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GEMINI XII TECHNICAL DEBRIEFING

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PREPARED BY

MISSION OPERATIONS BRANCH
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GROUP 4
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1.0 COUNTDOWN

1.1 Crew Ingress

Lovell

Crew Ingress Procedures went very smoothly and timing was good. We had no problems at the trailer on the part of myself but I believe we had a suit problem on the part of Buzz.

Aldrin

Yes, when I first put the suit on, as I was putting my left arm into the suit, it appeared as though the vent tubes were twisted or helixed around the left arm. I was unable to get the Y in the vent to position itself around the elbow the way it should. It seemed as though it twisted around the arm. It was somewhat similar to what I had experienced on SLD, except that it was considerably worse in positioning. During SLD, the vent tube appeared to be in the right place in the lower arm, but in the upper arm, it appeared to cut across the fleshy part of the muscle. On SLD, it didn't appear to be too much of a problem and we were able to maneuver it out of the way and I had hoped that they would have looked into it and re-positioned the tube. I got out of the suit and we tried to re-position it by twisting it around a little bit and it looked like we had it. I put my arm back in and it still wasn't exactly right, but it appeared as though it was not going to hamper the operation very much. When we did pressurize, even though it was not the way other suits have been; it didn't appear to hamper the operation at all. As it turned out in the flight, it wasn't a problem. It was a little uncomfortable in comparison to the right arm, but not a significant bother.

1.2 Communications

Lovell — We had no problem with communications during our precount on the final count. We heard Stony very well, had good communications as I recall with Houston. We were on mostly Push To Talk to cut off the background noise that the suits were giving us at the time.
The communications from the trailer to the pad were good, which was amazing, because they hadn't been too good in the past.

Aldrin — I would like to mention one thing on the actual Ingress. The ECS hoses didn't appear to be in the same order that I had expected them to be before. When I went through the original routing of them I guess it was the weight and balance. The exit or the outlet hose appeared to be positioned so that it would be on the bottom and could be routed around outside and make a loop around the inlet hose. But in the spacecraft, this didn't seem to work out quite so well and the outlet hose was actually closer to your body on the right seat and it had to be twisted a little bit. In addition to that, I think the technician that put me in the suit in the simulator and also in the spacecraft several times had to disconnect the electrical connector because the first time he had it hooked up, it was on the inside of the hoses and that isn't the way I wanted it done. He had to break the electrical connection and hook it up again on the outside. We also had a problem back in the suiting trailer. The technician cut himself somewhere on my suit and I don't know whether we have ever found out where that was, but he cut his finger rather moderately, I guess and deposited a certain amount of blood on my suit.

Rep	It was in the neckring area.
Lovell	Yes, it was those dogs.

1.3 ECS

Lovell	We had an oxygen problem because we didn't have enough of it, so we had to conserve and we did not use the O_2 High Rate to relieve the negative suit pressure. This is a normal procedure to do to make yourself more comfortable, but I know I wasn't uncomfortable with negative suit pressure during the ECS cabin purge.
Aldrin	No, I wasn't either. As long as we knew what we were up against.
Lovell	If oxygen is a problem in future flights, we should consider this approach, because it uses up quite a bit to use a high rate oxygen system like that.

1.4 Prelaunch Checkout

Lovell	I have no comments there, the prelaunch checkout went according to our SEDR and according to the SLD. It was very smooth, in fact the whole countdown right through zero was smooth.
Aldrin	I think we had a good running account of the Agena status. I thought that was quite good.
Lovell	Excellent to have Agena count and update.

1.5 <u>Launch Azimuth Update</u>

Lovell — About the Launch azimuth update, did you find that to be okay?

Aldrin — Yes, that was as we had been through it before and as we had expected. The beach crossing roll angle and fall angle.

Lovell — One comment on the countdown that I found out to be very helpful. The amount of training you do in the suit seems to have some effect on it, because it makes you more comfortable and is not a strange environment right away. I think that doing this type of work in the simulator with the suit on does give you some comfort in doing the actual thing.

Aldrin — I think we should note for the record here that we did both have the D-Rings and the pins removed and the pins stowed back. The D-Rings were handed to us and we did not have to take them out ourselves. It was not particularly uncomfortable while we are sitting in the suit. I was able to stretch my legs out and move around a little bit in the suit. I found that in orbit, when I was cinching up my lap belt, I was cinching it up to a point where there was just about an inch between the buckle and where the other end of the lap belt rolled through it on the right hand side. I'm sure that it wasn't anywhere near that tight prior to liftoff and I am just wondering if I did have it cinched up tight enough for any ejection in liftoff. It sure could have been a lot tighter and weight and balance checks, of course were tighter. So, we might not be cinching people in tight enough.

2.0 POWERED FLIGHT

2.1 Liftoff

Lovell: Liftoff was as expected from previous experience and I believe we could definitely tell at liftoff when the bolts blow. Do you want to break in with any comments, Buz, or anything particular?

Aldrin: I guess I was about a second behind in getting my clock started. I got it about time I heard liftoff and Jim say the clock was started. I guess it was just that time lag in getting it going. The Comp Light came on about the same time I heard liftoff and of course, that was a cue. There may not have been a sensation of moving right at the first second, but it wasn't but about 2 or 3 seconds later there was no doubt that we were moving upward and it was just increasing from that point on.

2.2 Roll Program

Lovell: Roll program came in on schedule, as advertised, no anomalies.

2.3 Pitch Program

Lovell — The pitch program was the same way. I called both roll and pitch program as we saw them.

2.4 ECS

Lovell — ECS, why don't you comment on that, Buzz, you were monitoring the cabin pressure.

Aldrin — I picked up the cabin pressure beginning to increase at around 20-25 seconds, right after the pitch program and called that out. The suits didn't show any particular change in their pressure. As we were coming up on 50 seconds and released the D rings; the cabin pressure seemed to reach its maximum, I think it was around 5.8. I didn't write down what I called out, but I think that was what it was.

2.5 DCS Updates

Aldrin — The DCS update came in at 1:44, something like that and we got a call at 1:40 going to Mode 2.

2.6 Engine 1 Operation

Lovell — Engine No. 1 operation was nominal.

Aldrin — I did notice during engine 1 operation, as we were reaching the maximum g that the right secondary O_2 bounced up at about 6,000 psi. It had been reading about 53 or 5400. It was a definite jump up there and after staging, it appeared to drop back down and then during second stage around insertion as we reached high g again, it went on up to 6,000. After insertion it dropped back down to about 5,000 and stayed that way for the rest of the flight, whereas the left secondary O_2 stayed right at its original value of 53, 5400 for the entire flight, through liftoff.

Lovell — Also, during engine 1 operation, I believe we got a delta p light didn't we?

Aldrin — That's right, this occurred also during the maximum g and I think it was Section 1 and it went out at staging.

2.7 <u>Engine 2 Status</u>

Lovell — Engine 2 status was Go all the way during the engine 1 operation.

2.8 <u>BECO</u>

Lovell — BECO was nominal as far as the cues on the booster indicators were concerned. Both engine 1 and 2 lights came on and engine 2 light went all out as soon as we got staging. The time, I believe, was 2:33 if I'm not mistaken. Exactly at BECO.

2.9 Staging

Lovell Both of us saw the flash at staging and I looked at the window definitely to see if there was any coating and you could tell there was coating on the window after staging.

Aldrin As soon as we got the deceleration at staging, I saw several particles move forward. This is an impression I have now and I saw one flash move ahead and time delay after that seems as though I heard a noise right at that same time. A short instant later it seemed as though there were two flashes that occurred afterward. I think there was just a sensation of one noise that took place but the original flash followed by two quick ones maybe a half a second after that. I didn't observe anything accruing on the window.

Rep You're talking about a reflected light flash and not a direct light.

Lovell Well, one could be the engine lighting off and the other could be the . . . No, it was a glow up ahead. It looked like it was an enveloping flame and it looked like they were both about the same.

Aldrin — I mean the first one and second and third were about the same sort of thing but the first one lasted longer and the second and third were quick behind it. Now, whether there were really any particles or not, I'm not sure. I may be confusing it possibly with reentry. I really can't be too sure about that.

2.10 <u>Engine 2 Ignition</u>

Lovell — Engine 2 ignition was normal as far as I could tell.

2.11 <u>RGS Initiate</u>

Lovell — RGS initiate came on time and with a slight deviation of the booster yaw needle. Steering and rates were nominal. We had no big excursions just some occasional minor ones. Do you have anything on the attitude?

Aldrin — No, let's see, before staging I got the DCS update and of course wasn't able to reset that. In general, I found that I was able to move forward and turn switches up to three and a half maybe four g's. After that there wasn't

	much to be done except to look at things. I reset it after staging.
Lovell	At 2:23 the g's are pretty high.

2.12 Steering (IGS)

Lovell	Okay, how about the attitudes on the steering on the IGS.
Aldrin	They moved off and then recentered again before I could really say much at all about it.

2.13 GO/NO GO

Lovell	GO/NO GO, we got a GO.

2.14 Systems Status

Aldrin	I was able to make about two cycles during the second stage around the electrical system, CRYO, OAMS and RCS. I was able to look over, as the g's built up, and verify the circuit breakers were in their proper position.
Lovell	We had, I believe, two fuel cell Delta P lights on during the second stage . . .
Aldrin	One of them, Section 1 came on again and then Section 2 came on prior to SECO. I guess this was normal initially in the program and then they stopped doing that but it turned out to be just a prediction that was yet to come. They both did go out at insertion.

2.15 SECO

Lovell — SECO was late from what we had gotten on our prebriefing. It was scheduled to occur at 5:40 and it occurred at 5:44. There were a few seconds there when I thought it might not occur for awhile and I was afraid we were just going to keep burning and burning.

2.16 Communications

Lovell — Communications during the powered boost phase were excellent. I, at all times, heard the CAP COM. There were no problems there.

3.0 INSERTION

3.1 Post SECO

Aldrin — Jim mentioned that the booster was going to be hunting just prior to SECO and I could see a little but not as much as I had expected from your....

Lovell — It didn't, because I looked up there and I couldn't see any. I was amazed, that nose just went back and forth as she hunted and I looked up there for Gemini XII on final stage to see if I could see it with respect to the horizon and that thing didn't move. So I guess there is a difference between boosters and this RGS guidance depending on how tight the deadband is. Rates at SECO were very small. I don't recall what attitudes we were in other than being on our side. I think slightly yawed south.

Aldrin — I saw the horizon come up about when it was supposed to.

Lovell — It came up exactly at 4 minutes on the ball. The FDI indicator crossed the horizon and went into dark exactly at 4 minutes as predicted, right on pitch program. What was your address 72, Buzz?

Aldrin 25748 and were hunting for...I don't know what we were hunting for. They gave us the number 25740 as nominal and I assumed that that was nominal before. I guess I'm a little bit hazy but I got...let's see maybe they updated us twice and gave us 25740. I have that written down here. And we got 25748. That's the number you got. I have that written down here, I don't have it written down in the right spot. That was the second update. 25748 was an update. I didn't record it but I read it down to the ground.

3.2 <u>SECO Plus 20 Seconds</u>

Lovell Spacecraft separations and thrusting were normal, and I don't think I gave it a full 20 seconds though.

Aldrin I copied your IVI readings at SECO.

Lovell What were they at SECO.

Aldrin 25 forward, 13 left and 3 down and indicated what our attitude was.

Lovell Okay and I've got the IVI's that we burned out after we got to our normal attitude.

Aldrin — After I read out 72 and confirmed that 95 was essentially the same as the forward IVI. I then read out 94 and called it down to the ground as the 0 0 1 4 just to see if it might help them.

Lovell — Okay I think we got those down to the ground. The separation spacecraft thrusting were nominal. Attitudes and rates were as expected-no anominallies were there. You remarked about something that occurred at spacecraft separation.

Aldrin — I just commented that there was a loud bang; that you have to expect it.

Lovell — The only thing I could say about spacecraft separation was the fact that I had 6 minutes to fix up my mind and I think I might have separated a few seconds early. Instead of separating at the full 20 I might have separated at 18. At 5 second separation and I came off in Direct mode; I switch to Direct and OAMS power on and I rolled for heads up position in DIRECT stopped it with Rate Command.

Aldrin — We revised the procedures somewhat from what other people have been doing. The one who really knows when he wants to separate and wants to start thrusting is the command pilot, and he's just inches away from both those buttons so we changed it to the command pilot function that he would punch the button and start thrusting as a coordinated effort and I think that worked out well.

Lovell After we got around to a SEF position with the pitch needle nulled out our IVI then read 28.4 to 9 left and that's what we burned. We went into RATE COMMAND and burned 24 to 9 left and that's all right. I could have been between eight and nine. I just burned out to zero. That was our IVAR burn. We got a GO for IVAR. Someplace in here we lost communications. First of all did you have any trouble loading Module III-A?

Address 95, we've already talked about. You recorded that.

Aldrin The window cover jettison, all it took was just a small twix. I was expecting to have to back that knob off a little before releasing it, but I found that I could just turn it. It just flipped open and took off. Someplace we lost communication with the ground and didn't pick it up until Tananarive. Normally, over Ascension we give the Insertion checklist complete and we get a one Alpha update, how we do on orbit or GMT clock check, liftoff, or something like that. We couldn't reach them at all. We didn't hear a thing until we got to Tananarive. I think it must have been a ground problem because I checked the communications and went to number two UHF and you thought we were broadcasting on HF. I thought you might have heard them or something. But we didn't have HF on, so we couldn't have picked that up.

Rep — We had some air-to-ground problems. The ground was trying to call you of course.

Lovell — Yes. They didn't get through, so we didn't hear anything until Tananarive.

3.3 Insertion Checklist

Lovell — Insertion checklist was nominal. We went through it much similar to previous flights and there were no problems.

4.0 ORBITAL OPERATIONS

Lovell — Platform alinement after insertion was nominal as the flight plan called out. We alined the platform and we had no problems. N_C1 update at Ascension. Do you have those figures down, Buzz?

Aldrin — I think it's in our log here. Yes, 60.2 feet per second was what we picked up. No, wait a minute. We only got one update in orbit. So that must have been the pre-liftoff.

Lovell — 60.2?

Aldrin — That was pre-liftoff. Okay, we got the other one at 49:40 at the same time we got an 87 by 146 orbit, and we had 66.6, which seemed to make sense. We didn't get up high enough so we had to raise our perigee so we could decrease our catchup rate.

Lovell — And still we didn't burn enough. No problems with unstowage at the rendezvous or any of the books. We got that over with okay. N_C1 translation after the update at Tananarive was put in and we burned it in the Orbit Rate and Plat Mode of the attitude control system. The actual PQI after the burn was 85 percent.

After the burn, we did a platform alinement. Out-of-plane translation was computed onboard, and Buzz, why don't you give us the figures on that?

Aldrin: I had an address 69 reading of +00250, and I had been led to believe that the numbers you got out of address 69 always had a zero on the end. In other words, it was the number tens of yards. I was led to believe that you always ended up with only a zero on the end. But this wasn't the case. I read it out 10 to 30 seconds later, and it seemed to me it started decreasing. It was down to - oh, I just seem to remember 247, which surprised me quite a bit. That it wasn't just to 10's of yards, which is different from what we've ever seen in the simulator. It did indicate to me that we were not continuing to go out-of-plane. So either we had an out-of-plane displacement and were coming back in or maybe we overcorrected. As it turned out, I guess it was a pretty good insertion burn. With the 250, I interpolated a little bit and got a burn of 8-1/2 feet per second. And address 27, since V perpendicular was positive, was 90085. The time was 14:22. One hour, 14 minutes, 22 seconds.

Lovell — So for the one hour, 14 minutes, 22 seconds, you were going to burn right, is that it?

Aldrin — Right.

Lovell — And the ground gave us a GO to burn it. Which also surprised us. Unstowage checklist. We had no problem with the unstowage checklist that I can recall. Do you have any?

Aldrin — We just started doing things and then started catching up by going over the list to make sure that we had everything out.

Lovell — We made sure, of course, that...

Aldrin — I think it's almost impossible to get a list that any one crew is going to follow. Unless you've gone through this operation and know just what it's like, it's pretty hard to anticipate what is available for you to do at certain times. I found that unstowing the T-2 sextant bracket was a heck of a lot easier than I had figured it was going to be.

Lovell — I don't recall exactly when we had our accelerometer bias check.

Aldrin — That was over Hawaii. Right after the plane change.

Lovell We had a go for the accelerometer bias check.

Aldrin We were not exactly in an SEF position when we started that. We were drifting off, so we told them to hold off just a little bit and tweaked it back and then they started the check again.

Lovell Another comment on the out-of-plane translation. We made the out-of-plane translation with the lateral thruster but we offset the burn 26 degrees to take into account the forward portion of lateral thrust. This procedure worked out quite well since when we completed our burn, we didn't have to take out any more translation in the fore and aft plane.

Aldrin Yes, that was a good little procedure.

Lovell Buzz thought of that one. We had no problems with platform alinement. We maintained an SEF and PLAT configuration. We used secondary scanners and they worked quite well. After the out-of-plane translations. We started to get an intermittent lock on and I think we got a solid lockon at something like 235 miles.

Aldrin Yes, I called it out to the ground; I didn't write it down and it appears as though it was

235. We had a lock slightly prior to that.

Lovell — You called out solid lock at 235.52.

Aldrin — Yes. We were getting intermittent before that. That was solid enough to give us a range rate reading also. You have to have a good solid one otherwise you get all nines.

Lovell — We got both the CSI and CDH updates. Buzz put in the CSI burn that we received and after that I burned the CSI as he was computing the time for us to start the clock for the CDH onboard computation. Stop me if I'm wrong, I think the ground CSI was a Delta V of 7.6.

Aldrin — One of these burns, address 81, did a couple of funny things. It was sitting at one tenth positive and we blipped that and read it out again and it went to two positive. I couldn't understand; it went the wrong way. So we blipped it again and it went to negative one and we said forget it. There must have been some drift in there or maybe it had rounded off somehow - it was unexpected - the simulator didn't do that sort of thing. I figured that we had some drift in there but they didn't have to update our accelerometer bias so we assumed that it was adequate. There was plenty of time to go through the calculations to get the time to start the clock for the CDH. We had a couple of minutes to spare.

Lovell — During the CDH determination we switched to the Rendezvous Mode so we could get new data every minute while Buzz was getting range data to compute the CDH burn. I was getting out-of-plane data to compute the out-of-plane component that we should apply at CDH.

Aldrin — Both procedures worked quite well. I was hoping to get switched into the Rendezvous Mode, 2 minutes early as I had been able to do in the simulator but something came up. Either we had switched back and forth from catchup to rendezvous and after going into rendezvous that one time I then checked address 20 again and it didn't have 100 in it, and it must have been, as I look back on it now, because I didn't hit ENTER but hit something else. So we didn't get into the Rendezvous Mode until the 00 time which didn't give us that little leeway. It pointed out that it was a good procedure to try and get in early because if you try and get in early and don't get everything squared away you can reinitialize as we were forced to do this time. We didn't lose anything; we just weren't getting address 27 quite as soon.

Lovell So see the plot on address 27. We got a good plot finally as she came on down, came right on down here. We got the CDH determination completed between 26 and 28 minutes after we started our computations. It agreed with the ground.

Aldrin The ground burn was 49.8 forward, 3.5 up and 7/10th right. The best I could calculate with the width of the pencil that I had was 49.5. I had quite a bit of difference in the up/down. I had 6-1/2 instead of 3-1/2 and, let me see, we ended up with one tenth right and you know more about that right/left.

Lovell That's right. I followed 2708 through the CDH determination and since the line was going very smoothly, I just left the last address 27, that was to the right, in there. However, they didn't switch over, so we had to....

Aldrin I had to reinsert the last one of address 26 but I did read what I thought was a good burn, which was one tenth right.

Lovell: Yes, that's because we didn't switch to NAV at that time, and so I burned what we had computed onboard for out-of-plane instead of using the ground burn.

Aldrin: The procedure is one where Jim would input the nominal 25 and 26 and then play 27 as he saw it. So we had a solution already in there and we could either change the IVI's based on my numbers, in which case we could not thrust out residuals, or if we had time after the calculations I would insert 25 26 which I did and we still had about 30 or 40 seconds play with before START COMP. None too much but it was about typical of what we had in the simulator.

Rep: Did you have any problems with residuals on that burn?

Aldrin: No.

Lovell: Now at that point, at the end of the CDA's translation, sometime probably after the main burn, while we were thrusting out residuals, which we didn't notice, we had a power glitch.

Aldrin: Yes, the last range I had out of address 69 was 65.15, this was at 26 minutes. Since we didn't switch out - we must have had another 27 minutes and it was probably, if we can go from these calculations, about 7/10th of a mile less than that, which would have been 64.40. It seems to me that this is exactly the number that I read out of 69 for the next 15 or 20 minutes. So 69 was not updated after we switched out of Rendezvous Mode which is rather unusual. What we are trying to pin down is what happened to the radar.

Lovell — In the NAV Mode when you read address 69 you will get the same thing that is in address 36 and it didn't appear that this was being up-dated at all.

Rep — At what GET?

Lovell — The burn was to be at 2:22:54 and we didn't change that. To get this thing back to our time, the event timer was counting up to 30:28 when we burned. Correct?

Aldrin — Yes.

Lovell — So, when I say 27 minutes on that time scale, counting from zero to 30:28, 27 would be 3 minutes and 28 seconds before the start of the burn.

Lovell — We are at the point where we were discussing just after the CDH translation maneuver, no residuals and then we began as follows. We found out that we didn't have a lock on. Buzz didn't you check the computer for setting up for TPI?

Aldrin — We finished the burn and I looked up at the event timer and inserted 100 in address 20 and was standing by to switch in to RNDZ at an even minute which I did. Then I read out 69 and I saw that familiar number of 64 miles which did not sound right. Then I read 36. I forget what I got out of there, but that didn't look right at all. I looked over at the range rate and I was getting nothing out of the computer in range rate except nines. I looked over at the LOCK ON light and there wasn't any. We obviously had not synced in at that point and I figured well, we're just going to have to try it again. But we didn't have a lock on at all. We were outside of analog range so we couldn't recheck it against what was going on there. We switched back to NAV and stood by to try and figure out what the problem was and waited for some sort of a lock on. I guess it was about this time that we realized that along with this radar problem we seemed to have an indication of some OAMS problems.

Lovell The only OAMS problem along with the radar failure at this time was that I went around just to check the circuit breakers to see if any had popped. I did notice that two were out. One was the OAMS control propellant circuit breaker and the other one was either the number one or number two OAMS control regulator. I'm sorry I didn't write it down, but I was in such a hurry to get them back on the line to see if this would have any effect on it, and obviously it would not, that I didn't record which one it was. I put both these circuit breakers back on the line.

Aldrin The point I was trying to make before on the other tape was that we ought to make sure that we don't just assume that it might be a problem in the transponder but look and make sure that this set of events that took place in the vicinity of CDH wasn't just coincidence. It seems to me that you just wouldn't expect two abnormal things to happen right in the vicinity of a burn. If I'm correct, and I'm not sure about this, it seems as though address 69 ought to be continually updated when you're in the NAV mode so it should not keep just that last number that it had in a rendezvous mode. As soon as we switched out of RNDZ in to NAV, it should have been updating itself all the time between when we switched out, and the burn. If it didn't do this, there might be a problem and this problem could have occurred at the time we switched from RNDZ to NAV and of course I'm sure neither of us really looked to see whether we had a radar lock on at that point. We were too busy doing other things. The radar could have broken lock at that time which would have been substantiated I think, by the fact that 69 was not updated after switching. Then the other circuit breaker problem would indicate that we could have had a spike of some sort that affected those circuit breakers and also affected the radar. This would tend to rule out a problem with the Agena. Other symptoms that we had later on were that we were getting commands through. Carnarvon suggested that we send status display bright and dim to see if we were getting commands through. They verified that we were and I queried them to see whether we should under these circumstances perhaps switch over to spiral antenna. By the time we got to Carnarvon we were beginning to pick up an intermittent LOCK ON light but we weren't getting anything out of either address 36 or 69. The intermittent lock on I thought might get more steady if we switched antennas. Since we were getting MAP lights through and we were over a station, I felt that we could switch to SPIRAL and then if we were unable to switch back to DIPOLE because the spiral is too weak the ground could switch us back to DIPOLE. I asked them to check with Houston to see which one we should be on. They said to go back to DIPOLE. In SPIRAL we were getting a flashing of the light. It was nowhere near as steady as DIPOLE, indicating that DIPOLE was by far the better one to be on.

Lovell When we lost the radar this precluded a good

TPI determination for awhile. We didn't know if we would get the radar back in enough time to make a TPI closed loop. We also didn't have sight of the target at this time.

Aldrin To backtrack a little bit, just prior to the CSI burn, I had mounted the sextant. I was making the readings and started looking through the sextant and it seems to me that shortly after I started looking, I saw a flash and read out a range at that time of about 85 miles. This must have been at 10 or 11 minutes. 85:15 is right. I think that's what I reported for address 69. So we did have a visual in the sextant at that time. It was not just a dim light. It was quite visable which would indicate to me that had we looked seriously a little sooner we probably would have seen it at further ranges.

Lovell Well, do you recall I picked up the visual?

Aldrin I don't think I ever lost it.

Lovell You picked it up before the CDH translation.

Aldrin You didn't have the visual, because your procedure said to track the target and you didn't have a target to track.

Lovell — I didn't have a target, so we had to track it nominal. I forget the exact time when I did pick up the target.

Aldrin — You were tracking radar needles up to that time. Wait a minute. That's right, radar needles up to CDH and radar needles went to worms.

Lovell — I thought that you had picked up the target on the sextant. About that time, I saw them also because you said, "Look I've got them in the sextant".

Aldrin — Yes, I think you did shortly after that.

Lovell — There was a period between the time that we lost the radar until we picked up the target visually that we had nothing. I can recall I was watching that light flash and I said I hope it stays steady so we get something.

Aldrin — It wasn't a flashing light.

Lovell — I'm talking about the green light on the radar system. It went on and came off again. I picked up the target visually and we began to go through our radar failure procedures for computing TPI.

Tracking the target in the daytime, it was a bright point of light which is very noticeable once you had it. Tracking it was no problem. You could keep it right on. About that time we reported to Houston that we lost the radar and made my famous comment.

Aldrin — We alined the platform at about 10 and 1/2 degrees so we must have had visual there. We started alining based on an angle read out of the computer I know. We went down and alined and this was an estimated 2 hours and 30 minutes. At about 2:40 or so, we were trying to figure out when to stop alining the platform because we were pitched down. You normally stop alining based on what you read out the sine of elevation angle but of course we didn't have any. So I got the great idea that I'd crank 13 degrees into the sextant, which was bore sighted straight ahead and when the target reached there we'd stop alining. This worked out, so we went on up and picked up an angle of 12.3 degrees.

Lovell — I have to add that Buz is a great sextant man here and he's got a silver bracket one way or another.

Aldrin — The boresight was excellent in yaw and it was about 1 and 1/2 degrees up. When Jim said he had it right on, I remarked right where it was. It was just about on the sextant markings which were excellent. Incidentally -- the reticle. He was holding it the best I've ever seen him track, really.

Lovell — Listen, it was serious business.

Aldrin — In looking at the angle versus time, it became quite obvious to me that we were going to be late at TPI and the estimated time was 8 to 10 minutes late in arriving at TPI. We got a ground update a lot later than I figured we would get one because it was getting pretty darn close by the time we got it. I didn't know what we were going to do if we reached TPI at the normal time, their ground update, I don't think, got to us until just about the time we would have been reaching point A nominally.

Lovell — That's right.

Aldrin — Actually, we were about 6 or 7 minutes behind their update which, would have TPI occur at 3:05 which was quite a bit earlier than I figured it would be. They gave us a burn of 22.8 forward, 3.2 up and 2.7 right. And then they said that Delta H varied from 9.4 in the vicinity of CDH to 10.0 at about TPI which means that we were going down, which seemed to indicate that we were approaching perigee, and seemed to indicate that we would need somewhat of an up burn at this point so that those two indications would jive. However, the numbers that I got were not really what I had asked for. What I was hoping to get was the total spread of apogee to perigee and about where apogee or perigee was in relation to time. I think what they gave me was the altitude difference at CDH and the altitude difference at TPI which really didn't help quite as much. But there was a small amount of ellipticity. And the ellipticity that we had of six tenths of a mile, which might have actually been one mile peak to peak, would in no way call for as large a burn as three feet per second up, according to my "handy dandy" little chart.

So I questioned somewhat their 3 feet per second and we pressed on looking at angle and got our angles quite normal for point A, B, C and D. The angles that I had indicated instead of a two point nine (2.9) difference, a three point two (3.2). A 3.2 would give us something on the order of 2-1/2 to 3 feet per second up but somehow I still didn't feel that we needed to do that. Just one tenth, of course, would change it by a foot per second.

Lovell   Shall I tell them the true story?

Aldrin   In a radar failure procedure you put in numbers in the catchup which end up giving you 22.0 forward and then you change these in the IVI's and burn. So, it looked like we had about 10 so I said, well, let's burn to 22 forward and said something to the effect of three up which got lost in the traffic I think. We burned based on Jim seeing the target cross from bottom to top in the reticle.

Lovell   What happened, when you burn you get a nominal in and you null off the needles and the target walks its way up and when it gets on point you burn it. We were late in doing this in the first place and when we got the burn in, the target was already there.

Aldrin: Which was surprising because we shouldn't have been. We should have had a minute and 45 seconds from D. It looked like we burned a little bit soon and I had looked at the clock and wrote down the number here and had the wrong hour, incidentally. But I wrote down 2:05:48 at the start of burn and it was really 3:05:48. A little bit after I looked back at the ground update and it was 3:05:51. So they had their time pretty close.

Lovell: Well, actually, after the ground gives us three up and Buz passed over three up to me, the story I like to tell is I just eyeball it and say we don't need a three up. As a matter of fact, I didn't hear Buz and I just put in the 22 feet per second forward.

Aldrin: Okay, now I'll add a third version to that. Because it seems as though if you burn just a little early which I think maybe we did, the burn that you would need to get on the trajectory is a little bit down from what you would have solved for.

If you burn a little early you wouldn't put the three up in and you would burn just all of it forward, which means we really came out smelling like a rose. Well, anyway we were really on top of the whole situation. But nobody is really going to squibble over a foot or two per second.

Lovell — Up to TPI we had 85 percent of our fuel left, that was at the end of CDH translation. At the end of CSI we had 83 percent left. Then we went down, of course. The big CDH brought us down to 75 percent of the fuel. Lock on intermittent at 2:38, I have here. Just to bring up some more points that I have written down. I also have written down that the OAMS regulator and the OAMS propellant circuit breakers popped but I didn't write down which one of the OAMS regulator circuit breakers. After TPI our onboard PQI reading was 74 percent.

Aldrin — The first angle we read showed that we burned

Aldrin — right on time. Despite what I said earlier and the angle change looked very close. It came out about 1-1/2 foot per second up which seemed rather insignificant. We had in the back of our mind that maybe we hadn't burned enough up at TPI, but the first midcourse correction seemed to burn one up. It seemed that there wasn't any point really in putting it in so we didn't burn anything for the first midcourse correction. Of course, we didn't have any range and range rate. I wrote down some numbers for range that we had here and put them on the plot. Incidentally, to backtrack, we were getting range at about 45 minutes prior to TPI and the thought occurred to me, maybe we could switch into RNDZ and see what happens. I thought this over while we asked someone at the same time, thinking out loud to them, and I came to the conclusion the same time they did. that that wouldn't be a wise thing to do because it would destroy our pointing command for the radar failure and would tend to complicate things, so we didn't do that at all. But we were getting range at this point. It wasn't at any particular timing interval so we had to read it out of address 36.

Lovell — How about your midcourse corrections, Buz, the second ones? In fact, we had four. The first corrections we had were all zeros.

Aldrin — Seems to me somewhere in there I read a range that agreed fairly close with what the ground said the range ought to be. This was around

TPI but I don't seem to have it recorded. However, I did read a range at 4 minutes that would seem to indicate that we were getting, from TPI on in, fairly consistent range readings. At this point I don't have any range rate numbers logged. The second correction angles were about a degree higher than they should have been for the corresponding time. A degree to a degree and a half. We got a 6.6 Delta Beta instead of 6 degrees which called for an up correction of around 2 feet per second. This confirmed two previous readings, one of them the possible under burn TPI up and the one up at first midcourse, so that it seemed fairly consistent. We burned two up at the second correction.

Rep — I've got down here that you called down that R dot was good as of 3 hours and 21 minutes elapsed.

Aldrin — Okay, I have one written down here at 14 - 3 hours and what?

Rep — Three hours and 21 minutes.

Aldrin — Okay, that agrees, because it was 3:05 when we started and at 14 after that ...

Lovell: Art, that was still at intermittent though, wasn't it?

Aldrin: Well, not out of the computer. I got all the necessary numbers I needed here for the third correction of angle which again was about a degree and a half higher all the way in than it should have been. Instead of a range of 7.46 I had 7.30. Range rate, instead of 72 I had 74 which indicated that there isn't really any point of braking at that point for the 2 feet per second. Incidentally, because the angle was slightly higher, it would probably run it up to around 73 required. About here, I started looking at out-of-plane angles. I logged them a little bit at TPI and one or two at first correction and I got a little bit more serious on the third correction because Jim seemed to notice that it was drifting off a little bit. For the third correction since the angle change in Theta was 8.4 which was exactly what it should be, I forgot about that. The range rate looked real good so then I concentrated on the two angles that I had written down out-of-plane and it looked like it was going a little bit to the left. I figured it so close to the belly band that maybe we ought to put in a tad left to see what happens. So we put in one left on the third correction.

In the fourth correction, the first angle was again about 1.8 high. The next angle was about 1.5 high and the difference between them, 11.2, and we were low on angle change but high on angles. I thought we ought to maybe burn a tad down so I said we'll burn one down and I looked at the range and range rate and for those angles the range rate required was about 45. We had 50. So we burned five aft at this point. Figuring that, well, we might as well take it off now since that was what the chart says we ought to have. If it had been the other way around we probably wouldn't have added it forward. So we did take five aft and one down for the fourth correction, and immediately went to inertial needles.

Lovell I might add here that the analog meter was giving me the range intermittently at first and I think I was getting range towards the end but I never got range rate. The analog never gave me any range rate at all. We went inertial needles and did the flight control and braking. The target was fairly steady. It was moving slightly to the right with respect to the stars. I maintained inertial needles most of the time until towards the final part and I went on the stars and did the inertial line of sight control using the stars.

Aldrin — The plot throughout the trajectory showed us going right along the nominal curve but a little bit ahead in time. In other words, the range was a little less and the angle was a little greater than it should have been at that particular time. We were proceeding along just outside the curve and then we started to cross a little bit and it looked like that was about the time that we got the 1 down for that fourth correction and, of course, the 5 aft meant that we were over speed. An overspeed at that point would tend to bring you on up which would make you cross the trajectory. So all of those things seemed to jive together there.

Lovell Do you have our rendezvous time here? GET, I didn't write it down here.

Aldrin After the fourth correction, we had the situation pretty well in hand, and there wasn't much drifting. At about a mile and a half, as I recall, we did some braking down to about 17 feet per second. This is what I was reading. The angle at this point, was well past 90 degrees. Braking at this point, was a little further out than we might normally do. I had no concern about this particularly, because I knew that this would carry us on out further in front which tends to give you a lower closing velocity which also tends to minimize the fuel. This looked like the thing to do, especially since the line of sight rates were in such good shape. What I was trying to do, was to chase along with the sextant. Since we had, supposedly, a radar failure, and trying to see how close the sextant angles would work with it in sideways position. It is something that requires a bit of practice to be able to come out with these things at the same time you're changing the inertial needles and also reading range and range rate out of the computer. So I was, to say the least, a little bit behind in being able to get precise range readings out of the computer. As a matter of fact, I was getting the angles off the day chart instead of the dark chart, which was why the sextant was telling me that we weren't at the range yet, whereas the computer says we were already there.

Lovell — Well, the line of sight braking was no problem because the simulations which we had gone through. The one down here on the skid strip using mock-up in the car, actually is a pretty good simulation. Just by observing the night lights, we could see the running lights. Getting some hack on the range rate, and knowing that our line of sight rates were not ... If we would have had a large line of

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sight rate, we'd have been in trouble probably, but we didn't. We could use the stars, so we had no problem during that phase of the ...

Aldrin — If we had actually had a radar failure, I think the sextant would have done a very good job, telling you whether you were still closing. I was calling readings off to Jim since he didn't have a vernier gage.

Lovell — I thought we did have a radar failure, I didn't know you were getting that stuff out of the computer until I kept asking for range and range rates and then you said, "Well I'm getting them out of the computer." Then I thought, "gee, this boy is doing a great job."

Aldrin — I had faith in the computer, so I didn't want to degrade that ...

Rep — What do you feel is the maximum usable distance of the sextant, a mile and a half to two miles?

Aldrin — No, I think it is much farther than that, but I can't say that we tested it at that because we did have good range out of the computer, so I was leaning on this rather than concentrating

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on the sextant. If we had had a complete radar failure, the sextant would have been the only thing I would have been looking at and we would have gotten a much fairer evaluation. I guess what we can conclude is, that we really didn't establish an outer limit to the sextant. But I did see the running lights when the flashing lights were flashing.

Lovell I did, too.

Aldrin Based on that, you could leave the flashing light on until you see the running lights. As soon as you do, you could turn them off. My commentary on the fact that we were still closing as we were coming in was; I said we were still closing, still closing.

Lovell If you can get that information out of the sextant, it's a great help.

Aldrin We sure don't want to over-correct right there at the last.

Lovell As long as you know that you're closing and the line of sight rates are null, you're in fairly good shape because you can tell if the rate of closure is great, by visual means. You can't tell it if you cross that area where you start opening and that's the dangerous part.

Aldrin — Now, when we got stationary, we were well underneath and out in front of the Agena and pretty much in plane. We weren't out of plane much at all as I recall. The horizon was visible. When I looked way up, I could see the horizon up in the top, so we did get out in front. I had written down here in the braking chart, 68 percent.

Lovell — Yes, our PQI at the end was between 68 and 69 percent after we "horsed around" with the Agena. When getting into position to look at it, I called down a 67 percent or something like that.

It was a good exercie being able to do a prime rendezvous in a failure mode even though it was not a full failure mode. We took full advantage of range and range rate since it was available to us. It verified to me that when the pressure is on, the backup techniques can come up with as good midcourse corrections series as the closed-loop can. We said that we really hadn't been wasting our time working on these things.

Aldrin Well, I'm certainly glad we had the radar training anyway.

Lovell And we had a radar. I'm glad that it was still working.

Aldrin Well, we had parts of the radar working anyhow.

Lovell Yes, computer inputs we didn't have. I actually had no use of my analog gage at all. I had a range indication, but the range rate was bouncing back and forth. Range rate, which usually is used, was non-existant and I had to rely on the closing.

Aldrin How was the lock on light doing when you were in close ranges?

Lovell It was steady. It finally got steady.

Aldrin Stayed real close?

Lovell That's right, but the range rate never came in, I wonder why the range rate . . . Do you know at what range the light came on steady?

Lovell — I think it was around TPI.

Aldrin — I was waiting for it to come in to get range and range rate out of the analog.

Lovell — I didn't start getting range rate until that second correction so probably about that time it was going steady. Range rate was never good on my analog. Range was intermittent most of the time. We looked the Agena over and made a daytime dock, which was no particular problem. The Agena seemed to be in good shape. There was some paint burned off on the side of it, but the engine was very clean. We took some photographs of it. I hope it comes out.

Aldrin — Yes, the engine was white on the inside of the bell. I was thinking the other night that we sure missed getting Gene's picture. He wanted a picture looking right at the bell.

Lovell — We have one looking almost at the bell.

Aldrin — We got a couple there, but they weren't with the sun and ourselves looking at the bell at the same time. It surprised me that it was white on the inside. I guess it was just the residual that you get out of the propellant when it burns.

Lovell — I think control of the spacecraft next to the Agena, when we have full control, is a lot easier than when docked on the Agena, don't you?

Aldrin — Yes, I think so.

Lovell — We had no trouble with the first docking. We undocked, it took a little longer to get the rigid light on than I figured.

Aldrin — Okay, we undocked and we decided to fly around it again. This time we were taking pictures of the Agena and as we went around the bell...

Rep — While we are talking about the Agena, what was the configuration of the tether loop?

Aldrin — It was out. The tether was out and looking nicely and waving in the breeze and I hope we have a few shots of that to give the poor

McDonnell people who were so embarrassed the the last few times when it didn't go out.

Lovell: On the way around the second time we got about three quarters of the way around the Agena when the sun started going down so we were going to make a night docking. I came around in front, started to go in and I don't think I was closing fast enough. I hit it a little askew.

Aldrin: We didn't have the tape recorder on RECORD, did we?

Lovell: I don't know. It seems to me we should have.

Aldrin: I thought we kept it on RECORD.

Lovell: I don't think we recorded it. Looking back on it, we sure should have. I'm not sure if it's been a standard procedure for everyone to have a tape going into rendezvous. No one has ever really mentioned it. It hasn't stuck in our minds. It wasn't in our procedures and I don't think we had one going. But I think it should have been. We came and docked the second time and we engaged, but we didn't engage all the way so I added thrust to go all the way and the docking light just wouldn't engage. When I went to back out, it wouldn't back out. It was caught but it was loose. So, I moved back in again to get it completely rigid, and it wouldn't rigidize. So then I backed out a little bit and it was still stuck. I then translated up because it appeared that it was low. I translated up and backed aft again, and it came loose.

