC as 22:48:08.9 due to roundoff to the nearest tenth second. Liftoff time was set in the LGC one tenth second later; therefore spacecraft liftoff time was arrived at in the following manner:

S/C GMTGRR	22:48:08.86
Input to RTCC as	22:48:08.9 (Roundoff)
L/O set .1 sec later	.1
S/C GMTLO (as used in RTCC)	<u>22:48:09.0</u>

At liftoff the LGC clock on ALDS format 1 was -00.07 sec, indicating the clock was .07 sec. fast with reference to the ground; that is, the clock would require a .07 sec. decrement to be precisely synchronized with the ground to the nearest centisecond.

01:14 Reported "max q time" to Flight Director.

02:00 Status "GO" to Flight Director.

02:30 Informed GDO of inadvertent Clock and Compare Pulses.

04:00 Status "GO" to Flight Director.

04:55 Cross range report to Flight Director.

08:20 Status "GO" to Flight Director.

09:58 Copied S-IVB cutoff from BSE.

10:13 Copied insertion parameters from GO/NO GO solution based on IU insertion vector  
 $V = 25685 \text{ fps}$   
 $\gamma = -0.00^\circ$   
 $h = 88.1 \text{ NM}$

10:40 Confirmed insertion on basis of data displayed on RFO Launch Digitals. Gave FDO a "GO" for Orbit Phase.

10:45 Obtained S-IVB cutoff of 9:58 from GDO.

12:00 Copied insertion orbit of 87.4X118.2.

13:00 Provided FDO with separation time based on S-IVB cutoff time of 9:58

16:35 Confirmed cold soak attitude with RTACF.

18:30 Obtained update of S-IVB cutoff of 9:53 from GDO.

20:00 Recomputed separation time based on update to S-IVB cutoff time. Provided this data to FDO.

23:11 Monitored enabling and loading of timer number 1 to call Mission Phase 7 at 49:54. This forces separation to occur at 53:54, or 6 sec. before nominal.

25:00 Generated GMTLO load. Informed Network. Transferred the load to all sites.

30:00 Generated and passed to AFD the PAD for Mission Phases 7 and 8.

42:00 Performed time hack for phase enable and separation times with CSQ and CRO.

48:00 Monitored CSQ and CRO pass for separation.

50:00 Monitored CSQ state LGC time lagged GET by 1 sec. Began investigation.

54:00 Confirmed CRO had the correct cold soak attitudes.

58:00 Monitored timer number 2 enabled and loaded to call MP=9 at 3:55:04.

1:01:00 Computed and provided FDO with the following values for maneuver initialization:  
MP=9 T<sub>DI</sub> = 4:00:19  
MP=11 GETEN = 4:32:49

1:08:00 Received separation time of 53:59 from EECOM. This is with a delay time of 4 to 5 sec. Confirm separation time of 53:54/55.

1:10:00 Requested Computer TM to change the K-factor in LGC  $\Delta T$  computations to +.023, a value previously established as compatible with the MSFN.

1:15:00 Updated vehicle weights in RTCC.

1:20:00 Performed vector check with RTACF to ascertain they had states TM and TRK vector for double integration computation on DPS 1.

1:26:00 Monitored RKV pass and noted statement that all clocks were in sync.

1:53:00 Monitored LGC  $\Delta T$  values on states pass. On the basis of this data informed Flight Director that the clock was in error by about .05 sec. and that CSQ statement of clock 1 sec. lag from GET must be a site problem. During the flight the clock was monitored for drift. A slight change in LGC  $\Delta T$  was observed toward a more negative value which was compatible with a fast clock.

1:56:15 Coordinated with FDO in committing to DPS 1. The following parameters were the result of computations:

GETBI	3:59:41
GETCQ	4:00:18
PITCH	32.0
ROLL	355.0
$\Delta T_B$	00:37

2:18:00 Confirmed CSQ CAPCOM query that MP=9 was to be enabled at 3:55:04.

2:19:00 Generated MP=9 PAD. Held until FDO re-confirmed maneuver based on CRO vector.

2:46:00 Provided AFD with MP=9 PAD.

3:00:00 Provided FDO with ignition time for MP=13 APS 2 based on the computed DPS 1 and DPS 2 maneuvers and the nominal timer loads.

3:07:00 Computed PRA SEQ V call time as 22 sec. plus delay time of 10 sec.

3:08:00 Provided Flight Director with estimate d time of 32 sec. to call PRA SEQ V.

3:14:00 Monitored Compare Pulse for PRA SEQ V and so informed GDO.

3:22:00 Monitored inadvertent Compare and Clock Pulses from PRA and so informed GDO.

3:28:00 Performed time hack for MP=9 enable and ignition time with CSQ and CRO.

3:40:00 No comment for Flight Director on MP=9 briefing to remote sites.

3:55:04 Counted down to MP=9 predicted enable time

3:57:00 Monitored CRO pass for DPS 1. Predicted LGC GETI was 3:59:40.

3:59:40 Counted down to MP=9 predicted ignition time.  
Copied engine on at 3:59:40  
Copied engine off at 3:59:54

4:03:00 Monitored timer number 1 did not load.

4:15:00 Performed weight update for RTCC and RTACF.

4:20:00 Concurred with FDO in performing Alternate Mission "L".

4:24:00 Generated data for POSMAX load to timer number 1 for MP=11 in Alternate Mission "L". Will also require a GET update to call MP=11 at correct time with respect to the predicted ignition as computed by FDO. At this time scrubbed the load due to Flight Director's decision to go Alternate Mission "C" at 6:15:00.

4:25:00 Requested RTACF to run a PRA SEQ III at 6:15:00 to determine impact points from a worst case attitude burn.

4:28:00 Confirmed Compare Pulse for calling of PRA SEQ III. Informed GDO.

4:38:00 Concur with FDO in a DPS 1 maneuver with a TDI = 5:33:00. This requires a POSMAX load to timer number 2 and a GET load of 5:27:45.

4:42:00 Generated Timer Load PADS for POSMAX and GET updates. These were scrubbed at this time on Flight Director's decision to go Alternate Mission "C".

4:47:50 Received PRA SEQ III burn information. Results showed on ignition time of 6:15:46 has on IP of 70:38 W.

4:54:30 FDO has Alternate Mission "L" maneuver which RFO and GDO concur with. Required POSMAX and GET updates for timer number 1 to call MP=11 at 6:10:14 for on ignition time of 6:14:14.

5:00:00 Generated PADS for POSMAX and GET updates to timer number 1 for MP=11 for Alternate Mission "L".

5:08:00 Flight Director confirms will go Alternate Mission "C" with cutoff between APS 1 and APS 2 and run APS 2 by MP=13 in LGC. Scrubbed the POSMAX and GET PADS.

5:20:00 Generated PAD for POSMAX load to timer number 2.

5:40:00 Recommended to GDO that after AGS SEL is sent to stop the PRA between APS 1 and APS 2, that we return to PGNS control to guard against any inadvertent action by the PRA since we are stopping in mid-PRA III.

5:45:00 Generated PRA Burn Message PAD for PRA SEQ III to start the sequence at 6:10:00.

5:55:00 Performed a time hack with RKV for PRA SEQ III start time of 6:10:00 .

6:10:00 Monitored Clock and Compare Pulses from PRA SEQ III when initiated on MSK 1302. Monitored AGS SEL at 6:12:30.

6:20:00 Updated weights in RTCC and RTACF.

6:53:00 Generated Mission Timer Update PAD for a GET load of 7:36:09 to timer number 2 for MP=13.

7:01:00 Coordinated with FDO on commitment to APS 2 under LGC control, with an ignition time of 7:38:59.

7:12:00 Generated LGC Burn Message PAD for MP=13 APS 2. The maneuver is contingent upon loading at CRO.

7:23:00 Scrubbed the Timer Update and LGC Burn Message PADS because we were unable to get all loads to LGC to pre-condition it for MP=13. Will go with PRA SEQ V to be initiated by MCC. 4

7:42:38 Monitored Compare Pulse when PRA SEQ V was called. So informed GDO.

7:43:19 Monitored spacecraft reject when PRA START command transmitted.



7:43:55 Monitored Clock and Compare Pulses when PRA received the re-transmit of the PRA START command. So informed GDO. Monitored the burn on MSK 1306. Monitored engine at 7:44:19. Predicted cutoff was 7:50:42 based on LM Propulsion estimate of 383 sec. burn time left in the APS.

7:48:00 Copied RKV report that pitch, yaw and roll were off-scale high.

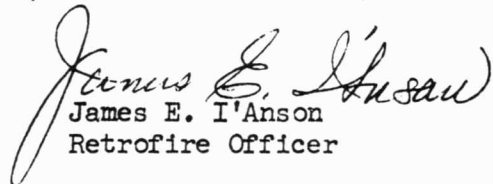
8:00:00 Requested RTACF to run PRA SEQ V at worst case attitudes with ignition at 7:44:19.

8:15:00 Received following data from RTACF with respect to effect of PRA SEQ V on the orbit.

