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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

# APOLLO 12 TECHNICAL CREW DEBRIEFING

(U)

DECEMBER 1, 1969

PREPARED BY:  
MISSION OPERATIONS BRANCH  
FLIGHT CREW SUPPORT DIVISION

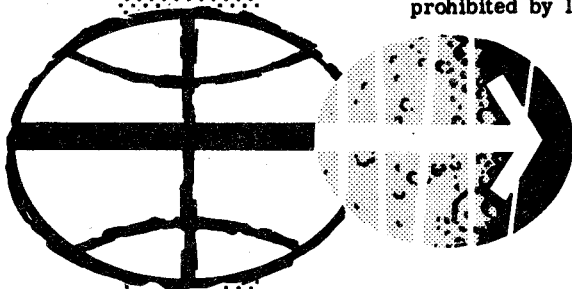
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SECURITY CLASSIFICATION

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1-1

1.0 SUITING AND INGRESS

CONRAD . There were no noted differences from the published procedure.

GORDON I agree. It was all nominal.

CONRAD It was like a CDDT.

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1. [Illegible text]

2. [Illegible text]

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## 2.0 STATUS CHECKS AND COUNTDOWN

CONRAD There were no noted differences from published procedures.

BEAN The S-band antenna was in the wrong position in the spacecraft and we changed that before lift-off. The other is the water under the BPC.

### 2.5 Distinctions of Sounds in the Launch Vehicle Sequence, Countdown to Lift-Off

CONRAD We noted no sounds whatsoever from the boosters. It was extremely quiet up there. The only noteworthy condition was discussed the previous evening with George Page in the control room. We had discussed the heavy rain and the fact they were going to roll back the White Room. I was concerned about water and he rested assured that the BPC was waterproof and that it was perfectly safe. My other concern was that the upward firing SM RCS thrusters were all going to be full of water. Everybody concluded that this was no problem. During the countdown with the wind blowing up there, it was obvious to me that water was leaking between the BPC and the spacecraft. I could see water on my two windows — windows 1 and 2. We experienced varying amounts passing across these windows, dependent on how heavily it was raining. These were the only things noted up to lift-off.

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[REDACTED]

[REDACTED]

### 3.0 POWERED FLIGHT

#### 3.1 S-IC IGNITION

CONRAD The three of us felt that the noise level was lower than anticipated. None of us wore anything except the normal helmets. We had no earpieces or eartubes as some previous crews had used. Throughout the atmospheric portion of powered flight where you can expect high noise levels, we didn't find it particularly noisy. The flight was extremely normal for the first 36 seconds and after that it got very interesting.

#### 3.2 LIFT-OFF

GORDON I want to say there were very good physical cues and there was no doubt in anybody's mind that lift-off had occurred. The cues were there, and you knew when lift-off had occurred regardless of the clock and the lift-off call from LCC.

CONRAD I'll run quickly through the launch program here.

#### 3.3 Launch Vehicle Lights

CONRAD The launch vehicle lights went out as advertised in the proper sequence. They are slightly staggered and it was about a second and a half before lift-off — all the lights were out and we had lift-off.

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### 3.4 Roll Program

CONRAD The roll program was on time.

### 3.5 Pitch Program

CONRAD The pitch program was on time.

### 3.6 Rate Changes

CONRAD I didn't notice the rate changes, because, at 36 seconds, I first noticed that something had happened outside the spacecraft. I was aware of a white light. I knew that we were in the clouds; and, although I was watching the gauges I was aware of a white light. The next thing I noted was that I heard the MASTER ALARM ringing in my ears and I glanced over to the caution and warning panel and it was a sight to behold. There's a little disagreement among us and I'll have to look at the tapes, but my recollection of what I called out was three FUEL CELL lights, both AC 1 BUS and AC 1 OVERLOAD, FUEL CELL DISCONNECT, MAIN A and B BUS OVERLOAD lights, and I was not aware of AC 2 lights. Dick thought they were on. I don't think they were because I remember thinking that the only lights that weren't on of the electrical system was AC 2 and maybe I ought to configure for an AC BUS 1 out.

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GORDON Let me make a comment here. A considerable length of time elapsed between the time those lights came on and when Pete read them off to the ground. I can't swear positively that they were all on. To help Al, my usual habit was, when any light came on during the boost phase, to read it out so that he didn't have to be concerned with which light it was. My recollection is that when I first glanced up there I didn't read any of them to him, but I scanned all of them and the only thing I said to him was, "Al, all the lights are on." I am under the impression that at one time, or initially at least, they were all on. Pete read it out quite a bit later. We'd talked about it and you read them out a minute or so later.

CONRAD I went back to my gauges and ascertained that everything was running on my side. About this time, the platform tumbled. The next thing I noted was that the ISS light was on. This was obvious because my number 1 ball was doing 360's. I even took the time to peek under the card and we had a PROGRAM ALARM light, the GIMBAL light, and a NO ATT light. So we lit up just about everything in the spacecraft. Since that time, we found out that we were hit a second time and that's probably what did the platform in. When the platform went, Al was telling me that we had voltage on all buses and that we had all buses. I remember him telling me that the voltage was low — 24 volts.



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BEAN We got all the lights. I didn't have an idea in the world what happened. My first thought was that we might have aborted, but I didn't feel any g's, so I didn't think that was what had happened. My second thought was that somehow the electrical connection between the command module and the service module had separated, because all three fuel cells had plopped off and everything else had gone. I immediately started working the problem from the low end of the pole. I looked at both ac buses and they looked okay, so that was a little confusing.

GORDON You looked at the voltage meters, not the lights.

BEAN Yes, that's right. I looked at the volts — the lights were on. I looked at the voltage and the voltage on all phases was good. This was a little confusing. Usually when you see an ac over-voltage light, either a inverter goes off or you have one of the ac phases reading zero and you have to take the inverter off. In this case, they all looked good and that was a bit confusing. I switched over and took a look at the main buses. There was power on both, although the voltage was down to about 24, which was a lot lower than normal. I looked at the fuel cells and they weren't putting out a thing. I looked at the battery buses and they were putting out the same 24 volts. They were hooked into the mains and it turned out that they were supplying the load. As I did this, I kept telling Pete we had

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BEAN (CONT'D) power on all these buses. One of the rules of space flight is you don't make any switch-a-roos with that electrical system unless you've got a good idea why you're doing it. If you don't have power at all, you might change a couple of switches to see what will happen. When you have power and everything is working, you don't want to switch too much. I didn't have any idea what had happened. I wasn't aware anything had taken place outside of the spacecraft. I was visualizing something down in the electrical systems.

CONRAD We had a crew rule to handle electrical emergencies. Al did not do any switching without first telling me what he was going to do. When he told me that we had power on all buses, I remember making the comment to him not to do anything until we got through staging.

BEAN Yes, that is right. I didn't have any ideas anyway. I knew we had power, so I didn't want to make any changes. I figured we could fly into orbit just like that and that's exactly what we did. The ground came up a little later and said to put the fuel cells back on the line. I was a little hesitant about doing that, because I didn't understand that we had been hit by lightning. I gave it a go and, sure enough, things started working very well after that.

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CONRAD Because I could see outside, I made the comment to them several times. I told the ground that I thought we had been hit by lightning. I was the only one that had any outside indications. Dick didn't note anything over his little hole in his center window. I was the only one who noticed anything and that was only the first time. I was aware that something external to the spacecraft had happened. I had the decided impression that I not only saw it, but felt it and heard it.

BEAN I think the one thing I should have done was put battery C on both buses. I don't think you're going to hurt yourself doing this. I would not have tried to reset the fuel cells or anything else any faster than when the ground called up, because everything was working fairly well and we were in a critical flight phase. I didn't want to take a chance of taking out a bus with a bad switch.

GORDON I think it was a smart decision. We've all learned that by arbitrarily switching the electrical system around, you can get yourself into more trouble.

BEAN You could lose the whole ballgame and we had the whole ballgame. We were in pretty good shape.

CONRAD I never considered any kind of an abort. The only concern that passed my mind was winding up in orbit with that dead spacecraft.

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CONRAD  
(CONT'D)

As far as I could see, as long as Al said he had power on the buses and the COMM was good, we'd press on. We had a long time to go before we could do a mode II and so the thought never crossed my mind about aborting at any point. I wanted to make sure we had enough time to psych it out. The main concern I had was getting through staging where we got the g levels back down again and we had a little more time to sort out what was going on. So we can back up and say that we heard cabin pressure venting. Engine gimbaling was apparent to everybody in the first 15 or 20 seconds of powered flight, especially going by the tower. The "Tower Clear" call was loud and clear.

GORDON

Let me inject something here. During this time, we didn't have any roll or any calls from the ground or anything. I didn't hear I-B called out; during all the confusion of all the lights, I did not throw the RCS propellant command to RCS. I missed that switch. The next thing I recall being called from the ground after this electrical problem got sorted out in everybody's mind was a I-C call and I thought, "I've got to get over here," and I turned off the RCS propellant command at that time. Then, in 2 minutes, I got the EDS. I guess the rules say that when you lose a fuel cell you turn off the EDS; but there was so much confusion at that time that I just got the EDS functions at the 2 minute time.

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CONRAD I guess the most serious thing was the second lightning strike, which we weren't aware of. I was under the impression we lost the platform simply because of low voltage but apparently that's not the case. Apparently we got hit a second time at that point. Dick's right with that EDS AUTO enabled. All we needed to do was blow a battery off the line and I have a decided impression we would have gotten an AUTO abort.

GORDON No, you need two of them.

CONRAD I think because of previous crew briefings, there were no surprises in S-IC staging. We got all the good things that most people mentioned and so much for that.

### 3.10 S-II Engine Ignition

CONRAD S-II engine ignition was smooth and the ride throughout the S-II flight was as advertised except for a 1 to 2 Hz vibration we felt throughout the whole burn.

GORDON It was not necessarily longitudinal and was just a general vibration.

CONRAD I don't really know what it was. I was just aware of it. I don't think any of us noticed the mixture ratio shift on the S-II. We did notice it on the S-IVB. The tower and BPC went as advertised; but, when they did they unloaded a whole

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[REDACTED]

CONRAD (CONT'D) pile of water on the spacecraft again and this water streaked down the windows and froze immediately. At the same time, the water picked up particles from the LET jettison motor and deposited a white ash in the form of oil droplets and streaks all over windows 1, 2, and 3; a little on 4, and none on 5, which was our best window. The ice sublimated later enroute to the Moon after TLI, but it left white deposits in the form of spiderweblike things in the corner crevices and as a white deposit on the windows. The S-II center engine shutdown came as advertised and S-II shutdown came on time.

### 3.15 S-IVB IGNITION

CONRAD S-II and S-IVB separations were smooth and normal. S-IVB ignition was smooth. The ride on the S-IVB was very nice. Communications throughout the whole launch were outstanding. One other anomaly during all this mess with the lights: We had several MASTER ALARMS after the initial one that turned out to be the CO<sub>2</sub> sensor. It flashed on and off several times; when we looked at the gauge, it was just cycling from zero to full scale. It finally quivered one more time and gave up the ghost and died somewhere in the powered flight, never to be heard from again for the rest of the mission. The remaining controls displays operated as normal until we were in flight, when we noticed we had a failure of our service module RCS

[REDACTED]

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CONRAD quantity gauge. This must have been a gauge failure because  
(CONT'D) it failed for all four quads.

As far as any other sensations through powered flight were concerned, we felt that they were all normal per previous crew briefings.

GORDON Number 1 window picked up some ice right in the center sometime after launch. The ice looked like it was about 3 inches in diameter and was located on the inside of the outer pane. It actually sublimated off during our first night and was gone the morning of the second day.


CONRAD I don't know where that came from. I don't have any idea and there wasn't anything like it on the other windows.

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4.0 EARTH ORBIT AND SYSTEMS CHECKOUT

CONRAD There was no evaluation of the insertion parameters. We didn't have a computer or we didn't have a platform. So, we started our normal postinsertion systems configuration checks. We knew we had to do a P51 immediately upon hitting darkness, so Dick started hustling down the LEB during daylight. The ground was going through a full-scale review so it could be determined what happened and whether they were going to give us the GO for TLI or not. We had to get the platform up. I knew they wanted to look at that and I was sure they were going to come up with several other things for us to look at; which they did. All of them we agreed with; all of them were no strain to pick out. I think the ground organized it very well by passing us the pages of the checklist they wanted to run over. They wanted a quick P52. We knew they were going to ask for second P52 to get a look at the platform. They wanted an MTV check of VERB 74 on the erasable and I presumed they looked at many other systems on the telemetry. We got the ORDEAL up and operating. Dick jettisoned the optics covers.

GORDON ... No debris was noticed as I saw the optics covers go through the sextant. I heard them go. I just had the optics control full-right so that the shaft angle was increasing. By the time





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GORDON (CONT'D) I got over to look through telescope, the cover had already gone. I did not see it go, but I was positive that both covers, in fact, had left the spacecraft.

CONRAD The S-IV responded as it should, there was no doubt in my mind without a COAS in the window that we were in local horizontal torquing. The unstorage went per checklist. The COMM was good and per previous simulations. Except for the additional systems checks we went through, the TLI PREP went exactly according to checklist. We'll each cover the one anomaly we noted in the CO<sub>2</sub> sensor and the two anomalies in the RCS gauge somewhere along the line. I was very surprised I couldn't hear the RCS thrusters fire when we did the pulse check. The ground came back and assured me that Neil couldn't hear them either. The reason I pulsed several times on it was that I was still worried about the water in those thrusters. I wasn't convinced, in my mind, that we had not frozen some thrusters full of ice as there was water on the windows. Everybody thought it would disappear and it hadn't. I was concerned about those service module RCS thrusters, but the ground assured me they were working okay and it was all right with us. We all had a fullness in the head and, other than that, I don't think anyone suffered any nausea, vertigo, or any other symptom.

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[REDACTED]

CONRAD Unless someone wants to comment on that, I'll let Dick talk  
(CONT'D)  
about the P51.

BEAN I think we were all pretty careful and I had the feeling that if I had moved around a lot, I could have gotten dizzy. But I never did. Everyone was pretty careful and after about a day, it didn't make any difference. We were doing anything we wanted. I don't know if anyone mentioned it before, but your head shape changes. I looked over at Dick and Pete about 2 hours after insertion and their heads looked as if they had gained about 20 pounds.

BEAN Did you mention that inside some of those windows, not only did we have that icy stuff, but we have that fluffy cottonlike material?

CONRAD That cottonlike material was on the outside and that's what I called a spider web. It was actually ice to begin with, and when the ice sublimated, it just left those filmy deposits.

GORDON I'm sure it was the deposits we picked up during BPC jettison. I don't know where it was from, but it was there.

BEAN You did a gimbal motor check too, didn't you?

GORDON Yes, MTV check. I guess Pete has covered all the extra things

[REDACTED]

~~CONFIDENTIAL~~GORDON  
(CONT'D)

we did as far as the systems are concerned: E-memory dump, self-check, TVC check, and getting ready for TLI. Before I get in the P51, I might comment on the nausea, vertigo, and other disturbances I fully expected in the head, which was experienced in other flights by other people. I guess my comment is, that it was there and was recognized and there was no concern. After the first night, it was gone and never returned. I was hustling around the LEB area quite a bit because I knew we had a lot to do before we could get a commitment for TLI. Even though I was not as careful in the manner in which I moved, I was not concerned about moving out ahead or underneath the couches and all that. I did this without any sensations of vertigo or nausea whatsoever. I think the more you think on these things, the more susceptible you are to it. So I just forgot about them. Knowing I would have to do a P51, I grabbed the star charts out of the storage area, along with the rest of the unstored items that had to be accomplished and started looking on the star chart as to where we might pick up some stars and I just sat there waiting for darkness. I heard this comment before and was fully aware of it. When we got to darkness, I looked in the telescope and didn't see anything. I was concerned at that time that I hadn't gotten rid of the optics covers. I knew they were gone, I heard them go.

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[REDACTED]

CONRAD We had a short discussion about that, as a matter of fact.

GORDON When I looked in the telescope I couldn't see anything. There was no light or anything coming from there. I thought it must be because I'm not dark-adapted and probably this was correct. The more I stared and the more I looked in there, the less I could see. So, I just went to full range of coverage; full left, full right, up-down, crossways and still couldn't see any stars. I finally went back to zero optics and got the star chart out, and looked at the orbital parameters. The GDC was still operating, so we had an idea of our inertial angles. I looked at the chart and picked up the zero optics point and knew which stars should be coming into the field of view at that particular time. Fortunately Al was helping me with this. He was looking out his window and could see Orion coming up on his side. So, I just waited until it came into the field of view of the optics. Because of the ORB RATE torquing, the zero optics point was looking actually to the south of Orion. When I looked at my star chart, there wasn't much down there that I could recognize, even under favorable conditions. Fortunately, it happened that Orion did come into view in the very upper-left-hand portion of the optics. When I drove it to the fullest extreme, I saw the belt of Orion

[REDACTED]

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GORDON dimly in the very edge, and then I could pick up Rigel and  
(CONT'D) Sirius. Once I had picked up Rigel, I could find Sirius.

They were the only stars I could see in the entire field view.

CONRAD It was a cooperative effort between Al and Dick. Al was  
looking out his window with one star chart and Dick was hustling  
in the LEB.

GORDON The pressure was on and fortunately those two stars were the  
only ones I ever did recognize. They were Rigel and Sirius.  
They were just barely in the field of view. I grabbed those  
two quickly and got a P51 and did a quick P52. I think that  
one of the stars it came up with was Acamar. I wouldn't have  
been able to find that without a P52 under any circumstances.  
But the P52 worked fine and the second P52 over Carnarvon, just  
before TLI, indicated that we had a good platform. Drift angles  
were very low. The torquing angles for the second P52 were  
extremely low and everybody breathed a sigh of relief that we  
had our platform back again.

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5.0 TLI THROUGH S-IVB CLOSEOUT

5.1 TLI BURN

CONRAD The TLI burn was normal in all respects. My one comment is that we had the little additional program in the CMC to count down to timebase 6 which I thought was extremely good. Dick set it up and had it running. We always knew where we were and the S-IVB performed exactly as advertised. The lunar orbit torquing on our ORB RATE ball worked extremely well. We had very small dispersions about it. I had the decided feeling that, if we had had to fly a manual TLI, it would have gone just like the ones in the simulator and wouldn't have been any big deal.


GORDON I thought all the cards and procedures that we had on board were excellent and adequate.

5.2 S-IVB Performance and ECO

CONRAD The S-IVB performance and engine cutoff were on time and exactly as predicted.

5.3 S-IVB Maneuver to Separation Attitude

CONRAD The S-IVB maneuvered to the proper SEP attitude.



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#### 5.4 S-IVB Maneuver to T&D Attitude

GORDON We had it all set up. I had the NOUN 17 needles set up for the TD&E attitude and we monitored the S-IVB maneuver with NOUN 17 needles. It was smooth and went right to the pre-flight attitudes.

#### 5.5 SEPARATION FROM SLA

GORDON On the separation from the SLA, we were ready in plenty of time. We had everything set up. The separation was made on time with the normal procedures. It was another one of those pyrotechnic events. There was no doubt in your mind that you had come off the SLA and were on your way.

#### 5.6 High Gain Antenna Activation

BEAN Completely nominal.

GORDON There were no problems; it was all nominal.

#### 5.7 FORMATION FLIGHT

GORDON I don't know why we even comment about formation flight. There really wasn't anything to be done at this time. Everything was okay; we had no particular problems.

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## 5.8 TRANSPOSITION

GORDON I guess my main concern here was fuel usage, procedures, EMS, and the amount of complexity we tend to put into this thing when we're trying to do a very simple operation. We just compound things and procedures by getting fancy and it messed me up once. If I'd been smart and used my head, recognizing all these problems with the EMS in previous flights, I'd have taken these TD&E procedures and scratched all reference to the EMS whatsoever.

CONRAD Yeah. You have to thrust on time and that's good enough.

GORDON That's exactly what I would have done. I would have separated from the SLA. I'd have thrust forward on the time, whatever it was, to get 0.8 ft/sec — I'll arbitrarily say 3 to 4 seconds. I'd have waited to 15 and I would have backed off thrusting for a couple more seconds. And that's all you need. This fancy monitoring of the EMS, with these things being bad — there's a hysteresis in them. They go forward before they go down. They're wrong because of the rotational effects and here's what happened to me. The EMS was set up at minus 100 before separation. I hit forward translation and then hit the S-IVB/CSM SEP button and got the pyrotechnic event. I was going to look up to monitor the EMS when I got 100.8 ft/sec and the EMS read minus 98. So I had no idea how much velocity

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[REDACTED]

GORDON I'd put into the thing and I just continued thrusting forward  
(CONT'D) for a few seconds, probably being conservative because I wanted to make sure I got far enough away from the booster before we did the turnaround. The rest of the procedures are excellent. SCS and the DAP control coming off the booster held that thing right on the money.

CONRAD You had to do very few up/down, left/right translations. You turned right around and went into AUTO and it was looking right back at it.

GORDON I used the VERB 63 needles (the NOUN 17 needles came off during the turnaround) and went to SCS control, ACCELERATION COMMAND in pitch, and pitched up at 1-1/2 deg/sec. It was extremely smooth. There were no problems at all. When it pitched 180 degrees, the S-IVB was right smack dab in the middle of the COAS. When I finished the 180-degree-pitch maneuver, I stopped the opening velocity by thrusting towards the S-IVB and did a VERB 49 maneuver to the docking attitude, at the same time closing all the way. Now I estimate that I was probably a good 100 to 125 feet away from the booster and I was twice as far as I wanted to be. I'm sure the only reason I was there was because of relying on that EMS to give me the velocity when I ought to have kept it as simple as possible. I could have used a clock to get those velocities.

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[REDACTED]

CONRAD Well, I don't think that distance was too great. That is a big moose back there and you sure don't want to take the chance of running into it turning around. The only other problem is that you want to return and dock. I think that, had we just sat there and left a very low closing velocity and accepted 10 or 15 minutes (which we didn't want to do), we'd have drifted in there okay.

GORDON Yes. Even at that, I think it was approximately 8 minutes or so before we actually docked and the thing that's disturbing to me is that I got myself in a box and it's due to my own stupidity in not recognizing these bad features. My whole philosophy right now on the EMS, whether it's a good one or a bad one, is that it should be used only two times: One is for entry and the other is for backing up an SPS burn.

CONRAD Yes, I agree.

GORDON And when you're doing RCS maneuvers, you can use the G&N or you can do it on time. It's perfectly adequate and it's the simplest approach. The EMS was never designed for anything else other than those two functions. But it was disturbing to me to be able to get in the simulator and consistently dock — consistently do the whole thing using less than 20 pounds and then get in flight and end up using 70 pounds. My recommendations now are that the procedures for TD&E are adequate in our

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GORDON checklist, if you scratch all reference to the EMS and sub-  
(CONT'D) situte times to get your separation velocity.

CONRAD Yes.

#### 5.9 DOCKING

GORDON The docking was easy. I have no comments on docking. The spacecraft, as heavy as it is, flies beautifully within DAP control for attitude with the VERB 49 maneuver and it was lined up perfectly with the COAS. All I had to do was translate left, right, up, and down; and control the closing velocity. On contact of the probe and drogue, there were no oscillations, no visible motion at all. I went to FREE as soon as Pete called barber pole and the spacecraft didn't even move. We just sat there for 10 or 15 seconds to assure ourselves that there were no dynamics involved and then we retracted the probe.

CONRAD Yes, I think the only way you know that you really have two heavy vehicles up there is when you retract the probe. It really is obviously moving a lot of mass together.

GORDON It takes a long time to get down and then we had the ripple fire on the latches being made and we got the gray indication on both talkbacks.

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5.10 CSM Handling Characteristics During T&D

GORDON All I can say is that the SCS control during the turnaround was excellent. There was no question as to where it was, what it was doing, or where it was going; the control response to the DAP for ATTITUDE HOLD and for the VERB 49 maneuver was excellent.

5.11 Sunlight and CSM Docking Lights

GORDON My opinion is that we probably never would have any sunlight problems unless we were looking directly at the Sun.

CONRAD That's my belief too.

GORDON The docking light was not used, because it wasn't required or needed and that ought to be a closed subject.

CONRAD The procedures for the LM pressurization went per the checklist. The hatch was removed, the umbilicals were hooked up and CSM power was transferred immediately. We were all aware of our two circuit breakers, which we had to make sure were in and Al had that well in hand.

5.12 EXTRACTION

GORDON In fact, Al was so concerned about getting that LM out of there that he had both Pete and me check that he, in fact, did have

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GORDON those circuit breakers in. He wasn't going to be the only  
(CONT'D) one responsible. The extraction by spring ejection was smooth  
as glass. There wasn't any unevenness, oscillation, or any-  
thing. That whole package just whipped right out of there  
straight as an arrow and we soon lost sight of the S-IVB, as  
a matter of fact, because it just went right straight aft and  
was of no concern. We thrust aft for the 3 seconds that then  
did the VERB 49 maneuver to the S-IVB viewing attitude.

CONRAD The maneuver was good; it put the S-IVB right in the center  
hatch window.

#### 5.13 Photography of Ejection

GORDON My only comment is that it was probably okay. I had no sense  
of even having the 16-millimeter running because all I was  
looking at was the LM. I don't know if Al took any pictures  
of the ejection or not on his side. I didn't see. You  
couldn't take any pictures because there was nothing to see.

BEAN No, I was looking at the TV in the window and you can't do  
them both.

#### 5.14 Attitude Control and Stability During Separation and Ejection

GORDON It was good as we mentioned. The VERB 49 maneuver was okay.

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## 5.15 SEPARATION AND EVASIVE MANEUVERS

GORDON There is no problem here. We were all able to observe the S-IVB. I could see it through window number 2. The maneuver was designed to put the S-IVB in the hatch window or window number 3 for TV purposes and it was a good attitude. There was no particular problem with that at all. We saw a lot of things on the S-IVB venting which Pete called out to the ground at the time. Now here's an area that I'm going to comment about again and I think this is one of the other areas where it got us behind the fuel curve. I don't know whether it was a requirement, but at least tracking the S-IVB during its evasive maneuver was in our procedures. Now, this we did to watch it and the only thing I can say is that it's a bunch of nonsense, for the simple reason that it uses fuel. The less maneuvering you have to do with that CSM/LM combination, the better off you're going to be.

CONRAD Yes, that's strictly a warm feeling. After that thing has maneuvered to the proper yaw angle and done the APS burn, our observing the LOX dump or worrying about its running into us are wasted effort; Dick's 100 percent right. I guess we shot another 25 or 30 pounds of fuel that weren't in the flight plan trying to track that thing after that LOX dump and we quit before we saw it.

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GORDON Yes, and I just think that it's a very bad thing. We got behind on the fuel curve and I remained behind the rest of the flight because of messing around within the first 10 minutes of flight with the LM docked. All of a sudden, I began to realize that you don't want to do anything with the LM docked except to maneuver to an attitude at 0.2 deg/sec with a wide deadband, get into PTC as soon as you can, and turn off those thrusters.

CONRAD If I can remember the numbers right, when we wound up, we didn't use any extra gas after that time. We were some 93 pounds behind in RCS propellant and the rest of your ground calculations of nominal usage were very, very good and I don't think Dick either lost or gained.

GORDON I don't think I did either.

CONRAD We must have shot 30 on the extra distance on the docking and the other 60 had to go on trying to hack around to track the S-IVB which was more than adequately far away from us. There was no doubt in my mind that it wasn't going to hit us once it made the APS burn, once it had maneuvered to the proper attitude which we saw it do. That didn't cost us any gas. Once it made the APS burn, it was on its way and wasn't going to bother us again whether it did a LOX blowdown or not.

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GORDON That's right. In defense of some of this fuel usage, I'm not sure that doing the P23's with the LM docked might not have used more fuel than was in the budget. That DELTA in there from separation to the end of that P23 — we shot a lot of fuel and I just can't recommend more strongly that you just flat don't maneuver with that LM on there.

5.16 S-Band Performance

CONRAD The S-band performance was nominal throughout all that.

5.17 S-IVB Slingshot Maneuver

CONRAD The S-IVB slingshot we didn't see.

5.19 Workload and Time Line

CONRAD As far as the workload and time line go, there's more than adequate time throughout that whole operation.

BEAN Yes. You pointed out in real time that it looked like the S-IVB had some sort of nonnominal venting back there by the engine. It looked as though, right around the upper end of the engine, there was a broken line or something. It was venting and I think from seeing the pictures of the TV that Huntsville's going to want to figure out what happened back there.



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CONRAD One other thing that we didn't mention was that at CSM/S-IVB SEP we had one occurrence that I hadn't heard of before. Normally, it's been the fuel valves. We had a helium 1 B and a fuel secondary A barber pole on us. Of course, we were advised to check these. I watched them. As soon they barber poled, I reset them and that was that.

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6.0 TRANSLUNAR COAST

6.1 IMU Realignment and Optics Calibration

GORDON IMU realignment. There never was any problem in the rest of the flight with any of the IMU realignments. As far as I'm concerned, you can get any star angle difference you choose to get. If you want to spend the time and make sure that you have the stars exactly in the center of that reticle and the sextant, you can get 00000. If you don't want to be that fastidious with it, you can accept 0.01, or if you just want to put the star in the center and mark on it, you'll get 0.02 and it really makes very little difference as to what you get, other than your own personal satisfaction or gamesmanship.

CONRAD Yes, let me comment there. There's no doubt that this involves a learning curve because Dick did a couple of 00002, and then after a while he consistently got 00001. We decided that maybe he'd been too rough with the optics and banged them off the stops doing P23's or something; and sure enough a little later, he started getting 00000 and I think that was strictly a learning curve that's not 100-percent obvious to you right away. I think it came with the longer we went through the flight and the more he handled the optics, the better he got at knowing exactly where to put it to get 00000.

[REDACTED]

GORDON Well, it's a gamesmanship problem anyway.

CONRAD If it's 00002 or less, it's in the noise level and we never saw any difference in torquing angles.

GORDON And you can even do that during PTC if you want to. You can do it at medium speed and keep that star right in the center. There's no problem. So that takes care of the alignments as far as I'm concerned for the rest of the flight. The P23 procedures we used during this flight, I thought, were excellent. There's no problem with them. The VERB 49 maneuver to the optics calibration star was no particular problem. It's a maneuver, however, with that LM out there on the nose that we wasted gas on I'm sure, because I feel now that we could pick any star for the optics CAL. In fact, the P23 star that I used trans-Earth coast was Gienah, which is probably one of the dimmest out there, and it's still adequate for the optics CAL. There's no problem with seeing that star in the landmark line of sight. So, we didn't need to go to the best star in the sky and use I2 or Sirius for that optics CAL. It's completely ridiculous. I recommend that you go find a star that's as close to, or if not at, the VERB 49 attitude as you possibly can to commence the P23's. I recognize that all the fuel is used in starting and stopping a maneuver, and it doesn't

[REDACTED]

[REDACTED]

GORDON matter how far you go, but it just seems more logical to me  
(CONT'D) that you just take a star as close to the P23 attitude as you  
need to. I guess the P23's went all right as far as I was  
concerned. There were no particular difficulties with doing  
these. I thought the stars and the angles that the ground  
supplied beforehand were perfectly adequate. I'll say one  
thing about horizon identifier or locator, whatever you want  
to call it. That was misleading to me even though I had taken  
the opportunity to go over to the G&C building and spend a  
night up there doing P23's off of a slide. I think this whole  
problem of marking on the airglow layer for the P23's as  
opposed to what you might consider the true horizon of the  
Earth is completely overplayed. It was misleading to me that  
the first series of marks that I took, I was on a portion of  
the airglow that was 49 miles away from the true Earth horizon  
and it was my own fault that I didn't recognize it at the time.  
I was using a part of the blue airglow layer that appears blue  
in the landmark line of sight when I should have been using  
the one much closer to the Earth, which appears as an amber  
color in the landmark line of sight. This was used during  
the second series of P23's and gave me a delta H of 19 miles  
and which was the one I used for all the P23's trans-Earth  
coast. I think that whole thing of not marking on the true

[REDACTED]

[REDACTED]

GORDON (CONT'D) physical horizon and using an airglow is much overplayed and it was misleading to me. But other than that, the ability to take the marks and to stop the motions of the spacecraft, particularly with the LM docked, and the ability to identify the substellar point and to put the star in the substellar point is an easy task to accomplish. There's no problem with it.

### 6.2 Systems Anomalies

GORDON I noted none at this time.

CONRAD No. Other than the gauges that were out, we noted none. As a matter of fact, I'll make the comment right now. We had no master alarms except for O<sub>2</sub> high flow throughout the whole flight. Never saw a thing. And in that respect, CSM 108 was a beautiful spacecraft.

### 6.3 Modes of Communications

CONRAD Modes of COMM on the way out were satisfactory. The ground handled the antennas most of the time. We didn't pay much attention to the OMNI switching. One comment I would like to make that happened both in the LM operations and in the CSM operations with respect to COMM, I think we got the ground on the same frequency. It was something that was not apparent doing SIMS. Nor was it apparent until we were in flight. Nor

[REDACTED]

CONRAD did I hear anybody mention it in any other flight reports.  
(CONT'D) But, there's a decided COMM dropout when they switch stations. We finally got the CAPCOM's up to speed so that 2 or 3 minutes before we got a station handover, especially on the big dishes, they seem to drop out and disappear for 2 or 3 minutes. It never failed to happen at a time when we were communicating with the ground and the next thing you know, we wouldn't be talking to anybody. So they finally got cued up and I recommend, as a standard procedure, that the CAPCOM get a standard callout from the AFD, or whoever is handling that, that there is a station handover coming up at 2 or 3 minutes and just cease COMM until they come up on a new station.

#### 6.4 Passive Thermal Control

CONRAD Passive thermal control worked extremely well. Tom and those guys worked out good procedures. We had no trouble with it. We lost it one night when we started it poorly. We had a water dump after we started it, or something like that and it was ridiculous. We all should have known better, both us and the ground. And Dick had to restart it one time. That's the only time that happened. Dick has covered the P23's.

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## 6.6 Midcourse Correction

CONRAD We made our one and only midcourse correction on the way out. It was our first SPS burn. It went exactly like the checklist and, if I remember right, it shut down with 0.1. It was ridiculous, it was so good. No trimming was necessary under the rules and that was either 61 or 62 feet per second and a very smooth burn. We used both ball valves and everything went as advertised.

## 6.7 Photography, Television


CONRAD We had our little gauge for the Earth and the Moon when they were full-view in the 500 millimeter and the 250 millimeter and we took pictures on the way out.

GORDON We didn't use a 500 on the way out, I don't think at all, did we, Al?

BEAN Yes we did. We used it a couple of times, some Earth pictures. We tried to handhold it. It will be interesting to see how they came out.

CONRAD Unfortunately we could not get the pictures of Mexico that everybody wanted because of tracking the S-IVB and everything; so, we decided we'd fool around with the TV and we used too much fuel and we just quit. So we didn't get those pictures.

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### 6.8 High Gain Antenna Performance

CONRAD High gain antenna performance worked fine until later in the mission. We can talk about that. Dick already has and we can get a pretty good handle on what happened.

### 6.9 Daylight IMU Realign and Star Check


CONRAD Dick's talked about IMU realignment. It doesn't make any difference whether it's daylight or nighttime, it's a P52; whether you're moving or not moving.

### 6.10 CM/LM Delta Pressure


CONRAD We apparently had a very tight LM; so, the ground had us bleed it to get a sufficient oxygen environment in there. I might add that our CSM procedures for getting rid of the nitrogen apparently worked as advertised. We had no need for our second purge. By going the route of dumping the LM and repressurizing from the command module for our ingress, we went into the LM the first day, early.

### 6.11 LM and Tunnel Pressure

CONRAD The LM tunnel pressurizing went as advertised, which happened early in the game.





  
6.12 REMOVAL OF PROBE AND DROGUE

CONRAD The removal of the probe and drogue was done twice the first day. Once, we went in for the check to see if the lightning had done anything. Then we had a slight argument with the ground because we were sure we left the circuit breakers in the right configuration and they told us we were using too much power. It turned out they were right and we were right. We had a microswitch mis-rig on the upper-hatch tunnel which did not turn off the floodlights when the hatch was closed. Therefore we had to pull the flood circuit breaker and we psyched that one out pretty fast.