Aldrin — I cycled the TDA to DOCK and then RIGID just to make sure it was working and not just a bad light.

Lovell — When we were loose it worked. We backed out again and we were going to try it again. About this time, for some reason, I looked at the eight ball and the platform was still alined fairly decently. This was on the night side, of course. The lights on the Agena caused us to lose all visual cues outside except the Agena. It appeared to us that we were pointing quite a ways down, in a downward position.

So I backed out and I looked at the Agena and it was...

Rep — You had a central angle change but you were in ORB RATE.

Aldrin — Yes, we were in ORB RATE, so the eight ball should have given us a good position.

Lovell — Were we gyrocompassed at this time?

Aldrin — Yes, after we docked the first time we gyrocompassed.

Lovell — That's right.

Aldrin — We gyrocompassed it in flight, and then we undocked and looked around again. I was going to back...

Lovell — How about the way that gyrocompassing worked? You recall that? Because we're going to be getting into gyrocompassing problems later on.

Aldrin — Gyrocompassing there seemed to work okay.

Lovell — I certainly don't recall any problems.

Rep — What mode did you use for that one?

Lovell — I think we were in plain old Flight Control Mode 1 right there because we were in Flight Control Mode 1 when we gyrocompassed around.

After the first docking we gyrocompassed and everything seemed to be normal. We undocked, flew formation around the Agena, photographing it, and came back just about nighttime. Buzz did some of the flying from the aft end of the Agena around to the forward end. I started to make a night docking. When I engaged the docking cone my speed was low and the engagement was not complete. I fired forward to complete the engagement but it wouldn't rigidize. So I translated aft to disengage and try another pass, but the nose would not leave the docking cone. It seemed to be stuck, or hooked on something. I then attempted to reengage firing forward thrusters but still we could not get a complete docking. I then backed off seeing that we were still stuck. I translated up to try to relieve whatever was holding on to the spacecraft nose, which I figure was one of the latches. That plus the translation aft did undock us, and we moved aft.

Aldrin — In that first undocking, we left the computer on and we hit START COMP - and I read out 80, 81 and 82 during the undocking; and right afterward while we were holding a stationary position. It seemed to indicate that when we were holding a stationary position the addresses were showing about a tenth of a foot per second. There's a little inconsistency there. But it indicated, with respect to the upcoming tether exercise, that we could possibly use this as an assistance in establishing a stationary position. It really didn't thrill me, the results that we had, but it indicated that they weren't as bad as we had seen in the simulator. So I guess we lost them here during this darkness period, or you lost them and I picked them up in the right window.

Lovell — And I, at the time that I lost them, had no yaw at all in Rate Command.

Aldrin — No yaw right.

Lovell — No yaw right, for some reason.

Aldrin So I took it in DIRECT.

Lovell You took it in DIRECT and I went to throw the switches to find out - I lost them completely. Looking back on it, what I think happened was, we put a rate into the Agena while it was fully loaded with fuel. We disturbed it off of its normal axis. That, coupled with the fact that we moved away and the fact we think now that this might have been the beginning of our thruster problem, but we didn't realize it at the time, gave us some concern.

Aldrin Well, we knew that there was something wrong with the thrusters and it was dark and the Agena was moving away and we didn't have good attitude control. And I was getting a little concerned because I could just see the whole thing going up in smoke at this point if we lost the Agena.

Lovell Yes, it was a few moments of concern there since...

Rep You kicked it off with the forward firing thrusters?

Lovell	I feel that we kicked it off of its axis by trying to disengage. And being so heavy I think that the Agena just started to move off.
Aldrin	Right. And it was in this flight control mode where it was very sluggish.
Rep	Flight Control Mode 1, right?
Lovell	So, it was trying to do something but it wasn't very logical what it was trying to do.
Aldrin	So, I moved over there and got it docked again.
Lovell	Buzz went to DIRECT and I . . .
Aldrin	There was a little sigh of relief there.
Lovell	Yes, and we got it back in there and Buzz docked it.
Rep	It was okay in DIRECT , though, you had complete attitude control in DIRECT?
Lovell	Well, it wasn't the greatest. We used up quite a bit of fuel, by the way. We actually did our first docking, I think, with about 67 percent, and we ended up after that whole night period - let's see, that was attitude gas.
Aldrin	Do we want to say something about the X-ray and Beta?

Rep — During the second docking you had no problem with the docking?

Lovell — Well, I don't think it was acting correctly.

Aldrin — No, I moved into it rather slowly while lining up. When I was a couple of feet away it looked like it was lined up pretty well. I pushed the thruster forward and it seemed to go in but it didn't seem to engage. So I squeezed it in a little bit more, and then finally when it looked like things were beginning to move, that's when we breathed a sigh of relief and the light came on indicating a dock. I think we made another docking.

Lovell — We did.

Aldrin — I did a day docking, after that.

Lovell — We checked it again later on.

Aldrin — The behavior on that wasn't really smooth or anything like that, so we though we'd forget about any further....

Lovell — We talked to the ground about this time. We used up quite a bit of fuel. We were ahead of fuel on the rendezvous but by the time we finished up all our work we were behind fuel. I thought, well, let's forego the docking and formation flying since we wanted to save the gas. After discussing it awhile, we decided maybe we better do a third docking just because we didn't know what was wrong with out spacecraft.

Aldrin — We never did get this Mode A which is the roll bit.

Lovell — No, we had to bypass Experiment M-408, Mode A at this time, which we should have done. We called down to the ground and said, that we were undocking. So Buzz undocked this time and then just sat out there a couple of feet.

Aldrin — What we were trying to do was figure out just what it was that was wrong with it.

Lovell — And we couldn't find anything although I had done two things to the control system. It seemed like we had a roll problem so I went to SECONDARY on the roll gyro and I went to ROLL JET PITCH at this time. This is after we had the initial problem at night when I lost sight of it.

Rep — Your second docking which you made, Buzz, was in DIRECT correct?

Aldrin — Yes.

Well, we still weren't confident of Rate Command

Rep — What about your third docking?

Lovell — I was in DIRECT. We didn't know too much about Rate Command but we got back onboard again and we thought we might as well leave well enough alone.

Aldrin — So we got docked. Of course, we weren't really sure what was up. What was the Agene attitude at that time? I don't think it had stabilized down any.

Lovell — No, it hadn't. And to complicate the fact I think it was still translating. So, we had a combined problem. We were looking at a nose of something that was also translating, which if we figured it was steady, would give us a false indication of what we were doing.

Lovell We did a third docking just to check out the spacecraft and we moved out a couple of feet. It was a daytime docking and Buzz just checked out the system to see if we had it. I didn't check that configuration out at all but it appeared with the roll jets in pitch. I felt that maybe that did something because Buzz got control again that night when I switched them. I left them there and it appeared that we did have control and Buzz made another day docking this time in DIRECT. We decided that we'd forego anymore docking or formation on this Agena since we needed the Agena to continue on our flight plan. We were behind and we used up quite a bit of gas and we were trying to save on fuel. During this period of time both of the fuel cell lights came on. This was around 7 hours and 30 minutes. Let me backtrack a second. We got the indication at this time from the ground that we were not going to do a PPS burn. At the same time we had heard an update that we were going to do an eclipse phasing maneuver, which we had written down. This eclipse phasing maneuver required gyrocompassing the Agena. It was here that we had trouble getting the Agena gyrocompassed. It seemed to be very sluggish in the gyrocompassing mode. The ground suggested Flight Control Mode 2, which we went to. We had problems. Buzz, do you have the time on the SPS maneuver? It was 7 hours 5 minutes and 6 seconds. The delta V the ground gave us was 43 feet per second. We just got the Agena around in position in enough time to make this SPS translation. We used Flight Control Mode 7 to do it. The ground at that time had sent up a procedure saying that if we could not get the Agena to burn or get the Agena around that we should use the OAMS system to make the burn.

Aldrin — Yes, I would like to go over this horizontal retrograde maneuver at 7:05:06, 43 feet per second a little bit. We loaded this in the computer and we loaded the VM word. It was read out by the station that gave us the VM word. We burned it and as I recall it held attitude quite well in flight control mode. But the communication that we got from the ground was very confusing. Just a short while before the burn they said, "if you can't burn it with the SPS, burn it with the OAMS and only burn 41.3."

Lovell — We couldn't understand why the difference in delta V, if we burned it with the OAMS system.

Aldrin — What I figured out they meant afterwards, was that they had a new burn for us. It was too late to change the VM so if we didn't go with the VM for the 43 and there was insufficient time to change the VM to the $41\frac{1}{2}$ that we burn the spacecraft for $41\frac{1}{2}$. They were trying to tell us this but they didn't give us enough words to give us the story. Looking back on it, we also made a mistake there in that it was an update and it was a change in the flight plan. There were no words sent along with the horizontal retro update that it should be a minimum delta V. If they had told us a minimum delta V we would have burned 80 to 0. Now in looking back on it, I think we should have been able to figure out that it was a horizontal retro for eclipse. Which meant that it was a precision burn and we surely had it within our capability to burn 80 to 0, but we didn't. As a matter of fact if they wanted $41\frac{1}{2}$ instead of 43, we could have very easily burned the Agena and re-burned with OAMS the difference. If we only knew what they wanted, we could have done it.

Lovell They not only didn't tell us all the story but they didn't give it to us soon enough. During that previous night period, we had an experiment M-408 again which required a rolling Agena two degrees per second to the South Atlantic Anomaly. Now here we were docked to Agena full of fuel, we started to do M-408 and we got an update for an SPS Agena burn. We stopped the M-408 to translate the Agena to position for the burn. We had difficulty in gyrocompassing the Agena and we just got it there in time.

Aldrin All these changes meant that the Agena burn was right in the middle of our eat period. Fortunately we had started to eat a little bit sooner so we got that out of the way. We purged the fuel cells earlier then called for in the flight plan and we got both fuel cell delta P lights on.

Lovell Fortunately we got the burn in on time and then we burned the Agena system and the burn was nominal.

Aldrin I wasn't sure whether the VM had shut off the Agena or whether we shut it off. As soon as it crossed to 0 I hit the Arm Stop to STOP and I asked the ground whether we had shut it off or whether they had shut it off. They seemed to give us an indication that the VM had run out.

Lovell At this time we checked the attitude gas in the Agena and it was down to 56 percent. When we docked originally I believe that gas figure was up around 75. You can see how much attitude gas we used on the Agena just in that docking - just in that problem we had the previous time.

Aldrin: Another comment here, I wrote down an update here that said at 7:30 we should sleep. Which means that according to the flight plan we were still horsing around with an Agena that wasn't working properly; we had a burn right in the middle of the eat period at 7:05, and we were supposed to go to sleep at 7:30. Then they were going to close the S-12 door. We had an EVA the next day. Now, this is a heck of a way to get things set up. Well, the point I'm trying to make is, I hope not an embarrassing one, because we were emptying out UCD's and using the urine system. We knew that they were going to open the S-12 doors, and we were horsing around with these various systems trying to get everything pumped out the urine dump. We finally shut the urine dump off at 8:04. I don't know when they actually closed them. It seemed to me we got a DCS light before that time. But if they closed it right at 8:05, I'm afraid that it might possibly have affected that experiment. But we did have the system off. Do you have any idea at what time they actually shut them?

Rep — No, we had undoubtedly left here and were at the Control Center at that time.

Lovell — Anyway, after purging the fuel cells, both fuel cell lights were on around 7:30.

Aldrin — Now let's see, I think there is another thing that got in there. We did turn off the X-ray, and the Beta. At this point we were operating off of a preliftoff flight plan that was being considerably updated. The updates obviously didn't include everything. They didn't include things like when you turn those on and when you turn them off. We just didn't have enough time at this point to look ahead into the flight plan to see the sequence for that experiment. To see that we should have in fact left them on for that night period.

Lovell There was nothing in the flight plan that said do not turn them off. It just said -

Aldrin No, I think that that really ought to be listed that way. If you are going to have an experiment, it ought to say right in the flight plan, leave them on until... because the procedures for the experiment said per flight plan. That leaves it up in the air just a little bit too much.

Lovell We ended up the first day docked, we completed an SPS burn, we had fuel lights on, attitude gas was down, we had trouble controlling Agena gyrocompassing.

Aldrin We were supposed to go to sleep I guess about 1 hour earlier than the initial flight plan. But as it turned out, I don't think we were really ready to start thinking about going to sleep until a good bit after the flight plan, which left us pretty short.

Lovell About the end of the day, our actual PQI reading was about 55 percent which was about

7 percent below nominal at that time. This was quite a change mainly due to the spacecraft trying to bring the Agena around and then trying to redock.

Rep — I notice there was some comment about a 16MM camera magazine one in formation flying. Anything off nominal on the developing of that?

Lovell — Well we took movies of the -

Aldrin — I think we took about a magazine and a half or something like that. It wasn't an abnormal amount. But after going over the flight plan in preflight, we figured we didn't have a whole lot of film to devote to this. Did the ground ever ask us for status display meter readings? Maybe they gave that up.

Lovell — Okay, essentially the flight plan was then changed to make a rendezvous with the eclipse using the Agena SPS the next morning since the PPS burn was eliminated in the flight plan. Wakeup time was 14:40.

Rep — Do you want to cover the sleep period, or have you already done that?

Lovell	I've covered the sleep period I think at the medical debriefing. The one thing I found when I got the sleep period time was that there was a pretty short period of time to sleep.
Aldrin	In relation to the - well, let's see the flight plan had it from 8:30 -
Lovell	They moved it up an hour.
Aldrin	To 17:00, right?
Rep	17:00 that is right.
Aldrin	Okay, well that is 8-½ hours.
Lovell	Well, our wake up time as they had it was 7:30 to 14:40, which was 7 hours.
Aldrin	But of course, we weren't near ready for sleep at that time.
Lovell	We had to go into the initial night period. Getting everything squared away after.. Over the Canaries at 14:42, we got a flight plan update and we got the word on the eclipse. Again the ground information was somewhat lacking or peculiar in the eclipse update. They had asked us to take certain photographs

of the eclipse including the 16MM Maurer, which we had, a Maurer 70MM which we had onboard and and also a Hasselblad, and also for Buzz to put an opaque filter over his window. I defy anyone to take a 70MM Maurer and a Hasselblad photographs of a 7 second eclipse through an opaque filter, when you have the optical site mounted. No, I was operating the 16MM camera and tracking and Buzz was going to try to ... and I said, "Buzz, hand me the Hasselblad", then I said, "Forget about it, I've got the optical sight." So, it just couldn't be done, and I thought that something like that should have been screened prior to when it got to us, on the ground. Anyway, we did make a phasing burn by the SPS which was a nominal one to adjust our orbit to rendezvous with the eclipse.

Aldrin Have you got that one in there?

Lovell I'm looking. I think it's in here. Here it is at 15:16:18 we made a phasing burn with a Delta V of 15 feet per second for an 18 second burn. It was TDA forward posigrade. This burn did go according to plan.

Aldrin It seems to me that just from retracing it that the fact that we over burned by probably 3 feet per second at night in retrograde would call for the opposite direction somewhere around 15 feet per second the next morning; which meant that we wouldn't have needed that burn or anything like it, if we had nulled residuals the night before.

Lovell We didn't and so we burned. Paid the price. I'm sure after tracking throughout the night they got a better handle of where we were.

Aldrin Yes, but it would have been so much simpler to burn 3 or 4 feet per second OAMS than it would have been to go through all that "Mickey Mouse" with the Agena.

Lovell But we might have had a burn again on this. The eclipse itself was quite spectacular, I first looked at it based on the computer run that we had gotten just before the flight showing us the position of the moon and the sun and how the moon would cross the sun. Using that as a background, I didn't think we had made the eclipse rendezvous. It appeared that the moon was actually going to cover up a majority of the sun, but leaving a top sliver still exposed and I thought that we were actually going to not hit the umbra. As a matter of fact, I was grossly mistaken, because just at the right time that eclipse occurred completely and for a brief moment, I whipped off the filter and looked at it to see what it was like and at the same time I ..

Aldrin: That's all right, I was looking to see where the sun was to keep the camera pointed that way.

Lovell: I was well aware of the lighting conditions . and at the same time..

Aldrin: I looked at the sun, also, and it looked beautiful. And I took one good exposure for that minimum and I had 1 second one. The 4 second I think overlapped because it was coming back bright again.

Lovell	I changed the shutter setting and the aperature on the camera as he went in the total to get as much as possible of 16MM and I hope this ... Shoot it all at the same time. I'm sure that the beginning of the eclipse is over-exposed because I couldn't stop the camera down that long.
Aldrin	Well, I had my camera down there too. I guess I had it going at the same speed yours was. F/2 at 150.
Lovell	Well, you might have picked it up before.
Aldrin	So we should of had two 16MM going. Now one thing that I am not sure of looking at the updates for the Hasselblad of F/11 and 1/250. I don't think that is what I had it set on I'm pretty sure, that's right because I said there isn't any F/.2 setting on the 18MM lens, there is a F/2.2. Right?
Lovell	Yes.
Aldrin	So, we both had them set on F/2.2 and 1/50,6 frames per second.
Lovell	But, maybe we weren't verbose enough on the eclipse because they asked us if we did

the eclipse rendezvous and we had.

Aldrin Pitch down 25°, yaw 135°, to pick up the shadow. I never got whether it was yaw left or yaw right. We didn't have the platform up.

Lovell I thought the ground did a wonderful job on the rendezvous. Again the update said to turn around and pick up the shadow. Now, this we realized before the flight was going to be very improbable, due to the low sun angle at the time the eclipse occurred. We took their instructions and did it. We attempted to turn around again with the Agena spacecraft combination. We had to turn around rapidly since the shadow was moving rapidly across the Earth. When we finally got around, we couldn't see anything. I saw a brief shadow off from the terminator area, which I suspected was the retreating penumbra. We saw nothing of the umbra. We must consider on these updates what we are working with in doing these things. The Agena right then was a hindrance to us in most of our operations.

This serves as a very important stowage area for the Command Pilot to put things down underneath. This strap or bungee had broken off while Jim was trying to hook it up, right after insertion. We decided at this point to switch pouches, so that he would have mine that was still good on his side that he could put things underneath it. I took his and tried to rig up a way where it would be velcroed to the floor and one snap would be on. I re-routed the leg straps so that instead of going over each side, they went straight across the top over the D-ring at the front sill of the seat. I got the bag in underneath this and this worked fairly well. It did seem to come apart a little later on and we finally made the last standup EVA without any covering on the D-ring.

Lovell The Soft Suit Checklist for the first standup EVA I thought was quite comprehensive and well prepared. The training prior to the flight in

We were horsing it around because we couldn't wait for it to get us around.

Aldrin: The fact that we did take these pictures of the eclipse at this time messed up our stowage. We were stowed so that we were able to get 3 pouches out and be all ready to go for the standup EVA. But we needed the red bag out and that was about 4 or 5 pouches down. So, this had to be done the night before and that was the beginning of juggling all sorts of things around.

Lovell: We're into the first standup EVA preparation. The flight plan update was good. We got a GET time from the ground of sunset. We determined our event time setting of sunset minus 20 minutes. That was the time we were to open up the hatch.

Aldrin: One thing that I might note here that affected our stowage a slight amount in our preparation was that we had a failure in footwell floor bag on the left side, which snaps up to cover up the D-ring.

this standup was valuable training in that the actual standup preparation and EVA was very similar to the training.

Lovell There was no problems in stowing the left hand aft pouch. Actually, the equipment was somewhat easier to handle in zero g and easier to get out as far as the left hand aft pouch goes than in one g.

Aldrin Yes, I might remark here, I had severe concern about getting things out of the right hand aft box because of the problems experienced in one g just turning around and pulling various pouches out andgetting lanyards all tangled. I was pleasantly surprised that the lanyard and its hooks just seem to float rather freely in space. It's quite similar to the way strains of cord behave under water. Nothing seems to tangle up under water and things didn't have a tendency to tangle up in space either. They obviously don't stay where you put them and we had to make several more excursions into the right aft box then we had figured on, prior to flight because of some of the changes that we had that affected the order in which things were stowed. What I tried to do is to look ahead in the check list and plan when I would be turning around to get things out so that I could get as many other things done at the same time. There still is a bit of a problem getting all set and loosening up the lap belt in order to turn around because I had things in the footwell that seem to float around. If there was a camera mounted my back would rub against it some and I think in some of the turnaround maneuvers I managed to hit switches into their wrong positions. For example, I think I hit the TM switch at one time to Real Time and Acq instead of Command or vice versa. I was never sure when I came back around whether some of the switches had been affected. In general the preparation for the standup EVA was a fairly simple one.

We just needed two or three boxes out of the left box and a few out of the right box. I mentioned before we had already taken a few things out for the eclipse photographs and we had to shuffle some of these things around because there wasn't room in the camera boxes to stow the things that had been taken out of the right hand box.

Lovell I have no other comments on the preparation. I believe that the check list that we used should be used as a standard for standup EVA. It eliminates some of the difficulties and time consuming preparation that usually goes into these EVA check lists.

Aldrin The use of the elastic straps around the extended hose setup that I was using by making use of the ELSS hoses attached to the ECS hoses worked out quite well. It was in fact the first time that I had ever had these elastic straps to actually see how they put the hoses together and how they routed them together.

This was a bit of a problem in our training in that the hoses that I had were considerably longer than we had in standard training units like the GMS, the zero g airplane and the mock-up in particular. The mock-up is where we ran through most all of our preparation for all EVAs and tried to work out the procedures and unfortunately the wiring hook up for the electrical leads was not at all typical of what we had in flight. We didn't have the same type of an electrical connector so the training that we got in setting up the hose configuration for standup EVA in the mock-up left a little bit to be desired. It was in some senses a little negative training. I think we were able to anticipate this and in flight we found that things were as we expected them to be.

Aldrin Let's see I quess we ought to.....

Lovell Let's talk about..........

I have no comments on that integrity check.

I went just as.....

Aldrin — I think we're on the order of 3/10ths to 4/10ths leakage.

Lovell — We kept that way during most of our EVA 3/10ths to 4/10ths leakage on all our integrity checks for EVA. One of the new things for the preparation which we had tried to do is to get complete tape recorder coverage of the EVA periods to correlate photography and the pilot's reports on the EVA exercise for future work. We put some velcro on our leg and took the tape recorder out of its holster on the side of the spacecraft and placed it on my leg. I was able during the EVA period to lift the tape recorder up and change cartridges.

Aldrin — I think this placing velcro on our suits along the thighs was an outstanding contribution to the command pilot. It was a terrific idea. It turned out that I used this little feature to store the food while I was preparing it to eat and the check list would go quite well on your leg. I think that we could begin to expand on this a good bit more and apply this sort of a temporary stowage configuration to the Apollo suits. I think it would benefit considerably.

Lovell — Another contribution that would help along this line was one which we got from Gemini 11. That was the clothes line technique. The clothes line has little snaps along it and was hung between the guard on the center pedestal to a guard on the left hand circuit breaker panel. With the snaps we're able to snap on film cartridges and by means of clips we're able to hold tape cartridges. This permitted me to change film in the camera and also change tapes which would otherwise be impossible because of the handling problems of these small items during hard suit operation. Perhaps we ought to go into depressurization of the cabin. We got the go for depressurization after our integrity checks which were as reported before 3 to 4/10ths. We went down to zero. We had no undue feelings that I know of. I do not have any. We conducted at that time an exercise period. Buzz, you want to cover that?

Aldrin	Yes, I think I may have led the medical people astray in our debriefing yesterday because I wasn't sure whether we had done this inside or outside.
Lovell	It was inside.
Aldrin	Thinking it over again, I'm sure that we did it inside. The only thing that was in my way in doing this was one pouch that we were jettisoning. I was able to get this down between my legs so that it didn't interfere with the experiment or the exercise and at the same time it was really available for a jettisoning. In order to conduct this exercise I had to use my legs a little bit to push my body back and down to get adequate arm clearance to raise my arms up and lower them back down. I found that the exercise, in comparing it with what was done on the ground, meant that the arm movements had to be much further toward the inside instead of a more outward swinging arm motion. I didn't attempt to count the

number of arm movements. I started at a fairly comfortable pace and we ran this for one minute. I guess about half way through it I increased the pace a good bit trying to compare the tired feeling that was slowly coming into my arms to what I had experienced in doing the exercise on Earth. In general it was a little easier to exercise than perhaps I had anticipated. Maybe I didn't expend quite as much energy as I had on the ground. It didn't seem as though the rest period was needed particularly afterwards. I wasn't at all winded or out of breath as a result of it.

Lovell Hatch opening was very easy. There was no tendency for the hatch to pop open. Cabin depressurization seemed to be complete. Both Buzz and I were on the spacecraft system. The hatch opening was absolutely no problem whatsoever.. The primary purpose of the first standup EVA, as originally conceived, was use the S-13 experiment, some star photographs using a 30MM Maurer camera. To do this, we utilized the experience of previous flights in the fact that the Agena had much better attitude control, smaller deadbands, and hence better tracking capability in the inertial mode than the spacecraft. The Agena was placed in flight control mode 2. It was TDA aft. We utilized spacecraft propellant to maneuver the combination to the star that we wanted to point at, and then the Pilot was able to send control to the Agena to hold inertial position on that star. We found out that this procedure, with our particular combination of full Agena system, and being hard suit while controlling the spacecraft, was time consuming. In the first night period, we did not complete all three programmed star photography maneuvers. We had to skip one because daylight was coming on and we couldn't get all the photography that we needed. In preparation for this particular experiment we didn't realize the time that would be consumed in getting from one star to another. The Agena did hold nicely on the star once we were alined properly, and damped the rates.

Aldrin I would like to comment on the actual hatch opening. We expected that the hatch might open suddenly once we had unlocked the dogs. But, this was not the case at all. When the hatch was completely unlocked, it took a very small force to get it started in the open position. It seemed as though the hatch would remain in any position that it was placed in. I had anticipated from training that I would have to push the hatch all the way open, then go through a complete standup in order to turn around to position the gain and drive selectors to the locked position. I found that this wasn't the case at all. I could just open the hatch, perhaps a foot at the opening and easily reach up and change the position of these and also lock the hatch handle. This made it considerably easier and eliminated taking the time to actually turn around.

The waste bag was jettisoned without any particular trouble. It was heartening to see it keep moving away and away. Putting up the camera wasn't a particular problem. It seemed a little bit more stable than we had anticipated. The bracket still had a certain looseness to it. We put the velcro strap across it at the bottom, which helped to keep it steady at the attached point to the hatch. We worked out a configuration on the cable release, whereby it was velcroed to the back of the camera magazine back. So it was pretty much out of the way while we were going through the installation procedure.

In general, we had a little bit less trouble with all the tethers and brackets, at least I did as far as mounting it, than

I had anticipated from the many, many problems that we have had with this configuration in training.

In one of the exercises, the S-13 experiment, changing the fitting on the camera from a prism to a grating or vice versa, was no problem at all. The clothesline came in handy because we had the prism attached to the clothesline by means of a ring. When the camera was handed in to me, I was able to disengage the grating and velcro it to the side of the spacecraft, at the same time mount the prism on the camera and hand the combination back to Buzz after we reset the camera position on the bracket.

One other comment on the S-13 experiment. This experiment required a reticle being placed in the left side for me to track the star. The reticle itself is quite a big device, takes quite a bit of room, and left very little room for me to move around in.

Planning all of the EVA's I had my shoulder harness attached and locked and lap belt pinched down and the helmet tie-down straps cinched way down.

During the middle portion of the EVA period, during the daylight pass after the first night photography, my lap belt gave way. It was probably due to the fact that I didn't attach it correctly and the pressure of the suit just let it go. This forced me up to the top of the spacecraft and made it very difficult for me to look through the reticle... As a matter of fact I could barely look through the reticle and at the same time I could barely read the hard suit checklist. A lesson learned, to make sure all the straps are correctly fastened to prevent something like this because it makes operation very difficult in a hard suit.

Aldrin

Before we ever got started on S-13, we set aside some time to investigate basic EVA problems. The purpose of this was to compare the motion and the dynamics that he would experience in the standup hose configuration with what I was going to experience in the umbilical EVA. We had indications from people in the past that had done the umbilical EVA, that the ELSS or perhaps something else tended to give a considerably different reaction in terms of floating out of the cockpit tendancies than had been experienced on standup EVA. To find out just what the situation was on the standup EVA I had the tether that was attached to the left armrest of the right seat extended to the full opened position. The hoses that I had were quite long with the extensions on them. I tried to raise up in the hatch area to a point where no part of my body was touching the hatch or the cockpit at all. I had my left hand on the sill between the two hatches and my right hand on the strap on the open hatch. And with two hands, very lightly, I was trying to position my body so that there would be no reaction when I let go. To the best of my observing capability, when I let go, nothing happened. I stayed put. As I gave a small tap with my fingers I would glide and gently impact the other side of the cockpit, I could turn my body around with small differential actions with the fingers and raise myself up and down. Now let's see, we were talking about standup dynamics.

Lovell — Right, and you were mentioning what you discovered in our initial look see or evaluation of standup dynamics.

Aldrin — There is always going to be some reaction force put on the body from the fact that you have hoses and an electrical connector attached, but I was trying to make every effort to see that these did not interfere with the evaluation. In my opinion, it appears as though my body was in a zero g position or as completely independent of outside forces as it could be.

It tended to behave just like everything inside the cockpit did; that is, if it was placed in a position it stayed there. Small forces were required to start me moving up, down or from one side or the other. We have no way yet on earth to train people just how large a force is required pushing or pulling to get the body moving. Underwater tends to mask these effects because of the drag and the viscous effects. In the zero g airplane, it is extremely difficult to attain this pure zero g and we never really know whether we're working against a small perturbation in the aircraft trajectory or whether this is an actual response that we have. The cockpit of the Gemini spacecraft is not very large and it doesn't allow much freedom of movement at all before either the hips or the arms, the elbows or the feet begin to come into contact with one of the surfaces. I was quite thankful that we did have the standup EVA first because it gave me an opportunity to see just how small the forces were that were required to get the body moving. I'm sure also that having this standup EVA first, with its smaller priority than the umbilical EVA, tended to have a slightly lower psychological effect if there really was any in terms of effecting any mental tension or something that might have impaired the activity or changed heart rates...

Lovell What you are saying is the standup EVA prepared you for the umbilical EVA.

Aldrin I'm glad that we did that one first instead of the other one. It put me in much better shape because then I could devote all my attention to the particulars of the umbilical EVA when that came up. I would like to tell you a few things about the visibility. When I first got up, we were in a SEF condition, generally, under Agena control. As I stood up the sun was back over my right shoulder and it illuminated the Agena and the spacecraft, especially the retro adapter in a rather brilliant fashion. The white of the retro adapter and the white on the Agena provided a considerable contrast with the background of dark space. I think one of the first observations that I made, and this was with the visor up, was that, "Would you believe I see stars"? And it turns out that on a little closer inspection it was not stars at all that I was seeing but it was very small particles that were continually being emitted from the spacecraft and also from the Agena. They were at such a distance, and under the lighting conditions that we had they were illuminated by the sun, they appeared to be stationary against the sky background. Now this became quite obvious as sunset descended upon us because these objects began to disappear. The first thing I knew Jim was saying that he had Cassiopeia in sight and that he wanted me to turn the ACS system off so he could move on around to pick up the stars. It amazed me because I was still, at this time, in daylight. With his window on the left side and the sun being on the right rear, he was able to get dark adapted much sooner than I was. As a matter of fact, he was getting in position on the stars before I began to pick up any of them at all. I think this points out the problems that we may have in terms of dark adaptation of a person outside of the spacecraft. The spacecraft is of a white finish as I'm sure they're all going to be in the near future. We're going to run into this type of a problem and we may want to take some steps to provide some means of dark adaptation before we get into night work. The taking of pictures with the cable release setup that we had was, to say the least, not a very good setup. The cable release required a force to depress the cable to get the camera going and it had to be held in the depressed position for the duration of the photograph. These varied from 30 seconds to 2 minutes. The reason that we went to this type of a cable was because of problems that we experienced on previous flights and failures of another type of a timer that would automatically time these exposures for us. Some of the early cable releases that we had you could depress and they would hold down for you.

It seemed to me that it was quite cumbersome to rely on this feature. It required depressing the cable and turning it and then releasing or turning it back again when you wanted to actually release it. It seemed to me that this was a less reliable way of getting accurate time exposures than what we adopted which was getting a mark of the start and the stop of the picture. Looking back on it, all the photographs that were taken with this cable release amounted to a considerable effort on my part in holding the cable release depressed. I was continually experimenting with different ways of depressing this release and holding it for the time period. I would try it first with one hand and two fingers on the cable depressing it with the thumb and this got quite tedious. Then I tried to shift to using two hands and squeezing the two hands together. Each time I went to release it I was never sure that it was really going to release so right after releasing it I would pull the plunger back out again. The one method that turned out to be the least effort was if I could position the cable release in my hand in such a way that a squeezing of the fingers against the palm of the hand would hold the cable release depressed. This required the least effort. However, it wasn't quite reliable and there was some danger that the cable release could be depressed before it was really desired. In all these photographs I don't think we made a mistake on any of them in terms of having it depressed to soon or not having it release on time. The only way that I really knew that it had been depressed and released properly was when I went to cock the camera again. One interesting observation I had on either the first or the second night pass was that in the process of holding two hands together to depress the shutter release, I noticed that as my hands were moving one against the other I saw a slight glow coming from between my hands. I figured, the only thing that this could be from was some sort of a static electricity discharge so I started

I could create this effect. I'm not sure how important that is. I think we'd have to look at the surfaces that are involved and figure out whether there is anything significant . Perhaps we should have taken a little bit of time to really look at this and try to generate this sort of a thing again. We did have the time but I didn't investigage this more. Once I got dark adapted I was able to see the star fields quite well and assisted Jim in going from one star field to the other. The visibility at night as far as seeing things that were in my hand, when viewed against the spacecraft, was rather poor. However, if I was able to raise my hands up so that the star field background was behind my hands I could barely see what I was doing with the light. We had no moon up at this time. So this was coming from the night glow of the sky plus whatever was being reflected up off the spacecraft. The interior lighting consisted of a red light shining on the encoder and we had a light on the timer, the clock, and the light over on the left hand side. I don't think that either of these lights could have any affect on the Agena.

Lovell

No, I might mention that the technique we used was to have me time your exposures with the event timer - and have you take them. We checked prior to that time with the experimenter and it appeared that this light would not interfere with the photography on the EVA portion. It would for interior type work through the window. I might mention we received pointing commands from the ground to pick up the star fields but the lack of a platform made it necessary to know the stars and know how to get to them without any type of pointing commands. In this regard, a person outside who has a greater field of view could be of some assistance. Buzz, I think we've covered everything on the first night. Back to the S-13 experiment. We mentioned the fact that it was difficult to get more than two good star fields in per night pass.

Aldrin: Yes, we continued to take pictures until the sun started to illuminate the Agena.

Lovell: That's right.

Aldrin: It appeared as though this would be blocking out any of the photographs.

Lovell: Why don't we cover the day period here . . .

Aldrin: Right. As soon as the sun came up and we were through taking the pictures, the first task that I had was to turn around and pick up off the left top of the right seat the EVA camera that was affixed there to the velcro and install it in the bracket mount. In doing this, I was able to get my right hand in good position on the camera with my thumb depressing the locking lever and a very good grip on the camera. My left hand then, grasped the rear of the seat in the vicinity where the ejection rail came up. This afforded an excellent hand grip. Then, with a moderately tight tether configuration, I let my feet drift up sufficiently to be able to reach out and put the camera bracket in the hole. It seemed to take a rather small amount of twisting until it was in the right position and with the lever depressed the camera went down rather easily. With the lever released, it appeared to lock in the way that we expected it. I then moved out to a slightly more extended position. This actually amounted to full standup tether deployment. It didn't change the configuration quite as much as we had planned on to begin with. I guess the first tether was a little bit looser than we had hoped. Anyway, it did afford the opportunity to take the camera down and to remount it. The purpose of this was to compare these operations with what other people have done in our previous flights,. and to what I was going to have to do several times during the umbilical EVA. I can't say anything significant came up in taking the camera down again or putting it up for the second time. It seemed to go up the second time just about as easy as it did the first time. In the process of mounting the camera, your fingers just naturally fall over that part of the camera where the lever is that controls the camera settings. Invariably after you have mounted the camera, you also have changed the setting to 1/50th of a second instead of 1/250th, so I had to reach over and make sure that the camera was back on the 1/250th and 6 frames a second. We had the lens taped to the f/11 position. After the camera was mounted for the second time, we decided to check its operation. Jim turned it on briefly and I felt the camera body and could feel the cycling of the camera so we were assured that it was operating properly. The next task that I was involved with was deploying the portable hand rail. This required that I turn around in the cockpit and disengage the pip pin that was holding the handrail in place. As soon as I pulled the pip pin out, the handrail jumped toward me about 3" because it was under a small amount of tension. This surprised me a little bit, but of course it was so big and it was essentially wedged between me and the hatch. So there was absolutely no danger at all of its going anywhere, or going much further to get out of reach. I jettisoned the pip pin and pulled the handrail out and then started turning around. This was a rather easy task. I turned around to face the hatch sill, and then started deploying the telescoping sections of the handrail from the small end first. I got that one deployed all the way out and then started deploying the second one that had the ring on it. The first section didn't have any alinement mark and it wasn't really needed. It was quite simple to pull it out to the full deployment and then a gradual twist would engage the seating pins. The second one came out quite easily also. We had alinement marks on this one and they lined up rather nicely and the pins engaged there. The third one came out just as easy also. The actual placing of the small end into the Agena cone worked without any problem at all. It was quite easy. I think I was using two hands. I was probably making use of my feet in the cockpit pushing against the bottom of the instrument panel and perhaps against the front lower part of the seat to give me a little bit of resistance or friction force so that I could then make use of two hands. With the end of the rod in the receiver in the docking cone, it was a simple task to just compress the end and engage the spacecraft end into the bolt. This slipped very nicely into its place. The fit was excellent in that it was about 2 inches from full compression, which meant that there was no chance at all of disengaging the handrail, once it is in place in the receiver, by pulling it toward the spacecraft and disengaging it from the Agena. We were a little concerned about this because there wasn't any real way after plan X to verify that in a true docked configuration of the actual spacecraft, that the fit was going to be as close as this. So we were quite happy that it turned out okay.

REP Did you have any problems with GLV strips for this unit? Where they were going to be. You've recovered 2 and...

Aldrin Yes, I think I put up the camera next and we went according to the flight plan. Putting up the Maurer camera, wasn't particularly difficult. It took a little concentration to get it seated in the slide properly. It didn't glide real smoothly on the slide. It took a little forcing, but it gradually slid back into the full seated position and I engaged the Velcro on it then. The GLV strips, the two white ones, had been stowed, in the EVA preparation, in the top of the seat. I turned around and it looked like I had my choice to exchange them with any of the four black ones that I wanted and I thought, why don't I take the ones that are furthest away. So I took the ones that were on the left side as I faced aft. I don't think we have them recorded anywhere but they were serial numbers three and four. I took off the first black one and put it on the seat and put the white one in its place and then did the same thing with the second one. There may be some small finger marks on them but I tried to take as close pains as I could to assure that this wouldn't happen.

REP Is there any problem in this stuff at all? (Referring to things listed on debriefing guide.) In other words, the telescopic handrail was just as you had trained for. There were no anomalies with that particular aspect.

Aldrin We got the GLV strips. Were they hard to .

Lovell Were they hard to get off do you think? This had been mentioned to me before flight, that the short little tabs might break off because they got hot during insertion. Sure enough, one of them did pull off and it made it a little difficult to peal it back. While retrieving the

S-12 experiment we worked up a way that we could have a lanyard attached to the zipper on the food bag on the right hand hatch. I deployed the fairing and tossed it away. It came off with no problem. I engaged the hook on the tether and pulled the experiment aft and the zipper bag was open and it slid into place with no effort at all. Then I zipped it back and tucked the tether back in. This took a little effort just as any other tucking operation of tether does in zero g.

Lovell We used the hatch pouch to stow or ease the whole technique.

Aldrin Of course, we had enough tether attaching various things all over to keep from losing them and we wanted to keep this particular one away from all the rest if at all possible.

Lovell Just a comment. We're just about saturated with tethers and in the EVA we are going to have to work out techniques that eliminate or shorten tethers.

Aldrin	Actually, we did pretty well on this one because we had the Hasselblad tucked up in the front, so it wasn't in the way. In some of our training it looked like we were really going to be snowed down with tether.
Rep	Okay, I don't believe you had any problems with the S-13 camera reinstalling. How did you feel about the way the camera went on the bracket on the center?
Aldrin	I mentioned that going on. It went on fairly normally.
Rep	Did you have a tendency of disengaging it with your body when you moved out at all?
Aldrin	Let's see, I took the thing off and handed it to Jim and then put it back up again. There of course is a tendency, if you push against the camera, for the camera to come off before the bracket comes off. No, there wasn't any problem when getting in. It was a one-handed operation. I had to move the Hasselblad out of the way to do it. We stowed the Hasselblad up forward of the hatch closing device on some velcro that was there. This very neatly

kept it out of the way for all the other turning around in the cockpit.