GET of 25K attitude	7:50:24
$\phi$ IP	26:37 N
$\lambda$ IP	135:05 W

8:17:00 Briefed Team 2 Retrofire Officer on present status.

POST APS-2 (EXTENDED MISSION)  
 Provided post APS-2 weight of 4758 lbs to RTCC and ACR for use with a post APS-2 vector. Also, passed a  $\Delta T = -.05$  sec. to GDO as the value for a SC clock time increment update. No post APS-2 vector became available. The last signals from the LM were received by GYM during APS-2 (approximately 7 hrs. 50 min.). The LM probably reentered during or just after APS-2 burn. The ACR was released after HAW in the next Rev. Secured the console at 9:58:55 GMT (~ 2 Revs after APS-2).

  
 James E. I'Anson  
 Retrofire Officer

## CONCLUSIONS

1. I believe the Flight Director received superb support from the Flight Control team. I feel sure that the tremendous disappointment associated with the failure of DPS 1 was shared by all, but I also feel that each Flight Controller then redoubled his efforts to explore all avenues of resources to be presented to the Flight Director so that the mission could satisfy as many objectives as possible.

2. It is also my opinion that the Flight Director utilized all information presented to him in a most cogent manner. I thought his attempts to play off Alternate Mission "L" against "C" and APS 2 under LGC control as opposed to APS 2 under PRA V control were splendid tactics as indicative of his dedication to securing all possible objectives. His decisions to perform the maneuvers as he so selected due to system constraints, and tracking, command and uplink constraints were the only possible decisions he could have made in my opinion.

## MISSION EVALUATION

1. The LGC clock performed satisfactorily during the mission. During the mission it drifted less than 1 centisecond.
2. The mission phase timers performed satisfactorily and loaded their nominal values including that to call MP=9. When updated with POSMAX the timer number 2 performed as expected. The inference is that if other timers had been updated they, too, would have performed as expected.
3. The PRA performed in an exemplary manner. Having been so intimately concerned with the design of the sequences stored in it, and especially so with respect to SEQ III (MRS), with the operation of the PRA, its eccentricities and the verification of the tape stored in it, it was an immense gratification to see it perform as expected and I hope its usage allowed us to achieve many mission objectives that might not have been obtained otherwise.
4. For my own part I think the mission was a success from the standpoint of DPS and APS burns and restarts, and also from the fact that we obtained FITH.

## RECOMMENDATIONS

1. If we are to continue to have clock alignments done more than one day before launch I recommend the Telemetry Display Processor have a MED capability for a day of initialization input so as to release MCC from depending on KSC for computer clock drift computations.
2. I recommend the granularity of the MED input into the RTCC for GMTGRR, GMTZS, and GMTLO be expanded from the present one tenth second to one one-hundredth second.
3. I recommend a MED input of spacecraft inert weights into the RTCC. They are presently computer program constants; they should be updatable.

POST MISSION REPORT - AS-204/LM-1

BOOSTER SYSTEMS ENGINEER NO. 1

The Booster Systems Engineer submits the following as the AS-204/LM-1 Post Mission Report on the Saturn Launch Vehicle systems performance and the flight controllers activity during the course of the mission.

The Launch Phase was essentially nominal. The S-IB outboard engine cutoff occurred at approximately 2:22 GET. The S-IVB engine ignition and propellant utilization activation were nominal. Ignition occurred at approximately 2:25 GET and P.U. activate at 2:31 GET.

The thrust chamber pressure for the S-IVB engine indicated a high nominal value from P.U. activate until P.U. shift (engine mixture ratio cutback). P.U. shift occurred at approximately 7:48 GET, 15 seconds later than the predicted nominal time but within the possible excursion.

An attitude error in Yaw up to four degrees was indicated throughout S-IVB burn. This could have been the result of a thrust vector misalignment, since the vehicle end conditions were nominal.

S-IVB engine cutoff occurred at approximately 9:53 GET, with a normal velocity cutoff.

Venting was nominal after cutoff with a slightly greater rate of LOX ullage decay than was expected.

The Nose Cap was jettisoned nominally at 10:38 GET (TB4 + 0:45). Attitude control after cutoff was nominal, rates and errors being held to dead band limits. A nominal pitchover to a posigrade earth rate attitude was initiated and proper attitude and rates were achieved.

The environmental control system GN<sub>2</sub> sphere indicated an off nominal pressure decay which was attributed to a system leak. First lifetime estimate was greater than 3 hours GET. As the mission progressed the pressure decay rate was observed to decrease and ultimately the pressure followed closely the minimum predicted value for the system.

During the CYI pass there was a data dropout of an estimated one minute forty second duration. Data was apparently good at the time for SLA deploy.

The TM indication for SLA deploy physical monitor K149-900 was not received. BSE #1 transmitted SLA DEPLOY command (FMR 6 - 6) at an

estimated time of 21:05 (no command history is available from CYI because of a fault in the command computer.) The command computer recognized valid CRP's but the TM indication (K149-900) was still not received.

A readout of the TM parameters for SLA Deploy Relays A and B, K147-900 K148-900, was requested from the site M&O. SLA Deploy Relay A K147-900 indicated the relay latched but LOS occurred before the second readout was obtained. Subsequent tape playback and readout by the M&O verified K147-900 and K148-900 SLA Deploy Relays A and B indicated closed, and the SLA Deploy physical monitor K149-900 indication was not present. CSQ subsequently verified the above indications and the decision was made to separate the LM.

The LM separation at CRO was nominal from the Booster's viewpoint and the LH<sub>2</sub> Vent occurred as programmed.

The CONUS pass, rev 1/2, was nominal. Passivation was enabled at approximately 1:36:54 GET and all vehicle systems were go for passivation.

At CRO, rev 2, the LH<sub>2</sub> ullage pressure D21-408 indicated - .1 psia, considerably lower than expected. This could have been the result of a greater than expected boiloff and venting rate during the previous venting sequences.

The S-IVB stage experienced a nominal LOX and LH<sub>2</sub> dump and the vents opened properly after the dump. At LOS CRO the LH<sub>2</sub> ullage pressure D21-408 indicated - .4 psia. The Cold Helium dump at HAW was nominal.

The CONUS pass, rev 2/3, was nominal with the following exception:

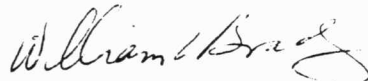
The LOX vent closed TM discrete K2-424 was not received at the time for the closing of the LOX vent valve, and LOX ullage pressure D179-424 and D180-424 indicated 2.4 psia (expected value was zero) during the pass.

BSE #1 transmitted the LOX VENT CLOSE command twice (FMR 5 - 35), SLV REJECTS were received for both transmissions. Subsequent information indicated LOS of TM immediately prior to the transmission of the commands. (HOSC reported that the LOX vent open discrete did drop out at the nominal time and it was probable that LOX had gotten into the valve and prevented a full closing.)

CSQ reported normal operation of the valve and on the next CONUS pass, rev 3/4, proper indication was observed on the closed discrete.

The ambient helium dump was nominal at the CONUS pass, rev 3/4.

At termination of BSE support the vehicle was go in all systems. Lifetime predictions were excellent.



William L. Brady  
Booster Systems Engineer #1



UNITED STATES GOVERNMENT

# Memorandum

*GENE - This is a  
copy of the  
original document*

: LM-1 Flight Director

DATE:

DM : LM-1 EECOM

SUBJECT: AS-204L EECOM Post Mission Report

1. This report presents a brief summary of events observed during the preparation for and the conduct of the AS-204L (LM-1) Mission as observed by the EECOM team. Data sources are only those that were available during real time.

## 2. PREMISSION ACTIVITY

A. Data Flow/Network Validation: Support was provided for three data flow tests, one network validation, and three network simulations. With the exception that during the first network simulation, it was noted that the various computers were not programmed to look for the data in the same frame/word bit stream locations for those parameters that were redundantly located, all discrepancies were fairly minor in nature and were corrected prior to flight. The source of the majority of discrepancies appears to have been the result of a lack of action taken on verbal inputs provided during the division configuration "freeze" review meeting. The instrumentation slot problem resulted from the fact that primary/secondary bit stream location designations were not provided to the various computer programmers.

B. Vehicle Interface: Although direct support was not provided during OCP 8000, a test was conducted at KSC at FCD's request which indicated that the telemetry BER using the S-band system was not affected by placing the RANGE/TV switch in the ranging position prior to liftoff. Based on this data and the fact that the procedural commanding of this function had many drawbacks, the decision was made to liftoff with this switch in the RANGE position. Support was provided for SIT I (6 December, 1967), Plugs Out (15 December 1967), FRT (22 December 1967), and SIT II (27 December 1967). All interfaces with the vehicle were normal except that during the Plugs Out TCP, a glycol pump switchover discrete was observed during the switchover from the glycol trim control unit to internal pump operation. This measurement, GW5158, PUMP SWITCHOVER, had been officially deleted from all documentation when it was decided to fly LM-1 with both pumps online. Subsequent to this OCP, checks indicated that the measurement point was valid, although previously unknown to exist, even though the automatic glycol pump switchover capability had been disabled. Also noted were battery voltage/current readings that would not correlate. This discrepancy was determined to be the result of battery voltage instrumentation inaccuracies, and the



5010-108

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calibration curves were biased to correct this situation. During the period of time between SIT II and the start of CDDT, the following occurred in EECOM system areas:

(1) 14 January 1968 The water glycol was replaced after tests indicated that there was air in the system. Inflight electrical batteries were installed.