## 6.13 ODORS

CONRAD As far as odors, we did notice a slight odor in the tunnel. It was nothing. It was gone in a short while.

## 6.14 Passive Thermal Control

GORDON I think the passive thermal control, the attitude you go to for PTC, whether it is 90 or 270 degrees, should be dependent upon which hemisphere the Earth-Moon system happens to be in. And for the picture purposes going out, we would have been much happier if we had gone to the 270-degree pitch attitude as opposed to the 90, because that would have brought the

  
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[REDACTED]

GORDON Earth and the Moon up into the number 1 and 5 windows. As it (CONT'D) was, it was down pretty low in it.

CONRAD If you're going to do a good job on the photography, you should stop. The thought never entered our minds to stop enroute for photography because we were behind the power curve on the fuel. If you get off with a batch of fuel and you're not behind the power curve on the fuel, the 4 or 5 pounds it would cost you to start and stop at the proper place to get good Earth-Moon photography enroute - -

GORDON I think you can get those pictures even during PTC, provided you select either 270 or 90, depending on which hemisphere the Earth-Moon is in. To us, it didn't make a bit of difference whether we were looking at the south pole or the north pole or which was up or down. That didn't bother anybody.

CONRAD No, but I got a sneaking suspicion that a handheld 500-millimeter picture is not going to be worth a hoot. We'll have to see when we get back.

GORDON I don't think a handheld 500-millimeter is going to be worth a hoot even if you're stopped. The fact that it's handheld is to your detriment - -

[REDACTED]

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CONRAD That's what I mean. If you're going to take that kind of photography, I think you have to stop and point the spacecraft.

GORDON Well, there is no way you could use a bracket for that 500 millimeter. It points out the rendezvous window with the LM out there. There's no reason to do it. I think it's a good comment to go ahead and select either 90 or 270, dependent upon where the Earth-Moon system is. Well, you can at least look at them every time you go around.

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7.0 LOI THROUGH LUNAR MODULE ACTIVATION

7.1 Preparation for LOI Burns

CONRAD The only thing that I can say is that preparation for the LOI burn went per the checklist.

BEAN The only thing that I noticed was on the fuel line temperature of the SPS. It was up at 90 degrees at the start of the burn and this is where it had risen after the midcourse correction. The maximum limit is about 75 degrees. We were a little concerned about that. We knew the ground was watching. I also noticed that, as the burn started, the temperature immediately dropped to 75; then, after the burn was completed, it rose again to 90. And this was the situation for all subsequent burns. Another interesting anomaly was that the oxidizer pressure on the SPS was 10 psi higher than the fuel pressure at the start of the burn. And then as the burn began the pressures equalized and stayed there. We never saw this DELTA-P again for a major burn. I guess it must have had something to do with regulator lockup.

I might also mention the performance of the PUGS. We monitored the PUGS during the first midcourse correction. After the burn started, I moved the PUGS from NORMAL to FULL INCREASE and left

[REDACTED]



BEAN (CONT'D) it there for the entire flight. At the beginning of each burn, the PUGS unbalance meter jumped around a bit as the burn started, then settled down, and at the end of each burn indicated about 100 pounds increase which agreed with the usage; that is, the differences between the oxidizer and the fuel gauge reading itself. So it looked like it was a pretty good move to go ahead and put it in INCREASE and leave it there the whole flight.

GORDON Of course, that's going to vary depending upon each individual SPS engine. For our particular system, that was a smart way to go; when we got all through with the SPS engine, we were down to 50 pounds increase and that was it.

BEAN You're right. They were able to predict it fairly well for our engine and if they can do it for others, the crews will perhaps be able to do the same sort of thing with another engine. It worked well for us though. It saved having to fool around with that during the burn.

GORDON If we had fooled around with it, we'd have never caught up with it, because one time it did go to DECREASE, I think, and if you had gone there, you'd have never caught up.



## 7.2 SPS BURN FOR LOI 1 AND LOI 2

GORDON The burns were nominal; there is nothing to say about them.

CONRAD As a matter of fact, the engine shut off 6 seconds early on LOI 1 and LOI 2 was too brief a burn to shut off on time. I think the ground had a better handle on the engine for time anyhow. Everything went by the checklist. We went right by the LOI 1 abort rules. We called out "tight," "loose," and "tight." I followed the stuff and monitored the burn to determine whether we were in tight or loose rules. And I'd like to mention that we got fairly complicated on mode I, I-A, II-A, II, and all that business and really there were too many of those to call out in the cockpit.

CONRAD So we went on the tight/loose scheme. Whenever we were in the tight rules, we called "tight"; when we were in loose rules, we called "loose"; and then we went back to "tight" and in that way we let the modes fall out where they would - -

GORDON Where they would if we shut down.

CONRAD - - if we shut down. And all that I-A and II-A business; whether it was APS/DPS or DPS only or anything like that; whether it was a 2-hour or 30-minute one; that got kind of complicated. They were simple when we first started out about



CONRAD 4 months ago, but it got exercised into a very complicated  
(CONT'D) thing. I think it's a good exercise though, because we had a  
lot of confidence before we went that we could burn both the  
DPS and the APS to get ourselves out of trouble. And so in  
that sense the whole thing was a good exercise.

7.4 Maneuver for AOT Star Observations

CONRAD We were in a position, when we entered the LM before LOI and  
when we entered it after LOI, such that Al was satisfied that  
he had seen enough through the AOT.

BEAN Well, we saw Dick Gordon out one of the hatch windows.

CONRAD Yes, he can look right in the command module if you put it in  
the back detent.

GORDON Yes. I can look back and see their eyeball.

7.5 Communications

CONRAD LM communications were as advertised when we powered up.

7.6 Television

CONRAD The television worked in lunar orbit as well as anyplace else.



7.7 TUNNEL MECHANICS AND PRETRANSFER OPERATIONS

CONRAD The tunnel mechanics and pretransfer operations were straightforward. We had a set of checklist items that we packed and took over at the various times.

7.8 IVT to LM

GORDON IVT was no problem. We were all over there at one time or another.

CONRAD Yes. Everyone whistled in and out. I don't know about anybody else, but I never got disoriented going back and forth. It seemed relatively easy to me to straighten out where I was going. I could go in and out head first or feet first, in either direction, and it didn't make any difference.

7.9 LM Entry Status

CONRAD That was in good shape. We mentioned the upper hatch micro-switch. That was the only anomaly that we noted.

7.11 Housekeeping

CONRAD I think that the LM stowage is excellent. It's well worked out and well thought out; everything worked and we had no problems.



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### 7.12 Power Transfer to LM

CONRAD Power transfer was nothing.

GORDON I don't know why we even talk about that. RESET, OFF; not too difficult.

### 7.13 Landmark Updates and Tracking

GORDON I really don't think there's much to comment about. The procedure is established. The attitudes, the 0.3 deg/sec pitch rates, were easy to perform. You need a good map, a good photo of what you're trying to look at. And when you look through the telescope the landmarks ought to be easy to recognize. The AUTO OPTICS feature of P22 puts you so close to the actual landmark that there is just no doubt about it, but it's reassuring to have a good photograph of the landmark and to know exactly what you're going after. The LM does occlude the target for a considerable time and I think the ground has already worked out those attitudes to make this an easy task. All I can say is that it was easy. There is no question about anybody's ability to do that. I think it's one of the easier things and I was surprised that it was as easy as it was from the experiences that we have had in the CMS. I have a recommendation here in that particular regard. They ought to provide

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GORDON (CONT'D) slides of the landmarks that the crews are going to use on their flights. We have pictures of them and, because we have pictures, we could make slides for use in training — slides of the exact landmarks you're going to be looking at in lunar orbit. That really didn't make much difference, but it gives you a little warmer feeling as to what you're going to be looking at.

7.14 IVT to CM

GORDON The same remarks apply as going the other way. It's a two-way street to that tunnel.

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## 8.0 LUNAR MODULE CHECKOUT THROUGH SEPARATION

### 8.1 Command Module

#### 8.1.1 CSM Power Transfer

GORDON This is the CSM power transfer to LM at 104 hours; it was done on time and on call from the LMP. It was done without any particular problem, as expected. The time interval between that power transfer until closeout, of course, helped Pete finish putting on his PGA, making sure the zippers were all locked out and secured.

#### 8.1.2 Tunnel Closeout

GORDON Tunnel closeout was actually accomplished in the suit with helmet and gloves on. There was no particular problem. We had plenty of practice with that tunnel, during transfer and coast. We were into the LM on a couple of occasions. We had already had a chance to look at the tunnel hardware, and it all performed and operated properly. Pete put the drogue back in the tunnel; I installed the probe, hooked up the umbilicals, preloaded it, and then cocked all the docking latches. All of them cocked with two strokes with the exception of the three that were called out during translunar coast as being only partially expanded. They weren't all the way in and it was expected it would only take one stroke to cock those

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GORDON two latches. That was the case in fact. There was no surprise  
(CONT'D) and everything went according to plan. The hatch was put in  
without any difficulty whatsoever. When locked and sealed, the  
tunnel bled down to approximately 2 psid where it was stopped.  
The integrity check of the command module was conducted at that  
time and there were no leaks. The tunnel was bled down the rest  
of the way. It was a smooth operation. As soon as that hatch  
was in place and secured and the integrity check completed, I  
removed my helmet and gloves and stowed them.

#### 8.1.4 Undocking

GORDON The undocking, from the maneuver to the undocking attitude, was  
done using the P30 and P41 from the PAD values sent up from the  
ground previously. That went without a hitch to DAP maneuvering,  
and no particular problem was experienced. We could have been  
in the simulator for all I was concerned. The soft undocking  
was done on time. The EXTEND switch was hit just momentarily.  
I guess I was a little surprised at the speed at which that  
probe actually extended and at the reaction when it hit the  
end. I suspect, in watching it, there was a little rebound  
when the LM hit the end of that probe. There was nothing large  
or exciting, but it was a rebound that I really hadn't quite  
expected. Neither vehicle showed any tendency to diverge or  
oscillate or anything; everything was quite stable. I sat

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GORDON there for probably 30 seconds looking at the vehicles to make  
(CONT'D)

sure that they didn't oscillate or have any perturbations. Then while I was holding the probe switch to the EXTEND position, prior to aft translation - for about 2 seconds - the vehicles parted cleanly without disturbing either vehicle's attitude. The command module was in SCS ATTITUDE HOLD at the time with RATE, LOW, and DEADBAND, MIN, and the DAP had been previously configured to CSM ONLY.

As soon as we separated, I switched the probe back to RETRACT; and, without really trying to stationkeep at that very minimum distance, I let that separation velocity imparted to the two vehicles just translate the CSM away away from the LM. It just slowly drifted back until I suspect we had probably 100 to 150 feet, somewhere in that vicinity, at separation time. It was smooth. Nothing unusual occurred other than that rebound that I did notice when the probe hit the LM.

#### 8.1.5 Attitude Control Modes

GORDON It was a little bit different seeing the LM no longer on the nose after 3 days or some 104 hours. But as far as the control modes are concerned, the DAP provided an excellent control mode with no particular problems at all.

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#### 8.1.6 Undocking and Separation Photography

GORDON The undocking and separation photography, sequential and Hasselblad, was conducted without any particular problems. Hopefully, we got some good photography from this whole sequence. In fact, the television was on during this time, and I had the monitor down between my legs. It was on the extendable storage compartment, right above the number 1 couch, right above the seat belt right between my feet. I could actually see the pictures that the TV was taking and occasionally, I reached over and adjusted the zoom control as well as the focal length. The TV was mounted in the right-hand rendezvous window.

#### 8.1.7 Formation Flight

GORDON There really isn't much to be said about that. The control modes were with the DAP set for attitude control; I used the translational hand controller sparingly, if any at all, to keep the LM in sight within the field of view of me, the 16-millimeter DAC, and the television camera.

#### 8.1.8 LM Inspection Photography

GORDON We really hadn't done any inspection of the LM. We were well assured that all four gears were down and locked. I could see three gears before separation, so I knew they were out and

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[REDACTED]

GORDON extended, so we decided that a LM inspection was not required  
(CONT'D) or necessary at this time. Photography was taken in conjunction with the undocking and separation photography. It was kind of lumped all into one big package. The separation maneuver was simple in itself. I might stop here just before I mention that. Pete had mentioned in his section on the LM debriefing that there was some out-of-plane. I noticed this also, that the LM drifted slightly to my left, but after I drifted off to the right, a small distance, it seemed to stop and stabilize and there wasn't any particular concern. I didn't waste the fuel trying to get back in plane for the separation maneuver. I did another P30/P41 separation attitude; and, as would be expected with a 90-degree orbital travel, there was no, or hardly any, attitude change at all. It was more or less a re-trend maneuver than anything else, or a trend maneuver, until the separation attitude. That's the point in time a 2.5-ft/sec Z-translation was performed and we were separated.

#### 8.1.10 Rendezvous Radar and Optics Check

GORDON All I can say is that they worked okay. My VHF corresponded with Pete's rendezvous radar and, at that particular time, there was no concern about the optics checks. In fact, I waited for quite a while before I even went to the P20 attitude to take a look at the LM through the optics.

[REDACTED]




  
8.2 LUNAR MODULE

BEAN We ingressed the LM exactly on time. The only difference between the checklist and what we actually did is, both Pete and I suited up before we got in the LM. I think this is a good plan. This way, we were both able to listen all the time to what was going on during the LM checkout, and also, didn't have any unusual circumstances come up when I was supposed to go back into the LM and put on my suit.

CONRAD We didn't want to make a change to the flight plan because we weren't sure whether it would work or not. Listening to previous occurrences, some people had problems suiting and some did not. Now all three of us are small, and we all three managed to do the suiting exercise in the amount of time laid out for one person. All three of us had no difficulties getting in the suits by ourselves. The only help we gave to each other was to actuate each other's zippers.

BEAN Just as we were getting suited up, the doctors came up with a comment that my biomedical harness wasn't working. So, we had to stop and spend about 15 or 20 minutes replacing sensors. My only comment here is that they ought to have a handle on these sensors. By the time you finally get to the Moon, if it looks like one of them's going to be going bad about that time,



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BEAN (CONT'D) maybe we ought to, a day previous to that, go through the sensors and find the one that's bad and fix it. Actually, we had to take off three of them before we found the bad one. That was at a bad time to go through that exercise. We could have done that the night before. No use waiting until the last minute.

#### 8.2.1 Power Transfer Activation and Checkout

BEAN Everything went exactly as planned. The transfer took place at 104:00:00. All the caution lights, warning lights, and operational checklists were completely normal. The voltage on the batteries was a little bit lower than would normally be the case; we had one low voltage tap, because we'd gone in and activated the LM two previous times, but this didn't give us any problem at all. We just went over the high taps immediately and the rest of the checkout progressed normally.

#### 8.2.2 ECS and Suit Loop (Cabin Atmosphere)

BEAN ECS and suit loop operations were normal all the time. The only difference we encountered was the suit integrity check that was performed after separation and prior to descent. This normally is done at 3.7 pounds above cabin pressure. We didn't do that. We did that only at about 2.5 pounds above cabin pressure, because my ears were stopped up at that time, and I was unable to clear them.

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### 8.2.3 VHF and S-Band Communications; Steerable and OMNI Antennas

BEAN They were all excellent; operated just exactly as we had hoped.

### 8.2.4 PGNS Activation and Self-Test

CONRAD We got two alarms, neither of which was expected. Although I closed the ground, I wasn't too concerned about them. If I remember correctly, we came out of STANDBY and brought the computer on the line. We got an alarm, an 1100 series alarm, which was "uplink too fast." Then in doing VERB 35 (Warning Light Check and DSKY Light Check), we got another alarm which said "PIPA fail." But PIPA is not in use, which was a 212 alarm if I remember correctly. Those were the only two anomalies. Everything else went exactly as per activation checklist.

### 8.2.5 AGS Activation, Self-Test, Calibration, and Alignment

BEAN This went per the checklist. We also looked at some erasable memory locations that were voiced up the previous day from the ground to see if they had been affected at all by the lightning strikes we had at launch; they were not. All the numbers were exactly per the data that had been voiced up.

The only thing I noticed that was slightly anomalous was when we performed PGNS to AGS alignment - when I would check the

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BEAN FDAI, by moving the attitude switch from PGNS to AGS, the ball  
(CONT'D) would jump about a quarter of a degree and sort of roll and  
pitch. The ball would jump. At other times, when I would make  
that alignment, it would remain perfectly still, indicating, I  
guess, a perfect alignment. On all these cases, we did a  
VERB 40 NOUN 20 beforehand, and I never did figure out exactly  
why it didn't make a perfect alignment each time.

#### 8.2.6 Ordeal

CONRAD The ORDEAL worked as advertised.

#### 8.2.7 Deployment of Landing Gear

CONRAD Deployment of the landing gear left no doubt in our minds that  
the pyros fired. Dick was able to see three of the four gears  
from the command module and we got a gray talkback, which indi-  
cated the gears were down and locked. Everybody was satisfied  
that the gears were down and locked. Therefore, we proceeded  
as planned on the undocking and we did no turnaround for Dick  
to inspect downlock.

#### 8.2.8 DAP Loads

CONRAD The DAP loads went as they were listed in the checklist and  
updated from the ground.

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### 8.2.9 Rendezvous Radar Landing Radar Self-Test

CONRAD We had two minor anomalies on the rendezvous radar self-check. Our first anomaly on the rendezvous radar check was that we did not get 500 feet as advertised on our tapemeter. We got 493 feet. The systems specification number was 500 feet, and 493 feet were specified for our particular radar. The checklist did not reflect our specific numbers. This is something that we argued about before flight, that we did not want a specification number in there. We wanted our right numbers in there. Somebody chose to disagree with us and continued with the specification numbers.

The other anomaly, although it didn't affect us because we were never at great ranges, was that our power was slightly low. It should have been on the order of 3.7 volts. It was 2.65 volts, and it remained that way throughout the flight. We achieved lockon, both on the lunar surface and in flight, at some 240 miles or so with no problem at all.

The rest of the checkout, the four gimbal angle readouts, the platform alignment, and everything went per checklist. The one thing that we did was that anytime we could get ahead on the checklist by taking whole blocks at a time, we would go ahead and do these early. Now our very last SIM before we left

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CONRAD  
(CONT'D)

Houston, we ran a SIM which came out almost exactly the same as in flight, in that we pressurized the RCS early; we got our torquing angles back up from the ground before we lost MSFN on the first pass, instead of having to wait until AOS on the second pass. This allowed us to get many things done in advance. Dick got the tunnel closed out early, we had the LM closed out early, and we were in the independent mode still docked well in advance. We had our RCS pressurized in advance. As a matter of fact, I think we got that done far enough in advance that the ground was able to observe RCS pressure, which was not a requirement. Therefore, when we came up on the second pass, we managed to get our really tight one out of the way early, before Dick did his tracking and the RCS checkout, hot and cold fire. This would not have worked as smoothly had we not practiced this with the ground, and the ground was anticipating our hustling.

You can't do enough of these SIMS with Houston so that Houston gets used to the individual crew and how they operate. We let them know that we were going to hustle, they were anticipating our hustling, and they were ready for us. This really worked well as far as the gimbal angles and getting things done in advance were concerned. Had we run into a problem somewhere along the line, we would have had more than adequate time to

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CONRAD cope with it. Fortunately, we didn't run into any problems,  
(CONT'D) so we had a lot of dead time, which is the way it ought to be.

#### 8.2.10 Undocking

CONRAD Now, we were all checked out and ready to go and sitting around waiting for undocking. The soft undocking worked very well. When Dick undocked, we hit the end of the probe, and there were some very slight longitudinal oscillations; but the probe damped it very well. When he undid the capture latches, the two spacecraft were completely null to each other and did not separate. Dick physically had to back off. I had no indications from either the AGS or the PGNS that we got any velocities, if I remember correctly. What we really got was some slight PIPA bias, in the order of 0.1 ft/sec, which was well within anything that we were going to null. So, we never nulled anything in separation.

#### 8.2.11 Formation Flying

CONRAD Formation flying worked very well. I did the yaw and pitch maneuver, and after that Dick did nothing but slowly drift away from us. We were so well stabilized at undocking that the little SEP maneuver that Dick did to back away from us at undocking was about the only time he touched anything.

We remained in good sight of each other all the time. Neither spacecraft imparted velocity to the other or to itself.



8.2.12 SEPARATION

CONRAD Dick performed the SEP maneuver, and for some reason it looked out of plane to me. I don't know why. They may have gotten a slight amount of out of plane, but very small. It did look like he drifted a little bit out of plane to our left as we faced him, which would have been to his right. At that point, we busied ourselves with the time-line portion of our checklist, which was to get into the landing radar check and, as soon as that was done, to perform our first alignment in the darkness.

8.2.13 Lunar Landmark Recognition

CONRAD Lunar landmark recognition was easy. MSFN relay was not used by the LM.

BEAN When Dick was doing his maneuvering to the landmark track attitude, he had the S-band antenna in AUTO TRACK. Sure enough, just like they said prior to flight, when he fired his thrusters, I could hear the antenna move. It would come back to its AUTO track position. I had forgotten to put it in either the OMNI or the SLEW position, which I think is a lot better than AUTO track; because, when he drives it off with his thrusters, it's likely to lock up on the side lobe or something like that.



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BEAN  
(CONT'D)

So, I would recommend next time that we either go to OMNI during that period or to SLEW. The antenna makes a lot of noise, and you can hear it move around.

The medical kit in the IM doesn't contain any Afrin and it ought to. When you really want to have the ability to clear your ears, if you're a bit stuffy, it's before you go EVA. With no Afrin, you're going to be stuck. We had taken some over from the command module.

I noticed that you need to use the restraints in the IM if you don't have on your pressure suit. If not in the suit, you didn't really need to attach any restraints; you could float about and do whatever you had to do. But in the suit, you need to attach a restraint. The TSB over on Pete's side - the lower loop on the back side - is supposed to hold it down. It does not perform that function because the dimensional relationship between the place that it hooks in and the place that it hooks to the IM allows the TSB to float up, and it tends to bother you. That ought to be rearranged so it holds it down.

The K-factor update from the ground came up in about 1 minute after we updated the AGS. That's the way it ought to be. We never touched it after that. The rate needles had the same problem that they've had on all previous flights; i.e., when we

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BEAN actually had zero pitch, Pete's was reading minus 0.5 deg/sec, (CONT'D) whereas mine was reading plus 0.5. Did that ever bother you?

CONRAD No, because the only time that I flew manually, which was after ascent, I had radar lock and I never used the rate needles. There was no reason to. We did all our AOT work by AUTO maneuvering the star; and then I flew in PULSE again and used the attitude error needles to indicate what I was doing.

As soon as we undocked, we got on the SEP checklist; and that went exactly the way the checklist was written. There were no anomalies; everything worked as advertised. The ball angles were good. The landing radar self-check went exactly as advertised. The numbers, which I believe were our radar numbers, came in perfectly. We knew we had a very good landing radar. We went all the way through to SEP, and Al got some pictures of CSM SEP. Unfortunately, that's the magazine we left on the lunar surface. SEP was at 108:24:22, and the time line had it published as 108:24:22. So we were in good shape, right on to nominal.

BEAN The changes we made in the PAD, so that they were shorter than those on Apollo 11, worked out real well. I don't think we had a bit of trouble getting the information or copying it. It didn't interfere at all with all the other things that we had to do. So I think the PADs are in pretty good shape.

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[REDACTED]

CONRAD We were passed the proper torquing angles that were to meet our limits, which were quite wide anyhow. Our torquing angles were very low on our alignment. Al and I had practiced doing a two-man alignment. Al looked at the stars. I flew the vehicle and ran the computer, and we got the alignment done in pretty snappy order. I think Al came up with 00001 on his first alignment. Is that right?

BEAN I can't remember.

CONRAD They were all good.

BEAN Yes. I think that's the way it ought to be done. That's a good way to do the alignment. It lets the fellow who's looking out at the stars keep his night vision up. He doesn't have to take his eyes out of the AOT. Pete was down there using the attitude error needles, which worked real well, and punching the computer. We were able to do it very rapidly without any errors. There weren't many changes passed from computer to AOT to computer. Everybody had something to do, and it went very rapidly - the same way on the lunar surface and the same way after ascent.

CONRAD Yes. We worked three marks for a start, and that seemed to give us very good alignment. Our rendezvous radar check, which came before the alignment, went as advertised. The tapemeter checked out. The needles checked out, and the PGNS readouts in VERB 63

[REDACTED]

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CONRAD checked out. We were very happy. The stars that we had picked  
(CONT'D) for the alignment, Capella and Rigel, were good stars. We had  
no difficulty finding them.

The AUTO maneuvers were smooth. As soon as we had done that,  
we went to DOI attitude. We went through our checklist and set  
up for DOI, and did it exactly from the checklist on the time  
line.

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9.0 DOI THROUGH TOUCHDOWN

9.1 Command Module

GORDON There was no particular problem with this one. I had the P76 PAD ready to go in the CMC for updating the LM state vector. As a matter of fact, I watched the DOI burn through the optics and it was kind of funny to see that engine burning right at you during the burn. Through the sextant it was almost like looking right straight up the tailpipe of an airplane. That object was out there and I was looking right down the descent engine nozzle, watching the burn. Through sextant, of course, it looked like it was right next to me. We were only 3.4 - 3.5 miles apart during that time.

9.1.3 Optics Track — Ease of Tracking LM

GORDON There was no particular problem here and as far as the optics' ability to look at the LM; I could read it through a telescope or the sextant. It was easily visible and tracking with both optics was exceptionally smooth. I guess you might say it was a pleasant surprise, from the experience that most of us have had in the simulators — that the optics drive in the CSM was exceptionally smooth. It was really a simple matter of being able to follow the LM throughout this whole phase.

## 9.1.4 SXT/VHF Track

GORDON All this after DOI was no particular problem. I put in a P76. Preferred tracking axis was verified right on the LM and there was no particular problem. The VHF ranging was good. It stayed locked on. There was no particular problem and the sextant, of course, was tracking the LM. Now, something happened here - I had planned to follow the LM down from DOI to PDI using the sextant and VHF tracking to update their state vector. For some reason, I was doing something with the computer and at the time there was a NOUN 39 right after the P76 was inserted on VHF ranging. It was a fairly significant one, rather large, and without even thinking or recognizing what it was at the time, I was doing something other than worrying about tracking of the computer. I looked up there and saw those numbers and I just proceeded to get back in a normal P20 sequence and I'll be darned if I didn't proceed with a very bad NOUN 49, which I should have rejected. It was the first one that came in. And, of course, the computer accepted it and it kind of blew the state vector. I looked out the sextant and saw the LM again, but then I really wasn't very concerned about keeping the LM state vector up to date. In fact, by accepting that bad VHF, the LM state vector was essentially lost; so, rather than be concerned about tracking the LM from

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GORDON DOI to PDI, then as far as I could for training, I just forgot  
(CONT'D) about it.

CONRAD When did you put that in?

GORDON Right after DOI.

CONRAD The first mark?

GORDON Yes.

CONRAD How bad was it?

GORDON It was several hundred miles or something. It was just out to lunch; it was just nothing there. I guess it was taken at the time the VHF was coming in. I should have known beforehand not to accept those particular marks. Without thinking, I just reached up and hit the PROCEED button, without recognizing there was a NOUN 49 sitting there.

## 9.2 Lunar Module

### 9.2.2 DPS/DOI Burn and Performance

CONRAD The DOI burn was excellent. The burn was on time. The residuals were zero, plus 0.2, and minus 0.6. The AGS residuals were plus 0.3, plus 0.1, and minus 0.6. Because we had very good agreement, we didn't exercise the rendezvous radar option and

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CONRAD (CONT'D) make a lockon with the command module. We pressed on. Our computer showed that it put us in 60.5 by 8.9, which was very close to the pads I used for DOI.

BEAN The AGS showed 60.5 by 8.5.

CONRAD We immediately went to the PDI attitude, 01090, which left us face-down looking at the Moon. From that inertial attitude we watched ourselves pass from face-down through local horizontal to pitch-up at PDI. It gave us an excellent look at the Moon going around; and we had a relatively easy checklist at that point. We reset the DAP and our 20-degree stick and accomplished the checklist, put on the helmets and gloves, buttoned everything down, put the COAS in the overhead window, and went right down the line. We had lots of time. We brought on the ascent batteries. Did we bring them on early that time? The ground wanted us to bring them on. One time they wanted us to bring them on early. I guess battery 5 was a little low. It took a little longer to heat up later. Now, we got to our perilune and altitude checks and that's a place that we didn't realize any error could crop up. It turns out that the predicted perilune and altitude checks at PDI are based on the command module being in some fixed orbit. It turns out that Dick was not in that orbit. We realized something was wrong with the checks because, not only did it show us high, but it

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CONRAD didn't show a consistency. At each mark, our altitude at PDI  
(CONT'D) grew from 56 000 feet finally up to 64 000 feet; and the ground  
said, "Forget it," because they had a good track on us and said  
that we were still showing a 50 000-foot perilune — right on  
the money.

BEAN I'd like to recommend that this check be eliminated. It's just  
busy work. As you can see, it didn't provide any intelligence  
that let us make a decision. No matter what the numbers would  
have come out on that, I think we would have gone ahead and  
made the landing just as we did because it showed us diverging  
from our nominal PDI altitude and headed up. So, unless we  
come up with something better, which I don't think we need with  
the way the PGNS is working and with good ground tracking, I  
think we ought to eliminate it. This will give you more time  
to prepare for PDI; to look out the window and make sure all  
is in order.

#### 9.2.7 VHF Ranging

CONRAD We were on the VHF ranging mode for the command module. We  
could tell when he locked up. We could hear the tones. It  
never bothered us, and I'm sure that Dick got the information  
that he wanted.

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#### 9.2.8 MSFN Acquisition Via PCM High and Update PADs

CONRAD The communications were excellent. The PAD updates were given on time, and as Al already commented, were easy to copy. We never had any trouble with telemetry that I know of. We had good telemetry all the way, I think.

BEAN I've got one comment. I noticed, when we were coming into PDI, that there was a lot of background noise. I guess it must have been on the S-band. It had sort of a roaring, whistling sound, and it persisted for about 10 or 15 minutes. I don't exactly remember when it stopped, but it finally ceased so that from PDI through landing, we didn't have that sound.

CONRAD Yes, I remember that now. It didn't really interfere with the COMM because the voices were good and loud. This whistling, windy sound was on there.

#### 9.2.9 PDI BURN; PGNS PERFORMANCE AND PROCEDURES

CONRAD We got a GO for PDI, went into P63 and had our final trims brought on the landing radar. We had ignition on time and the engine was very smooth. It throttled up right on time. We started down the trajectory and, because I could not see the ground, I religiously kept my head in the cockpit and used the ENTER button at 30 seconds, 1 minute, 1 minute and 30 seconds, and right on down the line, carefully checking the PGNS first

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[REDACTED]

CONRAD as to predicted values, while Al checked the AGS versus the  
(CONT'D) PGNS. The AGS and PGNS stayed in very, very good agreement.  
We got the ED batteries checkout. They came up with a NOUN 69  
at plus 4600 feet, if I remember correctly.

BEAN 4200 feet.

CONRAD Plus 4200 feet at about a minute and a half. We entered it.  
The ground read it so that it was okay. We pushed it into the  
computer. This seemed to be the right number later on because  
it looked like we were targeted right dead smack in the center  
of the crater. The landing radar came in exactly as predicted  
at 41 000 feet. Here, I noticed something that is different  
from the simulator. The altitude beam locked on and apparently  
the velocity beam locked on also. Now, in the simulator, if I  
remember correctly, the velocity light will not go out until  $V_I$   
is 2000 feet per second or less. Apparently, the lockon light  
is independent of the 2000 feet; that is, when it will take  
velocity information. The altitude light went out and shortly  
thereafter at a higher velocity than 2000 feet, the velocity  
light went out indicating a lockon. Now, I'm sure that the  
computer did not use this information. So we got to a  $V_I$  of  
2000 feet, which was different from what we had seen in the simu-  
lator. That's the only difference that I noted between flight

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CONRAD and simulator during P63. The other comment I have in P63,  
(CONT'D) and it didn't bother me too much although I commented to A1  
about it several times, was the fact that we had considerably  
more RCS activity than we had noted in the simulator; but Neil  
also mentioned that, all the way down, he had more RCS activity  
than he had noted. So, I think this is due to radar updating.  
Our DELTA-H, the first time I noticed it, was a minus 1100 feet  
and it had some noise on the radar. It jumped to 1900 feet and  
steadied out between 1100 and 1900 feet. We watched it for a  
few seconds, and the ground gave us a good update which we did.  
I'm sure that we were taking radar data at some 39 000 feet.

## 9.2.11 BRAKING

CONRAD The throttledown did not happen quite as predicted. It seems  
to me we were off by a second. I don't remember whether it  
throttled down a second early or a second late. I believe it  
throttled down a second early. I think they gave us a throttle-  
down at 6 plus 22 and we throttled down at 6 plus 23 or 24 or  
something like that. But it was close enough that we felt that  
that part of it was going all right. Every once in a while, I  
took a peek to see if I could see the horizon; and, along around  
25 000 feet, I could see the horizon out of the bottom of the  
window, but seeing it didn't help so I went back on the gages.  
I'll have to go back to the time period of our alignment.

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9.2.12 LPD ATTITUDES AND ACCURACY (CALIBRATION)

CONRAD (CONT'D) We used the COAS option and pumped in a 40-degree angle for the LPD. It was easy to read the LPD in darkness and see where the star was. We had a reading of 0.8 degree right and 0.2 degree down, which was where the star was located. This showed a lot smaller yaw bias than we thought we had. I thought that the numbers were insignificant, and in the noise level for me to worry about them. I was going to interpret the LPD just the way I saw it. We went into P64 at - -

BEAN 7000 feet, and I think we hit high gate right on the money.

9.2.13 Final Approach

CONRAD As soon as we started the pitch maneuver, I proceeded on the computer to enable LPD and immediately went outside the window. For the first couple of seconds, I had no recognition of where we were although the visibility was excellent. It was almost like a black-and-white painting. The shadows were extremely black, illustrating the craters and all of the sudden, when I oriented myself down about the 40-degree line in the LPD, our five-crater chain and the Snowman stood out like a sore thumb. I started asking Al right away for LPD angles; as best as I could tell, we had absolutely zero out-of-plane error. We were targeted right dead smack in the middle of the Surveyor crater

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CONRAD and I just left it alone. I didn't LPD for quite a while until  
(CONT'D) we got down around, as I remember, 2300 feet or so. I LPD'd  
one right to move it off the crater and headed for the landing  
area short of the crater. At that point, I listened to some  
more LPD angles from Al and I had the feeling that I was a  
little high; so I LPD'd two clicks short, and I let it go for  
a while. Then I decided that I was going to land a little short  
and Al called out something like "30 seconds worth of LPD  
remaining." I gave her one click forward, let her go for a  
while, and decided we were high and fast. I didn't like the  
size of the area short, where we had normally been trying to  
land, and I looked for a more suitable place. At the same time  
I took over manually at about 700 feet and immediately killed  
the rate of descent. It looked like we were going at the ground  
like a bullet. I had plenty of gas and I wanted enough time to  
look around. At that point, Al got a little nervous because  
I had killed the rate of descent to 3 feet a second at 500 feet.  
I left a very high pitch angle on it, on the order of 30 de-  
grees, because we were moving quite fast and I wanted to get  
stopped. I had the horizontal velocity under control about  
the time I passed the near edge of the Surveyor crater. I  
saw a suitable landing area between the Surveyor crater and  
head crater, which now meant I had to maneuver to my left and  
sort of fly around the side of the crater, which I started to

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CONRAD do. I guess I wheeled it pretty hard, because Al commented a  
(CONT'D) couple of times that I was really cranking her around and I  
told him it was no problem. I had everything under control  
and I did increase the rate of descent after he called my atten-  
tion to the fact that we had leveled off quite high at 500 feet.  
I got down as soon as I got over the area that I wanted to land  
on. To me, it looked like a perfectly smooth, good area,  
between head crater and Surveyor crater and I started a vertical  
descent from a relatively high altitude, 300 feet at least.  
It may turn out that I actually backed up a little bit; but I  
don't think so. As soon as I got the vehicle stopped in hori-  
zontal velocity at 300 feet, we picked up a tremendous amount  
of dust; much more so than I expected. I could see the boulders  
through the dust, but the dust went as far as I could see in  
any direction and completely obliterated craters and anything  
else. All I knew was there was ground underneath that dust.  
I had no problem with the dust, determining horizontal or  
lateral velocities, but I couldn't tell what was underneath me.  
I knew I was in a generally good area and I was just going to  
have to bite the bullet and land, because I couldn't tell  
whether there was a crater down there or not. We came down  
with a relatively low descent rate. I think I speeded up to  
about 6 ft/sec and got her down around 100 feet, where Al called  
it, and I slowed to about 3 ft/sec and started milking her down.