Lovell Now we had a small Hasselblad magazine full of film that we devoted entirely to this pass coming up over the states. Originally, it was going to be a high altitude one, but we changed things around, and it was not high altitude. The weather, I hope, will pretty well be evidenced by the photographs that were taken. I was using essentially, a shotgun technique; just taking continual pictures trying to get the Agena in the field of view and varying it. We pitched down to a near vertical position coming across Mexico and into Florida. I might mention here that the best technique of controlling the Spacecraft/Agena was to use the Direct Mode and short blips much like a Pulse Mode with the spacecraft alone. That was the only way we could effectively move the Agena in a short period of time. I think we had some communications with the ground concerning our inability to get all three star pictures in, and they told us to omit, during the second night pass, the photographs of Algol.

Aldrin — Right. We went from Deneb to Gamma Velorum. And at that period--I think this was the last shot of Gamma Velorum--we were coming into the sunlight.

Lovell — Right.

Aldrin — It takes time and I think that trying to get three star fields in S-13 was over ambitious.

Lovell — Well, we also learned from 11, in looking at the photographs that the experimenter showed us, that you don't want to start taking pictures immediately when you turn on the ACS system of the Agena because it takes a while for it to stabilize. In our configuration, having much greater mass, it was going to take even longer for it to settle down.

Aldrin — Let's go on into ingress.

Rep — I have one question here. Buzz, you mentioned that your right mike became inoperative, during that first standup.

Aldrin — Well, I discovered it during EVA prep. During umbilical EVA, it appeared to operate normally, in that blowing into it I could get the thing to work. I used the same electrical connector between the spacecraft electrical and the suit for the standup EVA as I used for the umbilical EVA. So, it wasn't in there. I think we ought to look at the helmet rather closely. During the second standup EVA the right mike didn't seem to be working there either. And I don't think it was working during reentry.

Lovell — But it worked during the umbilical EVA?

Aldrin — It appeared to work during the umbilical EVA. Now, I could be wrong in all four of these cases. I would tend to think that maybe it wasn't working at all.

Rep — Okay, I have one other question. Jim, you happened to mention that before the EVA prep, you were having trouble with the urine dump system. Would you care to make a comment on that?

Lovell — Yes, let me see if I can recall what the problem was-----

Aldrin — I know what the problem was. We had gone through the checklist, in configuring the switches and everything, and we turned off the secondary coolant valve circuit breaker.

Lovell — Oh, yes. That's right. It was a procedure error, or forgetting that we had turned off the secondary coolant valve circuit breaker. We couldn't dump it. But, actually, that circuit breaker controls the dump switch, so we couldn't dump it with that switch off. There was no problem.

Aldrin — I might mention just briefly here, to cover all the subsequent cases, that I elected long before flight, due to my own personal problems of small kidney capacity, to install the UCD for all EVA operations, since the actual time outside the cockpit was going to be in excess of 2 hours and the EVA prep, in some cases, might take 2 hours, and we might be delayed a rev. It seemed an insignificant task to go through, at least I hoped it would be, in comparison with the difficulties that could arise, in jeopardizing experiments by my own discomfort and perhaps having to relieve myself inside the suit. This just didn't seem to be the way to go at all. So I worked on a tab system on the UCD and made use of the swizzel stick to install the UCD while I was turning around unstowing things from the aft box. I found in the first training session that I tried this that it installed rather easily. This also turned out to be quite useful in all the efforts that I had in space. I didn't run into any particular problem. I think we might want to, in the future, work out some way of changing the rubbers that are used on it instead of having to use the same one over and over again. It gets a little messy in that respect. On the ingress we had to hand in the S-13 bracket which Jim had to position someplace, and then I took the EVA camera down and installed it on the seat behind me. It installed in a nice way there and was quite secure. The velcro held it quite well and there was no problem with it drifting up into the hatch area when we were closing the hatch. I kept the wires out of the way by the little velcro tabs on them.

The Hasselblad-- I had to change its location for ingress, and I handed that in also, as I recall. So Jim had his hands full. The exercise period was done in daylight. By the time we had the camera and everything else down, we were well into that daylight period. This exercise was done standing in the hatch, in contrast to the first one. I'm not sure whether we were over a station or not, on this particular one. I think perhaps we were. Doing the exercise standing in the hatch, there was a tendency for the left arm to hit the rail and the right arm to perhaps come in contact with the hatch closing device. But, it afforded me a good bit more freedom than doing it completely inside the cockpit. It went normal. I did it for the full one minute and near the end I started increasing the pace, or the rate, of arm movement. It didn't appear to tire me out, unduly, at all. I think just before the exericse, I had deployed the hatch holding device and checked the hatch pawls to neutral. After the exercise I turned around and verified that the seals were clear of any debris. Before the ingress, I checked the hoses to make sure that they were out of the way so that I could get my knees up underneath the instrument panel and then gradually work my feet as far forward as possible. With my hands on the ingress bar, I was able, with one surge, to throw my body back and down into the seat. It seemed to work very well the first time that I tried it, and I was well down below the hatch area as far as clearance went. We both grasped the hatch closing device and started moving it closed. We had done it before with just Jim doing it, but I found that I could get my hand up there too.

Lovell We were amazed at how easily it closed.

Aldrin The hatch just came closed as simple as can be and with very little effort. It got past the last locking ratchet in the hatch holding device, and either on this one or one of them, I told Jim, "No sense pulling any harder; it's already past the locking point." It was quite simple to reach up and unlock the handle and then start pumping it. I did find that unless you pulled the handle all the way back, you didn't really start engaging the locking mechanism. It took about 3 to 3 1/2 pumps on it before we had the release in tension, indicating that the dogs were fully engaged.

Lovell — I might mention one thing that I had forgotten before. I had no occasion to use the leg strap that was on the Pilot's suit to help hold him down. I didn't deploy it, mainly because there was no need to during this particular EVA period. Ocasionally, I would put his foot out of the way of the switches, or maneuver his leg into position so that it would not get tangled up inside the cockpit while he was doing something else. Other than that, I did not have to use a particular amount of effort to keep him positioned while he was doing this EVA.

Aldrin

Yes, I might mention that without the chest pack it was a good bit easier to look down and to see that the hatch area was clear for ingress, and also to look down at the encoder when changing the position for the ACS on and off. Visibility was quite good, and I think we had a good suit configuration. Of course, in order to do some of these things you did want to pull down on the helmet tie-down a fair amount.

Lovell

I had no difficulty operating the switches necessary for ingress or for the EVA work, such as the coolant pumps, radiator by-pass, the vent valves, or the repress valves. All worked fairly decently. They were within reach. We pressurized the cockpit to 4 1/2 psi and then, as prescribed in the flight plan, opened up the visors, shut off the repress valve and let the cabin pressure regulator take it up to the nominal 5.1 at which we were operating.

Aldrin

I think the stowage and everything after the first standup EVA went quite smoothly. We had been through this many times before and we had an idea where things were going to go, and there weren't any major problems. I just got hold of one of the empty bags and started putting the hoses and the electrical connector in there, and before long we had everything put away. I think with enough training you get to the point where you know all of the things that have to be done, and you just go ahead and do them. Then you resort to the checklist in the cleanup operation to be sure you have everything done. It's very difficult to cover every single detail in the checklist. I'm not sure whether we want to continue trying to put everything down. I think it's very good in initial training to attempt to do this, but you're continually changing your techniques for doing it. I'd say that we should continue putting just as much down in the checklist as possible. But I can't say that we followed them exactly in some of these procedures.

Lovell A lot of the EVA gear that we had that we were going to use later on, of course, was stowed in sort of an orbital stowage around the cockpit.

Lovell: I believe that ends all of our first EVA. We might discuss eating and some of these experiments as an integral thing. Let's hit the eating right now.

Aldrin: Okay. I think our scheduled eating periods were violated by all sorts of activities throughout the flight. We never really had the eat periods to ourselves. We recognized this real early in the game. So whenever we had a spare moment, we would try and get ahead of the game by whipping out the food bags and start getting them ready. This is unfortunate because we ended up doing too many things at one time. We were copying updates, trying to eat, purge fuel cells -- I defy anyone to get all these things done without ending up making a few mistakes here and there, spraying water around the cockpit, maybe, or leaving the fuel cell purge on too long, which we did from time to time. All I can say is it's a shame to get yourself into this type of a position, but unfortunately with the crowded flight plan and the changes that we had, I don't see any way around it other than just calling a halt to what you're doing and sticking with some sort of an orderly progress.

Lovell — Well, the program normally points out that there are all these periods of activities which are not scheduled mainly because of problems that occur with the spacecraft hardware, or changes in procedures, or changes in the general mission of the flight plan in some respect. For instance the eclipse photography. All this takes time to put down in a chronological order in your procedures book and your flight plan update books. It takes time to analyze what you have to do to get prepared to make these changes good. The only time we could utilize for this is the time that we do things that are not pin pointed to a particular point on the ground or for particular star sightings. This usually is the eat period, and they seem to get violated all the time. I think this is an old problem which we really have to look at carefully. We've got to allow time to do nothing because we're going to have to do something in that time that we haven't planned for.

Aldrin We have to recognize that updates and everything else are tied to the orbital track and you just can't say, "Well, let's take the flight plan and set aside this time and this time for eatings and make it even periods." There has to be a certain amount of juggling and this is a problem that's going to always be with us, I'm afraid, to try and schedule these things in between passes in some way. On things like Go/No Go, status checks, I think we were able to perform one of them perhaps the way it should have been. In other words, we had advance knowledge that we were going to have a Go/No Go at some future point, and I took the time and went through and recorded down everything that was in the procedures book. We noted this and called it out a slight difference in the RCS pressures. I don't know whether this has any effect at all on what we discovered later on, prior to reentry, but it might very well have and it could have flagged future problems. Now, if you don't have time to do this sort of thing and record it and set aside a minute or two and mention any little abnomalities that you see, you're going to end up doing quick-around-the-cockpit checks sporatically whenever it appears that you've got a little time. You're not going to make a particular note of these things and you're going to end up saying, "Yeah, things look good", you know, and they may not be as professionally done as they really ought to be. I think the intent was to set it up so that we could, but this didn't turn out in the flight at all. We had a lot of Go/No Go's from that one point on but we never did go through this formal procedure. The ground would say "Okay, you're GO.", and we were GO. We were gone.

Lovell We might mention the food as part of the eat period. There was no trouble, to my knowledge, in obtaining the food in the stowage places. The hatch stowage areas were adequate. They were stowed quite tightly, but a little work made them available and we could utilize that space. The orbital stowage of the food--we of course emptied the right hand hatch right away in anticipation of the EVA period.

Aldrin Looking back I'm not sure that was required, except that we did use that pouch for the S-12. I think we may have gone overboard in some ways in trying to clean up everything. It's great to have the right side completely free of things, and I think we continually did that. My particular area could have had food in it. It just turned out that we used it for something else. I was a little leery of having food there in case it pressurized, in case they weren't completely evacuated, and depressurizing would cause them to swell. The food itself hasn't improved too much since Gemini VII to my knowledge, and we're still having trouble with a lot of those food bags. On two bags the valves failed, not permitting any water to get into the bags and made it impossible to rehydrate the food. Again, a lot of the food, such as the salmon salad and shrimp cocktail and things of this nature that are semi-liquid, are very difficult to move through the end of the tube.

Aldrin I think it necks down too rapidly there as it gets to the tube that goes into the mouth.

Lovell That's right. It didn't form a nice round cylinder. It's very stiff plastic and it forms just a small opening. It is very difficult to get the food out. I imagine we lose about a quarter of it trying to eat this stuff.

Aldrin Well, it depends on how much time you devote to it. I think some simple roller mechanism would help out a lot in squeezing things from one end to the other down there. There is a lot of effort that's expended just continually massaging all these things from one end of the food bag down to the opening on the other end.

Lovell Yes, there should be some more looking into this particular problem. The food itself was not bad. It was edible.

Do you have any more comments on food, Buzz?

Aldrin There could have been a little bit more, but

	if there was anymore it would have taken so darn much time to eat.
Lovell	That's right.
Aldrin	Our main comment on the food period is that they were violated with other things.
Lovell	Crew Status Reports were okay. There was no bugging the crew on the Crew Status Report all the time. We reported the water gun count and the food eaten.
Aldrin	I think, in general, we'd like to tell them a little bit more, but there just isn't any easy way to have this information available to give them what they want.
Lovell	There's no way of giving a quantative indication to them without an awful lot of work, in the present way the water gun is set up. Of course, it's hard for the crew to evaluate how well they slept. It can be good, fair, or bad or something like that.
Aldrin	Well, if it's so important to know the differences in water intake I think we ought to look

into a redundant system which, for a two man spacecraft, would give you two different guns and use one of them apiece. When you get to three men, I don't think you really want to do that.

Lovell — Well, I don't think there's a requirement. And I think we are just complicating the system if we have a requirement like that. Well, there's not much more to add on the crew status report other than we gave them the water gun count, gave them the number of meals eaten and the quality of the sleep when appropriate.

Rep — Right. In this point in the debriefing we'll skip to time line 39:30, umbilical EVA prep.

Lovell — One advantage of the umbilical EVA is the fact that we've done one before so a lot of the equipment was already out that was needed for the umbilical EVA. I might add that the update was good, that we got from the ground. They gave us a GET of sunrise. I had set the clock ahead some 30 minutes so that I could start it up and when the clock reached zero, it would be sunrise. In some preliminary work with the spacecraft we got the spacecraft TDA south and the rev before just after sunrise when the sun had come up, maybe, about four minutes after sunrise, we went inertial on the Agena, such that it maintained its position. Now we did this a rev before, we wanted to check out the sun angle since there is a requirement not to get any sun inside the hatch and also, to allow ourselves to forget about the Agena and the control system so that we could concentrate on the EVA preparation without worrying about having to get the Agena back in position. This worked quite well and we were able to get the Agena in position and inertial at the proper time.

Aldrin We used the same ELSS electrical jumper for all three EVA's instead of alternating. We did carry a backup unit with us, and I think the primary reason for that was some concern initially about using an ELSS jumper as the electrical extension for the first standup EVA. There were other types of jumpers available but to be compatible with the hose lengths that we already had the ELSS one was the longest.

Lovell — I don't see any particular problems with the preparation that I know of.

Aldrin — Another advantage - no, I think you already mentioned that, having the standup EVA first. We had a lot of the stuff out and ready to go.

Lovell — Yes. Now I had two things to bring out. I had the connectors for the ELSS, the equipment, and I also had the umbilical bag and I had absolutely no problem whatsoever bringing any of that equipment out. The umbilical bag was very easy to come out and it was very easy to stow between my legs, wedged underneath the forward instrument panel, and at no time did it present a problem of getting tangled up or anything.

Aldrin — I guess looking back on things - hindsight is always a lot better than foresight - what we should have done, I think, is to take that EVA work station camera and plugged it in and tried the thing out before taking it back to the adapter. It had the film in it already and we had the capability of doing this, instead of just hooking it up and taking it right back. It's possible that we could have discovered that it was jammed or going to jam, then maybe substituted another film magazine in there.

Rep — Anything else on the EVA preparation?

Aldrin — No.

Rep — Any anomalies at all?

Aldrin — Well, it was a little bit different in the time line approach than I guess we had expected even though we'd gone through this many, many times because in some cases we were a little ahead of the game on a few things. The updates, of course, we'd never fooled around with during training so we had to estimate ahead in time about when we should really push forward. As it turned out we had plenty of time. Of course, we didn't want to get behind anywhere.

Lovell — Well, I think the big thing in the soft suit checklist is the fact that the Agena controlling was too far down in the checklist and we had to actually skip over to do that first.

Aldrin — Yes, we had already done that really.

Lovell — Right. To make sure that we weren't worried about them. I think it's important to get that out of the way because by this time we were fairly familiar that it would take a long time to gyrocompass and things of this nature. So, we did that before we went on to something else.

Aldrin — Checks with the ELSS went off real fine. I think there was one of them that didn't work quite right. I think we didn't have the ELSS power circuit breaker on at one time or other. The battery - no, wait a minute, we didn't have the emergency O_2.....

Lovell — We didn't have the emergency O_2 opened up all the way. We didn't get that checked but we went back and checked it again and it was on. The reason for setting the clock at sunrise minus 30 minutes was to check for the integrity check. I think this was another case where we learned by other people's experience. We didn't want to wait in the cockpit after our integrity checks because there had been no flow or no coolant in the pilot's part. From time lines that we had run in training and from going over our checklists we determined that we shouldn't stop the integrity checks until 30 minutes prior to opening the hatch, which we did. And as it turned out, we were right on schedule when the hatch was opened up.

Aldrin

I noticed in taking the plugs out of the ELSS, there was a moderate amount of water in the inlet and outlet ports, and this surprised me a little bit. I thought no one had ever mentioned this before that this would happen. And then I thought, well, maybe there might be some leak in the water boiler system. So, I mentioned it to Jim and we just pressed on from there. I stowed the plugs and let's see, I guess we went to the check and had the waist tethers hooked up on the ELSS. I elected to hook up the right waist tether to the bar that went across the top of the ELSS. Then I was debating whether to hook the left one onto the little plate that had a hinge on it with two rings on each end. Or whether to just use the velcro that was on it to put it on top of the ELSS. All the training ELSS's that we had didn't have this velcro over the H_2O_2 quantity gage and, of course, this was on the flight item and it was a means of attaching it that just didn't appear available during the training. I'll probably have some more to say later about that little bar with the rings on it. In connecting up to the ELSS, of course, I disconnected from the spacecraft hoses and that left the flow off. I didn't notice the change in cooling particularly at that time. I went ahead and hooked up to the ELSS and proceeding on in attaching it and in getting the rest of the things in shape and it wasn't until three or four minutes later that I realized that I still didn't have any flow but I wasn't getting warm, particularly. I just realized that, well, I kind of skipped over that point where it says, put the ELSS flow selector to high. The reason that I tended to skip over it, is because it looked like I didn't need to. I really didn't feel that I needed a good bit of flow at this time.

So, I put it on and went to high. It was right about this time that we were getting some communication from the ground saying that they didn't like the pressure level that we had in the O_2. It was a little bit too low and we were using the manual heater to run it up and I coupled all of this together and elected to put the flow selector on to medium because I was getting perfectly adequate cooling at this time. Of course, I wasn't particularly buttoned up yet. So, I left it on medium during this time with the idea that this would help at this time to build up the pressure because it wouldn't be bleeding off as much O_2 and, of course, we were at the beginning of umbilical EVA, a little bit behind the oxygen consumption that had been set up preflight. And, of course, this oxygen consumption was right down to the nub as far as the whole flight plan went. It indicated that we were - if everything went according to schedule from that point on, we'd have been a little bit shy near the end. So, I elected to deviate from the flight plan in not going to high because medium was perfectly adequate. As a matter of fact, no flow was adequate for awhile. Well, we went through the suit integrity check for the pilot and that went very normal. Having the ELSS on in front of me was no different, really, than the training sessions. I wasn't any more crowded. I didn't have a tendency to drift away up to the top. Just a little bit of foot pressure against the front of the wall of the spacecraft was able to keep me down. We went to the - let's see, that must have been the hard suit checklist now.

Lovell That's right. After the soft suit checklist was complete we had no problems that didn't show themselves up in training that we worked out before hand. I think it's an important point since here again we utilized everybody's experience to write these checklists and to make sure that they were in good condition.

Aldrin Okay, I really wanted to make a comment and I guess it is back in the soft suit checklist. The ELSS evaporator on. I was pressurized at the time of doing this and I had a little bit of difficulty in making darn sure that it was in the full on position. As soon as I turned it on, why, some water seemed to spray out of the condenser and this again surprised me, coupled with the water that was in the ports. I wasn't too sure just what the water status was in the ELSS. It sprayed a little bit on the window and it put considerable amount on the right waist tether up near the buckle. But it didn't continue to come out and didn't look like anything near the capacity that it was loaded with, about .8 pounds. So, I felt sure that there was still a fair amount of water in there but this is something that we hadn't gathered from previous experience. Now going into the depressurization.

Lovell You're on the ELSS now and we're all set to depressurize and I mentioned that I double checked the lap belt this time and made sure that it was tight. Cinched down the helmet tie down and we didn't use the reticle this time, so I had more room to operate. For the preparation, I just doubled what I originally was going to . . . I put an extra voice tape on the clothesline, and I believe I had five film cartridges. I had a change of film for the retro EVA camera and two changes of film for the left hand camera plus there was already one in the retro and one in the left hand camera, so I think we had five rolls of film to operate with.

Lovell

I want to make one comment about the routing of the umbilical. We routed it the way we had trained to do; that is, through the hatch closing device and coming on down the side. The electrical extension that goes between the umbilical electrical and the spacecraft electrical is still way longer than it should be and it forced me to route the spacecraft's electrical down a lot lower than I had done before. And again, I don't feel we had enough time to really use flight-type configuration gear in that the velcro strap underneath the Volkswagen pouch and the proper length of electrical connection was just not available to us in the mockup. It looked to me like we had way too much in this electrical connector. Also, we had elected to tape the mike switch on the spacecraft electrical to the connector itself, and we just left it there from liftoff through the entire flight. It turned out the way that I draped this down underneath the Volkswagen pouch, it was positioned so that the button was inboard. Occasionally I would trigger the button by pushing it when we were in the "push to talk" position, and of course, we'd be transmitting all the time when this happened.

Aldrin — The first time that happened, I triggered the UHF relays circuit breaker to see if that was it. I didn't realize what was going on.

Lovell — The suit button was sticking inboard and my leg pushed it against the Volkswagen pouch and actuated it.

Aldrin — Well, let's see, the depressurization down to three and then down to zero was nominal. Normal procedures was to take it down to 3 psi and check that our suits were holding at least 3.5, staying in the green, and they were, so we took it down to zero. I might mention that, I'm not too sure, but I felt the water that had come out of the ELSS that went on the window, your window, stayed in a liquid form while we had the hatch closed. . .

We can't really say that that's true. I didn't notice what happened to it, but it was there. There were about five or six drops. I didn't observe them, after depressurization, changing significantly to a different state. We were faked a little bit by the ease with which the hatch opened in the standup EVA. When we started unlocking the dog, instead of waiting for us to push the hatch open, it snapped open about six inches. Well, maybe not quite that much, but it was quite sudden. As soon as it did this we went from a very low pressure to zero. Evidently, that was enough to cause this evaporator to actually start working. In other words, the water didn't really boil at this temperature until it got to this extremely low pressure. Evidently, we didn't get the cabin down to this level before we opened the hatch. Even though the gage looked like it was the same as during the standup EVA I was surprised to hear before flight how low that pressure really had to get before the water boiler became effective. So it means, essentially, to me that we didn't have water boiler cooling until the hatch was open.

Lovell Until the hatch was open, right.

Aldrin As soon as the hatch snapped open this water rushed out of the condenser. The stuff was just hanging there. Some of it sprayed on the window and a considerable amount sprayed on the waist tether. In the complete vacuum that we had there, it immediately froze and the window frosted over on the inside. All of this happened so fast, that it surprised us a good bit. Fortunately, the hatch didn't keep moving. It tended to slow down where it was, we were holding onto it, of course, but we weren't really expecting it to do just what it did. So, I kind of flicked a little bit of the ice off, to see just how stiff it was, and played around with that awhile while we were getting the hatch fully opened. There was ample room to move up. I anticipated after the hatch was opened, a tendency to rise up in the seat. I can't say that prior to the hatch opening that I was prepared to hold myself down. I didn't expect the hatch to open so fast, but when it did go open and I thought to myself, "I'd better find out why I am or am not drifting up", and I wasn't drifting up. I tended to release any force that I had against the footwell to hold me down and lo and behold, the hatch pushed open and locked and I had no tendency to drift up. So I started adjusting the position of my body up so that it was free of the footwell and my feet were not touching. Then I went about trying to duplicate the dynamics and the evaluation that I had done in the standup EVA. I think I mentioned something on one tape about, "There goes one of those washers". We know the mass of a washer and it was right about this time that it was drifting up and out. We can affirm this with the voice tape, but I'm pretty sure that this was on the umbilical EVA that this happened.

Lovell Yes, but I think that this drifting up and out is due to outgassing.

Aldrin Oh yes, there's no doubt about it, but this washer was not really motating out, it just gradually drifted out.

	It wasn't accelerating. It got its velocity when it was low down and it was not continuing to increase in speed. This kind of force just isn't going to push a human...
Lovell	I don't think there is any great force along that line. There's the force on the hatch when you open it up, but as soon as the pressure is relieved there, the overall flow is very little.
Aldrin	I tried to see whether there was any tendency to push me up and out. I really didn't have a feel for how tightly I was constrained by the umbilical. I know Jim had hold of part of it, but I'm sure that it was slack at this time. At least I hope it wasn't taut.
Lovell	Yes, I kept on the umbilical. I didn't let it all go. I just played it out a little at a time. Because the first thing you wanted to do was evaluate the standup dynamics in comparison with the standup EVA.
Aldrin	If there was any tendency to be pushed out it was so small as to be, in my opinion, inconsequential as far as effecting the ability of a

person to hold a precise position. It didn't take any effort at all. If there was a tendency, it would be one where you'd position your body stationary, let go, and maybe in a period of 10 seconds, you might drift 3 or 4 inches. This sort of a motion could very well come about by your inability to set up the initial conditions to perfectly zero. So it is a very low force, if there was any, pushing me out of the cockpit.

Lovell — Our timeline for the umbilical EVA was based on the ones we had done in the water. We allowed eight minutes for the unlatching of the spacecraft hatch to the final jettisoning of the waste pouch, and the pilot getting up and outside the hatch by standing up. We were actually very conservative on the time and completed this prior to the eight minutes we allowed.

Aldrin — We really had no use at all for that two minute rest period in there.

Lovell	That's right. It was just too soon. The way we managed to hit the proper hatch opening time, and be ready at the same time, didn't allow us to sit around. We weren't rushed during the umbilical EVA preparation.
Aldrin	Let me mention one thing in here. It seems as though we might still be on medium, but we were not.
Lovell	We went to high.
Aldrin	Just prior to hatch opening I switched over to high flow.
Lovell	It didn't change the flow observably. It really didn't change the cooling effect to much either. I noticed a different noise or sound. A little bit of increase in flow, but not significantly.
Aldrin	Medium might be a better flow to put it into if you wanted to open the hatch up, to cut down the forces.
Lovell	Yes, looking back on it, I think you might want to do that.
Aldrin	Just flip it to medium and let the pressure bleed out a little bit.

Lovell — Of course, the EVA was designed to get the most out of basic EVA with rest periods to anticipate any problems which we might encounter. We took the rest periods as they came along; however, it was getting obvious to me that rest periods which we had allotted were either to long or to frequent. We managed to stay on the timeline throughout the entire umbilical EVA.

Aldrin — We had three different ways of mounting the camera. The first two were essentially the same as the standup EVA. I was really still inside the cockpit. The next one, I was completely out and switched over to having the right hand on the handrail and the left hand taking the camera off and then putting it back in. This was quite a different method of putting it in than the other two. It required the use of one hand and a little bit of torquing operation with that hand to get the camera into position and put it on down. But, again, this didn't appear to be any real difficulty. The thing we are trying to find out is, in going back and forth putting the camera up and taking it down, did you want to go through the procedure of getting back in the hatch, as far as your feet go, and using the left hand on the seat to put the camera in, or could you do this in passing? Could you stop there and put it up? If you could, then you might be able to save a little bit of time.

Lovell But, you found out that basically there was no difference.

Aldrin I will have a little bit more to say about that when I put the camera up the next time. I may turn out that going back in might have saved a little bit of time. It is a toss up, I guess.

Lovell — After we had opened up the hatch I had taken the umbilical out of the umbilical bag and stowed the bag. We had designed the umbilical bag so that it could be ripped down one side. It was just attached by velcro so it would not get wrapped around the umbilical during EVA and present either a problem or a sore point on photography. And I put the loose umbilical between my legs, letting out only that umbilical that was required. And although I found out in training that sometimes it was hard for me to handle the umbilical in 1 g, it was fairly easy in zero g. I had no problems at all taking care of the umbilical or pulling in what was not used or to release what was required.

Aldrin — I am not sure, as I recall, whether we checked the camera operation after that third one. I know I checked the settings on it. I think maybe we did. It was the third time I put the camera up, that I didn't check it for operation.

Lovell Well, it worked, at least the light.

Aldrin Yes, you could see the light on. I guess that is an adequate indication, once it worked the first time.

Lovell That is right. I had the light on.

Aldrin I guess I moved on up to the nose. This motion was from the retro adapter handrail, because that is where I had installed the camera. I rested for 2 minutes holding on to the retro adapter handrail. My feet were over toward Jim's area. In other words, the left hand was toward the nose, and the right hand was back toward the equipment adapter. It surprised me just a wee bit because I expected to be in a position resting where my feet would be going almost radially out from the spacecraft. But, evidently, the forces in the suit were enough to over come this. These are the forces in the arms, the natural position, and just holding on very loosely with my hands, just putting them around the handrail, and minimum force to keep from moving away, which was, incidentally, very small, and relaxing my body completely, the suit force took over the arms assumed their natural position, which is not up high, but right out in front of you. Now, this just automatically brought my feet down to a point where they were very nearly in contact with the retro adapter. So, my feet were almost touching the side of it, right behind Jims' cockpit.

Lovell — I might add that when we joined up with the Agena, we noticed that the Agena tether was fully deployed, which was one controversy in our training.

Aldrin — After that rest period there -- incidentally, that was a very comfortable position to be in. There was no concern about drifting head the other way. There was no concern at all about the attitude that the vehicle was in with respect to the earth. No disorientation on my part in looking down at the earth or up at the sky. Everything was done relative to the spacecraft and that was the entire frame of reference. There was no concern about up and down. The up and down was relative to the spacecraft, rather than to where the earth happened to be. Somehow, I think I must have turned around to the right in getting to the handrail. I am not sure how this took place, because I moved out along the handrail right hand first. This is the way I had planned to do it all along. I did move out right hand first and it was no problem moving from one handrail, the retro handrail, to the portable one. And as I moved out in front of the window, right hand first, out toward where the ring was, when I got into the vicinity of the ring on the telescopic handrail I started turning around to the right. Oh, I think I know what happened! We didn't have the umbilical all the way out. So I moved back into the area of the hatch and we started getting the umbilical out. That is right. Pulled the umbilical out of the bag. That is what turned me around, the process of getting this out.

Lovell Yes.

Aldrin Then I got out what looked like about 10 or 15 feet.

Lovell And I held the rest of it in.

Aldrin This looped in one big loop off to my left and I looked back at it, holding on with one hand, and assured myself that when I grabbed the umbilical I could pull and see that it was attached right to the ring on the parachute harness. This type of arrangement was a very good hookup. It wasn't a tight and fixed mount of the umbilical. It tended to route it directly aft, which would tend to put it in a position where you are never sure where it is, but I could just grab hold of it and pull it up and almost see where it was connected to the parachute harness. I moved up along the handrail, and again this was quite a simple operation of just very light hand forces on the handrail. If there was a little bit of a tendency to drift up and down, or rolling around the axis of the handrail, it was very easy to just put a hand out on the spacecraft and push gently to maintain myself. Of course, moving along in the axis of the handrail was quite simple to do. I started the turn-around maneuver and I think the film will show this. As I recall, I put the right waist tether on first. It ended up in the ring. The left one ended up in one of the u-bolts on the docking cone. I think it was the far one, which gave me a little bit broader stance to go ahead and hook up the Agena tether. Now, once in this position, we got another rest period. Again we really didn't need it, but the idea here was to see, for the first time, what it was like to rest without holding on, with just being tethered. So, I let go completely and remained stationary. The tethers didn't seem to jerk me back in at all. They just eventually assumed a natural position and I was drifting very lightly, maybe in one direction, and then perhaps my foot would contact it and I would bound back a very slight amount. A very comfortable rest position.

Lovell There was no problem in resting in zero g position if you are properly --

Aldrin None at all. Throughout certain EVA activities it is easy for a person to develop a tension in the body, usually in the legs, maybe trying to put a little body English on his position. If I didn't like my twist attitude, with respect to what I was tethered to, I found it easy to just unconsciously start twisting my body, which puts tension and exerts muscle forces that you don't need

It takes a little bit of discipline to just completely say to everything you have got to relax. This rest period lasted about 2 minutes. I don't think I really gave it a full run, once I experienced this complete relaxation. And I certainly wasn't at all tired at this point. After evaluating just the stationary position, I went about moving up toward the tether. I think before Jim realized it I had the tether in my hand.

Lovell Was it hard for you to deploy the tether from the fixture on the ...

Aldrin No, I just picked up the loop and it came off very easily from the metal clip there. I put it over the docking bar and the mushroom head on it went over very easily. It was quite simple. I was holding on to a handrail with the left hand. As a matter of fact, during some of the operation I just let go of any handhold completely and used two hands. Slowly and methodically, I just started pulling it up tight and it was very simple. It didn't really take a jerk at all to seat the bead into the swage, or whatever it is. The thing that holds it in this taut position. Then, I took a look at the strap that was attached to this wire and looked to see just how tight it was. It hadn't been moved at all at this point and I decided that maybe the thing to do was to take it off and put it on very loosely so there wasn't as much velcro holding it on. This I did, and it looked like all the rest of it was free and the arc of the wire was well clear of the handhold that was on the right, as I was looking at the Agena. We had a little concern that perhaps it might possibly get entangled around this but it looked like it was routed so as soon as the spacecraft backed away for the tether exercise it would pull directly onto that velcro strap, without any possibility of getting entangled. Then I looked over at the clamp that was to push the wire tether loop and hold it down lower. I think just before I did this, I tried to take the loop and to see if I could push it down below where the bar fit into the docking cone. It wouldn't fit. It looked like the docking bar was very well centered. In other words, there was about the same space on either side of the docking bar to the edge of the docking cone. But still the tether wire wouldn't fit down between it, and I think we mutually decided that it wouldn't be a good idea to put it down that low anyway. So, I left it above the docking cone and put the clamp on. In order to get the clamp free I had to pull out a pit pen that was holding it in position, which was a very simple operation. I then pulled the clamp out and it was attached by two spring steel clamps, so to speak. This took a little bit more of a jerk than I expected but the waist tethers held me in good position. I think I was using the handhold at the time. I got the clamp by holding on to its grip and put it into position and slid it down and made sure that the four springs which were to lock in behind the docking bar were in position. I checked it for its rigidity and security and it seemed to hold quite well. At this point I think Jim mentioned something about it and I also was about to proceed to get the tether off of it. The tether was attached by a 1 $\frac{1}{2}$ to 2 foot length of nylon strap and it was attached both to the clamp and also to the Agena just by male and female velcro. So I pulled this off and it came off very easily. In subsequent use of this docking bar clamp or spacer as a handhold to maneuver from one place to another around the Agena, I found that some of those spring clips did come loose, and as soon as I saw that I decided that that wasn't to be used anymore as a handhold because it might come loose and come off. With this task completed in very short time and with no hitches at all, it was then our plan of action that if this proved to be the case that I would then move from that position over toward the Micrometeorite Experiment, S-10, and deploy it on the Agena. I'd also decided that since the primary purpose of EVA was to evaluate restraint systems in accomplishing various tasks, and it really didn't make much difference what the task was, the more important thing was to be able to hook up in several different restraint system configurations and to see how well they let me do any task, regardless of what it was. So I decided ahead of time that instead of trying to find one pair of restraint connection points that would enable me to do two or three tasks, for each one I would go through the procedure of changing the attach points to select the optimum attach point wherever they happen to be on the Agena and the spacecraft for each particular task. Now in this particular one it required relocating both the left and the right tether attach points, and I, of course, figured out where these two were going to go. The right tether went to the far right hand u-bolt attachment on the docking cone. This is right as I looked at the Agena from the spacecraft. The left one went on the u-bolt on one side of the flashing light. I think it was on the left side. Now, it was about at this point, I think, that I had a little bit of difficulty in making the connections. The right tether came off, it was hooked up all right. The left tether, in reaching it, was a good ways away. I wanted to move it from where it was located to a new position and I had a little bit of trouble getting a good grip on the tether hook, to be able to take it off and then to move it to a new place. As I recall, it was either in this tether change or the next one -- I don't think it makes to much difference for the purposes here. We will probably pick it up on the film -- I found that the new attach point was a little bit further away than I had anticipated and it took a little shuffling around with the temporary handhold on the Agena to be able to get into position to hook this up. Of course, this is just the thing that we were looking into -- what sort of problems we might find in making these connections. The S-10 fairing came off very easily. I pushed in both of the little things that disengage the fairing and the fairing came off, and then as you pull the fairing off there are two pins that are attached into the S-10 experiment itself and I wanted to make sure that when I jerked this off the whole thing didn't come flying off. So, I put one hand on the handle of the S-10 and pulled the pins out. They came off rather easily and then I discarded the fairing. Then, in deploying the S-10 I wanted to do it in its original holder, if at all possible, rather than use the velcro. Speaking of the velcro, I think before I even started this I decided to pull the cover off. It was covered with cloth velcro covering to keep the nylon velcro from being damaged in the heat of orbital insertion. This cover came off without much of a problem, even though it was one of pulling it off by pulling away from me instead of towards me, which was not the most advantageous way. The S-10 was pulled out toward me in its slide and then opened up and engaged very easily in its locking ports. Then I wanted to make sure it was seated, and this took a couple of extra seconds of cycling back and forth in the slide to make sure that it was in the configuration. I pushed back in the slide in the open position so that any subsequent maneuvering made by the Agena couldn't possibly jar it loose. It also appeared that the mechanism is fairly easy to slide so that I don't think anyone would have any trouble in recovering it from this slide arrangement. Having done this I then moved around to make another change in the tether location, the purpose here being to deploy the portable handholds and to pre-position them and locate pip pins on the work station so that we'd have that much more time left after the adapter work to make the complete evaluation of the work station. It was at this time that we were ahead of schedule and I checked with the ground to see how much time we had left on the pass.

Aldrin We had time left during the stateside pass and I wanted to deploy the two flags that I had stowed in the portable handhold. It looked like in order to do this, in the way with least jeopardy, would be to do it before I pulled the pip pins out, instead of trying to take two hands to do it. So I pulled them out and said a few words about Veterans Day and said a few more words about the Army-Navy game. I took the Veteran's Day flag and tossed it in the breeze. I took the other flag and tucked it as tightly as I could in the right side of the ELSS, between where the hoses were between the ELSS and my chest. I then went about the task of deploying portable handholds. I took each pip pin out and in turn put it into a holder that I wasn't going to use with the portable handholds that were going to come up from the adapter. I chose free pip pin attachments. They were ones that did not have stars. I wanted to then evaluate afterwards and compare a freely swinging pip pin as a handhold with the ones that were rigidly mounted in the stars. I put the two portable handholds in the outboard position, both on the left and on the right leaving room for the others to go in the inboard. I took the one remaining pip pin at this time and put it on the left side of the Agena as you face the Agena from the spacecraft, to get it out of the way for both the torquing operations and also so it wouldn't be in the center when the chest pack lights hit it. About this time I received a call from Houston to slow down a little bit. It was perhaps just after the little blurb about Veteran's Day and before deploying a portable handhold, as previously discussed in the medical briefing. I think that some of the reasons for the change in heart rate was the audience that I was addressing and I wanted to make sure that I didn't flub. There wasn't much of a rest period while I was deploying the portable handholds. I did pause there for a minute and before I started back, I did get the word from Houston that the recovery was good which meant the return of the heart rate back down to normal. I then started moving back along the handrail. I had to take the waist tethers off now, one at a time. I took the right one off and put it back on the ELSS. This time I took the left one and instead of attaching it to the folding bar with two rings on it, I stuck it with velcro on top of the chest pack. This bar that went across, I think was less than optimum in design. I had some experiences in training with it coming off and I thought that I might just as well leave it loose and not bother using it and try using the velcro instead. I started moving back toward the hatch area and I was just about there and Jim said something about you're not going to.... Then did I wipe the window off?

Lovell — No, I don't think it was.

Aldrin — No, because it was just before I came in for the last time.

Lovell — Yes, that's right. Just before your entrance.

Aldrin — Our original plan was to wipe the window off at this time but that wasn't in the flight plan so it wasn't done. I moved back toward the adapter, stopping at the hatch.

Lovell — Wasn't the rest period about then?

Aldrin — Yes, we had a rest period at TDA.

Lovell You came back to the adapter or to the hatch area and you took off the 16 millimeter camera.

Aldrin Right, I took it down from where it was located and handed it in. Handing the camera in was no particular problem at all. I made sure that Jim had a good handhold on it before I let go and actually that wasn't any particular problem either as it was attached to the wires. Again those strips were pretty handy to put that on. Then, I reached down to pick up the camera to take it back to the adapter and I stowed it above the camera box so that the first thing I would get would be the plug. I could then attach the plug with a snap onto the front of the ELSS and as I recall, in order to get close enough to attach this, I had to dislodge the camera completely. I had a camera with the wire and plug essentially floating right in front of me. I was pretty much on top of it and there was no real worry as far as I was concerned about it getting loose.