(2) 15 January 1968 Water was loaded in both ascent tanks. Samples pulled after loading caused some concern over "dirty" water. This alarm was roused after a sample at the top of the tower indicated that particulate matter was well above triple distilled water fed into the system at the base of the tower. Another sample pulled just downstream of the 490 module inside the spacecraft, however, revealed that the 2 micron filter downstream of the tower sample point had returned the water to original cleanliness. No action was taken.

(3) 16 January 1968 Pyro batteries were loaded. It should be noted at this point that the flight mission rules indicated that the pyro batteries must be checked no later than 65 hours prior to launch to be considered operational. When this question was raised prior to picking up the terminal count, the reply was that the time required to reverif pyro battery status was considered excessive and unwarranted, and therefore no action would be taken. The flight mission rules were not changed. It was also discovered at this time that the inverter bus read 118.6 when inverter 2 was placed online. Since this exceeded both the inverter spec (118.2 VAC) and the DECA spec (118.5 VAC) consideration was given to replacing this inverter. Tests with bench equipment at KSC and GAEC revealed this was not an instrumentation error, but rather that all inverters were running near max spec limits. Checks with RCA indicated that DECA could operate properly at 120 VAC. The launch mission rule redline was subsequently changed to 119.6 and the flight mission rule switchover criteria to 120 VAC.

(4) 17 January 1968 Ascent 2 H<sub>2</sub>O tank developed an ullage pressure leak of approximately 0.07%/hr. After considerable discussion, a coordinated decision was made to lower the redline limit for this tank from 100% to 70% and to change the launch mission rule category from both mandatory to Ascent Tank 1 mandatory and Ascent Tank 2 highly desirable, and to change the flight mission rule category from 1 of 2 tanks mandatory to the same as the revised launch mission rules. Continued discussions with subsystem personnel indicated that sufficient pressure would be available to expel the contents of the tanks <sup>upward</sup> orbital conditions with a WQMD reading of 25%. Attempts to pressurize the cabin were unsuccessful. Reportedly, this resulted from a reversed decal placed on one of the cabin dump valves such that it was placed in the dump rather than ~~close~~ <sup>upward</sup> position. This was corrected and cabin leak checks were completed on 18 January 1968.

### 3. COUNTDOWN

A. CDDT: Countdown support was started at 0800Z on 18 January 1968. The CDDT progressed smoothly with the exception of one discrepancy. When the glycol trim control unit was switched off and glycol pump 1 was allowed to maintain flow, the pump  $\Delta P$  dropped to 2 psid for several seconds. Although this should have been sufficient to cause a glycol pump switchover discrete, it did not appear until approximately one hour later. This switchover relay was subsequently reset, and no further discrepancies were noted. Assuming proper operating of the  $\Delta P$  switch, this sequence of events was impossible, and no explanation is currently available. Also during the CDDT, it was revealed that ASC 2 O<sub>2</sub> tank PCM reading would have to be biased by 0.3 psia to correspond to GSE pressures at termination of tank evacuation. The tanks were initially evacuated to 1.30 psia and were predicted to leak so that the liftoff pressure would be 4.0 psia.

The cabin leak rate test performed was subsequently reported as invalid when a leak rate of 3.5 lb/hr was measured. It was decided to go with the 0.95 lb/hr reading that had been obtained during MSOB checks.

Cabin closeout was delayed due to the loss of a mechanical commutator associated with DFI Transmitter D. It was decided to replace this with a solid state commutator.

Cabin closeout was completed at approximately 2050Z 18 January 1968.

During the CDDT, the EPS went to internal power three times, twice for internal power checks and once to enable a ground power supply problem to be corrected. A total of approximately 59 amp hours were consumed.

The CDDT was scrubbed at 01:36 GMT 19 January 1968 because of problems with ground computers used for the launch vehicle preparation.

### 4. TERMINAL COUNT

Support for the terminal count began at 0730Z 22 January 1968. At this time, the vehicle was configured the same as at the termination of the CDDT, i.e., both glycol pumps were running for coolant circulation with freon being used for cooling, inverter 1 was online, and the spacecraft was on external electrical power. The terminal count progressed as schedule until T-3:30:00 when attempts were made to increase the freon flow to drop the glycol temperature from the 55°F level to the desired liftoff temperature of approximately 35°F. In so doing, freon flow appeared to be completely lost and the glycol temperature rose as high as 65°F. A hold was called at T-2:30:00 while efforts were made to correct this problem. The problem was isolated to the GSE freon supply and

resulted in insufficient freon being available to extend the count until the desired KSC termination time if a high freon flow was constantly maintained. A desire to decrease the freon flow to conserve freon and the possibility that the glycol temperature could not be maintained as desired resulted in extensive discussion between ASPO management, MSC and GAEC subsystem engineers, and Flight Control personnel to determine the maximum glycol temperature acceptable for launch. The areas of concern were what effect would an elevated temperature have on water boiler start up, what effect would this have on the temperature profile prior to water boiler start up, and what, if any, equipment degradation might result from operating at elevated temperatures. The discussions brought forth considerable new data, including the fact that the GNC Division did not approve of PGNS critical temperatures or lifetime estimates. It was finally resolved that water boiler start up would not be jeopardized by a glycol temperature of 55°F at liftoff although all efforts should be made to maintain this temperature at or below the previously established maximum redline value of 45°F. Freon control was eventually regained, and although several excursions of glycol temperature occurred, stabilization was maintained under 55°F. Glycol temperature at liftoff was 48.5°F. The LM went on internal electrical power at T-42 minutes. Discussion had also occurred several times between ASPO and Flight Control personnel as to what the redline current limits should be. This discussion basically centered around the fact that the RCS heater duty cycle was unknown and that variations in current could be due to either a short or to an increased heater duty cycle. Because of data seen during the vehicle interface testing, it was felt that if a current of over 65 amps was seen for more than a few seconds, a vehicle problem was indicated. No resolution could be reached, and the launch mission rule redlines remained at 60 amps without heaters and 80 amps with heaters. It was agreed among the flight control team that we would call the hold if currents exceeded 65 amps and an explanation was not apparent. Variations in excess of 15 amps occurred during prelaunch, and the current was near the maximum observed level at liftoff (55 amps). The IMU, with a stabilized glycol temperature of 55°F, had a 17% duty cycle prelaunch. When the spacecraft was cooled for flight, the IMU heater duty cycle rose to 27% and remained between 27% and 19% for the rest of the mission. At liftoff, 96 AH in addition to the 200 AH that had been predischARGE (50/battery) had been consumed.

##### 5. LAUNCH PHASE

Liftoff occurred at 22:48:10Z 22 January 1968. The cabin began relieving at approximately T+53 seconds and stabilized at about 00:02:30 GET at 5.5 psia. The water valve opened at 00:03:07. The glycol temperature reached a maximum of 56.2°F, considerably lower than predicted based on a liftoff glycol temperature of 48.5°F, and began the predicted decrease shortly after water flow was established. Reference Attachment 1. The total current gradually increased from an average of 43 amps to a maximum of 65 amps at 00:02:00 GET and then slowly decreased to an average of 43 amps. Peak current levels were caused by the simultaneous turn on of most of the RCS heaters. Chart



recorder records indicate that the RCS heaters never came on again during the mission. Periodic thruster firing evidently kept the quad temperatures above the thermostat trigger level. Other than a few expected data dropouts during boost, data quality was very good during this mission phase.

## 6. ORBITAL PHASE

A. Coast Prior to Separation: The only anomaly noted during insertion and separation was that the physical monitor discrete for SLA panels deploy did not occur upon receipt of either the IU programed command or in conjunction with the backup RTC. Checks by the BSE indicated that the TM points associated with the redundant relays in the spacecraft jettison controller had been activated. Measurement KL49-900, SLA PANEL DEPLOY, is composed of eight lanyard switches (two per panel) which are hooked in series - parallel configuration. These switches are activated when the panel moves to approximately 40° or near the full open position. Malfunction in either the instrumentation point, one or more of the switches, or in the degree of panel deployment would have resulted in the lack of this indication.

B. Separation: Separation occurred nominally with the primary S-band system operating in low power mode coming online at approximately the time of separation. A data dropout of about 2 seconds in duration occurred at the time of antenna switchover. Data playback subsequent to the Carnarvon pass indicated that the S-band data was of good quality.