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CONRAD  
(CONT'D)

At that point, the dust was bad enough and I could obtain absolutely no attitude reference by looking at the horizon and the LM. I had to use the 8-ball. I had attitude excursions in pitch of plus 10 and minus 10, which happened while I was looking out the window making sure that the lateral and horizontal velocities were still nulled. I would allow the attitude of the vehicle to change by plus or minus 10 degrees in pitch and not be aware of it, and I had to go back in the cockpit and keep releveling the attitude of the vehicle on the 8-ball. I was on the gages in the cockpit doing that at the time the LUNAR CONTACT light came on. I had that much confidence in the gages. I was sure we were in a relatively smooth area. I had my head in the cockpit when the LUNAR CONTACT light came on and I instinctively hit the STOP button and that's how we got a shutoff in the air. We were, I'd estimate, 2 or 3 feet in the air still when I shut down the engine and it dropped right on in. We landed on a slight slope; therefore, the right plus-Y gearpad touched first and tipped the vehicle to my left. The vehicle plopped on on all four gears at that point with no skid marks that we could determine other than the first pad touchdown. When we set it in for a landing and looked around, it turned out there were more craters around there than we realized, either because we didn't look before the dust started or because the dust obscured them. One thing that I

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CONRAD  
(CONT'D)

wanted, and we still haven't figured out why I didn't get it, was the crosspointers. I reached up and hit the switch from HIGH MULTIPLE to LOW MULTIPLE and still had no crosspointers. I asked Al if possibly one of the switches was in AGS, but he said it was in the PGNS position. We should have had crosspointers, but, for some reason, we did not. It's an anomaly that I couldn't check out afterwards. The crosspointers worked with the rendezvous radar, so it's not that my gage was out. I don't know the reason for not having the crosspointers, but I wanted them very much. I think had I had them I probably would never have looked at the ground in the last 50 or 100 feet. I would have gone completely on the gages. Now, the landmark visibility I have to class as excellent. It was very easy from our model and the photographs that we had. There was no doubt in my mind when we finally zeroed in at about 6000 feet exactly where I was, that I was in the right place. Had I been short or long, I think it would have been very obvious to me. The lighting was excellent. The surface had a white-gray appearance; the shadows completely black. I was not aware of any washout and I was not aware of seeing zero phase. Everything looked a lot smaller and closer together in the air than it turned out to be on the ground. When we were on the ground, things that were far away looked a lot closer than they really were. The color does change with look angles. My yaw

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CONRAD  
(CONT'D)

only changed maybe 10 or 15 degrees in either direction, both times to the left and right. This didn't make too much difference to me in the change of color. Whenever we looked directly to our right or left, cross-Sun, things had a browner appearance than normal, which was expected from looking at Neil's photographs. None of these things appeared unusual. I think I might have used the LPD more, closer in, but I was sure that we were so much on target that I really didn't need it. That may have caused my slight overflying and taking over to stop what I thought was a relatively high horizontal velocity. As it turned out, I don't think we landed more than 400 to 500 feet past the Surveyor. We were right on the very edge of the Surveyor crater, the far edge of it. I could see it from looking around the side of my window as we sat on the lunar surface.

#### 9.2.14 MANUAL CONTROL

CONRAD

I think the manual control of the LM is excellent. The LLTV is an excellent training vehicle for the final phases. I think it's almost essential. I feel it really gave me the confidence that I needed. I think the simulator did an excellent job in manual control and LPD training all the way down to the last couple of hundred feet. I think both devices worked very well together.

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9-15

9.2.15 HOVERING

CONRAD Hovering was easy.

9.2.16 BLOWING DUST

CONRAD I've already commented on the blowing dust. I felt it was very bad. It looked a lot worse to me than it did in the movies I saw of Neil's landing. I'm going to have to wait and see our movies to determine if it doesn't show up as badly in the movies as it does to the eye. Maybe we landed in an area that had more surface dust and we actually got more dust at landing. It seemed to me that we got the dust much higher than Neil indicated. It could be because we were in a hover, higher up coming down; I don't know. But we had dust from — I think I called it around 300 feet.

9.2.17 TOUCHDOWN

CONRAD I mentioned the engine off while still airborne. That pretty well covers it through touchdown.

BEAN We gave them two or three AGS updates for altitude every time it looked like there was any sort of spread. There never was any except for the first altitude update. During the descent, while you were looking out the window, the computer operated just exactly like it does in the simulator. We had blinking

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BEAN  
(CONT'D)

altitude and velocity lights from time to time, but this didn't appear to have any effect on the measure of the altitude above the ground. Sometimes it would jump from an altitude of 50 feet to an altitude of 70 feet while we were still descending. At the very end, the indicated altitude agreed with the actual altitude.

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10.0 LUNAR SURFACE

10.1 Postlanding Powerdown

CONRAD The postlanding powerdown went per the checklist. Al called out my portion and his own portion. As soon as we landed, I was spring loaded and had the descent REG-1 OFF and the MASTER ARM ON and blew the vents. I think we were venting within 30 or 45 seconds after touchdown. It went as advertised. We got a descent redlight right away.

10.2 Venting

CONRAD It vented until the ground told us to secure the vents. They told us to secure the fuel vent, and we left the oxidizer open a while longer.

10.3 SITE LOCATION

CONRAD I was positive of where I was. The thing that confused me was that we were so close to the Surveyor crater. I didn't realize we were as close to it as we were. The thing that confused both of us in the beginning was the fact that distant objects looked much closer. It took us a while to realize that we were seeing many more of the craters that were on our map. They also looked smaller to us on the lunar surface than they did in looking at them on the map. We had a hard time



CONRAD convincing ourselves that the crater in front of us was head  
(CONT'D) crater.

BEAN That's right. When you're sitting on the ground, none of the shadows that are visible from the air are visible — the ones that are down on the bottom of the crater — so you end up always seeing the bright part of the landscape, and it's difficult to find the craters. You look out and say, "There's a crater over there." It's difficult for the other guy to see it for a while until you learn to look for the edge. Our plan was to land, discuss where we were for a few minutes, and then make some out-the-window evaluations. I would recommend on the next trip that you make a quick evaluation, knowing that you may not be precisely right. Then make a quick judgment of the general geological features out the window. Don't spend more than 5 minutes at the most on it, because the minute you get out, all these guesses that you were making through the window will be either right or wrong. You can walk behind the LM and look back like Pete did and find that you're standing right next to the Surveyor crater. I think we spent 20 minutes here that we could have better used getting out and getting to work. Then maybe when we got between the two EVA's when we knew exactly where we were, we could give a better geological description if that's what were in order.



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CONRAD We knew where we were within 1500 feet or closer at the time we landed. We were trying to pinpoint precisely where we were to within 10 or 20 feet, which was ridiculous.

10.4 Light/Shadow Contrast Effects

CONRAD We have mentioned the light and the shadow contrasts. Whenever we looked cross-Sun, we had the brown effect and we could see shadows. Looking down-Sun, the Sun angle was so low we never could see any shadows except our own shadow from the LM.

10.5 STAR, EARTH VISIBILITY

BEAN Star, Earth visibility was interesting. We could always see stars at the upper rendezvous window. We could see Dick go by us also.

CONRAD Al took a quick look around through the AOT and, except for the detents that had the Sun in them, we had lots of stars and no big problem night-adapting to see stars in the AOT.

BEAN I guess Apollo 11 had a different set of circumstances between the Sun and the Earth clobbering up most of their AOT detents. The Earth was above us and behind. The Sun was low and behind, so our front three detents were in excellent shape.



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#### 10.6 Horizon, Sighting Appearance.

BEAN In appearances, it took us a long time to convince ourselves that some of the craters which looked so close were really much farther away. Once we realized, we had ourselves pinpointed and all the craters that we could see.

#### 10.7 PANORAMIC IMPRESSIONS

BEAN Another thing that threw us a little bit was that preflight we saw some charts that showed little X's where boulders bigger than 1 meter were located, and we didn't see those boulders. We didn't see a lot of boulders lying around on the ground. Looking down in the craters, we could see a few. I think there will have to be some sort of reevaluation of what they're showing as boulders on these Surveyor charts because we didn't see a lot of them just lying around on the ground.

CONRAD They had me convinced that there were 1-meter or bigger boulders lying all over, and it turned out to be untrue. I'm sure Al's right in his estimate that there were many little 1-, 2-, 3-, or 4-foot secondary impact craters all over the surface. I'm sure that most of these were being interpreted as boulders.

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10.8 PGNS Drift

CONRAD The PGNS drifts were very small. We had no difficulty with our P57's, which we did twice. Our first one apparently was the best. They liked the RLS, and we incorporated our own RLS.

10.9 AGS

CONRAD The AGS alignment went in an excellent manner, just as advertised.

BEAN They did.

10.10 AUTO Optics

BEAN Let me make one comment about the AOT alignments. The stars that we had to use were near the extreme edge of the AOT. When a star gets out there, you can't center your eye in the opening of the eyepiece and view those stars and keep them and the cursor in focus. If you have a choice, try to pick stars that will appear right near the center of the AOT. I think by doing this you can center your eye very well in the eyepiece and you can come up with pretty small star-angle differences.

CONRAD You can do this in advance, and we ought to use the other 400 stars and unit vectors if that's the case. It's a lot better than trying to use an Apollo star, as Al says, and to

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CONRAD find one that's somewhat closer to the center of the AOT. I  
(CONT'D) think it will improve the alignments, and it's no problem  
loading unit vectors or doing that portion of the program.

#### 10.11 PREPARATION FOR EGRESS :

CONRAD This is one place that we made a mistake. We were a little  
bit behind and we started to hustle a little bit faster than  
we should have to get out. We made several mistakes because  
I allowed us to get off the checklist a little bit. That  
cost us another 10 or 15 minutes figuring out goofs that we  
made by simply not staying with the checklist. The checklist  
covered all items. My hat's off to Scott Millican and every-  
body else that had anything to do with any of our checklists.  
We didn't find any mistakes in the checklist. The checklists  
with respect to the command module and the LM were excellent.

#### 10.12 Evaluation Of Work And Thermal Load

##### In Egress Preparation

CONRAD The work and thermal load in preparation for egress were very  
low and they were not fatiguing. We got off the checklist in  
two places. One place it goes through a very detailed ex-  
planation of how to hook up the PLSS for the IMP. It has a  
statement to do the same thing for the CDR.

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10.13 PLSS and OPS Preparation Donning and Operation

CONRAD We forgot to hook up my hoses and, when it came time to turn on my PLSS fan, we got into trouble thinking my fan was either clobbered or out. It turned out my hoses weren't hooked up. That was a straight goof on our part. The next goof on our part was when we hooked up our RCU's. There was one switch check that we didn't make. The main switch was in the OFF position and not in the main position. We thought something was wrong with our COMM. Both our switches were in the wrong place, and neither one of us had COMM.

BEAN Another thing that brought this about is that the gear used down at the Cape have the COMM switches on them but you don't have to use them at all for COMM. The COMM is controlled by the simplex on the back of the OPS on top of those practice PLSS's. Here's an example of the gear we're using not being configured precisely like the gear we use in practice, and that cost us 5 to 10 minutes. That's going to come up again when we start playing with this TV camera, too.

CONRAD Yes, that's right. There are only two places we got into any trouble, and one was getting off the checklist. The couple of occasions that we got off it, we ran into trouble. The other place we ran into trouble was when we didn't have the

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CONRAD gear available. We either didn't have the gear available in  
(CONT'D) the proper configuration or the gear wasn't available. The  
TV camera was not made available to us, and I'm afraid that's  
what cost us the TV camera. We were not familiar with it and  
we'll point out what happened later. Those are the two places  
we got into trouble. They are places I knew we'd get into  
trouble, and I'll bite the bullet on the first one. It was  
my fault for getting off the checklist and hustling, although  
all it did was cost us some time. We'll both bite the other  
one on the TV camera.

10.14 MSFN, CSM Conference Communications

CONRAD MSFN CSM conference communications were outstanding. The  
lunar surface communications both inside and outside the LM  
on the PLSS's and on the LM itself were just like having Hous-  
ton outside the door right next to us. They were really good.

BEAN I always thought that somebody was located in a building about  
5 miles away and, if we would just look back over there behind  
the LM, we would see Jerry Carr and Ed Gibson standing there  
talking to us. It was beautiful.

There's one other thing that should be added to the checklist.  
When we went over completely on the PLSS's, there was a  
period of time when you reconfigured the cockpit before you

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BEAN  
(CONT'D)

turned on your PLSS O<sub>2</sub>. The reason you don't turn on your PLSS O<sub>2</sub> is that you are going to pressurize your suit. What happened was that I suddenly realized that both Al and I were in the grip of a great octopus because both our suits started to suck down around us, and we started hustling on the checklist again so we could get to the point where we could turn on the O<sub>2</sub>. In retrospect, I think what we needed to do was to put a little note in the checklist that as soon as you get ready to go over on the PLSS system and you completely hook up on it, you cycle your O<sub>2</sub> once and put a half pound or something above cabin pressure in your suit and then shut your O<sub>2</sub> off. I think we were breathing it down and we were being very careful to go through our circuit breakers and ECS configuration in the LM, and the suits got tighter and tighter and tighter. We finally got to the point where we could pressurize the suits, and we did. That happened on both occasions, and all I think we need is a little change there to cycle the O<sub>2</sub> and to put a positive pressure in the suits.

#### 10.15 DEPRESSURIZATION

BEAN

The first cabin depressurization was pretty interesting because as soon as Al opened the depressurization valve after our 3.5-psi check, everything in the spacecraft disappeared out the valve. There was much outgassing, which is not unusual.

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BEAN I had seen it in Gemini. All loose particles that happened  
(CONT'D) to be floating around disappeared from the spacecraft; it gives  
the spacecraft a real flush.

CONRAD The cabin went right on down to 0.2 and then the spacecraft  
outgassed for about another minute, I guess, and we finally got  
down to 0.1 and Al peeled the cabin door open. You have to do  
this or it just stays stuck until you push it open. It  
doesn't hurt the door or the seal or anything. We got the  
door opened and brought on the water boilers which came on in  
just the right amount of time. In 2-1/2 minutes or so, the  
water boilers were on the line and we were ready to go.

## 10.18 LM EGRESS - FIRST EVA

CONRAD It took me a moment to get oriented and Al gave me a GCA and  
I apparently was rolled to my right slightly on my way out so  
that the left lower corner of my PLSS tore about a 6-inch rip  
in the hatch insulation. That was the only problem - I didn't  
notice it going out except I did fray the insulation a little  
bit. I got out on the platform okay and I released the lock-  
lock mechanism on the MESA and the MESA handle was free in its  
holder. I tried it and it wouldn't come out. I pulled on  
that thing as hard as I could pull two or three times, jerked

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CONRAD (CONT'D) it and everything else and I couldn't get it out. I got tired of wrestling with it, so I just reached over, pulled the cable, released the MESA, and down it went. I went down the ladder and the lighting was excellent. I had no trouble seeing where I was.

#### 10.19 Environmental Familiarization

CONRAD At that point, it took me about 5 to 10 minutes to acclimate to what was going on. I didn't have any trouble moving around, but I felt a little rocky. It just took me a while to get organized. This feeling was not bad the second time I got out. As soon as I got out the second time, away I went. So, like anything else, there's a slight learning curve which took all of 5 minutes and away we went. The nicest part of the exercise was that everything went according to the checklist as best as I could see. It went exactly the way we practiced it. And we had no trouble with the equipment. I had excellent mobility in one-sixth g. I missed the fact that I couldn't bend over. That's something I knew I was going to face the whole time and it didn't bother me too much. Now, I guess the biggest note that'd I like to make, and I think Al and I agree on this, is that the side visor, the side blinkers, blinders were excellent. But you also need a top one. We had a low enough Sun angle that, anytime you put your hand up,

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CONRAD  
(CONT'D)

looked directly up-Sun, and just blocked the Sun out, you could see perfectly up-Sun. It was only when the Sun was shining in the top of the visor that we had difficulty. So, I think we need to modify the visor so that you have a center top shield that you can pull down and blink the Sun out. If you have that, you can turn 360 degrees and see perfectly in any direction. It will also allow you to look in shadows. The only other time you have difficulty seeing in a shadow is when some other object is reflecting sunlight into your visor when you're trying to look in the shadow. Once you're in the shadow, you can see well. This is nothing new; Neil already pointed that out.

BEAN

Let me say that, just as soon as Pete got out, I had to move over to the right window to take some motion pictures; when I did, I pushed the door partially closed and went to work. About this time, I got a low feedwater pressure. We stood around and tried to figure that out for a while and finally I happened to glance down and noticed the door was closed. I realized what had happened. The outgassing of my sublimator had closed the door, with the result that I didn't have a good vacuum inside the cabin anymore. I quickly dove on the floor and threw back the hatch. The minute I did, a lot of ice and snow went out the hatch. Pete commented about it, and it wasn't 30 seconds

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until my water boiler started operating properly again. I think that's something that you're going to have to be careful about when you're moving around inside there. I hadn't thought about it before the flight.

10.20 Walking (Traction, Balance, Distance and Direction,  
Pace and Stability)

CONRAD As I said, we listened to Neil's and Buzz's comments and ours are exactly the same. There's no need to go over them, other than just to remind you to lead your direction changes slightly, but you acclimate very rapidly and it's no problem.

BEAN I never noticed any slippery surfaces such as Neil and Buzz pointed out. The ground never felt slippery at all to me. The c.g. problems they had were the same. I was very careful not to walk backward; because, I noticed a couple of times when I did, I usually stepped in a crater or on uneven ground and it put me off balance. What do you think about the slipperiness?

CONRAD I didn't notice any slipperiness, but I think the other comment about moving backwards is the fact that you have such a mass on your back. Al commented to me and I noticed, watching him, that you look like you're standing with quite a forward tilt; but all you're doing is putting your c.g. over your feet and

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BEAN  
(CONT'D)

your c.g. is quite aft with that PLSS, so you have the tendency to lean at what at first glance looks quite far forward; it's not.

#### 10.21 Best Rest Position

CONRAD

The position described is a very comfortable position. I never got tired. It's just a normal position to rest in. You can stand perfectly still in that position and rest. Anytime you try to go backward you also have the tendency to stand up a little straighter. Did you feel the same way about resting? Did you just stand?

BEAN

I never remember doing anything but standing there and never seemed to get tired. As you said earlier, you could work 8 hours out there; if you got tired, you could probably stand against something or just stand there, cool off, and press on. At the end of the EVA, I was feeling as good, particularly in my legs, as I was at the start. The only physical thing I noticed on the second EVA was that my hands were more tired than on the first EVA. I would definitely work on the hands a lot more the next time.

CONRAD

I didn't notice that my hands got tired as much as I noticed that they got sore. When you work for 4 hours and use your hands, you have a tendency to press the end of your fingertips

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[REDACTED]

CONRAD into the end of the gloves; although my hands never got stiff  
(CONT'D) or tired, they were quite sore the next day when we started the  
second EVA. As soon as you got working again, you forget it.  
It wasn't until we got back into the command module that we  
noticed that our hands were sore again. But this was because  
we did almost 8 straight hours of EVA work which we had never  
really done before; and I think in one g you don't have the  
tendency to thrust your hands as far down to the bottom of the  
gloves as you do on one-sixth g. You really ought to hang onto  
something up there. It's not as apparent to you when you're  
working up there that you are pressing your fingers as far out  
in the gloves, and I think that was just a point.

BEAN Another thing that Pete mentioned is that it only takes you  
about 5 minutes to learn how to move around; the second time  
you go out, you don't really need the 5 minutes. Neil pointed  
out that this was the best thing to allow for acclimation. I  
concur 100 percent. Another good thing is both those POGO's.  
The mobile POGO that FCSD has is good except that it needs a  
Z-axis freedom that it doesn't have now. The one on the cen-  
trifuge is excellent. I found that running around on the lunar  
surface, moving from side to side, hopping, and so on were  
almost precisely like using the one in the centrifuge. I'd  
recommend having a couple of exercises over there before you

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BEAN (CONT'D) go and also recommend changing the terrain over there so that the simulations include a few more big craters, little hills and dales. I think it would be very good training.

CONRAD And there's another thing -- there's no such thing as walking on the lunar surface. Wherever you go, you just want to go at a lope. If you walk, it takes more energy to move slowly and take a normal step then it does to lope.

BEAN It's interesting and I know we commented about it when we were doing it. If you look at somebody's footprints on the moon, it's almost exactly the opposite of the way they are on the Earth. On the Moon, you can see a flat footprint as the guy lands and then he pushes off with his toe so it ends up being sort of dug in at the toe and flat in the rest of the print. On Earth, a fellow steps forward, lands on his heel, which digs in, and he kind of drives off on his toe. This sort of bouncing along, using your toes for springing and moving from side to side so that the c.g. is always over the foot that's landing, allows you to move out at a pretty good pace and to move a good distance. I had the feeling that, if our TV had been working and if the TV hadn't been pointed in exactly the right place when we went out to 450 feet to lay out the ALSEP, it wouldn't have taken us over 2 minutes to run back, position the TV exactly right, and return to the ALSEP.

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BEAN It would have been no trouble and would have been the thing  
(CONT'D) to do.

10.23 Contingency Sample Operations

CONRAD We've already commented on the COMM check and voice quality, so I'll go to the contingency sample. It worked very well. The only comment I have is that I probably filled the bag too full. I got some small rocks and then mostly dust and dirt and rolled the bag up later and packed it in the ETB, stashed it on the landing gear like we had practiced at the Cape.

10.24 Transfer of Expendables to Ascent Stage

CONRAD Then I went ahead and got the batteries and the LiOH canisters with no difficulty. I packed the ETB and our means of transfer worked very well. It took very little time to get the equipment up. The only problem I had was looking directly into the Sun. We were yawed off enough and the Sun was offset enough that I had to walk past, rather than stand directly in front of, the hatch. I had to get off to my right facing the hatch, which meant that I had to walk a long ways from the MESA and get into shadows, so that when I looked up I could see the transfer bag and help it over the porch and over the lip of the hatch. I think Al had no problem. I had no problem. He didn't tend to pull me over or anything like we suspected.

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BEAN No. That was good. The only thing that I noticed was that, on the rig that they gave us, there's a small metal pin in the strap that keeps it from accidentally sliding out to the hook and this small metal pin wasn't big enough to prevent this. I just happened to glance down one time and the strap had fallen on the floor. It was just about to go out the front hatch, which would have put a pretty good glitch in retrieval operations. That pin has to be modified. I definitely think that we don't want to go back to a continuous strap. I think the single strap is a workable thing. When you're moving a light load, most of the time, with the exception of the rock boxes, you don't have to use the strap feature over the top of the hook. You can just lean down near the hatch and pull the load in with your hands. It's a lot quicker. When you start carrying a heavy load like the rock boxes, you probably need to use the hook arrangement also.

CONRAD Our two rock boxes weighed out, Earth weight, at 44 pounds and 52 pounds, if I remember correctly. Neither of those boxes, which obviously were the heaviest things we sent up, presented any problem. The only problem was one that was already mentioned. We knew it was going to happen anyway and I really don't see a heck of a lot you can do about it. This problem is that the lower end of the strap got completely covered with

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CONRAD (CONT'D) dust and I got dust all over my hands and over my suit arms from handling that strap. I really don't see anything you can do about it.

BEAN One other comment: Both times I egressed the LM and tried to close the hatch, it took 45 seconds or so to find something on the hatch I could pull. I think it would be worth the effort to put some sort of hook or something as a permanent fixture on the outside of the hatch so that, when the last man gets out, he can pull the hatch closed without having to grab one of the protective doors over either the handle or the vent valve. It would save 45 seconds or so each time.

10.25 Egress Observation of LMP

CONRAD I observed the LMP on his egress. I gave him a little GCA which I don't really think he needed and got the photography of his descent. I started the first part of the TV deployment as we planned. I had the first two pins pulled and the upper door opened at the time Al decided to get out and I had also put up the tripod; I let Al finish the job. You can comment on your adaptability, if you want.

BEAN I kind of agreed with Pete in the stated area. It just takes about 5 minutes to get used to walking around, and this time should be allowed on the first EVA; once you learn that, you



[REDACTED]

BEAN can start easing over and doing your job. I noticed no effect  
(CONT'D) of our movements; I leaned forward and backwards about the  
same as I expected. I got used to it very rapidly.

10.27 TV Deployment and Operation

BEAN The next thing I did was get the TV. I think this is where  
we really got into our first problem. I took the TV off the  
MESA pretty readily and stuck it on top of the tripod and moved  
the tripod and the TV over to the deployment place, which was in  
front of the Commander's window which would be about 10 o'clock  
at about 20 or 30 feet. The only problem was that, when I got  
over there, I realized that, because the LM had landed in about  
a 10- to 15-degree right yaw, the MESA was now in the Sun and  
that, to put the camera where it could view the MESA, I would  
be looking directly into the sunlight. If I put the camera  
over in the shadow of the LM as we planned to do originally,  
when the MESA was in the shadow, you wouldn't be able to see  
the MESA. So, I said, "Well, I think I'll take it over and  
put it on the opposite side, over about 2 or 3 o'clock." I  
carried the camera over to the opposite side, stuck it there,  
pointed it at the LM, and called the ground. It looked to me  
like there were some pretty bad reflections off the LM and  
I was concerned that maybe they'd bother the TV. Apparently,  
that's just exactly what happened; these reflections were far

[REDACTED]

BEAN  
(CONT'D)

too bright for the TV to handle and it burned out. At least, that's my guess as to what occurred. Now, it seems to me, this was brought about by two main causes. One, I had personally always felt that we were just carrying the TV along to stand it around and show what we were doing; hence, I personally had never done a lot of serious thinking about how to operate it, the backup modes, its specific limitations, and that sort of thing. As a result, when we got in an off-nominal situation, I didn't really have any good plan for it. I didn't think that the TV was going to burn up from pointing at that descent stage, but I guess I should have been aware of the possibility before I went. I guess that brings up a point. You don't want to make a move with any equipment on one of these flights, even if you think it's not a particularly significant piece of equipment, if you don't understand 100 percent of its capabilities and limitations. Another point about the TV, which I thought about later on, in looking at our plan for how we were going to use it; namely, we were going to take the TV around in back and position it at approximately 4 o'clock so that we could view the - offloading of the ALSEP. Also, we were going to use the TV for some 360-degree pans. It's my impression now that either operation would have burned out the TV or given it a pretty good shock. I think this is brought about by the same situation. I never really thoroughly

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understood the limitations of the TV. I think that the way we can help a situation such as that, in addition to doing a lot more preflight thinking about it, is to get a TV to work with that's like our flight TV. We need to work with it outside in the Sun using the monitor. If we had done this, I think it would have become very obvious that the TV doesn't have to be in the Sun too long or even point at a bright object too long before the tube is going to saturate and you're going to run into a lot of trouble.

#### 10.28 Deployment of SWC

BEAN

The next thing we did was deploy the solar wind collector. That was pretty straightforward. I moved out a good distance from the LM, unrolled it, deployed it, stuck it in the ground. It went in about, I guess, about 10 inches fairly readily and tilted back; it seemed to hold its position very well. Then I started trotting back to the LM. I looked back at it. We were caught in the same predicament of not being able to estimate distances. It didn't look like I had gone out 60 feet, so I walked out, picked it up, carried it out another 20 or 30 feet, and stuck it in the ground quite quickly. Then I stood there, looked at it, and said again, "Well it looked like 60 feet, but now it doesn't." So I pulled it out of the ground again, went another 20 feet, and stuck it in. I

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BEAN  
(CONT'D)

probably got the thing out 200 feet, but we wanted to make sure that we got it far enough away so it wouldn't be affected by any of the LM outgassing or anything like that. The final time I inserted it, I pushed down with all the force I could get and put it in about 12 inches. One thing that continually disturbed us the whole time, particularly Pete, was the fact that the TV cable was right in front of the MESA. Our TV cable laid flat on the ground. It didn't tend to curl up or anything like that; but, because it rests on top of the dust and your feet go beneath the dust, you end up pushing the cable around quite a bit. I think this is a completely unsatisfactory situation and I would recommend that that connector for the TV be moved either over to quadrant 3 or quadrant 1 so that the TV cable would never have to be in the vicinity of the MESA or the area near the front of the ladder. It's just too highly traveled an area to have something like that TV cable underfoot. We never fell over it but it was just a constant problem trying to avoid it.

CONRAD

Yes, I bet you'd be able to use it so that you'd be able to move the cable and get another 40 feet out of it by being able to go plug it in the back of the spacecraft.

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#### 10.29 Deployment of Erectable S-Band Antenna

CONRAD I'd like to talk about the S-band antenna. The antenna was no problem to deploy from the descent stage. I took the antenna right around to the agreed position, which was at the plus-Y gear, and erected it. It went just as advertised, except for the fact that it was not very stable. It was very easy to tip over. When I finally got the antenna completely erected, I went around and got the cable and plugged it in; and even when we had anticipated it (I thought I had the antenna right next to the spacecraft), as it turned out, I just barely had enough cable to connect it. The antenna was exactly in the right place at maximum distance. At that point, we had anticipated that it was going to be very difficult to try to align the antenna with the Earth. One, the sight doesn't allow any latitude. If the Earth is in the sight, the antenna is perfectly aligned. If it's not in the sight, you don't know where it is. So, Al came over and helped because the antenna had a tendency to tip over, especially when moving the crank which moved it in azimuth and elevation. The crank itself tended to tip the antenna over. The crank was stiff. Al grabbed it, pressed it into the lunar surface, and held it as steady as he could while standing behind it and giving me sort of a GCA on the hand crank. Finally, I picked up a corner of the Earth in the mirror and he still hung on to the antenna while I

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CONRAD fine-tuned it. Because we anticipated this problem, it didn't  
(CONT'D) cost us any time.

## 10.30 LM INSPECTION

BEAN I don't have a lot to say. I looked at the LM and took the  
photographs and it's difficult to ascertain how much the high  
parts of the struts were compressed. I guessed 2 to 3 inches.  
I saw no skirt damage. I saw no thermal insulation damage.  
The outside of the LM, as far as I could see, was in perfect  
condition.

CONRAD Now the one comment that I made in flight was that there was a  
rock about 4 by 3 by 2 inches lying right under the engine  
ball. It hadn't been blown away. I can't figure how it was  
lying right out at the skirt edge. We took a photograph of  
it. I don't know whether it will show or not, but it didn't  
blow away. I was quite surprised after seeing all that dust  
and stuff flying on landing that it did not blow a rock that  
size away. We went around and did the PAN photograph and I  
made a mistake there. I got in a hurry, got off the checklist,  
and I took all my PAN's at 15 feet. I had Al pick them up  
later so that we wouldn't lose on the time line.

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10.31 ALSEP DEPLOYMENT (Traverse,  
Site Selection and Activation)

CONRAD We got back to the ALSEP and started a normal deployment. The first thing we noted was that, as soon as we put the packages down on the surface, they began to accumulate dust. Everything went as advertised until Al screwed the cask removal tool on the cask and the cask would not budge. We got the normal fix-it, the hammer; while I beat the blazes out of the side of the container, Al managed to start the cask out. He'd get a little notch on it every time I'd fumble a container. And I really, I guess, started cracking the container. We finally got the element out and the generator fueled. I guess you want to discuss carrying it.

BEAN Yes, it looked to me like the part that was sticking was about the first inch or so because Pete would beat on it, and it would move out one-eighth inch or so until about an inch of it extended from the cask. Once the element was about an inch out, it suddenly came free and came all the way out, if that will be any aid to whoever is designing the equipment. Something was holding it that first inch. After we mated the ALSEP and got ready to carry it out, the workload carrying it out was just about the same as I had guessed from working on Earth. The hard part is holding that weight in your hands.

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BEAN  
(CONT'D)

Even though it is not much, the combination of the weight, the fact that you're moving along, and the fact that your gloves don't want to stay closed tends to make it a fairly difficult task. I would say that it would be acceptable to carry it this way for distances up to 500 feet; but, at distances greater than that, I don't think you want a hand carrier arrangement. You will want to have a strap that fits over your shoulder, or something like that. It's not your legs that get tired; it's a combination of your hands and arms and it just makes you tired. Another thing that occurred that we hadn't seen on Earth is, that as you bounce along at one-sixth g, the RTG package tends to rotate. The c.g. is not exactly lined up beneath the crossbar. It tended to rotate and unlock the two-piece crossbar. This was disturbing because I would have to stop once in a while and relock the crossbar. I would recommend that we definitely put some sort of snap lock on that crosspiece so that when you put it in position and it rotates to the carry position, it locks there. If it had opened up as we carried it, we might have dropped the gear and broken some of it on the lunar surface. It's funny that never showed up in any of our one-sixth g work in the airplane or anywhere else, but it was a continual problem on the lunar surface.



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When we were at the ALSEP site, it looked as if we were about 450 feet west and about 50 feet north of the position of the LM. It was a pretty good level site. Later when I got back to the LM and looked back, I noticed it didn't look as if the site were that far away. This was the continual problem we had, trying to judge distances. In any event, we had no trouble placing the central station down. We had no trouble putting down the RTG.

I did notice, however, that you could feel the heat radiating from the RTG. When I removed the bracket that carried the power cable that ran from the RTG to the central station, it felt warm to the touch. I didn't want to keep my fingers there too long, so I handled it with the ALSEP tool as opposed to just my gloved hands, as I had been doing in practice. That may be something you should practice. Apparently that bracket can get pretty hot, although we only had the element in it a short time.

CONRAD

I guess the point is, when you fuel that generator, you had better get on the road and get going to wherever you are going to take it. You should get those parts off the fuel element as soon as possible, because they heat at quite a high rate.