	I did have to change the position in my left hand, as I was holding on with my right hand. I did have to let go of the thing just temporarily which bothered me a little bit that you had to let something go and get a new grip on it. It snapped into place fairly well and then I wanted to put it on the ELSS in front of it. This has to be done with the right hand so I had to move along the handrail a little bit to get my left hand on the handrail so that the right hand was then free to get hold of the camera and stick it with the velcro in front of the ELSS. About that time, we fed out the remaining part of the umbilical. I stopped about this time to make sure that the umbilical looked like it was routed in the proper fashion and wasn't tangled around anything. It seems to me as I started moving along the handrail that the umbilical did start to snake--
Lovell	You retrieved the four GLV strips.
Aldrin	This time I had to pick up four of these strips.

And of course the two white ones were quite easy to get off because I put those on before and they hadn't deteriated during launch. The two black ones, the aft one in particular, the little handle strip on it, broke off as I pulled it. I had to scrape it a little bit with my glove in order to get enough surface to get a hold of to pull it off. They went back into position on the top of the seat with very little effort and I was leaving a place on the top of the seat to put the camera when I came back. I started moving back from that position along the handrail going back right hand first so that the left side of me where the umbilical was attached, was trailing so that the umbilical was out behind me and moved back out toward the adapter toward the pigtail. As I got to the edge of the equipment adapter, I could see that the loose primer cord that I had noted during the first standup EVA was not as really loose in that there were not so many pieces around there to present any problem at all. I just forgot about trying to pull any of that off. With my right hand I got ahold of the pigtail and made sure that it was secure and locked and wouldn't swing freely. From that position I pushed a little bit to the rear of the spacecraft and made sort of a combination turning maneuver by pushing to the rear and then restraining myself from going further to the rear by holding on the pigtail. The net effect was to turn me around the corner. I turned around the corner and with right hand first, I got hold of the hand-rail back in the adapter. I found myself in pretty good body position to get ready to thread the umbilical through the pigtail. Around in this area it seems to me that I did have to use a little bit of torque with one hand on the pigtail to push my feet down a little further because my head was tending to float up at this time as I was going around the corner.

REP	What was the condition of the separation plane?
Aldrin	It looked quite clean with the exception of maybe 3 or 4 places where this primer cord was. Well, it was a smooth surface and then it was attached here and it would come here and back on again. There were a couple of places where it came off and was separated.
REP	Was the edge jagged?
Aldrin	I really didn't see anything that was particularly sharp. I didn't stop at that point to really examine it closely. I just kept away from it as much as I could. While I was still in that area, I started pulling the umbilical through the pigtail with my left hand until it was taut and Jim mentioned something at that time. I guess he thought it was taut about the same time and we agreed that was as far as the umbilical was going to come. I then started moving toward positioning myself in foot restraints. I guess that one becomes so used to going from this position to the

foot restraint directly as in the AMU operation that I looked down for the foot restraint and all I saw was a blank recess in the thermal curtain where the AMU foot restraints were going to be. I thought, gee, what happened to the foot restraints. I can't even see them. They were up the other way so I had to yaw around to the right which meant that my feet now were going about where the umbilical was coming through the pigtail. There are two ways that you can go through the umbilical. You either find yourself going through it headfirst and the umbilical would then be around you, or you find that the umbilical is in front of your feet and you've got to step over it. Both of these situations I had experienced underwater and had been able to step through it by holding on the umbilical and with its own stiffness direct it with your hand away from your feet. It tends to move away so you can bend your legs a little and move them through.

If it is the case of moving it over your head, why that's fairly easy to do also. Then I moved so that I had one hand on both of the handrails and sort of lowering my body down into the foot restraints. This was a very comfortable type operation that didn't require any particular torquing of the body that was abrupt or severe. There were some hand torques that were obviously required because the body was being moved a good bit during this time. I crawled out getting the right foot in and then the left foot and there was no problem getting the feet in the foot restraints. For some reason the left heel appeared that it wasn't down in as far as the right one. I just don't understand why that appeared that way. I made a mild effort to pull both heels out, but neither of them exhibited any tendency to come out. I think at this time I had the umbilical behind me. I thought I might just as well pull it taut through the pigtail and put it through clip right now, so I did that. Actually the checklist calls for it to be done a little later. Jim said something about putting the camera into positon. All I did was take it off where it was velcroed on and this did stay velcroed on the chestpack all through the tether operation. I took it off now with both hands and ..

Lovell Did we put that up first and then evaluate it?

Aldrin I think we put that up first.

Lovell Then you got everything squared away before you did the evaluation.

Aldrin I leaned over and originally the idea was to unfasten the plug and plug up first and then hook the camera up. In training I found that with the foot restraints I could very easily do this with a little bit of leaning to the side. It is quite easy to do in the foot restraints. I could just move my body over to right in front of the camera bracket and I could put the camera on first with the plug still attached to the ELSS which was, of course, a much lower risk of losing it. This is where we ran into the first little surprise of the day. The lever on the bracket on the camera appeared to operate normally right at first. I held it in position and started pushing it down to engage and it wouldn't go in. I tried turning it back and forth and still holding onto the top of the camera with my right hand, and it just wouldn't go in. I thought well maybe the little ball that comes out of the female connector, the part that's on the handrail, maybe that's sticking out too far. I looked at it and it was sticking out quite a ways. I thought well, gee, maybe I am not lining up the groove that's in the male part of it. I tried turning it a little sideways and it didn't seem to help at all. About this time, I released my hand from the camera to evaluate the whole situation to see what was wrong. At that time I noticed when I released my hand from the camera that the lever did not spring back. I looked at the lever and found that it was very loose and evidentally broken in some fashion. Now, this means when the lever doesn't work, the bar allows the steel balls in the bracket to recess so you can get by the first groove in there. I looked at the linkage a little bit and saw that one of the pins was missing on it. I was able to stick my finger underneath the bracket and operate the linkage in the way that the bracket was originally designed and this way it retracted the ball bearing. Then by hitting and shaking it a little bit, it finally got into position and I left it in and it looked like it would turn rather freely. It was in the right position as far as being located in the right direction. Then I unsnapped the plug and put it into position and made sure it was in firm. This action was all noted by the whole spacecraft shaking by Jim.

Lovell I might make a comment in here on the fact that I think you could communicate back and forth by just tapping, because vibrations certainly carry quite well.

Aldrin Well I did knock on the door one time.

Lovell That's right, I knocked on the work station.

Aldrin Were you hearing it, or were you feeling it?

Lovell I think I must have heard it, but I don't know how. Well, it must have been a vibration going through somehow.

Aldrin But, I don't know how you would feel it through the suit?

Lovell I don't know, but how do I hear through the suit? I could definitely tell. I think it is a possible way of communication and that it should be explored.

Aldrin Now, let's see, we went through the sequence of seeing that the camera was operating. Jim had two switches, the circuit breaker and the switch control. As soon as he had done that, I pushed the button making sure that the camera was sitting on 1/50 and one frame a second. I could feel it operating through the gloves and I thought, well, we are in great shape here. We've got the camera going so, let's proceed on, and at this point went through an evaluation of the foot restraints as far as total mobility goes. What I really intended doing was to compare in a subjective way the amount of mobility that a person has with these foot restraints in comparison with things that I had experienced both from the zero g airplane and under water. I did this by moving from the left over the right and standing myself up a little bit and back down bending my body down to get to the top and the bottom of the work station. I wanted to see just how well leaning back compared to underwater operation and in the airplane. Up to this point, everything was very, very similar in the way that the foot restraints allowed me to move my body around. Even in leaning back, it seemed as though I could do this quite well.

I did note that there was a little bit more leg tension required to lean back to the same degree. That is, leaning back so that the axis of my back was essentially parallel to the spacecraft longitudinal axis. To hold this position required a fair amount of force on the legs. When I released this, I gradually drifted back up. It is very easy to hold a neutral position from 30 to 40° rolled from the foot restraints to roll right. You could also pitch back about 40 to 45 degrees with very little strain or force and you could turn your body somewhat to each side. The real test of course comes when you start to do torquing type operations where you exert forces against the top of the boots. This is the prime purpose of them to keep you from floating away from them. I think both Gene and I decided in our training that the foot restraints, if they operated as they had in training, that they would enable a person to do just about any task that he is able to do in 1 g. If we establish that this was in fact true, then we would move on and do things on the waist tether. I can say now that the best restraint system that we have ever seen for doing any EVA work is undoubtedly foot restraints. We don't want anyone to think that just because we've concentrated on waist tethers that they are better. They are not. Foot restraints give you the best freedom of action. They give you the best restraint system for operating and a fairly wide region with respect to the foot restraints. You can't move too far afield, just by the fact that they are fixed. I think if I had to compare foot restraints located in a certain place for an optimum work station with a waist tether hookup that was also located in an optimum fashion for that same work station I think that you have more freedom of action with the foot restraints.

Lovell: Well, what you are saying, is that you could probably use foot restraints in a variety of positions when possible.

Aldrin Yes, well of course with waist tethers, you tend to rotate your body around the two waist tethers and you have a certain radius of action that is up and down. I think with waist tethers you can move up and down with respect to the location of them to a higher degree than you can with the foot restraints. They fix your feet. The ability of foot restraints to move from side to side is great. You can move up and down in foot restraints by bending your back and bending forward, but this then depends on the suit set up.

You may have to make up for your up/down motion in foot restraints by stretching your arms up or down. You can move from side to side better in foot restraints. It gives you a slightly better radius of action. Concerning stability of waist tethers versus foot restraints, the advantage is far on the side of the foot restraint because you can exert considerable torques in a two-handed operation without having to hold on with one hand. In certain setups with waist tethers you can effectively use your feet and the waist tethers to give you a 4 point suspension and approach the same condition. For any task that is important or very critical and it is generally located in one specific area, wherever possible we should try to make use of foot restraints. And secondarily go to waist tethers. While I'm comparing these, I might mention that it's not necessarily, unless there is a fair amount of torquing operation required. Torquing of bolts, I didn't really do in one foot restraint. I did it with two or on waist tethers. I think if you were to try and do it with one you would have to hold on to give you a good solid two point contact. In a case of normal work in preparing some structure one foot restraint

1 foot rest.

is perhaps as adequate as two. As a matter of fact, one foot restraint enables you to twist your body about that foot restraint, about the longitudinal axis of the body, to a much greater degree than two. Because with two you can only twist until the legs start to cross each other. If you've only got one you can swing that free leg much further from side to side. To get this freedom of action requires you have a little more force on the one, and instead of it being a foot to foot up and down type of differential pressure, it's an ankle type of twisting. Some sort of comparison between water skiing, two ski operations you don't plan to twist one ankle to maintain your balance, you use the two skis whereas one ski operation you are forced to either turn it or use one foot for balance from side to side.

Rep Okay, we ran into a rest period, there. Were you resting?

Aldrin Yes, I was looking around up there.

First thing I was looking for was a banana. I couldn't find it.

Mirror position there was no particular in unhooking it. The umbilical was a little bit in the way, when it was in the clip, to get the velcro off. Unstowing the pen lights: they unsnapped rather easily. Instead of trying to pick them out, you just take your finger and push them out from the other end, and they came out quite easily. They velcroed rather nicely. Both of the pen lights suffered at varying degrees from the heat back in the adapter and I think we'll just have to find out from someone's analysis whether this heat had anything to do with the boost phase or whether it was all from the sun. I personally suspect that it came from the sun because our configuration was SEF most of the time, either that or IDA North.

Lovell — You see the sunlight goes through the plastic onto the reflector and reflects back in again. There is a lot of heat generated there.

Aldrin — I'm not sure that the heat would have reached there to much from the reflector.

On one of them it would have. I'm sorry I can't remember which one of the pen lights came from which location. I'm not sure it is that important. One, instead of having a flat surface on the pen light was bulged out considerably and a little bit bent. They both turned on without any trouble. I attached those to the side of the handrails. Incidentally, the handrails were very secure. They had the characteristic looseness, play of maybe 1/2 inch to 1 inch, but there was no particular bother. Going to some of the tasks in the adapter, the pouch opened up rather easily; the wrench had a strap around the handle and it looked like this wasn't velcroed in; that it was stitched in. Evidently there was a loop in this nylon strap that was made just the right size for the handle to slide into. Well the heat must have gotten into this and shrunk it up because when I went to pull it out, it wasn't about to come underneath this strap. I looked to see if it was velcroed and it didn't appear to be at all. This cost maybe a minute or so to try and figure out just how to get that out. I pulled just straight away on the wrench; it didn't line up the way the strap was on it. It tended to be twisted which didn't let it slide freely. So, I had to get two hands in there and pull in the area where the strap was and pull the wrench out, and it finally came loose. The wrench looked like it was in good shape, so I proceeded to the torquing operati n, which consisted of looking at clockwise operation at four different places around the clock and then reverting to a counterclock wise operation. This was on the 1/2 inch head bolt. I found that the second time I torqued the wrench up to what I felt was a near maximum level without really straining myself; this was in the vicinity of 200 to 250 inch pounds, the wrench snapped in some fashion. But when I looked at the pointer, it was no longer zeroed. It was sitting at about the half-way point. I didn't think it was particularly meaningful to evaluate any torque numbers that I was able to read out from that point on. I tried to just torque it around to reach about 180 degrees from where I started out. I figured that that was a near maximum torque. I think I have on the voice tape my other comments on these configurations, which were more difficult then others. I had a quick evaluation of the 1/2 inch versus the 1/4 inch. Correct that earlier statement; all of this was done on the 1/4 inch head bolt. The center connector; there was no particular problem in doing that. I had to unpack the velcro first before I could get it free. It's a two handed operation. With two hands and a good restraint system there is no problem at all in lining something up, because you hold it right in front of you, both ends were loose. That kind of an operation is very easy. Part of it that made it difficult was that once you had them lined up, and while they were still lined up and you were pushing them together, you had to find a finger somewhere or thumb that you could start turning this locking device that only had one pin that stood out on it. There may be another way to do it. Maybe you could just grab a hold of that part right there and push it into the other one and turn it. Maybe I've been doing the whole thing a little bit more difficult than it should have been. But if that's the case, then the index marks are useless, because in grabbing ahold of the thing, you would cover up completely the index marks. We ought to be able to afford to put more prongs out there than just that one for that kind of a task. You just don't hook something up and then take your hand off and find out where this thing is.

Lovell — Do you think the four prong, that we had on there originally was beter than the one prong?

Aldrin — There is no doubt about it; four are better, you don't have to pre-position the locking device. You can just leave it wherever it is and you can always get ahold of one prong or the other. If one of them doesn't engage the first time you turn it around, you can catch the next one as it comes around. The situation that comes up with the one prong is that you position it where you think it is going to be okay, you put the two together, and you find that you've got to push it all the way around. So, now you've got to bring it back again and recenter the things. The fluid disconnect came off with no particular problems. A little bit more difficult to get undone than underwater or on zero g airplane. I suspect it was this particular connector. It took a little bit more of a jerk; whereas, once I had squeezed it together with my hands the straining device just seemed to pop out in your hand. This one, in addition to squeezing or moving the sliding part out, you had to then pull with your whole hand to get it off. Both of these I disconnected and connected twice, two times for each one. Got the cutters out next. The cutters were painted black. It looked like a heavy coat of black paint. The restraing system on the cutters worked fairly well. It takes a little extra time to open it up, put the fingers with your hand into it, and then tighten the strap on top of it, but I think that work is well worth the effort because during any subsequent operation with it you just don't worry about where that cutter is because it is sitting right there on your hand. The unlocking of the cutters was not too difficult. I think that strap that was on them was a little bit to long. Cutting the wires......I cut the medium one first and it took a little bit more effort with one hand than I thought it was going to, but on the second squeeze it cut through without too much difficulty. Then I took the smaller strand and cut through that quite easily the first time. Then, I went to the fluid QD. I'd never been able to cut one of these before in training periods because the cutters were either rusted from underwater operations or we were maybe saving this for some other work. I had tried it with training cutters, both one hand and two hand, and was unable to get through the wire. So, I was looking forward to seeing just what kind of problems I would have in cutting this.. With one hand I put it on the hose and started squeezing. I could see that it was going through the cloth, which made me feel pretty good, but it wasn't about to go through the wire. I tried that a couple of times and saw it just wasn't going to make it. So, then I moved over a little bit in the foot restraints and got both hands on it and squeezed hard and it cut it in two.

I think that this points out that this kind of a task would have been impossible without a very good restraint system. I think the waist tethers would have handled that if you could have stayed in position, if the work station was up high enough. The two foot restraints enabled me to get over there in good working condition to get both hands to squeeze on it.

Lovell This reminds me of a point that was brought up in training. I don't recall you mentioning this. How was the foot restraint position with respect to the work station -- low, high, good -- and did you float up more here than you did underwater or was it about the same or --?

Aldrin Very nearly the same. I can't compare in terms of inches.

Let me go to the velcro strips. Pulling the velcro strips down in one g takes a considerable stretch. In the airplane it's convenient to do and under the water it is fairly convenient. It was as easy to do in zero g as it was in both of the training situations, water and the airplane. So, that kind of a height is accessible from the foot restraints. It is not one where you'd like to do a lot of effort. As I recall, I worked across the velcro strips from left to right and did them all with the left hand except the last one on the right which was the big velcro strip. Of course, we had a couple of "do not pass go" and "go to jail" signs underneath there. Doing work down at the bottom end of the work station, you are beginning to approach the limit, I think, there. The wrench operation was about as low as I think you are going to want to go.

Lovell Well, I think this is a pretty good evaluation for our future work because it gives us a fixed set of dimensions that we can start with in any kind of future work.

Aldrin Well, I think rather than just taking those dimensions right there, the more important thing, I think that we learned from this is that the motion that you can get in true zero g in these foot restraints and the ability to move around is duplicated to an excellent degree by zero g flight and also by underwater. So, if we can take any situation and expose it to an underwater environment and make sure that the subject has gotten the right bouyancy and the kind of suit that reproduces the flight suit that he is going to have, we can check out the operation this way rather then trying to take any measurements from the Gemini adapter and extrapolate from there. I think we can cross check these.

Rep A lot of this comes from the suit fit, the mobility.

Aldrin It sure does. The suit is one of the constraining objects or factors in any EVA work, the work that you end up doing against the suit. Cutters were stowed back in the pouch as soon as we finished and I zipped it back up to keep them from coming out. The pip pins came out without any difficulty --

Lovell You got through the gas line, huh?

Aldrin Yes. The pip pins came out without any problems and stowed in the star fittings, and

I positioned them so that they wouldn't get in the way of any torquing operation or the left hand disconnect. Handholds were repositioned so that they were in a slightly better location, as far as not interferring with the waist tether hookup. The velcro on the portable handholds gave a very shaky handhold really. I didn't get a chance to fully evaluate the handholds as far as how much torque you could put on them back there, but it wasn't very impressive at all. I think you'd be better off grabbing hold of just about anything you know is secure. It may not be as good a handhold as the portable ones are. Of course, if you have nothing on a flat surface then you have to put something on, but that velcro just didn't appear to be adequate at all to go into that kind of an operation.

Aldrin — We stowed the cutters, removed the pip pins and stowed those, looked at the handholds, restowed those in a better location. I took the wrench off the velcro and started working on the

Saturn bolts; torqued it out to about a half way position where it was obvious that it was fairly easy to work from that point on. As in training, I found that in trying to rachet it back to the free wheeling position it also tended to turn the bolt back in again. So, I had to put a side force on the bolt and wrench during this operation and enough friction in the bolt and its threads so that it would overcome the rachet friction so that I wouldn't lose everything I had gained in the previous stroke. When I got to this point, I decided, well, I'll take it out the rest of the way with my fingers. I said, well, it looks like this operation will be fairly simple so I'll stop at this point and stow the wrench and do the rest of it in the waist tether. I hooked up the waist tether to the lower attach points and took my feet out of the foot restraints, tightened up the waist tether to 3 to 4 inches from full extension. The waist tether attach points relative to the Saturn bolt operation is far from optimum. The waist tethers are far too close. The right waist tether gets in the way of the wrench as it's turned and the left one is just too far up to get a good spread type of stability for any differential body torques that you need. But we knew that right from the beginning. So, I used the wrench and loosened it up just a little bit more and put the wrench away and started taking the bolt out with my fingers, twisting it out, and I discovered that the retaining washer that had been put on there attached to the rubber, wasn't coming out with the bolt. It was staying attached to the protrusion in which the bolt was screwed into. So, I got the bolt all the way out and was holding it in my right hand and then with my left hand I tried to loosen the rubber because this whole arrangement was covering up the other hole that I was supposed to put the bolt back in to. So by pulling away at the rubber it finally came loose. The reason that it was stuck I'm sure again was the heat problem melting a little bit of the rubber against the metal. In the process of unfastening this rubber restraint which didn't serve its original purpose at all, in getting it free I fumbled the bolt and its washer and it started drifting up towards me. Before I was able to get my hand in position to catch it, the bolt got so close to the ELSS and the bottom of my helmet that I figured the best way to recover the bolt was to push against it with my body, nudge it, and then back away. I had this motion toward me and I wanted to get it moving away from me a little bit and then back away and pick the thing up if I could still find it. In the process, I nudged the washer off the bolt and the washer and the bolt started going up and to the left. So with one hand I grabbed the bolt and with the other hand I grabbed the washer. Luckily, catching them on the first stab. Put the bolt inside the washer and chuckled at the good fortune and then started to try and put the . . .

Rep You made some kind of a remark about orbital mechanisms. Is that what you were talking about?

Aldrin Yes, I'm not really sure who really said what there. The way the papers had it it was a little backwards, maybe. Then I started trying to position the bolt to get it in and it didn't want to aline properly. I was using the left handhold, I think, trying to line it up. I started twisting, trying to very gently line it up so that it was lined up perpendicular to the hole. I twisted it, trying to engage it, however, this took, perhaps, four or five attempts before I finally got the threads to engage. I tightened it up with my fingers to about the half way point and picked up the wrench and changed the setting on the wrench and started torquing it up again. And again I found that I was unracheting about everything I was putting in trying to tighten it up so I had to use that technique of either holding the socket with my left hand, so that it didn't undo what I was tightening up, or to put a twist on the bolt creating a torque against the threads, while I was in the recovery position from the tightening operation. It finally tightened all the way up and got it to a reasonable high torque level and then we forgot about that operation. We went into the hook and ring connection and this operation was quite similar to the underwater operation. I think a better simulation to this is really the zero g airplane because underwater the hook and the ring both, of course, don't float as they do in space. I took the big hook and hooked it to the big ring and the little hook to the little ring and then a modest combination of hooking them all together. I could see that the rings were bigger in this flight item than they were in the training item and I wasn't going to be successful at all in getting the big hook around the big and little ring and the little hook also around the big and little ring because the little hook was too small to put both rings in. So I let it go.

I actually decided at that point to disconnect everything and hook it back up to the original place. The operation would have undoubtedly been simpler in the foot restraints. But again it was a two handed operation and you had restraints - gross restraints - with the waist tethers. You weren't concerned about where the body was going and as expected, the body just had a tendency to rise up as you started doing an operation with your hands, positioning the waist tether attach points down from where they were attached to your body. Then you just had a natural tendency to drift to a place where the lines and the waist tether attach point to your waist to structure was in a downward direction to your body.

Rep Do you feel the big rings are better than the little rings? Do you concur with Cernan?

Aldrin Yes, I think the big difference is not the size of the ring as much as it is the big ring has the rigid bar attached to it enabling you to get your hand away from the ring and hold it. With the little ring you've got to get your fingers right on top of it to keep it from flipping back and forth. I think we can deal with little hooks about as well as big hooks.

Rep — Nylon strips, were they any problem?

Aldrin — No, I already discussed that.

Rep — The connectors again, any problem there?

Aldrin — The center connector was a good bit more difficult this time than it was in the foot restraints. My body tended to rise up a little bit. Again I think it was more a problem of the bar that was on the locking device. The left connector in the waist tether configuration is a difficult connector to make because the only place you can hold on with the right hand is a good ways away from the connector that you're making. The waist tethers cannot give you enough stability to line up the connector perpendicular to the surface and at the same time let you play with the finger operation to get the locking bar into position so that you can twist it in. This requires pushing against the surface. Now it may be that if you really take pains and cinch up the tethers fairly tight with this special operation that this could be done in an easier fashion. The big point to make here is that two handed operations, where you can hold on to both ends of the connectors and then line them up right in front of you, are simpler to do than just a one handed operation where the other surface is fixed and you now have to position your whole body and everything with respect to the surface. Another factor that I think had a bearing on this is that I'm right handed and this was a left handed connection. I think that tended to make it a little bit more difficult. I would have far preferred to have done that with the right hand. I snuck in a quick evaluation of the right hand connector because we didn't have that on the checklist and it is a fairly easy connector to make. We had them up in the nose, and I wanted to compare that. This airlock connector on the right side is a very neat connector, quite easy to hook and to connect and disconnect. It's a right handed operation. It's a straight twist to disconnect and fairly small force - inward force - required to get it lined up and the alinement marks are simple. There is no prepositioning of the bar required. The alinement to engage the pins seemed to take care of itself. The only thing you have to do is position the connector in the right place and twist and push in at the same time and just keep doing it and you're bound to line them up. That's a great one. Up to this point I didn't feel that any of the operations particularly fatigued me. We added time so that no large amount of time was spent doggedly going after something that was difficult. None of the jobs were really that difficult to be done. There was a certain amount of chance I think. Some of those things that I did get done with chance could have been a lot more difficult I think. I guess we are getting close to the sunrise time.

Lovell — You have already covered the one foot evaluation which was...

Aldrin — Right, right. I hooked the waist tethers to the portable handholds, slapped them on the chestpack and they held fairly well. I took one foot out of the foot restraint, moved around a little bit, and then went to picking up the camera. I found that the camera wasn't going to come off, very easily. Incidentally, a little earlier in the operations when I discovered the camera wasn't working, during the rest period I decided to go eyeball to eyeball to the lens to see if I could see it clicking and I couldn't. So, I thought, well, I haven't seen it go before in training, so just to make sure that it is operating, I put my hand on it and couldn't feel anything moving at all. This is fairly early in the operations. So I asked Jim to check the switches to see if they were on. I hit the button again, which should have stopped it, and I checked it again and it wasn't working. So we recycled the procedure. I checked the plugs and at that time I got the definite impression that the camera was warm. I was feeling this through the gloves and there is no doubt that I had the sensation of heat going into my gloves from the camera. I couldn't tell whether this was due to the camera operating and slipping, just not engaging the mechanism, or whether it was due to the sun. This check was done before sunset. Just before sunset also, I might add, the spacecraft was held inertial and the sun orientation was such that as it was setting it was shining directly into my buttocks region. The covering on the suit, of course, covered the zipper down to a fairly low point in my back, but below that I could feel a definite warmth along the zipper line, in the crotch area. As I nestled down against the suit, just to check and see how warm it was, I could feel very localized heat and it was obviously coming from the metal zipper. It wasn't just the generalized area. Quite localized. Now it wasn't objectionable. I didn't notice any total heating resulting from this. There was no work that required your body to be positioned in the suit such that you were forced against this for any amount of time. It tends to confirm the results that we had from Gemini IX that when those zippers are exposed to heat it absorbs a tremendous amount of solar radiation and transmits it directly to you. Okay, so now we are back to getting the camera off.

Lovell — That is right.

Aldrin — I was trying to do this initially with one foot and when I had a little difficulty, I thought, well gee, let's see how getting the problem done with one foot is going to be. So, I spent a little time trying to do it and decided that the best idea was to put both feet back in again and go back after the task. Finally, by again sticking my fingers into the latching mechanism, I was able to dislodge it and eventually to break it free. I then got the plug undone and attachment on. I attached it to the ELSS. I unclipped the umbilical and stood by to maneuver around to the front. We went through the necessary steps to turn the camera off. I don't recall feeling at all tired at this point. Nor was I warm. The sun came up and there was nothing that prompted me to think in terms of changing the flow setting. I just left it where it was and started maneuvering around. I got my feet out of the foot restraints and came around the edge and just before coming around the edge unhooked the umbilical from the pigtail. This was nominal. I got it free from the area and in coming around there was a slight tendency for my head to drift toward the edge. Again I used the pigtail to torque my body down a little bit. I then handed in the camera. There was somewhere, either going to the adapter or coming back from it, that the umbilical got caught on something and I noted it just--

Lovell: --caught on the retro camera.

Aldrin: Yes, that is what I thought before, but when?

Each time the camera came down, before going back to the adapter. That is what stopped me. I was thinking about that before.

Lovell — That was coming back in from the TDA. I was bringing the umbilical back in during the ingress procedure. The umbilical had gotten caught, "briefly wrapped around something," you said. You said, "okay, I have it." Because I started bringing in the umbilical and you said hold it a second.

Aldrin — That was around the edge of the hatch, I think.

Lovell — I couldn't see back there, but I guess that what it was. I could see it floating...

Aldrin — I may be confusing this with one of the tests underwater..

Lovell — No, I recall you saying it is around something here, just a minute. I thought you said it was the retro camera.

Aldrin — Yes. I thought it was too, but of course, that wasn't up at this time.

Lovell — I thought it was at ingress.

Aldrin — Well, it is not a serious problem. It is a fact that as I was moving I looked in both directions and did happen to notice that it got caught on something and it might have been just the stubb of the handrail sticking up. I guess we can call it that, until we can figure out what else it might have been. It just happened to get caught at the time I looked at it and I noticed it and stopped and unhooked it. It points out that it could have gotten hooked on there and I might not have noticed it and it could have forced me to come back, you know, delayed some operation. Little things like this just sneak up and get to you. If you are not looking.

REP — Did you go to free flow at any time? Did you ever let go completely?

Aldrin — No, I thought that was just asking for trouble and it wasn't on the flight plan.

Lovell — We wouldn't learn anything. We have already done that on Gemini IV and Gemini IX and--

REP — I was thinking of the tendency to go up over the top.

Lovell — The Cernan Effect!

Aldrin Looking back, I think a good time to have done that would have been in pigtail, because you are in a corner there. You have about 5 feet which is enough so that you can pull it in. You are working in a region of jagged edges though.

REP Since you were hand over hand or tethered you didn't have any Cernan Effect.

Aldrin As far as the initial evaluation, I was free from any restraints in the hatch area. In other words, I had a hand on the handrail and a hand on the hatch and my feet just barely in the footwell, but up around the seat level. The umbilical was coming out. This was initially in the program. I just got stationary and very carefully let go and I didn't go anywhere. If I went anywhere it could have been from the way that I let go as much as any thing else. No, I covered that before. I just couldn't say there was any action really one way or the other. Now I handed in the equipment and retro camera and picked up the other camera. I ran into a slight little problem here.

Lovell Can I say something here?

Aldrin Yes.

Lovell I changed the film with no strain, changed the voice tapes with no strain. Okay, continue.

Aldrin I had to rest while you were doing it.

Lovell That is right. It was a lot easier operation than I thought.

Aldrin Now, mounting the retro camera for the second time before going up to the IDA. There was something we didn't really anticipate. Looking back on it, I guess there would have been other ways of solving it. What I tried to do was to just get hold of whatever was facing me when Jim handed it to me. I was holding on to the retro handrail with my right hand. I just picked up the camera and I obviously didn't have it in my left hand in an advantageous position to engage the lever to put it in the slot. I figured I would fumble around with it a little bit here against the top of the seat and try to get it in position but that didn't work really too well. I got hold of the top of the camera, but didn't have the lever and started getting it in position right on top of where it gets mounted. Then I said, well, okay, I will push it in gradually and then take my hand off of it and regrab it to get hold of the lever and did this about twice. All the time I was doing this of course, there were little forces pushing against the camera and these all had to be taken out with my right hand, holding on to the handrail. This could have gotten to be a problem if I had held just with my hand. I recognized that I needed a little bit more leverage to do this, so I took the handrail and pulled my arm down against it. I now had an elbow against the handrail and a hand, so I could get more torquing this way. This was enough to let me hold on with my hand and in essence pull up with my right hand, push down with my right elbow, which then pushed my left hand, which had the camera in it, down, so I could have some torque to push the camera down. This finally worked out fairly well in terms of getting the thing in. Then I had to reset it to the 1/250th position.

Aldrin — I moved up into the nose area. Did you pull in some of the umbilical at this point, Jim?

Lovell — I let you have as much umbilical as you wanted, and then I started pulling it in while it still floated. One point here is the fact that, again, in zero g it is much easier to pull in that umbilical because there is no tendency for it to get caught on the ...

Aldrin — ... hatch closing device and it will essentially stay there and you can go back and grab a new ...

Lovell — Yes, and it is also loose. It doesn't tend to bind around anything like it does in one g. Also it is stiffer because it's ... well, we had the same systems in one g as mock-up.

Aldrin Movement from the retro handrail to the telescopic handrail was the first time I just went from one directly to the other. The other time I was installing the camera and it went up front. I stopped in the hatch area to get the GLV strips first. This was a fairly smooth operation going from one handrail to the other. Oh, I guess it was about 3½ feet, maybe. But it is certainly well within the reason to go from one to the other, and I was holding onto both of them at the same time. I guess this was a left hand first operation. I must have turned around somewhere in here. I forget how I moved forward. It'll be on the film. I moved on up to the EDA and backed into it as I recall. I remember saying a few words about that, so it must have been I was leading with my left hand going up there and then just turned around slightly to the right and gradually backed my body back over the work station. As planned, I took off one of the portable handholds, put it in position -- this is holding on with let's say the left hand on the handhold, on a fixed handhold -- took the hook off the portable, hooked it on the pip pen, and again with the same hand took the pip pen off and put it in the star fitting, the one that I had chosen to use initially which was the furtherest aft and inboard fitting. Then I went from there to the other side, which I'm pretty sure was the left, and did the same task there. I guess we had a rest period here. Somewhere in there I think I did tighten the waist tethers up just a little bit to go through the action of doing it. Was it later on in torquing?

Lovell — You did tighten them up. You tightened both up at one time.

Aldrin — It might have been at that time. Somewhere in there I stopped and said, "Get a good shot of this because I want to really point out the fact of two waist tethers and two toes touching." The position that I had was just essentially riding up like this where I was, you know, just pushing myself gradually away.

I had plenty of good maneuver room and good spread four-point suspension. As a matter of fact, I think we learned in training that the waist tethers ought to be a little bit further apart than I used them in flight and than I had done in training. But, since I trained this way, and worked out all the procedures, I decided not to change and move them to wider position. I just have that feeling. We'll find out more, I guess, in other investigations. I think you want to have them a fair distance apart so that you can pull against them, in addition to just pushing straight away from the surface.

Rep — You still have the portable handholds on the ELSS ...

Aldrin — No, when I first got there the only way to hook up the tethers, since they were hooked to the portable handholds, was to take the portable handhold off, put on the velcro, take the hook off, put it on the pip pin, pip pin .... Then I went on to the electrical connector which was very simple, and the fluid connector which was also a simple task. Voice tapes may have a few additional comments on some of those.

Lovell: You found nothing in the IDA area that was of an unusually difficult task. Am I correct on making that statement?

Aldrin: Yes, the only time there was a little bit of a problem was the initial time up there making one of the waist tether connections.

Lovell: Yes, I have a feeling that I had a harder task trying to change film on the fixed bracket camera than you did, just from watching your operation on the TDA.

Aldrin: Yes. The torquing operation was very very similar to underwater. The wrench worked for a change. The left waist tether was off, disconnected by the emergency means. Incidentally, it was a little bit harder than I thought to pull the waist tether through the parachute harness. As a matter of fact, I didn't pull it through either of them that way. I resorted to cinching it up and pushing myself away from the hook. I don't think this means that I couldn't have done it, but it would have taken a good preparation and a good conserted jerk on it, I am sure. I think it would have come undone. I guess I took the right one off and was there without waist tethers. Actually, the torquing was not to difficult without the waist tethers.

Lovell: Do you feel that you were there without waist tethers long enough to really get a good evaluation, or do you think that you could have started setting up motions that would have been --

Aldrin: With waist tethers?

Lovell: Without.

Aldrin: I didn't really have a long enough time to really look at that. I was in good shape to do the task. The work station was a fairly convenient one as far as the handholds. I don't think I resorted to using the pip pins as handholds. I did make an evaluation of the free pip pin as a handhold, versus the fixed one. There is no doubt that the fixed one is far superior. You are really using finger-type actions to move yourself around, and when that thing is freely spinning it gives you nothing except a gross single point pull and push. The portable handholds just didn't appear to be as secure as I would have wanted them to be to entrust untethered operations, as a handhold. When you are using a handhold you want to have confidence, that you can start pulling against it and not worry about it coming undone. If it does come undone, you are in deep trouble because you have exerted a good force against it and now suddenly it is undone. You've got your other hand, obviously, engaged in some other work task and it may not be convenient to just drop things and grab hold of something. You've got a portable handhold in one hand that is doing you no good at all because it just came loose. In order to really make use of portable handholds they have got to have a good secure fitting. Now this polyester was a good bit better. I didn't have, of course, in space the opportunity to compare the polyester to the nylon, but, in building up this flat surface to get more area, they also had to cut out an area for the pip pins to turn around. This really stole about as much as it added. There wasn't just that much of a surface on the bottom of each handhold. As I would pull against the handholds I could definitely determine that they did have a little bit of give as it was reaching the limit.

Aldrin — Looking back on this now, it seems to me that the kind of action you want to put on a portable handhold, that's to the left or right of you, would be better accomplished by orienting the handhold perpendicular to your body, instead of parallel to it, as we had this oriented. This would give you larger bearing surface for the torque that you are putting on it. The torque was really a sideways torque which pealed the thing off the easy way. You want the long one in the direction that you are going to be applying any torque on the surface, and we didn't have that.

Lovell You had them parallel.

Aldrin We had them parallel and they weren't the best.

Rep Would you think that if they had these little pip pin handhold devices in a long line of star fittings that you could go hand over hand along the booster or the length of the spacecraft?

Lovell The pip pins don't go in real easily, I think we could come up with something that would let you just simply insert it in a hole. You can get quite a bit out of just having something in a hole. Just like the wrench, applying a torque against it so you build up friction, so it won't come out. If you can get your body over it and in close, you can go about the task of pushing the button down and getting it in. Maybe we can come up with a simpler way of inserting things. If you squeeze something, you can just jab it in and release it and its set. This gives you a spin free operation. I don't know whether or not you would want to keep disengaging these as you go along. I think you could move along that way. It might be a tedious way to do it. I think when you move along, you would want to turn around sometime and come back, so I think you would be much better off to have a clothesline full of pip pins, where you take them off and put them in as you go along and come back, because it would be one less operation.

Rep — I was speaking of an emergency transfer.

Aldrin — I think it's a good transport device. It certainly ought to be with a star fitting or something, to keep it from rotating. I was wondering if we really ought to do away with these T handles that were on these. All we are going to do is perhaps tangle up the tether and you're not going to use them much anyway. You can use the ring. That really isn't true. You use any little surface that sticks out to give you a convenient way to put a little finger torque on it. After disconnecting both of those and looking at the operation without waist tethers, I started cleaning up the area and throwing all sorts of things away; five pip pins, four hand holds, two waist tethers. I guess I threw away that bar also. The one that was on the ELSS.

Lovell The bar that went across the chestpack.

Aldrin What we really needed was a way of attaching the left waist tether to the chestpack and they came up with a design that had enough velcro on it. I think velcro alone is good enough. I don't think we need to hook them on; just velcro right near the end. I think the idea we had originally about putting them on your leg is not a bad one at all. With a chestpack, it was a little bit difficult to get down to your knee or to your leg. Of course, I did put the flashlight there, that came back from the adapter and it stayed there the whole time. Everything was free then from the TDA and I started moving back toward the hatch. I stopped and made one last look at the tether and it looked in good shape, nothing had changed on it. I started moving back toward the hatch and didn't get very far before I got a request for a window wash. So, I wiped off the window on Jim's side. The handkerchief came out quite easily. There wasn't any particular tendency to have it float away. This is obviously a one-handed operation. I held onto the handrail again with an arm and a hand. In other words, the arm was alongside of it and then somehow I used my feet against the handrail because it went back along the spacecraft. This gave me enough action with an elbow against the side of the spacecraft, so that I could push against the window fairly well and was in a good position to rub. I could see that I was obviously rubbing the film off the surface. I guess I got it off, except for that one square that heated up.

Lovell — No, you had it all off. That square came from the coating that was put on the outer pane.

Aldrin I wonder why the coating didn't get burned away from the rest of it.

Lovell I don't know, unless it was put on in squares or something like that. I could tell where you didn't wipe, which was right along the edge. I could see the cloth marks there.

Aldrin The big problem with the window, in addition to two blotches that I had on my side was just a little film that over the process of time just seemed to catch anything that drifted by and things would just stick to it. After awhile it would build up a sizeable accumulation of little dust particles. I don't know where they came from. Most of the dust and the interference to visibility was from the sun shining on the outer part of the window. We didn't try anything in the adapter with the wrench at a different torque setting. We left it at the 100 level. I feel that it would have been no problem in upping that to 200 inch pounds torque release. Coming back to ingress.

I got in the seat area and got the camera in with no particular problem. We were about to come in and I figured that we had to get rid of this handrail. I disengaged the handrail with no difficulty at all. I had already taken down the EV camera and it was probably out of film anyway. At the time, I wished that I hadn't taken the camera down, so we could have two of them taking pictures.

Rep — Did you get some movie film?

Aldrin — No, I think we were all out by that time. Well, anyway, it was discarded straight ahead, slightly down, which put it out-of-plane, and a perfect position to come back and spear us 180 degrees later. We didn't see it though. Maybe that's what caused our thruster problem. The umbilical came in, I guess, prior to this time. You were feeding it in. Did you have any problem getting it in?