C. DPS Cold Soak: Systems performance during the DPS cold soak period was nominal, with the only discrepancy the above-average number of data dropouts and periods of marginal UHF signal strength. Concern during the first CONUS pass was that the calibration curve for GT0619, UHF SIGNAL STRENGTH, had shifted. A request to verify this by executing the DCA SELF TEST RTC over CYI Rev 2 was denied. Trying to analyze the communications difficulty without this data point was inconclusive. The DCA SELF TEST command was executed three times during the Rev 2 CONUS pass; twice (03:10:12 and 03:10:26 GET) at a signal strength of approximately -106 dbm and once (03:12:58 GET) at a signal strength of approximately -92 dbm. Spacecraft rejects were received both times at the lower signal strength and a verify at the higher signal strength thus confirming that the calibration curve had not shifted (predicted threshold -99 dbm). Reference Attachment 2 for communications coverage reports during this period. Water usage was as predicted with the glycol temperature slightly lower than expected. (Playback of the USB data from CRO, Rev 2 indicated very good quality telemetry in the high power mode.) This is thought to be the result of lower structural heat inputs than computer analyses showed. No effects of day/night cycling were noted. Reference Attachment 3 for water usage trends. Cabin leak rate was considerably less than predicted. Reference Attachment 4 for the cabin pressure trend. The battery temperatures stabilized at 60°F for the descent batteries and 40° for the ascent batteries. The glycol temperature had stabilized near 41.5°F during this period.

D. DPS 1: All systems performed nominally during the DPS 1 sequence. VHF and UHF data dropouts were experienced until after the maneuver to burn attitude. Subsequent to this, VHF data and UHF signal strength were extremely good. UHF signal strength during the CRO pass was oscillating around -54 dbm.

E. Alternate Mission C: Prior to executing this sequence, based on GUIDO inputs that the vehicle attitude was expected to be such that the +Z axis would be pointing towards earth during the sequence, predictions were made that UHF signal strength would be adequate for commanding prior to the sequence and good during the sequence. The BAT 5 B/U CDR RTC was executed over HAW Rev 4 (06:00:28 GET), and systems behaviour was as predicted. Battery 5 assumed about 45% of the load while the descent batteries shared the rest. The MASTER ARM ON RTC was also executed over HAW Rev 4 (06:00:46 GET) as a backup to Sequence III ABORT STAGE ARM. The only anomaly noted during PRA Sequence III was that during the time the DPS was "armed" or "on" the inverter voltage oscillated between 113 to 124.5 VAC. No GDA fail indications or other effects were noted as a result of this fluctuating voltage. Abort Stage occurred as predicted with BAT 6 SE coming on line nominally. BAT 5 pulled 86% of the load for about 30 seconds. For the next 5 minutes, both battery currents sought stabilization levels. This was felt to have resulted from BAT 5 being warmer, BAT 6 having a higher charge, and a high load because of RCS thruster activity, although the number of variables involved prevents any definite conclusions. Thereafter, both batteries shared the load equally. Abort Stage time was recorded at 06:12:19 GET and adjusted for data delay to 06:12:14 GET.

F. PRA Sequence V (APS 2): PRA SEQ V was cued over HAW and executed over HAW RKV Rev 5. Communications coverage during the sequence was good. This sequence was nominal with the exception that following RCS propellant depletion, eight RCS thrusters remained on electrically. This resulted in the total current increasing to 81 amps and shortened the predicted vehicle electrical lifetime from 16:15:00 GET to 12:45:00 GET.

## 6. EXTENDED MISSION

The last site with any appreciable coverage was GYM Rev 5 at approximately 7:52:15 GET and solid lock at this site was never achieved due to excessive spacecraft rates. At this time, all systems were operational with a predicted vehicle lifetime, constrained by electrical power, of 12:45:00 GET. Sufficient water remained for a vehicle lifetime of 16:50:00 GET at which time the VHF transmitters were predicted to reach maximum spec temperatures. On Rev 6, carriers were received momentarily by ASC, GYM, and HAW, but the data was insufficient to process at MCC-H. The extended mission objectives of switching inverters, placing BAT 6 on its backup feed-path, opening up the secondary water feedpath, and monitoring system degradation during consumables depletion were never accomplished because of vehicle LOS.

## 7. SYSTEMS DISCUSSION

A. Electrical: The total average current was slightly below estimates because of the lack of RCS thruster heater activity during orbit. This has been estimated to be about 190 watts, or a 25% duty cycle, after the LM attained orbit. The IMU heater load was as predicted. Adjustments made to the predicted power profile following CDDT compared very favorably to actual power usage. See Attachment 5 for predicted vs actual power consumption. The main anomaly that occurred of concern was the inverter fluctuation. The inverter is expected to have a recovery time of about 0.3 seconds after a load is applied. With a sample rate of once per second, it is very hard to reconstruct the exact performance, however, since variations in inverter voltage were considerably above predicted and exceeded both the inverter specifications and DECA test limits, it is very possible that a serious problem with the inverter was encountered. It is recommended that exhaustive testing be performed to determine the type, extent, and effect of inverter loads for subsequent missions.

B. Pyrotechnic: All systems were pressurized as predicted, and no known sequential anomalies occurred.

C. Environmental: The ECS performed exceptionally well in the two pump configuration and with the 209 AD water boiler. As the ECS will not be flown in this configuration again, assuming LM-2 will not be flown, testing under single pump operation, a new water boiler, and with the water regulators referenced to the suit loop/cabin must be performed before earth orbital testing of this system can be considered complete. From LM-1 data however, there is no reason to suspect any problems.

D. Instrumentation: The instrumentation system performed very well during the entire mission. As predicted, several measurements floated considerably. They tended toward a minimum value but had occasional spikes. This was especially noted on the descent battery current readings. The RCS PQMD data indicated that these two readings, GR1085Q and GR1095Q, did not track properly until they reached a level of 87%.

E. Communications: UHF performance was well below that expected; VHF coverage, although adequate, was poorer than expected; and S-band on both low and high power modes was considerably better than expected. The exact reason for the below par performance on the VHF/UHF communications link was not discernible in real time. Considered ~~are~~<sup>were</sup> (1) poor vehicle attitude, (2) a loss of or damage to one VHF/UHF antenna, (3) an antenna gain problem, or (4) a phasing interference between the fore and aft antennas. At no time during the mission were there any indications of S-band corona.

F. Structural: No structural anomalies were noted, and as mentioned previously, cabin integrity was excellent during the early portion of the mission. Although not directly tied to any particular mission event, cabin pressure decay increased at 03:30:00 GET and by 06:30:00 GET had reached the predicted profile.



## RECOMMENDATIONS

### A. Spacecraft:

(1) Integrated testing be performed to determine the type, extent, and effect of AC loads on subsequent missions.

(2) Analyses/testing be performed at various vehicle altitudes to determine any interference that might result with uplink UHF capture of both spacecraft antennas and also the effect of simultaneous access to VHF downlink.

(3) ECS performance data be extrapolated to single pump operation and the new water boiler configuration.

### B. General:

(1) Positive indications of the status of incoming telemetry data at selected console operating positions is a must. The present indication does not indicate whether this is a site problem an MCC processing problem, or a spacecraft anomaly, and in addition, does not serve to indicate static data if the problem is within the RTCC. Voice reports proved inadequate for subsequent assessment of data quality and caused unnecessary chatter on the loops. The EECOM position had the reporting of AOS, LOS, and dropouts in data to other flight control positions as a major mission function.

(2) Some means be established whereby there is a meaningful exchange of data between KSC engineers, both NASA and GAEC, and the system flight controllers. This applies both during initial OCP checkout and during MCC/KSC interface testing. On this mission, the only data of significance, other than routine phone calls, was that obtained on communication tests to determine ranging switch prelaunch position. Requests for DVM vs ACE readings on several parameters, although requested officially, were never available. Also filled-in OCP's were never received although requested. The problem that continuously arose was a requirement for Flight Control Division personnel to concur in KSC/Program Office changes to redline values and operational procedures strictly on the basis of on-the-spot relayed information which was, in general, in direct conflict with previously supplied technical data. The addition of L. Lopresti as a GAEC representative for FCD at KSC greatly helped this situation although one man certainly cannot be expected to accomplish this task. Guidelines should be established as to the interface possible between cognizant KSC engineers and systems personnel during OCP testing. There appeared to be extreme reluctance to allow discussions of system data on OIS 258 during the conduct of OCP's. Although this is understandable, it prevents test data to be used in lieu of analytical data.

(3) Distribution of OCP's and applicable deviations until the CDDT were late in arriving and were insufficient to allow each operating console the necessary outline for test monitoring. Late delivery also precluded the desired review and resulting change coordination.

(4) A means should be established where items not covered within the time frame of Launch Mission Rules are coordinated between MSC/KSC personnel to insure a common understanding as to equipment status and last-check readouts.

(5) A strong organizational position should be taken to try and alert all appropriate personnel of the necessity of providing analytical vehicle data and test results in time to meet derived documentation cutoff dates. With only minor exceptions, the characteristics of nominal operation for all associated EECOM systems were changed or initially documented during the month preceding the mission. Considerable new data requiring assessment was received within hours of liftoff. The existence of these situations, although somewhat understandable for the first-of-a type launching such as LM-1, could have catastrophic impact on subsequent missions.

(6) A definite, although flexible, plan be developed as to what OCP support data flow testing, and network validation testing will be required for a mission, and what personnel are expected to support. On several occasions, SSR personnel were brought in on the understanding that their support was required, only to find considerably later that there was nothing specifically for them to do.

