Post Launch
Mission Operation Report
No. M-932-70-13

TO: A/Administrator 28 April 1970

FROM: MA/Apollo Program Director

SUBJECT: Apollo 13 Mission (AS-508) Post Launch Mission Operation Report No. 1

The Apollo 13 Mission was successfully launched from Kennedy Space Center, Florida on Saturday, 11 April 1970. Apollo 13 was progressing smoothly to a planned lunar landing until about 56 hours into the flight when a failure occurred in the Service Module cryogenic oxygen system. This resulted in a loss of capability to generate electrical power, to provide oxygen, and to produce water in the Command/Service Module. The decision was made to not perform the lunar landing mission and to return to earth using the Lunar Module for life support, power, propulsion, and guidance. Safe recovery of the crew and Command Module took place in the Pacific Ocean recovery area on Friday, 17 April 1970. An intensive investigation has been initiated to determine the cause of the anomaly.

The Mission Director's Summary Report for Apollo 13 is attached and submitted as Post Launch Mission Operation Report No. 1. Also attached are the NASA OMSF Primary Mission Objectives for Apollo 13. Since these Primary Objectives could not be achieved without a lunar landing, I am recommending that the Apollo 13 Mission be considered unsuccessful. Detailed analysis of all data will continue and appropriate refined results of the mission will be reported in the Manned Space Flight Centers' technical reports.

Rocco A. Petrone
Rocco A. Petrone

APPROVAL:

Dale D. Myers
Dale D. Myers
Associate Administrator for
Manned Space Flight

NASA OMSF PRIMARY MISSION OBJECTIVES FOR APOLLO 13

PRIMARY OBJECTIVES

- Perform selenological inspection, survey, and sampling of materials in a preselected region of the Fra Mauro Formation.
- Deploy and activate an Apollo Lunar Surface Experiments Package (ALSEP).
- Develop man's capability to work in the lunar environment.
- Obtain photographs of candidate exploration sites.

Rocco A. Petrone
Rocco A. Petrone
Apollo Program Director

Date: 24 March 1970

Dale D. Myers
Dale D. Myers
Associate Administrator for
Manned Space Flight

Date: MAR 28, 1970

RESULTS OF APOLLO 13 MISSION

Apollo 13, launched 11 April 1970, was aborted after 56 hours of flight and terminated on 17 April 1970. The planned lunar landing was not accomplished and this mission is adjudged unsuccessful in accordance with the objectives stated above.

Rocco A. Petrone
Rocco A. Petrone
Apollo Program Director

Date: 24 April 1970

Dale D. Myers
Dale D. Myers
Associate Administrator for
Manned Space Flight

Date: Apr 28, 1970

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO ATTN OF: MAO

20 April 1970

TO: Distribution

FROM: MA/Apollo Mission Director

SUBJECT: Mission Director's Summary Report, Apollo 13

INTRODUCTION

The Apollo 13 Mission was planned as a lunar landing mission but was aborted enroute to the moon during the third day of flight due to loss of Service Module cryogenic oxygen and consequent loss of capability to generate electrical power, to provide oxygen, and to produce water in the Command/Service Module. Shortly after the anomaly, the Command/Service Module was powered down and the remaining flight, except for entry, was made with the Lunar Module providing necessary power, environmental control, guidance, and propulsion. Flight crew members were: Commander (CDR), Capt. James Lovell, Jr.; Command Module Pilot (CMP), Mr. John Swigert, Jr.; Lunar Module Pilot (LMP), Mr. Fred W. Haise, Jr. Swigert, officially the backup CMP for the Apollo 13 Mission, was substituted for LCDR Thomas K. Mattingly, II, the prime crew CMP, when it was feared that Mattingly had possibly contracted Rubella, and if so, could be adversely affected in performing his demanding auties. A vigorous simulation program was successfully completed prior to launch to ensure that Lovell, Swigert, and Haise could function with unquestioned teamwork through even the most arduous and time-critical simulated emergency conditions. Significant detailed mission data are contained in Tables 1 through 4.