Lovell — Well, I brought in your side of it.

Aldrin — My end first?

Lovell — Yes, just fed it in there; had my legs spread apart and I just kept feeding the umbilical down through my legs and that's where it got caught a little bit. I remember stopping, taking some back out again and he said okay, it's free and I kept on bringing it in and he said okay that's enough. I had no problem handling the umbilical at all.

Aldrin — I think in a lot of cases these things are simplified in zero g, over what you think they are.

Lovell — Yes, if you use it to your best advantage.

Aldrin — A free line is very easy to handle in zero g. It doesn't get tangled particularly. It behaves itself very well. I stayed well up in the hatch area, so I could look at the hatch seal that appeared to be clear. I disconnected the upper ELSS restraints. They came off with no problem at all. As soon as I did that the two "Beat Navy" flags started drifting out and I was sort of amazed that they were still with me. I handed those in and made sure that they didn't get lost, and disconnected the bottom two.

I went back in the hatch and got rid of the handrail. I stowed the checklist that I took back to the adapter with me. Incidentally, the viewing back there was perfect. No problems seeing things.

Lovell — How about at night?

Aldrin — In the night? Really, when sunset took place the difference was very unnoticeable. As a matter of fact, I went through part of the night with the visor down. Raising it obviously improved the visibility some, but it really wasn't a big factor.

Lovell — There were no deep shadows? The gold cover-----

Aldrin — No, it was lit all over the whole place. There were no shadows.

Lovell — The gold cover, if you scatter enough light on it------

Aldrin — It seems to put it all over. You'd expect some shadows, but, boy, there just weren't any at all. The light didn't seem that bright at all.

The light seemed to come from everywhere. Let's see, we got the umbilical back in. Yes, you stuck that in your footwell.

Lovell	That's right.

Aldrin	There was no problem doing that.

Lovell	There was no problem handling the umbilical at all.

Aldrin	I got the hatch holding device and checked the hatch pawls.

Lovell	That's right.

Aldrin	---and the hatch seal. I released the upper restraints and the flags came loose and I handed them in. I had the Apollo wrench velcroed onto the front of the ELSS. I lowered the ELSS and reached back to get the lower restraints. Just as in the training, there was no problem locating where these were even though you couldn't see them. They were quite easy to feel.

Lovell	It is certainly a lot easier to handle the ELSS.

Aldrin	Oh, yes, it is very easy to pass it off and with the position that I had, I was able to put both hands on it. I'm not sure how I did it. I think it was just the stability that we had and the fact that I wasn't tending to shoot up. It wasn't the question of handing off something that was a thrusting machine. It was still on high flow. I passed it off and I'm pretty sure I was using a little bit of foot pressure against the inside and outside of my footwell area.

Lovell — You never went to medium when you went in did you?

Aldrin — No.

Lovell — I was just wondering about the closing of the hatch. It didn't seem like it was difficult at all, and yet we were working against pressure.

Aldrin — Was that the time that you pulled it closed and I said, "Gee, you don't have to pull on it anymore because it's already past....."?

Lovell — That's right.

Aldrin — There was a bit more stuff inside the cockpit when we came in than there was previously, but it was plenty clear on my side. You had the ELSS in front. I don't see anything that was out of the ordinary there. Oh yes, I did, too. It was about this time that you started having some problem with the eyes.

Lovell — Oh yes. We'll cover that. This was during the ingress period. We had just started to utilize the ELSS for repressurizing the cockpit. I turned off the repress valve. The ELSS was on HIGH, condensate was turned off, We were in normal.

Aldrin — Yes, and I said to go ahead and switch to by-pass once it started coming in.

Lovell — Yes. We started off in high and then we switched to bypass and my eyes started to sting. I was on the suit loop. Do you recall what fan system we were using?

Aldrin — Yes. You had number 1 on.

Lovell — Was it just number 1 fan?

Aldrin — Just number 1.

Lovell — At any rate, my eyes started to burn and they kept on. The more they watered the more they burned, and I didn't get rid of it until I could open up the visor at 4.5 PSI. I'm not sure whether this was the result of tearing and just stinging in the eyes, or perspiration that had come into the eyes of which I didn't have any, though, so, I can't quite visualize that.

Aldrin	I did not notice it on the EVA's. I had noticed, I guess more during my sleep period than anytime else, when I would yawn and be a little tired, or something like that, that my eyes would water. It was a little difficult to move the water out. I had to wipe them out. Maybe it wasn't during sleep time, but there were other times when I noticed in one eye or the other. It was characteristic to get a little stinging. But it was just an isolated case for a short time period. I think it was a question maybe of a little perspiration.
Lovell	I can't recall any definite odor. I did smell something, but I don't think.....
Aldrin	Well, we thought at first that it might have something to do with the camera, but that was eliminated.
Lovell	Yes. We didn't have any problem there. I was able to hold on until we got the pressure up to 4.5.
Aldrin	You couldn't see too well though, so I took the checklist because you weren't...
Lovell	That's right. Speaking of checklists--I want

to make a comment here. The large clip that I had over in the left hand corner of the cockpit worked out very well to attach the hardsuit checklist to during EVA. As a matter of fact, the design of the hardsuit checklist is a pretty good one. The only thing I changed on it was to move the velcro to the outside of each hard cover so that it would hit the velcro on the instrument panel and also on the lefthand circuit breakers guard which it didn't do before.

Aldrin — The stowage and everything else was normal. No problems there.

Lovell — Let's talk about the ELSS a little bit. The flight plan called for the ELSS to be operated in HIGH and MEDIUM BYPASS. We were rather short on oxygen, and MEDIUM BYPASS uses up a little bit more than HIGH. We wanted to conserve as much as possible, but we also wanted to make sure that there was no overheating on the part of the Pilot, or any problems with the CO_2 concentration and things of this nature. So we were willing to use some MEDIUM BYPASS.

Aldrin Yes. There was such a drastic difference, I think, in what we experienced and what we expected, even under the most favorable conditions. What we expected was nothing like what we actually experienced. Based on this, there was just no thought at all to changing it. We'd already discussed with CSD whether we should go to MEDIUM at any time, and they had no desire at all to try and do this. It seems to me the only thing we could have gained, perhaps, would be a little bit of oxygen and a demonstration that the ELSS could perform under medium flow. I'm convinced that it could. I don't think we really had to do that. So, I think that was a good decision not to attempt to fool around with the MEDIUM since no one's going to be using the ELSS from here on out. But, going to BYPASS makes a considerable difference in the cxygen in the oxygen usage. There was no real need to go to that extreme case.

Lovell Right. We had made onboard decisions when it came up to the time to go to MEDIUM and

BYPASS in the flight plan, not to, based on the fact that there was no reason to. Buzz told you that he was adequately cool. He wasn't perspiring, he wasn't overheating, and there was no reason to go to this MEDIUM BYPASS, so we kept the ELSS in HIGH during the entire mission. Did you ever go to MEDIUM BYPASS?

Aldrin No.

Lovell We kept the ELSS in HIGH during the entire umbilical EVA.

Aldrin I did mention on the voice tapes during the standup EVA that my feet were a little cool, but this wasn't at all to be considered or construed as a complaint. It wasn't bothersome, but it was just to indicate that they were noticeably cool in extremities. Evidently the suit gave me a good ventilation down to there and it kept the flow pretty well. It indicated, I think, that in that area the flow was cool. It certainly wouldn't have been cool down there and rather warm in other places. It would have tended to heat up all over. In comparing feet being cool on the ELSS versus the standup, there really was not much difference. It was essentially the same. I sure couldn't say that I was warmer at all on the ELSS than I was during the standup. I'm sure that I was doing more work, and the numbers will bear that out.

Lovell — That's right. I suspect you were, too.

Aldrin — But even at the time that the heart rate went up to its value of about 160, there wasn't any feeling of being warm. I think there was the feeling of, as I mentioned before, a little apprehension or something, associated with the comments to the ground. Because I was talking a fair amount continually at this time, I tended to lose my breath a little bit. But it wasn't a case of being out of breath at all.

Lovell — How about the ELSS itself, as far as being able to read the instruments and the gages and all that sort of stuff?

Aldrin — It remained in a very stable position, the restraints never had to be moved.

I can't say as it ever got in my way, particularly. Of course, I've been so used to having that thing strapped on.

Lovell — Did it ride high or low on you?

Aldrin — It was a very pleasant location. It was visible. It wasn't staring me in the face and it really wasn't in the way. I didn't have any need, particularly, to look at it. I didn't find that I was compelled to look over at my pressure gage either. Maybe this is something one ought to always do, but I think you'd have some cue, perhaps, that you ought to do it. I guess that's an individual situation, depending on how concerned you are. I wasn't at all concerned about the status of the pressure in the suit. I had faith in the system that it would give me the tone and the light.

Lovell — Okay, is there anything else on the ELSS? The harness was okay?

Aldrin — Yes, it was a great restraint system. It was tight. It didn't move around. A good solid fit.

Lovell — And, it wasn't unduly in the way. Okay. We have completed the ingress. There were no other items in the ingress, that I noticed, that were out of the ordinary, compared to what we had already practiced and experienced and had written in our own hard suit checklist.

Aldrin — Well, during the stowage we had a little concern about the camera in the back. It seemed to have an odor to it so we stuck it in a plastic bag because we thought that it might have been the source of the eye irritation. Obviously, it wasn't, so afterward we took it back out. I guess that it had a chance to cool down. The odor wasn't particularly noticeable then. We tried to use the film for some interior photography. Found that it didn't operate in either camera. I guess we actually tried the EVA camera too, by hooking it up. Seems to me--

Lovell — That's right. We found out later on that it happened to be the magazine.

Aldrin — I'm not sure whether we really established that the EVA camera was working.

I don't think we put another magazine of film in that one.

Lovell — No, we didn't run the adapter EVA camera.

Aldrin — That's right, we didn't.

Lovell — No, we used the magazine in another camera, and it ran for a few feet and jammed.

Aldrin — Yes, it was a little greasy, indicating that it had been overheated to a certain degree. There were marks that looked like things possibly had jammed in there somehwere on the magazine.

Lovell — Okay, we used the regular hatch closing device and we had no problems with it whatsoever. The hatch closed. I didn't notice any extreme pressures needed to close the hatch. Going back for a moment, we found out we lost control before the umbilical EVA, or we found out that during the S-6 pass that we were getting indications on our needles that the spacecraft wasn't behaving the way it should with certain thruster firings. A check of the thrusters indicated that numbers 2 and 4 were out at this time. We'll digress on the thruster problem a little bit later; however, at a later time we had a better indication of exactly what went on. With this combination of Agena and spacecraft it appeared to us that numbers 2 and 4 thrusters were out. The next item I think we ought to discuss is the tether since essentially it came after the umbilical EVA. The tether was attached during umbilical EVA. As we said before umbilical EVA we found out we had a control problem, in that thrusters 2 and 4 were malfunctioning. We did not know exactly what our problems were going to be once we got undocked from the Agena. We knew that we had a problem docked to the Agena. Our original idea, and the way the procedure was written up in the tether exercise, was to take the spacecraft control and pitch the Agena down so that we were essentially local vertical. We would be able to utilize the spacecraft control to get in to this vertical position, and when we were there we would then turn on the Agena system with geo-rate reversed, not normal as it was felt by the ground, anyway. Maintaining the Agena in the vertical position a while, we would undock and take the tether out. But, with the spacecraft having problems, the ground advised, and we came to the same conclusion, that maybe it would be best to use the Agena to pitch down. We did by sending the commands to start a 1 1/2 degree pitch rate down on the Agena to get into a vertical position. We had some difficulty with it. After we sent it down, we forgot to put geo-rate back on again, which meant that it was not working. It was still essentially inertial, even though we had a geo-rate reverse indicated. So it took us some time to get the Agena in position.

Aldrin The geo-rate had been set to reverse, but to go inertial we turned geo-rate off and we put the ACS back on again. The geo-rate had been reversed, but it obviously didn't come back on because we turned it off.

Lovell — We had some difficulty doing that and it is a good indication of what happens when you get off the flight plan and you start throwing in procedures. We tried to minimize that as much as possible, but we did get ourselves in a bind several times along these lines.

Aldrin — Well, the procedures that are in the checklist, if I'm not mistaken, for pitching up or pitching down, obviously don't cover that particular case, because usually, when you pitch up or pitch down, you leave it wherever you were before. It says "TDA up and righ". Part of it is, "geo-rate off", and then you turn the pitch on and then the pitch off. It doesn't say anything about re-establishing the initial condition that you want. Of course, it is rather obvious when you think about it, that you've got to set the situation back up again. You obviously don't want the horizon sensors on.

Lovell — We did use the local vertical needles though. We had the computer up, used local vertical needles, had the Agena pitched down. We then gave the Agena control. The Agena held us in a vertical position, and we proceeded with the undocking procedure. Undocking was nominal. We decided to not thrust aft, based on several considerations. First, we didn't want to disturb the Agena. Secondly, we wanted to have a minimum impulse outward to start bringing the tether out, but we didn't want to reach the end of the tether. We didn't want any violent action. Lastly, we weren't too sure what our control system was going to do, and we thought we had better take things very slowly until we found out exactly what our status was undocked and tethered to the Agena. After sending the undocking signal to the Agena the cone unrigidized. The spacecraft was thrust out, but was stopped by the tether and it appeared to us the break link which was covered actually stopped us.

Aldrin — The break link had pieces of paper, it looked like wrapped around it.

Lovell — It was a thermal protection over the break link.

Aldrin This caught on the first peice of velcro. Looking back on it, I sure wish that I had just stuck my finger underneath there and just loostened that up. It was just the first fold that got caught. After that fold in that break link covering was out, everything deployed rather neatly. Actually, I didn't see that hang up at the 50 foot point.

Lovell Yes, there was a hangup because we looked at it and the red flag wasn't out yet. But to get on with it, it hung up at the break link just as we undocked, so we had to thrust a little bit aft. That broke, of course, the hold end of the break line and the line came out very smoothly. Until we came to the 50 foot position, I suspect it's the 50 foot position. I'm not positive, but it's the only spot where I could see there would be any difference in the movement of the line through the container such that it would cause a momentary hold. It did hold, but another small thrust aft relieved that, and the entire line came out until we saw the red flag showing that we had about 100 feet out. We were able to stop our outward movement and we attempted to control to a vertical position over the Agena. It was here that we found out that the techniques that we had practiced in the simulator of maintaining attitude control with the local vertical needles, or, in other words, maintaining a local vertical position, and then using translation control to maintain a position directly over the Agena was not possible with our control system.

Aldrin We couldn't stay pointed straight down.

Lovell That's right. We couldn't keep pointed straight down because the maneuvers controllers themselves would put in attitude changes which the control system was not capable of handling at the time.

Aldrin What we really had to resort to doing was using the Agena itself in its vertical geo-rate position to tell us what the local vertical was.

Lovell That's right. Local vertical needles became useless to us at this time and we left the Agena attitude system on such that it maintained a vertical position.

Aldrin I think we found out afterward that we had marginal control to maintain an attitude in Pulse. As soon as you go to Direct you begin to make things happen faster and you begin to disturb your ability to hold a constant attitude. I think what complicated this situation was that the tether would occasionally give us rather small perturbations when it would come near the end, and this, in connection with the fact that we had a little rate and a marginal stability there, just meant we were kind of bouncing around and doing our best to hold things near steady.

Lovell Yes, we were trying to, by use of the maneuver thrusters, maintain a steady position.

Aldrin Really, we shifted and essentially gave up attitude control and let ourselves drift. Then, based on looking down at the Agena, if we saw we were moving ahead or behind we put in a little correction. I guess we put in maybe one or two. Right? It looked like we were drifting ahead a little and we put in a correction.

Lovell Yes, when we first started off, we weren't at the full length of the tether. We weren't anywhere near 100 feet. We had quite a bit of tether that was connected between us and the Agena, although I realize that it looks like a lot more than it really is. There were times when we lost the Agena completely. This led to a little concern since we were not at the end of the tether. But as time went on and I translated to null out relative motion, the tether slowly became taut.

Rep Did you have a requirement for thrusts? It seemed to be maintaining fairly good position.

Lovell The attitude excursions, because the tether was getting closer to consistently taut position, began to drop off.

Aldrin That's right. We maintained this position to determine what we really had to do to null out relative motion to get captured by gravity gradient. We came to a conclusion that we had just better roll it up alone and see what happens.

Lovell Didn't we have at one time a little slack in the tether because of one of the translations that started moving us forward. We pumped it back just a little bit, back to a fairly tight tether?

Aldrin I think that maybe we did that once. We didn't get a rebound off of that particularly and it might not be a bad procedure.

Lovell As a matter of fact we never really got any big rebounds.

Aldrin No.

Lovell If we started at a loose position with a loose tether, and just by trying to maintain a visual contact with the Agena and try to null out our rates with respect to the Agena, we slowly got a taut tether.

Aldrin We were considerably surprised at the onset of damping of the tether length in comparison to what we have been led to believe. We figured that we were going to just spring bounce back and forth.

Aldrin

It didn't happen. Considering that, I wonder if in any future work it wouldn't be a good idea to move initially and translate with four and aft thrusters until you do get a stable constant taut tether. I think that you could probably do it. We don't have any indication that says we couldn't. Get to the point where the tether has very little bow to it, almost straight, with a little aft thrust, then stop. If you're coming back in just pump it a little bit more. If you get going too fast you will hit the end and maybe rebound a little. That's the time to maybe tap it just a bit. Once we got that taut tether, the problems were essentially solved as far as visibility. We had a good idea where the Agena was. We could see which way the tether went. That's the way we looked upon the Agena. If you did have that, and had a little bit more than marginal control system, you could then maybe reinstitute attitude control.

We elected not to do that because by this time we'd made the decision that we would leave Agena on, but the spacecraft was on its own and we were going to just see what happened. I think there are a lot of ways of doing it and one of them might be to do a little bit more of this approaching the taut tether.

Lovell Well, we were in no position at that time. We had to take what we could get. We came to the conclusion that we might be in pretty good position, so we let the spacecraft go and let the attitude control maintain a local vertical on the Agena. We kept this position throughout the later part of the first day period during which we started getting the taut tether to some degree. It was still swinging quite a bit. I was hesitant as to whether to continue this thing through a night period since we had a marginal control system. But the argument was won by the night side so we decided to stay with it.

Lovell The docking light won the argument. It kept the tether illuminated to see which way it was going. The gyrations of the Agena combination showed us that we were getting to a position where it was not all over the sky. When we first started out, there was some concern that the tether would wrap itself around some part of the spacecraft so that we couldn't get it untangled. So once the tether became somewhat taut, there was no more concern that we would be in the way of the tether during the night pass. The docking light, by the way, worked very well. It didn't light up the Agena. The Agena had its own lights that were very adequate since the docking cone light gave us some perspective of distance, of depth of view. The docking light on the spacecraft lit up the tether itself, which gave us some indication which way the Agena was.

Aldrin — We did have command capability. I turned the acq lights on at this time and turned them back off. While they were on, I remarked that the battery must be getting rather low on the Agena because it certainly wasn't flashing at one per second. It was a good bit less rate than that, maybe once every two seconds.

Lovell I think it was 3/4 through the night period. Actually, we got in this position pretty good in the day and then we went in the night. It looked like we were captured. We stayed that way, and as we went through the night period, it became apparent that the amplitude of the swaying was going divergent. The Agena was approaching the horizon and we weren't going back again. After we got about half way above the horizon, and the tether was still taut, it looked to us like we were not captured. So we elected to utilize the translation system again to try to get to a better position and try getting captured again, which we did. We thrusted up and forward a little bit to move over to get the Agena in a upper position. They sent me the null translation while we were vertical above them.

Aldrin How much voice tape did we have gone at this time?

Lovell I don't know.

Aldrin Over stations I was trying to give the ground our position in a coordinate system oriented to the Agena plane. Incidentally, the dipole helped us considerably in this respect. It was pointing which way the forward direction was. I personally feel that that's the way you ought to look at this thing in setting it up. If you get to a maximum position, if that maximum you see is going to go past, you have got to make a maneuver right there to get it going back. You want to make it just small enough to stop the motion and get it moving back. Now you know that, if you reach that maximum on one side, chances are you are going to reach that maximum on the other side too. What you have to do is look for the closest approach to the local vertical and thrust in the direction that you are moving perpendicular to this closest approach, trying to keep that stationary. Idealy if you do this, then from that point you ought to move from that closest approach, across the local vertical. In trying to keep track of just where you are, it helps if you can log in your own mind about where you are in feet or in angles in this coordinate system of left or right of the orbit plane and forward or aft. Since your attitude is random, at one time you look down and you say well I'm off the Agena at such and such and attitude. You might find yourself moving from one side to the other or you could be going across. It helps to keep track of how you are progressing in amplitude. Whatever it is it ought to be a sine wave type action. The period, you are not sure what it is. The smaller the amplitude, the shorter the period is going to be.

Lovell   Our period went to zero, decreased definitely.

Aldrin   That's right. A period increases to infinity if you get to the 90 degree point.

Lovell — We tried it again, and not knowing exactly what we were doing because we didn't have a control system -- we knew what we were trying to do, but we didn't quite know how to get there -- We tried to null all our relative rates, and tried to get a local vertical again during the next day pass. It looked to us like it was pretty good again, so we left it go. At the time we were doing this, we felt that if we had an adequate control system that the procedure for positioning the spacecraft above the vertical Agena is really a simple one, and that we could have probably gotten rates down as small as we needed to get into this gravity gradient situation. In this regard, the simulator is much more sensitive, I think, in attempting this particular maneuver than the actual conditions are, which is typical of simulators.

Aldrin — The Gemini/Agena combination that we had was rather unique and you will never see it again, but I would just kind of guess that we ought to be able to get within a 30-degree amplitude without any problem at all.

Lovell	As it turned out the second time was a success. We left it go. We let the Agena have the local vertical control for awhile through that next night period --
Aldrin	Yes, we let it reach a maximum and then coming back up again --
Lovell	We did notice a decrease in amplitude as we were being captured. We were very low on attitude control gas in the Agena at this time. The ground wanted to conserve it and we then turned it off. Without control of either vehicle she maintained a gravity gradient.
Aldrin	Don't you remember the ground said that the Agena really wasn't firing a lot? It was a little surprising. It was maintaining its attitude without too much thruster activity.
Lovell	We think that it was probably easier to get into the situation, and one of the contributing causes might have been the fact that the Agena, by maintaining its own attitude control system, instead of hampering this local vertical was

actually damping out our oscillations and helping us get into it to some degree.

Aldrin — I'm not sure that Bill Schneider will agree with that because he seemed to indicate that his studies show that if the Agena was the other way it would be stable. I think it was a very specialized --

Lovell — Well, to give you some idea of the force that is in the line between the Agena and the Gemini -- the wire that was used as a loop to go around the docking bar wasn't even fully stretched out. We're talking in terms of very minute forces when we're talking about that particular situation...

Aldrin — Have you any idea of how many twists there were going down that tether?

Lovell — Yes, there were quite a few.

Aldrin — Well, I don't know how to guess, but I'd say maybe fifty.

Lovell — I'm not too sure but I noticed that every once in awhile we'd get a ripple down the whole line

Aldrin — It sure didn't seem to me that we made fifty revolutions around that thing or anyting like that. How did all those twists get in?

Lovell — Quite a few got in there in the beginning when we were trying to maintain control in the beginning

Rep — It was possible for you to observe the damping of the combination after capture?

Lovell — Well, the amplitude is like this. We're up here and it's down here, and we finally got to be like this. We had a taut line all the time, but the force in the line was maybe less than a pound.

Aldrin — Well, the only indications we had of damping was the fact that it didn't continue to bounce off the end, which indicated damping in the line, and when we finally let it go for the second time the total excursion that we reached this first pass was greater than the next one. And the attitude, of course, seemed to damp down a good bit at the same time, so we don't have any real qualitative feel for that. But we were looking at the Agena and it was in sight most of the time.

Lovell — That's right. I hope the pictures come out. There was one sequence which we took, in real time at 16 frames per second where we're going over the Pacific and the Agena is sitting down there with a straight tether and we're just following it right along without moving at all. Did we miss anything on the tether exercise, since we only had the gravity gradient portion of it? There are a few comments on tether itself. We thought before the flight, and I think we can re-emphasize after the flight even with the control system we had, that after the tether went taut, whether it was a slow spin or gravity gradient, that we wouldn't have any hesitancy of sleeping on the tether. This indicates that it would be a good station keeping procedure for low fuel, once we got attached. The only concern is getting to the spin or the gravity gradient, where you've got this tether snaking around and you don't want to get it tangled.

Aldrin I had the feeling, just intuitively that if that tether had been longer we'd have been in better shape.

Lovell Oh, I think that follows the laws of this particular --

Aldrin Yes, it does, but supposedly their studies indicated that once you get pass 100 feet, increasing it much more than that doesn't seem to help.

Lovell In any event, we had no problems with it, and I'd like to re-emphasize again that if we'd had an adequate control system I'm sure we could have got into it without any particular problems or any unnecessary difficulties.

Aldrin When we turned the attitude system off the Agena started to go through rather gentle attitude changes, and it was no longer easy for us to tell which way was forward. We started to roll and in combinations of pitch and yaw. They weren't very large. I don't think I ever saw them much over, maybe 45 degrees. But the Agena did obviously not stay in a straight up --

Lovell No, it was slowing -- the slight forces in the tether were causing it to change its position somewhat.

Aldrin Let's see. How about the disturbing forces, consisting of the urine dump and the fuel cell purge?

Lovell Well, I don't know if it was a coincidence or not, but after we were definitely capture and things were going along in great shape we had a urine dump and suddenly we got down to a pretty large amplitude.

Aldrin Before that, as we reached the peak, I said "Gee, I wonder if I move the spacecraft myself from inside, if it will help any." It may have been my imagination, but we needed to move back, it seemed to me. We were pointing this way and coming down. What I wanted to do was go back, so I leaned forward, just hit the back of the seat about 5 or 10 times, and, believe it or not, we seemed to stop doing what we were doing. Maybe I just happened to catch it at the right time. Forces required aren't very large.

Lovell Untethering from the Agena was quite a thrill. This thing really goes.

Aldrin We figured maybe it'll just piddle out there. When it went, it gave us a little bit of a pitch down.

Lovell	You push the Index Jet, and all of a sudden, as soon as you push it, there's a puff or something that comes out in the front. The debris goes.
Aldrin	The locks go.
Lovell	Well, whatever it is, nothing happens and then you start scratching your head and, ZOWIE! It really takes off and....
Aldrin	It went up like this and it just kept around like this and formed a spiral. Nothing had changed. The bar wasn't there any longer. That's interesting, I don't know what kept the thing there. Yes, I do. Sure I do. That thing fits over the top of it.
Lovell	Oh yes. Fits over the mushroom top. It has a big cut in the top of the handle where it fits over the mushroom. It really left.
Aldrin	Then our other problems began.
Lovell	Yes, then we had some more problems.
Aldrin	Yes, the desire there was to make a separation burn.
Lovell	Our next procedure was a 6 foot per second separation burn. At the end of the tether

exercise we had gotten this update and we were wondering just how we were going to make this 6 foot per second separation burn.

Aldrin I think part of the problem was that we had no idea what the ground had in mind. We were still under the apprehension that they might be thinking in terms of a re-rendezvous. I don't think we had really ruled it out yet. It certainly didn't look too promising. I'm sure the ground hadn't ruled it out when they set up this separation maneuver, but they didn't give us enough cues as to what they had in mind. They told us to burn posigrade and I guess Jim gathered it didn't make any difference whether it was posigrade or retrograde, just so it was 6 feet per second. I asked them if it made any difference whether we used aft or forward-firing thrusters, and they said it's your choice. Now to me that meant that they still wanted posigrade, but we could do it SEF or BEF.

Lovell It was my impression that they didn't care whether we used a retrograde or posigrade burn. They wanted 6 feet per second and they didn't care whether we used the aft or forward-firing thrusters. Cap Com called up and said, "What do you want to use?" I didn't really analyze the situation, and I said, "I'll use the aft-firing thrusters." After we had gone through sitting there in the gravity gradient exercise, it dawned on me that if we used the aft-firing thrusters we'd be out of sight of the Agena, which I didn't care to do with the control system we had, since we'd be firing forward and we'd have to have the Agena behind us someplace. So, at the end, we called up the ground and said, "Say, we'd like to change our mind. How about making it forward firing thrusters so we can fire aft?" I had the impression they really didn't care whether it was a posigrade or retrograde maneuver, just as long as it was inplane. Buzz thought it should be a posigrade maneuver but didn't care which thrusters we used.

Aldrin — The whole thing was rather academic because we had a hard time getting into any position.

Lovell — We left the tether. The tether gave us a false sense of security because it did sort of damp out everything in the spacecraft and we could see the Agena down there all the time, but suddenly we lost the tether and we immediately lost the Agena at the same time because we pitched up to get to a zero zero zero attitude and while we were--- actually this time was a learning curve of how we operate with these thrusters.

Aldrin Now what was in my mind was to try to keep the Agena in sight and then gradually translate keeping the Agena in sight, pointed toward him, a BEF position, when we could fire posigrade with forward-firing thrusters and we'd go on up and move away. Then we could take pictures of him while he was going away.

Lovell Well, we got to a level position and then we did a slow yaw maneuver to go around and pick him up someplace just make sure where he was. Would you believe, we went 360 degrees and couldn't find him? Essentially, what happened was that we found an SEF position posigrade and about the time we were ready to burn the

6 foot per second, what should appear in my window but a tether hanging up, but no Agena. We didn't exactly know where that baby was, so we said, "The heck with it. We're burning the posigrade." Actually, the Agena was below us all the time, following us around. We made the 6 foot per second burn in the Plat Mode SEF, which happened to hold except that we needed occasional maneuver thruster to hold it in position. We did get the 6 foot per second in fairly decently. I suspect that was before we had our complete thruster problems. I think that just 2 and 4 were in bad shape. Just to recap the separation maneuver after we got rid of the tether, we had limited control, of course. The Agena was below us. We did not see the Agena. We did a 360 looking for it. We didn't want to get into too much of a roll because it would require quite a bit of time and effort to get it back to a heads up position. We stopped the yaw maneuver at an SEF position.

The ground was at about 52 hours 14 minutes and 27 seconds. They gave us a separation burn of 6 feet per second. We elected then to burn with the aft firing thrusters, after some discussion with the ground, since we couldn't see the Agena anyway. Just prior to the burn I did get a glance at the Agena tether and determine that it was below us so we would miss it. We burned in the configuration of SEF and platform. I think we were in orb rate on the platform at the time. We found out after this separation that the platform mode would hold it, if all the rates were damped when you went into it and only required an occasional pulse. Although some of our thrusters had degraded in thrust, we still had enough to hold.

Aldrin: I am not sure whether we nulled residuals. If we did, it was probably a waste of time. It was just a separation maneuver.

Lovell Well, we burned it without much trouble, and I believe that you had to use the maneuver control to maintain yaw.

Aldrin Yes, that is right. I was thrusting aft, correct? You were thrusting forward-----

Lovell Yes, that is right--- you flipped it aft to maintain yaw control----

Aldrin ----circuit breaker off.

Lovell That is right, because the plat mode was not holding in yaw. As a matter of fact, most of our analysis of the plat mode, with our thruster problems, indicated that if we had any rates at all in yaw, it would go divergent and there would be continuous firing and the spacecraft would start yaw and roll combination. Now, shorly after the maneuver, we turned around and tried to see the Agena. Well, it wasn't immediately after, but it was some time period, it was maybe 10 minutes after, we had the opportunity to turn around and try to see it. But, of course, we couldn't see it al all. It was to far away by the time we got around. Well, a sextant would have seen it. We went to sleep that night, got up the next morning, which was quite a busy morning. We were given an update rather late. They gave us a phasing maneuver. We had, of course, we were in drifting flight, they gave us a power up platform of 61:07 after 61:07 had already passed. There was an eat period in there from 61:00 to 62:00. They wanted us to aline the platform at 61:30 and do the space suit adjust at 61:47:47. We also, I believe, had a fuel cell discussion in there and we had, of course, control the spacecraft. We felt that we were really rushed to do all this at one time. We attempted to get control of the spacecraft again. Which really required a lot of effort. And it took quite a bit of time to get the spacecraft under control. Then we turned the platform on, after we got the platform update, which was beyond 61:07. I think it was around 61:15 or 20 by the time we got the platform alined, if I am not mistaken.

Aldrin That is right, I think we got the update at 61:15 or 20 something like that. It was after the time, as I recall, that we were supposed to start powering up.

Lovell Of course, it takes about 20 - 22 minutes for the fast heat to drop out of the platform before it will start caging; so we were waiting around for this. We got that squared away just in time. We attempted to aline the platform.

Aldrin Let's look at the day/night status here. Were we in the daylight when this was happening? I guess we were.

Lovell Oh, that was another problem. We were just going into darkness. We had nothing to aline the platform with.

Aldrin Well, if that was right in here, that was right. Because we were a little late. We were going right into darkness and we had --

Lovell That is a good point I would like to bring out, because when you aline the platform, if you have to do a burn just at the end of daylight into darkness, and you are in SEF the only way you can get a quick alinement of course, is to have the spacecraft in an SEF attitude. At the proper pitch angle. You need visual cues outside, the ground, the passage of the clouds, and we didn't have that. But we attempted to aline and we did make the burn at 61:47:47, which was a very poor burn. We knew we didn't have the properly alined platform. We tried to get the best out of it we could. We lost control, actually, of the burn. We lost attitude control of the spacecraft during the burn.

Aldrin — It ended up the IVI's were showing 1 or 2 maybe up to 3 in the left/right and up/down. Well, the attitude was changing.

Lovell — We really didn't know what...

Aldrin — We did know what it was, and I think we stopped our burn short, because...

Lovell — Well, the thing is that -- we didn't even know which way the platform was pointing....

Aldrin — Sure, after the fact, it looked like it was maybe 30 or 40 degrees off in yaw, perhaps.

Lovell Well, there were a lot of factors that really hindered us. We had gear all over the cockpit. Of course, if you wanted to start the eating program, which we had attempted to do, then realizing suddenly that we were really short for time the platform alinement took time. The fact that we were going into a night period hindered our platform alinement. The control problems prevented us from quickening the alinement or getting SEF prior to it.

Aldrin That was just the beginning of the problems, because we still had to solve that one and get it under control. But then 1 hour later we had first pass on S-51. That is a heck of a way to approach a significant experiment. And also, 15 minutes prior to that S-51 experiment, we had to copy down a block 7 update. So, we were quite busy which points out that the flight plan is just a little bit too tight here. We have to take a closer look at where the spacecraft is, what's wrong with the spacecraft and allow time to get the most out of it. After all, we are trying to get the most knowledge and information out of the mission and we ought to utilize equipment to reflect this.

Lovell — Just one more comment on the phase adjust. It is advisable to allow the crew, or let the crew know the reasons for various maneuvers. We did not have a reason at the time for the phase adjust maneuver. It would have been much better if we knew what the grounds intentions were. Okay, let's get on into the third EVA, and we will cover the experiments as a group.

Aldrin — I guess the comment here is tied in to the flight plan business. It was very rushed in getting prepared for S-51, which was a rather touchy experiment anyway, and was something that required good pointing commands to see the thing and without a very well alined platform, it was pretty much a hopeless task.

Lovell — We began the standup EVA preparation around 63:50 according to an update. About this time, I think that the flight plan was mostly out of our flight plan update procedures section, which we were using. Most of our equipment was already out. Of course the basic reasons for the EVA, no. 1 was an equipment jettison of items that we had used for the umbilical EVA. In addition, we attempted to do some ultraviolet photography of stars, and also of sunrise. Well, the problems that faced us at this time, on the third EVA, were control problems which were getting worse. Although we hadn't run a thruster check at this time, I think that basically was a mistake. I think we should have taken time right here to run a thruster check as a matter of safety before we did that third EVA.

Aldrin — Well, I think we also should have cleared the air about just how acceptable or unacceptable the use of the forward firing thrusters would have been during EVA. We had our own opinions about it and they weren't too well founded really. My feelings were that I thought the hatch was plenty of protection the way it was for me so that I wouldn't have been concerned about the right forward firing thruster firing. But that sort of thing certainly was needed and if we could have used it, I think, in the EVA, as we will point out later, we could have enhanced the photography that we were getting a little bit.

Lovell We told the ground what our problem was; if we wanted good attitude control, we would have to exercise maneuver thrusters and primarily number 12. To get right yaw. We said that if we wanted to get good pictures of the sunrise, long exposures would be required which requires a steady camera, then we would have to mount the S-13 bracket, we would also have to yaw the spacecraft right, which was contrary to what our thrusters were giving us. It didn't want to go right. But, it was decided then that we would maintain an SEF position, which the platform mode would do, once the rates were

	nulled. And then the camera would be hand held.
Rep	Did the ground specifically say not to use those thrusters?
Lovell	That is right, the ground also suggested ...
Aldrin	They said to go ahead and stay SEF ... I don't think we had enough time to really figure the thing out. And I don't think the ground realized that handholding wasn't going to solve the problem, because the sunrise was right behind the hatch. I couldn't get up over it, so I had to get around it and well, we got the indication that, well, okay, the pictures would just suffer on account of that. But I think we could have gotten ourselves in a better position.
Lovell	Well, that was the situation at the time of the third EVA. I was a little concerned about the control system. I didn't want it to go wild while we had the hatch open and Buzz was in a standup position. We then elected

to stay in the SEF position in platform mode. We were not going to use number 12 thruster. Buzz hand held the Maurer camera.

Aldrin One difference from the flight plan was that we were obviously going to have the platform up whereas we had planned not to have the platform up initially.

Lovell Yes, the platform remained up for this particular EVA.

Aldrin We had already stowed the hoses and everything else, having made the decision to do this EVA on just the ECS hoses. Looking back on it, I guess, well there are two sides. I felt it was valuable to look at different configuration EVA and since the retro camera was not going to be mounted, there was no apparent requirement for extra long hose lengths. So, we made the decision that we do it without the ELSS hoses and discard those along with the jumper. I didn't realize that pictures of the sunrise were going to be difficult, so looking back on it, I guess it probably would have been better to have done that standup EVA with the other hoses.

Lovell — One operational comment, the flight plan called for the opening of the hatch in the night time because of our situation, I requested to the ground that as soon as we were prepared to open the hatch after the go, we would open the hatch in the daytime so that we would be all prepared, all set to take pictures at night time, we got that go and actual hatch opening occurred in the daytime.

Aldrin — Suit integrity checks went just as they had before, I guess 3 to 4 tenths was the maximum that they dropped down. We were getting to be old hands at that about this point. There was no problem depressurizing the cockpit. Same procedure as before, and the hatch worked like a charm. I tried in vain to talk the Command Pilot into using the block and tackle as the hatch closing device instead of the other one. We stuck with the reliable bar. I guess I didn't make the point strong enough that that thing really gets in the way when you try and take pictures around the front, and it sure did.

Lovell — The Command Pilot had visions of Gemini IV where the hatch didn't close at all.

Aldrin — I began the third EVA period, we decided to let well enough alone.

Lovell — I think we did come to a tentative conclusion there before we opened the hatch that what we would do is go ahead and hook up the block and tackle and close the hatch that way, but somehow in the rush of getting pushed back in by the ground and refusing to let us take any pictures with the Hassablad that we forgot that and we also forgot to jettison the EVA visor.

Aldrin — We remembered about using the block and tackle after the hatch was cinched down and I was reluctant to bother about reopening the hatch.

Lovell — No, you can't justify reopening the hatch just to go through an exercise like that or get rid of the visor.

Aldrin — So, we elected to forget about it, keep the visor, put the block and tackle in the museum. Now, let's see, the hatch opening was normal. And we got squared away and looked like, as I got into position, it wasn't disturbing the spacecraft too much. I could see the flashes of the thrusters firing, once we went into darkness. There were times when there were no thrusters firing and then I would move a little bit and Jim would comment, I guess you could hear them firing.

Lovell — I could feel the thrusters.

Aldrin — I think I could hear them or feel them, I am not sure which, I was definitely aware of the lights of the thrusters firing.

Lovell — My concern was the fact that, whenever Buzz made a major movement while standing up, the thrusters would really go. I knew that there was an anomaly there. They were overcorrecting themselves to take care of our problem.

Aldrin I think it's significant to say something about what we tossed overboard and how we did that. Well, of course, we had the ELSS and three other pouches, one was the umbilical which was crammed full of as much additional gear as we could get into it. Then we had one sidewall pouch, or footwell pouch, that was also stuffed full of ECS hoses and connectors. We had one additional pouch from the left aft box that was stuffed full of food and other things.

Lovell Waste food.

Aldrin Right, waste food. We opened the hatch. I got rid of the two smaller pouches first and I think the ELSS went next. It looked like such a great view that I asked Jim if he had a camera or something that he could take a picture of it. I don't think you had any at the time.

Lovell No, we didn't mount the camera on the third EVA.

Aldrin So I decided I had the only camera here, the Hasselblad. I got the ELSS ready and gave it a push. Got rid of the umbilical and they all went forward and up slightly. I picked up the

Hasselblad, this was before darkness. During my scheduled rest period I took some pictures with the Hasselblad of the ELSS and the rest of the stuff moving away. We'll see whether they turn out or not.