(7) A computer<sup>program</sup> should be developed to provide a continuous readout of vehicle~~2~~ attitude with respect to local horizontal - local vertical. Only with this type of data can circuit margin and other associated communication problems be analyzed.

Donald R. Puddy

## RF QUICK LOOK ANALYSIS

REV 1

SITE	UHF	VHF	S-BAND
MILA			
GBI	GOOD	GOOD	NA
BDA	GOOD	GOOD	NA
RED		TM COMPUTER DOWN	NA
CYI	GOOD	GOOD	NA
CSQ	UNKNOWN	INTERMITTENT	NA
CRO	UN-ACCP. (GOOD FROM SHORTLY AFTER AOS TO 22 SEC AFTER SEP. REMAINDER OF PASS HAD VIR- TUALY NO UP- LINK CAPABILITY.	GOOD, BUT NOISY LATE IN PASS	GOOD
RKV	UNKNOWN	GOOD	NA
GYM	GOOD, 1ST 90 SEC. UN-ACCP. THERE- AFTER	GOOD GOOD	GOOD
TEX	GOOD OVERALL, SUSPECT HANDOVER PROBLEM BTWN TEX AND RKV	GOOD	GOOD

SITE	UHF	VHF	S-BAND
MILA GBI	GOOD	GOOD NOISY FOR 20 SEC APPROX. 3 SEC AFTER TEX/MILA HANDOVER	GOOD
BDA	GOOD	GOOD	GOOD
RED	NO - UPLINK	MARGINAL (VERY NOISY)	GOOD (SLOW TO UPLINK)
CYI	GOOD	MARGINAL	GOOD
CSQ	UNKNOWN	UNKNOWN	NA
CRO	GOOD	GOOD	UPLINK LOOKED GOOD, PLAYBACK WAS A LITTLE NOISY
HAW	UN-ACCPT.	GOOD	GOOD
RKV	UNKNOWN	UNKNOWN	NA
GDS	MARGINAL (CYCLING)	NA	GOOD
TEX	UN-ACCPT.	GOOD	GOOD

## REV 3

SITE	UHF	VHF	S-BAND
MILA GBI	UN-ACCP	GOOD	GOOD
BDA	GOOD	GOOD	GOOD
RED	SAW GOOD CMD CARRIER DURING FIRST HALF OF PASS. NO CMD CARRIER LAST HALF OF PASS.	MARGINAL	<del>SAME</del> AS UHF
CYI	NO AOS		
AC/V	UNKNOWN	UNKNOWN	MARGINAL APPEARED TO HAVE UPLINK PROBLEMS
CSQ	UNKNOWN	UNKNOWN	NA
CRO	MARGINAL	CRO SAYS GOOD. TIC SAYS NOISY.	GOOD
HAW	GOOD* - UNTIL VERY NEAR LOS. WHEN S-BAND SIG STR INCREASED, UHF FELL OFF	GOOD	GOOD
RKV	UNKNOWN	UNKNOWN	NA
GDS	GOOD	UNKNOWN	GOOD AFTER AOS + 40 SEC.
TEX	GOOD	GOOD	GOOD

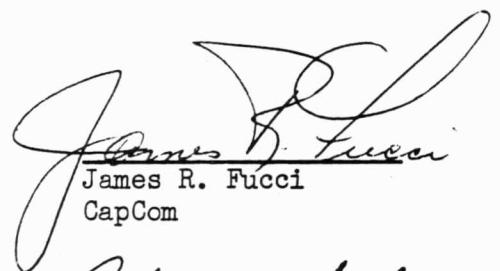
SITE	UHF	VHF	S-BAND
MILA GBI	GOOD	GOOD	GOOD
BDA	GOOD	UN-ACCPT	UN-ACCPT
ANT	GOOD UNTIL FINAL 1/3 OF PASS - SUDDENLY UNACCPT.	MARGINAL FINAL 1/3 OF PASS DATA ERRATIC	NA
ACN	UNABLE TO LOCK UP ON ANYTHING ARIA REPORTED GOOD SIG STR DURING THIS TIME PERIOD.		
CSQ	UNKNOWN	UNKNOWN	NA
CRO	GOOD	GOOD	GOOD
HAW	MARGINAL	MARGINAL	GOOD
RKV	UNKNOWN	UNKNOWN	NA
GDS TEX	GOOD GOOD	NOISY DATA DURING ENTIRE STATES PASS	GOOD UPLINK

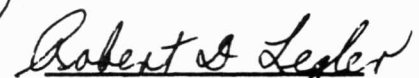
## REV 5

SITE	UHF	VHF	S-BAND
MILA GBI	NO DATA		
ANT	GOOD	GOOD	NA
ACN	UNKNOWN	MARGINAL	GOOD AFTER 3 MIN INTO PASS
CSQ	UNKNOWN	MARGINAL	NA
CRO	GOOD	MARGINAL	GOOD
GWM	NA	NA	GOOD
HAW	GOOD	GOOD	GOOD
RKV	UNKNOWN	UNKNOWN	NA
GYM	GOOD	GOOD	GOOD



APOLLO 5  
CSQ FLIGHT CONTROL TEAM  
FINAL MISSION REPORT  
JANUARY 24, 1968

  
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## INTRODUCTION

The Apollo 5 (AS 204/IM-1) Mission launch on January 22, 1968, was supported by the Coastal Sentry Quebec ship located at  $96^{\circ}\text{E}$  longitude and  $27^{\circ}\text{S}$  latitude. This report includes an analysis of premission and mission support as observed by the CapCom, IM Systems, and Booster Systems.

### Telemetry

IM telemetry was very erratic throughout the mission. Receive signal strengths were recorded; however, their calibration is not considered as accurate as desired. Accurate calibration could not be properly accomplished without bringing down the transmit carriers, since they cause interference noise. However, the receive signal strength was generally between -87 and -102 dbm. All five receive signals appeared to fade together and at approximately 25-30 second intervals. This caused frequent dropouts on PCM which was also observed on transmitter E IRIG 5.

PCM quality was not considered to be par with most Gemini flights. No explanation can be given, except the possibility of selective interference caused by driving both +Z and -Z antennas. It should be noted that since the spacecraft was inertial, the spacecraft attitude, with respect to the local horizontal, could cause a considerable difference in signal strength and PCM quality at the various sites around the range. The following approximate times out of sync were judged from analog recorders:

Rev 1	50 secs. out
Rev 2	1:40 out (last 3 mins. solid)
Rev 3	1:30 out (2:30 solid at midpass)
Rev 4	1:30 out
Rev 5	Probably would have been the best quality judging by

receive signal strength; however, a ground station problem at AOS affected R/T pass.

UHF receive signal strength also varied greatly during our passes.

#### SLV

The SLV had poor quality of PCM data reception during the second and third passes. No ground conditions have been found which could cause the problem, but Carnarvon did not report any similar problems. One area of question is the attitude relationship of the IU antennas with the CSQ and the resulting antenna patterns.

#### Network Communications

Voice communications for premission and mission support was fair to poor. Teletype was fair to good for all phases of mission support and poor for premission support. All problems associated with communications were attributed to the hours of support for the mission.

#### Mission Support Documentation

Mission support documentation was adequate but many changes had to be incorporated onsite. Specifically, revisions to the FCOH, Mission Rules, IM Systems Handbook, and the NOD. It was felt that the majority of the corrections could have been incorporated prior to flight controller deployment.

#### Site Support

Site support was excellent. M&O personnel worked many hours with us in trying to resolve problems encountered in the 1218 program. This support extended for a period of a week. Mission support was also excellent.

### Problems

The RSDP (1218) "Aspect" program would not process SLV command history requests properly. The requesting of an SLV command history would in most cases: (1) give an incorrect history containing errors or missing a command word and (2) cause the computer to loop leading to an eventual fault. Since no SLV commands were transmitted from the CSQ, this did not cause any problems except for premission testing.

A 1218 computer "fault" occurred midpass during revolution 3. No clue to the fault could be found. The program was reloaded and performed properly.

A telemetry power supply failed in the early portion of revolution 5. The problem was found and corrected prior to midpass.

The 1218 computer "faulted" at LOS of revolution 5. The cause was determined to be a faulty cable harness associated with ship vibration. The cable was repaired and the problem corrected.