PRELAUNCH

No problems occurred during space vehicle prelaunch operations to impact the countdown. However, the S-IC Stage No. 2 liquid oxygen (LOX) vent valve did not close when commanded at T minus 1 hour 58 minutes. After cycling the valve several times and flowing ambient nitrogen gas through the valve, it was successfully closed at T minus 1 hour 21 minutes. Weather conditions at launch were: overcast at 20,000 feet, visibility 10 miles, wind 10 knots.

LAUNCH AND EARTH PARKING ORBIT

Apollo 13 was successfully launched on schedule from Launch Complex 39A, Kennedy Space Center, Florida, at 2:13 p.m. EST, 11 April 1970. The launch vehicle stages inserted the S-IVB/Instrument Unit (IU)/spacecraft combination into an earth parking orbit with an apogee of 100.2 nautical miles (NM) and a perigee of 98.0 NM (100-NM circular planned). During second stage boost the center engine of the S-II Stage cut off about 132 seconds early causing the remaining four engines to burn approximately 34 seconds longer than predicted. Space vehicle velocity after S-II boost was 223 feet per second (fps) lower than planned. As a result, the S-IVB orbital insertion burn was approximately 9 seconds longer than predicted with cutoff velocity within about 1.2 fps of planned. Total launch vehicle burn time was about 44 seconds longer than predicted. A greater than 3-sigma probability of meeting translunar injection (TLI) cutoff conditions existed with remaining S-IVB propellants.

After orbital insertion, all launch vehicle and spacecraft systems were verified and preparations were made for TLI. Onboard television was initiated at 01:35 GET (hour: minutes ground elapsed time) for about 5.5 minutes. The second S-IVB burn was initiated on schedule for TLI. All major systems operated satisfactorily and all end conditions were nominal for a free-return circumlunar trajectory.

TRANSLUNAR COAST

The Command/Service Module (CSM) separated from the Lunar Module (LM)/IU/S-IVB at about 03:07 GET. Onboard television was then initiated for about 72 minutes and clearly showed CSM "hard docking," ejection of the CSM/LM from the S-IVB/IU at about 04:01 GET, and the S-IVB Auxiliary Propulsion System (APS) evasive maneuver as well as spacecraft interior and exterior scenes. Service Module Reaction Control System (SM RCS) propellant usage for the separation, transposition, docking, and ejection was nominal. All launch vehicle safing activities were performed as scheduled.

The S-IVB APS evasive maneuver by an 8-second APS ullage burn was initiated at 04:18 GET and was successfully completed. The LOX dump was initiated at 04:39 GET and was also successfully accomplished. The first S-IVB APS burn for lunar target point impact was initiated at 06:00 GET. The burn duration was 217 seconds producing a differential velocity of approximately 28 fps. Tracking information available at 08:00 GET indicated that the S-IVB/IU would impact at 6°53'S, 30°53'W versus the targeted 3°S, 30°W. Therefore, the second S-IVB APS (trim) burn was not required. The gaseous nitrogen pressure dropped in the IU ST-124-M3 inertial platform at 18:25 GET and the S-IVB/IU no longer had attitude control but began tumbling slowly. At approximately 19:17 GET, a step input in tracking data indicated a velocity increase of approximately 4 to 5 fps. No conclusions have been reached on the reason for this increase. The velocity change altered the lunar impact point closer to the target. The S-IVB/IU impacted the lunar surface at 77:56:40 GET (08:09:40 p.m. EST, 14 April) at 2.4°S, 27.9°W and the seismometer deployed during the Apollo 12 Mission successfully detected the impact (see "MISSION SCIENCE"). The targeted impact point was 125 NM from the seismometer. The actual impact point was 74 NM from the seismometer, well within the desired 189-NM (350-kilometer) radius.

The accuracy of the TLI maneuver was such that spacecraft midcourse correction No. 1 (MCC-1), scheduled for 11:41 GET, was not required. MCC-2 was performed as planned at 30:41 GET and resulted in placing the spacecraft on the desired, non-free-return circumlunar trajectory with a predicted closest approach to the moon of 62 NM. All Service Propulsion System (SPS) burn parameters were normal. The accuracy of MCC-2 was such that MCC-3, scheduled for 55:26 GET, was not performed. Good quality television coverage of the preparations and performance of MCC-2 was received for 49 minutes beginning at 30:13 GET.