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BEAN The first experiment I put out was the passive seismic. It had two anomalies that I know. One was the skirt. The aluminum foil, the skirt, didn't want to lie down. It wasn't that it had a memory. When I placed it near the ground, the many layers seemed to separate. The skirt seemed to have some kind of static charge on it that would not allow it to touch the ground. It took quite a little pushing to get it to lie down on the ground. The only way I could make it lie flat was to put a little dirt on it, which I tried. But that wasn't a very good idea because it's difficult to put little clods of dirt on it. I later got some Boyd bolts and made little alignment tubes to sit on it. That worked real well; it held down the skirt pretty well. The second anomaly was that the little dish the passive seismic sits in needs to have a solid bottom so when it is placed on the ground, there is no danger of dirt easing up through the center of it, as there was in the case of our dish, and touching the bottom of the passive seismic itself and causing a thermal short that would ruin it. We spent quite a bit of time tapping out a nice neat hole so this wouldn't occur. Really, I think the fix should be to put a solid bottom to that dish. I think the addition of the bubble level to the top of the passive seismic was a good one. I noticed it was really easy to level the experiment with that. While I was doing it, I kept an eye on the little BB in the bowl-leveling

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scheme. It was just rolling all over the place as it had for Buzz when he tried it on Apollo 11. I don't think that's the way to go for any other leveling. I think this bubble works real well, and it works pretty fast. I'll go ahead and cover the others that I laid out. The magnetometer was a beautiful experiment and it was easy to deploy. It was easy to align and level and it took quite a bit less time than the passive seismic because it was sort of self-contained. You just screwed the legs to make it level. You could grab one of the magnetometer arms and move it around so that it would be in alignment. In both cases, we aligned them exactly zero, zero, or exactly East. The suprathemal ion detector and the cold cathode ion gauge, which were combined experiments, were difficult to align and we knew this before we left. The legs are too close together for the height and weight of the experiment. When you try to get it on the ground, it just wants to tip over. The little place where you insert the ALSEP tool is on the end that has one leg; it's a three-legged configuration, and so that tends to, if you put any offset or force on that attachment, tip it over. Next, the cold cathode ion gauge. A screen comes out of the side of the container in the suprathemal ion detector. It is spring-loaded so that it will hold a flat position when it goes over center. It's a real problem to keep the side of the suprathemal ion detector balanced while you

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(CONT'D)

try to make this screen go over center so that it'll lie flat. It took a couple of minutes to get the screen to lie flat. These spring-loaded devices are a real pain up there. You should have one that doesn't have any spring load to it. You open it up and drop it on the ground and it just lies flat from its normal weight instead of having some spring-loaded, over center device. It just adds time and work trying to get these little devices to work properly. The cold cathode ion gauge comes out of the side of the suprathemal ion detector. The cable was so stiff that if you put the gauge in the proper position, the gauge itself was so light and the forces on the cable were so strong, it would just pick up the gauge and move it to a nondesirable position. It ended up with both of us, Pete and I, working together. He held the ion detector while I tried all sorts of different deployment angles of the ion gauge to finally get one that would work. The only way we could make it work after spending about 5 minutes on a 30-second job (if it had been designed properly) was to lay the ion gauge on its back so that the front end pointed straight up at a distance that wasn't near as long as the cable itself. This seemed to work pretty well. When we were deploying the suprathemal ion detector, the lid came open a couple of times. This lid was supposed to be deployed from ground command after we had left the area so that the exposed mirrored surface would



BEAN  
(CONT'D)

be nice and clean and the two detectors would not get dust in them. I'm pretty sure that we did get some dust on the top of it. I hope it's not enough to bother the operation. I've got two other comments. My experience working the Boyd bolts is that you can do them a heck of a lot faster if they don't have those little alignment tubes on them. I don't know how Pete feels about this, but I recommend that you throw those off and just use the Boyd bolts. I could always stick my tool in there a lot faster when there were no tubes, and I can also see when the little bolts jump up a lot better. The second comment; I think we're kidding ourselves if we think there is any way to deploy this experiment without getting a lot of dirt and dust on it. The pictures are going to show this. They just have to be designed to accept dirt and dust. If they can't accept the dirt and dust, then they are going to have to be packaged in some way so they can be deployed completely and then, the last act would be to pull some sort of pin and flip off the covering that would have all the dirt and dust on it, exposing the nice clean experiment.

CONRAD

The only one I deployed was the solar wind spectrometer and it went exactly as advertised. I checked the four legs down, took it out the proper distance, aligned it, and turned her loose. The Boyd bolts, as Al pointed out, were no problem; it would probably be easier if the cups were lower. The bolts



CONRAD should be kept covered with the tape though, because of the  
(CONT'D) dust problem.

10.32 Sunshield Deployment

CONRAD The sunshield deployment worked perfectly well and as advertised in one-sixth g; it popped up, lifted off the ground, actually. It was a real thrill. The antenna alignment went as advertised. I had played with it enough that I knew how to align it correctly. Apparently it is aligned all right, because you are receiving good signals. We feel we did most of our homework on ALSEP.

10.33 Visibility of Boyd Bolts, Light Piping with  
UHT, Decal/Label Legibility

BEAN I do too. I think we knew exactly what to do on it. One thing that turned out a little different than I imagined; I had difficulty reading the decals that we had put on the ALSEP. As I recall, looking at it on the surface, it looked as if there were black writing on silver background. When I tried to read this on the lunar surface, it was very difficult. The brilliant light reflected off the silver and you couldn't see the black. We had the sequence of laying that ALSEP down pretty good, and I would recommend on the next one, they use a black on orange or something like that to decrease the amount of reflective light off the decals. It's going to be needed.

[REDACTED]

#### 10.34 Selected Sample Collection

CONRAD The selected sample collection, I felt, took a fair amount of our time. We did not collect quite as many rocks as I would have liked to on the selected sample. However, we did go over to the large crater, collect some rocks from there, photograph them, and then return to the LM. We were beginning to run out of time at that point, although the EVA had been extended and we did get enough rocks to fill the whole rock box.

#### 10.35 Sample Return Container/Core Tubes

CONRAD The sample return container worked as advertised. I do want to comment here that I feel the practice we did on the K-bird was excellent for one-sixth-g work. Opening and closing those boxes on the K-bird took away all the surprises. I was ready for some of the heavier forces, and had a handle on them. I was aware of the fact that the cable hold down was going to tend to rise when they were holding the boxes down. All the work we did on the K-bird was excellent, and made things a lot easier on the lunar surface with respect to the rock boxes. Al drove the core tube.

BEAN The core tube was pretty easy to drive. I think we must have been in a different sort of soil than Buzz was in; I augered it a bit as I drove it in, but I really never had the feeling that

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that was necessary. I think all that was necessary was to hit it pretty doggoned hard and drive it in there. We had no trouble going the full length. A couple of things I noticed as we worked was that whenever I held onto metal tools for any length of time, anything shiny like the extension handle; the tongs; or later during the second EVA, when I was carrying the handtool carrier; that my hands would get warm. If I would put them down and remove my hands from them, my hands would get cool again. It was not too hot to handle; it was just the fact that I would notice they started to warm up. Another general impression I had working with all the equipment is that the lunar equipment we have is generally too flimsy. If we are going to work with this gear, we should beef it up so that we don't have to be so careful about breaking it. I was always concerned that I might actually break some of the ALSEP equipment. I really don't think we need to be quite that tender with it. The same way with some of the tools we used later on. Pete may not agree with it, but he probably should say something. I got the feeling when we were working on those selected samples and coming back, we needed two things. We needed a little bit bigger set of tongs so that we could grab bigger rocks. We always ended up being able to get little bitty rocks. If we had a bigger set, we could get the little ones, and also the big ones. With that little one, you just end

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BEAN  
(CONT'D)

up getting little rocks. You want to reach down, get down, and look at rocks, and you want to pick up things. You don't always want to stop and use those tongs. I had the feeling that if we just had a strap mounted on our back, or to one side of our back or something, we could work as a team. One fellow could hold the other while he leans over and picks up or inspects a rock, or looks in a hole, or whatever he wants to do, and then lift him back up and he wouldn't get dirty. We had talked earlier about just falling over on our faces and catching ourselves on our hands, or getting down on our knees, and inspecting whatever rocks we wanted to look at. When we got there, we could have done this physically, but the problem was, it was just so dirty that you didn't want to do it. I went down on my hands a couple of times, but each time I did, I went down where I would land with my hands on a rock. I would stand there until I saw what I wanted to see, and then do a kind of push-up from the rock. But there isn't always a rock around to do this sort of thing. If we just had some simple strap, worked as a team and got the big rocks fast, and looked at what you wanted to real fast, I don't think it would interfere with anything else you did.

CONRAD

I agree with all that Al said. There's no doubt about it, you need a bigger set of tongs. By the same token, you need a bigger set of sample bags. Those big Teflon bags are very

[REDACTED]

CONRAD unruly in the lunar environment. They appeared to get brittle.  
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They took a set and were hard to straighten out. They just didn't handle at all well.

I think we need to develop a cloth bag of some type that will maintain its shape and not take a permanent set. These bags had been folded and tended to take a set, and when we straightened them out, they tended to be brittle. They had several long cracks in them when we wrapped up the rocks. One other item in the first EVA, the colored chart, I took out because I could not bend over, and there was no reasonable way to stick it in the ground. I tried to work it into the ground so that it was perpendicular to the Sun. It didn't work because of the soft dirt. It fell over and became covered with dust. I got it back up and tried to brush it off, but it was impossible. I just made a complete shambles out of it. The dust clung to it so badly that we didn't get a color shot of that.

10.36 LM INGRESS - 1ST EVA

CONRAD Neither of us had any trouble ingressing the LM and getting the door closed. The cabin repressed right away, and we went right into the PLSS recharge.

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## 10.37 PLSS Recharge

CONRAD We had practiced the PLSS recharge several times, and it paid off. The PLSS recharge went as advertised. The equipment was easy to handle at one-sixth g. All the stowage was adequate. We followed our procedures to the letter and we never fell over any equipment. It all went in the right places and transferred around as we had practiced.

I wanted to weigh the water. I put in this 25-cent scale, which should be set at zero. If anybody had thought about it, including myself, the spring tension in the scale itself was never zero in one-sixth g. As I unscrewed it to zero, I unscrewed it all the way; and the screw, the spring, and everything disappeared into the bottom of the scale. We had a slight amount of difficulty, like 25 minutes, putting that baby back together again, which we finally did. It would be wise to put in a reasonable scale that can be zeroed in one-sixth g. Let somebody think about it a little bit, we can plan this one better. The water weighing went okay. We both had plenty of feedwater left. The levels passed to us indicated that we were working 900 to 1000 Btu's. Both of our oxygen supplies recharged to more than 80 percent. I don't even know what the top-off was; I didn't even notice.

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## 10.38 LM EGRESS - 2ND EVA

CONRAD The second EVA prep went a lot smoother. We stayed with the checklist. We had gotten over our excitement and we did it in a much more orderly manner.

## 10.39 Geological Traverse

CONRAD We covered a lot of distance on this EVA. We were told that we went more than a mile. We used our chart while on the surface. It was a good thing we had it along. We stopped and consulted it on several occasions. Although navigation is not difficult out there, you really do have to stop and pin down certain craters. They wanted us to go to specific craters, and I think we hit all of them except halo crater. I knew we were in the general area. Several craters were there, and the photograph map was not clear as to which crater was halo. We may have sampled the wrong crater. If so, it was very close to halo crater and should have accomplished essentially what they wanted us to pick up with the double core tube.

## 10.41 Contrast Charts

BEAN I want to discuss number 41 which is contrast charts. We had three of them. One of them got dropped in the dirt and was completely covered with dust; so it was useless. There was no way to dust it off.

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CONRAD We hung them on the corner of the table. We had three of them hanging on the corner of the table. When I removed the first LiOH box on the first EVA to send it up, that one fell off and I had to pick it up out of the dirt. Once it gets in the dirt, forget it.

BEAN There's no way to dust anything off there, which brings up a good point that we'll be covering in a few minutes concerning when we got back in. I took one chart and put it on the sunny side (and you can see all the different grades of gray), took pictures of it, and reported that over the air. I put the other on the shadow side, and the only thing that keeps you from looking into the shadows is if the Sun is low enough so that you can't get your hand up and shield your eyes from the direct ray of the Sun. If you can do that, you can see down in the shadows just like you can on Earth. I was able to do this in this case and so I could see the full range of blacks in the shadow. Pete's earlier idea of putting an additional opaque visor on the top of the helmet is a whale of a good idea. You could adjust that thing for the sun angle; you could wander around looking up-Sun, down-Sun, and across-Sun; and it wouldn't bother you a bit. I think that's one of the best suggestions that we got right there.

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10.42 Samples (Collection and Photography)

CONRAD Our documented sampling went exactly the way we practiced it on Earth. The sample bags were too small. There were many samples we had to put in that were too big to go in the bag.

BEAN One of the best things about the charts was that we had (this was Pete's idea during the last month) traverses planned for three different places that we might land. That is what gave us the capability to go out there and do some good geology. They have done a lot of thinking about what to look for. We named some of the craters, we knew the traverses, and we were able to massage one of the preplanned traverses a little bit. We were able to follow the traverse pretty well.

It looks like we can land now on one spot; thus, you want to practice the exact traverse on Earth that you are going to be doing on the lunar surface. I might even suggest that they make those little craters out in Flagstaff, Arizona, like your particular site. Then, you can do the exact traverse during training that you are going to do during the mission. This allows you to save a lot of time by going to the proper side of the crater and trenching and core tubing at the right place. Then on the Moon, you can follow the same preplanned traverse and get a lot more done much faster.

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CONRAD This was the trade-off. I knew it was going to happen. They wanted distance and documented samples on five specific points. Only on occasion between those points did we stop when we saw something that was different and sample it because we had to hustle all the way to cover all that ground and to make those five points. We really had to move out; therefore, there was a certain amount of compromise between the amount of sampling we did at each point and in between these points. There was no point to which they sent us where we couldn't have spent at least an hour very easily. Had we had a little bit more time to experiment, one thing we might have tried (and it crossed my mind at the time, but I thought if we do that we're going to get tied up) was to use the tether and get one of us down in the crater that had the melted looking rocks in the bottom of it. I think that would have been a real boon. But the tether wasn't really long enough, and the crater was pretty steep. I'm not so sure how well we would have gotten back out of it.

BEAN The entire lunar surface was covered with this mantle of broken-up material, fine dust of varying depth. As a result, everything looked pretty much the same — sides of the craters, tops of the craters, flat lands, and ejecta blanket. If you're going

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BEAN  
(CONT'D)

to do any geology, you're going to have to dig through this mantle of brown or black and to look beneath the surface a little bit. We had a shovel that we used for trenching, but because of the length of the extension handle and the inability to lean over and what have you, we never could trench more than about 8 inches. That was about the best we could do, and that was a pretty big effort. If we're going to do any good geology, it's going to take a lot of trenching to get down below the surface.

I'd like to recommend that we get a better trenching tool. Maybe all we need to do is lengthen the extension handle about 6 inches; but if we're going to look and see what's beneath the surface, we're going to have to dig it out of there somehow. I also recommend that we get a lot more core tubes aboard the next flight. I felt that, on the surface everything was pretty much the same and the real secrets were hiding about 2 to 8 inches under the surface. We really need to scrape away the upper surface or core down through it.

CONRAD

The environmental and gas samples went as advertised. I did notice on both of them a tendency for the threads to be a little bit sticky, as if there were a vacuum welding or maybe a slight expansion that was causing some drag. It wasn't bad, but it



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CONRAD did not need to be much worse before causing difficulty in  
(CONT'D) closing both the gas sample and the environmental samples.  
But, they worked okay.

#### 10.43 Surveyor Site

CONRAD When we looked at the Surveyor from directly across the crater,  
it looked like it was sitting on a vertical wall. It really  
looked steep. My first thoughts on the first EVA was that  
we're going to have one whale of a time getting down to it.  
At that point, it was sitting in the shadow; but by the time  
we got out on the second EVA, it was no longer in the shadow.  
It then gave the appearance of not being on so steep a wall.  
Sure enough, when we walked around the other side of the crater  
and got to it, it was on about a 12-degree slope. Just angling  
down the side of the crater to it was no problem whatsoever.  
No difficulty was encountered working around it.

We had been concerned about it sliding down on us. However, it  
was firmly planted in the side of the crater. The lower gear  
was well dug into the ground, and there was no chance of it  
sliding. I actually pushed on it several times; there was no  
tendency for it to tip over or to move.

So we went about our business just the way we practiced it at  
the Cape. I read the checklist and Al took the photographs.

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CONRAD (CONT'D) The only trouble was one tube which I couldn't cut. I bent on it as hard as I could and I hardly made a dent on it. I don't know what kind of a metal tube it was but I don't think it was quite up to snuff. It had to be a thicker wall tube than they told us because the five TV tubes were cut with hardly any effort at all. So we got everything but the glass sample. The glass was bonded to the metal sheet. We curved the metal sheet but all we got was fine slivers of glass, so we stopped messing around with it.

BEAN We did get a tube, however.

CONRAD Yes, it was a support tube to the large electronics box.

BEAN We noticed the Surveyor had turned to sort of a tan appearance, including the white parts, the chrome, and the shiny parts. We looked at it closely and rubbed it. You could rub off this brown color if you rubbed hard enough. It gave you the feeling that it wasn't blown on when we flew down in the LM, or rather that it had adhered to it over the years it had been in the crater. We took enough pictures so that we can document this.

It wasn't very difficult, I didn't think, to operate on that slope, Pete. It wasn't particularly slippery. One of the things I wondered about beforehand was, when once we got down the slope we wouldn't have a good sense of the vertical and

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BEAN  
(CONT'D)

we'd tend to lose our balance; but that wasn't the case at all. It was just like a 12-degree slope on Earth. I didn't have any tendency to slip down, and I wouldn't hesitate to try a steeper slope. But I do think that having a strap or tether that you could use, in the event that you got down into too steep a slope, to help you get back out is a good idea. It probably ought to be a standard piece of equipment on the following missions. As Pete brought out earlier, it would have been nice to go down to the bottom of that slope to the material that looked melted. Our strap was only about 10 meters long, and I would recommend that, as a standard piece of equipment, that you put a strap about 30 meters long in a saddle bag or somewhere in your equipment. That way, you could help a man down the side of a slope. He could just carry that strap down to the bottom and pick up any rocks he wanted to get, and then you could help him back up. I don't think you would have any trouble; you would have to use discretion in case you got half way down and found out the sides were a little more slippery than you thought.

The only thing I noticed about working on the inside of the slope, Pete, was when we tried to walk out of it, it took a lot more work because you couldn't bounce from side to side and spring off your feet like you could on level ground. It

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[REDACTED]

BEAN (CONT'D) just wore you out a little bit more, and I wouldn't be surprised if our heart rate wasn't up a little higher after coming up out of the crater. But there was never any danger of slipping down in the bottom or anything like that.

CONRAD I guess I ought to finish off one thing on the Surveyor. My hat's off to Al and Joe Roberts and all the people that worked on that bag we carried on our back. It worked out extremely well. Al's suggestion made earlier, but not on this debriefing, was that we should consider carrying a lot of equipment on the back of the PLSS for documented sampling and so forth. It's better than carrying that tool carrier around. You could hang a considerable amount of the gear on the back of two PLSS's and you work as a team. I think it would be a lot handier.

BEAN I do, too. The big pain with that tool carrier is that you have to hold it out from your body so that your legs don't bump into it as you walk, which means you have to hold it by one hand. That's not a big deal when it's light and there are no rocks in it; but when you start filling up with rocks, it gets to be a pretty good stunt to hold it out there for long periods of time. I was running two and a half miles a day towards the end

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(CONT'D)

[REDACTED]

of the training period to get my legs in shape, and my legs never suffered a bit. If I had it to do over again, I would run about a mile a day and spend the rest of the time working on my arms and hands because that's the part that really gets tired in the lunar surface work. If we could somehow eliminate that hand-carried tool kit and mount those things on the back of the PLSS's, half on the CDR's and half on the LMP's, you'd be able to move around the surface a lot better. Your hands would be more free. One could carry the shovel, one could carry the tongs, one could carry the gnomes, and you could end up doing better work faster by that technique than with your hands full of hand-tool carrier.

CONRAD

I had about 20 Earth pounds extra hanging on the back of the PLSS. It caused me no c.g. problems. I ran across the lunar surface, and it was not that tight. The bag and the camera itself were flopping around back there, and they didn't bother my stability one bit. I just kept whistling. Our only concern was that it might fall off or something, which it didn't do; and so I think it's a good idea.

BEAN

I was going to say we probably ought to make a comment here. I know that they are trying some sort of wheel vehicle for the next flight. My impression was that you could use a wheel vehicle but you probably should have one with wide tires.

[REDACTED]

BEAN (CONT'D) Although the dust was only an inch deep or something like that, if you had some skinny tires it might give you a little problem. I don't know how big in diameter they ought to be, but they ought to be fat things to help it ride along the surface.

#### 10.44 Sample Stowage

CONRAD The sample stowage on the second EVA worked out perfectly. I think we had the box packed as tight as we were going to be able to pack it there on the lunar surface. We wound up with four large rocks in a Teflon bag which we brought back for an additional 13 pounds of rocks. I've got one comment here and I know that this is one of the problems with not preplanning something. I know everybody, including ourselves, agreed with a preflight criterion of one EVA extension, but it broke my heart to get back in that LM and find out that we had 6 hours in those PLSS's and Mission Control hustled us back in after 4 hours. We killed 2 hours sitting in the LM - we wasted - we actually sat on our rear ends and did nothing for 2 hours. We weren't tired and it's really a shame that we did not get a second extension on the end of that EVA because we hustled past blocky crater and back up to the LM. I was hustling Al because I felt that he had committed us to get in at 4 hours and nobody changed their tune; so we were practically up the

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CONRAD  
(CONT'D)

ladder, and that's really a shame. I think we've got to be openminded on Apollo 13 and subsequently. If these guys are in good shape — and there's no reason to believe that they won't be (we were in excellent shape) — then let's not hustle when we don't have to. As a matter of fact, we could have gone another REV down there on the lunar surface before lift-off, and it wouldn't have perturbed anything.

BEAN

I agree 100 percent with Pete. That was a real shame. If there was anything in the whole flight that should have been done differently, we should have gotten in maybe an hour later right then. Like Pete said, we got in and we sat around for a couple of hours there just waiting for the time to start working on the ascent checklist.

10.45 SWC Retrieval

BEAN

We performed the solar wind collection retrieval, and that didn't work like I was hoping it would. When I reeled the collector out, it came out very nicely; and the foil itself seemed pretty flexible. At the beginning of the second day after we woke up, it looked like the foil had taken a set around the pole. It definitely had taken a set of some sort. When I tried to roll it up following the second EVA, it rolled up about 6 inches and then didn't want to roll any more. It wanted to crinkle

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BEAN  
(CONT'D)

and tear although I was very careful with it and tried to recycle it a couple of times like a roller shade. Finally, it did tear about a 6-inch longitudinal rip; and I realized then that it just wasn't flexible enough and didn't want to roll up. So I let it go and let it sort of window-shade all the way around and then tried to roll it up by hand and not get my fingers on any of the foil. I'm sure I wasn't able to do this entirely. I expect there is some dust from my gloves on the foil but I did the best I could. I understand that it is possible to dust that off, bake it off, or something like that and it doesn't bother the experiment. As a result of this, the rolled-up experiment was larger than the bag it was supposed to fit into; so I had to take and crush it with my hands — kind of squeezed down on the foil. It made it look sort of full, but I don't think it degraded the experiment at all. I would like to recommend that before the next flight goes up somebody take a look at what is actually happening to that foil as it sits out in the lunar environment. It may not be the foil that's presenting the problem. It might be the tape that they are using on it actually cracks or gets stiff or something. It may be the same effect they were seeing with those Teflon bags. They may take a set and it doesn't want to roll up any more. This does compromise the experiment somewhat.

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CONRAD The final comment that I would like to make is that Ed Gibson and Joe Roberts and his people did an outstanding job. Our checklist and procedures were well documented. We were able to handle all the contingencies that came up, and I think most of the success of the operation is due to their careful preflight planning and excellent work that they did on the EVA's.

BEAN All right. I think also included in there are the geologists Uel Clanton and his group and also USGS Al Chidester and his group. I think one of the best things was this preplanning of the traverses. That really saved us a lot of time and let us get out and go to the places that they thought were geologically interesting and allowed us to do the right things at the right places.

#### 10.46 Close-Up Camera Operation

BEAN As a result of having to hustle there, I don't think I really gave a good enough effort on this closeup camera. I did as much as the time allowed, but the time wouldn't allow me to go out to those three different types of soils that we had seen and to take pictures. I couldn't go down in some of the craters that had some good glass in them or glass-topped rocks. I couldn't go out and do many of the things that the closeup camera is very good for because there just was not time available.

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10.47 LM INGRESS - 2nd EVA

CONRAD The second ingress was the same as the first. No problem; we went right down the checklist jettisoning the equipment. The only comment I have is we shut off our PLSS feedwaters as we did on both ingresses down at the bottom of the ladder. My recommendation is that we take a fixed time prior to ingress, and even an earlier time like 10 or 15 minutes before ingress, and get that PLSS feedwater OFF because, when we dumped our equipment on the third cabin depress, we got quite a bit of water and ice out of the PLSS sublimators. I think the more you can dry out those boilers before you get in the better off you are. Otherwise, the equipment jettison procedures and everything worked extremely well, and we got rid of all the equipment.

BEAN One comment about the COMM between MCCH and ourselves up there: I don't know from their point of view what they thought, but we were getting about the right amount of information everytime we asked a question; and the answer seemed to come up pretty rapidly. From our point of view, the COMM between ourselves and Ed Gibson and the experimenters was very good. I am hoping that if they had any questions they did get to us and we answered them at the time or, at least, were able to look at what they

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BEAN were interested in so that we know the answers for them right  
(CONT'D) now.

CONRAD One other comment on the second EVA: we had a problem with  
the camera. The wheel on the bottom screw that locks the RCU  
plate and the trigger to the camera is a machine wheel that  
fits on the end of the screw. It was a press fit, and because  
of the thermal configuration and the tolerances of that fit,  
the wheel actually fell out and the camera came completely apart.  
The trigger came off the RCU guard. That was the end of the  
usefulness of that camera as far as we were concerned.

BEAN I would like to say something about that camera. We got a lot  
of dust on ourselves and also on the outside of the camera. We  
kept looking at the lens to see if there was any dust on it  
and to see if it was going to degrade the pictures. Neither  
Pete nor I could see it on each other's camera, although the  
other parts of our camera were covered with dust. We'll have  
to take a look at the pictures that we returned. If it does  
turn out to be a problem, we're going to have to come up with  
some sort of brush we can use to dust off the lens, because I  
don't see any other way. We were trying our best to keep the  
equipment clean; but just moving around, trenching, leaning  
over, and all the other things tend to get dust on the equipment.  
One other thing, when we go back to the LM, we tried to dust

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BEAN  
(CONT'D)

each other off. Usually, it was just Pete trying to dust me off. I would get up on the ladder and he would try to dust me off with his hands, but we didn't have a lot of luck. We should have some sort of whisk broom on the MESA. Before we get back in, we'll dust each other up high. Then the LMP will get on the ladder, and the CDR will give him a dust or vice versa and then will get on in. We are bringing too much dust into the LM. Another possibility is that just as soon as you get in you slip on some sort of second coveralls that fit over the feet on up to the waist, because that's the dirty area. Then you keep that on all the time you're in the LM and take it off just before you get out. The other alternative to this is that you put on a similar something when you're getting out onto the lunar surface. The reason I suggested the former was that I think you want to be as free as you can possibly be when on the lunar surface. Adding another garment over the top of the already existing equipment is going to be restrictive and might give you a few more problems.

CONRAD I got quite concerned with not only the wear and tear on the suits but the effect of the dust on the suits. On our final hookup back on the LM ECS system for ascent, it was all we could do to get our wrist locks and suit hose locks to work. They obviously were beginning to bog down with dust in them.

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CONRAD (CONT'D) When you go over these suits later, you'll be able to analyze this. I have no idea what the effects were on the O-rings. Suit integrities did stay good, but there's no doubt in my mind that with a couple more EVA's something would have ground to a halt. In the area where the lunar boots fitted on the suits, we wore through the outer garment and were beginning to wear through the Mylar. I'm sure that with all the wear on the outside surfaces there's bound to have been rubbing of the bladder. I'm sure they will be very carefully inspected to see what these effects were. Al and I had extreme confidence in the suits; therefore, we didn't give a second thought to working our heads off in the suits and banging them around — not in an unsafe manner but to do the job in the way we had practiced it on Earth. These suits were more worn than our training suits. We must have had more than a hundred hours suited work with the same equipment, and the wear was not as bad on the training suits as it is on these flight suits in just the 8 hours that we were out. I think it has to be the abrasiveness of the dust.

BEAN I think that one of the best decisions that we made was not taking the suits off at night. This allowed us to control our temperatures pretty well. We were always able either to turn on the LCG pump and get cool that way or to turn on the

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**BEAN** vent flow. If we had had the suits opened up, I'm afraid that  
(CONT'D) we would have had a lot more trouble with dust in the zippers,  
inside the suit, and inside the helmets. It was tough enough  
on just the wrist rings and neck rings. We tried to wipe  
them off before we put our equipment back on the next morning  
but we did notice it harder to put on. I didn't have any leak  
rate for all the pressure checks prior to launch and at other  
times, but during the last pressure check that we pulled I  
had a leak rate of something like two tenths over the minute.  
So, the thing was leaking somewhere and it must have been around  
the neck and wrist rings because those were the only openings  
that had changed.

**CONRAD** My suit was the same way. I had about 0.15 over a minute  
although I had very little on our first check prior to getting  
out.

#### 10.51 REST AND SLEEP ON LUNAR SURFACE

**CONRAD** I made a technical error before I left when the suits were  
sent back to ILC and the boots were put on. We knew that we  
had to refit the suits, and I let myself get conned into re-  
fitting my suit in long underwear and not with an LCG because  
the flight LCG was PIAed. That was a mistake. I wound up  
with the legs being too tight. I realized this prior to

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lift-off while staying in the suit for a long time. I had spent only about an hour or so before in it fitting it in my long underwear, but it became unbearable that night. It spoiled my rest period. I did not want to take the suit off so I stayed that way all night. I slept only about 4 hours, and it was mainly because of suit discomfort on my shoulders. The next morning, Al did an outstanding job on letting my legs out for me, which took him about an hour. As far as the remainder of the rest went, the cabin temperature remained good all night. I didn't notice any change in the temperature all night. I didn't hook up my LCG. The only thing that I noticed was that the very bottom part of my legs from the knees down to my feet tended to get hot while I sat in the suit with no air. Although they weren't uncomfortable, I had the feeling that I was beginning to perspire down there and that after a while it was either going to get wet or it was going to get cold or both. So, about every 3 hours, I put my suit hose blue to red and blew my suit out with dry air which took all the moisture out of the lower boots and dried out the LCG socks. I would let it blow for 5 to 10 minutes and then would take it off, and that's the way I remained all night long. I never used the LCG pump. I don't know whether Al did or not. I was never too hot or too cold. The hammocks were excellent. The first 4-1/2 hours I slept, and it was a good sound sleep. The

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CONRAD  
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only reason that I couldn't sleep the rest of the night was that my shoulders were so uncomfortable in the suit. My feet were plastered against the bottom of the suit and my shoulders were plastered against the top, and there was no easing it no matter what I did.

BEAN

The only comment about my hammock concerned that Beta cloth covering down at the foot end of the hammock. I wasn't able to tighten the hammock completely. I had to unsnap it and pull it back before I could tighten the hammock. I think that Beta cloth ought to be changed, modified slightly, so that you don't have to dismantle it so much to tighten the hammock. When we got back in, the ground said, "You can put 15 pounds of rocks," I think it was, "behind the OPS's." That's where we did put them and they set very well in there. We used the tie-down and tied them in there. It was a good place. Then they said we could put 25 pounds in the left-hand side stowage compartment. We didn't have the 25 pounds there, but I wasn't briefed, prior to lift-off, exactly how we were going to put the 25 pounds in there. Were you, Pete?

CONRAD

No, and I didn't quite understand the comment because both sides of the left-hand storage compartment got thrown away.

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BEAN All I can figure was that somehow we weren't supposed to throw part of it away. We didn't have any rocks in there anyway but, if we had, I guess we were supposed to maintain part of it or something. This is something that we should have been briefed on before we went. If we had an additional 30 minutes or so, I think we could have grabbed 25 pounds and stuck them right in there.

CONRAD This is one of these typical things, though. About 6 weeks ago, they went to Jim McDivitt and told him that there was no doubt that we could collect more rocks than would fit in the rock box and we needed some clarification. He took immediate action to find out about how much more rocks we could carry. Over that period of 6 weeks, people came and went and hemmed and hawed and changed their minds. How many extra rocks we could carry and where was one of the very unclear things when we left. That left-hand side stowage thing came completely out of the dark when we were on the lunar surface. I never heard of it before flight. The only discussions that I had heard were that we couldn't stack on top the OPS's because the OPS leg holders were designed only for the OPS's and that part of the structure wouldn't hold. But anything that we could stash on the floor behind them was okay as long as we kept it off Z27 bulkhead. Then they modified that weight once

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CONRAD (CONT'D) in flight and they came up with the left-hand side stowage, which didn't make sense to me. I wasn't going to argue with them because we didn't have that many extra rocks, but both left-hand side sections of the stowage got thrown out on the lunar surface at one time or another — one at the end of the second EVA and one on the third dump. So either somebody wasn't following our procedures or was not aware of them, and that again is an example of the last minute Mickey Mouse and unplanned things that are either unclear or cause problems. In defense of everything, I think we had very few last minute changes. I think we were in better shape than most flights on last minute changes.

BEAN I don't know anything to add, Pete. That's exactly right. That was just one of the unusual ones.

CONRAD We cooled our heels for 2 hours in the LM, ate more food, which was good, and picked up at minus 2 hours and 50 minutes on our lift-off checklist. It went exactly as advertised to the point that a couple of times I called the ground to find out if they were still around. We went through that thing by ourselves, absolutely per checklist, and counted it right down to lift-off. Nothing was done that was not published in the checklist.

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BEAN Two things I noticed. One, after I got the COMM set up, I noticed that it wasn't the same COMM that we had during descent. The difference was that during ascent we had VHF A receiver OFF and during descent we had VHF A receiver ON. I kind of thought it should have been ON for backup, but we asked the ground about it, they looked at the checklist, and said it should be OFF. We left it OFF, but I later turned it on during the rendezvous. That was one little anomaly that was probably our own fault for not catching it during training. The other one was when Pete performed the RCS checkout. When he fired the thrusters on the right side, it knocked over the S-band erectable antenna; so we switched over to the spacecraft S-band which didn't even lose lock. We got some good movies, I think. He fired some of the thrusters, and I took some 16-millimeter movies out the window. Hopefully, the geologist can get some feel for movement of dust with that engine and maybe compare or extrapolate down to the descent engine.

CONRAD I'm going to have Mission Control look over their data, but that RCS firing on the ground appeared to me to be excellent in that I noticed very ragged thruster firing on the first pass through all thrusters. I don't know why that was. The system should have been pressurized and we should have had solid fluid all the way out to all the thrusters, but, they were very

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ragged. The first trip around roll, pitch, and yaw, they steadied out to be very solid in firing. I'm sure that if they were ragged this shows on the data on the ground but I want to make sure somebody checks that. I'd hate to have that first portion of lift-off and not have very good thrusters during the very critical time of getting that baby off the descent stage.

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11.0 CSM CIRCUMLUNAR OPERATIONS

11.1 Operation of Spacecraft

GORDON About the only thing I can say on this particular one is that the operation of the spacecraft was excellent and I let the DAP fly the spacecraft practically all the time. Operation of the spacecraft by myself in lunar orbit was no particular problem or concern throughout the entire flight. The spacecraft systems were more or less taking care of themselves. There were no anomalies that caused any concern or required my attention other than an occasional glance to make sure that everything was functioning properly. I think it might be said at this time, during the entire flight after we had gotten on our way, we never had any caution or warning lights other than the O<sub>2</sub> high flow light.

11.3 Landmark Tracking

GORDON The P22 for the first REV after landing has some excellent maps for the landing site for use during orbit operations. I was completely familiar with Snowman, the four or five craters that formed an arc downrange right in front of Snowman, so that when I came up for landmark tracking in P22, there were no problems in this regard at all. I had used the landmark 193 for the REV before DOI and first REV after landing. And that

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GORDON (CONT'D) was just as easily done command module only as it was with the LM on. The landmarker was easily recognized. There was no problem in tracking the landmark at all. The difference between the weight input with the LM docked as opposed to the ORB RATE torquing with the LM undocked, caused no significant difference in technique. The P22 on the next pass was to be at the landing site. Through most of the conversation, I wasn't really sure where it was. I had an update for the LM charts, giving the coordinates for what the ground at that time thought was the landing site of the LM, near head crater. The targeting was pretty close to the actual spot where the LM had landed, but on the second pass after landing, when P22 came up, I found Snowman and I was actually looking at the Surveyor crater. Lo and behold, right there on the northwest edge of that thing was a bright shiny spot, a long shadow, and it was the only shadow in the area that I saw and as I got closer, it may be my imagination, but I thought I could see details of the descent stage and the landing gear extending from it. As I approached overhead where the Surveyor crater was at the nadir, right in the center of that crater, and the dark shadow was one shiny bright spot that I knew had to be the Surveyor, this excited me quite a bit. I was pretty surprised that we were able to see that and I actually gave the coordinates on Surveyor back to the ground, which I thought was the LM

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GORDON landing site and it turned out to be exactly where they were.  
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So once you know the general area, I should say pretty precisely the area in which they landed, anyone could find the LM itself in the sextant. Now there is a technique involved here. That is, first of all, not to search for the IM in the sextant. This is something I don't think can be accurately done because of the rate at which you're traveling over the surface and the field of view of that sextant. I had a good idea from their landing where they were. So, my technique was to find the area in the telescope. And when I found the Snowman on the telescope, I concentrated on the Surveyor crater itself, and positioned the telescope on the Surveyor crater; then transferred to the sextant. At that time, the alignment between the telescope and the sextant was outstanding. When I did go to the sextant, it was already pointed at the LM. The next pass around, realizing there would be a certain amount of sceptics about the ability to see the LM on the surface, I drug out the sextant bracket, put the DAC on the sextant and on the third time overhead, I tracked the landing site with the telescope, hoping to capture the LM and Surveyor with a 16-millimeter DAC (which I hope turned out).

