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SKYLAB 1/4 TECHNICAL CREW DEBRIEFING

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PART I

PREPARED BY

TRAINING OFFICE

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1.0 SUITING AND INGRESS

POGUE I have a couple of comments on the UCTA cups. No UCTA cup quite fits. They are either too big and slide off, or they are so tight that they cut off the circulation. I think some work could be done in that area. Perhaps if they were more elastic, they would fit the penis more exactly.

POGUE In regard to other life support equipment, I broke a biosensor on launch day. I think we need to improve the way the sensors fit into the biobelts. I can see that recurring. It doesn't bother me, but I'm sure it upset the people that are monitoring the data.

CARR In training, we had problems with the corners of the biobelts turning under, and we made some field fixes to the LCGs. Toward the launch I noticed that the biobelts no longer tended to dig into me.

CARR On the morning of the launch I can remember no problems whatsoever with suiting or with any of the lifesupport equipment or connections. Ingress was no problem. The only problem was when we were having cabin closeout. The BCMP had to claw his way out of the command module over the top of the SPT. The command module was so tightly packed under the couches that that route of egress was just not available to him, and

CARR (CONT'D) he had to come out over the top. It was not a big problem, but there was a possibility of throwing or breaking a switch. That certainly would have changed the nature of the whole launch sequence.

POGUE There was a problem with the cabin closeout concerning the visibility and interpretation of the hatch controls. We have a gearbox, a lever, a boost protective cover jettison knob, and a small safety release button. I never liked the setup for the hatch controls observations while I was suited and in the couch. Observation of the BPC jettison knob was probably the most difficult because I was looking over my head in a strange orientation. I memorized the correct position of that little knob, although it was Ed's job to check it. I remembered that for launch it pointed upward in the direction we wanted to go. That's the only way I kept things straight.

GIBSON Both the gearbox and the handle had LATCH and UNLATCH. One position was indicated by the whole word, one by a U, and one by an L. I think we should have had completely different words for each position because they did get confused at times. We had to read it twice to make sure that we understood it.

CARR The fact that both had the same nomenclature created a possibility of confusion which worried all three of us.

POGUE The fact that the documentation callouts used the words LATCH and UNLATCHed instead of U and L for both gearbox and handle added to the confusion. But we did not point this out in time to make a documentation change.

GIBSON Perhaps it should have been indicated by OPEN/CLOSE.

POGUE They weren't using nomenclature that was on the hardware.

CARR In general, the three of us completely agree that the people in the suitroom did a good job on suiting and ingress. It is easier for the crew, from a psychological standpoint, when people are reasonably relaxed. The people doing the suiting knew their jobs. There was no hesitation, questioning, or relunctance on their part. That is the way to send the crew out to the pad.

2.0 STATUS CHECKS AND COUNTDOWN

CARR I don't remember any problems with the ground communications. The ground comm was fine. There were no breakdowns of any kind, and I felt that the crew was kept well informed. They kept us informed about how we were doing on the countdown, where we stood on the time line and how far ahead we were. I thought the guys at the Cape did a good job of keeping the crew well aware of where they stood.

CARR Crew Station Controls and Displays: no great problems there. There are some switches and valves in the command module that were extremely inaccessible in the suited condition. I hope future spacecrafts will be designed a little differently in that area. One particular valve that gave me a hard time was the DIRECT O_2 valve. It was too tight, and it was in such a position that I could not really bring the right kind of body leverage into play. It required brute force to position that valve correctly. Certain circuit breakers on panel 8 were also extremely inaccessible in the suited condition.

POGUE Panel 275 is also very inaccessible when one is suited. When I was hard suited, I actually could not see it. I had to turn over a cue card and use a printed reproduction of the circuit breaker panel and reconfigure it by feel. I don't want to make

POGUE (CONT'D) it sound worse than it is. Panel 275 does not have to be reconfigured unless we have a problem, but we did have problems in flight with that panel, which seemed to be related to flight duration. It is impossible to get to panel 229. We would like to be able to use the circuit breaker panels which are used in training to show you the failures. We had failures on some of these panels in training, and it is not possible to reach them when one is suited.

POGUE I dropped my cue card for launch aborts and burn times during the countdown, but it did not matter because I had something else to write on.

POGUE The GIMBAL MOTOR and the BUS TIE indications that we get don't give you a good positive indication. Other than that, everything that is easily visible from the right couch is easy to control. The ones that are difficult to see give you problems.

GIBSON The center couch does not have those problems of circuit breakers and switches on either side. I had trouble reading the REPRESS PACKAGE PRESSURE. I should been able to read that while lying in the couch without having to roll over. Of course, suited it was impossible to do. If there is any kind of an oxygen leak it is impossible to read that. Having a mirror system or relocating the gage would help.

POGUE I could read two gages only by looking over the back of my head or turning over and looking upside down and backwards. One of the gages was the REPRESS PACKAGE and the other was on that hatch bottle. Both of them were tiny little gages about an inch in diameter and they were in darkened areas. It was hard to see the needle; it was just not designed for that sort of work.

CARR The sounds in launch vehicle sequence from countdown to lift-off were very distinctive. I think we would have wondered what a lot of them were if the people on the loop hadn't told us what was happening. We could certainly tell that the gimbal motors were moving when that old SM wagged its tail. This noise, as well as the sounds of pressurization and some of those early sequences prior to launch, when lot of the fluids were moving around in the plumbing down below us, would have worried us if we had not known what they were.

3.0 POWERED FLIGHT

CARR S-IB Ignition: I didn't feel that the visual cues in real time differed from those we had experienced in the simulator. Only the physiological cues were different. The ignition sequence and the lift-off ran exactly as they had in simulation.

GIBSON Ignition was much more explosive to me than I had thought it would be. I had the very distinct impression that we were on top of a very tall building and the bottom floor was exploding when each engine lit. They didn't all go off together; there was a little bit of lag.

CARR There was a very distinct sort of ripple firing, with exceptionally dynamic, exceptionally sharp cracks. At lift-off we heard the swing arm move away and break off from the vehicle. This sound and that of the pyros that go with it were very clear. There are about 3 seconds between the ripple firing, when the engines go off, and the dispersion of the holddown clamps, when the arms swing away. All that happens rather rapidly, each event producing a very discernible explosive sound. Had we not known in advance what was going to happen at any given moment, I'm sure we still could have identified each event. There was no doubt at all when those holddowns let go. We really scampered off that pad. I didn't feel as though we had that ponderous Saturn V vehicle under us, because it really leaped.

CARR (CONT'D) I did not even notice the slight physiological cue of the roll program. It was just as if I were in the simulator and had to watch the rate needle in order to verify that we did have the roll program. Similarly, I did not really feel physiological cues in the pitch program. The overpowering physiological cue was the eyeballs in g-force. Nor were there any particularly noticeable physiological indications in max q.

GIBSON There was a lot of vibration. It reminded me very much of the approach to the max q on reentry, or perhaps it is associated with going transsonic. It was a very distinctive buffing vibration; I'm sure it has been reported before.

CARR GO/NO. GO for staging, as far as I'm concerned, is a ludicrous callout, because staging will occur whether we are GO or NO GO. Why don't we simply say we are okay rather than GO for staging.

CARR S-IB ECO: I wouldn't call it a train wreck, as it has been called by other crews. Inboard cutoff and outboard cutoff were again strong physiological cues. They were sharp and crisp; no problem at all there.

CARR SIB/SIVB separation was prompt and unmistakable.

POGUE We could see flashing in the window when all this was taking place.

CARR That's right. SIVB engine ignition was softer than I expected. After all the buffeting and banging around we got on the SIB, I was braced for more. The SIVB powered on like a Cadillac, with a smooth start and a firm acceleration.

GIBSON It firmly accelerated, but I thought I noticed a little chugging in it.

CARR I didn't; I didn't at all. I felt as though I were sitting in a Cadillac that was slowly but firmly accelerating.

GIBSON It just didn't seem to be a continuous, completely smooth burn; there was just a little lurching.

POGUE I think what Jerry interprets as a chugging is a much shorter period.

GIBSON Yes. It was not really chugging; it was just a periodic lurching.

POGUE Yes.

CARR Okay. I do remember that.

POGUE On the order of 3/4 to 1 second.

CARR I guess I interpreted that to be engine bell steering rather than change in thrust level; more a movement of the bell changing the thrust vector direction a little bit.

GIBSON It has been such a long time ago that it's hard to remember in which direction those accelerations were. I thought that was fluid bounce, and I just forgot about it after a little bit. I thought maybe it was all that stuff settling down, you know. You have that feeling too.

CARR LET and BPC jettison was sharp and unmistakable. It was a relief to have all that restriction in visibility gone. I do remember being flooded with light and saying something about all the sunlight. All of a sudden, I couldn't see anything. I couldn't see my indicators. I had to raise my left arm to shade my eyes. My left arm felt like it weighed approximately 40 pounds.

POGUE It's unmistakable. It was starkly clear and when the tower and BPC went.

CARR PU shift was unmistakable. It was not an alarming sort of thing, but it was definitely unmistakable. As soon as it happened, I immediately knew what it was, right on time, just like I expected it.

POGUE We're grateful for Paul Weitz's comment on PU shift. He said he thought the engine had shut down. It's that dramatic, when therefore, it didn't surprise me.

CARR One thing that had been bugging me, for the last month prior to launch, was SECO. I had decided that I wasn't going to try to beat it, but I was going to try to be with it. I was bothered with the idea that I would go counterclockwise on the hand controllers, stop my digital event timer and have to reset that thing while I was busy backing up SECO. But in the flight, we had SECO and the engine shut down, and I was far enough behind it, so there was no worry. It was all done for me, so my worries were unfounded.

CARR Everything went well on orbital GO/NO GO. We called our NOUN 82's very quickly after insertion. We were pleased with the parameters. We reported our parameters to the ground and they came back with the parameters. There was no question that we had a good insertion.

GIBSON Communications: Did we have ARIA there again?

CARR Yes, we had ARIA, and it was ratty.

GIBSON It was bad, as usual.

CARR I think those ARIA are almost a disservice. If you expect communication, you rely on it and plan to have certain things accomplished during that time period; then the quality of the

CARR (CONT'D) communication doesn't allow you to do it. That happened both on reentry and lift-off. If something doesn't work right, you shouldn't have it at all.

CARR As I understand it, the downlink through ARIA on reentry was excellent; the uplink was bad. We were having difficulty reading them and they were reading everything we had to say.

GIBSON Sometimes it's worse having something you depend on and then have it fall through, than not having it there at all.

CARR I thought all the S-band communications were good. I don't remember how Newfoundland did. It was one of the new stations that people were concerned about. The only bad communication was the ARIA.

CARR Controls and displays: The only problem with controls and displays was when that BPC went. I was so light-flooded that everything washed out. I don't know what could be done about controls and displays that would preclude that from happening.

GIBSON The task that I had of monitoring the DSKY was no problem, even under the relatively high g at the end of the second-stage burn. We were able to follow the trajectory all the way up. The trajectory stayed right along with the card and was easy to follow.

CARR How about crew comfort through powered flight? Does anybody have any words on that? I felt comfortable.

POGUE No problem.

CARR My only disadvantage was because of eyeballs in the g mode and all of the new things that were happening. I figured I was 1 or 2 seconds behind, where normally I am as far as being in an abort posture. In training, we were admonished to delay our abort response, because we would be unable to abort instantaneously.

GIBSON Pogo comments: I wonder how much pogo we experienced, and how much we interpreted as lurching.

POGUE That's a good point. Pogo is much more dramatic than what we were experiencing.

GIBSON This felt as though it were in the engine and not in the whole stack.

POGUE I just wouldn't know.

CARR I didn't feel anything that would be pogo.

GIBSON We hoped to know what the frequency of pogo would be if we got it.

CARR Separation from SIVB, was on time. We had some flap after separation because we did not activate the DAP. We didn't do the VERB 46. We pickeled off the front end of the vehicle, and I fluttered and fiddled around with the hand controllers, and that didn't get any control responses. It took me a few seconds to realize that we hadn't activated the DAP.

CARR The DSE tapes will be useful here. We'll hold any further comment on separation. We're sure that we separated on time, and we had a control problem there. The solution was that we needed to do a VERB 46 ENTER on the DAP. When we did that, everything was copacetic.

CARR Section 3, SIVB separation: Separation was on time. The only anomaly that came up during separation with the SIVB was that I was supposed to start a pitch of 1/2 degree per second in the down direction. I got it going using acceleration command in pitch. When I went back to rate command, the DAP stopped the rate that I had put in and started maneuvering us back. That confused me. I did a VERB 46 ENTER to activate the DAP and to what we had put in previously. I did it all over again, and it worked. So we drew the conclusion that the reason for that anomaly was that we had not done a VERB 46 ENTER after having activated the undock DAP.

4.0 RENDEZVOUS AND DOCKING

POGUE Jer, you may want to comment on the flow of the checklist. That's mostly yours and Ed's work. It looked as if it went very good.

CARR The whole rendezvous sequence was just as smooth as glass. We had no big problems. The rendezvous went very good. I had very few comments in my checklist.

GIBSON That was one phase of flight for which we were well trained. We had few systems problems. We just knocked it off rather quickly and efficiently. We had no problems at all with the rendezvous.

POGUE We had a dramatic surprise at first SPS burn in the awareness of fluid noises.