Then we got into an exercise period as I recall. It was obvious that it was impossible to do any exercise before hatch opening. I don't think this was over a station. It was a little easier in a way because I had shorter hoses. We were a little concerned that perhaps the exercise might disturb the spacecraft a little bit, so I held fairly tight by pushing my feet to the outside during the early part of the exercise. Right near the end I let go completely, so that I was completely free, and then started gyrating my hands. I managed to bounce against the spacecraft every so often while I was doing this. Jim could certainly notice what was going on. He said take it easy, and the thrusters started to fire.

Lovell: They were going wild and I was waiting for that spacecraft to go.

Aldrin Now let's see, we went into darkness. I had the Hasselblad up in the front underneath the hatch closing bar. The Maurer was set up with the blue back and the clips filter, with no shutter release. It was set up at one tenth of a second. We had the tether on it and the tether was connected to the small electrical line on my suit electrical line just before it went into the mike button. This was a very good location to have something tethered. It was always right with you. To help out in case it was too dark during the night passes, I took the penlight and the pocket clip and clipped it on the tether so it was right handy. I had two things on one tether there. That was about it. I did take several other pictures with the Hasselblad other than just of the equipment going away. It was just about this time that Houston emphasized that we were not to stay open. As soon as we finished getting the pictures at night and sunrise, to go ahead and button up. I wasn't convinced that with what was coming afterward was so important that, once we had the hatch opened and with good attitude control (we had a good stateside pass coming up and the Hasselblad was out with a big magazine on it) it seemed to me a shame not to just stay out a little bit longer and take some pictures as we came over the States. Evidently they were in a rush to get us back in. That seemed to me it could have been a real time decision onboard based on the situation we had.

Lovell Well, you did get pictures of Orion and Gamma Velorum, didn't you?

Aldrin Oh, yes. Taking pictures of the stars we had a whole 42 frames to take. So I started taking pictures of Orion as soon as it came up, hand-holding it. This was quite an easy operation, really. Then as Gamma Velorum came up and moved over the hatch area where I could see it, I was able to get pictures of that.

Near the end of the night pass, I guess we had maybe 20 pictures left, maybe a little less than this when we were approaching sunrise. I started trying to figure out just exactly where the sun was going to come up. As the glow started to increase to the east I could only see the northern part of it by looking straight ahead and bending around the hatch a little bit. I tried to get up to look over the hatch and that didn't work. So I stooped down a little bit and looked through the window. This way I could get a fair idea of about where the sun was really going to come up. So I started taking a couple of preliminary pictures before the sun actually did come up. The experiment called for taking pictures every ten seconds from actual sunrise until the sun was two degrees above. The two degrees was supposedly where the sun goes through the UV horizon and this is what they specifically wanted to get. I continued to take pictures of the sunrise as fast as I could until the sun was well up. I would estimate maybe six, seven pictures were taken during the actual sunrise. This was a rather difficult operation and tiring. The only way I could get it done, as I could see at the time, was: cock the camera with both hands, then hold it with the right hand, put it out in front of me so that it angled off to the right around in front of the hatch, holding it with thumb and whatever fingers I had on the right hand, keeping the index finger above the trigger mechanism. Then I just pushed it to take the picture. I guess it could have been taken with the extended timer, or with the release cable. It might have improved the situation, but not too much I guess. I don't think the action of closing the shutter for the one second exposure caused too much motion of the camera. We'll just have to see.

After the sun was completely up, I wanted to get into position to take pictures of Orion. We had a fairly good update from the ground as to about how far back and off to each side it would be. We knew where both Orion and Gamma Velorum were with respect to the orbit plane providing we had the platform alined. I'm afraid that sunlight off the white adapter might have gotten into the lens while I was taking these pictures. I tried to look at the shadow on the lens itself while I was taking the pictures of Gamma Velorum. To take those pictures I had to point it off to the right in the area about where it could get into the sun. So, I had to drop the camera down below the shadow produced by the hatch. The pictures of Orion were well in shade at the time, but the problem there was the reflection from the adapter surface.

We used up the entire magazine. That was the end of the experiment and we finished, essentially, the primary purpose for the EVA. So, we cleaned things up and got ready for the exercise; went through that with no particular problems. Oh, I might mention that for both the umbilical EVA and the third EVA, we left the S-12 experiment in the right hatch pouch. It seemed to be so well situated in there that I hated to burden down my comrade by stuffing anything else in his footwell.

Lovell — I'm certainly glad we came up with that solution too. It saved the tether. It saved everything.

Aldrin — Yes, that was a good idea. It's something that you think is going to work out. You really have to see the real gear and the real situation to convince yourself that it is definitely no problem or no safety hazard at all having something like that above the hatch.

Lovell — Actually, I think in all the EVA's I found that I had a little bit more freedom of movement and could do a litle bit more than I thought I was going to be able to do in the cockpit. I was pretty well cinched in but I stood to do more than I anticipated.

Aldrin — Right, for ingress, when I got way down and the hatch came down, I could then move up and down without too much trouble. A little bit in contrast to what we'd experienced in the zero-g airplane and the mockup.

Lovell — Ingress was normal. We pressurized the cockpit with standard procedure and at 4.5 opened up the hatch.

Aldrin It was amazing how clean everything was after we had gotten rid of all that gear. It was about the cleanest spacecraft there had ever been.

Lovell One mention that I would like to make is the eye irritation. I was a little concerned about the third EVA, the fact that I had gotten this eye irritation just at the end of the second one. I was kind of curious as to what the situation would be on the third one, but, there wasn't any eye irritation on the third EVA. Both Buzz and I were on the spacecraft environmental control system.

5.0 RETROFIRE

5.1 T_R - 256 checklists

Lovell — Preretro operations in the spacecraft were fairly normal. We had one problem. We were going through the preretro checklist. I actuated the RCS system over the States so that they would have some good TM readouts while we were still over there prior to LOS. I actuated it about 15 minutes earlier than the checklist called for. Just about that time, as we were leaving ETR, we received a message from them that our Ring A regulated pressure, which we have no readout for in the cockpit, was high. It appears we didn't use Ring A enough. We ended up staying on Ring A, and going off the OAMS system early, for the remainder of the platform alinement. I was worried about this since we had limited control. I wanted to make sure I could still aline BEF with the OAMS system prior to our preretro work. This I was able to do. As a matter of fact, we still had enough control in the OAMS system to allow us to make this. We used Ring A to get down the regulated pressure to an acceptable amount for retrofire. We were a little reluctant to use it. I guess we got reprimanded by the ground several times because we were sort of scotchy with the fuel. Passing Carnarvon we did get it down completely. The updates were nominal.

Aldrin — We had discussed this with Cap Com beforehand. We used a slightly different technique in verifying the load into the computer, which worked out nicely. He was clued in on what we were going to do. What we did was ask him to give us a little bit of time between each core or address location. Jim copied the numbers down as they came up. As soon as we got the address, I had already dialed in the address. I hit READ while he was giving us the number that should be there. They all agreed to within one point in the last significant figure. It enabled us, after we got to address 04, 05, to really have it down pat. He'd read us a number and I'd see what I had and I'd say go. And he would just go to the next one, and I'd say go on all of them. It worked out very smoothly. So, they knew that we had verified everything right at the same time as reading the load up.

Lovell — We used our sequential checklist up until retrofire time. After that time I put mine away, and Buzz used his exclusively.

Aldrin — We used the card on the left hand side and updated it with the RET of 400K and RETB and the bank angles as they came in after retro-fire.

Lovell — We got a check with Carnarvon in updating our event timer and we were in good shape there. We had a retrofire time of 93:5...7:58, some-thing like that. We were given a change to the preretro checklist which consisted of leaving the Agena power circuit breaker in the closed position so that the S-3 heater would keep going to keep the frog eggs warm. I found out that, as Frank had told me before, we'd been so used to the degraded thrusters in the OAMS system that we were getting to be quite proficient at just maintaining a nice position because of the thrust level flow.

Once we went into RCS we again got full thrust and good control and there was an initial tendency to overcontrol the thing.

Aldrin We were in rate command there at one time. We obviously had a much greater response in RCS.

Lovell Much greater response. After our 2:56 checklist I went to a two ring rate command to get down to retrofire attitude. The response was tremendous. It would really jump and get into position. This was quite unusual because we had been so use to working with almost nothing for the last three days.

Aldrin We got the update for the onboard calculations in terms of the downrange needle deflection at 0:55 and 90. It changed the curve a small amount from the one that we had in the book. There was no problem discovering what this curve ought to be. One thing that changed in the preretro preparation was that they wanted us to power down or turn off completely section two. We came on with, I think it was battery one and three at this time and turned off the two remaining stacks that we had in section two. Section two was degrading considerably faster than section one. It was obvious onboard that most of the current load was really coming out of stack alpha in section one. A little bit was coming out of bravo . . .

Lovell — Yes, Section One.

Aldrin — Very little was coming out of the two stacks in section two. So, we shut that down and we had batteries on and fuel cells for the ....

Lovell — Retro preparation.

Aldrin — Yes.

5.2 T_R-0

Lovell — Retrofire was nominal. It was an automatic retrofire. We had no problems in maintaining control. The retros seemed to be very well alined and our update for the retro Delta V was 301 aft and 113 down and we actually got 302 aft wasn't it, or was it something else.

Aldrin — It is supposed to be 302 and 113 and we got 301 and 115.

Lovell — Right and we had a 4 left in there and I could almost predict the 4 left because I noticed the last rocket was not quite as well alined as the first three. During this retrofire, we moved slightly to the right which probably gave us the 4 left.

Aldrin — The countdown communications were excellent.

Lovell — We had good communications this time.

Aldrin — I was surprised a good bit because I wasn't prepared for the acceleration that we were going to get. It wasn't a large acceleration particularly but obviously I wasn't prepared for it. I had a finger on the manual retrofire button, or close to it and one right close to the start comp and the other one was sitting on my clock to get it going. As soon as retrofire went I found both my hands and fingers were about six inches aft to where they ought to be. Then I recovered and got the clock and start comp pushed and by the time I pushed manual retrofire it was rather academic. The platform wasn't switched to free until about I guess 30 or 40 seconds after retrofire. But, since everything went nominal the platform automatically switched. This is just a backup mode. I made use of the technique that I had discovered in the simulator. I'm not sure that it is of any value particularly, but I did read to the ground a more accurate number than the IVI's would give, by reading out 80, 81 and 82. I think the only thing we're updating with that is in case we fly the bank angle. In case it's an open loop reentry and we fly the backup bank angle, the ground should have a slightly better knowledge of where we are going to land. The increased accuracy of the retrofire would update the time of change of bank. I'm not sure whether it is significant or not. I guess we'll have to check with the retro people.

6.0 REENTRY

6.1 Reentry Update

Lovell — The reentry itself was as we had practiced and we had no real changes or surprises. I immediately took a real quick look at the first retro checklist, and got the clock started. For maneuvering I rolled upside down and got the horizon at the top of the window. This is in contrast to Gemini VII where we had a night retrofire. We had a day one this time and I'll have to admit that a day retrofire is a lot more comforting than a night one. We had no problems getting the horizon. I banked a little bit so that we'd have not quite a full lift position so that when we got to 400K we'd have a needle deflection and this would give us a check on our 400K time.

Aldrin — Did you see anything going forward when we retrofired?

When we set OAMS, electric and adapter, seems to me there were things going forward.

Lovell — That's right. The equipment adapter went out.

Aldrin — But also it seems to me that during the actual

	retrofire something was moving forward also. There was something that you could see out the window that was not normal.
Lovell	You might be thinking of when the rocket suddenly stopped. . .
Aldrin	Well, it might have been. Other things in the cockpit were moving around. The camera was mounted on the bracket in the right hand window and I am not sure whether we got picture of the retrofire or not. But the camera was running at the time. After retrofire, I then stopped that camera and took the camera down and put the wide angle lens on it and changed the film. I put that film that was in there in the orbital utility pouch and got ready for the actual reentry.
Lovell	400K time came just about as advertised if I am not mistaken.
Aldrin	It sure did, that was within a couple of seconds. As a matter of fact they updated us with new times.
Lovell	Right.
Aldrin	Just a couple of seconds before or after the 400K time. I think that was 20:08 and we got it about 20:10, something like that.

Rep They waited a little bit long.

Lovell Yes, they did.

Rep The only reason they were waiting was to get more track.

Aldrin It was 20:14 and changed to 20:08.

6.2 Attitude Control Modes

Lovell Just to record the modes of the spacecraft at this time. Retrofire of course occurred in rate command and two ring rate command. Acme position of course. Right after that I went to Pulse Mode, one ring. I used ring A because that regulator pressure was still high. I just held ring B in reserve, I used pulse mode all the way down to past 400K. Once we got to 400K I rolled to the backup bank angle of 46 degrees left. I maintained 46 degrees left all the way in. The one little surprise to me was the fact that guidance initiate didn't come as quickly as I thought it was going to come.

Aldrin Yes, I really think we discussed this. We ought to be given some ball park time on this.

Lovell Something within a minute or so. Roll bank was at 26 minutes and a few seconds.

Aldrin Yes, 26:03.

Lovell I was in the backup bank angle and we were starting to really reenter at this time. We were really coming down through it. I was wondering when I was going to get needle deflects. We had gotten an update of about 61 up for needle deflection but nothing had happened on those needles. I maintained the bank angle and I was prepared to go at 26:03 to the roll bank angle but just about - what was it two minutes before, 3 minutes before, something like that . . .

Aldrin It wasn't more than 2 or 3 minutes before 26:03. About 22 or 23, something like that . . .

6.3 Reentry Control Technique

Lovell We got an indication almost no cross range error and the needle did indeed go up to about 60 miles which surprises me. It was very accurate.

Just before that time though, I went from Pulse Mode into Reentry Rate Command and while I was controlling the spacecraft to keep yaw zero at 46. At that time I then controlled the spacecraft to zero the roll bug. After guidance initiate with the roll bugs then zeroed and after the spacecraft reacted, I switched to reentry mode. We were still in ring A and we went to reentry. Immediately the RCS systems started firing and the needle did not zero. It stayed off just slightly to the right I would say. About 1-1/2 units but the needles started to converge and it appeared like it was guiding correctly. I let it go. The thruster firing wasn't too great. The RCS wasn't really putting out too much.

Aldrin About this time, I guess the source pressure was reading 1700.

Lovell I think the onboard voice tapes are going to reflect it, too. I had Buzz check it every five seconds I guess to make sure. One thing I was a little worried about was that I didn't want to run out of ring A on the automatic reentry guidance, since we had used it the rev before. Then it would be a little while before we got ring B.

Aldrin: Well, you wouldn't realize it really. You'd suspect that the automatic wasn't working and it would take a while to figure out that the system was actually depleated.

Lovell: And in a day time retro reentry with the flames up there you can't really tell if those things are firing. You have to really look at them. Sometimes you can see the spurts but with a lot of flame up there, you can't.

Aldrin: I could see during the reentry some flame, but not in the thrusters itself. It wasn't coming from the thruster firing but there was some heating up between the two rings, right next to one of the nozzles that, as far as I could see was coming from the heat shield. Coming forward and causing a hot spot to build up there. But it wasn't from the thrusters.

6.4 <u>Guidance</u>

Lovell — I maintained a monitoring position with the hand controller. Everytime the spacecraft would roll or the needle would deflect, I'd put the stick over in that position in case something happened and we went diversion, or the needle started to diverge so I could go to Reentry Rate Command and take over manually. As the g's built up, at about 5 g's with the source pressure of around 1600 or 1500 pounds, I played it safe and put ring B on the line. We got up to a maximum of 6 g's that time and we were then in two ring reentry mode. I kept it that way. The needles did converge to zero. The spacecraft rolled just as advertised and maintained a zero needle position, all the way down through 100K where the altimeter started coming in off the peg. There is a little while there where it dances back and forth trying to figure out whether it should start going down or not. Finally she comes down and at about

80K the needles null. All the needles null. The guidance is all over with. At that time I went out of reentry mode. I went into two ring rate command, because we were already lined up along the wind line.

6.5 Drogue chute deployment

I wanted to damp out all the oscillations before the drogue deployment. Then at about 50K, I think maybe about 500 or 1000 feet lower than 50K, I punched out the drogue chute, in rate command mode. The chute came out okay.

Aldrin: Seemed to me that there were clouds above us when I saw the drogue come out. That doesn't sound reasonable at all.

Lovell: No, there is a puff when you go subsonic. About 70K you are still supersonic. When you go through that subsonic area for some reason you leave a puff of smoke or cloud or something there and that is what you see. So about 50K when the drogue is deployed the RCS system was still firing in rate command and there you settle down so I turned off everything. I turned off the control system and immediately we started getting this oscillation which really wasn't so great. I think I turned it back on again to damp out the system. But it really wasn't necessary. Then we went through our normal checklist.

Aldrin Before the drogue came out I was looking at address 86 and 87. About 70K I have recorded that 86 was 2441 instead of 2444. I didn't write down what 87 was. It's on the voice tape. It was supposed to be 29000 and my recollection is that it was 29006. It did change a little bit more from that, as I recall, and these will be on the voice tapes. They evidentally didn't receive our call on what they were. The same time I read them I called it out over the UHF.

Lovell Did you receive a drogue deploy call? Were we in VOX at the time, Buzz?

Aldrin No.

Lovell — From 50K, or whenever we put the drogue out down to main chute deploy at 10.6K, everything was nominal. It just came on down; we shut things down. We went through the normal check-list at the various altitudes. Things came up quite fast though, there was no waiting around.

Aldrin — We anticipated it some, by having the D-ring out as part of the post-retro checklist.

Lovell — We decided to put the D-ring out at post-retro. There is one thing I would like to mention. I think it happened to both of us and we didn't talk about it until we got on the ground. At the high g level on reentry, with the D-ring in my lap, the sidewall pouch with all the books and the filters for the window and everything, broke loose and slammed into the seat and up into my lap. I had great concern that I was going to just grab ahold of the D-ring and keep pulling it. There wasn't anything that I could do at the time. The g's were building up, so I just tried to squeeze my legs together and hope that it wouldn't go any farther.

Aldrin Mine didn't really come off completely, but I felt it give from its initial position and come back against my right leg. Afterward it seemed to be in about the right position though.

Lovell Well, this is bad news because I didn't want to see myself punching out right at this high heating area.

Aldrin I didn't have any pouch covering up the D-ring on my side. What did you have on your side? Did you put that thing back down flat on the floor?

Lovell Yes, I put the footwell pouches back flat on the floor. The sidewall pouches that were velcroed to the outside wall had torn loose at the high g level and came slamming into the D-ring area. As soon as we were on the two point suspension, actually before that, we were on single point suspension on the main chute, I looked down there to make sure that D-ring was okay. On two point suspension we then safetied the D-ring.

Rep — If it hadn't been okay, you would have been looking at it from the outside.

6.6 Main chute deployment

Lovell — That's right. I was kind of curious to see if it had actually pulled out a little bit more. We safetied the D-rings before we landed.

Aldrin — I didn't notice much oscillation on the chute before going to two point. It seemed to stay right up above us; it wasn't moving back and forth.

Lovell — No, on main chute there wasn't much oscillation. On the drogue chute there was a little oscillation.

Aldrin — Evidentally, we were swinging some, but of course, we couldn't detect that particularly. We went to two point; I wasn't able to get any pictures of that. I was naive enough to think that I might get a picture of the chute, but I think it was out of film by then anyway.

Aldrin I, perhaps was a little bit late in getting that D-ring stowed that was supposed to be stowed at 2K. It was probably below 1K. Jim was saying we might hit early, you'd better not trust the altimeter. But, I sure wanted to get that D-ring out of the way.

Lovell The two-point suspension wasn't bad this time.

Aldrin The camera during reentry was held initially flat against the window, with the wide angle lens. As we built on up to 4 or 5 g's, it looked like this was taking a good bit of effort to hold it there, so I just let it back off against the suit. It was taking pictures essentially with the lens perpendicular to the plane of the window. I felt this would give us a good angle exposure. The camera didn't give me any particular problems during the chute coming out or anything else. It tended to stay right in my lap pretty well, once we got into a g field again being on the chute. It did at one time drop down on to the floor. I am sure it did at impact.

Everything went down pretty hard there. I couldn't see out of my window, but I looked out of Jim's window and I could see the horizon on the water cut there as we were coming down on two point.

Lovell: We managed also to see a circling helicopter before we landed.

Aldrin: You did.

Lovell: Yes, I did. The two point suspension shock was very mild; we braced ourselves with our arms as we had learned previously.

7.0 LANDING AND RECOVERY

7.1 Impact

Lovell — Impact was more severe than anticipated. We hit sort of flat I am sure.

Aldrin — There was very little side force, a little bit back, but just mostly straight down.

Lovell — Straight down; it was quite a severe impact. Buzz said "We've got water in the cockpit" and sure enough we had water in the cockpit sloshing back and forth on top of the camera. I'm not too sure where the water came from. I am positive that there was no leak in the pressure hold. I think it came through probably the vent valve or something like that; due to the sudden impact.

Aldrin — I started getting the vent valve, water seal and the snorkel inlet down. We got the repress valve on to build up a little bit of pressure to 7.2.

7.2 Communications

Lovell — Communications were good. I called Recovery, but never did get an answer from them. I then put up the HF antennae and we went to HF and called. I think I called Recovery or Houston and the Cape Comm Tech answered and said we have you and we're passing you through Houston. Then I got hold of Cap Comm in Houston and told them that we were on the water.

7.3 Postlanding spacecraft status

It was while we were going through this post-landing check that we got a call, or just shortly after that, from the swimmers.

Lovell — Swimmers were in the water. I saw the helicopter overhead. They jumped in and put the outside phone on. First of all, they gave me a signal if we were okay or not. I gave them a signal back that we were okay. Then they put the phone on and said we'd have you out as soon as we can, but the seas were quite rough today, and it might take us a little bit longer. I looked at Buzz and he was busy throwing switches.

Aldrin I wanted to keep occupied now. The situation that you are in right after the end of a flight; you're down on the water and the seas are rough and you're perhaps not feeling in too great shape or you're not sure just how you are going to end up feeling. Personally I think I could have used more training in this sort of situation. Running through the switches to be thrown and going through the checklist. You can do it in a nominal way and its very simple; you just sit there and read the checklist off. But, things are just not nominal at all; you're being tossed about in the water, it's hot; you smell an odor and you comment about that and this detracts from what you are doing; there's water sloshing around. In the process, we omitted a couple of things in the checklist. We didn't getthe mortar pins installed until after the hatches were open. We ended up not getting the HF antennae back in.

Aldrin I think we have come a long ways in trimming up the checklist as far as which switches are on and which switches are off. But, we still ran into a little bit of trouble, I was reading off the list to Jim as to what configuration his ought to be, because it still says all circuit breakers off except--

Lovell This is a particularly bad area because of the way it is written. You want to save space in the checklist. So, they say all switches off except; and it is hard to find a place to start. You don't know which ones to leave off until they say everything else off. So, we stumbled through that a couple of times until we finally got it squared away. Buzz did mention that we had a smell in the cockpit. There was a smell of burned metal which is characteristic, I think, of all the flights. It wasn't as strong as what I had on 7. It did not burn the eyes at all. It was just an odor of burned metal.

Aldrin — At impact we hit quite had. Right after that we seemed to pitch forward a little bit while it was being drug for just a short time under water. We could both see bubbles and that were definitely under more than just plain foam. It was clear water that we were underneath. I think it was about the time you jettisoned the chute.

Lovell — One thing I was going to do to keep cool was I was going to open the repress valve. I did open it a couple of times, and that does afford a source of cool oxygen flowing into the spacecraft. Not only does it cool the spacecraft, but it wipes out the odor. It drives the odor out of the through vent valve. This is a good idea, but I was a little bit worried. I didn't want to build up the pressure in the cockpit for fear we might have an overpressure when we opened up the hatch. Looking back on "9's" experience we didn't want the hatch to fly open.

When we talked to the divers about opening up the hatch; he mentioned very cautiously that "Would you please open the hatch" and "I am going to stay clear". The same guy that got the concussion on "9", because he was hit by the hatch, was on our recovery team. He knew first hand then. I opened the hatch. I looked at the pressure and it was zero. I left the repress valve off. I wasn't too worried about water coming into the spacecraft.

7.4 Comfort

The sea condition was quite rough. The divers said it might take a little bit longer to get the collar on. We began getting ourselves prepared for Egress from the spacecraft by putting on the neck dams and wrist dams. We still had the fans going and we were fairly cool in the suits, although I was perspiring around the face. Weren't you, Buzz?

Aldrin — Yes, not only on the face, but inside the suit quite a bit also.

7.5 Recovery Team

Lovell — Once the flotation collar was attached, I noticed a definite improvement to the stability of the spacecraft, less rolling and pitching. Communications between the recovery team and inside the cockpit were very good. They had the phone hooked up and things were good.

Aldrin — I delayed getting my helmet off because they were still talking. You had yours off and we had to keep communications going.

Lovell — That's right. One item, I would like to mention again is the fact that on prime UHF frequency there is a continuing running commentary on what's going on. Now, this is okay if things are in good shape. I'd sure hate to have to use that frequency to say that the spacecraft has a big leak in it and it is sinking. If they want to have that type of coverage, they can utilize another frequency to do it.

7.6 Crew Egress

Lovell — Egress was nominal. The left hatch was opened up. They had a life raft next to it and both Buzz and I got out. We inflated our life vest prior to egressing.

7.7 Survival Gear

Lovell — We left our survival gear and everything of course, back in the spacecraft at this time.

7.8 Crew Pickup

Lovell — The crew pickup was nominal by the helicoper and we were flown back to the carrier. We made a mistake, We forgot to lower the HF antenna and when we were all set to be picked up by the helicopter the pilot did not want to get close to the spacecraft because of the HF antenna. So I went back and lowered the HF antenna.

8.0 SYSTEMS OPERATIONS

8.1 Platform

Aldrin: Alinement presented no problems at all. We alined as soon as we were inserted and the platform behaved properly. We maintained alinement as much as we could during the rendezvous, even with the degraded thrusters towards the end of the flight. The platform came up to speed at the proper time after a power up, and alined properly. We had no problems with any of the modes. Display was adequate, window markings were adequate. Controls were adequate.

Lovell: This has interfaced possibly with an experiment, but I think that we could have alined the platform. As a matter of fact, I think we could have alinged the platform quite adequately with the D-10 had we had some problems with the FDI indicators. As a matter of fact, before powering it up for reentry, we wanted to keep track of what our attitude was and this was about the only means that we had to look at the D-10 needles.

8.2 OAMS

Lovell	Operation checks from the pad were nominal. We actually made 2 cycles, I believe, before we got a GO.
Aldrin	I was a little bit surprised at the ability to detect acceleration with the translation thrusters. That is to detect acceleration by just observing things move and your body move when you hit the thruster. You didn't have to hear the thruster firing to know it was moving because you could feel yourself be jolted just a small amount ahead, or back, left or right.
Lovell	That's correct.
Aldrin	Yes. The monitoring is a general comment that I think covers all the systems. It has to do with this schedule GO-NO/GO. We've already made a comment about it but I will repeat it here. I don't think this was used as it really should have been. Originally in the flight plan, we

had GO NO/GO checks scheduled which is a good idea. This gives you a formal time to go around and check every particular system and record in appropriate places in the procedures book any discrepancies that you see. We really had the opportunity to do this only once, in a scheduled way. If we had had the time, I think, we could have scheduled our own checks like this and recorded them, but we didn't unfortunately.

Lovell We had little problems in the monitoring system itself as far as knowing what anomalies were in the pressures or source temperatures or regulated pressures. We of course, do not have a reserve OAMS equipment aboard so our O position read zero. Propellant quality read normally. We ended up the mission actually with slightly less than 20 percent showing on the gage. We would have much rather used a lot more fuel as that left quite a bit of fuel remaining. The problem which we shall discuss shortly will indicate why. Monitoring on the propellant remaining was an onboard function with the PQI and we never did get any indication from the ground of what they thought our OAMS quantity remaining was. They asked us every once in a while for our PQI reading, but we never got an update on what they had computed we had left. The controls and switches for the OAMS system, the attitude controller, maneuver controller, no anomalies. Everything was correct. The Attitude controller functioned as advertised and the Maneuver controller functioned as advertised. Inflight malfunctions - I guess it's about time that we talked about the OAMS thruster problem that we had, which was a major one on the whole flight. We discovered it during the dock mode. It was some time fairly early in the flight. We were trying to maneuver the spacecraft/Agena combination around, and we found out that it wasn't responding correctly to the inputs. This had occurred before slightly and I was at loss at first at what was wrong because

I knew that the Agena was heavy on fuel and that the Agena spacecraft combination might not respond the same way that the spacecraft would respond with the thrusters. However, it got to be fairly obvious one time when I had the platform up. When I would put in a pitch or yaw I notice that I got a roll and this is very familiar to some of our training malfunctions which we've had quite a bit of in a simulator. We ran a quick thruster check by turning off all the attitude thrusters, circuit breakers and then turned them on one at a time to find out what was wrong. At the time we did this, we found out that thrusters 2 and 4 were not working. This of course, was firing the thruster and seeing if we got any indication on the needles or any movement to the system. We found out that the thrusters 2 and 4 were not working. That's when we reported to the ground that we were beginning to have inflight malfunction. Later during the flight, we discovered also that thruster number 8 wasn't working. I think this was after we had gotten rid of the Agena. Around 88 hours the ground asked us to do a thruster check, which is something we really should have done before on our own. I think we are remiss for not requesting the ground that we have time to do it. We then ran a thruster check around 88 hours; but before that time let me explain our control problem. Every time that we would pitch or roll or yaw, we would introduce a right roll to the spacecraft. We found out that we would have to go to maneuver thruster and essentially we were using number 12 maneuver thruster that would give us a right yaw and this right yaw would take out some of this right roll. Now we were getting some degraded performance in rolling left. We could, if we put in a lot of left rolls, get it. But also we get a pitch up tendency. When we did do this and it was only by a combination of the maneuver thruster number 12 and a lot of pulsing with the attitude controller that we were able to get into position. It took some time but we were able to maneuver the spacecraft to a position and hold it to some degree, by this combination. Of course, the maneuver thruster gave us quite a bit of change and the attitude thrusters, some degraded, were giving us very little change. It just took a learning curve by the way to really determine what you had to do to control the spacecraft in this situation. At the thruster check, which occurred around 88 hours, we found out the following information. First of all, the thruster check consisted of turning off all the circuit breakers in the OAMS attitude system and turning them on one at a time, firing that thruster until we get 1 degree per second or for a maximum of 25 seconds to see what the response would be. We started firing the number 2 thruster at 88 hours 24 minutes 35 seconds. We let it fire to 88 hours 24 minutes 47 seconds and got a 1 degree rate or in other words for the number 2 thruster 12 seconds to get a 1 degree per second rate. We fired the number 4 thurster starting at 88 hours 27 minutes 5 seconds, we got no rate at all. We fired it for 25 seconds and absolutely no rate at all. Number 4 was completely out and number 2 was greatly degraded. We fired the number 7 thruster and found out that it took 17 seconds to get 1 degree per second rate. The thruster firing started at 88:30:10, went to 88:30:27, these times are to correlate onboard tapes. So it took 17 seconds of number 7 firing to get 1 degree per second. For number 8, which we started firing at 88:31:50 for 25 seconds,we got no rate at all. We heard solenoid clicking in number 8 however, but there was no rate at all. Fortunately with the other attitude thrusters and the 4 translations thrusters, 9, 10, 11, and 12 were operating directly and they gave us almost immediate 1 degree per second rates when we fired in the direct mode.

So this was our situation at about 88 hours. We first noticed control malfunction shortly after the first docking with the Agena and we attempted a second night docking with the Agena and after not engaging correctly or too slowly we tended to back off, and we then found out that we couldn't roll right. At that time I switched the roll gyro to secondary and I went into pitch on the roll select switch and we regained control good enough in direct to get night docking at which time we left it there. We attempted to analyze our control system that day and on a short day docking and it seemed to be working okay.

Lovell We kept that sequence of the roll gyro to secondary and the roll jet logic on pitch for quite a bit of the flight. During one of the EVA's, the ground asked Buzz to observe the thrusters firing on the upper right hand corner of the spacecraft as you are looking forward from back on the adapter. And Buzz did notice a difference in the plume coming out of one of the thrusters. I believe that thruster was probably number 2. But it was possible after some time to still have control of the spacecraft. The control being that we could place the nose of the spacecraft in the direction we wanted to. But I must emphasize that this took a lot of time. This phenomena of always getting right roll, no matter what you did, took an awful lot to get out. The OAMS heater was on, the circuit breaker was on continuously and it was checked several times when the ground thought we were getting freezing of the lines. We might have had a heater failure, but we did not know about it. I might add here that in having this malfunction, we were worried that whether certain modes like rate command or platform would indeed control the spacecraft. We found that if the spacecraft had rates of any magnitude at all, that going to rate command would not stop the rate. They would tend to increase it, and essentially the attitude would go divergent. This was essentially true on platform; however, if you manually controlled the attitude of the spacecraft, to damp out the rates, for instance if you wanted to align SEF, and damped out the rates completely, by using this combination of the maneuver and thruster and the degraded thruster that were operating, and then went into say a platform mode, SEF and platform, the platform would indeed keep the spacecraft in an SEF position, and keep the platform aligned.

Aldrin It must be due to the priority that the rate command has when you have no command input into it, and you're almost lined up, but have some residual rates. When you go to rate command it's obviously trying to null out one of the rates that it sees. In the process of doing this, it says that that one is more important, and it starts feeding in a bigger rate into the other one, but its logic says "Okay, get this one done first and then go to the other one", and it just can't hack it.

Lovell — It can't hack it or it's going off in all directions. Also, I think, that due to the fact that we were getting degraded performance on two of those bad thrusters and they were varying degrees. Maybe it actually helped us out in some respect, because one would override the other one in say PULSE or in DIRECT. We did find that out when we thought we had some thrusters. We used the DIRECT mode quite a bit to position the Agena.

8.3 RCS

We made our operational check as soon as we activated the RCS system, the ACME and DIRECT modes were both working in ring B, seemed to be operating normally.

Aldrin — Let me just interject one thing. I see horizon scan down here for the OAMS system. We really didn't have an opportunity to expand on that, but it appears to me that with the problem we had, it might have been a good idea, had we had the time, to go into horizon scan without the platform up. This doesn't control yaw at all, which would let it move off in yaw, but it would keep roll and pitch to the certain tolerances that the mode has. Then we could control yaw in a rather simple fashion and we'd also have one degree of freedom, that is yaw, that you wouldn't have in the PLAT mode. If we had found that this turned out to be a rather useful situation, it might have helped during that second standup EVA. But this is hindsight, as we've done on so many other things. Back to RCS.

Lovell We checked ACME, DIRECT, and both Ring A and Ring B. We were all set to turn off the RCS again when we got a call from the ground stating that we had a high regulative pressure in A, and so we maintained A throughout the next rev.

We had to deplete the regulator pressure down to an operating limit by operating the RCS system. As a matter of fact, we squared off quite a bit of gas just trying to get the pressure down, which we didn't need to do just for control alone. No problems with selector controls and switches, no inflight malfunctions.

Aldrin Now on our systems monitoring, in our first Go/No Go check we did call out to the ground that the source pressures were not equal in the two --

Lovell Source temperatures were not equal.

Aldrin Well, the pressures and temperatures. Ring A had 3000 and 80 degrees and Ring B had 2750 and 50 degrees. Now whether there is any connection between these differences, and the problem that we had when we armed those I don't know.

Lovell What was the lower ring?

Aldrin Ring B was lower in temperature and pressure

Lovell Maybe we had RCS heater failure on ring B.

Aldrin No, ring B wasn't the one that gave us the problem.

Lovell — Well, I know but I mean this might have been a separate problem. We went over the control modes in the reentry portion of the debrief, and I think that covered pretty well there. We never used the DIRECT at all. We were ACME at all times in both rings when we did use them. RCS heater was on and it stayed on during the entire flight. On an insertion I believe it was, wasn't it?

Aldrin — Right.

Lovell — Thruster plume observations. They were observable, of course, being right in front of my window. There was nothing unusual. We tried to get some photographs of it.

Aldrin — Yes, I tried to take a couple of pictures during one night pass. I'm not sure that they were synced at all with the actual firing. While we were bleeding off this excess pressure in ring A, I figured I might as well run the camera and see if I can get a picture of one or two of them firing.

Lovell Okay, we'll do that on Gemini XIII. Thruster fumes on systems shutdown. We covered all this in the reentry debrief. We had no fumes that I know of on the RCS system at all. I think the only fumes that we got in the cockpit after landing was due to burned metal around the shingles.

Aldrin Yes.

Lovell At least it smells like burned metal. It doesn't smell like the propellant of the RCS system.

8.4 ECS Command Pilot Suit

Mobility was good. Pressure was adequate. The pressure drop on the three integrity checks, I think the most was .5. I think he had a .5 drop at one time. Other than that they were less than .5. Temperature was good and humidity was good. I would like to compare a little bit here between the lightweight suit we had in Gemini VII and this one we had in Gemini XII. Of course, mobility was less than we had in the lightweight suit but the cooling capability of the suit, with the body inside was a lot better in this suit than it was in the lightweight suit. Mainly because of the big neck opening in the lightweight suit. There wasn't the high humidity and hotness in the crotch area that we had in the lightweight suit. The CO_2 indicator never went off the first figure, as I recall. The suit was comfortable. I think they had improved the suit tremendously from the original that I had back on Gemini IV. As far as the suit goes, it was fairly comfortable. Now during the EVA periods, my suit developed three areas of pressure points, I guess you could call it. I did not notice any of them until after I got back down on the deck. One of them was on the right arm where I got a bruise of some sort from doing something which I can't really recall. The second area was on the chest where I had both shoulder harness on to keep myself down in the cockpit during pressurized operation and the shoulder harness dug into the chest area. This was fairly uncomfortable. Controls were okay. The O_2 demand regulator, no problem. Buzz, how about your suit?

Aldrin The mobility was, of course, a little bit less due to the increased bulk of the coverlayer. The problem with the left arm that we experienced suiting up prior to getting into the spacecraft did not turn out to be any particular bother during flight. It was of no concern during EVA pressurized. It could still tell if I thought about it that the vent line was not routed exactly the way they had been in all the training suits. The left one was not the same way as the right. It had a hint of some sort of restraint to it, but this didn't really turn out to be true during pressurized operation. The pressure, the highest drop was .3 during the integrity checks. In temperature, generally I was slightly on the warm side during all the cabin operation. At night I would decrease the flow, especially as morning approached, if I happen to be awake. This was more to cut down on the noise that was coming through the neck dam. I only had three holes in the neck dam and they weren't large enough. Two of them were located so that there was one underneath each ear. What I finally did was switch over the secondary neck dam. I took the scissors out and cut two more holes in it and this seemed to help considerably as far as reducing the noise effect due to the air flow coming out of the neck dam. I also cut it down to a 16 size from its original 15 and this improved the comfort quite a bit. I was bothered initially by it being a little too tight and tending to bulge up and not let any air leak out from around the neck. This would tend to stick close to the neck and promote a small amount of perspiring.

Because of warmer than ideal conditions, it was a little bit more humid in the suit especially in the crotch area I guess. More than any other place. I tended to leave the zippers open for normal in-the-cabin operation. This, I think, tended to give me a little bit more ventilation by providing a little bit of outflow from that area. No comment about the CO_2. Comfort in the suit. The legs were very comfortable. The feet, very comfortable. The torso was moderately comfortable. The ECS hose connections and the electrical connections, stiffness in those areas was a little bit bothersome. The main complaint that I have is both arms were considerably tighter than I would want for optimum comfort. The left one a bit more so than the right. I think this is because of the pressure gage fitting. At postflight, we could see a few lines from the inner liner on my arm and especially on the left arm. For several hours

I could still see the imprint of the pressure gage. The medics took several pictures of this. No real comment on the demand regulator. Visor fogging was no problem at all. We used the anti-fogging for all the EVA's. There was no tendency at all to fog up, at any time. The umbilical was completely satisfactory. Its attach point to the harness, we had modified several times after the change in the mission. I routed it from the connection on the ELSS underneath the upper restraint so that it held it in close to the suit and then from there went to its connection point on the parachute harness. We were continually striving to shorten as much as possible the tether length from the hook to where it came out of the umbilical and I was quite pleased to see that this was down to its absolute minimum. It wasn't more than an inch or 2, I don't think. We actually had it stitched in there, so that it couldn't come out. And this proved to be very satisfactory.

No problems with the Y connectors. The positive locking devices worked very well. They were not particularly a problem in connecting up; making the last minute switchover from ECS hoses going in the top, to ELSS hoses connected going in the top. We elected to take two electrical jumpers with us. Primarily because there little concern that during the first standup EVA since we were using an ELSS jumper for this. The connection resulted in a torquing or a twisting of the electrical jumper, because it wasn't designed for this use. The one that we used for the standup EVA, we used also for the umbilical EVA and this was per our agreement with the CSD people. We jettisoned both electrical jumpers. We used the elastic strap that's normally in the spacecraft. There are normally three of them and we carried along one more and used these to wrap around the hoses and get them in the right configuration for the standup EVA. This worked quite well and was far superior to wrapping lots of tape around everything. During the standup EVA, I did use one strip of velcro upstream, or at least towards me from the last elastic restraint that was on my side of where the two hoses were connected together. In disconnecting the hoses from the interconnects, there was, as anticipated a pop, because the sea level pressure was still in the hoses. They popped apart slightly. We've had considerable difficulty with thermal gloves throughout the EVA development in trying to get satisfactory gloves. I probably had more trouble than anyone else did. Whenever gloves were designed specifically for me, they never seemed to fit as well as, when I used someone else's gloves. The training ones that I had were very comfortable. I used these in all the training under water and zero g and for everything that I was doing. I would have been very happy to have flown with these, when we found out that the flight gloves were most unsatisfactory. This unfortunately was quite late in the game, the last 2 or 3 weeks. Mr. Tucker shopped around and found that there was a pair of gloves that was very close, in terms of measurements, to the training gloves that I had.