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## 11.4 MSFN

GORDON The only thing I can say about this was, as expected, MSFN communications, transmissions, updates, and PAD messages to the command module were outstanding in all respects so there was never any doubt as to what was intended, wanted, or needed. In fact, I thought the flight itself, the conduct in this regard, was simpler than in the SIMS, with complete understanding on both parties as to what was going on and what was needed by each other. I have nothing but admiration for all those troops on the ground who handled this one.

## 11.5 Plane Change

GORDON This was a plane change maneuver to establish the orbit for rendezvous day. I guess the thing to say about this was, once again, there was no particular problem associated with it. All worked perfectly. I realized at this time that it had been a real long day and I was tired and more prone to make mistakes. I certainly didn't want to be making mistakes during an SPS burn. When I came around this time and had AOS I chose to go to VOX operation and read the checklist, as I performed it, to the ground so they could monitor exactly where I was, exactly what I was doing, and would be abreast of the status of the spacecraft at all times. I previously had gone over about 5 or

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GORDON  
(CONT'D)

6 minutes prior to the burn, according to the checklist, and turned on the bus ties and checked the LMP side of the spacecraft to make sure the functions over there were set in the proper position for the burn. There's no way I can monitor them during the burn but by reading the checklist over the air to MSFN. It gave me the assurance that I was reading the checklist correctly, not leaving anything out. Now, I would think that the ground probably appreciated this. They knew exactly where I was in the checklist, what I was doing, and if I was behind and if I was ahead, so if any particular problem came up, they knew that I was with it or behind it. The 19-second burn was on time. Once again, the SPS engines performed like a dream, TVC DAP was shy. This was our first burn without the LM. The acceleration, of course, is much more noticeable than with the LM docked, but the guidance was excellent. The DAP action, gimbal drives, and the control of the whole thing were outstanding. There was no question in my mind at all that things were going as they should. In fact, there was no trouble monitoring that burn by myself at all. Residuals were low. I don't remember what they were at this particular time. There was no trimming of the residuals, and I don't even remember if I copied them down. I'm going to mention the second plane change after rendezvous. That was the plane change for the bootstrap photography day. The only

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GORDON anomaly I noticed at all in any of the SPS burns was in this  
(CONT'D) one and I'm not sure it's an anomaly. During the burn, even though guidance looked good and it was tight, it felt to me like the spacecraft was doing a dutch roll throughout the burn. It felt like a typical aircraft dutch roll-type thing. It was oscillating in roll and yaw.

CONRAD I'm going to guess that we had some condition where the c.g. was passing through our low stability point.

GORDON That was the only one. The next burn, the TEI burn, was as solid as a rock.

#### 11.6 Update PAD and Alignments

GORDON Now at this time, we were getting short on P30 PAD's. I think we had 12 P30 PAD's in there and we could have used twice that many. So Al Bean had to manufacture some on the way back home so we could get all the P30 PAD's that were required. As far as alignments were concerned, the P52's were always done using PICAPAR in lunar orbit. It never failed to PICAPAR that I can recall and I always use those stars to align on. In fact, I think, Dnoce is one of the more common ones and it's probably the dimmest one up there and it was perfectly adequate to do the job. Once again, being in there alone, I didn't take the time, if the ground was watching the DSKY, to copy down

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GORDON any of the alignment PAD's and the flight plans as to the  
(CONT'D) stars; star angle difference, or torquing angles. I made sure  
that the ground was copying the DSKY and they wrote them down  
on the ground, and I don't have to record them inflight. The  
torquing angles were very small and we were pretty happy with  
the performance of the IMU. Drift rates were very small and it  
was an outstanding platform.

#### 11.7 Photography

GORDON I guess there isn't a great deal to say about this. Most of  
the photography at that time was with the 70 millimeter and  
was concerned with targets of opportunity. There was no re-  
quirement to photograph anything specific during this time.  
The second day period was devoted to SO 158 and also to spectral  
photography experiments. That experiment was conducted with  
ease. The updates were well thought out and well planned. It  
was all conducted on GET, so there was never any doubt as to  
what exposures, what times the camera should be operated, and  
so forth. The ORB RATE torquing allowed me complete freedom  
and did not require any attention to the spacecraft as far as  
flying was concerned, once I had maneuvered the spacecraft to  
the right attitudes so that the hatch window was pointing at  
the nadir and used VERB 79 to start ORB RATE torquing. I  
virtually forgot about the spacecraft. The ORB RATE torquing

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GORDON is precise, and as far as I was concerned, it never got more  
(CONT'D) than a half a degree off the proper attitude. It was an excellent control system to allow someone in there by himself to devote his entire attention to other things. I don't think this experiment could have been done without it. That 158 equipment was easy to handle, easy to install, and easy to remove from the hatch window when a change of F-stop was required, and easy to put back in place. The target of opportunity S-158 experiment VERB 49 maneuvers were passed in adequate time for me to load the DAP, maneuver the spacecraft after the last series of S-158 was completed, and there was no problem at all in getting the so-called target of opportunity Theophilus, Descartes, and Fra Mauro with 158.

#### 11.8 Monitoring Lunar Activity

GORDON On AOS, Ed Gibson apprised me of what had taken place during the time I was out of communication, from LOS to AOS. He gave me a quick brief on what Pete and Al had done, where we were in a lunar time line, how things were going on the lunar surface, and when he caught me up to the present time, he let MSFN relay do its job. I must admit that whole communication system was outstanding during this time. The communications from Pete and Al were clear and excellent, and I didn't feel, shall I say, "left out" any time. It was well worth having

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GORDON (CONT'D) this thought out ahead so I could know what was happening on the lunar surface, as far as the LM operations were concerned. I could talk to MSFN independently, without interrupting the LM operations. They weren't bothered by my communications with the ground. In fact, they didn't even hear them; at the same time it allowed me to listen to what they were doing on the surface.

#### 11.9 COMMUNICATIONS

GORDON The communications were excellent throughout this period. I might mention at this particular time, we had been having S-band problems before undocking. We started to pick-up some oscillation in the S-band antennas, the inability to maintain lock. It maintained lock, but it was oscillating in pitch and yaw so that the signal strength would decrease several decibels from peak. We did run tests on this later, on trans-Earth coast, but at that time we were operating the S-band in MANUAL so that every time I came around, we would acquire using a MANUAL mode and then go to AUTO and, being in BEAM WIDTH, I believe that in all cases throughout the pass, that S-band was never lost.



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## 11.10 Maneuvering to Support Lift-Off

GORDON . One other thing that I wanted to do, just to see if it could be done, was to try and track the LM. If I had encountered it on the surface I wanted to track it from lift-off to insertion. The pass before lift-off, we were to do simultaneous P22's; subsequently we decided that we didn't have to because the LM did not do a P22 a REV before lift-off. I did try to take sightings on the LM during that pass. It was left up to me whether I wanted to track 193 or track the LM. I made the decision to go ahead and track the LM, since I knew where it was, and I knew I could see it, and could find it. I think this was a bad decision on my part, if we had needed that P22 information. It turned out to be a bad decision because, in fact, I really didn't track the right landmark and I would have if it had been 193. The reason I didn't track the LM on this particular pass, I guess, was I got overconfident and forgot the procedures I had established before. I found the target first through the telescope and made sure, with the wider field of view, that I had the sextant on the right target. Well, I didn't do it this time. I had confidence in the state vector and the AUTO optics and P22. I relied on that to initially point the optics at the LM. Instead of going to the telescope and making sure that it was on the target, I went

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 GORDON immediately to the sextant and unfortunately neither the LM  
(CONT'D) nor the Snowman were in the sextant. I played with that a little  
while and couldn't find the LM and couldn't find the Snowman  
in the sextant. So, I went back to AUTO optics after trying  
to find it in MANUAL, looked in the telescope again, and by  
this time it was too late. I had gotten myself into a position  
where I couldn't find the right target. I had the Surveyor  
crater and when I went back to the sextant there was a crater  
that looked like the Surveyor crater, but there was no LM and  
no Surveyor in the area. I took marks on this crater anyway,  
and I'm sure it was the wrong one, but I think I had time to  
take about three marks. That was a bad decision. I should have  
gone back to something I knew I could find easily. I should  
have tracked 193 and I recommend that space flights that need  
a P22 the REV before LM lift-off not to take a chance on find-  
ing that LM. Go back to the known landmark and do it the right  
way. I was far too confident at this time and should not have  
done it. This is kind of unusual in this regard and that is,  
on the lift-off REV, I did it the right way again. I found  
the Snowman in the telescope and put crosshairs on the Surveyor  
crater and actually at that particular time on the LM. So that  
when I went to the sextant, there it was. It was in the sextant.  
I didn't have to search in the sextant. It was already there  
and all I had to do was keep it in sight. What I was going to  




**[REDACTED]**

GORDON (CONT'D) try was to keep the optics on the LM, reach up and go to FREE and then with the optics in MANUAL, so that the trunnion angle was approximately 22 degrees, I was going to try to use minimum impulse to actually maneuver the spacecraft to keep the LM in sight, but it didn't work. The ORB RATE motions were just fast enough at that time that I couldn't keep targets in the field of view of the sextant. I just flat lost it and once I lost it from the field of view of the sextant I couldn't find it again. So, I just gave that one up as a bad effort and immediately maneuvered to the insertion attitude. That's what I was doing from lift-off to insertion. When I got to insertion, I maneuvered to the P20 attitude which was approximately 118 degrees for the insertion attitude in pitch and then I maneuvered to 83 or 81 degrees for the P20 attitude, where I actually did the alignment. I looked at the alignment when I was at 118 degrees pitch to see if I could do an alignment there and I couldn't. The Sun/Earth combination of sextant to stars was not available, so I went on to the P20 attitude at 83 degrees pitch and the alignment was done there with no particular problem.

#### 11.11 Rest and Eat Periods

GORDON I guess, in this particular instance, the rest period was a relatively short one. For myself, it was started after the

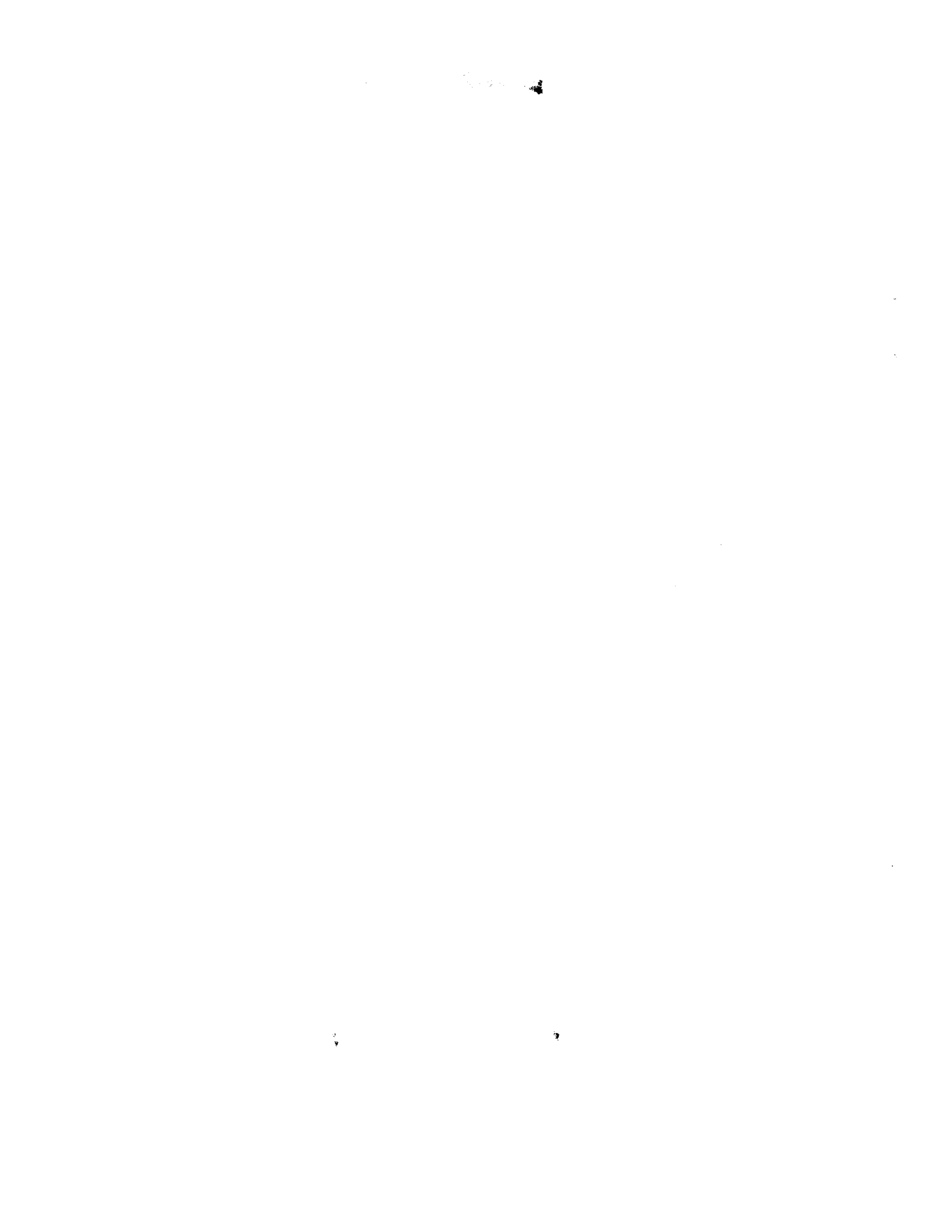
**[REDACTED]**

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GORDON  
(CONT'D)

SPS plane change. To be perfectly frank, one guy in that command module taking care of all the activities that must be done, as far as your sleep period, it takes a considerable longer time than when there are three of you. I was scheduled for a 9-1/2 hour rest period and I'm sure it was considerably shorter than that. That particular rest period was not inadequate, but it was certainly a short one. I was extremely tired that evening and could have used some more, although, it was certainly adequate to do the job. Our eat periods were in conjunction with this. It just takes time to prepare meals and eat them and then to clean up the dishes after you get through. We're all used to coming to tables, sitting down, eating, and then leaving and forgetting about the preparation and cleanup time involved. It does take considerable time. I did enjoy the rest period, however. I needed it.

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## 12.0 LIFT-OFF, RENDEZVOUS, AND DOCKING

### 12.1 LIFT-OFF

CONRAD Lift-off went as advertised. I, probably more so than necessary, stuck my head in the cockpit and religiously punched OFF, every 30 seconds ENTER, and read out my parameters. We looked like we had a slightly hot trajectory. We were running a little high on  $V_T$  and a little high on altitude all the way. However, that may be due to the fact that we were targeted for 37.0-ft/sec R-dot to target for the zero CDH at rendezvous. Everything went absolutely as planned. At 200 ft/sec, Al went to open the shutoff valves and close the ascent feeds, and that's when I goofed up because he got a barber pole on the left main shutoff valve. I got interested in watching him instead of paying attention to my own checklist. I should have left him alone, and I didn't de-arm the ascent engine until we'd overburned 30 ft/sec. I knew exactly what I'd done, and I didn't wait for the ground I just backed it out. There was no reason for me to suspect that there was anything wrong with the PGNS because the PGNS and AGS were together all the way. They stayed right in there together.

BEAN The ascent was pretty impressive. The only thing that bothers me a little bit is I had the camera mounted on the window bar and it was pointed out with pilot's eye view right at the

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BEAN  
(CONT'D)

horizon. I started it at about 30 seconds prior to lift-off, and then I noticed about 3 minutes into the flight that it wasn't running any longer. I don't know when it stopped, but I just hope it was running during the pitchover, because during the pitchover you could look down and see the descent stage. You could see all the Kapton blowing all over the place. You could see the ALSEP that was still deployed down there. It wasn't knocked over or affected a bit. It was a beautiful sight. I just hope it was running. I started the camera again, and it ran for 10 or 15 seconds and then quit. I started it again and it continued to run. I don't really know how much we have. It didn't look like very much of the film had been run out. I hope we don't miss that, but we brought the camera back with us.

CONRAD. That reminded me of something else. We had one anomaly at engine ignition. We had a MASTER ALARM with no light. I don't know what it was or what triggered it, and it had to be a transient event, but we did get the MASTER ALARM at lift-off.

BEAN I don't remember it.

CONRAD We got a MASTER ALARM. I looked up, there were no lights on, and I punched off the MASTER ALARM, and that was it.

BEAN I don't think that I saw it.

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#### 12.4 Rendezvous Navigation

CONRAD: Okay. I don't really know that there's much to discuss in the rendezvous. We got inserted, and I backed off my overburn. The ground passed us a rough CSI solution of 46.5 ft/sec. We did an alignment, which was done just the same as the previous one. It was a good alignment. It was a four balls 1, small torquing angles. We called P20 and a first update gave a NOUN 49 that was very small. I incorporated it, and that's the last we ever saw a NOUN 49. We were right on the time line. We got into the radar at 36 minutes. We had plenty of updates for the CSI solution which came out to be very close to the ground-predicted solution. It came out very close to the command module's, and the rendezvous went exactly the way it's laid out in the checklist. The burns were no problem. I burned them exactly the same as I did in the simulator. The simulator and the spacecraft were no different as I could see. I saw no differences in anything between the simulator and the actual flight all the way through TPI, and of course, we had absolutely no out-of-plane. We saw nothing greater than one-fourth ft/sec throughout the rendezvous until TPI. A TPI solution came up with a 1.5 ft/sec, which I burned. As far as I can see, we were right down the pike all the way. The 1.5 ft/sec at TPI must have been a good one, because after

C [REDACTED]

CONRAD  
(CONT'D)

the two midcourse corrections, which were both small, we made no line-of-sight corrections in either yaw or pitch. I just made none until we were a thousand feet from the command module. I never had to touch it. All I did was back off on the braking rates at 38 ft/sec. At 1 mile, I backed off to 30, hit AUTO braking rates on the way in, and from a thousand feet on in, I used my normals. I take 1 ft/sec off per hundred feet of range. We slid right on in there, and that was that. It was Mickey Mouse. We had a tracking light failure. Al can give you PGNS and AGS residuals and burn parameters for CSI, CDH, TPI, and the midcourse correction. I'll talk about docking in a minute, and he can talk about his AGS updating.

#### 12.5 LM and CSM Updates

GORDON

My only comment is that they were okay. I never had to have an update repeated to me specifically for the CSM. When all the updates were read to the LM, I just copied down those portions or those nouns that I needed for my own information. We had already made arrangements with Jerry Carr that when he read the updates to the LM he was familiar with those portions of the LM update that I required for the CSM, and he prefaced every one of those nouns by titling them, so that I would be alerted that this was in fact one of those that I needed. In other words, when he gave lift-off time, he just gave it as

C [REDACTED]

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GORDON that. That was all I really needed, the lift-off time. He  
(CONT'D) gave the whole lift-off PAD, and when he came to the CSI PAD, he merely stated it was the CSI time and the TPI time. All I needed out of those PADS was NOUN 11 and NOUN 37. The rest of the information was superfluous to the command module. It was required by the LM, and that way it was only read up one time. I picked out of the LM PAD's the information that I needed. This was done throughout, and it worked extremely well. I can't recall ever missing any of the PAD's that came up to the LM during this particular time.

#### 12.6 Adequacy and Clarity of MSFN Data

GORDON Adequacy and clarity of MSFN data was excellent and okay.

#### 12.7 Updates for CSI

GORDON Updates for CSI were good. I got the ground CSI solution with no particular problem. The problems that I had at this particular time were that I was actually getting a number of NOUN 49's, both from the VHF ranging and also from the sextant. I rejected the first one that came up and they were very small, although they didn't at the time meet the criteria of being less than 12 000 feet in 12 miles. When I looked through the sextant, I could see that I needed those updates. The LM appeared about half a radius from the center of the sextant

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GORDON  
(CONT'D)

and, in fact, I needed them so I got a number of NOUN 49's even after three or four updates or acceptances into the computer. I kept looking through the sextant, and AUTO optics was not pointing directly at the LM so I just accepted them. They were down in the relatively low numbers, and I guess that by this time they were actually less than 12 000 in 12, but I considered after the first few marks it was more or less the steady-state type operation and the criteria then was 2 000 in 2. I just made an arbitrary decision that they were needed and I took them. Now, the first solution for CSI that I obtained was, I guess, a little out to lunch, and I guess it was a matter that we didn't get enough time yet because when I recycled at approximately 22 minutes, I was ahead in this time line. I was taking marks long before the 35 minutes, and this, of course, was allowed because the ground got the LM state vector up even before I had time to do the alignment. I was ready to do it and they had the state vector, so I took the state vector before I even did the alignment. The VHF broke out twice during this time before CSI, and I think that is the only time it did after the VERB 90 to get the out-of-plane which was virtually nothing. For the LM, I had plus 1.8 ft/sec and for myself, I had a minus 1.6. The out-of-plane distance was 0.32 nautical miles, so we weren't concerned about out-of-plane at all. My first solution for CSI was bad. It really

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GORDON hadn't converged yet. I got 38.8 ft/sec which I passed to  
(CONT'D) the LM. This was calculated with nine VHF marks and 14 optics  
marks which I thought was plenty to get a fairly decent solution.  
It didn't, and I continued tracking, and I continued taking  
sextant marks. I just continued marking through the whole time  
period and I ended up with 14 VHF marks, 21 optics marks for  
my final CSI solution which finally converged and compared very  
favorably with the ground and the LM. I got a minus 45.9 ft/sec.  
The LM was 45.3 and the ground was 46.5, so we were all right  
there in the same old ballpark. It was interesting to note  
that after I had done the VERB 90, for the out-of-plane solution,  
that no longer did I get any NOUN 49's. I went right back and  
all the updates were acceptable and below the NOUN 49 thresh-  
old.

#### 12.8 RCS/CSI Burn

GORDON As far as I was concerned, everything was okay. The one  
hitch here was that the VHF communication was so bad during  
this particular period of time. For some reason, we did  
everything we could without having any effect on the communi-  
cations at all. I never knew for sure that Pete was burning  
CSI. I naturally assumed that he was, but I never had any  
confirmation and I kept asking him. I'm sure I bothered him  
by asking him whether he was making the burn or not, but I

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GORDON really felt that I ought to know. He could hear me, but I  
(CONT'D) couldn't hear him. The only thing I could do, of course, was to assume that he had made the burn. Right after our CSI burn, we got communications back again. The P76 went in, AUTO optics was excellent, went right to the LM, and away we went tracking for the plane change.

#### 12.10 RCS Plane Change

GORDON Of course, none was required. I looked at the plane change after CSI. I obtained 12 VHF and 12 optics marks, did VERB 90's for both the CSM and LM, and got plus 0.4 ft/sec for the CSM, minus 0.4 for the LM and the out-of-plane was 0.2 nautical miles. Once again, no plane change was done. I continued marking until I had 16 VHF marks, 17 optics marks up to the nominal plane change time and then reinitialized the W-matrix, took a short series of marks and then recycled P33 at this time. For comparison purposes, I got plus 10.7, zip, and plus 8.3 for CSI, continued VHF and optics marks all the way up to the 10-minute time break before CDH, and with 17 VHF and 20 optics marks, once again the solutions compared extremely favorably. Command module solution was plus 10.3, 0 for Y, and plus 7 for Z. The LM solution was minus 10.2 and minus 9.3. So, everything was converged. State vectors looked excellent, AUTO optics was excellent, and we were on our way home free.

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GORDON  
(CONT'D)

There was no trouble monitoring the CDH burn, even though VHF communication was still bad. We were able to get through to each other after several tries. There was no particular problem after that, even though it was still pretty lousy communication.

#### 12.13 Updating AGS with Rendezvous Radar Data

BEAN

The residuals on CSI was plus one-tenth, minus one-tenth. The burn was 45.3 for CSI, and the residuals were plus one-tenth, minus one-tenth, and minus three-tenths. The AGS had a minus four-tenths, plus four-tenths, and plus six-tenths. The CSM solution there was 45.9, which converts to 44.9. That's pretty close to the 45.3. The CDH burn was a minus 10.2 DELTA  $V_X$  and a minus 9.3 Z, which compared with the CSM as a 10.3 and a 7.8. The residuals there were minus one-tenth, a zero, and minus two-tenths. The AGS saw zero, minus two-tenths, and minus one. NOUN 81 was plus 25.9, minus 1.5, and minus 11.9. I didn't copy down the CSM solution here. While we're looking at the polar plot for the rendezvous, it looked to me like with a great number of points that, at the polar plot anyway, we were about 2 miles low. We stayed 2 miles low and slightly to the outside all the way in. It was just a nice neat rendezvous all the way. And we never crossed the line. We always just stayed about 2 miles or so and

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BEAN  
(CONT'D)

gradually got closer and closer as the rendezvous progressed. The plan had been to align the AGS independently on the surface, keep it independent all the way through rendezvous, and then make a comparison and see how it did; not just to get data on the AGS, because the object is to rendezvous rather than get data on the AGS. So we did that on the lunar surface. It worked well at insertion.

We did the PGNS alignment, but we did not align the AGS to it. It was in very good agreement with it anyway. I tried switching back and forth on my FDAI between PGNS and AGS, and I didn't notice any jump at all. I started taking rendezvous marks right on schedule. The one concern that we'd had using the AGS was that I'd enter a RANGE for RANGE RATE or vice versa. So, in order to have a way out, we also recorded the information in the time line book. This would allow you to solve the CSI charts or CDH charts or TPI charts at the appropriate time. So, in case this did occur or the AGS did diverge, you'd be able to get a comparative solution. Well, sure enough, about the third mark, I entered either RANGE for RANGE RATE or RANGE RATE for RANGE and blew that AGS solution right apart. Fortunately, I'd copied down these values that I just discussed and I was able to go back and get a chart solution, which turned out to differ from the

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BEAN  
(CONT'D)

PGNS by only one-tenth ft/sec, which was pretty good. This showed that the charts were pretty accurate. But that right there shows the limitation of the AGS, in a system of this type.

CONRAD

You don't take that one unless you had a failure.

BEAN

If you take nine marks, it'd be 18 individual entries for CSI, and you can't stand one error. You got something that doesn't really do the job you want it to.

After CSI, we realigned the AGS to the PGNS. Then I made all the AGS marks after that just as we'd planned to do, and got solutions that all compared very favorably. This shows that the AGS would do the job, would get solutions which we, of course, suspected anyhow. But the whole point is that you don't want to use the AGS as the normal rendezvous mode. It requires that every 2 or 3 minutes you make a lot of entries in the AGS. It requires that you point the spacecraft exactly at the command module, which takes time and effort. The LMP is working continually and isn't able to sit back and think through exactly what's going on in the rest of the spacecraft. It's way too much work. I think we need something better than charts that you solve as a backup manual system. We do need an automatic backup system. The system

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**CONFIDENTIAL**BEAN  
(CONT'D)

has to perform its work automatically, something like the PGNS does. Or, if it can't, it at least has to have the capability to perform a closed-loop solution without so many manual entries and so much work being done during the rendezvous.

I continued to work to input the data into the AGS until the second midcourse when Pete said, "Hey, why don't you quit working and sit back and enjoy the flight?" I got to thinking about it later and that was the first time I'd really looked out to see what was going on. The rest of the time I'd just been working my fanny off trying to get all those marks into the AGS, and that's not the way you want to fly a spacecraft.

We did try to operate the AGS the way it was designed to do. We saw that, if you don't make an error, it does a good job. But it's just way to much work, and it takes too much time away from watching what's going on, just doing a lot of busy work.

CONRAD

The rendezvous radar low transmitter output didn't affect us. We got a lockon as soon as we tried, which if I remember correctly, was about 235 miles.

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CONRAD  
(CONT'D)

I'm sure the only reason we had the 17.5 DELTA-H was my screw up on the ascent shutdown because I didn't really trim out that 30 ft/sec too accurately. You know what happens to those residuals; they start growing and messing around. So, I backed off the 30 feet and got out of the program. I think the reason we didn't have a completely nominal 15-mile DELTA-H rendezvous was because of my screw up on the ascent shutdown. But the PGNS is quite capable in handling that, and it was no problem.

BEAN

Did you mention you didn't do a plane change?

CONRAD

Yes, no plane change.

BEAN

Did you say anything about the COMM?

CONRAD

No, we didn't cover the COMM. The VHF COMM for some reason became totally unsatisfactory. I guess we never did change configuration, did we? We always left it so Dick had VHF ranging, and something very definitely was wrong. Was my COMM clear to you, Dick?

GORDON

No, but it was readable.

CONRAD

Yes. You were almost unreadable to us. The other thing which I thought was very serious was, not only was the COMM garbled, but at CSI, Dick and I completely lost COMM with



12-14

[REDACTED]

CONRAD  
(CONT'D)

one another. He didn't have the vaguest idea whether I burned or not. I could hear him, but he couldn't hear me. I don't know what the problem was, but I think this VHF has to be looked at very carefully in both the command module and LM.

GORDON

I tried all sorts of different settings with the VHF. I tried different antennas and also tried different squelches. There wasn't a thing that seemed to enhance the COMM one bit.

#### 12.14 CSM Monitor

GORDON

I guess the only thing I can say is it was easy; it was a fairly relaxed time. It was to me just about as simple as being back in the CSM. I conditioned myself to be that way, to exclude myself of external surroundings and confine myself to that lower equipment bay and occasionally to the MDC. As it turned out, I obtained a lot more than was actually required and could have relaxed a little on it.

#### 12.15 RCS/TPI

GORDON

In the marking from CDH to TPI, there was some shafting in the telescope. I couldn't see anything; but with AUTO optics, when I went to the sextant, even though the field of view in the sextant was extremely white, after about 2 or 3 minutes I finally picked out a very dim white dot that was the LM. I

[REDACTED]

GORDON  
(CONT'D)

actually obtained eight optics marks before darkness. This was at the time that Sun shafting was supposed to preclude taking any optics marks, and I got eight between CDH and darkness. When we got to darkness, there were no more optics marks because the LM had lost its tracking light. I asked them to verify that it was on, and in fact, they had said it was. They cycled the switch with no apparent effect. The ground said it was taking power, but there was certainly no light. So from here on, it was VHF only. So with the eight optics marks, I obtained 16 VHF marks for the TPI solution. My TPI solution for comparison purposes was minus 26.0 in X, plus 1.7 in Y, and plus 11.1 in Z. I didn't write down what the LM solution was, but when I used their time option I came up with minus 26.1, plus 1.6, and plus 10.6 which is extremely favorable. It is within one-half ft/sec in the Z parameter and practically the same in the other two. It is interesting to note that the angle I came up with using their time option was 208.10 degrees as opposed to the nominal 208.30 for the command module transfer. It was extremely close. And the state vectors had still converged even though I had only eight optics marks.

#### 12.17 CSM Sextant/VHF Track

GORDON I guess the only thing I can say about that was it was kind of ragged. Once the state vectors got locked in, the NOUN 49's

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[REDACTED]

GORDON disappeared never to be seen again. Everything else was right  
(CONT'D) down the track. The NOUN 49's only appeared for about a half  
a mark schedule prior to CSI; then they went away as I mentioned  
before.

#### 12.18 Midcourse Corrections

GORDON I let the P20 and P35 programs run with VHF only, and as ex-  
pected, these parameters kind of blew up. Or the solutions, I  
guess I should say, blew up with VHF only, as I knew they would  
and as was predicted before flight with VHF only. My solution  
for the first midcourse was minus 1.6, plus 0.10, and minus 5.3.  
The LM's was minus 0.50, zero, and plus 2.0. So, you could see,  
it started deviating right there. The second midcourse, with  
VHF only, I had a solution of minus 6.1, plus 0.3, plus 1.6,  
whereas the LM was minus 0.9, minus 0.3, and minus 0.7. So,  
there's a data point; VHF only does blow up after TPI. But it  
gave me a chance to relax and just kind of watch the rendezvous  
from there because VHF, of course, functioned by itself and I  
merely monitored their solutions. Just to keep the preferred  
tracking axis at them so they'd have a full signal strength  
from the transponder, I just kept the P20 running until after  
the midcourse 2. I did a VERB 77 P20 and allowed the DAP to  
point the X-axis of the spacecraft at the LM. By this time,  
of course, I think the state vector was off enough that it

[REDACTED]

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GORDON actually didn't point the X-axis at the LM, but there was no  
(CONT'D) particular problem in climbing onto the couch and looking out  
the window and picking up the LM visually. I guess it was  
about 3-1/2 miles.

#### 12.22 Photography

GORDON When I first picked up the LM visually, I had the television  
once again in the right-hand rendezvous window. I had the DAC  
in the left-hand rendezvous window, this time with the 75-mm  
lens, and I had about half a roll of color in the magazine. I  
exposed that at six frames per second until it was done and  
then I changed, took the camera down, and put 18-mm lens back  
on the DAC with a new, full, film magazine and let that run  
throughout the remainder of the rendezvous and throughout  
the docking. That was a slow-motion time. Pete had the  
rendezvous well under control. The braking was smooth and  
moderate, and there was no particular problem. I could see  
that the out-of-plane and all line-of-sight motions were locked.  
In fact, I took the COAS and put it on the LM at about 2 miles  
and I don't think he drifted more than a half a degree out of  
that COAS until he got right into stationkeeping where we were  
both starting to maneuver. As far as photography, television,  
and all those good things, there was no problem in doing all  
three of them — tracking, TV. As a matter of fact, I did most

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12-18

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GORDON of the tracking with the TV monitor so that the folks back home  
(CONT'D) could see this, rather than just me seeing it out through the  
COAS. I used the monitor to keep the LM in the field of view.

CONRAD Did you take any 70's?

BEAN Didn't have any cameras.

CONRAD That's right. We didn't have any cameras. We threw them out.

#### 12.23 RENDEZVOUS

GORDON All I can say is that it was okay. Pete flew the whole thing  
up to stationkeeping distance; this was about 10 feet or so,  
10 to 15 feet. I had already had a 60-degree roll in so that  
high gain antenna could be obtained for the television. When  
he actually stopped and started stationkeeping, I completed  
that roll to 180 degrees; and when I got there, I took over  
the active stationkeeping while Pete pitched over and did the  
yaw maneuver to essentially line up the docking target.

#### 12.24 DOCKING

GORDON I guess all I can say about the docking is it was as Pete and  
I both expected all these many months. In spite of all the  
arguments we got from, I guess you might call them contact  
dynamicists, about the dynamics of two vehicles coming together,

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GORDON  
(CONT'D)

one being 5000 pounds and the other roughly 35 000, it was a simple, easy task to perform. It could have been done in darkness as well as daylight with just as much ease, and the fact that the command module was active, rates were down low, the control was excellent. I used the DAP once again to dock with half a degree deadband and half a degree rate, and once I got the target lined up, my attitude corresponded to the LM attitude, and it was merely a matter of leaving my hand off the DAP and just translating. I thought the docking itself was a very simple task and relatively easy; however, at contact I felt it hit. I knew it was going to hit the LM; I just looked up and got the barber poles on the probe indicator and flipped the switches to FREE and didn't notice any motion in either vehicle during this whole time. I just sat there and watched it and let her stabilize and do what it wanted to do and it didn't wander hardly at all. I think I made a couple of pitch-up pulses with the rotational hand controller just to make sure that the alignment was exact when I retracted the probe. I don't think that the vehicles moved hardly at all at contact. There was certainly no noticeable motion, anyway. Retraction was as expected. It was a long period of time; it was very slow and easy, and there was no doubt that those capture latches or the docking latches had unmated.