At approximately 55:55 GET (10:08 p.m. EST) the crew reported an undervoltage alarm on the CSM Main Bus B. Pressure was rapidly lost in Service Module oxygen tank No. 2 and fuel cells 1 and 3 current dropped to zero due to loss of their oxygen supply. A decision was made to abort the mission. The increased load on fuel cell 2 and decaying pressure in the remaining oxygen tank led to the decision to activate the LM, power down the CSM, and use the LM systems for life support.

At 61:30 GET, a 38-fps midcourse maneuver (MCC-4) was performed by the LM Descent Propulsion System (DPS) to place the spacecraft in a free-return trajectory on which the Command Module (CM) would nominally land in the Indian Ocean south of Mauritius at approximately 152:00 GET.

TRANSEARTH COAST

At pericynthion plus 2 hours (79:28 GET), a LM DPS maneuver was performed to shorten the return trip time and move the earth landing point. The 263.4-second burn produced a differential velocity of 860.5 fps and resulted in an initial predicted earth landing point in the mid-Pacific Ocean at 142:53 GET. Both LM guidance systems were powered up and the primary system was used for this maneuver. Following the maneuver, passive thermal control was established and the LM was powered down to conserve consumables; only the LM Environmental Control System (ECS) and communications and telemetry systems were kept powered up.

The LM DPS was used to perform MCC-5 at 105:19 GET. The 15-second burn (at 10% throttle) produced a velocity change of about 7.8 fps and successfully raised the entry flight path angle to -6.52°.

The CSM was partially powered up for a check of the thermal conditions of the CM with first reported receipt of S-band signal at 101:53 GET. Thermal conditions on all CSM systems observed appeared to be in order for entry.

Due to the unusual spacecraft configuration, new procedures leading to entry were developed and verified in ground-based simulations. The resulting timeline called for a final midcourse correction (MCC-7) at entry interface (EI) -5 hours, jettison of the SM at EI -4.5 hours, then jettison of the LM at EI -1 hour prior to a normal atmospheric entry by the CM.

MCC-7 was successfully accomplished at 137:40 GET. The 22.4-second LM RCS maneuver resulted in a predicted entry flight path angle of -6.49°. The SM was jettisoned at 138:02 GET. The crew viewed and photographed the SM and reported that an entire panel was missing near the S-band high-gain antenna and a great deal of debris was hanging out. The CM was powered up and then the LM was jettisoned at 141:30 GET. The EI at 400,000 feet was reached at 142:41 GET.

ENTRY AND RECOVERY

Weather in the prime recovery area was as follows: Broken stratus clouds at 2000 feet; visibility 10 miles; 6-knot ENE winds; and wave height 1 to 2 feet. Drogue and main parachutes deployed normally. Visual contact with the spacecraft was reported at 142:50 GET. Landing occurred at 142:54:41 GET (01:07:41 p.m. EST, 17 April). The landing point was in the mid-Pacific Ocean, approximately 21°40'S, 165°22'W. The CM landed in the stable 1 position about 3.5 NM from the prime recovery ship, USS IWO JIMA. The crew was picked up by a recovery helicopter and was safe aboard the ship at 1:53 p.m. EST, less than an hour after landing.

MISSION SCIENCE

The S-IVB Stage, weighing about 30,700 pounds, impacted the moon 74 NM from the Apollo 12 seismometer at an angle of about 80° to the horizontal with a velocity of 8465 fps and an energy equivalency of 11.5 tons of TNT. These data compare with the Apollo 12 LM, which hit the moon at a distance of 42 NM from the seismometer at an angle of 3° to the horizontal, and an equivalent energy of approximately 1 ton of TNT.

The overall character of the seismic signal is similar to that of the LM impact signal, but the higher impact energy gave a seismic signal 20-30 times larger than the LM impact and 4 times longer in duration (approximately 4 hours vs 1 hour). The signal was so large that the gain of the seismometer had to be reduced by ground command to keep the recording on scale. A clear signal was recorded on the three long period components so that it is possible to distinguish each event with absolute certainty. Thirty seconds elapsed between time of impact and arrival of the seismic wave at the seismometer; peak amplitude occurred 7 minutes later.