These turned out to be Gene Cernan's backup gloves on "9", so we had another pair of these made. We took those particular gloves and made a few modifications in the metal restraints and relocated the strap along the back. I tried these on and worked them a little bit and we decided that this by far the best that we had to go with. I think it's a very poor situation that we were not able to use these actual gloves very much pressurized with the entire suit and glove type configurations so that I could get quite familiar with the way they operated. I don't believe that there was any training done at all using these.

The only time I had a chance to hook

them together with the suit, I think, was during a little bit of extra time for SLD, or something like that.

Rep — Did you really feel that you had any problem with the gloves during any of the EVA's at all? Were you still able to complete all the tasks?

Aldrin — There was nothing in the gloves that prevented me from doing any task, it is all relative. Several tasks were difficult because of hand and finger restraints. The picture taking in the standup EVA with that remote timer was quite difficult. This was because of the configuration of gloves. As far as any pressure point, there was only one large or considerable pressure point. That was in the base of the right thumb, where the skin tends to form in a little band as the thumb joins in the hand. It is where the thumb joins the hand itself. There seemed to be a ridge that tended to cut across this point. I noticed it while I was back in the adapter that this was binding and tending to rub across this part of my hand. In subsequent work, it didn't appear to be noticeable and certainly didn't impair the operation, particularly. I just think that we could do a lot better in gloves. It is just one of the weaker points that we have in suit development and we've got a long ways to go. Interconnects, I have no particular comment about those. The positive locking devices worked very well. I was very happy with the ELSS restraint and way the ELSS was supported in front of me. There was no tendency for it to move around and it was held tight. I didn't have to readjust the upper ones or the lower ones at all. There was no tendency for the upper ones to come loose or to fold over. The restraint system that we had was developed specifically for this flight and it was a change in the configuration where we previously had just two straps crossing over in front. The previous design used up a large amount of the velcro space in the front of the chestpack. It also didn't anchor the bottom of the ELSS as well as I wanted to have it anchored. This configuration that we had was a very stable and very rigid restraint system and it gave complete usage of the front part of the chestpack for attaching other devices to it. Electrical Extension-I assume that this is the one on the umbilical and I think that this is very poor. It is way too long. We noted this several times in training, but it looked like nobody was real interested in picking it up or doing anything about it. When the umbilical was hooked on the Egress bar with the hook; then trying to route both the umbilical down to the repress valve in the electrical down along the edge of the center instrument panel, so that it could then be routed underneath the Volkswagen pouch and strapped down there. It forced this connection with the spacecraft electrical to be a little bit too low. As a matter of fact, to keep it from being too low, we had to let the electrical extension bow out and this tended to get a little bit in the way more than it should have been.

Hatch Closing Devices. The velcro attach points, I think, worked out very well. It kept the lanyard from snaking around and getting in the way. Once the hatch was opened, the lanyard on it was not too long and it wasn't particularly a bother at all. The hatch closing device that we used was the one that had been proven through all the other flight. We carried the block and tackle and left it in the Volkswagen pouch from the first standup EVA on through the rest of the mission until Retro Prep. The velcro that we had in the Volkswagen pouch to keep it shut enabled us to take the unconnected hook that would have been connected in an emergency to the hatch area and enabled me to put velcro around it, so that this was always exposed.

If we did need it I didn't have to open up the pouch and reach down inside to get it. All I had to do was to pick up the hook and put it right on. The hatch closing device that we used did tend to constrict mobility in the hatch in that it prevented me from using the foreward area of the hatch for mobility or to move around and take pictures. The block and tackle would have given us a better situation in this respect. We had intended to close the hatch with the block and tackle after the last one, but we were rushed a little bit and overlooked doing that.

Lovell We had slightly high cabin pressure at insertion. I believe it was on 5.75 or 8, or something like that. It came down. It was a regular characteristic of cabin pressure and the nominal cabin pressure was about 5.1 and it remained that way. It didn't vary at all. We would pressurize the cabin at 4.5

and would let the cabin pressure regulator control the cabin. It would go slowly from 4.5 to 5.1 and stay there. The temperature, I thought, was very good control during the day. The temperature decreased quite a bit during the night time. It was probably due to the inactivity of the crew-less heat output.

Aldrin Well, due to the windows being covered.

Lovell The windows being covered over cut off a lot of the heat.

Rep You mean during the sleep period?

Lovell During the sleep period, that's right. As a matter of fact, I think I turned down my flow to zero to get my body warmed up again.

Aldrin I think in looking back on it that we were in an SEF condition and since our orbit had the sun on the southside of the orbit plane, meant that the sun during the sleep periods was hitting most of the right side of the spacecraft, instead of the left.

Lovell Well, this occurred during drifting flight, too.

Aldrin Yes, I was just saying you had the light suit and I had the heavy suit and I had the hot side of the spacecraft and you had the cold side. If we could have readjusted that someway without it bothering things, it probably would have been a better way to do it.

Lovell Humidity - I think it was fairly dry. My skin that was exposed in the cockpit was dry. This has been an expected characteristic to the fact that you have the suit on and the suit ECS system takes the moisture out of the body and sends it back through the water remover.

Aldrin It seems to me that the temperature readings in there were 80 - 85 degrees or 90 degrees--

Lovell No, some of it - we have it on the G-2. Well, it didn't seem as warm as those readings were. For instance, the one on here was 32 degrees spacecraft temperature. Earlier in the flight, 80 degrees spacecraft temperature, 80 - 78 degrees spacecraft temperature. It might be slightly on the warm side for spacecraft temperature, suit temperatures were lower than that.

Aldrin Yes, much lower than that.

Lovell But the spacecraft essentially is a dry one. It is much dryer than when you have the suits off and the body can increase the humidity in the entire environment. The consequence, I think, both of us got stuffed noses quite a bit. Things like this are characteristic of a dry humidity. I didn't notice any CO_2 partial pressure or anything of this nature that indicates that we would have a CO_2 problem or even a buildup, did you?

Aldrin No, it stayed down.

Lovell It was comfortable day and night in the cockpit from my point of view. At night it got cold, as I guess is to be expected. And I wish I had more control over the suit temperature at that time. It took me a long while to get warmed up again.

Cabin pressure relief valve worked as advertised. It operated several times during the flight, especially on the ELSS operation where we were pouring oxygen into it. It wasn't anything to concerned about. Cabin pressure regulator maintained cockpit 5.1 - between 1 and 2. Cabin vent valve operated correctly along with the cabin vent check valve in the proper sequence of depressurizing the cockpit. We had no problems with it in depressurization or repressurization. Cabin repress valve worked very easily. It had a positive stop to it and had no problem to operate the valve on either of the three EVA's pressurized. Cabin air inlet valve, which is snorkel valve, which we never operated until we got on the water; however, it worked. Cabin air inlet valve worked as advertised. No problem.

Aldrin I sure didn't notice much change in the flow in the suit, or in the temperature or anything when the cabin recirc was open or closed.

Lovell You didn't?

Aldrin No. Maybe I didn't give it enough time to--

Lovell — Oh yes, I would get a definite change in pressure anyway in the suit - or was that cabin recirc valve? You're talking about the cabin air recirculation valve now.

Aldrin — Yes, one on the far left.

Lovell — Primary O_2 system monitoring - no problems there. We had continued monitoring of the pressure and intermittent monitoring of the quantity whenever we were in the O_2 position.

Aldrin — I think that's an unfortunate requirement to place on people to have to continually monitor a system like that to get good operation and have to manually turn the heater on, when you've got things like rendezvous and docking going on in the early part of the mission.

Lovell — There's no reason why they can't devise a heating system to keep the pressure up, because during half the flight, we had to worry about bringing the pressure up. During the umbilical EVA prep, this was a pretty critical item, because we were down to 600 psi and we needed around 700 to start it and would be delaying the umbilical--

Aldrin — Especially when we've got the flight plan being changed so much from being updated. You turn the heater on and of course you have a light showing that it's on, but one time we let it get too low and I imagined we were burning some oxygen, because it got to around 800.

Lovell — I have no problems with the controls. Secondary O_2 - Buzz, why don't you mention about the insertion on this.

Aldrin — Yes, we covered the abnormality on the right Secondary O_2 in the lift-off through insertion. Briefly, I will just mention again that they were both reading about 53-5400 psi prior to lift-off. As the g's increased, at about the same time Delta P lights came on during the first stage, the right Secondary O_2 went on up to about 6000 psi and then at staging it dropped back down again to around 5000. It repeated the same sequence during second stage operation and we reported the difference in the two. We also reported after insertion that it had gone up high. No one seemed to be at all concerned about it.

After insertion the right one stayed at about 5000-5100 psi and the left one stayed constant at 5300 or 5400 psi.

Lovell — CO_2 partial pressure, no problem. ELSS, why don't you just make some brief comments on that.

Aldrin — Controls, no problem maneuvering the controls on it. We discussed during the EVA the condenser operation and the fact that when I took the plugs out that there was water in the inlet and outlet monitoring system. It checked out properly and we had no occasion to use the monitoring system itself during the EVA. None of the lights or tones came on. The operation of the ELSS went normal. It's my brief opinion here that the ELSS is fully capable of handling the type EVA operation we did and some. I think it's a perfectly adequate system unless one exceeds the limits and obviously we were not anywhere near the limits of the ELSS capability to provide cooling.

Lovell — We've already covered the exact modes of operation.

Rep — We covered the ELSS yesterday in EVA.

Aldrin — Yes. Just to summarize the modes of flow that we had, prior to opening the hatch we had, prior to opening the hatch we were in MEDIUM and from that point on, we were in HIGH. After ingress we went to a bypass to repressurize the cabin.

Lovell — You'd better make some favorable comment about the restraining straps on ELSS since you did design them.

Aldrin — I did.

Lovell — Oh, you did?

Rep — We've already talked about that.

Lovell — Okay, 25 foot umbilical stowage was no problem. The left hand aft food boxes. Easy to get out, in fact, it was a lot easier than in our walk-throughs. After it was stowed, just prior to EVA prep in the left hand footwell as we had practiced, but after the end of the umbilical EVA, since he had done such a wonderful job on the umbilical EVA, I decided to present him with a present and BUZZ then got the stowage of the umbilical for awhile. Okay, haven't we had dynamics?

Aldrin — No, the dynamics to me means when I would reach out for it and try and move it to position it somewhere, which was only really done while in the hatch area one time, to keep it clear before going up to the nose, it tended to make one large arc. You let about 10 to 15 feet of it out for going up to the TDA the first time and it made this one big arc and into my side. There was no problem in hooking it into the pigtail. It went in and out very easily. I think it was a lot easier to handle from my standpoint than any simulations or training had indicated. I think you have a couple of comments about how easy it was to bring in and also to stuff in the footwell.

Lovell — We had essentially no problems with the cooling system whatsoever. The pumps worked as advertised, we varied the pumps depending on our power up, power downs configuration and our EVA configuration. We did not go to normal and flow on the cooling system until a little bit later than the flight plan had indicated.

Aldrin: It was about 45 minutes or something like that.

Lovell: Yes, 44:30 we went to radiator flow and evaporator normal. Mainly because we were having a little communication difficulty at the time, which we'll get into a little bit later. But cool loop operations were normal in all modes. We had no trouble with the cooling system whatsoever. Water management. Panel accessibility is a standard gripe among everybody who has flown this thing. The panel is very inaccessible, and normally requires the swizzel stick to operate. I don't want to dwell on that any longer. Valve usage was normal in all respects except when we ran out of water, which I think was the first time that ever happened. We were a little shy on water anyway. We knew that before the flight. On the morning of the last day, we did indeed run out of water. We put the blood pressure bulb on the fitting. We opened up the line and went to the H_2O Pressure Off switch. We had some difficulty at first, because the blood pressure has a slide valve which relieves the pressure required in blood pressure operations, and when we first attempted to pump up the survival water tank in the capsule itself, the pressure would bleed off, and we'd just get a little dribble of water. And the ground told us about this and said that we should have checked anyway. And we finally got enough water pressure up there to operate the system. It was not much trouble. Did you try to put water in the food bags, Buzz?

Aldrin — Oh yes. It went in just about the same as it had on the normal water system. The pressure was a little bit degraded, so it took a little bit longer for one cycle to go through. I didn't really understand what the ground meant about with decreased pressure, the water gun readings wouldn't be valid. It seemed to me that you'd be getting about a half an ounce out of there. I guess they just didn't want to be bothered with it.

Lovell — The water dispenser itself has worked good before, no problems with it whatsoever. We utilized it in much the same way we had. We had a leak in the water dispenser prior to the flight, but it was fixed and we had no problems.

Rep	Was the water okay?
Lovell	The water was great.
Aldrin	I thought it was very good.
Lovell	There was a little air in some of the water, which we noticed when we pumped up -- put water in some of the food bags.
Aldrin	It took a while to get used to how you could drink it without ending up with a mouthful of air and water and trying to swallow the two of them at the same time. Let me just mention briefly what the procedures were that we got from the ground. This is prior to reentry, they gave us the procedure for after the last drink, they wanted us to go H_2O normal, condenser tank filled, and urine valve off. And if after landing we wanted to get a drink of water, we were to go to condenser normal and water valve pressure off. Pump it up. This was to get the tank in the proper configuration for the G's of retrofire and reentry.
Lovell	And essentially after landing, it was the same configuration we were using at the time, prior to our last drink of water. Urine system assembly and operation.

Again, we utilized the, I guess you'd call it the GT-5 system. We didn't have to collect any urine samples. We kept the urine hose and the valve -- the filler in the hole between the two seats during most of the operation, during all the burns and everything except reentry, which I think you put it in the orbital pouch didn't you for reentry. Orbital stowage pouch?

Aldrin — Yes, right.

Lovell — Urine system operated as designed. We had forgotten at one time though that during EVA prep when we tried to use it, we had turned off the secondary cooling valve circuit breaker which also operates the urine electical valve, and so we thought we had a problem a little bit later on, but we didn't and then we got this a second time when we had the heater problem on the cryo system and it also operates the free heat on the urine system, and the light never came on when we turned it so we thought we had burned out the heater on that. And then we threw the switch on it...

Aldrin — It was actually a little bit more involved than that. We turned the switch on and the iris was closed. The light came on and how did the light go off again?

Lovell — Well, the light didn't come on and we -- then you went down and turned the iris and the light came on and we said it was the iris was just closed and then a little bit after that, we had the cryo problem and we turned the free heat on again and the light didn't come on, so I said, "Buzz how about hitting that iris again". And we went down there and turned the iris, and no light. So we though well, that's strange. So then we checked the circuit breaker on the cryo which we had turned off because of the switch failure and it turned out that that's exactly what it was.

Aldrin — We found, well initially I took the UCD and went through the prescribed procedure of squeezing it into the other bag and then emptying out the bag that was on the standard urine system. Subsequent to that, since I used the

UCD for all three of the EVA's, I found that that wasn't necessary at all. All you had to do was to hook the UCD up and then just put it in the dump position and it emptied both of them out without any problem. Near the end of the flight, I decided I'd experiment around with the direct overboard without going into the bag and then hooking up to the dump subsequent to that and the way I did this was to reverse the filter. So I put the filter into the spacecraft end first which gave me a little bit more flexibility in the hose itself, but I still had to turn sideways because the urine system itself is so long and I just wasn't made with a 90 degree bend. So the procedure was just one of turning the dump on and, of course, the bag was already emptied out and then opening the valve at the same time beginning to urinate, and I found that after I was finished with this that leaving the valve open, there was certainly this suction here, but it was nothing that left any scars or anything. A very acceptable system really. It tends to save time and effort. All you have to do is turn the switches on while you are -- and after you've got them on, it takes a little bit of time to rig them and get yourself in position, but I think it's a perfectly acceptable way of going and could serve as an alternate to the Apollo receiver type of system if that one tends to spray around we could just take a screw on receiver with a condrum and similar to, well, just like what we had in Gemini and use it in Apollo.

8.5 Communications

Lovell Communications, interphone. No problems. UHF performance, no problem.

Aldrin Now let's see, somewhere in here we want to talk about the helmet.

Lovell Yes, I'll get to that. Or you'll get to that. We had no problems with UHF performance. We used VOX quite a bit during the rendezvous and the extravehicular activity. I didn't hear the ground to much. I'm not to sure whether they were trying to get to us, but I think I checked with the ground every once in awhile to

	make sure they were still with us. We heard the HF music over the Cape, as we got there. It's very short range though. Actually, it was a lot shorter then UHF because ...for some reason.
Aldrin	I don't see a place in here that covers that part of communications.
Lovell	Well, we'll talk about that then. Let me just get through. Recovery..was nominal. We did get HF communications with Houston for a brief period on recovery. Voice procedures -- no comment there. HF performance, we've covered that. We only used HF to try to pick up some music. We didn't use it at all for voice communications. Voice tape recorder. I haven't seen the results of the tapes that we used. However, we did utilize a method which was started on GT-10 when John Young wanted to take the voice tape recorder and change tapes during EVA. We used his idea. And we were able to take the recorder out of the holster and actually change tapes during EVA. Buzz, whay don't you just briefly mention your helmet problem?

Aldrin Yes. As I put the helmet on, well, in the normal preflight checks, both mikes checked out fine and I noticed no discrepancies at all during the launch phase, and prior to taking the helmet off. When I put the helmet on for the first standup EVA and positioned the mikes and established communications with the command pilot, I discovered that the right mike didn't appear to be working. And I gave it a fairly good check as far as blowing into it and moving the other mike out of the way. We checked circuit breakers to see if there was one out of position that would have effected this, but they were all normal. And to my knowledge, the standup EVA was conducted, with only the left mike working. We got to the umbilical EVA; it appeared as though the right mike was working for this period. I'm just not sure if we find in analysis postflight that the right mike is not working now, I would conclude that it wasn't working at all. The second standup EVA, the right mike definitely was not working. The same situation as the first. And there isn't any logical explanation for this. You might think the terms of ELSS jumpers perhaps might cause this, but unless something happened that I didn't anticipate, I don't know - heck, we didn't have the ELSS jumper in the second standup EVA.

Lovell: No, that was strictly spacecraft communication leads, and oxygen leads. Okay, Buzz, why don't you talk about the digital command system here?

Aldrin: The updates prior to liftoff were normal and during the launch phase, we received the TX's over stations and it served as a very good cue that we were coming up and were about to receive voice communications. At night, I thought it was going to be a bit of a bother to have that light on, but I dimmed it down, and I am sure it came on each station we went over. But either my head was up high enough or the light was dimmed sufficiently so that it was really no particular bother. As far as the transmitter switches, these were controlled in a normal way and for the most part were left in command, in command mode, and at one time during one of my turn around maneuvers to get into the aft box, I evidently put the switch in the real time and acq position instead of in command, which is quite easy to do. And I guess if this is important enough, perhaps we should have had guards put over some of those switches. That's about all I have to say about those.

Lovell — We were in the UHF mode for transmission most of the time. We did go to interphone at night to save power. Audio modes: keying was either by the handle or by the electrical lead push to talk. While we were docked to the Agena we were on adapter and when we became separated we went to the reentry antenna position.

Aldrin — The volume levels were very good throughout the entire flight.

Lovell — UHF communications were no doubt the best I've ever seen.

Aldrin — VOX was just tremendous. It didn't sound to us as though the VOX was acceptable. It sounded like it wasn't keying right at the beginning of a transmission. Obviously this wasn't true from what comments we got from the ground.

Lovell — As I understand it, although I haven't talked to everybody, that the ground did get transcripts. Could you hear most of our EVA stuff when we were over stations without having to strain?

Rep — Very good.

Lovell — Sleep configuration: We merely went to interphone and kept the lightweight headsets on and we didn't go to the silence switch at all.

Aldrin — I hit it occasionally. You didn't know it though.

Lovell — Oh, you did. What a sneak.

Aldrin — I needed sleep that first night.

Lovell — Why don't you talk about beacon control? Do you have any problems with them? You just followed the ground update didn't you?

Aldrin — I have nothing to say about beacon control.

Lovell — TM control, we had nothing to say about that.

8.6 Electrical

Lovell — I'll let Buzz talk mostly about electrical but I do want to say that fuel cells and I just don't get along together for some reason. I get tired of seeing delta P lights. On Gemini VII when they were on the right side I saw them, and when I get over to the left hand side they moved the delta P lights over too. Buzz, why don't you talk to them about the fuel cell operation.

Aldrin We started out doing this according to flight plan. Then the delta P lights came on during the liftoff phase. They came on later on in flight during the first fuel cell purge and they stayed on after that. It appeared that they were going to come on as a function of how much water we consumed. They came on fairly early and then went back off again as we prepared a meal.

Lovell As a matter of fact it was beginning to depend on water usage. It would go off when we used a lot of water.

Aldrin The fuel cells looked rather even at the beginning of the flight. I think two-Charlie was taking a little bit more load and had a higher current in it. Then we lost two-Baker I guess it was. We put it into the warm up position on instructions from the ground. We shut it off and checked the open circuit voltage on it. It was zero. So we shut the thing down. The purges were done almost exclusively over ground stations because they were quite concerned with the operation of the fuel cells. They had far more indications than we did as to the condition of them. I was just noting what the currents were when the delta P lights were on. We were anxious to turn them off for sleep operations. I could see no reason for our leaving that circuit breaker on. The only thing it told the ground was that the delta P lights were on. We were using current to light the lights and it was bothering us. We eventually went to that mode near the end of the flight. The batteries were tested on the Go/No Go points. I think I've already mentioned that as the flight plan started changing these Go/No Go checks pretty much went by the board. We of course checked the main batteries prior to reentry. The number one battery was consistently reading about 22.1 or 22.2 volts, and two was reading about 23.8 and three and four were about 24 volts.

So, there was one battery that was obviously weaker than the others. Two batteries were normal. This 30-second purge that was instituted to try and get more purges. A lot of them were oxygen only. I think the reason was to keep the water to oxygen pressure within better limits. It was fairly easy to monitor these 30 second oxygen purges because they were fairly short. You turn them on and you don't do anything during that 30 seconds except wait to the expiration of the time. But with the number of activities that we had over sites, I was tempted to pay attention to a few other things while the purges were taking place. I'll have to admit that there were several times when I neglected to stop the purge at the proper time. As far as I know this had no detrimental effect on the fuel cells. The ground was aware of it one time because they asked me how the purge is coming. It was a rather general hint to stop the oxygen purge.

Lovell — We did loose a fuel cell during the night period. They told us the next morning.

Aldrin — Right, we lost one-Charlie I think.

Lovell — Yes.

8.7 Onboard Computer

Lovell — Why don't you talk about the onboard computers?

Aldrin — Everything as far as the computer went prelaunch in a normal way. The IVAR routine at insertion was as expected. The out-of-plane correction I think surprised me because I didn't think it was going to be as accurate as that. During training of course, the GMS didn't have the proper equation in there to give us realistic readings. One thing I did note that was different in the actual flight operation from training, that is the numbers that were read out of address 69 for the P perpendicular. Everytime we did this in the simulator the last digit was always zero and in talking to the people there they said that that was normal. I don't think we played around with this at all up at McDonnell. The reading that I read out of adress 69 at insertion was 250. I figured well that is great, it's just as it is supposed to be. But, I checked a little later and it was 247 and it really surprised me. So I don't understand that. The use of the computer in rendezvous was normal. No discrepancies were noted.

Lovell I didn't notice any in retrofire, did you?

Aldrin No.

Lovell It came out right on the money for the IVI's and we got good updates. Reentry was nominal as far as the guidance goes.

Aldrin In the updates we did have several addresses that were off by one digit.

Lovell Yes, but that is in normal operation.

Aldrin This is due to round off.

Lovell That is normal operation.

Aldrin There was one time when we were nulling address 81, that it came out to be positive 1/10th and that calls for a thrust to the right and we thrusted to the right and it went to positive 2/10ths. I'll be darned if I understand what happened there. We thrusted just a little bit more and then it went negative. The MDU seemed to work as anticipated in every way.

Lovell — I didn't see any problems with the computer during prelaunch, ascent or in the navigation mode, or rendezvous or reentry, did you?

Aldrin — No.

Lovell — It worked as advertised. There were no problems. Auxiliary tape memory, we loaded two. One in the beginning in module three and one again in module four. Did you have any problems there, Buzz?

Aldrin — No problems. I think that the ground was aware of one. I neglected to turn the switch to standby and turn the ATM power off. The ground noticed this and called it up and we switched it off.

Aldrin — Automatic load both times. The reentry module four went in normal.

8.8 <u>Radar</u>

Lovell — We gave the radar plenty of time to warm up I recall.

Aldrin — I think we can tell more from the trajectory exactly the time it was turned on. I didn't log the time. I doubt if you did either. It was prior to the out-of-plane burn.

Lovell — I have written down the nice range we got from it just about the time you started getting operational

Aldrin

I turned the radar to standby before the out of plane translation to give it time to warm up. We yawed off 26 degrees right for the out of plane translation. Right after that when we were back SEF again and pointing at the Agena. Where the flight plan says Standby, I went to On and we recorded 231.15 miles. It was steady from that point on. We got range rates out that indicated we hadn't reached perigee yet, around 300 feet per second. The light was solid; we were receiving sufficient radar information to allow a good computation in range rate in addition to just getting range. The radar was working through CDH.

Lovell

It worked in a perfect fashion up through the CDH maneuver.

Aldrin

I can't explain what really happened when the radar gave us this failure indication as we tried to get a lock on and radar information out of the computer after the CDH maneuver.

Rep

You had good radar needles up the point where we had the problem.

Aldrin — Through the CDH computation I had good radar needles.

Rep — How about wandering?

Aldrin — No, they were steady but they were off a little bit. They were fairly steady and I used needle pointing commands. I didn't have visual target at the time, so I used needle pointing commands and all the CDH computations.

Rep — So once it went out you had no more needle operation at all.

Lovell — At the end of that I went down to align the platform, put the CDH burn in and by the time we got finished burning the radar light was on.

Aldrin — Even at close range during the tether operation, we didn't have any needle operation after that.

Lovell — I never had range rate on the analog. I never had range rate and questioned range. I wasn't too sure that range was right.

Aldrin — I was looking over there it seemed to be zapping back and forth. We did have communication with the Agena in terms of ability to send commands with the radar light off.

We didn't have a lock on light but when we're separated for the tether operation I was sending commands to the Agena and they were getting through. I did not receive a MAP light. The only time we received MAP lights were when we were docked and had hard line connections.

Lovell

I can't comment on bore sighting because I never had radar and visual at the same time.

8.9 <u>Crew Station</u>

Lovell

No comments on Sequential Telelights. Event timer. No comment. Digital clock.
I inadvertently stopped the digital clock one time by hitting the tone/vox circuit breaker off. I was told by the ground to check after I had checked the electronic timer and found it on. That was my fault.
GMT clocks. As advertised. IVI's. I have no comment on the IVI. They performed as designed and there were no funnies in them.
Flight Director Indicators worked very well.
Range and range rate indicator. We have commented on that. It didn't work at all because the radar was off.

GLV and fuel oxidizer pressure gages worked as advertised, very steady, no dropout, no changes, and they gave accurate indications. Altimeter. Worked as an altimeter works. Rate of descent indicator was okay.

Accelerometer was okay.

Switches and circuit breaker panels. We did have a few circuit breakers that we popped off. Two were at TW CDH. We mentioned that. The OAMS prop control circuit breaker and OAMS regulator, I forgot which one. I think it might be in conjunction with the radar going out, but I'm not too sure. There is no comment on switches.

Aldrin — Switches, I'd like to register a complaint about the H_2 heater switch. It's spring loaded out of the manual on position. It looked like in the ground preliminary analysis we ended up with a switch failure. What transpired was as follows. They wanted us to run the hydrogen pressure up to 667 psi and we were down around 580 or something like that at the time. I turned the heater on and held the switch down and was getting absolutely no response out of the pressure gage. There is a very strong spring in the switch so I decided I had to do something about that. I got the swizzle stick and pried the switch on. I used the lanyard on the swizzle stick attached to the vent valve, I guess it was, to hold it in a levered position. I realized there was some load being put on the switch while I was doing this but it appeared to work. The ground seemed to reach the conclusion that after it was put in the off position that it still remained on and they woke us up to check on this.

Aldrin So we turned the circuit breaker off on the heater. When I turned the circuit breaker on and off with both heaters in the off position I told the ground that there was a change in the am-meter, which would indicate that one of the switches was still on.

Lovell Mirrors. No comment.

Swizzle stick. No comment.

Do you have any comment?

Lovell — Lighting, indicators and instruments. No comment.

Aldrin — You broke a light covering didn't you on the red light?

Lovell — Yes, it was the rubber red filter over the left auxiliary light that came apart. I have no comments on any of the lighting situations. It is the same since the beginning of the Gemini Program and it is adequate. Outside lighting. The docking light was pretty good to keep an eye on the tether during our gravity gradient. How about the EVA light. Did you use that?

Aldrin — I never did get a chance to see how much light the one that shone back toward the adapter really gave.

Lovell — Did you like the lights back in the adapter section?

Aldrin — They were more than adequate. As we went into sunset I really wasn't aware of the exact time the sun went down. About that time I raised the visor and got an increase in how much I could see. There was really plenty of light back there with those two working.

Lovell	Did you also notice that the curtain back there reflected and scattered enough light so there wasn't any deep shadows.
Aldrin	There wasn't any real shadowing at all from the lights. They were diffused.
Lovell	If you ever wanted to work outside in some EVA activity you would probably want this light scattering effective. Otherwise you would have a shadowing effect. Fingertip lights. I never used them.
Aldrin	I turned them off. They inadvertently came on.
Lovell	I have a sneaking suspicion that fingertips lights belong in the museum now. Onboard data. Flight plan rendezvous, and experiments, and systems books preparation. It was a continual battle because we continually updated them. I think that our training plan paid off immensely for us in the fact that we trained almost entirely out of training flight plan books, or procedure books. We had books made up early in the program and most of our training followed these books. As we revised these

experiments or procedures we revised our copies to keep them up to date. We use these primarily since we were going to have only those onboard the spacecraft. I think it really paid off. Availability. They were available.

Aldrin — I think the people in the flight plan section did an excellent job in getting those books ready for us.

Lovell — That's right. Great job.

Aldrin — We made one comment on the procedures book. It's used so much the little tabs on it ought to be a little thicker. They were fairly thin. A small point. We probably won't be using books like that again.

Lovell — Useful. All the books were useful. The only thing I have a comment on is we forgot to put a procedure for the reentry tank in our systems book. I looked all over that thing and I couldn't find it. I thought I knew how to do it but I wanted to check with the ground. That's why I called up about those systems.

Lovell — Checklist EVA, rendezvous, miscellaneous cards. Very good. Checklists were good and you could not emphasize more than we have those for training, although they kept being updated. Again, let me say that alligator clip in the corner in the left hand part of the instrument panel came in handy. It was adequate during the hard suit operation.

Aldrin — We made use of the velcro on the suits to put the checklists on. I came up with a little cluge during reentry where I used an alligator clip to hold the book open to the right page so I could log things and go over critical procedures right at retrofire. The book was velcroed right to my leg. I think we could actually have done that sort of thing at insertion. You would launch with the book velcroed to your leg so that the two pages were open. You wouldn't have to have a lot of velcro on the pages. As you opened the two of them like this, you put a clip right across here and it holds it just where you want it.

Lovell — MAPS and overlays. We had a celestial map, a polar star map, and a ground geographic track map. I must admit that we didn't use any of them during the whole flight. Although we kept getting little updates and we kept faithfully writing them down, we were so busy that we didn't use them, nor did we have a need to. I think we knew the stars well enough so that we didn't need to. The geographic map is a good thing to have if you have plenty of time to look ahead during an S-6 but when you get a pointing command and the time for an S-6 and an area, you don't know that you're over Africa and not South America then you're in trouble anyway.

Aldrin — I think the flight plan really tells you what you're over just by the ground station.

Lovell — I imagine the tracking map would be very necessary if we had lost communication. We didn't have any use for it this time. Star charts again. The stars that we utilized were so well known to us that we didn't feel that we needed to go to a star chart.

We didn't use it. We knew the stars and we knew how to get to them without a platform, so we didn't use the star charts. Stowage. This has always been a big item. It's one which we can never optimize because there always seems to be a better way if you think about it long enough. We certainly had a lot of stowage problems in Gemini XII. One of the first things we did in our training cycle was to go through a stowage review and one of the last things we do is to revise the stowage prior to lift-off.

Aldrin I think the EVA preparations that we had, for the three different EVA's and getting in there with suits and going from one to the other helped. Of course, things changed and we had to modify them but the fact that we had gone through this exercise of appraising the stowage problem many times ahead put us in a configuration situation where in flight we are able to think in terms of where things were going to be going and what kind of shuffling had to be done.

Lovell I think that a lot of our EVA work even at McDonnell when we're still working with the AMU EVA helped us out.

Aldrin Yes, I might say we had things so well set up the night before retrofire that the stowage that took place the next day was very minimal. We had a comment from the people that unstowed the spacecraft aboard the USS WASP that they were amazed at how clean and neat everything was tucked away. Everything was in pouches.

Lovell Several of these comments they say to everybody.

Aldrin I felt like we had that stowage under real good control there. We got rid of everything.

Lovell The life vests were all okay. The life vests were stowed. After insertion we had . . .

Aldrin I'd kind of like to see a better way of getting rid of those shoulder restraints, rather than just reeling them up . . .

Lovell That was not the best way of . . .

Aldrin We'll probably never run into this again, I guess.

Lovell Color coding. We still had problems with the power of the TM on the color codings, black on white, white on black. We violated it several times.

Aldrin — The first connection we had to make was a black line to a white line, hooking up the camera.

8.10 Spacecraft Exterior

Lovell — No problems with the hatch. It was beautiful on all three EVA's. We used the original hatch closing device to operate it. It was a very smooth operation.

The window covers were jettisoned at station checklist. Both of us noticed -- at least I noticed -- at staging that we had a film over my window and I also saw the flash through the windows. Since we had the film on the window, Buzz had to wipe it off during umbilical EVA and actually got it clean.

Aldrin — I'd like to comment a little on that. The polaroid job would be very useful, especially in the S-11 experiment and alining the spacecraft up where the sun was setting. Other than that I didn't have any need to get it out. I just kept my head out of the way and had sunglasses on when the sun was coming up.

Lovell — I used the polaroid several times and I thought it was handy.

Aldrin — Now the opaque one; we were just marginal on it. It should have overlapped the window by another quarter of an inch all the way around and it would have kept all the light out. I just don't think there is any excuse for making one that allows just a little bit of light to come in all the way around the edge.

Lovell — Let me make a comment about the IR filter that was put on for the eclipse. I have some reservations about putting on another filter. I thought the polaroid filter would do the job but I was glad that it was on there at the time because I needed a perfect filter to watch the eclipse and track without having to squint or to be in trouble. The way they cut it to let the camera point through the window was excellent. Docking bar worked as advertised, according to procedures. There was that two second delay when we fired it off to get rid of the tether. EV camera mounts. You might mention the retro camera. That thing was loose, wasn't it, Buzz?

Aldrin — The problem back there was a bracket problem.

No, it wasn't really loose once it got in properly.

Lovell — The retro camera wasn't loose?

Aldrin — Oh yes, however, they came up with a huge spring attachment that was supposed to keep it from vibrating while the camera was working and I assumed that worked, but I think the film will really tell us. If it was smooth enough during camera operation, I think that it being loose wasn't a problem. I just don't think that's the kind of camera mount you want to have.

9.0 VISUAL SIGHTINGS

9.1 Countdown

Lovell: On the countdown we saw about five wasps. They were all over the RCS system.

9.2 Powered Flight

Lovell: Visual sightings, nothing. Well, I take that back. At staging we did see the flash. We saw the coating on the window and the horizon view came up. At exactly four minutes we crossed the horizon on the ball as advertised.

Aldrin: I saw the horizon coming up in the right window as advertised.

Lovell: At fairing jettison and spacecraft separation, we had all kinds of debris around the spacecraft.

9.3 Orbital Flight

Lovell: There was quite a few pieces of working metal - old rivet heads and things like that - that came out of the TDA section that held the work station and we see these things floating out - broken rivets and all sorts of things. They just floated around for awhile and then left.

Aldrin: It was amazing. Really funny, to see them sitting up there about 6 to 12 inches, in a gradual little tumble and then they'd move off. I could swear that when we yawed they yawed with us because.....

Lovell: They seemed to out maneuver the spacecraft. Inside the spacecraft we sighted some objects - there was a dime that floated by us that we picked up. We made some money on this trip. Someone left it in there. There were five or six washers and a few bolts.

Rep: Did you actually find a bolt?

Lovell: Yes.

Aldrin: Some of the RTV was coming off the back of the seat.

Lovell: Yes, there was some RTV floating around at insertion. I will be honest and say that on this flight I didn't see one satellite. I saw two meteors beneath us and one Agena, which was ours.

Aldrin: I think we've already mentioned about seeing the debris or what we feel quite sure was the debris we jettisoned on the third EVA, seeing it several revs later. I don't know how we'll ever establish exactly what the time line was, how many revs. I think it's just interesting to note that we did see things that we feel quite sure was these things that were jettisoned. At the velocity that they went they must have been - I hesitate to say it but a couple of miles away, when we saw them. It must have been that far.

Rep: Did you see the javelin again?

Aldrin: No, it was black.

Lovell: Acquisition light flash rate was satisfactory. We first picked up the Agena in the daytime. We saw the reflection of the sunlight off the Agena so it was a brilliant pinpoint of light; easy to track. As we went into nighttime I was a little bit apprehensive, since we had to have visual sightings for the radar open loop solution, that I wouldn't pick up the night lights in time. However, there was absolutely no period between daylight and darkness that I didn't go from a visual reflection target to a acquisition sighting.

Aldrin I think the reason is twofold. One is because of the smaller Delta H that we had compared to other flights, and the other is wer were at a closer range and at a higher angle when we went into darkness; even though we were five minutes late getting to TPI.

Lovell The Agena exterior condition after we came aboard was very good. There was some areas of burnt paint....

Aldrin There was paint blistered in several areas. I saw it during the EVA. There was one umbilical door that was not closed and I did a little inflight maintenance and closed the door on the Agena.

Lovell I might add that contrary to majority opinion, the Agena tether was out and extended and in good shape.

Aldrin On the flash rate of the Agena, I did send acq lights on during the tether exercise and it was quite obvious that they were not flashing at one flash per second. It was more like one every two seconds. The batteries probably dropped down a good bit.

Lovell I don't have anything to say about the Agena ACS except we ran out of it too fast.

Rep Did you ever see the thrusters?

Lovell A couple of times I actually saw the cold gas thrusters firing. I don't know what was causing the visual sighting of these cold gas thrusters at firing but, it was obviously there. I think it might actually be the freezing of the gases that comes out. The sunlight does play a important part in seeing the status display. However, you should not have the sunlight reflection when you view them, Agena observations after undocking.

Aldrin The Agena was quite visible with just the running lights not illuminated by the docking lights during the tether exercise.

Lovell The running lights plus the docking cone light was a very good device to operate the tether because it gave us some idea of where it was, the attitude it was in and the range of it.

Aldrin During the rendezvous the running lights and the acq lights were on. At a mile or a mile and a half, we were able to see the running lights in addition to the acq lights.

Lovell Geographical, nothing.

Aldrin — Did you talk about the ship wakes?

Lovell — Yes, we could. We did see ships and their wakes. One in the Pacific. Sunlight reflection actually caused the wake to show up which we could follow up and see the ship. In the Arabian Sea and that area, because the water was so blue and obviously so calm, we could actually see the wake themselves and the ships. It was amazing.

Aldrin — You made a comment and I can add to it from the outside about the visibility of the stars during EVA. I think I've seen about as many stars on a very, very clear night from the surface of the earth as I was able to see during the standup EVA at night. Perhaps a few more during the standup EVA. You had a comment about the star background.

Lovell — It's obvious it has background. We were fortunate not to have a moon. I say fortunate because it gave us the best dark adaptation for the eyes and also made us see the most stars.

Actually that sky is not black when you are up there. The sky is sort of gray and there are big stars or dust beyond that actually give off a light and it lights up the area. It is definitely not a black sky between the stars as we know back here on the Earth.

Aldrin One thing I did get the impression of was the number of stars increased in a particular area. It was harder to pick out the constellations because of the increased number of stars that were available. If the situation enroute to the moon gets a lot worse or you actually end up seeing a whole lot more stars I think, we could possibly have an acquisition problem in picking out certain well known stars because there are just going to be so many.

Lovell I don't think we'll ever see any more stars than we saw on our flight. We had no moon and no atmosphere.