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CONRAD We came right in and stopped. I pitched over and did the yaw maneuver after Dick did his roll. We did the docking just the way we stated before, and everybody objected to it. But we insisted on doing it that way, and I'm convinced it's absolutely right. Dick came in and docked; I maintained attitude hold — tight deadband. As soon as he got his top latches barber poled, we went to FREE. Neither spacecraft so much as moved a muscle, and we got a complete, good lock. He straightened out attitude with his translations thrusters and went to hard dock, and it pulled us right in there without either spacecraft deviating; bango, we had 12 latches.

#### 12.25 Postdocking Checks and Pressurization

GORDON Postdocking checks and pressurization was all according to the checklist. There's no particular problem in doing all that stuff. In fact, I was down there as soon as we docked. I was in FREE and I changed the DAP. I had the ascent stage only and went to WIDE deadband and LOW RATE, went to plus or minus a half a degree and two-tenths deg/sec and just let it sit there in docking attitude while I pressurized the tunnel, verified its integrity, and completed the pressurization.

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## 12.26 TUNNEL OPERATIONS

GORDON I removed the hatch and stowed it under the couch. I reached up and had to take the preload off so that the extended latch would engage. Of course, I knew what was going to happen, and at once it was engaged. It was merely a matter of waiting for Pete to get ready to take the probe and drogue into the LM. It came apart as advertised. There was no particular problem in this area at all. I might go back and mention one thing at this time. I had intended to wear my suit during the whole time I was in lunar orbit by myself. But I had gone so far as to take the struts off of the couch and put the EVA stabilizer bar in. I actually lowered the center couch. I lowered it to the floor. I couldn't stow it because of the SO-158 experiment or 810 stowage area. It had to be accessible the next day, so I knew I couldn't stow the couch at that time anyway, but I was going to lower it to get it out of the way. The more I thought about this, the more I looked around, and the more I tried to thrash around with hoses on the suit and doing all those things by myself, the more I realized that it was absolutely ridiculous to spend all that time in lunar orbit wearing my suit. So I made the decision right then and there to take it off, and I did. I attached the lanyard to the zipper so if I had to put the suit back on again I could do it by myself. I

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GORDON (CONT'D) knew that I could suit up by myself because the day of separation I had actually done so without any help at all and took less than 5 minutes. Once I had the suit unstowed, the only thing I had to have help with was getting zipped. So I attached the lanyard when I took the suit off. I folded it up and stowed it in the L-shaped bag, and there it stayed forever. I thought about this EVA contingency thing and there was no reason to suspect at this time this was even going to have to be done. If it had to be done, I was just going to have to take the time to put the suit on and reconfigure the spacecraft and I figured it would take no more than 20 minutes total time. I felt that Pete could stationkeep at that time until I got ready. To be perfectly frank, it made the entire single-man lunar operation easier and more comfortable than expected. I hate to think of the shape I would have been in if I'd had to wear the suit all that time. And I had no qualms about docking or anything else with the suit off, because I'd already done it during the transposition and docking and the whole thing went as planned. In a nutshell, tunnel operations were okay. No hitches, no problems, and it went according to the checklist as planned.

CONRAD Tunnel operations were smooth as glass. The LM was filthy dirty and it had so much dust and debris floating around in it

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CONRAD  
(CONT'D)

that I took my helmet off and almost blinded myself. I immediately got my eyes full of junk, and I had to put my helmet back on. I told Al to leave his on. We left the helmets on and took off our gloves. Once we got stabilized and had the hatches open and everything, the flow system of having the command module more positive than the LM seemed to work. We did not pick up much debris in the command module; very little, if any, that was floating in the LM. But, it stayed very good in the LM all the way through our checklist.

We tried to vacuum clean each other down, which was a complete farce. In the first place, the vacuum didn't knock anything off that was already on the suits. It didn't suck up anything, but we went through the exercise. It did clean the rock boxes, that much I'll say for it. I don't think it sucked up any of the dust, but it brushed the dirt off the boxes. We put them in their proper containers, and transferred them.

Dick brought over the LiOH B-5 and 6. We stowed those and it took a long time to get all the gear transferred. Then Al and I, because we and the spacecraft were so dirty, stripped naked and transferred the suits up to Dick. He stowed them under the couch and let us come in dirty and pack our own suits to keep himself and the spacecraft as clean as possible. We packed the

**C [REDACTED]**

CONRAD two suits in the lower part of the L-shaped bag, and to my know-  
(CONT'D)

ledge we had very little debris come across from the LM. However, something we found out later and not until we got back to the ship, was that the fine dust was on the suits and on almost all of the equipment that was contained inside the bags. The dust is so fine and in zero g it tended to float off the equipment and it must have permeated the whole command module. It floated out of those bags; it floated out of the contingency sample bag. This we could see any time we opened up (which we stopped doing right away) the LiOH container that had the contingency sample in it. The whole thing was just a cloud of fine dust floating around in there. You could actually see it just float out of the bag through the zipper; and you can forget those zippers. They don't hold anything in. When we got all the gear back here and opened it up, back on the carrier, we found out that it had all cleaned itself. That was where all this dirt was coming from in the command module. The dirt is so fine I don't think the LiOH filters were taking it all out. It would pump it in the ECS system and pump it back out the hoses. This was indicated by Dick's blue suit hose, which we had tied over the left-hand side and was blowing on panel 8 circuit breaker panel. That whole thing was just one big pile of dust that was collected on the circuit breakers. The only reason it's there is the ECS hose was blowing on it. It's got

**C [REDACTED]**

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CONRAD to have taken the dust in through the LiOH canisters and filters  
(CONT'D) and everything and blown it back out the blue hose. So the  
system is not doing the cleaning, the dust is too fine.

#### 12.27 Transfer of LM Equipment and Film

GORDON I think Pete has probably already commented on this during the  
LM portion of this debriefing, and to me it was a period of  
"hustle, hustle." I believe we had a lot more gear to transfer  
back and forth than did the Apollo 11 crew. Pete mentioned the  
vacuuming, the futility of trying to vacuum the suits and this  
sort of thing. He and Al both undressed in the LM and passed  
the suits over where we put them under the couches for stowage  
at a later time. It was a continual hustle to get ready for  
the LM jettison. A period of time after we docked, I had the  
tunnel cleaned out, but they were still busy gathering stuff up  
in the LM, so I went back and did the VERB 49 maneuver.

#### 12.29 Configure LM for Jettison

CONRAD We configured for LM jettison, and we got the LM off on time.  
Dick maneuvered right away to LM jettison attitude while we  
were doing the LM equipment stowage and everything. It was just  
a question of closing out and getting ready for it. The  
tightest part of the time line is the fact that it takes about  
20 to 25 minutes to vent the tunnel down. We just got the

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CONRAD tunnel vented down in time. We finally got it over plus 4,  
(CONT'D) showing that we had a good vented tunnel. We got the LM off  
and said goodbye to Intrepid.

BEAN That is a time period that ought to be lengthened up. We just  
didn't have enough time to get everything stowed, get back  
over, and get the tunnel depressurized. We just barely made it.  
We hustled like the devil. Tying down the bags and putting all  
the equipment in the LM just took longer than we expected. I  
think we were well trained to do it; it just takes more time  
at zero g. I'd recommend opening up the amount of time if we're  
going to do that again. There just wasn't quite enough time to  
do that job.

CONRAD Stowage in the command module went very well. We knew where all  
the gear was supposed to go, and we just threw it all in the  
bottom of the command module. We got Al out, closed the hatch,  
and got rid of the LM. Then, while Dick messed around with  
LM JET and all that business, Al and I went to work and started  
stowing the gear. That's the one place the ground started  
bugging us. During that time, Dick was busy and Al and I were  
naked. We didn't have any clothes on; we wanted to get cleaned  
up after we had stashed everything because all the gear we were  
stashing was dirty. So we didn't have any COMM on, and I guess  
somebody got a little excited on the ground. They started

[REDACTED]

CONRAD (CONT'D) bugging us, and that was a bad time. That's the one time that I got a little snippy, or Dick did. We shouldn't have, but we were very, very busy and on a very tight time line. We got it all done; everybody collapsed into bed that night.

GORDON We maneuvered into a holding in the jettison attitude the whole time we were transferring the gear back and forth. There wasn't any doubt about what we had to transfer. There was no confusion in this regard about what had to go where, it was just a matter of there was a lot of gear and a lot of things to be done and not very much time to get done in. In fact, by the time Al finally got out of the LM, after setting up the computer and making sure that the LM was set up for the deorbit burn, we just barely made getting the hatch back in and getting the tunnel completely vented before separation. Now, I realize we could have separated without having the tunnel completely vented, but I wanted to have the tunnel vented before we jettisoned the LM, and we did get it done, but it was a tight time line.

#### 12.31 Maneuvering to LM Jettison Attitude

GORDON Maneuvering to LM jettison attitudes I already mentioned; the DAP did it.

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### 12.32 Equipment Stowage

GORDON We had stowed the spacecraft after the LM was jettisoned. Pete and Al did most of that while I was concentrating on getting rid of the LM by tracking it through the sextant.

### 12.33 TUNNEL CLOSEOUT

GORDON Tunnel closeout was no problem.

### 12.34 IVA Photography

GORDON We didn't take any IVA pictures.

### 12.35 SEPARATION MANEUVER

GORDON The separation maneuver was photographed. We had the camera in the right-hand window that was taking pictures of the maneuver. It was an out-of-plane jettison maneuver. There was another P41 maneuver to the separation attitude where we fired 1 ft/sec retrograde for the separation. There was no problem keeping track of the LM. I couldn't see it all of the time out the left-hand window. Because of the out-of-plane attitude that we were in, Al could see it out the right-hand window. There was never any concern about a mid-air collision.

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13.0 LUNAR MODULE JETTISON THROUGH TEI

13.1 Lunar Module Jettison and Trajectory

GORDON There was no problem with the LM jettison. The checklist was adequate. We were able to track and watch the ascent stage of the LM through the sextant. I took some marks to try to update that LM state vector as best I could. We wanted to photograph the LM descent and, hopefully, get the impact on the lunar surface. I don't think this was done even though we attempted to do it; we didn't have an adequate LM state vector using VHF ranging and AUTO optics to do this. I tracked the fire through the deorbit maneuver with the optics and VHF. I put a P76 in after the deorbit maneuver. I found it in the sextant and I took more marks. Then I put the sextant DAC on and tried to photograph it. I was watching the AUTO optics through the telescope, and I don't think we were too successful in preserving that LM state vector so AUTO optics on the sextant could keep track of it. I don't have any confidence that this worked.

13.3 Orbital Navigation

GORDON I assume this is the P22 that was done on two REV's. All I can say about P22 is that it was easy to do — there were no problems. The maps I had on board were adequate, and the landmarks were easily recognized. Tracking these through the telescope



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GORDON with the DAC on the sextant was easy. The ground suggested  
(CONT'D) that I was taking marks a little bit earlier than I should. I  
got the  $T_2$  time and I was not waiting the full 40 seconds to  
take my first mark. I did this on the first couple of landmarks  
and I observed that the trunnion angle was not as great as  
that of the sextant. I was being shortchanged when I went past  
TCA. I could judge this by the third mark that was supposed  
to be at TCA. I knew the time line was such that I should be  
taking the third mark right at TCA when the shaft was going  
through the 90- or 270-degree position. From that point, two  
more marks were supposed to be taken. I would wait 25 seconds  
and take the fourth mark, and then it would start to get crowded  
because the trunnion angle was getting out there near the  
35- to 40-degree point. I could see the edge of the field of  
view peeking up towards the target, and I would wait and take  
that last mark just as the field of view in the telescope was  
right on the verge of losing the target. In the sextant, it  
would have been able to carry on for a little bit further.  
There is some discrepancy here about how far beyond TCA the  
telescope can be used for tracking. Tracking targets was a  
relatively easy task. I might mention that P22 navigation is  
done in RESOLVE and medium speed on the optics drive.

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#### 13.4 High Gain Antenna Acquisition

GORDON High gain antenna acquisition, other than the S-band problem that I mentioned previously, did go a little unstable. We ran those tests on the way back and the ground has all that information. There was a heating problem. When it got hot, it did become unstable. When it did, we would have to go to MANUAL and WIDE. We would manually acquire at preset angles or leave it in AUTO and MEDIUM WIDTH. It didn't cause us any problem, although we did have a problem with the system.

#### 13.5 OMNI and S-band Communication

GORDON The OMNI and S-band communications were excellent throughout the flight.

#### 13.6 Strip Photography Configuration

GORDON Strip photography was easy to accomplish. Once we established the proper spacecraft attitude, we had ORB RATE torquing take over so that nobody had to fly the spacecraft. It was going in ORB RATE with the X-axis pointed at the nadir and the sextant DAC on. I was in the LEB trying to control the shaft and trunnion within 0 degrees shaft and 45 degrees trunnion angle. I would let it wander a degree or two and then drive it back to 45 degrees. The correlation between NOUN 91 and starting time was as planned. The times are written down in the flight plan.

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GORDON I think they're the preplanned times. Al operated the Hasselblad in the right-hand window and used the intervalometer. I don't think that he had any problem with that operation. Because of some of the other problems we had, we only did one REV of the strip photography whereas two were planned. We did have trouble with one of the 70-mm magazines. We had to go back and redo some higher priority high-resolution photography, and the ground had elected to eliminate the last REV of the strip photography.

### 13.7 Targets-of-Opportunity Photography

GORDON I would like to make two general comments about this. First, there is no such thing as targets-of-opportunity photography. Either you are going to do them or you are not going to do them. If they're going to do this type of thing then we ought to plan to do it. There obviously are areas that are of higher priority and of higher concern to the scientific community than to those people at NASA on the ground. They ought to take the time to sit down and say here is your film, here are the targets we want you to take, and here is how we want you to take it. Don't leave it up to the crew to take this, that, or the other thing. We had two different types of maps and charts. We had a chart and strip-photo maps of the orbit in which we were. Each crew chooses the one they feel is better. I used them

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[REDACTED]

GORDON both, and I found that the chart was a good one for generally  
(CONT'D) establishing where you were, what you were coming to, and at  
what time you should be over a certain area. I found that the  
photographs were more useful in identifying targets and allow-  
ing you to pick out those craters or whatever they wanted to  
be photographed. We need better maps and better charts for  
those areas. We should not call these targets of opportunity.

CONRAD I agree with all that.

BEAN I think the targets of opportunity ought to be made part of  
the flight plan.

#### 13.8 Television

GORDON We had no problem with the command module television. Our  
biggest problem was trying to figure out where to put it and the  
monitor. We had enough time in flight to figure that out.  
When we took outside television, it was generally in the right-  
hand rendezvous window, and when it was on the inside, we found  
the best place. The television is here to stay, and it ought  
to be used to its fullest advantage. I think it adds a great  
deal to the people's understanding of what we're trying to do  
and what is being accomplished. It's an excellent tool.

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13.9 UPDATES FOR TEI

GORDON No comment here. We were right on the money.

13.10 Maneuvering to TEI ATT.

GORDON No comment. It was a DAP maneuver.

13.11 Sextant Star Checks

GORDON The sextant star checks were all okay. We never had a problem with any sextant star chart throughout the whole flight. It was good.

13.12 Preparation for TEI

GORDON By this time we were all prepared for TEI. We were eagerly awaiting the time.

13.13 THE SPS/TEI BURN AND ECO

GORDON The SPS TEI burn and engine cutoff were right on the money. SPS performance was outstanding. The TVC DAP was solid as a rock. If I remember correctly, Pete told me that I had 1 second overburn, which I thought was pretty reasonable.

CONRAD It was the first overburn we had.

GORDON Yes, I guess that engine changes its performance.

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CONRAD We started out with a hot-engine shutdown early. The ground may have taken that into account and changed a couple of things.

GORDON That's right. The burn time was 211. TIG was on time, and residuals were down. We weren't concerned on manual or anything else. It was well done.

#### 13.14 High-Resolution Photography

GORDON I'll call this one the high-resolution photography. Lalande was the first target after the lunar-orbit plane-change number 2. I fouled this one up completely. I was on a crater that looked like Lalande. I didn't use my head. I wasn't paying attention to the times that the ground gave us. These times were accurate and were the ones we should have been using. I was looking at the ground, and this crater looked just exactly like Lalande, but lo and behold it wasn't; it was Herschel. We got some high-resolution photography of the southern lip of crater Herschel. We picked up Lalande during the REV prior to TEI. This didn't perturb any of the requirements for the rest of the bootstrap photography. I thought I should mention that. The pointing angles, the VERB 49 maneuvers, and the  $T_1$ - $T_2$  times that the ground supplied for the high-resolution photography on Descartes and Fra Mauro were excellent. They were right on the money. When I went to that attitude and a  $T_1$  time came up,

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GORDON I was sighting out the COAS and it was right smack dab in the general area of what they wanted. There was hardly any maneuvering to do at all. I did all the tracking in SCS minimum impulse and there wasn't any problem. It wasn't any problem at all to keep the COAS pointed at the target. You could pick out a crater on the ground, and the only time it became apparently difficult was when you were approaching the nadir or approaching TCA. With those high Sun-angles, the surface brightness was such that it was extremely difficult to maintain recognition of the crater that you were trying to track. There was a tendency for the surface to become generally washed out, but by judicious use of eyelids, eyeballs, and squinting, you were able to maintain a close resemblance to what you thought the target ought to be.

BEAN While we were taking the high-resolution photography — I think it was after Fra Mauro — I had the 250-mm lens on. I had replaced the 500-mm lens with the 250-mm lens and was shooting some targets of opportunity. Between targets of opportunity, I had the camera in my hands and was rolling it about, and all of a sudden the side popped off the magazine. When it did, I tried to clamp it shut quickly but was unable to do so. I was unable to tell how much of the film was ruined by having been light struck from the opening in the side. We taped it up. I think that earlier, when taking some of the 50-mm photography,

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BEAN (CONT'D) I may have operated the unlock mechanism instead of the film winding mechanism, which is on the other side. They both look the same, and I think this is a definite possibility for mistakes on future flights. I recommend that before any film is stowed on board that a tape be placed over the lock/unlock mechanism. There's never any use in flight for unlocking the magazines. This will prevent any accidental opening or closing when trying to adjust the film winding. The same thing applies for lunar surface. There's no reason for the lock/unlock mechanism being exposed.

GORDON I had a great deal of difficulty using the chart that had the targets of opportunity marked on it. I found it much easier to use the map that was made up of photographic strips. I really had a hard time using that other map — identifying where I was.

BEAN I think the main problem was the difference in scale. It seems to me that you don't want to have two different scales up there. It's tough enough, in the short time you're there, to learn one. The thing to do is to select the scale map you would like. We all agreed that the scale 630 000 to 1, which was the photographic-strip charts, was the better. If you make all the charts to that scale, you don't have to keep switching back and



C [REDACTED]

BEAN      forth trying to remember which size craters will show up as  
(CONT'D)      which size on your chart.

CONRAD    You should carry two of them so you can continually pass it  
            back and forth depending on which side you were working.

[REDACTED]

14.0 TRANSEARTH COAST

CONRAD My only comment is that we should have come home in 2 days instead of 3 days.

GORDON We had the fuel, too. We had 7 percent left.

CONRAD Yes.

BEAN This is when we were particularly glad we had that tape recorder on board where we could listen to those tapes. I just wish that we'd taken more tapes, more batteries, and I wish somehow we'd taken a pocketbook to read, because there's a lot of loose time on your hands on your way home. You don't feel like debriefing and in our case, the Earth was about 1/16th full, so you couldn't see anything. The Moon: you'd been looking at it for 2 days and you didn't want to look at it again. You would have really liked to just rest and come sizzling home.

14.1 Systems

CONRAD All transearth systems performed normally.

14.2 Navigation

CONRAD Navigation again was no problem.

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[REDACTED]

14.3 Passive Thermal Control

CONRAD Passive thermal control was the same as on the way out.

14.4 Fuel Cell Purging

CONRAD Fuel cell purging went as advertised.

14.5 Consumables

CONRAD The consumable updates that we got from the ground were the same all the way throughout the flight, and they were satisfactory to us.

14.6 SPS MIDCOURSE CORRECTIONS

CONRAD We made no SPS midcourse corrections.

14.7 Midcourse Lunar Landmarks

CONRAD We did no midcourse lunar landmarks.

14.8 Star/Earth Horizons

GORDON The P23's were done again coming back. The only thing to say about all that is that it's an eyestrain. I guess that's about it, really. It's well worked out.

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[REDACTED]

CONRAD Mention the fact that this was done primarily because of the proximity of the Sun to the Earth, and we never got those data before.

GORDON Those data come out in the wash, Pete. From the ground, I think. It was not hard to do. Some of the stars that I was given to look at were unobtainable simply because the light in the sextant, near the proximity of the Sun, was such that the star was not visible. These are identified and I think the ground, when we get the data back, will be able to resolve it so that we can see through the sextant, as far as proximity to the Sun is concerned. I might mention that the stars that they passed up with the unit vectors were no problem. You just use the planet option and stick in the unit vectors, and in all cases, if there were a star to be seen, as far as the lighting condition was concerned, it was always there. There was no problem with that at all.

14.9 DAP Loads

CONRAD The DAP loads were as the flight plan published. Only every once in a while was there a difference. I don't think it even affected the DAP loads that much. I guess it did, once in a while, as the ground would call up a different set of quads to

[REDACTED]

CONRAD use, which is standard procedure for balancing, when we went  
(CONT'D) into PTC or something.

#### 14.10 IMU Realignments and Star Checks

CONRAD IMU realignments and star checks were the same on the way back  
as they were on the way out.

#### 14.11 COMMUNICATIONS

CONRAD The COMM was good except for our little anomaly. We ran  
several S-band COMM tests by pointing the S-band antenna at  
the Sun for 4-hour periods of time to isolate our thermal  
problem which seemed to cause some trouble with auto lock and  
narrow scan.

#### 14.12 Television

CONRAD We did some television on the way back, which they had good  
reception on, as I understand it.

#### 14.13 Photography

CONRAD We did some photography on the way back.

GORDON I had in my written notes under the photography section, para-  
graph 13, all okay. I added that I wanted to talk at this time  
about this solar eclipse.

[REDACTED]

CONRAD Yes. Well, I was going to cover this at the end of this thing because I think that's enough of a separate subject that we ought to do it.

GORDON Okay. Fine.

CONRAD The photography listed in the flight plan or wherever it was was carried out, and Al did most of that.

14.14 Eating & Rest Periods

CONRAD Eating and rest periods were more than adequate.

14.15 Flight Plan Updates

CONRAD The flight plan updates were nothing.

14.16 Maneuvering to Entry Attitude

CONRAD Maneuvering to entry attitude was nothing.

14.17 Boresight & SXT Star Checks

CONRAD Boresight and sextant star checks were done just like they're called out in the flight plan. You can do it in the simulator.

14.18 ELS Logic & Star Checks

CONRAD The ELS logic was checked out at the proper time — so many hours before reentry.

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## 14.19 EMS

CONRAD We checked EMS. You ran two test patterns in one flight.

## 14.20 Entry Corridor Check

CONRAD An entry corridor check was made.

## 14.21 Final Stowage

CONRAD Final stowage was done. As a matter of fact, if you keep a clean spacecraft, you don't have much stowage to do anyhow.

## 14.22 Systems Verification

CONRAD Systems verification was per the check list and flight plan.

## 14.23 Final Entry Preparations

CONRAD Final entry preparations were per the check list and flight plan.

GORDON I think you might comment that it's really an easy, relaxed, slow, methodical time line to follow. We had enough time in reentry to play chess. It's really well organized, and there's no particular problem with it at all that I can see.

## 14.24 SPS DEORBIT BURN

CONRAD Number 24 is not pertinent because that's Earth orbit.

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14.25 CM/SM SEPARATION

CONRAD The CM/SM SEP went on time — 15 minutes before entry.

14.26 ENTRY INTERFACE

CONRAD Entry interface was on time.

GORDON Let's discuss the horizon check at the 267-degree pitch attitude, and the time, and so forth. It was dark and I never was certain that there was a horizon out there. I felt that there was one out there and that it really didn't make any difference. We had already checked the alignment. We were satisfied with the IMU. We had a boresight star. We had a sextant star check. We knew where we were, and the DAP was working properly. We were confident the whole time, and I didn't care whether I made that check or not.

CONRAD We ought to change the rule, because we actually violated the rule.

GORDON Well, we actually picked up the horizon check later on during the entry. That's that warm feeling once again — that you don't rely on anything and that you've got to look at the horizon to make sure you're pointed in the right direction. You don't do that when you're going to do LOI. You can't see the horizon on the Earth or the Moon, so there you go. I wasn't

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GORDON concerned about that, even though the horizon wasn't verified.  
(CONT'D)

We picked it up later in plenty of time before we got to entry interface where it became daylight. I was actually tracking the P22 or the NOUN 22 needles. The Moon was out there, and it went through the horizon. You've got the chart of the Earth horizon angles versus time from entry interface and you can check that any time prior to entry interface. It's a nothing check, and you can either do it or not do it. I could care less.

BEAN Did you say we did see it later?

GORDON I should say we saw it later. Oh yes. We didn't get it at that time, but we picked it up about 5 minutes later.

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15.0 ENTRY

15.1 Entry Parameters

CONRAD The reentry parameters were exactly as given to us. I think we hit our clock time right on the money, except drogue time. And that's got to be very hard to hit, because that depends on an absolutely nominal thing.

15.2 Communications Blackout

CONRAD Communications blackout came on time. As a matter of fact, I gave them a call after we were supposed to have ended blackout and had Houston loud and clear.

15.3 Ionization

CONRAD Ionization came when it was supposed to.

GORDON We photographed that.

15.4 Control Mode(s)

CONRAD All those were done according to the checklist. Dick flew it in MINIMUM IMPULSE.

GORDON Well, maybe. I may have deviated here. I'll just make a comment. Once the service module was separated, I went to SCS MINIMUM IMPULSE and flew the command module back in-plane and

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GORDON tracked the NOUN 22 needles all the way down to 151 degrees in  
(CONT'D) MINIMUM IMPULSE. Once we were satisfied everything was okay  
and the DAP was operating, I just went from MINIMUM IMPULSE to  
the DAP control for reentry.

CONRAD Made Al Bean nervous because you never had gone back to RCS  
RATE COMMAND. But that's good that he was watching us.

#### 15.5 Visual Sightings and Oscillations

CONRAD We had a couple of fantastic visual sightings on reentry. Moon-  
set for example; that really was spectacular. It's too bad we  
didn't have a camera to photograph that. It was a full Moon;  
and it was exactly aligned in the yaw plane behind us. Just  
watching that thing settle behind a beautiful, lit daylight  
horizon, with clouds above the Pacific, was phenominal.

Oscillations. I thought, boy, the spacecraft was steady as a  
rock. It's just like the simulator. I found that hard to be-  
lieve and even made the comment I wanted to see whether the  
spacecraft was that steady and stable during reentry.

GORDON It really is.

CONRAD And it was just like the simulator. You get in the transonic  
region, and if you get it to oscillate a little bit, you get  
some more RCS firing.

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15.6 DROGUE CHUTE DEPLOYMENT

CONRAD Drogue chute deployment was quite late.

GORDON We had 8:04 as the drogue deployment time; and I think it was 8:24, because I was counting it off to you and Al thought I was counting altitude, but I was counting clock time to get a hack on how late it really was.

CONRAD They didn't hit that time very well.

15.7 MAIN CHUTE DEPLOYMENT

CONRAD Main chute deployment was as advertised.

15.8 Communications and ECS

CONRAD COMM was good and the ECS was good.

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16.0 LANDING AND RECOVERY

## 16.1 TOUCHDOWN - IMPACT

CONRAD We really hit flatter than a pancake, and it was a tremendous impact, much greater than anything I'd experienced in Gemini. The 16-mm camera, which was on the bracket - and we may have been remiss in this and I'm not sure, but it wasn't in the checklist - whistled off and clanked Al on the head to the tune of six stitches. It cold-cocked him, which is why we were in stable II. Although he doesn't realize it, he was out to lunch for about 5 seconds. Dick was hollering for him to punch in the breakers, and in the meantime, I'd seen this thing whistle off out of the corner of my eye and he (Bean) was blankly staring at the instrument panel. I was convinced he was dead over there in the right seat, but he wasn't, and finally got the breakers in. By that time, we'd gone stable II which was no big deal.

## 16.3 Postlanding Checklist

CONRAD I went through the stable II postlanding checklist and uprighted okay.

## 16.4 Temperature and Humidity

CONRAD I thought the temperature was extremely good in the spacecraft.

  
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[REDACTED]

GORDON Super.

CONRAD Not like Gemini; Gemini really got hot in there.

GORDON It really kept it comfortable.

CONRAD We had the normal propellant smells in there from when we started sucking air back in the cabin on the chutes. We'd heard about that and didn't think anything about it.

#### 16.5 Communications

CONRAD We had good reception on all frequencies. We had 64 hours of battery power.

#### 16.6 Postlanding ECS System

CONRAD We activated the postlanding ECS system per the checklist, and at that point, that was bad news. Well, I don't know whether it was bad news or not. We really didn't need to because the cabin was plenty cool and nobody was seasick, and nobody even got the slightest tendency to be seasick, although it was very rough out there. I would like to comment that I think that had I done this in the Gulf in that rough sea, I'd have gotten sick. I think that 10 days of zero g sort of numbs you to the motion sickness, and none of us even felt queasy. I could hardly get down in the LEB without feeling queasy in the Gulf egress

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CONRAD exercise, and I was hopping all around that spacecraft out there  
(CONT'D) in a sea three times as rough as it was in the Gulf. It didn't  
bother me at all.

GORDON Do you think our vestibular response may have been desensitized?

CONRAD Yes, I really do.

GORDON For a period of time after zero g, maybe it's just not picking  
up those motions very well.

We didn't take any medication or anything.

CONRAD No. No medication or anything. I could hardly get down the  
LEB. I had to get right back in the couch again in the Gulf.

GORDON Let's go back to ventilation. The procedures say, of course,  
to open the PLV ducts. With that rough water out there, when  
we did, we just took water in through the intakes and that fan  
just blew it into the spacecraft. After a while, we got tired  
of getting wet so we just turned the PLV duct off. We just  
turned it off, and then when we got real warm again, I turned  
it back on just to let some more air in.

CONRAD Until they got the collar on and that sort of stabilized things  
a little bit.



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GORDON Yes. But we did take a considerable amount of water in through those ducts, even though we were in stable I position at the time before the collar was on. So, we just secured the post-landing vent.

#### 16.8 Couch Position

CONRAD I think for the couch position everybody went to the 180, which was adequate. I eventually dropped mine to the 270 position once we got the gear in the spacecraft, and I think Dick did too. Al, you got dressed in the couch, right?

BEAN Yes.

GORDON I got dressed back in the couch, too.

BEAN Turned out to be no trouble at all.

CONRAD We had plenty of time. We even got the medical kit out and put a Band-aid on Al so the whole world wouldn't get upset. As far as the inside of the spacecraft went, we were just waiting for the recovery people.

#### 16.11 RECOVERY OPERATIONS

CONRAD Apparently somebody keyed the primary 296 or whatever it was and we were receiving it, but nobody was reading us on primary except the Hornet. Now, I don't understand that.

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GORDON I don't either.

CONRAD If somebody was keyed, I still don't understand why the Hornet was the only one that was reading us.

BEAN We came up on primary A and B, so we had all our transmitters and receivers on.

CONRAD Maybe the Hornet was reading us on secondary?

GORDON The helicopter could read us.

SPEAKER I'll comment on all that later. I don't want to put my comments on the tape, but I'll comment to you fellows.

CONRAD Okay, but we had COMM, I mean we heard everybody. Apparently they couldn't read us, except on the Hornet.

SPEAKER No. Apparently what happened was that Airboss, who was 25 miles to the south, was the only one that didn't receive you. All the HELO's heard you. The Hornet heard you on 296.8. His instructions are that if he doesn't hear you to tell you to switch over to secondary; and you switched over to secondary.

GORDON We had no anomalies in the spacecraft as far as COMM was concerned.

CONRAD The COMM was super.

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SPEAKER We feel the same way. We just played the recovery tapes back, and I'm as convinced as you are. No problem.

CONRAD Okay. The decontamination procedures worked as advertised. The swimmer got the suits and the masks in to us. We had no trouble putting them on. It's one whale of an improvement over the BIG's, and I think caused us no problems whatsoever.

GORDON You can see, and you're not hot.

CONRAD I have a comment to make. I am really against inflating these life jackets. I went along with it, and Jerry Hammack, I guess, didn't believe us. He had the swimmers instructed to pull them on the way out the door, and that I object to strenuously. I don't want some swimmer pulling my life jacket when I'm halfway out the hatch, which he did, and it made me mad.

GORDON Same thing to me.

CONRAD Look, I know he was only doing what he was told to do, and that we've got to settle with the recovery people. There's no reason, when you've got a healthy crew in that spacecraft, to put them in that dinghy raft with those life jackets inflated, and it's bad news getting into that Billy Pugh net. I argued that with Jerry. I told him I'd go along with it, but I'm going to argue with them when I get back. I'm particularly hacked about having

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CONRAD somebody pulling on me. Going out the hatch, a guy was hauling  
(CONT'D) on me, and the next thing I knew, he inflated my life jacket.  
I don't want to say anything to them because they're only acting  
under orders.

16.12 BIOMED GARMENT OR COVERALLS AND MASK

CONRAD As far as that mask goes, it didn't bother us at all. You can  
see well enough. We were, I think, in fairly rough waters.  
We didn't have any trouble getting our masks wet or anything  
because we didn't have those silly BIG's on, and we weren't  
stumbling all over ourselves unable to see where we were going.

16.13 Spacecraft Power Down and Procedures

CONRAD We powered the spacecraft down per the procedures, and the  
swimmer had a little trouble closing the hatch because the PLV  
vent cover got in the hatch. I think we should modify our check-  
list to remove that PLV cover completely and put it on the floor.

GORDON Put it on the floor. That's a good idea.

16.14 EGRESS

CONRAD The egress, otherwise, was okay.

## 16.15 CREW PICKUP

CONRAD The crew pickup, I think, was excellent. The helicopter crew did an outstanding job considering the rough sea state. The swells were at least 15 feet, not 5, and the waves were a good 4 feet on top of that.

BEAN I think one thing they should do is remove that sea anchor they have hanging down on that line about 10 feet below it, because it got in the raft. Then when they lifted up Dick Gordon, that line came whipping out of the raft, and I'd hate to have seen it if he'd gotten his arm in it or leg in it or something like that. It would have really injured us, so my recommendation is just to eliminate that completely. We sure didn't use it in our practice at all. We didn't need it.

GORDON That's right.

SPEAKER Yes. That sea anchor bulkhead is supposed to be placed in the net after pickup raft, and the first guy jumped into it, about that time we'd slide on one of those 15-foot swells, and he'd be on his way like he was catapulted. It had nothing to do with the winch or the chopper.

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17.0 GEOLOGY AND EXPERIMENTS

The topics listed for this section are not discussed herein because they were covered chronologically in section 10 (Lunar Surface) of this volume. These topics will also be discussed in the followon photographic/scientific debriefing that is published separately. Additional information about these topics can be found in the technical air-to-ground voice transcription, which contains all the EVA conversation as well as the informal inflight geological debriefing.

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18.0 COMMAND MODULE SYSTEMS OPERATIONS

18.1 Guidance and Navigation

18.1.A ISS Modes

GORDON ISS modes were okay; the only anomalies were during launch, and they have already been discussed.

18.1.B Optical Subsystems

GORDON I think the optical subsystem worked well. There were no anomalies in its operation. I did notice a red spot in the telescope on the eyepiece. It was approximately 12 or 13 degrees up and approximately 5 degrees to the right. It was a little red chip mark. It was unattached; it didn't bother anything, but it was always there.

18.1.C Computer Subsystem

GORDON The computer subsystem worked fine; no comments.

18.1.D G&N Controls and Displays

GORDON The G&N control and displays gave us no anomalies, no problems.

18.1.E Procedural Data

GORDON I thought our procedural data in onboard documentation per



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GORDON procedures, was excellent. We never lacked anything; in fact,  
(CONT'D) there was far more information than we ever needed, but it was  
all well written and fairly concise.