CARR Battery A charge was nominal. Tunnel hatch removal, tunnel pressure integrity, et cetera was nominal.

CARR Command module RCS propellant reconfiguration, no problems. We did not turn up any RCS propellant configuration problems until later in the mission. It was right after the first trim burn. The ground decided we had leakage or a problem with the isolation valve. We closed PSM Bravo and opened primary propellant Bravo. The P52 was no problem. GDC alignment was completely uneventful and the P50 was strictly nominal.

CARR Rendezvous and orientation, no problems at all with the separation maneuver. After the separation maneuver, we reloaded the DAP to get two jets and half a degree per second rate. We then maneuvered to the launch REFSMMAT attitude in preparation for getting our P52's down at sunset. We encountered no problems there. We did the EMS delta-V test with null bias check and sent the data to the ground. The data indicated that we had some bias, but it wasn't too bad in the delta-V counter. It was something like 4 degrees per hour or 4.4 feet per second from ENTER. It was very small and was acceptable. We noted after 84 days up there, when I did some delta-V tests and null bias check, we got the same numbers. The P52's that were done at a ground-elapsed time of about 040 were quite nominal. We had no problems at all with them. We had a very good platform alignment. We did option 2 and aligned to the rendezvous REFSMMAT. There were no problems whatsoever with that. Everything worked very nicely. I noticed at ground-elapsed time of 1 plus 22, we had some puffs from the SIVB. That was probably venting when we made our separation from the SIVB. I reported that on the air to ground.

CARR NC 1 Burn: The final NC 1 pad had one change. That was a 1.2 pitch change; from 11 to 13 degrees. The NC 1 was nominal burn. The ignition, shutdown were good and the residuals were in good shape. We did little nulling. We were all surprised at the kick

CARR (CONT'D) in the pants that we got. We had been told by other crews that the SPS burn was a good solid kick in the pants, similar to the afterburn in an airplane. Once we had experienced the first burn, we were convinced that it was considerably more than a kick in the pants or the afterburn in an airplane. It really plasters you back into your seat. I was dubious as to whether or not I could have accomplished a good MANUAL takeover had the situation arisen.

POGUE I was aware that we would get approximately one-g acceleration and had braced my arms. It was still a surprise. I was able to time the burns properly, although cutoff was all over by the time I said anything. The ball valve was slow as reported by the other crew. It was a very slow delivery rather than a very sharp swing of the needle as in the simulator.

CARR This was the 2-second burn. I was impressed by the fact that it seemed to be a lot wilder than I had anticipated.

GIBSON It felt greater than one-g.

POGUE VHF powerup: Nothing really impressed me about that. We did it and it worked.

CARR VHF ranging: We picked that up about the nominal time that we needed it.

GIBSON Sextant marks: They were very easy to control and we had exceptionally good visibility. I had no problems seeing the stars. The Apollo telescope, sextant, and the sextant marks were more simple than the simulator.

POGUE Marking on the workshop was no problem either. As per Owen's briefing, we started seeing the shape and configuration of the workshop prior to the first Moon force. But I just wanted to center the vehicle in the mark.

CARR NC 2 burn: It was about a 7-second burn. The chamber pressure was about 93 percent. The NC 1 burn was so short we had just an impression of chamber pressure. It was above 90 percent. The NC 2 burn was long enough that to judge and we recorded 93 percent. It was a good burn with the exception of VG_Z which was minus 0.7 feet per second. The solution was very close to the ground's. The ground solution for Noun 81 was 153.2. We got a final computation of 153.1.

CARR NCC Burn: Noun 81 was less than a foot per second in X and less than 2 feet per second in Y and Z. We had good agreement. The NCC solution was a computer solution. We felt very comfortable about it. The NCC burn was 10 seconds long. We trimmed the residuals back to within 0.1.

CARR NSR Burn: NSR solutions were good. The X solution was identical to the pad. The solution for Y was 5.4 in the pad and 6.9 in the computer. The solution for Z was in the pad and 4.9 in the computer. So we had good agreement. However, we did burn the first recycle on NSR. After NSR, the checklist here said POO. We're not sure, but we think we got one mark in before we did the recycle. We were supposed to recycle before marking. We were going a little too fast and we marked before we did the recycle, right after NSR.

GIBSON I've recorded that you had 24.6 in X, the computer got 24.6, and the pad was 23.7. In Z, I got 2.5, the pad gave us 4.8, and the computer gave us 4.4.

CARR TPI Burn: The TPI was so stable the ground did not update the preliminary pad. The pad NOUN 81 in X was plus 19.0 and we got plus 19.1. In Y, the pad was plus 00.7 and the computer got 00.1. In Z, the pad was minus 08.6 and the computer was minus 09.0. We had a fantastic agreement on TPI. We had a little difference on TPI times. The the pad was 6460453, and the one we burned was 6473664.

GIBSON I got 648.

CARR The first recycle was 648.56. The second recycle was 648.26. The PI chart solution was X of plus 18.8, the computer had a

CARR (CONT'D) 19.2, and the pad was 19.8. The comparison was good. For Z, the pad gave us minus 8.6, the chart was minus 8.6, and the computer was minus 9.0. So we went with the computer solution. We had residuals nulled to 0.1 and the delta-VC we copied was minus 13.3 after TPI. We got into the midcourse gain. We had problems with theta. We don't think the theta mark at 04:30 was any good. So we didn't believe the chart solution; and because of that theta error, it caused the chart solution to be late.

GIBSON Our data solution was minus 2.76 in X and Z was minus 6.9.

CARR The computer solution was minus 2.0 and plus 0.6. There was a lot of discrepancy in up/down, but 4.5 was not too terribly bad.

GIBSON It's the up/down that depends on theta.

CARR In looking at the polar plot, the polar plot did agree with the CMC and with that, we just decided to go with the solution of the CMC and decided that the chart solution was bad because of theta.

POGUE The polar plot was following a nominal line of the family of curves and it was so good that I don't think I even said much. Finally I said, "From here on in, it's all by eyeball."

CARR Okay. Then we started on the markings for TPI_2, and I have no notes concerning TPI_2. The computer solution was forward 3.5 and up 1.4 and the chart solution in which we had confidence was forward 2.5 and zero up/down. The polar plot agreed with us. We went with the CMC solution and came out beautifully.

We have no notes that indicate we had any problem with the switch list, prebraking switch list, or the predocking switch list. Braking was no problem. We just followed our braking gates and never at any time felt there was any line-of-sight rates or any kind of rates that were out of control. I never felt a lack in depth perception on in the necessary visual cues I needed to get in. The workshop is large, with visual cues in different directions. It was much easier than the simulator.

Stationkeeping was very simple. It was very stable and no problem at all.

POGUE Workshop photos: I have not seen any of the photos. We used the narrow-angle lens on that and I did have a viewfinder. The photos were probably nominal. I took perhaps 30 to 50 photographs. I tried to frame the workshop in the camera against the darkness of space with the top of the workshop at the top of the frame so there would be no appearance of rolling as we came in. I took a few photographs of specific areas of the vehicle as we got in very close. I took some photographs of

POGUE (CONT'D) the underside of the ATM solar panels as we came in for the docking maneuver. Those can be compared with photographs taken on the EVAs if anyone is interested in progressive degradation.

CARR Docking: phase. We aligned with the workshop plus X axis. It was very solid. I initiated the maneuver to move toward the workshop. It was surprisingly easy. I made a few corrections coming in and had no problems at all. We had a nice slow rate of closure. We did our predocking switch list and were ready for capture. We went in very, very gently, made contact, and got a capture. We got a barber pole and thought everything was really copacetic. Then had the definite impression the workshop was backing away from us a little bit. We had apparently tripped the capture latches, but had not captured the drogue and were very very slowly drifting out. I threw in some plus X while we were reasonably well aligned and tried to jam us back into the drogue again. That was a mistake. We should have recocked our capture latches, but we didn't. Had we recocked our capture latches, capture might have been made the second time because we still had good alignment. We were approximately 8 inches to 1 foot away. I gave it a small plus X and went back into the drogue and we hit slightly off center. We got up into the center of it, but did not capture and bounced back

CARR (CONT'D) out again, picking up pitch down yaw right drift rate. I backed out and aligned for a new start. At that time, the ground came up and we discussed the problem. The ground reminded us to recock our capture latches, which we did. As we approached, we had approximately 0.2 or 0.3 feet per second closing rate. However, I increased the rate slightly as we were approached contact position. We hit the workshop approximately 0.8 to a foot per second. We hit it hard and rebounded. We got a barber pole. We felt the workshop hesitate momentarily and then snap back. Apparently we stroked the probe and then when it was fully extented, we were on the end of it and it snapped. We immediately did a retrack, pulled right in, and locked up.

Mission Timer Update: We had no problem syncing. Everything went nominal.

GIBSON Because we had so much training in that area, when there were no real systems problems, it was just piece of cake to pull it off.

CARR It was very smooth. We were concerned mostly with getting behind as we came up on burns. And we just didn't allow that to happen. We found ourselves Prior to every burn, just lying there waiting. However we were ahead all the way. The only time we were behind was at ignition. But with each successive burn, we were a little closer.

GIBSON Once we understood what was going to happen when the burn started, we braced ourselves for it. I pushed myself back into the couch before the burn started so there would be no sudden thrust back.

5.0 WORKSHOP ACTIVATION AND CSM POWERDOWN

CARR Command Module/MDA Tunnel Press: I don't recall any problems. No comments on Command Module/MDA Tunnel Press.

Secondary Glycol Evap Dryout:

GIBSON It was straightforward, with no problems.

CARR A note in my activation checklist says, "Try again." So we must have had trouble.

GIBSON Were you doing it, or was that something we did as soon as we docked?

POGUE I started it, and Jerry finished it.

GIBSON I am thinking of something else.

CARR No, this was done that night. Get the launch checklist.

GIBSON We didn't bring one back.

CARR Section 13-5, item 13. We don't recall any problem, but we have a note in our checklist. If there was a problem, it's on the air-to-ground tape, and the date is available. Battery B Charge is the next item.

POGUE That's such a nominal procedure, I don't recall doing it.

CARR I have Battery A Charge checked off in the checklist, with no comment.

POGUE The only anomaly we had was at the end.

CARR Command Module Tunnel Hatch Removal:

GIBSON It was much easier than in training.

CARR It was no problem at all. It was nice to move it around and not strain yourself.

Docking Latch Verification: In my notes, I have number 1 was loose. It didn't feel like it had fully latched and I recocked it, refired it, and it was tight. That was the only one that we had a problem with. The docking angle was plus 0.7 degrees and after I verified the docking latches, we put the hatch back in.

The checklist indicates we put the hatch back in, pressurized it, and did an integrity check. It took 15 minutes to get to 3.5 psi. There were no problems through time to go to sleep. I completed Potable Water Chlorination in the evening with no problems. I was worried about water spills and having water squirting in while I was changing things around, but I had no problem with it.

CARR Section 5 is day 2 or the time after sleep. I'll go back to the Flight Plan. Because of Bill's illness, we swapped jobs. Essentially, Bill stayed in the command module and remained quiet. He dried out the primary and secondary glycol systems in the command module while I worked in the workshop. We worked this way until lunch time; then Bill did his normal work, and I worked in the command module. I had no problems with probe/drogue removal and storage because I had looked at this item a week before launch and all the handles, knobs, and indicators were fresh in my mind. If there were other problems in docking other than those I induced by being too gentle, we didn't see them. We documented to the ground the scratches and dents in the drogue that were possibly there when Pete had his problems. The scratches were put on the drogue before we came, and we didn't add any.

POGUE About 2 months into the mission, I went out there and took about 15 photographs of the drogue at different lighting angles. It should be well documented.

CARR Command Module Suit Circuit Deactivation:

POGUE I did that, and there was no problem.

CARR I did the MDA hatch opening, and everything worked the way it should.

CARR (CONT'D) MDA Lights On: No problems.

CARR MDA/STS Entry: When I threw the MDA hatch open and looked inside, there was no sense of disorientation. I felt at home; I knew where I was; I had been there before; and I was glad to be there.

GIBSON You and I went down there. You went first, and there was no problem. Things were written out so that we went slowly in a holding fashion. I saw no reason why we shouldn't go in, turn the lights on, and get the whole thing operating. This was opposed to the piecemeal holding fashion in which it was set up.

CARR It was surprising to see the fan cooling the rate gyro packages. I don't remember being told that I would see that fan, and I remember being aware of this fan with the straps hanging off of it in different directions to hold it down.

GIBSON It was my understanding that people wanted TV as soon as we entered the MDA, and all we had to do was turn on the input station and get TV on us coming out of the command module into the MDA. It turned out they wanted that much later, and I found that aggravating when we were getting things set up there.

POGUE I remember your saying that.

CARR I remember that, too. We aimed it, fired it up, then the ground said, "No, we don't want that." We turned it off; then we weren't sure when they wanted it. As we found out, it was in the time line considerably later.

GIBSON That's right. It has TV activation in here, so we just covered that.

CARR STS Circuit Breaker Panel Configuration: Panel 202, HIGH POWER ACCESSORY OUTLETS, number 1, was already CLOSE. On the SAL CONTROL number 2 circuit breaker, I have a handwritten star that is probably there because the ground told me to CLOSE that one.

POGUE To achieve this configuration you had to close it.