The signal arrival time had been predicted on the basis of velocity measurements made on the Apollo 11 and 12 lunar sample materials in the laboratory. The average velocity of the seismic wave through the lunar material is 4.6 km/sec which compares favorably with the 3.2-km/sec velocity recorded by the LM impact. The depth of penetration of the S-IVB impact signal is believed to be 20-40 km (vs 20 km for LM impact). This result implies that the outer shell of the moon, to depths of at least 20-40 km, may be formed of the same crystalline rock material as found at the surface. No evidence of a lower boundary to this material has been found in the seismic signal, although it is clear that it is too dense to form the entire moon.

One puzzling feature of the signal is the unexpectedly rapid build-up from the beginning to its maximum. This part of the signal, at least, cannot be satisfactorily explained by scattering of seismic waves in a rubble material as was thought possible from the earlier LM impact data. Scattering of signals may explain the later part of the signal. Several alternate hypotheses are under study, but no firm conclusions have been reached. One possibility is that the expanding cloud of material from the impact produces seismic signals continuously as it sweeps across the lunar surface.

The fact that such precise targeting accuracy was achieved for the S-IVB and that the resulting seismic signals were so large have greatly encouraged scientists to believe that planned future impacts can be extended to ranges of at least 500 km and that the data return will provide the means for determining the structure of the moon to depths approaching 200 km.

The Suprathermal Ion Detector Experiment (SIDE), also part of the ALSEP 1 experiments package deployed during the Apollo 12 Mission, recorded a jump in the number of ion counts after the S-IVB impact. Since the instrument was in lunar shadow at the time of impact the ion count was essentially zero. A few ions were recorded 22 seconds after impact; a second frame of data showed a jump to 250 ions, the third jumped to 2500 ions, the fourth dropped back to a few ions, then the count fell back essentially to zero. These ions were in the 70 electron volt energy range. All of the counts were observed over a period of 70 seconds. In addition to the ion counts, the mass analyzer of the instrument also recorded ions, almost all of which were in the 50-80 mass unit range (hydrogen = 1 mass unit).

Two possible mechanisms have been given for producing ions: (1) temperatures in the ranges 6000-10,000°C generated by the S-IVB impact could produce ionization; (2) particles that reach heights of 60 km could also be ionized by sunlight.

SYSTEMS PERFORMANCE

Saturn V S-IC ignition, holddown arm release, and liftoff were accomplished within expected limits and indications are that S-IC systems performed at or near nominal. LOX tank pressure was as expected throughout the burn.

All S-II Stage systems were nominal throughout S-II burn until the center J-2 engine shut down approximately 132 seconds earlier than scheduled. Low frequency oscillations (14 to 16 hertz) experienced on the S-II Stage resulted in a 132-second premature center engine cutoff. Preliminary analysis indicates that a "Thrust OK" pressure switch cutoff occurred due to large pressure oscillations in the LOX system. No apparent engine or structural damage was incurred. Oscillations in the stage and outboard engines decayed to a normal level following center engine cutoff. Preliminary data does not indicate any off-nominal performance of the four outboard engines.

All S-IVB systems operated within expected limits during both the first and second burns. The first burn was 9.2 seconds longer than predicted, making up for the velocity deficit at S-II cutoff. The second (TLI) burn was approximately 5 seconds longer than predicted from observed orbital conditions. A small vibration was reported by the crew approximately 90 seconds prior to second burn cutoff.

All IU guidance and control functions were satisfactory and all systems performed as expected.

Performance of the CSM fuel cell and cryogenic systems was nominal until 55:53:36 GET when an unusual pressure rise was noted in oxygen tank No. 2. The pressure continued to rise to the relief valve crack pressure of 1004.1 psia (pounds per square inch absolute). One second later, at 55:54:45 GET, the pressure reached a maximum of 1008.3 psia at which time the tank vent valve apparently opened. The last valid tank pressure reading prior to loss of data was 995.7 psia at 55:54:53 GET. At 55:54:54 GET an undervoltage caution light occurred on Main Bus B, which was powered by fuel cell 3. Concurrent with the abrupt loss of oxygen tank No. 2 pressure, oxygen tank No. 1 pressure showed a rapid decrease to about 373 psia in 87 seconds. Fuel cells 1 and 3 were removed from the line about 18 minutes after the anomaly. Fuel cell 2 remained in operation for about 2 hours before the oxygen pressure in tank No. 1 had decreased to 61 psia and the fuel cell was removed from the line. As a result of these occurrences, the CM was powered down and the LM was configured to supply the necessary power and other consumables.