#### 18.1.F CMC/SPS/TVC

GORDON The CMC/SPS/TVC was in all cases, except for one burn, good.  
It solved, and there was never any question about its capability  
to juggle this burn. Even during the LM burn, we noticed some-  
thing in the lunar orbit plane change number 2; guidance was  
still good, however. A dutch-roll-type of oscillation was  
noticed throughout the burn. It appeared to be a classical  
aircraft-type dutch roll or a snaky oscillation, if you want  
to call it that in roll and yaw.

#### 18.2 Stabilization and Control System

GORDON On the subject of control, thrust vector control, and displays  
in loop control functions — these control functions all  
worked normally, without any malfunction.

#### 18.3 Service Propulsion System

GORDON The thrust switches were used on all burns. All burns were  
started on bank A, and then followed by bank B approximately  
3 to 4 seconds after ignition. That system worked okay. The  
thrust vector alignment was always excellent in all starts.

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GORDON  
(CONT'D)

There weren't any trim transients noticed at all. The engine was trimmed from ground information for all burns. The DELTA V remaining counter and rocker switch all worked satisfactorily. The SPS THRUST DIRECT ON switch was not used; the DIRECT ON button was not used; and the THRUST ON button was not used. The SPS channel pressure indicator was good; there was no oscillation and the indicator worked fine. PUGS was good and operated satisfactorily. The only comment is to plan prior to the flight. The PUGS increase-decrease switch was operated in full increase throughout the mission.

#### 18.4 Reaction Control System

GORDON

The service module RCS worked okay. No particular problems were noticed in the gaging side of the system. The propellant quantity gage was too dark. It seemed to stay 100 percent throughout the flight. No problems were noticed in the command module RCS.

#### 18.5 Electrical Power System

##### 18.5.A Fuel Cells

GORDON

The fuel cells have been better. The only anomaly we had was during launch when apparently a lightning strike knocked all three fuel cells off the wire, disconnected all three fuel

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cells from the bus. Their operation, however, was good throughout.

#### 18.5.B Batteries

GORDON The batteries were all okay; they accepted charges readily, and we had no problem with them. In fact, we practically never charged BAT C throughout the flight.

#### 18.5.C Battery Charger

GORDON The battery charger worked nominally; there was no problem with it.

#### 18.5.D DC Monitor Group

GORDON The DC monitor group was okay.

#### 18.5.E AC Monitor Group

GORDON The AC monitor group was okay.

#### 18.5.F AC Inverters

GORDON The AC inverters worked okay, that is, nominally throughout the flight. We never even used or checked out inverter number 3.

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## 18.5.G Main Bus Tie Switches

GORDON The main bus tie switches worked as advertised.

## 18.5.H Nonessential Bus Switch

GORDON The nonessential bus switch was not used; in fact, all non-essential bus circuit breakers remained out throughout the flight.

## 18.5.I G&amp;N Power Switch

GORDON The G&N power switch was never used.

## 18.5.J Cryogenic System

GORDON In all respects, the cryogenic systems aboard the spacecraft worked nominally. There were no anomalies — there was an unbalance one day. The day Al and Pete were on the surface, I had to turn off heater number 2 on hydrogen and oxygen number 1. They ran for most of the day that way. They became balanced again, and I went back to AUTO. The system worked well; the ground did have to balance them a couple of times.

[REDACTED]

## 18.6 Environmental Control System

### 18.6.A Oxygen System and Cabin Pressure

GORDON The oxygen system and cabin pressure worked well. There were no particular problems. The cabin seemed to stabilize at 5.1 psi.

### 18.6.B Cabin Atmosphere

GORDON The cabin atmosphere was okay. On the way out, it was clean. On the way back, we got lunar dust in the command module. The system actually couldn't handle it; the system never did filter out the dust, and the dust was continuously run through the system and throughout the spacecraft without being removed.

### 18.6.C Water Supply System

GORDON The water supply system was okay, the hydrogen separator being on the spacecraft. We did use the gas cartridge separators on both the water gun and the food preparation valve. The one on the food preparation valve didn't seem to work too well, and it was removed during flight.

CONRAD We think, though, that we might not have charged it properly.

GORDON Well, you can't help but charge it. Every time you use it, you charge it. Water won't come out of there unless you fill it up.

[REDACTED] CONFIDENTIAL [REDACTED]

[REDACTED]

CONRAD Well, I'm talking about the technique we used.

GORDON Yes, there is.

CONRAD The best possible charge.

GORDON We never really went back and recharged the thing, but I don't think any of us felt confident that it was really working. The one on the water gun was no particular problem to use. During the last two days of the flight, we removed both gas cartridge separators and never noticed any difference in the performance or couldn't tell any difference between their use or their nonuse. I suspect it was because the hydrogen separator was performing satisfactorily in removing most of the gas from the water. We did get water or gas in the hot water all the time. However, this is not necessarily a problem. We did get a little gas in the hot water system, but maybe that was because we were heating water and forming bubbles in the heating system. The cold water didn't contain the gas bubbles that the hot water did. One of the big problems we had with the water supply system was the inability to shut water off readily at the food preparation station after use. That valve seemed to leak or drip water for 10 to 15 minutes after each use, and we were continually wiping it up with towels.

[REDACTED]

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#### 18.6.D Water-Glycol System

GORDON On the water-glycol system, the mixing valve was put in manual, and the glycol evaporator temperature was placed at approximately 55 degrees manually through panel 382 on the way home because we were too cold. We used the manual valve to jack up the temperature a little bit. The water boilers were deactivated after TLI, and they were never operated again until just prior to entry. The crew never verified their function or operation, except that it was noted that the primary water boiler was operating. The steam pressure increased near 90 degrees K. Other than that particular fact, the crew never noticed the water boiler operation.

#### 18.6.E Suit Circuit

GORDON The suit circuit performed satisfactorily. There was no problem. The suit circuit was used during launch and undocking prep and was never used again.

We did, of course, use the suit hoses as our ventilation system, and we put the screens over the exhaust hoses, which worked satisfactory. Going out, they were no particular problem. We cleaned the screens approximately once a day on the exhaust hoses and on the suit circuit return-valve screen. On the way

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GORDON back, with all lunar dust, this operation was increased to  
(CONT'D) twice a day for the suit circuit screen and sometimes three  
and four times a day for the screens on the exhaust hoses.  
The screens were always covered with gray lint material that  
we never did seem to get rid of.

#### 18.6.F Gaging System

GORDON The gaging system worked properly. We had two failures in the  
gaging system and the environmental control system. The CO<sub>2</sub>  
sensor failed during launch and never worked again. The last  
day, the suit pressure gage failed full scale low.

#### 18.6.G Waste Management System (Urine and Fecal Disposal Problems)

GORDON There were no problems other than the pain of using bags to  
dispose of the feces. Other than that, the problems have  
always been the same with that system. We had the GFE URA  
system in addition to the old Gemini-type bags and also the  
launch day UCTA's which, of course, were used. At night, we  
used the Gemini system. Sometimes, when we didn't want to dump  
water during PTC, we actually stored it until the next morning  
when we did dump it. The GFE URA was used most of the time  
during waking hours and flight. It was very convenient to use

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GORDON and seemed like a worthwhile system. There is one problem,  
(CONT'D) however. The URA always contained urine. The surface tension was such that even after you used it, it would have a film of urine on the inside of the cover; the Teflon top seemed to have a film of urine on it all the time and in general, even though it functioned properly, it was a sloppy thing to handle. Every time you used it, you came away with urine all over your hands. We were generally cleaning up with the towel and wiping off this excess urine that the system did not seem to do away with. The use of the GFE URA was easy and convenient. It was noticed, however, that the stream of urine had to be directed parallel to the honeycomb to prevent splashback. There were no cases where it actually backed up and overflowed.

We did clog both of the filters of the urine system. Did the first one clog on the way out?

CONRAD I think the first one went after four days or sometime when we got into lunar orbit.

GORDON I thought it was way over half the mission.

BEAN It was when we got back.

GORDON That's right. It became clogged one day after Al and Pete got back from the lunar surface, and the second filter, which had

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GORDON not been used until then, was clogged one day from reentry.  
(CONT'D) We used the system without the filter for the last day. Did you have a comment on waste management?

BEAN I have a comment on that device. It would have been a lot better if it had been a little bit longer and a lot thinner. I noticed when we directed our stream of urine down the center honeycombs, the urine tended to go right through and dump. You could see the hose jump as the urine went out, whereas if you'd directed it down any of the other paths, I had the feeling that the urine was sticking around inside the device. I think making that change and the one that Dick mentioned might help. I don't know how you're going to fix it — perhaps some sort of band that keeps the urine that's down in the device from flowing up the sides of the device and then onto the cover where it sticks and makes it a little messy when you take it off.

CONRAD Break the surface tension.

BEAN That's right. You need a surface tension break right there so the urine doesn't tend to get on the cover.

GORDON In case anybody's wondering about these clogged filters, we were fairly free and liberal in our use of fresh water to run through the system. It was, we felt, fairly well flushed and

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GORDON (CONT'D) kept as clean as possible. We were continually purging the system. In fact, we would use it and leave the valve in the dump position and generally be reminded that we had done so because of the O<sub>2</sub> high flow light. We were continually getting those, and it didn't seem to bother the ground. They had commented on our oxygen usage, and it was a little higher than nominal. I think this is probably the reason for it. We had always purged that urine system quite freely and generally left it on until the O<sub>2</sub> high flow light came on.

#### 18.6.H CO<sub>2</sub> Absorber

GORDON The CO<sub>2</sub> absorbers worked fine. Their usage, change, and accountability were all perfectly normal. We did forget to change cartridges one night, and the next morning when a cartridge change was scheduled, we changed both filters instead of one so that cartridge 15 had double duty on it and cartridge 17 only had half a cycle.

#### 18.7 Telecommunications

##### 18.7.A Monitoring

GORDON It was our desire as a crew to leave the monitoring and antenna selection up to MSFN for real-time control. It was our desire not to mess with antenna selections or antenna monitoring,

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[REDACTED]

GORDON (CONT'D) except during certain phases of operations during the waking hours when we were to monitor and switch when we lost gain on any particular antenna. It really didn't cause any problems. There were a couple of cases where maneuvers affecting the antenna switching were not caught right away. There was a communication dropout a time or two during the flight, but it never seemed to really cause any problems. We just felt freer by letting the ground take care of that. Al, do you want to say anything about management of the antennas or anything other than what I just mentioned?

BEAN No. You've already covered the problem with high gain.

#### 18.7.B Individual Audio Center Controls

GORDON We never had any problem with the individual audio center controls. Everything worked okay.

#### 18.7.C VHF

GORDON Our VHF worked properly throughout the flight, except during the rendezvous. We've mentioned in a previous section of the debriefing that during the rendezvous, reception was very poor. In fact, it made VHF almost unusable for communication between the LM and the command module during the rendezvous. We had to repeat, and sometimes the system was completely lost.

[REDACTED]

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#### 18.7.D Operation Of S-Band High-Gain Antenna

GORDON The S-band high-gain antenna was okay. There was never any problem. It seemed to operate satisfactorily for most modes. The anomaly in the high-gain antenna, which has already been mentioned, in the test we ran during translunar coast will help clarify some of those problems. It seemed that when we'd break lock, the antenna seemed to lose signal strength and would tend to hunt when it was in the REACQ narrow band. We had to go to manual for acquisition on occasion, and then it operated after acquiring in the AUTO medium mode. The ground has a handle on this because of the tests we ran during transearth coast.

#### 18.7.E Use of CMC/DSKY To Obtain

##### Antenna Pointing Angles

GORDON We did this most of the time, and when time permitted, we felt it was the best way to go rather than have the ground call up angles all the time. A VERB 64 can be used almost any time during most of the programs and unless we were particularly busy or something, we generally used that for high-gain pointing angles. However, when we were busy, the ground readily came up with pointing angles for reacquiring when needed.

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CONRAD My impression was that I spent about an hour one day in the simulator learning how to run that high-gain antenna. I think the simulator did a very good job of simulating how the high-gain antenna actually ran in flight. I don't think anybody had any trouble with it in that the simulator high-gain operation was excellent. I think we were in good shape to run that equipment, thanks to good training.

18.7.F S-Band

GORDON The S-band was okay. No problem other than those already mentioned was noted.

18.7.G Tape Recorders

GORDON As far as this crew is concerned, tape recorders are probably one of the weakest areas in the equipment. I don't have a section for DSE operations. I'm going to use this section to talk about the Sony tape recorder we carried on board. Okay?

We were very displeased with this. We never used a tape recorder to record any onboard data throughout the flight. We used the tape recorder for our own entertainment. We had several tapes with music that were made personally for us so that we could use them during the dull, boring hours during trans-lunar coast and transearth coast. We used every single battery

[REDACTED]

GORDON we had available in the spacecraft for this purpose. We had a  
(CONT'D) lot of trouble with the tapes. Several times we had to stop  
the recorder and rewind the tape by hand. The batteries were  
good, but their lifetime is extremely short, and we felt this  
system, although not required, was not the best that could be  
utilized in the command module. As a crew, it is our recom-  
mendation that this is a very important matter, and steps  
should be taken to improve these tape recorders. It's sug-  
gested that a better tape recorder, not battery operated, be  
made available for this purpose. Instead, the recorder should  
use 28-volt dc power from the spacecraft.

#### 18.7.H VOX Circuitry

GORDON Whenever VOX circuitry was used throughout the flight, it  
seemed to operate satisfactorily. I did notice that the VOX  
setting had to be higher with the lightweight headset than with  
the COMM carrier, but this was no problem to adjust.

#### 18.7.H DSE Operation

GORDON The DSE operation was okay, and it was up to the ground to  
operate the DSE equipment most of the time, except when no  
particular downlink situation was being conducted in the space-  
craft such as in SPS engine burn and entry where Al, in accord-  
ance with the checklist, used the DSE and select HIGH BIT RATE

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[REDACTED]

GORDON for recording purposes. The rest of the time, the ground  
(CONT'D) controlled the operation of DSE.

18.8 Mechanical

18.8.A Tunnel

GORDON No comments, really. It worked excellently, and the equipment  
functioned properly. There was never any problem with the  
tunnel equipment. The probe, drogue, and hatch all worked as  
they were supposed to.

CONRAD I've got one comment, and I'm not sure you could improve on it.  
Everybody's aware of the water collection in the tunnel after  
LM jett. I got quite a shower bath, even though I had spent a  
great deal of time wiping up the water in the tunnel. I'm not  
sure that you ever get to all the water, but I thought that the  
Kleenex was not the most satisfactory thing in the world to  
wipe that tunnel down with, and I'm not sure that we shouldn't  
provide some kind of rag -- I don't know if you can do this in  
zero g -- and a bag that you can put the rag in and wring it  
out. We need something to mop out that tunnel with instead of  
winding up with a wet Kleenex.

We had to wipe off the main hatch, and then the glycol panel  
next to the commander's couch, left-hand side, caught large



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CONRAD amounts of water on it during the flight. I think we need to  
(CONT'D) work up some means of being able to mop up water rather than  
just using a Kleenex that's on board. I think we used at least  
a box and a half of Kleenex sponging up water.

#### 18.8.B Struts

GORDON The struts worked okay. We had no problem with them. They  
had been disconnected. The foot X-X struts were both dis-  
connected from the couches on occasion. There was never any  
problem with disconnecting or reengaging the struts. The  
locks on the main chutes were activated during entry, and there  
was never any problem with them. I guess that takes care of  
Command Module systems.

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19.0 LUNAR MODULE SYSTEMS OPERATIONS

19.1 Guidance and Navigation

19.1.A PGNS

19.1.A.1 Inertial

CONRAD The inertial platform was excellent. We had low drift rates; we never had any problems with it. We had problems with the AOT. Alignments went well. The previously noted anomaly on the rendezvous radar, which was low transmitter power output, didn't present a problem. We weren't at maximum ranges, and that's the only noted anomaly on the rendezvous radar.

19.1.A.4 Landing Radar

CONRAD The landing radar performed in an outstanding manner. We had landing radar at 41 000 feet and it worked perfectly. We've already talked about the only noted difference between the simulator and the landing radar — that's the fact that the velocity rate went up shortly after the altitude light, which is not in accordance with the simulator. I'm sure the velocity updating didn't take place until 2000 feet  $V_I$ , but the light went out. This is a slight difference that ought to be cleaned up in the simulator.

## 19.1.A.5 Computer Subsystem

CONRAD The computer subsystem worked in an outstanding manner. We mentioned two uncalled-for alarms which seemed to be part of the program, and they showed up in the command module also. So, I'm sure it's part of the software. The G&N controls and displays all operated in a normal manner, and the only noted anomaly was in landing. The PGNS display of horizontal and lateral velocity did not work; and this time I'm not exactly sure why. Al and I are convinced that we were not out of configuration switch-wise. I don't know what the problem was there. As far as the procedural data went, the checklists were correct. The G&N dictionary (what limited use it had) was correct.

## 19.1.B AGS

BEAN The AGS operated exactly as we hoped it would. The only anomaly I noticed was that several times when we did an alignment with PGNS, we would check it with the FDAI, and it would be exactly the same. Other times, maybe it would be 10 minutes later, it would be maybe a quarter of a degree down, so you could pitch, roll, or yaw and the balls would jump. We used a confirmed alignment, right after that, with a VERB 49 NOUN 20, and they wouldn't seem to change anything much, so after a while if they didn't line up perfectly each time, I don't know. All

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BEAN        the modes of operation seemed to work. I just discussed  
(CONT'D)    initialization. The AGS calibration and all the numbers were  
             well within limits. We then performed part of descent with  
             the AGS, twice, to see if we could get repeatable data, and  
             sure enough, the data were right with it the second time.

#### 19.1.B.4 Rendezvous Radar Navigation

BEAN        The problem of the AGS is that it takes too much manual work  
             on somebody's part, mainly the LMP's, to close the navigation  
             solutions. We did demonstrate, though, that if you do this  
             and take the time to input the range and range rate at  
             either 2- or 3-minute intervals, you can get a good solution.  
             But I don't think this is the way you want to have a backup  
             system in a spacecraft because it takes one man's complete  
             attention to do the job. There are better ways to do it. One  
             is the charts; I don't think the charts are what we want for  
             a later system. We certainly want some sort of an automatic  
             mechanical system that is better than what we have on board  
             now. I recommend using the charts, taking discrete data points,  
             and then installing the charts manually to operate the AGS in  
             the mode that they recommend. We gave the engine/no-engine  
             commands to the AGS. We always operated on the PGNS. The  
             electronics, the burns program, the controls, and displays  
             all worked exactly as advertised. We were able to monitor

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BEAN  
(CONT'D)

the DOI burn, and we also set up the AGS to monitor all the rendezvous burns. They seemed to perform properly each time. During ascent, I noticed that the AGS needles were in complete agreement with the PGNS, and I had the feeling if we had to use the AGS for ascent, it would perform properly. At that burnout, the residuals were about the same as the PGNS during burnout.

## 19.2 Propulsion

BEAN

The propulsion system operated as advertised. The simulator is an excellent training device. It seemed to me that the engine came up after start at about the same rate the simulator did, and it operated pretty much the same as the simulator.

### 19.2.A Descent

BEAN

The only thing that we noticed that was different was during descent. We actually got more RCS firings than the simulator gives you, but we were prepared for this because Neil had pointed it out. I don't recall the DOI burn ever firing an RCS thruster. It probably did, and we just didn't notice it. The rest of the operation of the descent engine was nominal. The venting of the descent engine was much like that in the simulator except that the venting took much longer than it did in the simulator. I don't know the exact time that it would

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BEAN  
(CONT'D)

be on the tapes because the ground gave us a call. I don't think it would hurt to modify the simulator so that it vents at about the same speed because it looks like that's what we're going to be doing now.

#### 19.2.B Ascent

BEAN

The ascent performed magnificently. There is no sound associated with it. As you lift off, there is a large bang as you separate the ascent and the descent stages, and then you just move rather rapidly as the ascent engine burns. It makes no noise. The ascent stage does a Dutch roll as it climbs out. It is not objectionable, and it actually feels very good as you are ascending. The RCS firing seems to be at about the same rate that you see in the simulator. There is quite a bit at first, then you pass through a period where there isn't any as the c.g. passes near the thrust vector; as it goes back out the other side, you start seeing more and more RCS firing. I think waiting until 200 ft/sec to open the main shutoff valves and close the ascent interconnects is cutting it a little bit close. When you're up in that air, you're getting fairly light in that you are accelerating fairly rapidly, and if I had to do it again, I think I would recommend that we open the shutoff valves at about 300 ft/sec to go and close the ascent feeds. You're not going to use much more RCS. You have plenty of it anyway,

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[REDACTED]

BEAN and you wouldn't run into any problems such as getting a sticky  
(CONT'D) interconnect or having something else occur. There just doesn't  
seem to be any reason to wait until 200 ft/sec to go. You have  
plenty of RCS.

CONRAD I feel that I have trapped myself by getting interested in Al's  
problem; but, by the same token, the engine redundancy is such  
that if the engine has been burning that well for 7 minutes, I  
think you should get the ascent ENGINE ARM switch off in suf-  
ficient time really to monitor shutdown. It was not apparent  
to me in the simulator that the vehicle was accelerating as  
rapidly as it was; and, for that reason, I got involved; I did  
overburn. That is my fault, but I feel that anytime you are  
within 400 ft/sec to go, you are well in an RCS capability, and  
inadvertent shutdown is not going to do anything to you. You  
could relight the engine for that matter. I have a suspicion  
that the ground can check to see that all those relays are  
closed and give you a GO. The ground can verify that you have  
normal arming through the normal system, which is something  
that we never thought of; you should get that ascent ENGINE ARM  
switch off along with the main shutoff valve in sufficient time  
to handle sticky barber pole indications or to psych out a  
problem with the ascent feeds or main shutouts. You should have  
sufficient time to get that ENGINE ARM switch off and get in AUTO  
shutdown.

[REDACTED]

### 19.3 Reaction Control System

#### 19.3.A Attitude Control Modes

BEAN As far as the reaction control system went, the attitude control modes, we did no flying in AGS. I didn't feel that it was necessary. It wasn't going to buy us anything on the flight. I felt that the simulator training, flying the LLTV, and everything else gave me sufficient knowledge of the AGS system. Other than checking it out to verify that it worked, we never flew in AGS, and I don't see that that's necessary. I used the most efficient system that I had at my means, and I think that is the way you should go.

#### 19.3.B Translation Control

BEAN Translation control was excellent through making burns and trimming. It was adequate stationkeeping in the little bit that I did on the command module after rendezvous with the ascent stage. All control modes, ascent and descent stage, I thought, were excellent.

### 19.4 Electrical Power System

BEAN The batteries performed just as advertised with the exception of battery 5, which didn't seem to want to pick up the load of the system engineers bus when we put it on the line just before

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BEAN  
(CONT'D)

PDI. One other point on the batteries — we went into the LM early, powered up, took a look at the erasable memory, and gave the dump to the ground so that we could see if there were any effects of the lightning strike. As a result, the batteries were a little bit low when we powered them up DOI day, but it didn't seem to affect us other than that we went to high taps almost immediately after switchover from the command module. The switchover was nominal and everything else about the electrical power system was nominal. The dc monitor operated properly as did the ac monitor.


#### 19.4.A.4 Power Transfer CSM/LM/CSM

BEAN The CSM/LM/CSM power transfer was completely nominal the three times that we did it.

#### 19.4.A.5 Abort Stage Configuration

BEAN The batteries operated properly. We didn't notice any transients when we deadfaced the descent stage. The six main buses operated properly. The amperage on them was just about what we saw in the simulator. We never knew for a minute that anything unusual was taking place on the main buses.

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19.4.A.7 Deadfacing

BEAN Deadfacing was completely nominal and the only thing we saw was the talkback going barber pole.


## 19.4.B Explosive Devices


BEAN The explosive devices, except for one, operated properly. We checked out both systems — one with deploying the gear and the other with activating the RCS — and it looked like both ED systems were operating in the proper manner.

## 19.4.C Lighting

## 19.4.C.1 Interior

BEAN The internal lighting was satisfactory. The only difference we noticed was the previously reported fact that the switch on the upper hatch turns out the floodlights. When we closed the upper hatch, it must have been out of rig. When we closed the upper hatch, after exiting the first time, the interior lights did not go out. We eliminated this by pulling the circuit breaker on panel 16. With that exception, everything was nominal.




  
19.4.C.2 Exterior Lights

BEAN The exterior lights did not operate as well as we had hoped. By that, I mean the track light operated properly when we undocked because it was checked by Dick in the command module, and seemed to operate properly during descent; that is, the part of descent during which we had it on. The lights operated partially during ascent and the command module came up, right after CDH, and asked us if we had our light on, and if we were pointing the wrong direction. We tried to verify that the light was on by looking out the window, but I don't believe you can do that. We did ask the people on the ground. They indicated that the power was nominal for the light being on. We cycled the light in the circuit breaker, and it showed that when we turned the light on, the indicator light went off. When we finally rendezvoused, they indicated that the light was off. We pulled the circuit breaker, I guess. For some reason, that light had failed right around CDH.

## 19.5 Environmental Control System

## 19.5.A Oxygen and Cabin Pressure

BEAN Oxygen and cabin pressure operated nominally the whole mission. We didn't have any trouble during the several cabin repressurizations, depressurizations and repressurizations that we



BEAN  
(CONT'D)

went through. The pressure came out very rapidly, and stabilized. The repressurization portion of the system was nominal in all respects. The one caution here is to be aware of it when you switch from REPRESS, AUTO, to CLOSE and back again. You're going to get a very loud bang, and you'll want to be sure to let the crewmen in the command module know when this is taking place.

#### 19.5.B The Cabin Atmospheres

BEAN

Cabin atmosphere from activation planning was excellent. When we got back inside the first time, in one-sixth g, the atmosphere remained that way although we brought in quite a lot of dust. The same with the second time and the cabin jettison depressurization. Once we got into orbit in zero g, there was a lot of dust and dirt floating around the cabin, and we chose to remain in our suit loops as much as possible because of all this dirt, dust, and debris that was floating around. When we finally got back to the command module and docked with the CSM, we wanted to figure a way to keep this dust and dirt from filling the command module, but we weren't really sure how to do that. I think procedures should be developed so that a positive flow of air is maintained from the command module to the LM, not necessarily to keep lunar bugs out of the command module, but to keep all this dust and dirt out of the command

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(CONT'D)

module. We were plagued by it when we finally did get back into the command module. Pete and I had to remove our hoses so that we could use them for vacuum cleaners. Incidentally, they didn't perform too well. There wasn't enough vacuum there. We had to remove our helmets from our suits, to keep our eyes from burning and our noses from inhaling these small particles floating around; we just left our helmets sitting on the tops of our heads. This isn't a very good configuration to be in, but we had no other alternatives at the time. I think this is completely unsatisfactory, and there must be some way to clean up that cabin atmosphere so that you can work in a good, acceptable environment when you do get back to the command module. It's possible that you could get up and dock with the command module before you open the upper hatch, dump the cabin down to 3-1/2 psi, and hope it doesn't blow a lot of the dirt and debris out of there, and then slowly fill the cabin up in the command module and that will keep it filled. There ought to be some way to do this job.

## 19.5.C Water Supply

BEAN

Water supply in the LM was good, cold, and adequately supplied throughout the whole flight.

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## 19.5.D Water Glycol

BEAN It proved nominal the whole flight. The ECS, the glycol temperatures remained normal throughout the flight.

## 19.5.E Suit Circuit

BEAN The suit circuit was nominal.

CONRAD This is probably the same problem that Neil and Buzz had. I continually got water in my suit down on the lunar surface. This was written up on the Apollo 11 anomaly reports as their not having their water separators in the A position. We double checked the water separators numerous times and it must have something to do with the length of the Commander's hose condensing water out in the system because Al never got it. But when I disconnected my hose several times we got 2 to 3 ounces of water out my hose. It came out in big bubbles, balls of water. And so there was no doubt that I was getting water in my suit, and I think there's some kind of design deficiency. We need another moisture trap or something in the system because it's very uncomfortable. I got enough water in the feet of my suit so that it wet my feet. I never could drain water out of the hose. I used the recommended procedures passed up from the ground. I tried to drain the hoses and could never get any water to drain out of them, but then after I ran them

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[REDACTED]

CONRAD connected to my suit for a while, I started feeling water again.  
(CONT'D)

During the night, I only used the hoses intermittently to dry out my suit from my normal sweat, as I mentioned earlier. The next day when I hooked up on the hoses preparatory to EVA and after the EVA at ascent I didn't notice any more water. Somewhere in there, we got the water out of the system and it stopped doing it. It was only the first day up until our sleep period on the lunar surface that I had any trouble with water. But I think that this very definitely is a design deficiency and not improper operation of the ECS system, as it was cast off in Apollo 11 and something should be done about it.

#### 19.6 Telecommunications

BEAN We had no difficulty in monitoring the telecommunications. The S-band angles and the signal strength provided a good index of what was going on as far as the ground COMM was concerned. The VHF was completely satisfactory during descent. During ascent, we've already covered. The operation of the S-band high gain antenna was nominal. The only thing that I noticed that perhaps should be reviewed and modified was when we were in the AGS CAL attitude just before we were going to an attitude where Dick could track the landmarks just before undocking for DOI. I had my antenna in AUTO TRACK and when the thrusters fired, it would make it move around a good bit and

[REDACTED]

BEAN  
(CONT'D)

the opportunity existed there for the antenna to lock on to a side lobe (which it didn't do), but it's probable that you would want to go to OMNI there, put the high gain antenna in SLEW and find the optimum attitude to prevent straining the antenna drive during this period. I really didn't see any reason to be in high gain at that time. The S-band was beautiful the whole flight, particularly on the lunar surface. It seemed as if Houston were right there on the edge of the mare with us. It was fantastic. The VHF was good in descent. We both covered the VHF during ascent; namely, that it did not work at all. It sounded as if our receiver were being overdriven, similar to having a transmitter right next to your antenna. It kind of garbled it and overdrives it. In the LM, we tried switching antennas; we tried adjusting the A and the B squelch at all possible settings and it never did have any effect at all. We didn't want to change COMM modes because we wanted VHF ranging for Dick and we just kind of muddled through. It was not acceptable and that's one of the main things of the flight that should be fixed. The audio centers operated properly. We had no problem with them. The flight recorders worked okay. We operated per the flight plan and, at the end of the EVA's, we checked to see whether the ground estimated if there was any recording time left. There was 10 hours total; and we operated in a CONTINUOUS mode for descent and then VOX mode during EVA's,



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(CONT'D)

because the EVA's were rather long. We suspected that the recorder might run out of tape before we finished the rendezvous. Whether it did or not, we don't know. Because the EVA's are going to get a little longer, there's probably going to be a desire to operate the recorders in a different mode during descent and ascent; otherwise, you're always going to exceed the capability of the recorder.

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20.0 MISCELLANEOUS SYSTEMS, FLIGHT  
EQUIPMENT, AND GFE

20.1 Cabin Lighting System and Controls

CONRAD I presume this is for both spacecraft. We found the cabin lighting adequate in the LM, and as far as I was concerned, I found the lighting in the command module adequate. There were only one or two occasions that I remember that we had to use the flashlight for something down in the back end of the spacecraft. The lighting wasn't inadequate enough to warrant any changes, do you think?

GORDON No, it was perfectly adequate. In fact, I liked the lighting in there, but I have one comment on its use. I noticed that none of us used the EL lighting by itself. I think the EL lighting is a little harsh and we always did subdue it a little bit. We always used the EL lighting, of course, for the MDC, but we also used the floodlights in conjunction with it. It tended to soften up the whole panel.

CONRAD I want to make another comment about the EL lighting. When I set my watches a couple of times at night with all floodlights out, I noticed that the EL lighting is adequate to read all that it's illuminating. Unfortunately, it doesn't illuminate any of the switches, and I would hesitate to ever throw a switch in there at night with the EL lighting only. I always wanted

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CONRAD the floodlights up enough so that I could physically see where  
(CONT'D) the switches were.

### 20.3 Event Timers and Controls

CONRAD About an hour or two before lift-off, we noticed the tuning fork of the main MDC mission timer in the command module was intermittent. Finally, we all concluded that something was wrong with the timer. Nobody felt that it was a big deal, that it was the timer and not the CTU; with that, we launched. The next thing we noticed about the timer was that we thought we'd broken it. There were two cracks, one in the right corner and one in the left corner. In searching our memory, we all remembered that there has been a history of the faces of these timers cracking. If I'm not mistaken, it was in the LM, though. I thought it was the LM mission timer that cracked, and as a matter of fact, ours cracked and was replaced in LM-6. Anyway, these timers are all the same, I believe. We had no trouble with the mission timer in the LM, and the mission timer in the command module continually lost time at a fairly high rate. After we'd sleep 8 hours, the timer would be off over 5 minutes. We never set the timer on the MDC as I remember, and at the end of the flight, it was off 2 or 3 seconds. That clock worked fine.

The event timer in the command module never had a problem. It

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CONRAD worked in an outstanding manner. I've heard that the command (CONT'D) module timers have been great before, and we never had any trouble with that one.

GORDON What about after launch when it reset to zero after the first lightning strike?

CONRAD No, it reset to 23 minutes and 26 seconds or something; how it got there, I don't know.

GORDON Really? I thought it went to zero and stopped.

CONRAD No. It went to 23 minutes and something, and I finally reset it to zero.

GORDON Oh, okay.

CONRAD It had some horrendous number, like 23, on it. The mission timer in the LM worked in an outstanding manner. We never had any trouble with it at all. We never reset it. It worked fine. It ran all the way through landing and all the time we were on the lunar surface. It was a good clock. The event timer in the LM worked in a fine manner. We never had any problems with it either. I think that's about it for clocks.

#### 20.4 Crew Compartment Configuration

CONRAD As far as the command module crew compartment configuration, I thought the stowage was outstanding. I can't really think

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CONRAD  
(CONT'D)

of any other comments on that, can you? I also thought the stowage in the LM was excellent. All fittings worked correctly; the only thing I noticed was that Al used to do battle with the mounting of the 16-mm camera over the window, and I'm not sure if that just wasn't because it was hard to reach.

#### 20.5 Mirrors

CONRAD We never used the mirrors in the LM. In the command module, we used the mirrors for shaving, mainly.

#### 20.6 Clothing and Related Equipment

CONRAD I'd like to make several comments on the clothing and related equipment. First, I understand that people are negotiating for a single-piece flying suit versus the one that we have right now, and I think that's a mistake. We found several different temperature modes, depending on whether we were in PTC or not. We spent much of the operation wearing only our two-piece pants, long underwear, and the outer jacket off. When you have to go to the john, it seemed a lot easier to get out of the two-piece operation. I feel that the two-piece suit is better, and I think that is the general feeling of all of us. The two-piece suit affords you the opportunity of changing your own temperature a little by being able to take off your jacket. We operated quite a bit with the jacket off

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CONRAD  
(CONT'D)

and the pants on. The pants were handy because of the big pockets; we carried a lot of gear in those pockets. The zippers were great; we carried our dosimeters, our toothbrushes, our spoons, and this type of equipment in there.

Now, the other thing is there's no doubt in my mind that we ought to do something about all this electrical mishmash. A continuous source of irritation to me was the hookup of the lightweight headset to the gigantic connector, the stiffness of the equipment, and the fact that it didn't bend in the right directions for a normal hookup, even when those electrical connectors were form-fitted.

GORDON

I think we need another set of inflight coveralls. The one set, after a few days, gets so clogged with urine and so dirty that you just hate to put the thing back on. We also need more towels.

It would be advantageous to include a second set of inflight coveralls to go along with the second set of constant-wear garments. It is refreshing to put on that clean constant-wear garment. I think we all got into those after the LM rendezvous was completed and after we had a chance to clean up a little bit. All of us enjoyed bathing, and we certainly enjoyed shaving. We each shaved three or four times during the mission.

[REDACTED]

GORDON  
(CONT'D)

It's kind of a highlight during the day when you're in a grubby environment and you can't get clean. In this regard, the inadequacy of towels on board the spacecraft was acutely noted by all crewmembers. In fact, we didn't even have enough towels for one day. We used the towels for several purposes; one purpose was to clean up the urine that was always in the couch areas, on the suits, and on the GFE urine dispenser. It is our recommendation that at least two towels per day be afforded each man.