CARR We might check back into the tapes and find out why there is a handwritten pencil star in my checklist on SAL CONTROL, 2, circuit breaker, page 2-20.

Primary Glycol Evap Dryout: Bill did that.

POGUE I just recorded the times in the checklist.

CARR AID Install: Ed, that was you.

GIBSON I did that. It was no problem at all.

CARR Did you have any problems with it in training?

GIBSON No.

CARR We had trouble with the workshop airlock module. We always had trouble winding up those Calfax.

POGUE That's right. At the end of the fourth EVA, I learned the easiest way to do it. There was no easy way; only a best way.

CARR STS CB Panel Configuration:

I have no notes in the Activation Checklist on that. The whole morning's work in Activation went smoothly, although we got a little behind because we were going slowly.

GIBSON In general, I felt comfortable working in zero g, initially. I enjoyed it, and felt as though I'd been there before. Seeing the motion pictures of other crews working in zero g and thinking about that before we went, made it feel natural.

CARR I moved slowly so I would not tumble any gyros, or join Bill in feeling bad. I felt in control and in no need to rush.

GIBSON I felt the same.

CARR Center Couch Stowage:

POGUE I got it out, and tied it up; you achieved the final configuration.

CARR You pulled the pins in the headrest and had it pushed up out of the way. I put the pins back in the headrest and strapped it down more tightly. Folding the couch was easy in zero-g. You don't have to worry about pinching your fingers or breaking any bones.

CARR CSM/MDA Umbilical Connections:

GIBSON I hooked up the umbilicals, and you did the electrical work.

It was straightforward except that there were two bags in M151 and I had to sort out the umbilicals and caps in it to be sure I was getting the right ones. It was surprising to find the other bag, and it took longer to get everything sorted.

CARR Bed 1 and 2 Bakeout:

POGUE We changed roles here.

GIBSON I don't remember doing that.

POGUE There were no problems; the job required time-dependent sequences, covering a long period. I used the portable timer.

CARR O_2/N_2 Activation:

POGUE Same thing.

CARR Caution and Warning Activation:

POGUE I never felt comfortable with Caution and Warning checks because I got confused by the nomenclature saturation, all the words in the list you're supposed to check. It is a very complex system to check out.

CARR And there was a memory test and a tracking test using the same switches, but the switches were used in a different manner to test memory.

POGUE That is time for delta-Ps.

I never felt that the caution and warning tests were straightforward; I read the checklist word by word. It was an operator, document, system-interface problem.

CARR That covers both the Caution and Warning Activation, as well as SWS Caution and Warning Checkout. Ed and I did the SWS Caution and Warning checkout and there was a lot of yelling back and forth as to who was going to look at what.

CARR We gathered the items and put them in place.

CSM/SWS Basic Comm Configuration: I knew the first day I looked at CSM/SWS comm configuration that we were going to have troubles with it. It was a couple of weeks before we finally ironed out the wrinkles and reached the point where we could change the configuration without completely fouling it up. Most of the time we found that we had misread a checklist or cue

CARR (CONT'D) card, and left a switch either in the wrong position, or threw one when it wasn't supposed to be thrown. The comm configuration was a gigantic kludge. Somebody should design comm configurations that are straightforward and not so interlocking that one switch can foul up a whole system.

GIBSON I tried in training to learn what would be a general, functional flow of information through the comm system and how to understand what you were doing with the switches. Each time I tired, it became a ball of confusion. I finally gave up and said, "The only way you're ever going to do this is to have a switch by switch configuration that you have to follow, and if you ever get out of configuration, you're lost."

POGUE I agree. We need to know the status of comm. We need a status board to tell us what stations are transmitting S-band, VHF, etc., and by station, if possible. We have ways of indicating status of fluid and electrical systems; why couldn't we have a status display of the communication system?

CARR We've talked about the desirability of having an orbital display console. You need a panel that you can go to and find out what is going on.

GIBSON It's important to have display that you put in the format of a flow. The oxygen and nitrogen systems were easy to understand because they always started with the source, flowed through

GIBSON (CONT'D) the toggle valves, and finally out to where the gases were used. You can do the same with electricity and communications. You need some logical sequence that begins with the voice, goes into a processing system, and ends up getting to the ground or to a recorder. You could follow such a system. The people that built the comm thought we were going to analyze switch positions and figure out what was going on; but the system was a kludge.

CARR If you don't have to worry about your comm, then you can handle it easily; then you can give other things the attention they deserve.

GIBSON We're asking for a simple display with a relatively simple structure of the thoughts that lay it out. If the display is not simple, you cannot understand it, and there's a problem somewhere.

POGUE It would have been useful to have one light showing when we were transmitting and a different light showing when the ground was trying to transmit.

CARR AM Single Point Ground Disconnect:

POGUE You have to verify a certain configuration status and then you throw the switch. There was no problem at all.

CARR SWS Comm Act/Check:

GIBSON Before we got the squeal attenuator, life was really hard.

CARR Yes. The attenuator is a big improvement. We still suffered from feedback problems in the SIAs. On several occasions, as I was busy looking for something that was causing the squeal, I was thankful we had a squeal attenuator. I felt sorry for the SL-2 crew because I knew they had it much worse than we did.

AM/Dome Entry: I remember sticking my head through the hole and looking down in the area and not being surprised at what I saw; nor was I disoriented. O_2 Configuration: That is closing off the main REGs, also the demand REG off. There was no problems there. Bill logged 0.2 for the O_2 flow rate at that time.

CARR S190 window protector installation was next.

GIBSON I did that one straightforward, no problems.

CARR OWS CB Switch Configuration:

POGUE That's just going by the pictures.

CARR Were there any anomalies?

POGUE No.

CARR Ergometer Activation:

GIBSON As I recall, it was straightforward, no problems.

CARR Water System Gas Bleed:

POGUE Water system gas bleed, water sample, H_2O system flush, H_2O system bleed, WMCH activation: I didn't like the design. The procedures were well written. Everything was nominal except for the error on me. It was recoverable. All it did was cost me time.

CARR Triangle Shoe Distribution: I was very relieved to get them. I was tired of not being able to anchor myself properly to do anything.

GIBSON I think the triangle shoes are a perfectly adequate way of restraining yourself. The more grid you have available around a work station, the easier it's going to be. My only regret is that even though we had grid, the floor people had managed to bollix up at least 50 percent of the available triangles. I'd say at least that.

CARR I remember being impressed right at the outset with the triangles shoes. I wish we hadn't gone for hightops. I wished we'd gone for low-cuts. I never did lace my shoes to the top. I always laced to about two or three eyelets short of the top and tied the laces around my ankles. I would have much preferred low-cut shoes.

GIBSON I did that, too. I did it to try to allow the calf muscles to get a little more exercise. Rather than have the ankle restrained with the hightops, sort of make them into a low-cut. We get more exercise in the legs. I think it would be an idea for the future. Those hightops, if anything, gave you support that you shouldn't have had.

CARR I'm sure that was the purpose of the hightop, ankle support, so you wouldn't hurt your ankles.

GIBSON Yes. The problem is that you want to work your ankles so you don't lose all that strength. You keep your legs in trim. That's one reason I tied them down a couple of eyelets. We should have had lowcuts instead of the hightops.

POGUE I like the hightops. I have weak ankles to start with. The point you're making is very good. There's no reason why we couldn't have had both. They don't weigh that much. I ended up breaking one of my shoes. It would have been nice to have a backup there.

CARR Yes, we should have had backup shoes.

GIBSON Foot-plates. All we had was a canvas cover. One evening I tried to put the toe-guards on mine. I spent 2-1/2 hours and nearly put the screwdriver through my palm a few times trying to get them on. I thought that was a poor way to go. We

GIBSON (CONT'D) should've had shoes that were right to begin with. Secondly, to change we should not have had to unscrew every little screw. There must have been about 20 screws in each. That was a real waste of in-orbit time.

CARR I have to take a lot of the blame for that one. I was the one who bought off on bringing up new shoe tops. The choice was to bring out new shoe tops or nothing. The option was not open to take up a new set of shoes.

GIBSON From the amount of time and effort it really took inflight, it was a poor trade off.

CARR We were forced into taking shoe tops because of a weight consideration.

CARR IMSS Miscellaneous Medical Supply Transfer: That was very badly handled both by me as well as by the people on the ground. We should never have got ourselves into a situation where I had to open up those cans and start miscellaneous medical supply transfer on activation day. That was absolutely ridiculous. That should have been done many days later. It shouldn't have even been attempted in activation. We should have transferred only that which we felt would be possibly needed early. All of that foolishness of working with tubes of lidocaine and epinephrine was a gross waste of time in activation. We never

CARR (CONT'D) should have fooled with it. As a result I don't think the medics ever knew where all their stuff was. I quite frankly am not sure I could have told them where all their stuff was. The auxillary medical kit - penicillin injectables, Thorazine suppositories, syringes, needles, all that folderol - we should never have done that. About 20 minutes was allowed and I bet it took me an hour and 15.

GIBSON You were fiddling around with that stuff. You had many small items flying around in zero g, plus the checklist, plus trying to figure out what was going on. That was just a poor thing to be doing.

GIBSON Wardroom Disinfecting: First of all, a general impression. I was really impressed with the overall cleanliness of the vehicle. Almost everything was polished clean. It looked as though it had hardly been used. So I think the SL-3 guys just did a tremendous job of cleaning up and keeping it clean.

CARR The SL-3 crew came back with dish pan hands. They did a super job of cleaning.

GIBSON Disinfecting - no real problem; just took a lot of biocides.

CARR PGA Transfer/Drying: No problem. It went perfectly normal. Wardroom Water System Activation:

POGUE In order not to leave the impression that I thought that that water system was the greatest thing since peanut butter, I was addressing my flattering remarks to the procedures people who worked on the water activation procedure, I think the water system itself had a lot of things about it that were undesirable. One thing, which was not peculiar to the water system, is hiding panels. It seemed to be a favorite game of the designers. There were two panels which were hidden. One in the waste management compartment, 851 or something like that, was down inside another panel. You had to open a door which was inside another panel. The same thing was true in the wardroom water dump. There's a panel number hidden underneath the pedestal. The food preparation table also had a highly undesirable panel number feature to incorporate in it. The panel number is not visible. Also, all those hoses and so forth that we were threshing around in the forward comparment did not seem to have straps and snaps designed for them. They had enormous flexibility, but it was confusing to work with them.

CARR WMC/Sleep Compartment Disinfecting: It was clean. I went ahead and did it because I figured there could be something growing there that we couldn't see. Again, everything was just super clean. We went ahead and did all of these things because we felt they had to be done, but we didn't feel that they were quite as critical as we might have believed earlier.

CARR Experiment Compartment/AM/MDA Disinfecting: Same.

GIBSON Command Module Urine/LiOH Fecal Bag Transfer: No problem.

POGUE 100 Parts Per Million (PPM) Flush. A nominal procedure. You have to very, very, carefully follow the procedure.

GIBSON Urine/Fecal Collector Activation: The only problem I had was knowing whether I had a separator going as well as the blower. I never really worked with the real system on the ground. There was some confusion in my mind of what noise and what system, also, some of the circuit breakers in the system which were open and all we were supposed to have to do was to throw the switches to get the system running. I had to talk to ground on that to find out where the circuit breakers were. There was just a little procedural problem there in the way the checklist was written as well as in our training. I had never really worked with the total system.

CARR I think our problem was in training. The procedure was straight forward.

GIBSON I don't think the procedure called for closing circuit breakers.

POGUE They used the term switches. I think that's what put you off.

GIBSON I was thinking of the switches on the right side next to the collector and not the circuit breakers which were inside. I never expected I'd have to open the door and throw circuit breakers.

CARR Trash Bag Installation: Routine and straightforward.

GIBSON ATM C&D Coolant Loop Activation: No problem.

GIBSON ATM Console Activation: The problems we had was getting adequate ground coverage so that we could get some of the verification. All went off really quick and ground was always there at the time we needed to get it done. It went real smoothly.

CARR CM Stowage Reconfiguration and Transfer: This particular transfer was not difficult at all. It was stowing EV gloves, moving food packages down. I followed the checklist and did all the stowage as called out. I changed a few stowage locations. I made those changes on my checklist and I called them down to the ground - things like the condiments and things that we put different lockers.

GIBSON UCTA Sampling: I went right through it. I don't recall any real major problems. It was just a long, time-consuming, messy thing to accomplish.

POGUE H_2O Separator Plate Servicing: One major point with the H_2O separator plate servicing. I did the full 9 yards of the procedure - the timer, the waiting so many minutes, and checking that the pressure didn't decay or did decay. I went through the procedure just as I had been trained. It was a complex procedure. It did not even need to be done, I don't think. When I took the plates off, they were already moist. The separator was moist. I think it was already working properly. I spent the better part of a half hour total time. The point here is why can't we verify a system like this instead of actually going through the procedure. It was actually still working from the previous flight. If there was a quick way of verifying this system by some test, by maybe even the incorporation of an additional circuit, it would save an awful lot of time. It would give you a way of verifying this system under troubleshooting procedures.

POGUE Condensate System Activation: No problems.