One comment on the stars though, that Buzz and I want to make is that the stars show up good in the daytime. After one of the T-2 experiments we got over on our back and we decided to see how long after sunrise we could hold onto visual acquisition of stars. I held on to Aldebaran and I could see it through the initial part of the day period until some light reflection on the window got so bad that I just didn't care. If you acquire a star at night and track it during the day and you have good visibility without the sunlight in your eye, I think you can see them.

Aldrin I was quite surprised at the long time that I could keep Sirius in view. It was past the time that the window had complete sunlight on it and was illuminating all the particles that were on my window. I could see the horizon and the Earth were illuminated completely I'm sure we were past the point of having the terminator underneath us. I think the whole Earth's sphere was illuminated by sun at this time. I could still see Sirius and I think it was Canopus at this point. The sextant helped a little because it wouldn't focus on the particles on the window even though there was an increased light level entering the sextant. The sextant afforded a greater opportunity to see and retain stars like Sirius straight out of the window. Alternating back and forth between the two I finally lost Sirius. I thought I still had it but I picked up another object that was illuminated by the sun at this time. Unfortunately because of our attitude control problem we were unable to do this in a more precise manner. We had hoped for the time to actually do this. We carried onboard a procedure whereby we could have added a good bit more knowledge to this.

Lovell During the rendezvous phase I used stars as the final terminal phase for last phase braking. I couldn't tell you what two they were.

I saw no Aurora this time. The airglow wasn't as thick this time because there wasn't a moon. Our dark adaptation was better than it was before that night. The light appeared as, as light appears I guess!

Aldrin I think it is pertinent to point out, at least from my standpoint that star to horizon measurements would be extremely hard to do with any accuracy. We just don't have enough information as to where that airglow is and at night the horizon is not defined. The only thing you can tell is that stars all of a sudden start to appear but there is no well defined line as to where the actual horizon of the Earth is. As a matter of fact, the situation is so changing as you go from daylight to darkness that any star horizon measurement has to be pinned directly to the time of orbital day that you're in. I think we're just barking up the wrong tree to take star horizon measurements.

Lovell — This has been advertised I think by just everybody that has been up there especially without a moon. You don't have any definite horizons for star horizon shots and the error you're going to get will be terrific. I could see thrusters firing at night. I could see the forward thrusters firing.

Aldrin — One time I looked back during standup EVA. I could see some particles coming out of thruster four up to about 2 or 3 feet out. We fired the pitch thruster for comparison and in that case it was quite obvious that there was a difference in the velocity of materials coming out. The thruster performing properly seemed to spray out in a cone angle of 30 degrees at the most, maybe 20 degrees. It was observable out to maybe 4 feet and going at much higher velocity than the one that wasn't working and they were just very small particles coming out at high velocity. At night when I saw the thrusters going they were going out at least 10 feet or more, the light from them.

Lovell	I think, we could mention here the fact that during the final thruster check we got nothing out of four. It might have been that four was degrading and finally just quit. It might be because we didn't have our heater on.
Aldrin	I'm sorry, I didn't get a chance to bend over and look into the aft firing thruster while I was back there. I'd intended to do this in some of my simulations.
Lovell	That's right.
Aldrin	I didn't get around to it. I was afraid you were going to fire one of them while I was looking at it.

9.4 <u>Retrofire and Reentry</u>

Lovell	We never saw the adapter nor the retro pack during the separation.
Aldrin	Well, I think I saw something moving out there at one time.
Rep	Yes, that could have been a scanner.
Lovell	Buzz, took some photographs of the reentry which will probably explain better than we can exactly what we saw. It was a daylight reentry.

We saw the United States prior to entering the atmosphere. Spacecraft oscillations were nominal. Drogue deployment was nominal. R & R separation was okay. Main chute deployment was good. The reefed condition was good. Single point was nominal.

Aldrin — It wasn't a very severe jolt at that point.

Lovell — We didn't have any oscillations at all. The landing, we have already covered and it was pretty severe.

10.0 EXPERIMENTS

10.1 Frog Egg Growth

Lovell — We performed three functions. Turning the heater on, fix unit one and fix unit two and we don't know anything else about that.

Aldrin — We left the Agena power circuit breaker on to keep the frogs warm.

Lovell — Yes, to keep the frogs warm on reentry. We kept the cover on.

10.2 Synoptic Terrain Photography

Aldrin — We attempted to get the photography as much as possible. The problem encountered was the maneuver system, the attitude control system actually I should say. We got some good photography. Again, the updates some of them were too short to get proper position to take good photography. There were the Synoptic Weather Photography, we did not take any targets of opportunity that I know.

Lovell — We got one of the islands that they wanted.

Aldrin — Yes, one of the islands in the last three. We were a little bit rushed for that at the time and we bypassed two of the last three S6 updates. Mainly because they didn't give us

	enough time and too, we had a hard time controlling the spacecraft to the proper position.
Lovell	Weren't there clouds over the Mississippi Delta when we were looking for that red dye marker.
Aldrin	That was a special that they had for us and we never saw the red dye on the Mississippi Delta. Camera, we used the wide angle Hasselblad.
Lovell	How about some of these cirrus clouds coming from inter-tropical conversions area that they wanted us to take pictures of.
Aldrin	We just couldn't tell what it was at all.
Lovell	Well, actually it seems to me that we took pictures at the time they wanted us to take pictures.
Aldrin	Nothing really significant. We couldn't relate to what we had been trained with, what we should see to what we actually saw. I'd like to question just how accurately they know that there are cirrus clouds at the inter-tropical conversional zone at the time they gave us- the update is to the nearest second. So, unless someone is standing right down looking up to it knowing exactly when we pass overhead or

get to a particular pointing angle, I'm not too sure that those updates are valid.

Lovell — We never did see any of those tropical storms.

Aldrin — No, we didn't. We saw a lot of cloud coverage. If we saw a tropical storm it wasn't too bad.

Lovell — There was a considerable amount of lightning activity during the night.

Aldrin — Especially over South America...

Lovell — Let me make a general comment of voice recorder usage. We had a limited amount of tapes and we utilized the tapes primarily for operational type usage. EVA, reentry, liftoff, and things of this nature, so we did not use the voice recorder for the experiments as long as we could do one without it.

10.3 Airglow Horizon Photography S-11 experiment

Aldrin — A general comment on the experiments, the data, times, figures, angles...we will provide a written report and we will not cover them to be briefed at this time. Continue on with 10.3, I might comment there, that the first S-11 experiment was done with spacecraft control instead of Agena control as had been planned in the flight plan mainly because of the difficulty we had in getting the Agena to the correct attitude, the second one we did, we did use gyro rate, reverse and inverted there.

Lovell — Right, that was gyro rate, reverse and inverted and it worked out quite well. Mode C of course was low orbit, that was at 70:45 and we utilized the spacecraft.

Aldrin — I might comment that it was rather frustrating in the S-11 because the cable was not working all the time and the red lens for the S-11 did not operate with camera body the way it was supposed to. In other words, I would depress the trigger and go to release it and it would not release. So, I would have to readjust the lens and then it would get in the release position. There was obviously something jammed in this particular camera body. This was the backup one that we had that was stowed in the aft box along with the red magazine attached. We just left it that way and started taking pictures with it. We eventually junked that one and went back to the original one that we had in the camera box. That didn't work much better either. What I had to do for the S-11 and S-29 in low orbit, I had to put the lens in so that it was not in fully engaged position but slightly backed off from there and in this position I could depress the shutter release and it would take a picture and then release it, and it would release. But it is very far from a optimum way of handling it.

Lovell That's right. Spacecraft control and the malfunctioning of the Maurer 70mm seriously degraded what we got on the first S-11 pass. And also, the Maurer camera effected the second S-11 pass.

10.4 Micrometiorite Collection S-12

Aldrin I refer back to the comments we had earlier in the flight plan concerning the rush of activities the first day and a possible -- depends on the exact timing that they opened the doors.

10.5 UV Astronomical Camera S-13

Lovell Our before flight and during flight and post-flight views on the Maurer set up for the S-13 remain the same. I think it's a cluge that could be improved however, it worked, at least the construction of it worked satisfactorily in mounting it for the experiment. One major item, we were not able to get three star photograph configuration during this nightpass. We were only able to get two. This is primarily due to several things, a control problem, which we really didn't understand on the first S-13 or during the S-13 experiment but I'm sure it was there and also the fact that we had no platform, although we knew the stars. It took it a while to go from one star field to another.

Aldrin — I think I have already talked about the problem with the cable as far as depressing it in EVA.

Lovell — Inertial hold capability of the Agena was excellent.

Aldrin — Did I mention anywhere in the EVA about that glow that I had?

Lovell — Yes.

10.6 Libration Regions Photography S-29

Aldrin — Again, we had solar problems. We had one at 27:13:36.

Lovell — Well, this is a question of getting a pointing command to go to this when we didn't have a platform. Going into darkness without knowing for sure where SEF was. We had to go on up and get him and then once there with the control system that just wasn't functioning properly, the prime alined so that it wasn't the reticle that was pointing, but it was the S-11 bracket which was an offset location. Actually once we finally got it going, just in the process of learning the control system for that particular pass, it worked out fairly well, but by the time we got there, the libration region was beginning to reach the horizon and the last shot I think on both attempts were taken late. It had to be abbreviated; it couldn't have been a two minute pass and it was cut back to one minute just as it entered the airglow.

10.7 <u>Sodium Vapor Clouds S-51</u>

Aldrin — Several comments. Number 1, we got the update, we didn't get a Delta T at first, I thought we had clarified our update requirements to

Houston, and I feel that we didn't do those. Probably our fault for not double checking.

Lovell We talked to the experimenter. We made it quite clear that we wanted a time to the nearest 5 seconds - it didn't make that much difference. For acquisition we wanted a Delta T to 5 seconds because I made it clear that I would take pictures each time the clock went by a 5 second interval and I think the initial pictures; since we had an odd time, were not spaced evenly at 5 seconds. I got on to a 5 second interval and continued taking the, perhaps two to three more than what Houston requested. On the next pass, I just took the nearest 5 second interval and took all the remaining film that we had in that particular pack. There are several items on S-51 I would like to comment on that sort of compromised the experiment. Number 1 was the fact that we were updated on the experiment with rather short notice. At the same time we were beginning preparation for EVA. I know they wanted to complete the experiment and we accepted this procedure even though we knew that it would degrade the EVA prep or S-51. A second problem, of course, was our control problem. We were going to have to do tracking in attitude control to get the position; and it took a little time and a little conversation to do this. The third problem we had was the goggles. We never had them for training. We never saw them until the day before the flight. Wearing them, actually was poor. They were poor in design and by merely moving slightly you could change the actual color that came through the goggles. And they appear to us not to have any value whatsoever in picking up the sodium clouds. We got on position at the proper time and started taking pictures. We saw the cloud at no time during either pass. I believe on both passes, or on the second one for sure, we had the EVA camera operating to pick up the background. Again, this particular time, North

Africa had a cloud layer toward the Mediterrean area, which increased the difficulty in picking up the sodium clouds and increased the intensity of the background area.

10.8 Tri-Axis Magnetometer (M-405)

Lovell: I have no comment. Just set it up and let it go as planned.

Aldrin: Well, we unfortunately shut it off the first night.

Lovell: Was that 408 or 405?

Aldrin: Well, we shut off both of them. That was my fault, I think. Because you asked me not to shut it off.

10.9 Beta Spectrometer (M-408)

Lovell: We missed the first control roll rate, mode A, because of the docking control which we commented on before during the night pass, after we got the Agena. We intended to get the rest of them. We didn't get too much the second mode A, but I believe we got everything else.

10.10 Bremsstrahlung Spectrometer (M-409)

M-409; I have no comment.

10.11 Manual Navigation Sightings (T-2)

Aldrin

Do you want to talk on that? Yes, the equipment setup. We had plenty of time on each of the passes. I think we ran two T-2's the third day and three of them the fourth day. The equipment setup was nominal. I used the preflight diopter setting, and checked the reticle. I think I exclusively used the number 2 position on the reticle. In general, I found that the operation in zero g was vastly simpler and easier to manage than anything I had seen before in one g simulation and in either the simulator itself or at Ames. I still had somewhat of a problem in positioning my right eye so I could minimize the amount of side blurring of the star. In other words, what I was trying to do was find an eye position where the two stars would be as close to the point source as possible. And this was really difficult in space as it was in training exercise. The focus of the diopter setting was rather hard. I would move it to one side and the other and it just did not seem to change too much. So I was relying on preflight diopter settings that we had, and in general, I can verify that this gave nearly the best viewing. Looking back at the entire T-2 operation, I believe that the results might be improved some if filters were used in both primary and secondary line of sight. Because I think this would tend to decrease the slight blurring of the stars and make them more of a point source. It would decrease the intensity, but it would make them smaller. On the zero bias measurements, I was told before flight by the experimenters that the flight sextant was going to be adjusted so that there was a small offset. In getting the zero bias, the primary line of sight would not line up exactly with the secondary; I was able to rotate the angle for the adjustable line of sight enabling me to instead of superimposing the star images, to line them up in the horizontal axis of the sextant by using the reticle. I found that this was not the case in the flight sextant. The two images superimposed exactly the same way that the training sextant did. I think that this tended to degrade, somewhat, the zero bias measurements. In the future they could be improved tremendously by having this small offset of several hundreths of a degree, so that the two images just barely missed each other. Further, in the zero bias measurements, I found, and I think the experimenter also recognizes, that there is a slight catch in the cog in the vicinity of zero, 5 zeroes on the dial. Now since we are going in an increasing direction start out with four 9's or three 9's and an 8, something like that, gradually increase the angle reading. Because of the slight blur and the fact that they were superimposed, and this catch tendency, the first series of readings, the first three were four

9's and a 5 and the second two were four zeroes and a five, which is far from what I would expect to have. In other words, the last two obviously jumped past this catch. Now, I recognized this and attempted to be a lot more precise in the control rate in the region of zero and tried to anticipate where this catch might be and stop right near the center of it. I think this was somewhat successful in the subsequent zero bias measurement. During the first sighting period of measuring angles from Betelgeuse to Rigel there was a small tendency - small amount of difficulty in acquiring these stars. I think we have to allow time to make sure that what you see out the window is exactly the same star that you have got in the sextant. Now, of course, we had very simple constellations, very easy constellations to use. The two stars, Betelgeuse and Rigel, had a different color to them, which helped out considerably in making the angle measurements. In using other stars I think we are liable to have more trouble and the suggestion that I had originally in the experiment that we provide some exterior sighting device, I think would be beneficial. When you look out the window and you see the star you want in normal vision you can look through the sighting device and be assured that the line of sight is going to be looking right at the star you want. Getting Aldebaron for the zero bias measurements I had to continually make sure that I had the right star. I went through a learning process in the first setting. And this resulted in my acquiring a new technique for adjusting the angle measurement knob. Preflight, I had been doing this by putting my index finger on the wheel and using my hand and arm as a long lever action in the increasing angle measurement. I found that with the suit on I had some difficulty. We had done this some with the suit on in the GMS, but the GMS has a very poor representation of the stars as far as good optical images go. I did practice this several times, but not enough to really uncover this particular difficulty. In flight, I found that with the suit on and my head positioned next to the window and my right hand holding the sextant, gently resting against the top part of the window, the left hand and arm, trying to position the index finger to measure the angles, the arm was bent too severely for the suit. With all the padding and insulation that the suit had it was rather fatiguing and not at all relaxing to make the measurement in this fashion. And for the last three measurements in the first sighting period, I changed to the procedure of putting my thumb on the knob and going in the increasing direction and the last three measurements were very consistent. It convinced me that this was the way to go and this was the technique I used in all subsequent measurements.

I was quite pleased with the ability I had to gradually bring the two stars together. I had the variable line of sight to the right and the pitch line of sight to the left, rolling the sextant slowly so that, as I was increasing the angle to make the measurement, I was also bringing the two images together. Instead of a saw-tooth type continual sweeping across, I was just gradually bringing in a slow time fashion one star into the other. And having reached what I thought was the right measurement, I then gave the word to stand by and again check it to make sure that it was right, and then I would give a mark at the same time I pushed the timing button. Throughout the experiment I don't think there were any inadvertent depressions of the TM button. On one of the runs I think it was the second one, I did say that after I had depressed the button and given the mark, that in the pressure of lowering the sextant to turn on the light to read the angle, my finger hit the knob and changed the angle setting. We voided that particular reading. After the first run, the ground requested that we relay to them the results that we had and they came back and said that it looked fairly good. We proceeded on with the second sighting period. The second sighting period seemed to be fairly nominal using the same two stars of Betelgeuse and Rigel. In locating the position of the sextant in the window as to the part of the window the primary and alternate line of sights were being used, I think if we were really looking for extreme accuracy on this we ought to provide some other means other than after all the readings are made to hold the sextant up and try and put an X-mark on there. I think this is an indication that may be accurate down to an inch or an inch and a half perhaps. If this is accurate enough, why fine. We did have control problems, as we have discussed before throughout this experiment. Maintaining the primary line-of-sight, exactly in the center of the reticle was not an easy task.

I think a more difficult part of it then just maintaining in the center of the reticle, was maintaining a zero, a perfectly zero roll. We would sometimes have to stop and readjust the roll in order to get it back to where we wanted. I found, incidentally, while we were doing this that the sextant in measuring a large angle is an excellent device for telling what kind of roll rates we have. It is very simple just by looking at the two stars in the primary and alternate line of sight, and their motion, to see just exactly what sort of roll rate the spacecraft has. This might prove to be an additional use of the sextant in the roll rate damping. As far as making measurements when there is a roll rate going, if the roll rate is in the direction it tends to move the secondary line-of-site toward the primary. It is a very advantageous situation because you can displace the secondary off to the right of the primary, and you know that with time, it is going to drift toward it in a slow fashion.

So now, holding the sextant perfectly stationary we can just gradually rotate the knobs so that it is increasing as the two lines-of-sight come together. If the roll rate, on the other hand, is in the opposite direction, one must continually rotate the sextant to keep the secondary line-of-site off to the right and then bring it back together against the roll rate and at the same time you are moving the sextant to perform this, you have to also rotate the dial and this makes it a much more difficult measurement situation. The next two passes that occurred on the 4th day, were by using the stars Betelgeuse and Bellatrix. The angle measured here was smaller; the star differences in terms of color were about the same and I can't say that the smaller angle was particularly easier, or more difficult than the larger angle. I think the measurements did improve certainly during this time period.

It is fairly obvious, just by looking at a series of measurements when one of the measurements is a little bit out of the ballpark and I think subjected rejection of measurements is a technique that can be used. Going to the Mode B, with the helmet on and the visor down; this was done with the gloves off because it was my understanding and this was the arrangement that we had, that the idea was to evaluate the sextant with the eyepiece and the helmet and visor; and it was not particularly a pressurized or gloved operation. The decrease in the magnification was noticeable with the long eye relief; but at the same time, the images appeared to be sharper and this tended to increase the accuracy of the measurements whereas the decrease in magnification had a tendency to decrease. Getting the proper eye position with a long eye relief required a bit more time, and of course, the sextant had to be lowered down each time that the measurements were made and then we would have to reposition the eye and the helmet and the sextant resting against the helmet. All in all I think I was quite pleased with the way the experiment went and I hope we learned a lot out of it.

11.0 PRE-MISSION PLANNING

Lovell

This is a very good section because essentially Gemini XII didn't have a Mission. It was, I guess by default a spacecraft and a flight that was supposed to wind up the Gemini program and catch all those items that were not caught on previous flights. We were to expound on certain areas that have proved to have difficulty or that had to be redone. This is bad procedure essentially because it means that you have nothing to train on until the flight previous to yours has been completed.

11.1 Mission Planning

As far as Mission Planning, we were still perfecting trajectories up until a few weeks prior to the launch. I believe that XII suffered from too many "crooks" and that we didn't decide early enough on a definite plan and stick to it.

This is essential in any space flight endeavor that required a lot of training, a lot of different hardware, and a lot of procedures to work out. Because if you don't have a firm mission plan and flight plan, then such things as stowage, hardware items, procedures, just are not possible until you get a flight plan and a mission plan, then you might just as well forget your training. The flight plan, of course, depended on the mission plan and again the flight plan was being revised right up until we were actually into orbit, as far as major concern shows such as the eclipse. Spacecraft changes were held to a minimum. I have no complaint about changes that I could recall right now. The mission rules, I thought were reasonable; they tended to become scattered with previous flights, only changing with regards to experience learned on previous flights and particular rules that pertained to our flight. I saw no problems with mission rules, I thought the way they handled the rendezvous mission rules was quite equitable and quite workable.

11.2 Experiments

Lovell — Again in premission planning, the experiments have to be aboard early enough so the crew can get proper training. This in XII was a gross violation of this concept. Everybody wanted to get their experiment in at the last minute. We were torn between EVA prep and certain experiments. We should have turned off the flow a lot earlier than we did. We thought we had a pretty good handle on the experiments, except that towards the end we were getting such things as S-64, Dim Light Information, and things of this nature that we just couldn't handle. As it turned out on the actual flight, we were too rushed and I believe had too crowded of a flight plan. Training activities of course, depended only upon the other five items; we cannot train unless we have a good flight plan early to train on. That is, of course, the heart of the entire flight. If you know what you are going to do early enough, you can train to meet all contingencies and do a good job.

Aldrin I agree.

12.0 MISSION CONTROL

Lovell There are several items 12.1 - 12.5; essentially all of them go tegether in a general comment, which I would like to make on mission control on this particular mission.

1) Because of control problems and increased time required to get to certain attitudes and do certain things, we needed plenty of time to know what we were going to do next. In several instances, this was not given to us. Another general comment is the fact --

2) We would have liked to have known better what the thinking was at mission control of what was coming up next. In some cases, this was adequate, as they said we were going to be rushed between an EVA prep and S-51, and could we do it. We said we would give it a try. The phase adjust burn after separation from the Agena; we didn't know exactly why we were burning this thing, and we had to inquire to the ground, why this should be burned and what time we should burn. These things, I

think should be explained; when we have a major change in the flight plan you ought to present a little comment of why we are doing things to let the crew in on the problems.

3) In many cases, when we had a fuel cell problem -- when we had control problem and we had an oxygen problem and we were doing things other than was required for the experiment, then it is up to the ground to allow time enough to have the crew do these items and then do the experiments. They should be done at the expense of what the flight plan calls for, which means either cut out an experiment.....

Aldrin I think along this line, the one situation that came up along the consumables was in the fuel cells; we were getting ready for umbilical EVA prep; the ground came up and told us that they wanted us to drink a lot of water and I resented this a little bit, because I set out in my own mind just how much water I wanted to consume before going into the critical umbilical EVA. It took several communications back and forth before we finally established that the reason that they wanted us to do this was not one concerned with the umbilical EVA from a medical standpoint or ELSS performance standpoint, but more from a fuel cell standpoint. I don't think we should of gotten ourselves at this late stage in EVA prep into a position where we needed to siphon off some water from the fuel cells at the expense of possibly changing the physical set up and the water balance in an individual or just complicating the situation by having to go through a lot of drinking.

Lovell In regards to the section twelve entirely, I can't say that mission control was entirely at fault at giving us too much to do at the same time, but just trying to get things done during the Eat Period, like PLA updates and status reports, because I think this really reflects back at our flight plan, in the fact that the flight plan was overly ambitious anyway; and the Mission Control had the flight plan and was trying to get it completed as soon as possible. Again, and this is an old argument, that has always popped up in that we should get a good look at how much time we had and allow time for contingencies which occurred in almost every flight that I know of.

Aldrin I think a lot of this is inherent in the type of spacecraft we are flying. We are flying a manually controlled spacecraft, which takes time and attention to get into certain attitudes. We may not be faced with this sort of thing in the future, with things on the Apollo spacecraft that are tending to hold certain attitudes and where you can have some portion of the spacecraft under automatic control and then you can devote your time to the things that are manual.

Aldrin In the Gemini spacecraft everything that really is accomplished requires crew attention. You've got to write down everything.

You have to go through all the eating procedures. We don't have the means of communicating up basic data like PLA's and CLA's. These all have to be recorded and they are all geared to the particular trajectory to our tracking stations. Major activities are geared to stateside passes and these are the times also when we get a lot of these updates. Unfortunately they are also times when we are usually going through an eat period, fuel cell purges and everything else.

Lovell Well, I guess perhaps some of the eat periods and fuel cells purges and other things that were not planned correctly because our trajectory even changed when we didn't make the PPS burn. This changed times that we were over stations and it tended to confuse the entire situation.

Aldrin Yes, you can't blame anyone in particular for these. It is just a set of circumstances. The reason we are talking about them is to just make people aware that these things will arise and they are characteristics of orbital flight. There isn't any way to solve them that we know of right now. The people must be aware of them when they are planning and attempting to conduct activities of this sort that require a high level of activity.

13.0 TRAINING

13.1 Gemini Mission Simulator

Lovell: There is no doubt in my mind that the Gemini Mission Simulator is the best single device in preparing for a Gemini Mission. We tried to utilize it to the maximim capability. I believe this is the place that we had to perfect our procedures, systems training mission training and crew station configuration. Again, much of the experimental procedures was worked out by the crew in the GMS. I am beginning to doubt whether the crew has to be completely involved in procedures as part of their training program. It appears that in future missions, especially Apollo, that there should be a working group with operational experience that works out these procedures for the crew.

Aldrin: Right, I think an experiments office should have people in it that are quite qualified individuals perhaps not with orbital experience space flight experience but at least pilot experience.

They ought to get in and fly simulators and work these procedures out then talk to the crew. So, that it doesn't end up with the crew working procedures out or trying one thing and then talking directly with the experimenter. He is too busy doing his own things really to be able to get in and do these things himself. When you have just one or two experiment coordinators, you can't expect these people to get into the details on each individual experiment. The sponsors somehow have to supply some people or the experiments office have to supply people. I think an example of where this was done was in the D-12, the AMU. We had a man working in that who is now in our office who was quite familiar with the problems. He got right in and was involved in the testing, writing up the procedures and working very closely with the flight crew in setting this particular experiment up. It is just too bad that we weren't able to capitalize on this.

Lovell There are three areas that this is true, rendezvous, EVA and the experiments. For rendezvous the technique works fairly well. We had a group of people who developed rendezvous techniques depending on what the flight plan was and presented them to the crew for training. The crew sometimes modified these techniques according to what they thought was best, but, still they had something to work from. The EVA and the experiments areas were not done this way. EVA was almost entirely a crew procedures workout. Experiments were almost exactly the same thing.

Aldrin Right! On EVA the crew had inputs and evaluated pieces of equipment to come up with changes that were absolutely required. We just couldn't deal with the equipment as it existed. We had to make changes because of mission changes. We would come up with the requirements and suggestions for equipment. The Crew Systems Division then would take these and try to come up with a piece of gear and give it to the crew to evaluate in a near operational training situation. Very large amounts of time were wasted in evaluating this kind of gear. The same thing is true completely of the experiments. We came up with modifications of brackets, things that were unacceptable and suggestions on ways of improving them. It always came right back to the crew and ate into our training time considerably in trying to look at these things and evaluate them.

13.2 Launch abort training

Lovell — Launch abort training, of course, with the DCPS is good. It gives you some basic procedures, then you go in with the GMS. Especially working with them in Houston where we get some actual realism, I think is very good training.

13.3 MAC Engineering simulators

Lovell — We only utilized the rendezvous Hybrid simulator at McDonnell where I felt we got some very basic and valuable rendezvous training. It was used somewhat as a tool to develop the rendezvous technique. However, I think it is valuable training and something of this manner should continue for Apollo. It is especially good because you can make shorter runs in the Hybrid than you could with GMS.

Aldrin Well, there are a much wider number of initial conditions and dispersions could be worked. The GMS, I'm sure the AMS is the same way, is rather inflexible in terms of the total number of dispersed cases. It just isn't set up as an R&D engineering type of simulator such as the one up at MAC is. I think, looking back on it, we wasted quite a bit of time up at MAC working out the rendezvous techniques, working out passive rendezvous techniques and things that we did not use in flight. We could have concentrated more on the prime rendezvous. This goes right back to the idea of mission planning. We were conducting this training before we really had pinned down just what the final flight plan was going to be. Of course, due to the schedule of activities, we had to schedule this training in early in order to get down to the Cape to make use of the facilities of the GMS.

Lovell Yes, one comment we had on the mission plan which I forgot to mention is the fact that when we formed as a team for GT-12, our purpose was to not only have a flight plan but have a contingency flight plan and train for them so that we wouldn't be caught short if we had to change drastically even close to launch date. The big changes in the mission during the phases of our training precluded this contingency training and if we'd lost the Agena, we would probably have been in pretty sad shape before we could have launched again.

13.4 Translation and docking trainer

This is a good device. We not only utilized it for docking practice but also for hard suit training to fly and eat. As it turned out we didn't have to utilize this particular training aspect of it, since EVA had changed quite a bit.

13.5 Planetarium

The planetarium was always good. The planetarium is basically good to give you a general knowledge of the celestial field. A good basic knowlege of most of the major navigational stars is required I think in space flight. It is clear to me that when you have a good knowledge of these things you don't need a platform. You can find yourself fairly decently by just looking at the stars.

Aldrin — Well, I tell you I would like to see something like we have at the Moorehead Planetarium a little closer down near to the Cape, so right as you approach the launch date you can review things right at the last minute. When you have a slip, we felt that it was important to keep the orbital plane the same so this placed constraints on the launch time that perhaps were a little bit undue. It would have complicated our training to have taken the time out to have gone to Moorehead to review a slightly different orbital plane. I think in the future we ought to be able to be flexible enough to take these changes. In order to do that it has to be easier or we have to have better access to planetarium type displays. It may be that this can be accomplished by use of the AMS and the visual displays that are available or something as a substitute.

Lovell — We have a planetarium in Houston, but it is not as good as the one at Moorehead.

Aldrin — Yes, but I think what we really need is something here at the Cape. Especially, in Apollo when so much of the traming is going to be done here.

Lovell — Actually what is really required is a visual device like you have in the GMS but with perhaps a wider field of view plus a larger magnitude of stars to choose from. I think the GMS is limited to fourth magnitude stars and we missed such things as Pleiades. Now if we had a starfield of that nature we'd be in great shape.

13.6 Systems Briefing

Let me briefly review our training concept on systems since our training record does not reflect large amounts of time spent on systems. Both the prime and backup crew has had previous experience in Gemini. We had quite a large amount of changes in the flight plan that required a lot of concentrated effort and since our time of launch had not appreciably lenthened we decided that we'd rely on what briefings we had previously and only be updated on things that had changed. I think that essentially this worked quite well. We were briefed by the McDonnell people on the spacecraft changes. We had no particular problems with the spacecraft itself. On the Agena, we were briefed by the Agena people on 9. We begin operational briefings on 12 of what to expect. The only surprise to me in the Agena operation was the operation with the fully loaded Agena. I knew that there was sloppiness in flight control mode 1, I didn't realize perhaps that we had so much change. I thought that the heavy load on the end of the nose of the large mass really made operations difficult on the Agena.

Aldrin I'd like to mention something here. This may not be the section, but early in our training while looking at how we were going to handle the Agena, it occurred to me that there might be some advantage to keeping a log as to what commands were in the Agena. Then, at any particular time, you'd know the status of the Agena. As we started working more with the flight plan, and with the procedures book in terms of making changes in the Agena configuration, it looked to me like this might be an unnecessary burden. We dropped thoughts of doing that sort of thing. It would have complicated things quite a bit. As it turned out, the problems that we had with the Agena, were compounded by the spacecraft attitude system difficulties. I think it might have beneficial if at any particular time we had ready access to something that would tell us exactly the status of each command that existed at that time in the Agena. It takes time to do this. I'm saying this because we did have several cases where we started a maneuver that was in the procedures book. It was not completely successful and we had to restart it again. This took us off the normal set of procedures and tended to deviate us and several times, we ended up not having the Agena in exactly the configuration that we thought. This resulted in increasing the attitude gas consumption.

Lovell — One more comment. 13.6 GLV I think both of us were adequately briefed on the GLV. Especially from the operational viewpoint and what to expect during the launch phase from sight, sound, feel, and vibrations on the GLV.

Aldrin — I'd like to add one comment on the systems briefing. When we had change of mission, that drastically effected the EVA by eliminating the AMU and when we also made the change in the flight plan that meant we were going to be doing a lot more maneuvers docked and undocked, it meant a considerable increase in work load in order to meet any reasonable launch date. We recognized that things were going to have to be squeezed somehow to do this and the most important objectives were the EVA and the rendezvous. We concentrated on these. When you compare this with the way we would have been trained, had we gone on the other type of a mission profile, something had to give. Either it was the working hours and certainly we put in long working hours on this mission as a result of the changes. Something else did give a little bit and I think that was the total systems briefing. I personally felt that I was flying with someone who backed up 2 flights, had flown 14 days and was quite familiar with the systems.

I felt that if I didn't know some things at least I could count on Jim to fill in what I didn't know. I concentrated on my particular part instead of both of us understanding everything about the whole systems operation. We tended to specialize in order to get the job done in the minimum amount of time.

Lovell — What experiment training?

Aldrin — Urine system training is what I was talking about.

Lovell — On flight experiments training our training consisted of taking the experiments that were designated for 12, looking over the definitive experiments plan, and then adapting them and working out our own procedures. I think in very few cases where a set of procedures handed to us that were adequate without extensive reworking. Equipment operation. A lot of times, we didn't get the proper equipment. We mentioned this in our experiments area. The goggles for

M-51 and the Maurer cameras were especially late. We got a training item that didn't operate like the flight item. The training item had pins that were gouged out or missing and actually did not operate the way the flight item should operate. It wasn't until about a week or so before the flight that we got hold of a training item that was redesignated from a flight item that worked similar to what we could expect.

Aldrin I'd like to mention here, that indecision or late decisions effected what we were doing in terms of experiments. An example I'd like to make is the decision on which camera we were going to take. This went back and forth between the wide angle and the standard Hasselblad many times. At one time, it was going to be used attached to the ELSS and at the last minute we ended up with a superwide Hasselblad. It was going to be used handheld EVA and at the time, we just had no opportunity to really look at this situation.

As a result the crew had to look into the situation and see what the problems were and try and identify how we were going to adapt this particular camera to an EVA use. We had some last minute changes in trying to develop a hand holding bracket to do this. I think this is a significant example of how this handle was developed. I think people did a great job in coming up with this particular item as they did on many other items. I don't think that the crew ought to be involved in doing any of these things.

13.8 Spacecraft Systems Status

Lovell — Our philosophy on the spacecraft system tests were that if tests substantially trained the crew or gave the crewman operational knowledge the crew would participate. If there was a decision made on some hardware changes on the spacecraft that required crew operations, either the prime crew or the backup crew would participate. Many of the spacecraft systems tests did not compensate for the time involved. We skipped that part of the testing and we concentrated on GMS training.

13.9 Egress Training

Lovell	We had been briefed on pad egress training. We did not participate in the Gulf exercise on 12 since all 4 crew members had previous experience in water egress training in the recent past.

13.10 Launch Simulations

Lovell	I thought these were adequate and desirable and especially operating with Houston was a necessary part of our training program.
Aldrin	The SLD, simulated launch demonstration, the purpose of it I think originally was to provide people counting down both the Atlas/Agena and the spacecraft, but I think a more important reason is that it gives the crew one good opportunity to go through the entire ingress into the spacecraft and countdown procedures and I would highly recommend that we do that at least once.
Lovell	It's a dress rehearsal for the real thing.
Aldrin	And it was very, very important and it was quite enlightning to me to go through this particular SLD exercise.

13.11 Reentry Simulation

Lovell — Again, necessary, good training, and recommended maintaining this in future programs. Especially when you work with the control center in Houston.

13.12 Simulated Network Simulation

Lovell — Simulated network simulations are important since they cut down the total amount of time that we had to use. We can recycle quickly. Network sims, we did not participate in since we felt we could not justify the time that we would devote to them.

13.13 Zero "G" Flights

Aldrin — Well, I think we've touched on these a little bit in some of the discussions on the actual flight plan items of the three EVA's that we had. Perhpas I can summarize a little bit in saying that zero g aircraft has advantages and disadvantages. The advantages that it gives us the only physical representation of actual zero g in a medium, that is an air medium that is similar to the vacuum medium of space. It suffers considerably from the short time that is involved, the fact that you have to experience the two g pullouts between each one and it is a rather difficult pilot task to keep the perturbations down to zero. I think it was a necessary part of the training that we went through. I personally feel that from my experience that zero g flight is not needed as much now, I think we've learned in the accumulation of EVA experience in Gemini, that EVA is not as difficult as it looked like we thought at one time. I think that certain isolated cases of transfer activities in Apollo should be looked at in the zero g airplane and that future people involved in these should sit down with other people who have experienced EVA and attempt to in a general controlled bull session, just talk over what it is people plan on doing. Zero g flights have their place obviously, but there are many, many disadvantages.

13.14 Underwater Zero "G"

Aldrin — The underwater zero g, I think here we have a medium that has considerable advantage over the zero g aircraft in that we can timeline things, we can look at the entire flight plan item, or whatever the EVA activity might be. It has disadvantages also in that there are buoyancy effects. One of weighting the suit down, I think these are minor in looking at the whole underwater situation. I would say that it is an excellent training device and we should attempt to make as much use of it as we can.

Lovell — Essentially, to summarize, I think that you feel that zero g flights might be valuable in certain short time look see of other actual zero g conditions, but the underwater will probably give you more of a long timeline overall look at the problem.

Aldrin — Right, you have to look at what the problem is. If the problem involves pieces of gear that will float around, then you might want to look at them in the zero g flight.

There's not much point looking at these things under water because you can't buoy them up. Total timelines are much more valuable to look at in underwater work. Body positioning I think is very well simulated in underwater work.

13.15 MSC Altitude Chamber

Lovell — The altitude chamber, I thought is good training mainly with two items. Number 1 it gives you a chance to operate the actual equipment, and number 2 it gives you the confidence in the equipment that since you are operating it in somewhat of the environmental conditions of low pressure. And I think that anybody who contemplates an extravehicular type exercise in the flight, should go at least one time and perhaps more through an altitude chamber to get confidence in the equipment they are going to work with.

Aldrin — I definitely agree with that. I think that people who have not been exposed to altitude chambers before or to any spaceflight, that several experiences or runs in an altitude chamber are required.

You've got to look at the work load you have, that you may be required to perform. You have to look at the type of gear that you are going to be using, ELSS or PLSS, and look at its capability to handle the work load that you are going -- it gives you an opportunity to look at flight type gear in contrast to the training gear that we end up using so many times in the walkthroughs. I think even for people who have gone through this unless their experiences have been in recent past that they certainly ought to avail themselves to the altitude chamber experience.

13.16 <u>Gemini Crew Station Mockup</u>

Lovell: Gemini 12 crew used the crew station mockup primary for EVA walkthroughs, EVA prep walkthroughs, and I believe this is an essential part of training to have a mockup of this nature. Certainly, it was used extensively and it came in very handy, and I think that it proved itself to be a valuable tool.

Aldrin: I'm not sure what the Apollo plans are, but certainly, whatever mockup was used -- provisions ought to be made to keep it as up-to-date as possible. I think we found that some cases the mockup was not kept up as well and we would resort to taking simulator time to go through some of these exercises.

13.17 Gemini Adapter Mockup

Lovell — Adapter mockup, I feel, I guess, Buzz, you feel the same way, but for one g walkthroughs, on your particular EVA work that the adapter mockup was a valuable tool.

Aldrin — Yes, I think we used the same philosophy. We can take whatever gear is going to be used underwater and look at it in a preliminary fashion. It all depends on what the task is you're doing. It helps you to refresh your mind, helps you with your engineering. Some of the things, research and developing, where certain handholds are attached points ought to be. You've got to look at this from time to time in a one g situation.

13.18 Agena Mockup

Lovell — I felt that the Agena mockup primarily was utilized by us just one night, but it did prove to be fairly good training, and this particular training item was picked up from the GT-11 crew.

Aldrin Talking about the rendezvous approach?

Lovell Yes, they approached rendezvous on the skid strip utilizing a crane and the Agena lights and we had about a two mile run and we could also have sextant operations and we could correlate somewhat the approach speeds with what we see through the reticle. I think that this was important and actually corresponded very closely with what we actually saw in our night rendezvous. We did have a night rendezvous.

13.19 Sextant Training Equipment

Aldrin Well, rather briefly, I think the experiment itself was handled in a most professional way as far as the experimenters getting down and talking with the crews, and assisting them in setting up the training. I think the sextant training in general suffers from the one g situation. In comparison to zero g operation, in a way that I'm not too sure that we know how to get around rather than suspending it in some fashion. It was very difficult with a fairly heavy handheld sextant to use it in day-to-day operations in the GMS without it being a very degraded type of operation.

Lovell We could probably improve that somewhat if we looked at it.

13.20 Camera Training Equipment

Again for some reason, the cameras are always the last items to be received by the crew for training. I've already mentioned the problems we had with our training 70MM Maurer. We, of course, didn't have a decision on what kind of Hasselblad we were going to carry until late in the game, and we didn't get a wide angle Hasselblad until quite late. It appears to us that cameras should start to get standarized, that the crews ought to be able to get the cameras early enough to get thoroughly familiar with the cameras. After all, photography is one of the most important byproducts or prime products that we're getting from space flight and the crews should be thoroughly familiar with them.

The End