There's no particular problem getting this on board for stowage. We found that once a day we liked to strip down. We'd strip down completely and use the hot water with those towels that we did have on board. We'd completely sponge down and give ourselves a bath. I don't think enough can be said for this type of thing and for the way you feel. We wanted to shave and bathe daily, on a regular basis, but we simply didn't have the equipment on board to do it. There is no reason why this equipment can't be provided.

#### 20.7 BIOMED Harness

CONRAD I had a reaction to the blue jelly which I'd never had before. I think everybody had a little bit of a reaction, which is kind of unusual. I know Dick never reacted before, and I

[REDACTED]

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CONRAD didn't. Maybe there was something wrong with that load of  
(CONT'D) jelly, for all I know.

GORDON I had a very slight reaction or itching on the left axillary  
sensor. It really didn't bother me.

#### 20.8 Pressure Garments and Connecting Equipment

CONRAD Our pressure suits were okay. As far as I know, all the  
connecting equipment was okay. I made one comment about my  
suit not fitting right, which was my own fault. I should  
have insisted on fitting it in a LCG.

#### 20.9 Couches

CONRAD The couches were good.

GORDON Couches were no particular problem; the mechanisms all worked  
properly, functioned properly. The center couch was lowered,  
and the X-X struts were disconnected and connected again. The  
mechanical functions of the couches all worked satisfactorily.

#### 20.10 Restraints

GORDON All restraint systems worked as advertised; there was no par-  
ticular problem with them. In the command module, they were  
never in the way.

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### 20.11 Flight Data File

GORDON The flight data file was complete, more than adequate. We all thought that the inflight data file for both vehicles was in excellent condition, with two exceptions. Those exceptions were the P30 PAD's and the lunar surface maps.

### 20.12 Inflight Tool Set

GORDON The inflight tool set was never used. In fact, it wasn't even unstowed; I guess it was at one time. We used tool E all the time. It was the only tool that we really used. Al used a crescent wrench one time to pry the finger brackets for the window covers. Those things just didn't fit at all in those windows. They were a constant source of irritation every time we put them up or take them down. This has been a constant gripe for almost every flight we've had in the command module. Those things have been fitted on the ground; they've been fitted in altitude chambers, and when you get them in flight, they can hardly be put in place. There must be something that either changes their configuration, such as the foam padding behind them or whatever it is, so that we can barely get those covers on. The ones that were particularly bad were the covers for windows 1 and 5. Other than that, the inflight tool set was never used. It was kept in its stowage place throughout the flight.

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### 20.13 Data Collection

GORDON There was plenty of space to write things. We used the flight plan almost exclusively, as it was the best place to record data that we needed, besides the forms and charts that we had for that specific purpose.

### 20.14 Thermal Control of Spacecraft

GORDON Thermal control seemed to be generally okay. We did notice at night that it would cool off, warm up, cool off, warm up, and so forth. I guess this was basically because of the manner in which we conducted PTC in that there was occasion where one side of the spacecraft would get cold and then warm. We did notice this very instant temperature change on our bodily comfort as well. It was no big deal, but it was noticeable. Our configuration for sleeping took care of this problem. We generally left our clothes on and used the sleeping bag. However, when we powered down the spacecraft, it did seem to get a little colder than normal. In conjunction with this, the moisture going out was no problem at all. The amount of moisture coming back with the LM off of the nose of the command module tunnel area, the hatches, and the side walls was considerable.

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20.15 Camera Equipment

GORDON In most respects, the only thing we can say about the camera equipment is that it was adequate and excellent. It seemed to operate properly. None of the camera equipment in the command module gave us any problems, with the exception of one magazine, magazine S, that came apart. It's our recommendation that, once magazines are loaded, they should be taped, or at least the locking mechanism on the magazines be taped, so that they cannot inadvertently be actuated during flight, possibly with the loss of some very expensive pictures. The flight plan had procedures for photographing the ionization layer and chute deployment with the 16-mm DAC in the right-hand rendezvous window. There's nothing wrong with this, of course. We left it up throughout the entry and landing, and this is where we got into a little trouble. It actually came off during impact and hit Al over the right eye. We had looked at it; questioned it; and without really thinking too deeply, we decided that if it could stand a reentry, it could probably stand the impact. It was our mistake; we should have removed it.

If anybody ever has any intention of using that DAC for pictures during rendezvous or during high-g loads, reentry, or landing, they had best remove it before touchdown.

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BEAN The LM camera equipment, 16-mm specifically, did not operate like it was supposed to. We turned it on prior to descent and it worked all the way through descent; I noticed it was still running after landing. It worked all the time we used it for EVA pictures. Every time I got back in the LM after the EVA, the camera was still running and had been for 3 or 4 hours, which is the normal mode.

The time that it did fail was during launch. I turned it on approximately 1-1/2 minutes prior to lift-off. Then, I noticed approximately 3 minutes after lift-off that the camera had quit running and that the little ball on the side, indicating film usage, had hardly moved. So, I feel pretty sure that we didn't get near as many photographs of the lift-off as we wanted. I tried to start the camera again. It started, ran for approximately 10 seconds, and stopped again. We brought the camera back for evaluation, but it doesn't take very much of a failure mode in one of those cameras to really blow some very, very good movies that you go a long way to get. I think that's just what happened on the lift-off.

We're going to have to do something about those cameras so they work 100-percent of the time instead of almost 100-percent of the time. On the two 70-mm cameras, we've already discussed the fact that the handle on one of them broke - not actually the

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BEAN  
(CONT'D)

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handle, but the nut that holds the handle to the camera pretty straight forward. The thing that worried me most about the cameras was that we were getting a lot of dust on them. I was afraid we were getting dust on the lens, and we had no means whatsoever to clean it off. I think it would be definitely desirable to have a whiskbroom on the MESA. We could use the whiskbroom to dust off the suits, and perhaps the back of the broom could have something so that you could use to dust off the lens of the camera. I suspect that as missions get longer, we're going to get some pretty good dust coverings on the lens of the cameras. Such a dust covering is going to degrade the photographs unless we have some means of cleaning the camera lens off, which we did not have in this case.

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21.0 VISUAL SIGHTINGS

## 21.1 Countdown

CONRAD There were no visual sightings during countdown. We mentioned the lightning. We also mentioned the water during the count-down between the BPC and the spacecraft.

## 21.2 Powered Flight


CONRAD During the powered flight, we mentioned the first lightning strike. Apparently we didn't see the second one.

## 21.3 Earth Orbit

CONRAD In Earth orbit, nothing unusual; nothing in translunar. We want to talk about the solar eclipse and the fact that we all were caught with our pants down. We should have had good camera settings and film available for that because it was certainly a spectacular sight.

## 21.4 Translunar and Trans-Earth Flight

GORDON I feel very strongly about this. I think that someone, the crew as much as anyone, really dropped the ball on this. We knew this was going to occur before flight and we mentioned it. The people who are interested in this type of thing, if there was any interest in it, were very remiss in not planning further



[REDACTED]

GORDON in this particular event. To us, it was one of the most spectacular things we saw throughout the entire flight. I'm sure there's obviously some scientific value in this type of thing. However, the reaction in this regard was virtually nil. In conjunction with this the response of the people on the ground, at the time that we reported this, was extremely poor. The crew was left on their own entirely to come up with guesses on camera settings, films, and film speeds. Repeated inquiries to the ground took a considerable length of time before any information was gotten out of the ground at all as to what type of film, what exposure, and what time settings to use on the cameras. It was a very poorly handled phenomenon we all knew about before flight.

#### 21.5 Lunar Orbit

CONRAD I'm sure in the scientific debriefing, if there are specific questions we're well prepared to answer them. I don't think that we saw anything unusual in lunar orbit. One thing that I noticed, I mentioned over the air already, were the black rock slides and the very white craters only appearing in a specific area. That's about the only one I can think of.

BEAN The only thing I saw was practically near the site area, and it was the only place on the Moon that I saw anything that

[REDACTED]

BEAN (CONT'D) looked like it, was a different color. This was over in the Sea of Vapors. There, many of the craters appeared to be black surface near the rims of the craters. Out in that Sea, in several places, it looked, from a distance, like a black field covered with sort of a white snow. This was the only place I saw anything other than the nominal basic, either light tans or grays or whites, or whatever color you want to call the Moon, depending on the Sun angle. The only obvious difference in colors was the Sea of Vapors and the slides that Pete pointed out.

21.6 ENTRY

CONRAD I think we saw the normal sights on entry, except for the spectacular moonset. It was a full Moon. And we commented on that.

21.7 LANDING AND RECOVERY

CONRAD We saw everything we expected to see on landing and recover.





22.0 PREMISSION PLANNING

CONRAD The mission plan was followed.

22.1 Mission Plan

CONRAD There was never any question about the mission plan.

22.2 Flight Plan

CONRAD I'd like to compliment the flight planning people. We saw no mistakes in flight. Chuck Stough and all his people did an outstanding job on it.

GORDON The flight plan is one of the better ones I've seen, as far as information in it for the crew. We asked for a lot of it ourselves and the flight planning people responded in a very unique and unusual manner. They were excellent to work with. They did an outstanding job in response to our inquiries and questions during the flight. I thought those people did an outstanding job for us on this flight.

22.3 Spacecraft Changes And Procedures Changes

CONRAD There were no late spacecraft changes that we weren't aware of and didn't agree with. The only one that I can think of is on the TV camera, and that was a drastic mistake. We did do battle with our own people, and those of you that I did battle with

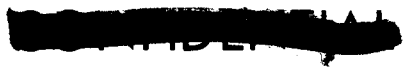
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CONRAD know who they are, to get the TV camera out of hock and you  
(CONT'D) wouldn't let us use it. I think that's partially responsible  
for our foul up. We never saw any drawings of that camera, or  
had the vaguest idea of what it was going to look like. Maybe  
we would have picked up this F-stop thing sooner. Let's be  
smarter on the next one.

#### 22.4 Mission Rules

CONRAD No comments on the mission rules. We had our day in court with  
everybody. We all concluded, to our mutual satisfaction, that  
the mission rules were all right. Everybody was treated fairly  
and I'm thinking in terms of the changes to the descent rules  
with which we worked.



23.0 MISSION CONTROL

23.1 GO/NO-GO'S

CONRAD GO/NO GO'S all came as advertised. They were preplanned and given on time.

23.2 UPDATES

CONRAD The same can be said of the updates.

23.3 Consumables

CONRAD My only comment is that we got several LM RCS consumable updates on the lunar surface; these were really meaningless, because we weren't using the RCS system.

CONRAD We didn't get SPS fuel updates because we didn't ask for them. The one quantity that we asked for was the predicted helium values after the first big burn, the LOI burn. You know exactly where you are supposed to stand, because these had been discussed in advance. The quantity was passed up when requested. I think it was real good. There wasn't any comments on DPS other than which fuel gauge was to be the most accurate one for descent. That's something we practiced in SIM's and it came out fine. They called low fuel, just as advertised. I think everything was fine on that.

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#### 23.4 Flight Plan Changes

CONRAD There were no flight plan changes before flight that we weren't aware of and agreed with; very few changes were made.

#### 23.5 Real-Time Changes

CONRAD The real-time changes were very few in flight and were necessary.

GORDON I have a comment on the flight plan changes. It's always been my observation that daily flight plan updates usually came to the crew in the form of questions and usually these things were nominally written and carried out in the flight plan. It was our agreement with the CAPCOMM's and we assured FAO that we would knock off these so-called chit-chat sessions in the morning. If it appeared in the flight plan and it was nominal, that's what we were going to use and we didn't want to hear this information repeated. This suggestion or request was carried out quite well by the ground and our flight plan updates were those that were absolutely necessary for the conduct of the flight. I guess that covers the real-time changes.

#### 23.6 COMMUNICATIONS

GORDON We talked about communications enough and most of the time they were excellent.

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24.0 TRAINING

24.1 CMS

GORDON In a general statement, it was excellent. I don't think we were wanting in any particular area to simulate any particular phase in the mission that we felt was necessary prior to flight that the people in the CMS didn't come up with. They are extremely cooperative. They are capable and talented instructors, and they are easy to work with. They responded to our requests in all cases. I think the ability of the CMS to support lunar missions of this type is excellent. As far as the visual is concerned, it is excellent. The star ball and the MEP are generally good. I would suggest that there are two areas in the command module simulator that could be improved. One of these is the P22. Landmark tracking needs improvement, and my suggestion is that they take the maps that are provided to the crew well before flight of the specific landmarks that you are going to be working with and make slides of these landmarks. You can use these in the actual mission SIM's so that the P22's you are training with will be exactly those which you will see in lunar orbit. That area got straightened out pretty well throughout the training cycle; P23 is the only anomaly in the CMS that is constrained somewhat in time and to Earth radius. There is some slight anomaly

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GORDON (CONT'D) in what you can see, as far as the horizon-star relationships are concerned. By and large, I guess it's pretty good. The docking was okay. We insisted that storage and configuration be up to date early in the training cycle. Larry Thompson and his people did an outstanding job of keeping the crew station in what we would consider flight configuration. Availability of the CMS was excellent in all respects. There was more CMS time available than I needed, required, or wanted. The ability of those people to run integrated with the IMS was outstanding, and we never missed a single mission SIM throughout the training program. It was excellent in all regards.

CONRAD I go along with the CMS training. The instructors all did an outstanding job.

#### 24.2 IMS

CONRAD The same goes for the IMS. The mission capability was complete. The visual adequacy of the L&A was outstanding, and as far as the MEP's went, forget it. They never worked, and they are not needed. In the docking end, although I didn't practice much docking in the IMS, it always seemed to work all right when you wanted to use it. The crew station was good and exactly like IM-6. They did a good job on the configuration. The availability was outstanding.

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### 24.3 CMS/LMS INTEGRATED SIMULATION

CONRAD The CMS-LMS integrated simulations, we never dropped a one. My hat's off to the people who moved the stuff in Houston. The SIM software went over to Building 45. I was worried about that. It came back on the line in good shape, and we never missed a SIM. The same for the simulator people.

### 24.4 SIMULATED NETWORK SIMULATIONS


CONRAD The SIM NET SIM's, I can only say that my opinion is still the same. The more of them you fly, the better the mission; and we flew plenty.

### 24.5 DCPS

CONRAD The DCPS is a good training device. Six to 8 hours, and that's all that's necessary. Dick and I used it normally together, so that we worked as a team.

### 24.6 LMPS

CONRAD I had no occasion to use the LMPS, although Al did run AGS rendezvous, and it ran okay. Due to our previous training on the D-mission, we didn't feel it necessary to run PGNS on the LMPS.





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## 24.7 CMPS

CONRAD That's the same feelings Dick and I have on running the CMPS.

## 24.8 Centrifuge

CONRAD I think the centrifuge training was a good run and worth the day we spent in it.

## 24.9 TDS

CONRAD As far as I am concerned, the TDS is a waste of time. There's no need for it anymore. I think that if you have to dock the LM yourself you're in serious trouble and it's not that big a task. Perhaps an hour or two is all that is needed in the TDS.

## 24.11 NR Evaluator and GAEC FMES

CONRAD The North American evaluator and the GAEC FMES are okay for a day or two to look at burns. Dick looked at some rendezvous, some tracking, and some burn information early in the game. Al and I waited until late in the game during our software check-out, then went up and flew DOI, PDI, and some ascents on the FMES. I wanted to see if there was any difference in the software, the computer lights, or anything else versus the LMS. There were a few minor points that we picked up.

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## 24.12 Egress Training

CONRAD If I go through that rubber room one more time, I'm going to go out of my mind. You can forget that one. Once is enough. We have more time in the rubber room than we do in anything else. If you have a crew that hasn't been through egress training, you ought to run them through the tank once, and that's enough. Gulf egress is always a good training exercise just prior to the mission, and I don't disagree with that one. The mockup egress at the Cape would be a good exercise if we had decent COMM and it could be run correctly. The COMM is terrible. The whole thing needs to be updated, and somebody needs to pay some more attention to it.

## 24.13 Spacecraft Fire Training

CONRAD Spacecraft fire training is worth it one time around. We had 1 hour, and that's plenty.

## 24.14 Planetarium

CONRAD We didn't use it because of our D-mission training.

## 24.15 MIT

CONRAD The MIT operation, if it is up to speed; their simulator star ball does the job just fine. We held the G&N briefings at the

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CONRAD Cape and they were all right. Every once in a while, someone (CONT'D) would get off on a long-winded trail that wasn't necessary, but I think they are improving all the time.

#### 24.16 SYSTEMS BRIEFINGS

CONRAD We held systems briefings to an absolute minimum. Again, due to our D-mission training, all we wanted were the differences between LM-3/CSM-104 and 108/LM-6.

#### 24.17 LUNAR SURFACE TRAINING

CONRAD Now we get to lunar surface training. I trained on the one-sixth-g pogo, and I trained one-sixth g in the KC135. I thought these were excellent training devices for operating rock boxes and all our equipment one time around. As far as one-sixth g goes in the WIF, forget it. I think that's a waste of time, and it doesn't do the job. I think the WIF's okay for your zero-g egress training and practice, and that's about all I'd do on the WIF.

BEAN A couple of real good things to run through about twice and towards the end of the mission when you want to see what it's like is the mobile pogo which is a very good representation of walking around on the lunar surface. The mobile pogo lacks Z-axis freedom, and that ought to be fixed because it tends to

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BEAN (CONT'D) either tow you or drag you, and that's unacceptable. Another drawback of the mobile pogo is it doesn't have any uneven ground, and it's pretty easy to move around on the flat concrete. Those two changes ought to be made. The one in the centrifuge is quite a bit better. In particular, the rig that you get into that supports the weight of the backpack and you at one-sixth g is better than the mobile pogo. Maybe mobile pogo ought to take a look and see if they can adapt it? The ground over there at the centrifuge ought to be changed to be more representative of the lunar surface. But in either case, they are good training and I think they let you learn your normal pace. I noticed that I got on a nominal walking pace very rapidly once I got on the Moon. I was surprised how representative this simulation was.

CONRAD I can't say enough about the one-g walkthrough suited exercises. I feel that the crew, the suit technicians, and the lunar surface operations group working through Joe Roberts and Ed Gibson put together an outstanding training program for us. They spent a lot of time suited, as we did, and it's a direct contribution to the success on the lunar surface. Field trips were a boom. I want to compliment Uel Clanton and his troops on well-organized field trips. I don't think that we wasted any time. I think they learned, and I think we learned because we

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CONRAD insisted on using our normal lunar surface tools and not make (CONT'D) them straight geology trips. I think there was a little bit of education on both parts. I also want to compliment the Flagstaff troops through Al Chedister and Thor Carlstrom for all the maps they put together for us late in the game. They really came through, and this was real fine. I think everybody that's going to do lunar surface operation needs an actual run on the PLSS in the SESL. I know you've cleaned up the 8-foot chamber business and you do all this in the SESL now, and I think that's a good refresher for anybody. It gives you a chance to exercise your gear in a vacuum under heat conditions, and I think it's well worth the exercise.

#### 24.18 CONTINGENCY EVA TRAINING

CONRAD Contingency EVA training, did not use the KC135. We did use the WIF, which was satisfactory, and we did one-g walkthroughs. We may not have shown too much of this on our training records, but remember, we already had gone through this complete exercise once in D-mission.

#### 24.19 MOCKUPS AND STOWAGE TRAINING EQUIPMENT

CONRAD I thought our mockups were in excellent shape. The support that we had at the Cape from Houston and the Cape on our LM mockup was outstanding for the lunar surface operations.

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## 24.20 PHOTOGRAPHY AND CAMERA TRAINING EQUIPMENT

CONRAD We had cameras, and I feel we had the necessary equipment. We had enough time on that equipment to take it into the simulators and used it a little bit plus the lunar surface operations.

## 24.21 LUNAR SURFACE EXPERIMENT TRAINING

CONRAD Lunar surface experiments training was satisfactory. The ALSEP training package did its job, and I think we learned a great deal from it.

## 24.22 LUNAR LANDING

CONRAD I can't say enough for the LLTV. I really feel that that was the real frosting on the cake. It made me feel a lot better flying around up there on the Moon. I think the IMS does an outstanding job and where it breaks down in the last couple hundred feet, the LLTV fills in. It also gives you a chance to fly dynamically a vehicle that flies similar to the LM. I feel that the night flight up at Langley was worthwhile in the LLRF.

## 24.23 GENERAL SUPPORT

CONRAD All our general support procedures, suits, checklists, and onboard data went well. I think everybody did his job. I also feel that the new procedures in handling the checklist, which we endeavored to implement and stick to, worked well. We had a few glitches in the beginning, but I think it's a very satisfactory procedure. I want to compliment the boys at the Cape that handled that data for us, the simulator fellows, Bob Pierson, Frank Hughes, and Glenn Parker, in particular.

## 24.24 PLANNING OF TRAINING AND TRAINING PROGRAM

CONRAD I don't have anything to say about the planning and training; the flight speaks for itself.

BEAN I think we ought to get regular TV to use for all the rest of the flights with a little monitor on it and use it inside and out, and I think by doing so we'll end up controlling the TV a lot better.

CONRAD Yes. I'm afraid we let that one slip down the crack.

[REDACTED]

25.0 MEDICAL AND FOOD

25.1 PREFLIGHT

25.1.A Preventive Medical Procedures

CONRAD Preventive medicine procedures were, as far as we were concerned, fine when we needed them.

25.1.B Medical Care

CONRAD We really didn't need that much medical care, but when we needed it the doctors were there.

25.1.C Time for Exercise, Rest, and Sleep

CONRAD We had plenty of time for exercise, rest, and sleep.

25.1.D Medical Briefing

CONRAD The medical briefing was okay.

25.1.E Eating Habits and Amount of Food Consumption  
for F-5 + F-0

CONRAD I don't think any of us changed our normal habits except we took the Dulcolax 3 days before the flight. Everybody went for the head the third day out on the flight and everybody but myself went two more times, right? Both you guys went 2 more

[REDACTED]



**C [REDACTED]**

CONRAD times on the flight on about the 8th and 9th day, was it? I  
(CONT'D) didn't, but it didn't cause me any discomfort and I think that  
was adequate.

## 25.2 Food

### 25.2.A Appetite and Food Preference

CONRAD As for hunger sensations in flight versus 2 weeks preflight,  
there was nothing. I didn't notice anything, did you? As  
for differences notable in food taste in flight versus pre-  
flight, I didn't notice anything there. I thought the food  
was excellent, and I'm sorry we didn't have the freezer and  
the cooker, but the food that was provided I thought was a  
whole order of magnitude better than Gemini food. My food  
preferences didn't change particularly in flight. The things  
that I didn't like before the flight I didn't like during the  
flight, and the things I liked before the flight I ate  
during the flight. That's just about the size of it. I ate a  
lot better than I did on my last 2 flights. I think Dick did  
also.

### 25.2.B Food Preparation and Consumption

GORDON Yes. I have one comment about the size of the food portions.  
I think Pete and I ate most of every meal. Al may not have  
eaten quite as much, but I would certainly think that the size

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[REDACTED]

GORDON (CONT'D) of the food portions was more than ample. There was probably more food than is required or necessary. There is more food than we had been eating in the MQF and preflight as well. I think my preference, of course, was in the direction of one meal. It seemed to me that the spoonfuls where you could use hot water to prepare the food were probably the best type food. The wet packs, although good and tasty, would be much more appetizing if they could be warmed up. There's just something about chunks of meat immersed in cold gravy that is not nearly as appetizing as it would be if it could be warmed, although it was edible and tasty. I think all of us stuck real well to the menu during the first 5 days when we had total meals packaged for each individual. By the time we got around to the pantry, I'm afraid that we deviated somewhat from the preplanned menu in that it was somewhat difficult to look at the menu and then scurry around in the pantry for that particular item selected that day.

CONRAD Now, wait a minute. Speak for yourself. I stuck very close to my menu.

GORDON Well, that very well may be true. Al and I apparently didn't stick extremely close to the menu although we did try. I did at least try to find the food on the menu and if I didn't, it really didn't make any difference. I'd leave out one item and

[REDACTED]

[REDACTED]

GORDON  
(CONT'D)

substitute other items for the menu. Al apparently deviated from his menu quite a bit, and Pete tried to stick extremely close to his in the pantry, but the first 5 days were very simple because the entire meal was packaged. I thought the pantry was a pretty good idea. It allowed us some latitude in the things we liked at the time. The amount of juices on board was certainly adequate. The fruits were extremely well done, and I think Rita Rapp and her people in CSD did an outstanding job of meeting our desires. Food on the whole was excellent. In fact, I don't think any of us hurt for food on this trip at all.

CONRAD

We noted some of the problems with dehydration, but I'll tell you where the problem came from. I don't think it was that the food wouldn't rehydrate. The problem was mainly with the hot food. When we got a little air in those packages, water saturation throughout the food was not good, and you tended to get some pockets. I thought food temperature was good on the hot food. I didn't notice any difference between the command module and the IM food. Did you, Al? We had wet packs; we also had spoon packages. The only thing that was missing was the hot water. I thought the spoonful packages worked extremely well. We had no trouble with food getting away from us, and I used the spoon — everybody used the spoon — all the time.

[REDACTED]

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CONRAD I thought it was great. I used it in the LM and in the command  
(CONT'D) module and I found it extremely handy.

#### 25.2.C Food Waste Stowage

CONRAD We had one waste food dump into the LM, and the rest of the food garbage went into B3. The last day of the flight, we put the 3 last meals, if I remember right, into the pantry. The germicidal tablet pouch worked well. We just kept that in one of our right-hand lower little under-the-eaves shelves and we'd pull out the package and pass the tablets around. I noticed no undesirable odors in the spacecraft. B3 was getting a little rank towards the end of the flight, but as long as we kept it shut it was okay. Now, the quantity of food eaten on the lunar surface varied according to the difference in individuals. I ate everything in sight, and Al didn't eat quite as much as I did. As a matter of fact, I ate a lot of Al's food.

BEAN Yes.

CONRAD I ate the whole ham paste tube and a couple of other things of Al's. I really wanted to keep the old energy level up and I enjoyed the food; I wanted to eat it.

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## 25.3 Water

CONRAD We chlorinated at night and didn't drink after we chlorinated until the next day, and we never had a bit of chlorine taste in the water. I thought that was an excellent set of procedures. We've already griped about the leakage around the hardware, but that's another subject. We noticed no iodine taste, or at least, I didn't in the water in the LM. How about you, Al?

BEAN The first drink.

CONRAD First drink?

BEAN Very first drink in the LM had a slight iodine taste. After that, it was cold and good the rest of the time.

CONRAD Didn't notice any other taste in the CM or LM.

## Physical Discomfort

CONRAD We mentioned gas only in the hot water, I didn't suffer any physical discomfort from that sort of thing. I don't think anybody else did. I didn't notice any intensity of thirst during the mission, but we all drank heartily most of the time.

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25.4 WORK/REST/SLEEP

BEAN When I got ready to go to sleep at night, I never had a bit of trouble going to sleep at all. The only problem was that I'd wake up in about 5 hours and be wide awake. I had a choice then of either staying awake for 5 hours until everybody else got up or taking a sleeping pill. So I got in the habit of going to sleep for 5 hours; then I would wake up and take a sleeping pill and go to sleep for the next 5 hours.

CONRAD We had more than enough time for sleep; there's no doubt about that. I got over on an 8-hour rest cycle and I never slept more than 8 hours that I remember, except maybe the first night, and I would just lie around the last 2 hours. I would sleep the first 8, and that was it.

GORDON Sleep period programming was okay. Sleep is probably an individual preference. I definitely had a preference for actually sleeping in the couch. I slept in the couch all but two nights. These two nights, I slept in the sleeping bag underneath the number 1 couch, the left-hand couch.

But it was always my preference to put the sleeping bag on, then get in the couch, and tie myself in the couch with a harness. For some reason, I slept better with the lap belt and the shoulder harness on, and securely lashed down to the

[REDACTED]

GORDON  
(CONT'D)

couch, rather than free floating or being suspended in the sleep restraint under the couch. That was just a personal preference and it seemed to work better for me. During sleep periods, I would wake up maybe two or three times. I would look around the spacecraft and make sure everything was okay and then really go back to sleep. The sleep period programming was more than adequate, particularly in translunar coast and transearth coast. I got extremely tired at the end of that first day of lunar orbit activities. That sleep period was scheduled to be a relatively short one anyway. It necessarily turned out to be so because at the end of the day was the SPS plane change, lunar orbit plane change number 1 occurred. But then I found that I had to do all the housekeeping and presleep activities by myself, whereas the 3 of us had been able to do them before and to clean them up in fairly rapid order. It took a considerable length of time to wade through all that by myself, and this cut short the sleep period. So I actually was pretty tired in lunar orbit and didn't really catch up until one day out of lunar orbit on the way back. I don't think anybody's performance was affected by fatigue and I'm not sure that fatigue really came into play. But certainly most of us in this particular occupation are used to performing while we are fatigued.

[REDACTED]

## 25.5 EXERCISE

GORDON The thing we had for exercise, other than just moving around using the struts and the flat areas in the LEB for doing pushups and armpulls or whatever you wanted to do, is the exergym. We all used it on the way out a couple of times a day for 15 or 20 minutes each session.

CONRAD Al and I used it longer than that.

GORDON Maybe a half hour each time, maybe a couple times a day. I didn't use it at all coming back. Al didn't use it coming back because the exergym rope was frayed. Pete was using it on the way back when he noticed that fibers were coming loose. So we elected not to use the exerciser at all on the way back.

CONRAD What the exercise did for us on the way out was to prevent us from getting completely relaxed. Other than the discomfort in my shoulders which was the result of my suit being too tight, I never got stiff during any of the lunar surface operations other than my reported finger soreness. That was mainly from shoving them into the gloves for so long.

Al and I took a look at our heart rates, and I would exercise until I was just getting warm. I didn't want to exercise heavily enough to really perspire up there because I wanted to

AL



~~CONFIDENTIAL~~

CONRAD keep my clothes as clean as possible. I think we exercised  
(CONT'D)  
for periods longer than a half hour but at a slow, steady rate.

#### 25.6 INFLIGHT ORAL HYGIENE

CONRAD I guess everybody used his toothbrush to one degree or another.  
I didn't use it as much because my mouth doesn't get that bad  
in 100-percent oxygen. I did use the dental floss. I guess we  
all did. We all used the toothpaste.

BEAN I liked the toothpaste.

CONRAD I don't know where the rest of the guys kept their toothbrushes,  
but I just put mine back in my pocket after I cleaned it. I  
think everybody did.

#### 25.7 Sunglasses

CONRAD We transferred our sunglasses to our spacecraft uniform. The  
funny part about it is I used to use sunglasses all the time  
in Gemini. Orbiting the Earth and looking out at the ground,  
I'm used to the changes in color of the ground on the Earth,  
from flying and using sunglasses. I never used them in lunar  
orbit. I put them on a couple of times, but I didn't like the  
color that it made the Moon. I felt it degraded my observations  
of the lunar surface, so I never wore them. I don't think that  
any of us felt it was so bright that we needed them. The one

~~CONFIDENTIAL~~

1. [Illegible]

2. [Illegible]

CONRAD (CONT'D) time that I did put them on was as I took my helmet off at one mile from the command module. Anticipating it being very bright, I put the sunglasses on and put my helmet back on. I was sorry that I did that. The command module really wasn't that bright. That's the only time I used my sunglasses. I think I'm the only one who used them.

BEAN Yes, you were. I kept mine off for the same reason.

CONRAD That's an individual preference. I don't recommend putting them on or taking them off or anything. It's entirely up to the individual. I never noticed any trouble seeing instruments inside or outside the cockpit in any lighting conditions in daylight.

#### 25.8 Unusual Visual Phenomena

CONRAD I don't remember any unusual or unexpected visual phenomena or problems experienced that we haven't already mentioned.

We all did see these corona discharges; and by paying a little attention to them, you could pin down that it was happening to one eye at a time. The discharges appeared in two manners. They appeared as either a bright round flash or a particle streaking rapidly across your eyeball in a long thin illuminated line. You either got a flash or a streak, and I could determine

[REDACTED]

CONRAD whether it was my left eye or my right eye that did it at the  
(CONT'D) time. Most of the time I did this was during our sleep periods  
when we would be lying in our bunks. The next day we would  
either discuss it or write it up in the flight plan.

BEAN One thing they wanted to know was how often and where. I didn't  
record where they were because it just seemed like anytime in the  
dark, if you wanted to, you could stay there a little while and  
one, two, or three of them would come by. If I was thinking  
about watching for them, I would see one every minute or some-  
what less. One of them would be a flash, and about a minute  
later there would be a line. It didn't appear to make any  
difference whether we were in lunar orbit, translunar, transearth  
or anything else. If you just wanted to look for them, you  
could see them going by.

CONRAD I do remember them the first night out, but I don't remember  
them the last night coming back. Otherwise, it didn't make  
any difference whether we were around the Moon or where we  
were. My only impression was that I noticed them more with my  
left eye than my right eye.

Now, the other phenomenon which we didn't experience on VHF  
(and I'll be darned if I remember any VHF noises) was the  
whooshing sound that we had going down. We didn't have it

[REDACTED]

CONRAD coming up. It was a steady whooshing sound that was present  
(CONT'D) on the front side of the Moon and the back side of the Moon.  
It didn't make any difference.

GORDON The only time I heard it at all during the entire flight was  
just prior to LOI on the back side.

CONRAD I don't think it was VHF. It was on S-band; and I think the  
other noise was on S-band, too.

BEAN You don't have time to start troubleshooting those things and  
to try to figure out where they are.

#### 25.9 MEDICAL KITS

CONRAD We already talked to Dr. Jernigan about the aspirin in the  
medical kit. The idea they tried was a good idea, but it didn't  
work. And what you can do about that I don't know.

BEAN There wasn't any aspirin in the IM where it really ought to be.

CONRAD Yes, I think you ought to put a bottle of aspirin in the IM  
medical kit.

#### 25.10 HOUSEKEEPING

CONRAD No new wheels to invent there. Housekeeping is its normal  
time-consuming occupation which needs to be done. You can keep  
a neat spacecraft if you just spend enough time on it.



## 25.11 SHAVING

CONRAD I think I shaved 4 times or 5 times. I enjoyed it and it made me feel better. I shaved twice on the way out and three times on the way back, if I remember correctly. I think everybody else did roughly the same thing.

GORDON I think you guys shaved one more time than I did.

## 25.12 Radiation Dosimetry

CONRAD The personal radiation dosimeters were worn in our flight-suit pockets at all times. The readings were passed down for the record. We turned the radiation survey meter on once. We had a large increase like 30 millirads over the night before and, arriving on the water, all three showed it. So, we must have passed through something. We took the radiation survey meter off the wall one time to see if it worked, and it did. It didn't show much of anything. We put it back on the wall, and that's the last we ever paid any attention to it.

## 25.13 Personal Hygiene

CONRAD I think the wipes should be bigger. I would personally prefer more towels and maybe a smidge less tissue.



GORDON I would not decrease the amount of tissues. We used quite a bit of it; and if somebody gets a cold during flight, you're going to go through that tissue like it was going out of style. I don't think there is an oversupply of tissues in there. It was a general feeling that two towels per day is what ought to be allowed, and is required. Not only as a urine wipe when they are dirty, but also for bathing and cleaning.

CONRAD It's more like you're going on the toilet. There are sure a lot of hangups. Hangups all over the place. The potable water was used for personal hygiene, and I'd also like to have some soap along for personal hygiene and just to get clean after lunar surface operation — just to get the dirt off. That's another reason we wanted more towels. We all stripped down all the way and washed down with the water and our towels several times during the flight.

BEAN I have a comment on personal hygiene. The only thing I noticed on the whole flight that had any medical symptoms was the fact that when I got back up to the command module after the LM operation and took my diaper off, I had a pretty good rash on my buttock. I washed it 2 or 3 days and it went away, but it surely did itch for about a half a day. I don't know what it was; I guess it was just the same as a baby's rash.

26.0 MISCELLANEOUS

CONRAD I have no quarrels with the medical, PAO, or MQF requirements; they are satisfactory with us. PAO requirements didn't bother us particularly. I think the MQF operations have gone as well as can be expected to keep us cooped up for 5 days. I really don't think the MQF is built for a long-term stay. We have no comments yet regarding LRL operations.