Power down of the CSM began at 58:40 GET. The surge tank and repressurization package were isolated with approximately 860 psi residual pressure (approximately 6.5 pounds of oxygen total). The primary water glycol system was left with radiators bypassed. Indicated water tank residuals were 18.0 pounds in the waste tank and 37.5 pounds in the potable tank. All SM RCS quads were powered down with heaters deactivated. All SPS parameters were nominal before and after the anomaly and no configuration changes took place after the anomaly.

All LM systems performed satisfactorily in providing the necessary power and environmental control to the spacecraft. The requirement for lithium hydroxide to remove carbon dioxide from the spacecraft atmosphere was met by a combination of CM and LM cartridges since the LM cartridges alone would not satisfy the total requirement.

The crewmen, with instructions from Mission Control, built an adapter from the CM cartridges to accept the LM hoses.

The LM supercritical helium (SHe) tank pressure exhibited an increased rise rate after the second DPS firing. Prior to the burn, the rise rate had been 11 psi per hour. After the burn, the rate increased to 33 psi per hour. After the third DPS maneuver, the SHe tank burst disc ruptured at 108:54 GET at a pressure of about 1940 psi, within the expected range. The passive thermal control mode in use at the time was affected by a small attitude rate change from the venting SHe changing from a right yaw rate of 0.3°/sec to a left yaw rate of 3.0°/sec, but did not cause any problem.

The CSM was partially powered up at about 101:53 GET with the following results:

Telemetry - Following a brief period of intermittent S-band reception, solid telemetry was received from 101:49 GET to system power-down at 102:03 GET. Telemetry system performance was nominal throughout the time period it was powered up.

Instrumentation - A summary review indicated no discrepancies. The central timing equipment updated correctly in resetting to 0 (zero) and indicating accumulated time from the turn-on associated with the status check of the CSM at 101:53 GET.

Electrical Power - All system bus voltage and inverter performance was nominal. Only Main Bus B, Battery Bus B, and AC Bus 1 were powered up. Prior to instrumentation power-up, the three entry batteries had been on "true" open circuit (i.e., no parasitic loads) since approximately 58:40 GET. All performance to that point had been nominal. CSM Main Bus B was powered up using Battery B and performance under load was nominal. Approximately 2.5 ampere-hours were consumed. Battery A, which was used to supplement CM power immediately following the fuel cell anomaly, was recharged from the LM ascent batteries. Battery B was also recharged.

Displays and Controls - No discrepancies noted.

Thermal/Propulsion - CM RCS helium tank temperatures were approximately as predicted with one about 4°F higher than predicted. SM RCS engine package and RCS and SPS temperatures indicated satisfactory passive thermal control. A CSM RCS engine heat-up procedure was required prior to separating the LM/CM combination from the SM. Other data available indicated the CM RCS system was nominal. All SPS parameters remained nominal during the powered-down portion of the flight. The oxidizer and fuel tank pressures decreased 6 psi each after the CSM was powered down, which can be attributed to helium absorption.

CREW PERFORMANCE

The Apollo 13 flight crew performance was outstanding throughout the flight. Most noteworthy was their calm, precise reaction to the emergency situation and their subsequent diligence in configuring and maintaining the LM for safe return to earth. Despite lack of adequate sleep and the low temperature in the spacecraft, neither their performance nor their spirits ever faltered throughout the flight. Similarly, the flight operations team exhibited outstanding performance throughout the flight in planning and aiding the crew to a safe return.

All information and data in this report are preliminary and subject to revision by the normal Manned Space Flight Center technical reports.