CARR Fecal Processing: I guess I have the distinction of being the first guy on this crew to use the fecal system and encountered no problems. It worked exactly as advertised and I was pleasantly surprised to see that it worked as well as it did. After hearing all the horror stories from the guys in Gemini and Apollo and all the problem they had, I was very pleasantly surprised to

CARR (CONT'D) find it worked so well. As I remember, Bill went the contingency bags route a bit earlier in the day before we got the fecal system going. I remember him saying that everything that had been said about the Apollo system was true and more so.

POGUE That is from an undesirable standpoint.

CARR Right. The fecal system worked like a clamp the first time. Next is WMC water activation and Bill lumped that in earlier with a bunch of the other comments.

POGUE I just thought of another comment I'd like to make on this. It has to do with nomencloture. I think it was the dump part line or something like that. It was always called out in the procedures and in the momenclautre, but the vehicle was different. I may not be exactly correct but I can't overemplasize the fact that the nomenclature used in the procedures ought to be exactly the same as that in the vehicle.

CARR The vehicle ought to be plainly marked.

POGUE You always had doubt. I always had to draw on that schematic. Whoever put that schematic in there did us a big favor.

POGUE The schematic had the right nomenclature on it, but the vehicle itself did not. Where you saw the vehicle had the right nomenclautre then all the documention was wrong, however you want to use it. There shouldn't be that element of confusion. You always wonder if you're connecting the right QD or not.

CARR Well, it's a time waster, too. When something doesn't have the proper nomenclature on it, you're going to waste time tracing it to make sure you have the right item before you plug something into it.

CARR Wardroom Window Activation:

GIBSON Okay. Entry battery isolation was mine. Everything went according to the checklist without any problems. Mission day 3 urine bag prep. We started using the urine system that day.

GIBSON We were still using the cups up through the second day though, were we not?

CARR Yes. This was the bit of putting boric acid in the bags.

GIBSON Was that boric Bill's job?

POGUE I think Jerry did the first ones.

CARR Yes, I did, and it was no problem. It went exactly as the procedures, but I remember thinking at the time that we were

CARR (CONT'D) going to learn to hate that job. And sure enough, I was right. I know Bill did not relish the times he was assigned it. I was assigned it a couple of times, but I don't think Ed was.

POGUE I finally figured out a good system, but I didn't like to do it.

CARR It was a time user and nobody wants to spend good time up there fooling around inserting boric acid pills in the urine bags.

POGUE That's right. You had about 10 little tablets to push down in there, and a lot of times, they'd bounce right back up through the hole. One point I'd like to make on that is that anytime you're fooling with a urine system, there is always the potential of the O-ring seal coming out without your knowledge. I sweated that out everytime I finished those bags. I always tried to doublecheck them, but I don't think we ought to, as a rule, fool around with the urine system, because you have the potential for a big leak.

CARR Okay. Sleep Compartment Activation: We slept in the sleep compartment that night. Do you have any comments on that?

GIBSON Yes, that whole sleeping bag - the number of blankets, the under blanket, the top blanket, and the cover - that whole thing. Maybe I had not been trained to use it; I think that was part of the problem. To me that whole thing was so complicated, much

GIBSON (CONT'D) more so than it really needed to be. We had arm holes and head holes, straps, snaps, zippers, and flaps that came out the top; to me it was overdesigned. At the end of the mission I wanted to replace mine, but I could not find a top blanket. I finally just took anything I could fit on there and cut if off at the top and hopped in; it worked great. All you really needed was a blanket which would go across you, and three straps. Climbing in and out of that thing mystified me everytime I did it. I asked myself why I was going through all that. I had probably not trained for it; that's probably why it took me so long to find everything. They were not well labelled. Even though the location where they were supposed to be was labelled, there were two or three things inside - like a headrest, a top blanket, a bottom blanket. One other thing which I've forgotten; the individual items were not labelled and I could not recognize them from the outside. So when you took the paper off and unrolled them, to find out what you were looking at you had to roll it all back up if it wasn't right, which it usually was not.

CARR As I remember now, Ed did the whole sleep compartment activation, because I did not. Those guys fixed my bed for me; I think it was because I was busy picking up other items. As far as sleep compartment and the sleeping bag was concerned, I found it to be a pretty nice system. I used the armholes, and found those

CARR (CONT'D) to be nice, but again it could have been simpler. Compared with the night when we slept underneath couches or on couches in between suit bags, that first night's rest in the sleep compartment in our sleeping bags was a very welcome thing as far as I was concerned, and as I remember, I got a good night's sleep the first night.

GIBSON I think the idea of being restrained is a good way to go in order to get a good night's sleep. I just thought the complexity of all the folding material was a little greater than need be. But I guess the problem we had to please everybody and each guy wanted something else incorporated. As a result it looked like it was designed by a committee.

CARR The whole idea was flexibility, meaning, you had to have lots of different flaps and things.

GIBSON What I didn't like was having to struggle through the neckhole every morning, in and out.

CARR I guess I didn't have the feeling that getting in and out of that neckhole was too conducive to an emergency situation. A couple of times we had an alarm go off. As a result, there was a lot of struggling and banging and thumping going on while getting out of that thing. It's too bad we didn't have a system that you could whip out of a lot quicker.

POGUE I took my scissors and cut the neckring hole on my second one. The first one was okay, but they seemed to vary in tightness and size. The one thing I'd like to mention about the sleep compartment itself is that you should be able to adjust the airflow from your sleep position. A couple of times I got airflow noise. I then got out of my bag and checked it, then went back to the bag. I'd get rid of the noise but then there wasn't enough airflow. It would be nice if you could just adjust that from your sleep bag. Other than that, I like the straps very well. I think you have to have those straps in order to give you the semi one-g feel in bed. I kept mine real tight.

GIBSON I might mention that I tried a couple of nights just sleeping out there in the dome, just drifting around without being restrained at all. I found that I was able to doze, but could never really sleep soundly. I would just slowly mash into a wall and slowly come off it and 5 minutes later I'd hit something else and eventually, like everything else, I would end up on the diffuser screen. I found that I could not really get a good night's sleep even after I'd become accustomed to zero g. So I think the straps are a good idea.

POGUE Mol Sieve Activation: There was no problem on this. It was just a matter of timing it - coming back at the right time in order to get the next step. I used my portable timer, and the procedure was just as it was written.

CARR Postsleep with M110.

GIBSON The first time I went through that thing, I went over the amount of time which was allotted, which was more than the nominal time. You had to read each step and do each step one at a time thinking each small item that you were doing. Once you understood what you were doing - I think perhaps if I had gone through this once or twice more in training it would have helped - you could whistle through it maybe in a third to a quarter of the time. Towards the end of the mission, we got through that in much less time than was originally allotted. There is an appreciable learning curve. You can really cut down a fantastic amount of time but the first few times though, it's just painful step by step.

CARR At first, I thought, we didn't do as good a job training as we should have done because we went up there and got into trouble doing a lot of things. But the more I think about it, the more I'm becoming convinced that it doesn't matter how much you train at things. When you get up there and get in a new enviroment, you are not going to do it fast; you're going to do it step-by-step as slowly as if you had never seen it before in your life. We did a lot of mini-siming and it still wasn't enough; I don't know whether or not we could have ever done

CARR (CONT'D) enough mini-siming to completely iron out all the wrinkles we found. You're in a new enviroment; you start from ground zero, all over again as if you'd never seen it before. We just flat went too slow because we were reading every step and verifying that we were doing that step correctly, and we were not willing to trust ourselves to depend on our training.

GIBSON Well, maybe so, but I think that was the way we had to be because every once in a while if you end up assuming something which wasn't so because it was a little bit different than in training or the way you had understood it, you could loose an awful lot of time making some big mistakes. Go slow. Make sure you understand what you're doing. You can't over-emplasize that when you do mini-sim training. You ought to do it without anything left out; for example, M110. We should have drawn each other's blood and processed it exactly the way we would. The way I trained was to have the PI over there and have Owen over there as we went through the checklist, but I never really went through it on my own in the exact type or environment that I would have in flight.

POGUES You should have done it the first thing in the morning when we got over there, just like we did in flight.

GIBSON That's right. Exactly the same as we did in flight.

CARR As far as the actual procedure of drawing blood from one another, I think that we were all reasonably proficient at it. We did it and we were able to draw blood without getting sloppy, and we didn't hurt anybody. I guess the TV that we showed the people on the ground horrified one or two, but for the most part we got the blood out and into the places where it was supposed to be done then put it where it belonged.

GIBSON Using a finger lance was something else. That was towards the end there when we were trying to get a few extra hemoglobin samples. I think perhaps if anything I was a little bit tender on that and I really didn't jab it hard enough, but when we worked on each other, the lance worked pretty well. I tried using it on myself, but there's just no way I could stop the reaction of flinching or pulling away. I just couldn't do that to myself.

CARR Anthropometric Measurements and IR Photos: Let me state right now that we do not deny the value of these measurements and the good that was done by doing them. I talked to Dr Thornton and a few other folks, and everybody was convinced that was a good thing to do. We answered a lot of questions that the flight people couldn't figure out an answer for, but limb measurements, IR photos, blood pressure measurements were the things that

CARR (CONT'D) screwed up our time line more than anything else. And we did not seem to be able to convince the ground that they had to give us more time to do them. We knew whenever that thing came up on the pad in the day's Flight Plan that our day was in trouble. I think the very first time we did the measurements with the jigs, it was probably a 45-minute per man effort. With a little experience we managed to pull it down to 30 to 34 minutes per man, but we were never able to beat that time. It just takes time to measure 4 limbs. The IR photo stuff took a great deal of time, and the one thing we didn't seem to be able to convince anybody or the ground about was that it took time to set this stuff up. It isn't just a quick "take off your clothes and lay down we'll snap a picture of you, baby." You've got to get all the stuff together.

POGUE That's right. If you're over in a trainer and somebody came to you and handed you the camera with flash and filter already configured, he's already done 80 percent of your work for you. That's what was biting us in flight.

CARR Okay, Blood Pressure Measurement: We found no problems in the arms, but we found it was rather difficult to get leg blood pressure. We also found properly locating the cuff and the stethescope in order to be able to get the K sounds rather difficult. I think we felt pretty shaky about the accuracy and validity of the blood pressure values we were giving from the

CARR (CONT'D) first blood pressure measurements that we gave from the leg. It seems to me we made some qualifiying statements when we sent that data down. I remember we were asking the ground if the comparison between arm and let blood pressure looked reasonable, and the ground kept assuring us that it did. We should have done some preflight training, but it was strung on us very late in the game, and we were distracted and had no time to really think about it. You guys galloped in with this blood pressure stufff and the measurements late in the game and we just didn't have time to take an indepth look at it.

GIBSON Let's just put down what those things were. And we're talking about the limb volume measurements, limb blood flow, leg blood pressure, facial photos, stereo photos, IR photos, and sweat samples. Those seven items were put on at the very last minute in terms of the paper work. In most of them we never had any detailed training. On some of them, we only talked with the PI in general about what we were going to do, but we never actually went through it several times in a mini-sim format so that we could understand exactly what had to be done to accomplish it. The net result was that it took 1-1/2 to 2 times longer than the ground anticipated, and we got far behind the power curve. I think those things are a perfect example of why we should never allow things to be put on at the last minute.

GIBSON If something's worthwhile, then people ought to think about it early enought to get it figured out, get it put onboard early and make certain people are well trained and understand the objective. As it was, I'm sure - even though you consider the data useful - we could have done a much better job and given you higher quality data had we actually been trained for it. It not only affected your data, but put us behind the power curve. That in turn affects the whole operation because everybody else's data is affected.

CARR Let me add a rebuttal to all that we've just said. We did get that in fairly early; it just took a long time for it to get through the paper mill. And for crying out loud, we told you guys about this stuff. We told you it was coming. We did it to you in a lot of baseline data such that you could see what it was. We also say that this new stuff hit us at a time in our training when we were the least receptive. We were getting saturated and that's a fact that we much face up to. We have an inertia in our paper work system that we have to do something about, because you have to to able to plow data from the previous mission into the mission that's going on. We have to find some way to shorten the time required to swing in the new stuff.

GIBSON Let's make it clear that on the majority of these seven items which I mentioned neither had we gone through the full procedures, nor had we even seen the cue card from which we were going to work.

POGUE It took a half hour just to read the cue card on IR photos.

CARR The fact of the matter is though, there are rebuttals that will say we lay there and watched you do it to us. But that kind of rebuttal doesn't hold water.

POGUE There are several things about this. First, you hit us early in the mission when we were in an adaption period. Even completely removed from that, some of this stuff could not possibly have been thought out too well in one g, let alone in zero gravity. Now take for instance IR photos. The concept is great; however, the positioning in the workshop in order to take the IR photos was not possible as it was designed on the cue card. You were supposed to move around in zero gravity with these camera and take these photographs from various vantage points. But we changed the procedure. We had the subject move him body and the man with the camera maintain his positon, because this was the easiest way to do it. Another thing, too, is that in putting stuff on late like this and not having prepared work stations for the cameraman we ended up affecting another major system in the spacecraft. I kicked off the pressurization valve

POGUE (CONT'D) to a water tank, inadvertently, of course while I was thrashing around trying to stabilize my body in zero gravity in order to get the proper position for taking an IR photograph of a man anchored down on the grid floor in front of the film vault. We let a set of circumstances build up that led us into a situation where we affected a major system onboard the spacecraft. This confused the ground. They thought we were missing all kinds of checks. I first admitted to an error because I couldn't see how I possibly kicked the valve when it was off. Later I became convined that I kicked the pressurization valve off by watching Jerry work up in that area. He put his foot right back in the same area when he was trying to stabilize himself. The point is when you throw this stuff on late because it looks real good, if you haven't really gone through all this and specifically defined the work station - the location of the photographer and the location of the subject crewman, then you're really laying yourself open.