### IM Mission Analysis

A thorough analysis of data was made in an attempt to determine the problem associated with Mission Phase 9. Mission Phase 9 events were recorded in GMT as follows:

A.	FW2 B5 TIMERS DISABLED	02:43:12.5
	FW2 B7 ORBIT INTEGRATION ON	02:43:12.5
B.	FW2 B7 ORBIT INTEGRATION OFF	02:43:16.5
	<del>FW2</del> B12 KALMANU IGNORE FINAL YAW	
C.	FW2 B13 START UPDATE CDU'S IN KALCMANU	02:43:17.5
D.	FW2 B13 CONTINUE UPDATE CDU'S	02:43:18.5
	FW2 B11 KALCMANU IN PROGRESS	
	DB B7 DEADBAND MIN	
E.	FW2 B11 KALCMANU NOT IN PROGRESS	02:43:33.5
F.	GL4221 DFI CAL ON	02:44:27
G.	GL4221 DFI CAL OFF	02:44:39
H.	GY0111/GY0112 ED ARM A/B ON	02:45:43.5
I.	FW2 B7 ORBIT INTEGRATION ON	02:46:43.5
	CH30 B3 ENG ARM ON	
	CH11 B14 AUTO OFF WENT ON	

J.	GHL348	DPS ARM ON	02:46:44
K.	FW2 B7	ORBIT INTEGRATION OFF	02:46:50.5
L.	FW1 B1	AVERAGE G INTEGRATING	02:47:19.5
M.	FW2 B15	S/C IN ACCEL FLIGHT	
N.	GHL419-23-27-31	PLUS X TRANS ON	02:47:41.5
		ALL DOWN FIRING JETS STEADY EXCEPT A4D ALTERNATED ON/OFF WITH ON TIME APPROX 90 PERCENT.	
O.	DB B6	ULLAGE REQUEST	02:47:42
P.	CHL3 B15	ENABLE T6RUPT ON	02:47:43.5
Q.	CHL3 B15	ENABLE T6RUPT OFF	02:47:47.5
R.	CHL3 B15	ENABLE T6RUPT ON	02:47:49.5
	CHL1 B14	AUTO OFF WENT OFF	
	CHL1 B13	AUTO ON WENT ON	
	FW1 B5	TO DV MONITOR, ENG ON	
	GHL301	DPS ON	
S.	GHL419-23-27-31	PLUS X TRANS OFF	02:47:50
T.	CHL3 B15	ENABLE T6RUPT OFF	04:47:50.5
	DB B6	ULLAGE REQUEST OFF	
U.	GY0111/GY0112	ED ARM A/B OFF	02:47:52.5
V.	FW1 B5	TO DV MONITOR, ENG OFF	02:47:53.5
	FW1 B1	AVERAGE G INTEG OFF	
	CHL1 B3	UPLINK ACTIVITY OFF	
	CHL1 B14	AUTO OFF WENT ON	
	CHL1 B13	AUTO ON WENT OFF	
	GHL301	DPS OFF	
	GG9003	PGNS CAUTION	
	DB B7	DEADBAND MAX	
	DSPTAB 11	B9 PROGRAM CAUTION	
W.	CHL1 B13	AUTO OFF WENT OFF	03:47:55.5
	CHL1 B2	CPTR ACTIVITY LAMP OFF	
	FW2 B15	S/C in NON-ACCEL FLIGHT	
X.	FW2 B5	TIMERS ENABLED	02:47:56.5
	CHL1 B2	CPTR ACTIVITY LAMP ON	

Many of the above events were patched to 150/150 pen recorder and times were obtained by tape playback.

CAM printouts indicated that the LGC issued all commands properly up to and including 005/005 master arm off.

A CAM P/O of LGC downlist (FMT 68) indicated that the following were available at T1/T2 of 03:55:49:

- a. State vectors with state time of 04:00:19/04:00:19.
- b. VG's/VG's and VD's/VD's.
- c. Pred. Eng. on time of 03:59:40/03:59:40.

Time-to-go LGC word 75B bits 7/7 through 12/12 were patched to event recorder and tape P/B indicated that time-to-go was not present when eng. on signal was given. According to LGC takes a ride, this time should have been initialized at eng. on.

CAM P/O indicated that eng. on time of 03:59:40/03:59:40 and eng. off time of 03:59:45/03:59:45 (Event LGC word 30/30).

The 12/12 LSB's of LGC words 58A PIPA X, 58B PIPA 6, and 59A PIPA Z were patched to event recorder:

a. PIPA X 7777/7777	octal	02:47:20/02:47:20
0001/0001	octal	02:47:26/02:47:26
7777/7777	octal	02:47:28/02:47:28
0002/0002	octal	02:53:03.5/02:53:03.5

through eng. on time and after eng. off read 00017/00017 octal (TLM).

b. PIPA Y and PIPA Z read essentially

7777/7777 octal through eng. on time  
with TLM R/O of 77723/77723 and  
77771/77771 respectively after eng. off.

LGC word 55/55 read after eng. off:

Failreg plus 0/0 01405/01405 octal  
Failreg plus 1/1 00315/00315 octal

LGC word 56B read after eng. off:

Almcadr 02013/02013 octal  
Almcadr plus 1/1 16003/16003 octal

Although failreg plus 1/1 displayed 00315/00315 forget it error code, not all items in LGC takes-a-ride were accomplished by forget it.

CH 11/11 read 02002/02002 vice 00000/00000  
CH 13/13 read 00100/00100 vice 34000/34000.

In conclusion, it appears that the failure occurred in the PGNS monitor DV routine.

SLV Mission Analysis

CSQ received very good voice reporting throughout the launch phase. The launch appeared nearly nominal based on these reports. The first report of any problem occurred shortly after insertion with announcement of a possible leak in the ECSGN2 sphere (D25-601). The second anomaly occurred after the CYI pass at which time the following voice reports were received:

1. No TM confirmation of SLA deploy.
2. SLA deploy physical monitor is confirmed.
3. SLA deploy relay A is all that can be confirmed.

CSQ gained acquisition of the SLV at 47:42 GET. At AOS, both SLA panel relays indicated the deploy command had been given but the SLA deploy physical monitor did not indicate full SLA panel opening. The decision was made by the Flight Director to go for separation assuming a SLA panel TM failure. Vehicle rates and attitude errors were zero and the separation attitude of pitch 86.2 degrees, yaw 359.1 degrees and roll 359.8 degrees was achieved. LM/SLA separation occurred at 53:54 GET. All SLV systems were go throughout the pass. SIVB tank pressures were well within nominal range (LOX - 20 PSIA; LH2-1 to 13 PSIA). LOS occurred at 55.28 GET.

Information received by voice and TTY reports indicated the Rev. 1/2 pass over the U.S. was nominal. LH2 tank venting and passivation buss enable occurred on schedule. ECS GN2 sphere pressure lifetime was extended to 5:30 GET.

CSQ started receiving signals from the SLV at 2:21:00 GET for the second pass. However, because of wide fluctuations in signal



strength, the PCM ground stations could not hold lock (synchronization) for more than several frames at a time. Meters were fluctuating wildly and it was not possible to determine good data from bad. It was near midpass when the PCM ground station finally locked up on the signal. LOX dump had commenced. Times for the following events were noted:

FC SIVB Burn Mode Off 2:27:37

LOX Dump Terminate 2:28:16

LH2 Dump Commence 2:28:25

The time relationship of FC SIVB burn mode off indicated that the FCC remained in thrust vector control for the full time period and attitude errors did not exceed the 12 degree limit. LOX pressure at the start of LOX dump was 26 PSIA. The pressure drop during the dump was slow but steady. The pressure at the completion of LOX dump was approximately 20 PSIA. All systems appeared to be GO during the pass and attitude data taken from the LOS buffer of the RSDP indicated that attitudes were correct at the time the RSDP buffer was locked up. LOS occurred at 2:28:34 GET.

CRO reported passivation was nominal and all systems were go. CRO did not have the problem with PCM lock that the CSQ had. Because of the poor SLV data and also poorer than expected LM data, extensive tests were made by the site to determine if a local ship problem was the cause. These results were negative and the poor SLV data appears to be caused by the SLV attitude with relation to the CSQ during the maneuver to passivation attitude. More analysis will be made into this problem.

The postpass message for Rev. 3/3 pass over the U.S. was nominal except for a questionable closing of the LOX vent valve.

CSQ acquisition for the third rev. occurred at 3:53:53 GET. LOX pressure at AOS was 3 PSIA which later dropped to 1 PSIA after the LOX vent was opened. PCM lock was bad during this pass also although not as bad as during the second pass. The time of the LOX and LH2 tank ventings could not be determined. LH2 tank pressure was 1 PSIA throughout the pass. All systems were go. LOS occurred at 4:00:39 GET. Sporadic bursts of data was seen until 4:01:21 GET.

Very little was heard about the SLV during the Rev. 3/4 pass over the U.S. The postpass message did indicate all systems go.

CSQ acquisition for Rev. 4 occurred at 5:27:10 GET. All systems were indicating an all-go state. Consumables were depleting but at an apparently slower rate. PCM lock was very good and only occasional dropouts were noted. The vehicle attitude was correct and the vehicle was very stable in rates and attitude errors. LOS occurred at 5:33:53 GET.

No further information was received from MCC concerning the SLV following this pass. An attempt was made to acquire the SLV on Rev. 5 but having no acquisition predictions. It was unsuccessful. No SLV pointing data was received during the mission. Up until Rev. 5, the LM and SLV were sufficiently close that LM data could be used for initial pointing. This, however, did not work on Rev. 5 since the LM trajectory had been changed by LM engine burns.

Based on the fourth pass data, the SLV should not have "died" prior to the fifth pass.

#### Passivation Experiment

The passivation experiment functioned very much as expected at CSQ. All events occurred on schedule, based on TB4 time.