C. M. Lee

TABLE 1

APOLLO 13
LAUNCH VEHICLE SEQUENCE OF EVENTS

EVENT	*PLANNED (GET) HR:MIN:SEC	ACTUAL (GET) HR:MIN:SEC
Range Zero (02:13:00.0 p.m. EST, 11 April)	00:00:00.0	00:00:00.0
Liftoff Signal (Timebase 1)	00:00:00.7	00:00:00.6
Pitch and Roll Start	00:00:12.5	00:00:12.6
Roll Complete	00:00:30.4	00:00:32.1
S-IC Center Engine Cutoff (TB-2 minus .1 sec)	00:02:15.3	00:02:15.2
Begin Tilt Arrest	00:02:42.0	00:02:43.3
S-IC Outboard Engine Cutoff (TB-3)	00:02:44.0	00:02:43.6
S-IC/S-II Separation	00:02:44.7	00:02:44.3
S-II Ignition (Command)	00:02:45.4	00:02:45.0
S-II Second Plane Separation	00:03:14.7	00:03:14.3
Launch Escape Tower Jettison	00:03:20.4	00:03:20.0
S-II Center Engine Cutoff	00:07:43.0	00:05:30.6
S-II Outboard Engine Cutoff (TB-4 minus .1 sec)	00:09:18.1	00:09:52.6
S-II/S-IVB Separation	00:09:19.0	00:09:53.5
S-IVB Ignition	00:09:22.1	00:09:56.9
S-IVB Cutoff (TB-5 minus .2 sec)	00:11:45.8	00:12:29.8
Earth Parking Orbit Insertion	00:11:55.8	00:12:39.8
Begin Restart Preparation (TB-6)	02:25:49.9	02:26:08.1
Second S-IVB Ignition	02:35:27.9	02:35:46.4
Second S-IVB Cutoff (TB-7 minus .2 sec)	02:41:23.6	02:41:37.2
Translunar Injection	02:41:33.6	02:41:47.2
CSM/S-IVB Separation	03:06:27.8	03:06:38.9
Spacecraft Ejection from S-IVB	04:01:23.8	04:01:03.0
S-IVB APS Evasive Maneuver	04:19:25.0	04:18:00.5
LOX Dump	04:40:43.8	04:39:19.3
S-IVB APS Maneuver for Lunar Impact	06:00:00.0	05:59:59.0
S-IVB Lunar Impact	77:48:32.0	77:56:40.0

*Prelaunch planned times are based on MSFC launch vehicle operational trajectory

TABLE 2

APOLLO 13
MISSION SEQUENCE OF EVENTS

EVENT	GROUND ELAPSED TIME (HR:MIN:SEC)
Range Zero (02:13:00.0 p.m. EST, 11 April)	00:00:00
Earth Parking Orbit Insertion	00:12:40
Second S-IVB Ignition	02:35:46
Translunar Injection	02:41:47
CSM/S-IVB Separation	03:06:39
Spacecraft Ejection from S-IVB	04:01:03
S-IVB APS Evasive Maneuver	04:18:01
S-IVB APS Maneuver for Lunar Impact	05:59:59
Midcourse Correction - 2 (Hybrid Transfer)	30:40:50
Liquid Oxygen Tank Anomaly	55:54:53
Midcourse Correction - 4	61:29:43
S-IVB Lunar Impact	77:56:40
Pericynthion Plus 2 Hour Maneuver	79:27:39
Midcourse Correction - 5	105:18:32
Midcourse Correction - 7	137:39:49
Service Module Jettison	138:02:06
Lunar Module Jettison	141:30:02
Entry Interface	142:40:47
Landing	142:54:41