GIBSON We had problems with the anthropomorphic measurements of the legs because the Activation Checklist called for a different reference than the Biomed Checklist did. We worked one from the ankle and the other from the tibial tuber crest[?] close to the knee. That was a source of confusion, also. That would have been ironed out had we a chance to go through it in training and catch some of those errors.

QUERRY Okay, anything else on blood pressure?

GIBSON No other than to say I think it's worthwhile. I'm glad we did them, but I sure wish they had been gotten in much earlier.

CARR Food Reconfiguration: Ed was scheduled for it, but it seems to me I was the guy that did it.

GIBSON I think you wanted to do it because you wanted to be the guy to get the food systems squared away. I don't recall doing that; I must have traded the job with you.

CARR I remember being uneasy about the food situation, and I'm pretty sure I was the guy that did it. I think this was one thing that probably got me behind personally on day number three. What this involved was moving some food packages in and stowing them for the next couple of days until we could get ready for the next ambient food transfers.

POGUE Let me take my blood pressure before and after talking about the film transfer. Nothing is intended to be directed against any individual; I'm not trying to get anybody in trouble. To be very objective, the bookeeping procedure was probably correct in the way that it was designed. That is, everything was called out in the checklist and dutifully documented. The implementation was atrocious. This was a big time waster. It seemed like

POGUE (CONT'D) I was asked to do the work for the people who designed the transfer. The labeling made it very easy to lose track of things. I did this in the trainer and I want to assume 50 percent of the blame for what I consider the worst single task I had to perform in the flight.

POGUE First I did this in a trainer, saw it was bad, and did not put my foot down. That was a big mistake. But the way the system was designed reflected absolutely no creative or original concepts. It was the most crude, simple, and uninspired design of procedures that I've ever seen. This caused much wasted time and if it had not been for the stowage people labeling these various little bags - what film container and cassettes were contained within - it would have been much much worse. All I can say is everything about it was bad, and it is not the way we want to go. It is definitely a very poor way to handle individual items. I think we actually got every cassette in the right place but it was time consuming, inefficient, and otherwise painful. It was a tramatic experience to conduct this sort of exercise early in the mission. Now the design of the film vault receptacle for this film item did not help simplify the operation. This was very bad not only for just finding the item you wanted, but in managing the multitude of small items. It was so bad that we were extra careful in managing the cassette and the bags and the nomenclature in

order to get them in the right location in the film vault. The film vault itself was poorly designed. Here is a case where a problem area was identified very early by all the crewmen in Skylab who went to the bench review out at McDonnell Douglas at Huntington Beach. We all identified these Teflon containers as being bad. For examples, the 35-millimeter cassettes had labels on them. But when you put the cassette container in the Teflon receptacle, you hid the label of that cassette container. Then you had to remove the thing in order to see if you had the right one.

CARR Or you had to refer to a key.

POGUE Even then you weren't sure. Because if you had a key which listed 822 as containing IR-12, the 822 label was metal foil label which slipped into a slot of a Teflon container. Of course Teflon is slick and these things would disappear mysteriously and then reappear. We tried to get them all put back in. The cassette and Teflon has a peculiar property. When you attempt to insert the cassette holder in the Teflon, it may take anywhere from 5 to 50 pounds of pressure to get the thing inserted, and it may take as much to get it out. Or after exerting 50 pounds to get it in, you may sit there and watch it float freely out of the hole. Those things were so bad I can't believe it. We identified those as problems at McDonnell/Douglas and we identified the labeling system as a problem.

POGUE (CONT'D) That is, the little labels would slip in and out. Everybody sort of looked the other way, thinking the problem would go away. But it didn't, and it hurt us in flight. It looks to me like Teflon is a very bad item to use for stowage containers.

POGUE There is something else I wanted to point out. We had several drawers that I think contained EREP cassette containers. You would put the EREP cassette container in a Teflon receptacle and close the drawer. Then you would open the drawer above it and close the drawer above it and it wouldn't close. The cassette container had floated freely from the container in the drawer below and gone up into the space behind the drawer above. So you would have to open the drawer below and reestablish all the configuration and close them fast enough to prevent the stuff from floating free again. It was a complete mess.

POGUE There are several simple principles that seem to suggest themselves in order to avoid some of the problems we had. First, don't ever use Teflon; second, make sure that the labels are fixed and that you can read the labels on the cassettes from their stowed position.

CARR I would add that we as a group bungled that one. I don't know why in the world we ever talked ourselves into thinking it was perfectly okay to put cameras in a drawer loosely and

CARR (CONT'D) close the drawer, hoping everything would be okay. Drawer G in the film vault was probably one of the most aggravating drawers we had. Everytime you opened that son of a gun you got three or four Nikons floating up, plus photomic heads, filters, E12 adapters and all that sort of stuff. There was no excuse for that. Why we stood by passively and let that go by, I just don't understand. We all know better than to allow stowage in zero G to be unrestrained, but we did it and we certainly did pay the price for it. As Bill said, there were other drawers also where items floated up and jammed. Frankly I'm surprised we didn't damage more film cassettes and expose more film just because we jammed things into drawers. Ed, do you have anything to add on this subject?

GIBSON Yes, I think the labeling that Bill was talking about earlier is a good case in point. Each cassette which came out of a drawer Bill had to label by hand where it came from.

POGUE I had to put the magazine number, like IR-12, on the little piece of gray tape.

GIBSON What we would do is take the gray tape off the film cassette and put it on the camera so we knew what we had in there. And we had to add some extra information to that.

POGUE Where it was to be returned.

GIBSON Yes, you put down what type of film it was, how many exposures, and where it was to be returned.

POGUE It had the ASA and the number of exposures already printed on there in ink. We had to put the cassette identification number and its location. That was left out of the system.

GIBSON Now to me that was a major oversight in the whole bookkeeping and the use of the film. Somehow we did not think that thing out very clearly to begin with.

CARR Sextant P52, option three and a couple of P50's - IMU ATM orientation and the IMU realign, option three - were no problem. The only comment I might add is something everybody knows; scattered light from the vehicle renders the telescope essentially useless during daylight. And if you're lucky and find the star in the sextant, you can see it. But you don't know what star it is. Later on in the mission we began using the sextant and telescope to verify our nu_Z. As long as the nu_Z was good to within about 1.8 degrees or so and if you could find it in the sextant, you were okay. But if you couldn't find it in the sextant there was not much sense in trying to find it in the telescope during daylight. It just had to be done during the night pass.

CARR E-Memory dump, no problem.

CARR The condensate blanket installation was no problem. Frequently during the mission I would look behind that blanket installation and find great blobs of water condensed out on the window - this was window number 5 - and I would towel it off. But I'm not sure what the condensate blanket was supposed to do. I thought it was to prevent condensation on the window and all it did was keep it on the window.

POGUE I never did understand what that was supposed to do either.

CARR Command module evap reconfiguration was no problem. The G&N and SCS power down was no problem. We just had no system problem whatsoever on the command module; it really went quite well.

CARR FDF Transfer and Update: The transfer was easy; the update was painful. I did as much as I could at the time as I remember. The insertion of changed pages and the pen and ink changes I just did whenever I had time over the next couple of days. It's too bad we have to do that to ourselves. I don't know how we could have avoided it because we had lots of changes to get into the documentation. If they don't get done on the ground, they've got to be done in flight. It looks to me like you allocated enough time to do it, but I was getting behind in other areas. When it came to that big block of time for update of the FDF, I'd already used it doing something else. So I

CARR (CONT'D) found myself in a position of having to update the FDF on a catch-as-catch-can basis. I don't think we got trapped using bad data, bad FDF as a result of that.

CARR Weigh food residue. We never weighed a particle of food. We ate it all. And the SMMD in the wardroom, as far as we were concerned, was an on-board spare. When the one in the waste management compartment failed, I wish there had been a simple way we could have transferred that one from the wardroom into the waste management compartment. But we ended up bringing our fecal bags into the wardroom to weight them; our apologies to the micro people for that, but there was no better way to do it.

CARR Plenum bag stowage. Bill, I guess that was yours. We didn't have a plenum bag to stow as I remember.

POGUE No, we waited. It wasn't until about 3 or 4 weeks into the mission I guess, that I took any bags down there. I took two or three bags down, and there was just no problem at all. The system had those little wires strung around there and I just moved around until I found a place to put them and snapped them in. It was super simple.

CARR The plenum bag that we found there only had one or two items in in, and it was sometime before we gathered enough items to fill it to make plenum bag stowage a requirement.

CARR Return water container fill and transfer. Bill, I remember you did that.

POGUE There's no problem on that; just follow the procedure and fill the bags and stick them in the command module. I saw them once more after that over there by L3 and that's the last I ever saw them.

CARR We never used them.

CARR ED Transfer and Prep:

GIBSON Well, now there is a whole host of EDs. We transferred some of the ED experiments down, but we prepped them when we actually used them. There was one problem with ED63, I believe the one with the vials. The word I got before launch was that the sooner as we could get those things looking at light the better. I think before we even got out of the command module I had those three vials out and they were up there looking at the sunlight through the command module window before we had even gone into deactivation phase. I found out from the ground that that is not what they wanted afterwards, that they were worried about sunlight on those vials. There was a little bit of miscommunication there. Those were the words I heard before launch and thought we were really getting ahead of the game ED63.

CARR Essentially ED transfer prep was no problem. We did most of the things as we indicated. Ed apparently over did something and we thought we were really doing a favor there.

CARR M133 Activation and Operation:

GIBSON That was really no real problem. I had gone through that only once previously, but I had gone through it in detail downtown with the PI. I found no problem with that at all, It was straightforward. I found M133 procedures and equipment well put together. And it all worked very smoothly.

CARR Tape Switches: Again their procedures were very straightforward and I had no problems whatsoever; I just went through it as written. We understood what we were doing all the time.

POGUE I had some down in the OWS experiment compartment, one or two on the STS area, and one EREP. It is pretty simple minded.

CARR They had a lot switched that needed to be taped.

POGUE I guess I did that on the ATM, too.

CARR PPO_2 Sensors and CO_2 Filter Replacement Items: They went strictly according to the checklist with no problems. I found on one of the sensors, that what looked like a CO_2 sensor filter, there was an O-ring missing. I put a new O-ring in it from a package that was stowed up there, and that went all right.

CARR (CONT'D) About a week and a half later I found the missing O-ring floating around. It was on one of the screens in the MDA. I remember being very concerned about white cystalline material that I found in the MDA. I didn't know what it was, but I did a very scientific job of describing to ground its salty taste and appearance. And then six weeks later I ran across it again and realized what I had been so concerned about was nothing but salt. Obviously somebody had been eating up in the MDA area and had used the salt dispenser. Apparently the salt landed on the edge of the PPO_2 sensor cartridge up there and just crystallized. So I told the ground that I didn't think it was worth all the preparation we had made for bringing it back. I had wrapped it in tape and stuck it to the end of the O_2 sensor. I suggested that we not bother bringing it back. The ground complied. It was not in our stowage list of items to be brought back.

POGUE Jer, I would like to add one word on the inlet and outlet CO_2 filter replacement. I changed all of them at one time or the other. But I got the feeling that those weren't too well designed, that you could not just simply replace them and figure on them working. Everytime that I changed those I experienced some kind of indication anomaly when I turned the $PPCO_2$ out and in back on.

CARR And you had to reseat them or something.

POGUE Yes, I switched them out once, and then both of them started working. Prior to that I had checked the O ring seal because I heard you make a comment on the RT. I was sort of unimpressed with that set up there. I think we ought to take a look at that. There were some peculiarities associated with that system, and I don't know if that was just the indicator, the mechanic, the hardware installation, or the plumbing tapoff points that happened to be selected for that system. But I think that ought to be looked at.

CARR CO sampling was something that I did. I remember that I took the tube out and looked at it. I noted all of this on the air-to-ground or dump tapes. It looked to me like the CO sampler indication was that we were already comtaminated before I even drew any air though it. The ground noted my comments and said to go ahead and do the sampling anyway; I did so. I don't remember seeing any change in the thing after I drew the air through it.

CARR CSM quiescent panel configuration check, and I did that. I don't remember having any problem with that.

CARR The last item in section 5 is the fire drill. We did not hold a fire drill per se. We were in the process of a Chinese fire drill for the entire activation period of time, and we figured

CARR (CON'D) that just about sufficed. We had two occasions during the mission when a fire sensor went off. We got a good chance to exercise our fire drill procedures then, and I thought they went pretty well. The first one went off while I was doing an out-the-window TV exercise. Bill was down pedalling the bicycle and I think Ed was doing some ATM work. We grabbed our cards and started through it and got as far as realizing it was a false alarm. We located the sensor that was giving the problem, carefully investigated around the area and found no problems. And the second time we did it, I think two of us were already in the experiment compartment when it went off. We immediately located the sensor that was causing the problem and assured ourselves there was no source of ignition anywhere.