<u>Event</u>	<u>Actual</u>	<u>Time</u>	<u>Nominal (GET)</u>
TB41 (for ref.)	9:53		9:58
FCC SIVB Burn Mode On	2:26:13		2:26:18.1
Commence LOX Dump	2:26:14		2:26:19
FCC SIVB Burn Mode Off	2:27:34		2:27:40
Complete LOX Dump	2:28:14		2:28:19
Commence LH2 Dump	2:28:23		2:28:29

The passivation attitude maneuver could not be monitored because of the very poor telemetry data received during that time. Later, data and CRO reports did verify the maneuver was correct.

The FCC remained in thrust vector control for the full programmed duration indicating that the attitude error limits of 12 degrees in pitch and yaw were not exceeded during the early LOX dump. The actual attitude error values will be added later.

During the LOX dump, the LOX ullage pressure (D179-424 and D180-424) followed the curve:

<u>Time GET</u>	<u>LOX Pressure</u>
2:26:14	26 PSIA
2:26:51	26 PSIA
2:27:51	24 PSIA
2:28:14	20 PSIA

#### SLV Systems

Sequential Systems - All IU and SIVB sequential systems functioned very well as far as CSQ data could indicate. All switch selector events which were monitored by CSQ occurred on schedule. All events were 5 seconds ahead of the nominal time because of the TB4

initiate time of 9:53 rather than the nominal 9:58. A comparison of passivation events with nominal times is given in the passivation section of this report. Attempts were made on several passes to verify that LVDC AOS occurred on schedule. However, the ground station synchronization and other data requirements from the ground station prevented getting any valid data.

Guidance and Navigation System - No anomalies were noted in the functioning of the G&N system. Guidance angles followed the nominal curves within approximately one degree. No automatic failovers to backup modes were indicated by the orbital status word or the error monitor register word. The correct mode bits were indicated by the orbital mode word. The following bits of the OMW indicated a one state at the noted readout time:

		Pass	1	2	3	4
TB4 Time			0:45:08	2:18:40	3:47:40	5:19:36
DCS Inh. Removed	D26		X	X	X	X
Orbit Att. Hold	D16		X	X		
Orbit Pitch Rate	D15				X	X
SIVB C/O Issued	D12		X	X	X	X
TB4 Started	D11		X	X	X	X
ECS Logic	D09			X	X	X

Attitude Control System - The attitude control system functioned very well throughout the mission from CSQ data indications. Vehicle rates were very small as were attitude errors (H71-602, H70-602, H69-602). Attitude error and rate recorded information had not be reduced at the time of this report. More specific values and times will be added. No failovers to backup modes were noted in the rate gyros or the spatat amplifiers.

APS propellant and pressurent usage rate appeared slightly

higher than the expected nominal in the earlier part of the mission (through passivation). However, after passivation, the rate dropped and actual and nominal curves were very close together.

Electrical Systems - No problems were noted in any of the electrical systems. However, there was some minor variation between predicted current values and the measured values.

Battery	Initial Prediction	Pad Test Prediction	Current (AMPS)			
			Pass 1	2	3	4
IU No. 1	24.7	29	26	26	26	26
IU No. 2	25.5	25	28	28	28	28
IU No. 3	25.1	27	19	19	19	19
IU No. 4	16.4	14	16	16	16	16
Aft. No. 1	4	3	3	3	3	3
Fwd. No. 1	47.3	43	43	43	43	43

All voltages were steady between 27 and 30 volts.

Environmental Control System - The air bearing supply system for the inertial platform functioned as expected. GN2 usage (D10-603) by this system was well within the nominal range and very close to the usage on Mission AS-203. The regulated platform inlet pressure (D11-603) initially in orbit was 15.6 PSID but during the latter part of the mission, it rose to 16.0 PSID. The internal ambient pressure maintained a solid 12 PSIA throughout the mission.

The temperature control system operated in two modes for this mission. During the first CSQ pass, the regular system maintained the temperature (C15-603) at 59.2 Deg. F. After the CRO pass, the LVDC temperature control logic was enabled. The temperature data was not recorded on Pass 2 because of PCM synch problem. By the third pass, the temperature had fallen sufficiently to close the water valve and temperatures were rising. From the relatively few data

points obtained at CSQ, the system appeared to function as expected. The usage rate of the GN2 supply system (D25-601) which supplies pressurant to this system was higher than anticipated during the early part of the mission. It later tended to stabilize at the maximum expected usage rate of 5.8 PSIA per minute.

Propulsion and Venting Systems - LH2 and LOX tank venting systems and pneumatic systems functioned very satisfactory from the CSQ viewpoint. Tank pressures at each pass were:

Tank	Pass	1	2	3	4
LH2 (D21-408)		11 to 13	1	1	0 PSIA
LOX (D179-424)		20	26	3	0
(D180-424)		20	26	3	0

The LH2 tank appears to have been depleted prior to passivation. The LOX pressure followed the expected curves very closely.


Helium requirements upon the stage pneumatic system (ambient helium) to do the venting appear to be very small. Tank pressures increased after the first CSQ pass from 3000 PSIA to 3200 PSIA for the second and third passes. Only after the supply was vented did the pressure drop to 900 PSIA. The pressure rise is assumed to be caused by a temperature rise but this has not been verified.

Control helium (engine pneumatics) usage appeared to be greater than expected during the launch phase. At CSQ Pass 1, the control helium pressure was reading 1750 PSIA, 150 PSI above the listed marginal value for passivation. By Pass 2, the pressure had risen to 1900 PSIA. This again assumed to be a result of temperature rise. During passivation the control helium pressures followed the curve:

<u>Parameter</u>	<u>St. LOX Dump</u>	<u>End LOX Dump</u>	<u>St. LH2 Dump</u>
Eng. Cont. Hel. PRS D19-401	1900 PSIA	800	600
Eng. Regl. PRS D18-401	370 PSIA	370	270




CRO  
APOLLO 5  
FLIGHT CONTROL  
FINAL MISSION REPORT  
February 8, 1968

  
Gary B. Scott  
CAPCOM

  
Hershel Perkins  
LM Sys.

  
Harold Loden  
LM Sys.

  
James F. Park  
Booster Sys.

1. CAPCOM Postmission Report

a. Telemetry Reception:

The LM TM quality was less than expected, thus causing more drop outs than I had expected. However, on Rev. 4, we switched ACQ AID assignments between the SLV and LM which vastly improved the quality of our TM reception.

b. DCS Operation:

AC We only transmitted one (1) command from the DCS itself, and it was excepted on the first transmit. The LM UHF signal strength was much less than expected. We noted many S/C rejects when commands were being uplinked from the Apollo site during periods of low signal strength. During one pass, we relayed the signal strength to MCC. They then commanded when the signal strength was good. As a result, the commands got in with no problems.

c. Network Communications:

Very good at CRO.

d. Mission Support Documentation:

Overall, the documentation was very good, but the NOD Supplements were in terrible shape. I don't know if it was a result of MSC inputs to GSFC or GSFC preparations, but the supplements were in a pretty sad shape. It also appeared that the Mission Rules Revisions, prior to the Network/MCC Mission Rules Review, could have been transmitted prior to the time of the scheduled review.

e. Site Support:

The support from the CRO site personnel was excellent, and I have nothing but praise for the M&O personnel.

f. Significant Mission Events:

Rev. 1 - LM/S-IVB separation; all events surrounding the separation sequence were nominal and it looked perfect. Ref. LM Sys. Postmission Report, dated 23/0826Z.

Rev. 2 - S-IVB Passivation; the passivation looked real good. The oxidizer tank pressure did not drop as much as expected but it was quite sufficient. Ref. SLV Postmission Report, dated 24/0717Z.

Rev. 3 - DPS-1 Burn; All the pressurization sequence looked good, but after ignition, we only got a four (4) second burn. After the early shutdown, we extracted all the significant times from various recorders and forwarded them to MCC via voice then TWX. Our personal feelings were that the thrust build up and the LGC delta V counter were not compatible.

Rev. 4 - Nominal Systems Monitoring

Rev. 5 - No S-IVB Contact

Rev. 6 - No telemetry contact on either vehicle.

## 2. LM Systems Postmission Analysis

a. All separation events occurred nominally. There were no surprises in this sequence as it was very much like many simulations we had run at Houston. The only noticeable difference was events were occurring about 6/6 seconds early. This was due, I believe, to an early cut off on the S-IVB.

b. The electrical systems looked real good on all of our passes. However, during prelaunch, we were looking at the inverter voltage with interest. We saw this voltage up to 118.08/118.08 volts on several prelaunch sums. However, this stabilized at 117.59/117.59 in orbit. I suppose this 118.08/118.08 figure might have been caused by higher GSE voltages than normal internal power.

c. Environmental looked good. No comment.

d. After staging, although we were in narrow DB, there was considerably more thruster activity than I had thought there would be.

e. Navigation: No comment.

f. Communication on the UHF uplink was quite rotten. The signal strength was very unpredictable from this end even though Houston EECOM seemed to be able to predict it pretty well.

The VHF TIM looked real good here and we had no problems locking up on it.