TABLE 3

APOLLO 13 TRANSLUNAR AND TRANSEARTH MANEUVER SUMMARY

MANUEVER	GROUND ELAPSED TIME (GET) AT IGNITION (hr:min:sec)			BURN TIME (seconds)			VELOCITY CHANGE (feet per second - fps)			GET OF CLOSEST APPROACH HT. (NM) CLOSEST APPROACH		
	PRE-LAUNCH	REAL-TIME	ACTUAL	PRE-LAUNCH PLAN	REAL-TIME PLAN	ACTUAL	PRE-LAUNCH PLAN	REAL-TIME PLAN	ACTUAL	PRE-LAUNCH PLAN	REAL-TIME PLAN	* ACTUAL
TLI (S-IVB)	02:35:27.9	Not Available	2:35:46.4	355.7	346	350.7	10,437.1	Not Available	Not Available	77:40:21.9 210	Not Available Not Available	77:51:17 415.8
MCC-1	11:41:23.5	N.A.	N. P.	0.0	N.A.	N. P.	0.0	N.A.	N. P.	77:40:21.9 210	Not Available Not Available	N. P. N. P.
MCC-2 (SPS)	30:40:49.0	30:40:49.0	30:40:50	2.2	3.39	3.37	14.7	23.2	23.1	77:15:00 57.3	77:28:34 60.22	77:28:37 64.87
MCC-3	55:26:02	N.A.	N. P.	0.0	N.A.	N. P.	0.0	N.A.	N. P.	77:15:00 57.3	N. A. N. A.	N. P. N. P.
Nominal mission aborted at this point--remaining maneuvers planned in real time for return to earth										GET entry interface (EI) Velocity (fps) at EI Flight path angle at EI		
MCC-4 (DPS)	N. A.	61:29:42.8	61:29:42.8	N. A.	30.7	30.4	N. A.	38.0	37.8	N. A. N. A. N. A.	151:45:06 36,141.2 -6.53	151:45:27 36,141.1 -6.53
PC+2 (DPS)	N. A.	79:27:38.3	79:27:39	N. A.	263.7	263.4	N. A.	861.5	860.5	N. A. N. A. N. A.	142:38:52 36,209.6 -6.50	142:39:00 36,210.6 -6.53
MCC-5 (DPS)	N. A.	105:30:00	105:18:32	N. A.	15:38	15:38	N. A.	7.8	7.8	N. A. N. A. N. A.	142:40:35 36,211 -6.51	142:40:34 36,210.61 -6.52
MCC-7 (LM RCS)	N. A.	137:39:48.4	137:39:49.4	N. A.	23.2	22.4	N. A.	3.1	2.9	N. A. N. A. N. A.	142:40:40 36,210 -6.50	142:40:41 36,210 -6.49

N. A. - Not Applicable N. P. - Not Performed * Actual values are as determined shortly after maneuver.

TABLE 4

APOLLO 13 DISCREPANCY SUMMARY

LAUNCH VEHICLE (SA-508)

1. EARLY S-II CENTER ENGINE CUTOFF/S-II LOW FREQUENCY OSCILLATIONS.

COMMAND/SERVICE MODULE (CSM-109)

1. SUIT PRESSURE TRANSDUCER READING APPROXIMATELY .5 PSI BELOW CABIN PRESSURE.

2. POTABLE WATER QUANTITY READING — READING ERRATIC. DROPPED APPROXIMATELY 20% AT APPROXIMATELY 22:42:50 GET, THEN RETURNED TO 100%.

3. 40:00 GET — OPTICS COUPLING DISPLAY UNIT FLUCTUATING 0.16 DEGREES IN ZERO OPTICS MODE.

4. OXYGEN TANK NO. 2 QUANTITY WENT TO OFF-SCALE HIGH AT 46:45 GET, CABIN METER CONFIRMED AS OFF-SCALE HIGH BY THE CREW AT 47:42 GET. PROBLEM OCCURRED AFTER THE CRYOGENIC FANS WERE ACTIVATED.

5. OXYGEN TANK NO. 2 PRESSURE DROPPED TO ZERO PSI AT 55:54:52 GET. OXYGEN TANK NO. 1 PRESSURE BEGAN TO DECAY AT THE SAME TIME, DROPPING 373 PSI IN 1 MINUTE 14 SECONDS.

LUNAR MODULE (LM-7)

1. BATTERY 2 SENSOR MALFUNCTION ON CAUTION AND WARNING AT 99:57 GET.

2. PROPULSIVE SUPERCRITICAL HELIUM TANK VENT.

3. CHANGE IN SUPERCRITICAL HELIUM PRESSURE RISE AFTER DPS FIRING NO. 1 (FROM 6.9 PSI/HR TO 11.5 PSI/HR) AND AGAIN AFTER DPS FIRING NO. 2 (FROM 11.5 PSI/HR TO 33 PSI/HR).