POGUE I have one point on the location and scheme of the sensors. You have a sensor that has a field of view toward a particular area in the spacecraft. It has a panel number or some other number associated with it. Then there is a fire sensor control panel itself which has switches and lights on it. This is associated with the eyeball that's actually looking for fire. Both have the same number. I think that's a cardinal sin to have the same number in two different locations in a spacecraft. They were not one panel number and one location number - I'll address that problem later, but they were the same number in different positions in the spacecraft. I don't think that's

POGUE the way to handle the numbering and nomenclature. Also, when I was on the ergometer I was highly fatigued. I was near the end of my protocol when the fire sensor went off. I got off the ergometer and literally, figuratively, and emotionally was in a big sweat, and I immediately saw the light that was illuminated on the panel. I had to look at it and say, oh yes, that's number 618 or whatever it is. Now I've got to go find 618, the one that's looking for fire. The numbers are about a 1/2 inch high, and at that time I was physically fatigued and sort of half panicky looking for that number.

POGUE We ought to very seriously look at that. That's not the way to handle fire-sensing problems. I made a mistake. I thought it was looking at the trash airlock. Jerry came down and say's, "No, the little lens is over here on the other side." Sure enough I was 90 degrees out. So there ought to be a great big arrow pointing toward the area this thing is looking at if we are going to have that kind of system. There ought to be some foolproof method of immediately finding the sensor associated with the alarm. At that time I was not prepared to handle that kind of emergency because of the situation I was in. The setup and the design of the setup did not help me.

6.0 TYPICAL ON-ORBIT DAY

CARR We'd do well to break typical on-orbit day into two typical on-orbit days; one being early in the mission, and one being late in the mission because they were two different kinds of days. We'll talk about the typical on-orbit day between day 1 and day 25.

Postsleep Activities: The thing about postsleep activities that bothered me the most was that it looked like we had a lot of PSA time, but I found it difficult to finish much of anything. We'd get up and Ed would start doing his dosimeter sampling and getting the numbers ready to record. Bill would run up to the MDA and get our teleprinter messages, and, at the same time, I would go into the wardroom and record the water-gun readings. During this period, we would urinate whenever the WMC was available. Once this first phase of the PSA was completed, the next phase was getting the urine sampled and getting breakfast started.

We all did our BMMD work, usually serially. Usually, Bill was in first, I was in second, and Ed was in third. It depended on who finished their first chore first and was ready to get in the BMMD. We started with two men there; one man sitting in the BMMD throwing the levers, and the other one recording the numbers. That seemed convenient.

CARR (CONT'D) After the BMMD, we did the urine sampling and breakfast preparation. I usually went to the head and started my urine sample. I was the one who took out the proper urine sampling bags and set things up. I would put the three bags under a spring on the top of the locker and take out three sample bags of the proper size. I would tape them to the locker above the SMMD. This is the top locker to the left of the waste management fecal system. The sampling was done somewhat serially. This was during postsleep; then we would have breakfast. The trouble was sometimes one of us had to do a S009 reset during that period. Usually, somebody had an S233 to do, which is the photography of the comet. Somebody had something to do at the ATM.

POGUE We had the ground asking questions about systems and giving us updates to the pad they'd been teleprinting all night. We usually had a few minutes. I had a list of 16 time consuming items, that differ from a normal "get up and get ready to go to work" sequence.

CARR Bill had a film-thread pad that he had to work on at that time. The postsleep activity period was not relaxed. We could not gather up our marbles and get ourselves ready for the day's work. And we found it to be not the way to start the day. This is one of the things that changed on a typical on-orbit day after day 28.

GIBSON During those first 2 or 3 weeks it was disorganized. It was a terrible way to wake up. We found out later that there was an easier way to get the job done and remain in a calm state of mind.

CARR That isn't the way I start a day's work on the ground, and that's not the way you should start a day's work up there.

POGUE Postsleep: The film-thread pad was a source of confusion and frustration because we had so much film breakage. We occasionally had down loading of a Nikon film magazine and uploading of other film. The film thread could take 1/2 hour. We had approximately 1 hour of postsleep activity. It took 1/2 hour to fix and eat breakfast and 1/2 hour to do some of the activities with the film thread, without consideration of the other items that I'm going to mention.

I had to get the pads out of the teleprinter, bring them down, and put them in a location where the CDR could see them. Each one of us had to look at those pads, cut them, divide them among the crew members to whom they had been addressed, put them in our little folder, and associate them with our summary flight plans that we had received usually the night before. We were not given any time to do that. That was supposed to be absorbed while we were doing something else apparently. Jer had to read the general messages and the permanent general messages

POGUE (CONT'D) and make sure that we were aware of those that applied to any part of that day's work. That is a management function that was not allowed for in postsleep activities.

Then we had urine sampling and drawer resupply. These are simple, straightforward tasks but they are time consuming. Toward the end, we were doing them within 10 minutes, but at the first, it was taking me approximately 20. We had to be careful to take your whole urine drawer out. We had the receptacle for the bag that we had to put in a position to measure the quantity. Then we had to sample it, get a new drawer and a new bag out, and suck it down to vacuum to make sure it didn't have air in it. Then we had to put it back in and reinsert it in the drawer. Then we were through. In the process, we almost always spilled a few drops of urine. What looks like a simple, one-line entry turns into a great complexity in total time management.

The BMMD required getting use to, and it took a little time.

The S233 could square wave the postsleep activity. The experiment only took 7 or 8 minutes, but we had to make sure we had a camera, took our pad, and got there in time to get dark adapted. We also had a remote device. If we didn't have time to get dressed then we wouldn't have the pencils in our pockets. All this added up to confusion if we were not thinking

POGUE (CONT'D) 1/2 hour ahead. We possibly had not eaten at this time nor changed the urine drawer and we were already thinking about comet photographs.

We had to urinate before we did the BMMD. So, there are many serial tasks that made it not dovetail together. Later on in the mission, this started to fit in quite well. The 233, a comet photograph, could take 12 to 15 minutes. We had to make sure that the camera had the right type of film in it. There should have been one camera didicated to S233 only and there was after some time. We did have occasions when the camera was downloaded, and there was confusions about it that did require attention. Most of the time, everything was all right but we still had to check it.

The early ATM work caused Ed problems. It usually did not affect us but we made sure that we worked around him the right way. The pad organization means getting the pads straight. We had to make sure we had the summary flight plan sent in the evening and all the supporting documentation sent the following morning. If we did that experiment twice, we had to make sure that we had them in the right order. Sometimes they were addressed to the wrong crewman. If I had a certain type of experiment, I may have had the maneuver pad for somebody else who was going to do the maneuver. This was not a simple, straightforward

POGUE (CONT'D) management operation; it required attention and interpretation. And all this time we're supposed to be weighing ourselves, getting breakfast, talking to the ground and answering the questions, throwing valves and switches for them, going to the ATM console and back down, getting another drink of orange juice, talking to the ground again, and this was supposed to be a nice, relaxed postsleep activity. It turned out to be a chaotic operation some days.

In between all of this we were supposed to be reconstituting our food. Updates and corrections of pads started at breakfast time and continued through the day. We were also supposed to shave, comb hair, brush teeth, and do whatever else was listed on a standard format. We did this very rapidly.

GIBSON We just skipped it.

POGUE We didn't do it, that's right. We did get cameras in position at the wardroom window.

Normally the first thing I do when I get up is I shower, shave, dress and then I go about my activities. We had to weigh in the BMMD in a standard configuration every day, unclothed. We did our first activities without shoes so we did have to wait until that was all done before we could get dressed. If I had to fit my film threading pad in with that, I ended up doing the film threading pad without my triangle shoes on, trying to save

POGUE (CONT'D) time so that I could fit myself in with the postsleep activity of the SPT and the CDR. That was difficult because I was barefooted doing the film threading pad. And, of course, 1 out of 3 days I'd have a loading problem with one of the transporters, and this would be time consuming. I will admit that after we organized, the film threading pad turned out to be much simpler. We were doing it in the evening.

I want to point out that what would appear to be a superficial type of complaint is not really that. I listed approximately 13 things that we were doing during that hour devoted to PSA in the morning.

CARR Okay, let's move on to experiments. Ed, talk about a typical day with the ATM.

GIBSON We're still talking about the first 28 days. Usually, I would be the first one there in the morning. I would try to get the pads organized and the numbers copied onto the cue cards, although that was not always the case. Sometimes Jer or Bill did it.

The first pass of day was usually devoted to a JOP 6, building block 1, and that was usually pretty straightforward. If you find yourself rushed from the PSA, you can get behind and start making mistakes. Again we are talking about the first 28 days. There were many mistakes made on the ATM in those first 28 days.

GIBSON (CONT'D) It wasn't that we didn't have good training on the ATM or didn't understand it. It was the frame of mind and the physical condition under which we were working the ATM. I think every one of us made mistakes. It really saddened us. At times I would just go out of my head after making one of these relatively simple errors; ones we all knew about. For example, letting a GRATING on a 65 go by or taking a picture of S082 with the wrong roll. Things that were well understood but were botched up because of the mental state we were in. Later on, the mistakes were way down when we were able to get ourselves better organized.

I was impressed, initially, by the quality of the display. I wanted to spend more time with it just to see what we could do with the display we had available. In training, we didn't have good simulation of the display. Eventually, we all got more time on the ATM.

CARR We were getting 4 to 6 day's passes.

POGUE One day, I got three. That was my big day in the mission.

GIBSON In general, the first days we decided to work into observing time relatively slowly and get used to what time we had available and the best way to utilize it.

CARR We were all making ATM bungles, which were a lot of the same mistakes we'd made on the trainer. We did things like starting the maneuver on the Sun, with the white light coronagraph door still opened and closing the white light coronagraph door with the WLC power still on - all those kind of dumb things.

CARR M092/93: We needed a lot more time in the beginning; later we improved. In the first 28-day period, the M092 took us on the average of an hour and 20 minutes to an hour and 40 minutes. The M093 was fairly straightforward and took about 30 minutes to do. Setting up the M171 metabolic analyzer was a very slow and pains-taking process. The learning curve was rather slow for all of us.

GIBSON That took a long time. Later in the flight there were still some things that I was becoming aware of in the metabolic analyzer. We were trying to follow the checklist by rote. Had we learned or understood that machine a little bit better, the M171 operations would have been a lot easier.

CARR I don't think we can point the finger at the instructors for that. I think they tried to teach us the operation, but we had so much training going on that we were forced into a situation of learning by rote.

POGUE The instruction was not supported by good nomenclature on the machine. That was very poor. That panel is one of the most inconvenient that I have ever worked as far as reaching for the right area of the panel to read the control called out. I really didn't know what I was doing. I certainly do not want to point a finger at the instructor. He did a fine job. He was always qualified to answer questions and was very careful not to give us the wrong information or to confuse us.

CARR I think the simplified dummy drawing that you had them make for us on the metabolic analyzer was good. They should have configured the instrument panel of the MA around that drawing and each switch would have been just like the panel.

POGUE Through the end of the mission, I didn't understand the nomenclature as it appeared on the cue cards. I generally understood what I was doing, but it never did become natural.

GIBSON We never really understood the flow of the gases and how the mass spec fed into the whole operation. Had a flow diagram been incorporated into the flow panel, we would have understood.

POGUE All you had to do was make one mistake and you lost about 20 or 30 minutes. I had to go back twice and regroup. I don't know whether I was at fault or if the panel was out of configuration. It was a very unnatural thing to do.

CARR That's a prime example of human engineering. The solar panel should have been engineered so the operator would know what he's doing while he's doing it, instead of just throwing switches in accordance with the checklist.

POGUE The operator should know what he is doing, more or less, by the natural layout of the panel.

CARR Let me add one other hooker that was thrown into M092/93 that caused us no end of fits, our friendly facial photos. On several occasions, one of us, whoever had the facial photos, would forget to take the photo. Usually there was no problem remembering to take the photo at zero delta-P, but the one to be taken at 50 delta-P, 50 millimeters of mercury, was very easily forgotten. The observer was busy observing the subject. He was watching the blood pressure. Every cycle he was checking the pulse pressure and looking at the heart rate. It was awfully easy to completely forget to take the facial photos at 50. We understood that it was important. In fact, I even came down on tape one day and asked if you were really sure you wanted to do this because taking the photo distracted the observer. We got an answer back from you folks on the med status pad saying that it was very important that we do it and so we bought it. It was a hooker that caused us problems and it wasn't just the first 28 days. This particular problem continued throughout the mission.

CARR M487: We spent little periods of time throughout the mission doing M487's; we were usually allowed 15 to 20 minutes. Most of the time we took from 30 to 40 minutes. I feel that we did the M487 investigators a good job. I think we really worked hard to give them the data.

POGUE On M487, we gave you a lot of extra data on taking velometer, temperature, sound level, and other readings. Any contribution to M487 was to criticize the stowage drawer. They gave us a little trouble in flight. I found it difficult to pull out some of this stuff. The one thing that I was really bent out of shape about, even before the flight, was the ability to get temperature sensor readouts against compound surfaces. An example is the little cigarette-package-sized thermometer. In fact, to use that thing to measure the temperature of S020, we had to use thermal goop. It caused a messy problem in the MDA. The point is, we anticipated that problem way ahead of time. When we were first looking at different metal-type surfaces, we wanted something like a piece of gum to use as an adhesive. We never got it; it was shot down. Obviously that problem was anticipated before flight, and it turned out to be the one item that caused trouble in flight. Ed worked around it by using that thermal grease, and we did get our temperature readings. However, it is also a contamination problem. I

POGUE (CONT'D) think that is one thing that should be looked at. I thought that the attention given M487 was about right. We tried to use off-the-shelf stuff.