The USB downlink looked very good on all passes and we could lock up on it in PRI or SEC with no problem, but we seemed to always have LOS on USB several seconds prior to LOS of VHF.

g. The instrumentation systems gave no problems during the mission but all the redundant loading of parameters sure gave us headaches in patching and station validation. General comment: I believe all this protection we take for PAM Gate failures, SEQ failures, etc, makes the ground system so complicated and hard to validate that it loses any significance. In other words, I just haven't seen enough TM failures to get very heped up over redundant loading.

h. Propulsion: We had a 4/4 Sec DPS burn. The pressurize Seq. looked good to us. There was no rate problem. We thought we were go, then it shut down and we got a program caution and PGNS caution but could not get any error codes. Houston put in a verb 15/15 noun 50/50 then we got the error codes. We thought this verb 15/15 noun 50/50 should already have been in.

i. The DFI CAL appeared to work OK but the parameter that we stripped out of IRIG 5/5 indicated the CAL was a 0/0 to 100/100 PCT vice 15/15 to 85/85 PCT.

j. I don't believe the NOD was up to snuff for this mission. We had found most of the errors in it before we left Houston, and these were submitted to MCRB for input to Goddard. I am sure MCRB did submit this info but it sure was slow getting to the range.

k. Station equipment and procedures were in order, however, we were still validating patching on launch day.

l. Recommendation: Keep remote site flight controllers remote.

### 3. SLV Systems postmission analysis

#### a. Sequential

The S-IVB and IU sequential systems performed well without evidence of any problems. All tank venting sequences were completely as programmed on every pass. The propellant dump sequences also occurred exactly as scheduled.

#### b. Guidance and Navigation

No problems were observed in the Guidance and Navigation System.

#### c. Attitude Control

Attitude Control was maintained throughout all phases of the mission occurring over Carnarvon. During the LOX dump portion of the passivation experiment, attitude errors were observed to reach approximately six degrees in pitch and yaw, but body rates held steady. Attitudes were within expected limits at all times throughout all passes monitored (4 passes). APS quantities and pressurants were more than adequate.

#### d. Propulsive

The Propulsive System, utilized during the propellant dump experiment, performed like clockwork. No problem was observed.

#### e. Electrical

All electrical systems functioned as predicted, with bus voltages and current close to those predicted. There were no electrical system failures.

#### f. Environmental

The Environmental Control System performed well. Because of low methanol water temperatures, the water valve closed after initiation of ECS control logic and was observed closed on all subsequent Carnarvon passes. The methanol water control temperature was low but in accept-range on the third pass, but was increasing by the fourth pass. The ECS GN<sub>2</sub> sphere pressure leak reported by MCC after liftoff was slight and not detrimental to system performance.

g. Instrumentation and Communications

No problems or complaints were found with the Instrumentation and Communication Systems. Performance was satisfactory on all passes.

h. Miscellaneous

(1) SLA deploy monitor, K149-900, did not indicate the panels were deployed at CRO acquisition, first pass, but this proved to be an incorrect vehicle indication and IM-SLA separation was nominal.

(2) The S-IVB oxidizer tank pressure did not decrease as much as expected during the propellant dump, probably because of dumping mostly liquid. However, when the tank vent valve was opened during the latter portion of the pass, the tank pressure was relieved to a satisfactory level.

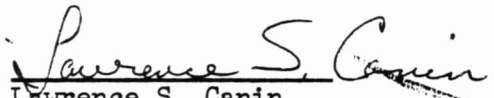
No other anomalies were observed.

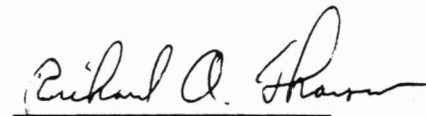
i. Conclusions

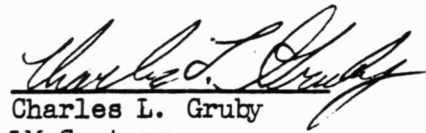
The SLV performed admirably and all its mission objectives are thought to have been achieved. The propellant dump experiment appeared to be successful.

No SLV ground commands were necessary or initiated from Carnarvon.

APOLLO 5  
RKV FLIGHT CONTROL TEAM  
FINAL MISSION REPORT  
JANUARY 24, 1968

  
Lawrence S. Canin  
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## 1. CapCom Postmission Analysis

a. Telemetry reception from the LM was excellent quality throughout the mission. Following the initial contact intermittency, we dropped lock several times midpass during Revs. 1 and 2. Overall, telemetry data was operational and presented no problems.

b. DCS operations presented no problem. This site transmitted two commands to the LM spacecraft during Rev. 4 Guid. Sel. AGS (40B), and PRA start. Both commands radiated only once and MAPS were received. For our Rev. 4 pass, I set the DCS retransmit switch to zero after clearing this procedure with the AFD. After the pass, the switch was set back to three.

c. Network voice communications during the mission was fair. Voice was loud although there was a good deal of high background noise as the day progressed. TTY receive was good at all times. In summary, communications were operational through the mission.

d. Mission support documentation was adequate and no problems encountered in that area. DCI's and Query answers were sufficient to keep our documentation up-to-date.

e. There were no problems encountered with site support. All station equipment was green and all station personnel did an excellent, professional job.

f. Significant mission events occurring over our site were as follows:

(1) On Revs. 1, 2, and 3, the passes were very nominal with no S/C activity. However, the UHF receiver signal strength was varying considerably and would oscillate from -65 DBM to -100 DBM.

(2) On Rev. 4 at about H-9 minutes, we received a pad message indicating that RKV would execute PRA Seq. 3 (MRS). Shortly after our acquisition, LM Systems sent the Guid. Sel. AGS command to the S/C. The command was received and acted upon by the S/C. At a GET of 06:10:00, the CapCom sent the PRA start command to the S/C. The command was received and PRA Seq. 3 initiated. The S/C performed the sequence nominally. Abort stage occurred about two seconds prior to our LOS. UHF receiver signal strength was approximately -65 DBM when both commands were transmitted (we say approximately because it was oscillating slightly).

(3) On Rev. 5 at about H-10 minutes, we were briefed by the AFD that PRA Seq. 5 would be initiated at HAW and that the S/C APS engine would be firing at our acquisition. The APS was firing at our acquisition. Within 30 seconds after AOS, the RCS fuel depleted and the S/C picked up high rates in all axes. The IMU went into gimbal lock. The APS fuel depleted and shutdown approximately three minutes after our AOS (approximately 07:49:00 GET). The high rates continued throughout the pass; however, telemetry remained solid throughout the pass.



## 2. LM Systems Postmission Report

### S/C Systems Analysis -

#### a. Sequential -

(1) LGC Control - All LGC sequential events occurred as planned through launch, RCS pressurization, S/C separation, and all events up to and including DPS-1 ignition. Unfortunately, the LGC Delta V monitor terminated the DPS-1 burn three seconds after ignition thus committing the remainder of the mission to PRA control.

(2) PRA Control - The PRA was used to accomplish the minimum mission objectives and performed faultlessly during PRA Seq. 3 over the RKV and PRA Seq. 5 initiated over HAW.

b. Electrical - The LM electrical power system performed as predicted with no noted anomalies.

c. Environmental - Our analogy indicated that the LM water sublimator performed better than predicted as determined by the glycol temperature and ascent water usage rates.

d. Control - The Control and Electronics System performed all its tasks and incurred no failures during the mission. On RKV Rev. 4, the guidance system was commanded to AGS. At switchover, no transients were observed in either of the three axes. PRA Seq. 3 was started and all events clocked off normally. During the two DPS burns, the rates and attitudes of all axes remained stable. Abort stage took place almost simultaneously with our station LOS.

e. Navigation - The only comment we can offer in this area is that the PGNS performed as expected and further demonstrated reliability by performing an attitude maneuver to positions uplinked by MCC and maintaining those attitudes within expected tolerances.

f. Communications - One problem in the communications systems area which affected all the sites around the range was that of the inability of the S/C to accept commands when the S/C UHF signal strength decreased below a -92 DBM. This measurement would cycle at a very slow rate from a -107 DBM to a -74 DBM. It seems very unlikely to be an antenna pattern versus S/C attitude problem. Telemetry quality was good on all passes and was especially commented on by the M&O personnel as being of the best quality of any vehicle supported by this site, which we might add dates back to the Mercury missions.

g. Instrumentation - No operational problems were encountered with the LM instrumentation system. However, it is appropriate to mention here that considerable difficulty was encountered in verifying proper station patching due to the errors in the Network Operations Directive (NOD) and GSFC's alphanumeric listings dated September 1, 1967. This

we feel is primarily due to the non-standard nomenclature used to identify telemetry parameter on NASA's vehicles. It is recommended that a serious study be initiated to standarize S/C vehicle telemetry formating and nomenclature, thus providing cost and time reductions in network programming and provide NASA with much faster turnaround between missions and vehicles.

h. Miscellaneous - In addition to the normally patched parameters to the Sanborn Recorders, we patched a special board for playback of the Rev. 5 RKV pass which was the APS and RCS depletion burn. The majority of all the APS parameters and RCS parameters patched in logical system flow order. The results will be turned over to the LM Propulsion Section.