GIBSON M133: No real problem was caused by the M133. It was a lot easier to wear the sleep cap in zero-g than in one-g. The ground expressed great concern about whether or not I was getting enough sleep while wearing the M133. This surprised me. It seems as though the rest of the day, the ground did their darnest to make sure that we did not have real comfortable presleep and postsleep periods. I found the M133 to be exceptionally easy to work. It was like getting a job as a mattress tester; it all took place while you were sleeping. There was no problem with it. I could not understand the concern expressed by the ground over and over again about the number of times I was doing M133. It just seemed exceptionally easy. I was happy to do it, and it was giving the investigators good data. We found a way of using the same cap over and over again. I put it in the shower so it would not dry out or grow bugs. By using a syringe, I put some more electrolyte in it each time I used it. Other than cleaning the electrolyte out of my hair in the morning which always proved to be about 5-minute troublesome job, I consider the investment we put into M133 worthwhile.

CARR I personally think all the attention we were getting about M133 could be attributed to the fact that someone appeared to be getting more than his share of film and that was bothering other people more than the time spent on the experiment.

M553: I guess they mean 518, the crystal growth experiment. The 550 series of experiments is actually a whole group of experiments, but it's the 518 multipurpose furnace application that we're discussing. That was a low impact system. We spent 15 minutes setting it up and left. The ground kept an eye on things for us and reminded us to do this and that and adjust the bulkhead's vent in the way they wanted them. That was certainly a low-impack set of experiments. It's too bad we had a weight allowance so we could have brought all of those things up and looked at them. I suspect that was pretty productive as far as results were concerned and it sure didn't cause us any work once we got the system activated.

POGUE I'd like some feedback on that one sample that was dinged. It had a dent in it, and I would like to know how it turned out. That kind of thing would be useful on Shuttle. There is very little tension once it is cooked up and started.

CARR S073: The SAL experiments were badly scheduled. I put the AMS in, put something on it, put something else in, and then put it back in. That seems terribly unproductive. It was so much more productive to put something in and leave it in there, getting as much data as possible before taking it out again. We were in that kind of mode at the end of the mission. From the training point it takes something like S063. The first pass or two was training, but from there on we made good time with it. That was the way we operated toward the end, and that is the way we should have operated from the very beginning. It is more efficient to just put an experiment in the airlock and press on. That way we get as much data as possible and your proficency is high in terms of logistics and crew training.

CARR TV Tour: We didn't have a TV tour.

GIBSON T003 was no problem. I fit it into the postsleep drill very well, and the only presleep problem I had with it was remembering to do it. Usually in the presleep I was involved in things which never had a presleep protocol. I might as well mention that the latch which was used to hood it up to the bottom of the container box became jammed. There was no way to get it off, so I put a screwdriver between the box and the container and pried it off. I stripped three threads on some of the screws

GIBSON (CONT'D) which held the latch; I then taped the threads. This happened very close to the end of the mission. There were no other problems with the operations; was fairly simple.

CARR I had one question about T003. I couldn't understand the data collection for sensor number 7, before and after taking your clothes off for a shower. We tried to get sensor 7 data, but we did not get it as often as requested. It was something that was very easy to forget. We also had the same trouble remembering to take it into the head with us during a fecal transfer. We did get meal data. It was not clear to us whether you preferred T003 meal data with all three of us eating at once, or whether it was good data with just one of us. Was that fact unimportant?

GIBSON The problem was a conflict with the time line. T003 meal data would be assigned on a day when we would not be eating together because of the constraint on the time line.

POGUE Another point to be made about T003 deals with the preferred orientation of the instrument in a specified location of the spacecraft. The hole was to face in a specific direction. The decal on the back of that case should have included a sketch of the workshop with arrows drawn in the various locations. A sketch would help determine exactly how the case should have been held at that specific location. Also, there should have been a big arrow on the case of the instrument itself.

CARR M151: It seemed as though whenever M151 was assigned to an experiment, no extra time was allowed to set up the lens, film, camera, and cables. You must realize that by the end of the mission, we were down to three operating cameras, consequently, a camera was not always readily available. At the beginning M151 took a lot of time because of the jams and hangups we had. We facetiously suggested getting some 151 of 151. I think it would have been interesting to look at the time and motion involved in the M151 experiment itself and see just how long it took us to gather up all of the equipment and put it together. We didn't mind doing it, but in the beginning we were short-changed on time.

GIBSON There was a problem when I was trying to do an ETC prep; something was always breaking. On the fourth try I finally got a successful ETC prep on 151. But I really appreciated Rudy's presence at our training sessions. He made sure we understood what was to be done.

CARR There was no doubt in my mind about what was desired on M151 in any particular case.

CARR Food Preps: We did not prepare the food as it was anticipated we would. It was too inconvenient. At the end of each meal,

CARR (CONT'D) we were expected to prep the following one. We just never got around to doing that. We took each one as it came, and if the food didn't rehydrate well, we ate it anyway.

GIBSON During the first 28 days, we did not have time for a long preparation.

CARR Some of the containers precluded an advance prep. Some of the extra food we brought up would not fit into a heat port, so we could not rehydrate it early.

GIBSON The only item I did ahead of time was the strawberries. I reconstituted them with hot water, let them set out for a couple of hours, and then tossed them into the chiller for a for a couple of hours. At the end of the day I would put them on some ice cream. That was my reward for the day.

CARR Eat periods: It didn't matter to us whether we all ate together or whether we staggered our eat periods. I agree with Al Bean that it is important to try to eat about the same time of day every day. Shifting the eat periods around to accommodate the schedule is a bad idea. The flight planners did a fairly good job of keeping our eat periods pretty well stabilized.

GIBSON Going too long without eating lowers the blood sugar; for that reason the eat periods should be stabilized. It seemed to make a large difference to us. If we went 5 or 6 hours without eating, we became terribly inefficient.

CARR Presleep Activities: During the first 28 days, the presleep period was very busy. We worked until we went to bed in an attempt to catch up on things that had fallen behind. As a result, we were so keyed up that it was difficult to go to sleep.

GIBSON We had several 18-hour work days at the beginning. We were up and working for 18 hours and did not have time to wind down before it was time to go to sleep. As a result, we got only 4 or 5 hours of good sleep. That began to add up after a while.

CARR Ed was probably most affected, but Bill and I were not unaffected by this sleep situation. We both had periods of time when we suffered from insomnia. We would have problems trying to get to sleep, or something would wake us up after we got to sleep and we would spend 2 hours trying to get back to sleep; or we would wake up early and not be able to go back to sleep. There did not seem to be any particular pattern to our sleep problem, but for Ed, things got worse and worse until

CARR (CONT'D) finally, he had to have time to catch up on his sleep. Bill and I seemed to suffer from random periods of insomnia. It would last a couple of days and then we would get back on the track again.

GIBSON I would get an adequate amount of sleep and feel great. Then slowly the days would get longer until, toward the end of the fifth day or so, I would be completely beat and have to take some time off to get 9 or 10 hours of sleep.

CARR I'm glad we did not allow anybody to cut down the 8-hour sleep period, just because Bean and his guys said they could get along with 6. Reducing the sleep period would have been a terrible mistake.

Evening Status Report: During the first 28 days I spent a lot of time compiling the evening status report, reading a lot of words and writing down a lot of numbers. I finally began abbreviating. I'm not sure that all that data was valuable to the ground. Again, there was a little bit of training curve involved in that. The ground managed to catch up a few times. In the first part of the mission the ground occassionally caught us when we did not have it ready. We were too busy. Then as the mission progressed, we were better organized. We managed

CARR (CONT'D) to get our evening status data down and we were ready to go at the proper time. As I understand it, each SL-3 crewmen was responsible for entering his own data. The only thing the CDR was to do was read it. We found that it was just as easy for the CDR to ask for the data and write it down. It keeps the CDR informed of how the other guys are doing, if he doesn't already know.

CARR Back to Postsleep Activities for days subsequent to day 28 and how they changed: There was a great change in the postsleep activities after that time. First let me reiterate one fact: We were living up there, we were not up there trying to see how much we could do in how little time. We needed time to get up to speed in the morning, and time to enjoy breakfast, and time to think a little bit before you get started on the day's activities. And at the end of the day, we needed time to be alone, to unwind and compose ourselves for sleep. It doesn't matter whether a man is up in space or on the ground; nobody works a man 16 to 18 hours a day every day of the week. We should not have allowed that sort of thing to get started. In postsleep activities, we deleted all the unnecessary things and tried to stick strickly to urine sampling and breakfast. We cut the postsleep activities to an hour. We needed an hour to weigh ourselves, sample our urine, and eat our breakfast.

CARR (CONT'D) That turned out to be just the right amount of time. Sometimes we were a little late getting started, and sometimes we were ready to start on time.

GIBSON Once I knew we were not going to be chasing something for the ground, I could get up and get everything done. I could read the PRDs, do T003, and weigh myself in 15 minutes, even though I was half asleep doing it. Knowing we had an uninterrupted hour allotted to ourselves was an improvement.

POGUE About that time, the film thread pad became less complicated, although that odd downloading continued to bother me for the entire mission. So we were getting the film thread pad in the evening. Occasionally they waited until morning because of problems in communications, but that helped a lot. Somebody suggested publishing a camera and transporter status, which was a very good idea. It did not come up everyday, but there was usually one left over from a previous day, and that too was a big help. Getting the film thread pad done in the evening simplified my postsleep activities more than any other single change.

CARR After day 28, the conplexion of the mission changed; things were much better after 28. We reduced postsleep activities time from an hour and a half to an hour and cleaned up a lot of the

CARR (CONT'D) postsleep procedures. As a result, we had a reasonable period of time to get up and go to work.

POGUE We got rid of the S009 when we cut down to 1 hour, didn't we? We stopped S009 after awhile, because we finished it.

CARR They moved the S009 sets later into the day, after we howled about it.

Urine Samples: There was no difference after day 28. After we got the change in the scheduling policy, everything eased up; we had breathing room. We had time to get from one experiment to the other, and we got ahead of the time line. We got to the point where we could actually do some shopping list items. Being abreast of the schedule or enough ahead to have some free time boosted our morale.

Having the time to read or do some creative work was certainly a very nice aspect of the latter part of the mission. I must also say that during the last 25 days or so, we began to see that kind of scheduling disappear again. The time line began to pack up, but we were more efficient. We knew our procedures well and could run a tighter schedule, whereas it had been very disturbing to run a schedule that tight in the early part of the mission. I mentioned to the ground that they were beginning to schedule us very tightly. I told them that there was no longer

CARR (CONT'D) time for shopping list items and I warned the ground that if they continued scheduling that way, they would see no more shopping list work done. The ground responded that the shopping list was low priority. They said that the activities they were scheduling were more important to them. As long as we could keep up with their schedule, we did not complain.

GIBSON Before we launched, I had wanted to do a lot of work with the science demonstrations. I thought there were many useful things to be done. As soon as we got up there and found ourselves with 18-hour days, no time to do anything and no time to catch up, science demonstrations had to be one of the first thing cut. So there were no science demonstrations done in the first month. After the schedule changed, we had more time to work on them; but even then because of the length of time that some of them took, more time had to be allotted in order to complete them. Once we started a science demonstration, we usually had to complete it on our own time. We all stayed up many nights working on some of them, but that was after we had been given a little bit of time to relax and try to fit it into our schedule.

ATM operations also changed along with the scheduling. We started trying to get more ATM passes, which meant that we did not have to pack so much into each pass. As a result, we

GIBSON (CONT'D) could get a little more observing time. That was one of the more useful things that we could do. We had a real challenge, and it made the ATM interesting.

M092/M093: We got ahead on that. Once we learned the procedures and had time to think them through, we became a little more streamlined in our operations. That went very quickly. For example, while running the M092, it was possible to keep an eye on the subject and set up the 171 at the same time. We picked up some time there. There were a lot of little short cuts like that, but it took time and a clear head to find them.

CARR I think the improvements we made in the running time on M092/93, were not really the effect of changing the schedule. I think we just moved up on the learning curve. And to a lesser degree, I think we were in a better state of mind. We got to the point where we could do M092 50 minutes or an hour. The 93 could be done in about 25 minutes, and the 171 could be done in about 45 minutes. We had cut the 171 down to about 30 minutes by the end of the mission. We found that we could get a lot of the MA prep done early during the 30- and 40-millimeter delta-Ps on M092. We found that we could really save time on the 92/93. We gave a lot of that time back to the schedulers. Giving time back to the schedulers made us feel good. We did not try to hoard time at all. When we wanted a cushion, we told you we

CARR (CONT'D) were using the time for a cushion. We were fairly honest with you about the spare time we had.

M133, 487, 553: There was no significant change there.

The only change in the SAL experiments that resulted from the new scheduling policy was a change in the corollary experiments. They were scheduled during the day and dropped out of presleep and postsleep. Only activities related to Kohoutek remained in the presleep and postsleep periods. We recognized the fact that observation time on Kohoutek was very limited.

T003 and M151 were unaffected by the change in the scheduling policy. The improvements in 151 were strictly due to our learning curve.

Food prep was unchanged.

Eat periods were essentially unchanged.

GIBSON Well, they were a little less frantic. I enjoyed my eat period after the schedule change. I did not have to eat on the run. During postsleep activities in the first 28 days, I found myself grabbing bacon bits for breakfast and running up to get something else done. After the scheduling change, however, we could sit down and have a meal; and even if it only lasted

GIBSON (CONT'D) 15 minutes or 20 minutes, at least it was some time to sit and relax and think about the day's activities.

CARR The new presleep period was a good idea. We asked the ground to leave us alone after 9 o'clock at night. They gave us an hour for dinner and we worked for about an after dinner, but after 9 o'clock they had to leave us alone. That was a very good idea. We used that time to do science demonstrations or to unwind. I think that was a smart thing to do, and I'm glad we did it. It does not seem to have infringed on the schedule at all. You had some well-defined time periods for work scheduling and a definite cutoff point.

Evening Status Report was unchanged by the new scheduling policy.

The sleep period was also unchanged, the changes in the scheduling policy were most evident in the presleep and the post sleep activities. The pace during the day eased up quite a bit, particularly in the corollary areas.

GIBSON It was actually fun to work there after the first 30 days.

CARR We want to mention housekeeping and the fact that okayed taking it off the schedule and putting it on the shopping list. That was a good idea. I think Bean's method of doing that was a good one. It is too bad we couldn't adopt it earlier. But quite

CARR (CONT'D) frankly, I don't think we could have handled it on that basis early in the mission. We were not sufficiently organized.

GIBSON There was no free time to do either housekeeping or shopping list items.

CARR We had no control over our time, therefore, we could not do our housekeeping whenever time was available. There just was not any time available, so we had to stick to the schedule as far as housekeeping was concerned at the beginning of the mission.

GIBSON Generally speaking, I don't think any of us enjoyed the first 28 days at all. I had the feeling that we could grit our teeth and last for 85 days, but it was not the way anyone would want to fly in space. I didn't think we were learning much about how to work in space during those first 28 days. After that, things loosened up a little bit and we began to learn a little bit about the techniques of living and working in space. The days became much more enjoyable, and we felt more productive.

CARR The Earth observations targets which the ground called to our attention during the first 50 days were, for the most part, optional sites, and were sent up in the details pad. We were quite satisfied with that. Apparently, the ground did not like that very much. Later in the mission we were getting a

CARR (CONT'D) separate handheld photography pad. It did not make much difference to us, but we were glad to get that information. We felt bad that we were unable to look at more of those sites. There were many good opportunities for us there, but we did not have time to take advantage of it. For the most part, anytime we were near a window, we tried to take some pictures. The big Earth slider map we had was a big help to us. It helped us keep track of where we were in regard to the Earth throughout the day, and we could keep track of what was coming up.

POGUE The times of each day's ascending nodes could have been added to the new Earth observations pad. It would have been very helpful, and you had everything arranged chronologically anyway. It was difficult to keep track of the longitudes of ascending nodes which were several hours apart. Mental arithmetic was not accurate enough. It would have been nice to have a few more times on the pad. The visual observations pad would have been the natural place to put it.

GIBSON That's right. That would have been a good idea. I had a problem fitting the pieces of paper into my book log so that I could use them. The ascending nodes always had to be put in a very awkward space.

GIBSON I always had to tear them off separately and put them where I could see them, or pull out all the paperwork every time I

GIBSON (CONT'D) wanted to see them. If it had been in the visual ops pad, it would have been very convenient.

POGUE One one of our days off, when Jer and I did so much visual ops, I added several times and slipped them under the slider map. It was very helpful that day.

CARR We worked visual observations into our typical on-orbit day whenever we could find the time. We all thought that those observations were among the most enjoyable times we spent in flight. Ed spent a lot of enjoyable time at the ATM; Bill and I spent a lot of enjoyable time on EREP. But on a day-to-day basis, the time we spent taking the photographs and debriefing for Earth observations was the most enjoyable.

7.0 ANOMALIES AND UNUSUAL ACTIVITIES

CARR The first significant anomaly that occurred was the loss of CMG 1. We didn't even know it happened. We found out the next morning that it had happened. There were no alarms. It's a pretty significant anomaly, and we have no complaint as to how it was handled. It certainly did change the complexion of the mission as far as maneuvers were concerned. I think it's a real tribute to the team on the ground - the fact that after about a week and a half of working with the ATMDC software, they were able to get us into a mode where we could do just about everything we had originally planned to do, using two CMGs. We got to the point later on, more than halfway into the mission, where any kind of maneuvering was strictly routine.

POGUE There was the false fire alarm, the day I was on the ergometer. We had the fire-sensor trigger in the aft airlock module, which was a known anomaly, during the EVAs; that was no big deal. We had the AMS drum problem, the S019 and S183 problems. All of these anomalies are thoroughly documented in the air-to-ground tapes.

CARR Let's discuss the six-cycle tone, the beep that we noticed when we first got up there. At that time, it was very low key and didn't bother us. It sounded somewhat like a vacuum pump in a

CARR (CONT'D) laboratory; it was about that noise level. About one-third of the way into the mission, it disappeared, and we never heard it again until the last quarter of the mission. Then it came back loud and clear and was a definite bother to us; furthermore, it degraded our dump tape capability. The ground and we did a lot of work on that, trying to get rid of it, but we finally had to give up on it. Subsequently, it faded back down into the background again and was a very low, quite acceptable level - as at the beginning of the mission - for the remainder of the time.

CARR For no apparent reason, we suddenly found it difficult to dump full urine bags out the trash airlock. I don't recall what day we finally ran into the change, but for some time there, we could put three, four, or five full urine bags into a urine disposal bag, seal it, put it down the trash airlock, and it would very neatly and cleanly swish right out when we pulled the handle on the extension mechanism. Then one day I opened the lower door of the trash airlock and pulled on the extension mechanism, and I ran into a brick wall. Nothing happened. I didn't force it. I just closed the door again. We repressurized the TAL and took a look at the bag. It was apparent that the bag had swelled up, because when we opened the top of the trash airlock, the bag was all sucked in; this indicated that

CARR (CONT'D) it had been blown out and that when we increased the pressure on the outside of it, it sucked in. I have no idea why that happened. We fiddled around with that for some time and then started taking out bags. We reduced to three bags for trash, per urine disposal bag, and it still wouldn't dump. We got down to two bags, and it would dump once in a while but not every time.

We made the sad mistake of opening the valves on a couple of the bags and then putting them in the urine disposal bag. We depressurized the TAL, dumped, opened the TAL, and found a sloppy, evil-smelling mess of yellow ice all over the trash airlock. Ed and I spent about 40 minutes holding our noses while we cleaned up that mess, and the trash airlock smelled bad from that day on. We biocide cleaned it about three times. I did it twice, and Ed and I did it together the first night. We never did eliminate the smell completely; it was still there when we left.

We ended up dumping the full urine bags through the urine dump system and dumping the bagged-up empty bags through the trash airlock. The latter did not work for more than about three empty bags per urine disposal bag. We found that the best way to dump even empty urine bags was to roll them up and put a

CARR (CONT'D) piece of tape around them; then you could put a half dozen of them in a urine disposal bag, and they would blow out of the trash airlock without any problem.

The trash bags, because of their size limitations, were very easy to use. I never once felt a trash bag hang up on the walls of the trash airlock. They just were not inclined to swell. We also used the trash bags to dispose of the food-over cans that contained the garbage and the wet trash. It was a bother, as well as a real task of fitting, to try to insert a large can with a herringbone around it into a trash bag, but it was really the only good way to dispose of it. We never felt that we had enough urine disposal bags such that we could use them as containers for dumping food-over cans.

The trash airlock functioned normally, and I don't have the slightest idea as to why the urine disposal bags suddenly would not go through it when they were filled with full urine bags.

POGUE About 2-1/2 weeks before the end of the flight, a certain development was observed on all the urine separators. First, I noticed that there was a peculiar odor when I opened my urine drawer. Then I noticed yellowish-white, crusty crystals forming at the junction between the two halves of the separator, at the

POGUE (CONT'D) seam where the two pieces of metal were joined. I cleaned it all off, and it re-formed. This is documented by 35-millimeter, closeout photography. All three of them developed this, apparently toward the end of the flight, and it appeared to be the result of a very slow time-constant thing that was very progressive over the entire mission. We must be using the wrong kind of gasket or the wrong kind of seal, because that stuff was working its way through.

CARR Either that, or we just were using those separators beyond their normal useful life. It appeared that the acids in the urine were just finally working their way through the gasket and the crystals were forming on the outside.

A problem that will be described in detail later involved the burn through of the vidicon in the white light coronagraph early in the mission and then again later in the mission.

POGUE Wardroom window icing was the same problem as that experienced by the second-mission crew. Jerry became proficient at hooking up that hose and getting rid of the ice, but we got a water mark. At the right Sun angle, at the right light angle, you could see the water mark or stain. I was always afraid that those marks on the windows would degrade our photographs. I

POGUE (CONT'D) was very pleasantly surprised when I saw those photographs of the undocking. Even the picture of that filthy window 4 turned out reasonably good.

I would consider the DAC/transporter problem as a major mission anomaly. The efficacy of those pieces of equipment in taking documentary photos on space flights is totally unsatisfactory. We had such problems as film breakage and end-of-film light that didn't come on when they were supposed to or did come on when they weren't supposed to. I blamed myself for a couple of anomalies that I now know were the fault of the transporter/DAC combination. Three times that transporter shoved film back into the supply reel. We'd do well to consider an alternative to the DAC and transport combinations.

I think the SMMD curtain in the head failed because the fecal bags were too large for the SMMD. That rubberized curtain always stretched when the fecal bag was put in there. Thus it eventually just pulled out and failed.

Concerning the BMMD: After the last M172 calibration, one had to be very careful when releasing the cocking handle or the BMMD would be released at the same time. I think that was caused by a cable run which could be fixed very easily.

The sleep equipment was very poorly labeled. The items were all called out in the procedures by names such as overblanket and

POGUE (CONT'D) underblanket, but the stowed items were marked by serial numbers rather than by nomenclature. You can't identify those articles just by shape and size unless you're very familiar with them.

I consider it a major anomaly to have equipment on board that leaks. I refer to the educational capillary experiment (ED72), which had a major leak of water and oil. I believe the leakage occurred early in flight, because the cardboard and other items were stained with dry, crusted water when I took them out. A major leak like that in the wardroom compartment is almost inexcusable.

GIBSON One morning when I opened my urine drawer, a big ball of urine, about 2 inches in diameter, popped out and started floating up towards me. I cannot figure out where it came from, why it was there, anything about it. It was a one-time anomaly.

Window contamination was a major mission problem. I'm not sure whether the people on the ground appreciate the fact that all the brown on the vehicle is not due to solar UV changing the paint. Some of it is actually a coating, an example of which you can see on the command module windows. Before we splashed down, it was uniform. But after water hit it, it wrinkled and peeled off in flakes. I'm sure some of the large pieces of it

GIBSON (CONT'D) are still on the windows. Just what that material is, I'm not sure. But the remaining pieces should be useful for contamination studies.

CARR One other item is the ammonia odor in the head which we discovered about the last week in the mission. We weren't sure what was causing it. Bill had changed out the charcoal canister. We disconnected the boot between the charcoal canister and the blower above it and took a sniff of that. We smelled, no ammonia there. When we connected the boot back up to the blower, a very strong ammonia odor came from the blower output. Thus it appears that the source of the smell was the blower unit itself and not the charcoal canister. As we said in our report of it to the ground, we decided that it was tolerable for the rest of the mission. Therefore, we didn't get into the mode of finding another blower to put in there. I feel that the odor very definitely increased in intensity during the final week of the mission.

CARR One other area of unusual events that we reported on the dump tapes was that on occasion we saw some lights flashing outside with very a definite motion relative to ours. We presumed that they were other pieces of Skylab, or possibly other satellites. We reported our two or three sightings of that kind as soon as they occurred. We have no special comments concerning them,

CARR (CONT'D) but we did find it very interesting to be able to see other objects up there with us. The fact that one or two of them appeared to be tumbling was apparently due to the oscillation of the light flashes that we were getting from them.

POGUE The OWS Heat Exchangers: There's a major design flaw there in that filters were not installed upstream of the OWS heat exchanger vanes. When we first arrived, the vanes were so uniformly coated with lint that I thought there was some kind of anodized surface on them. I was never fully convinced that I had done the vacumming job properly; therefore, I fabricated a special tool that fit flush against those surface vanes so that I could exert a good vacuum. Though they are not supposed to be condensive heat exchangers, I sucked quite a bit of condensate water out of them. I tried the best I could to keep those things clean, yet I never did get all that lint pulled out of there. That is why I think we needed a filter in the system.

GIBSON EVA anomalies might also be mentioned here. For example, you had the water leak outside, and I also got a water leak.

POGUE One thing that was not mentioned on air-to-ground as a possible cause of the problem was the single-point failure that exists in the mechanical way that the PCU composite connector is hooked to the PCU. I was able during EVA, maneuvering through the clothesline ropes, not only to open the lock but also to extend the arm which pulls the PCU composite connector off.

CARR I did that and it was a simple operation. It took a little more time than the time line allowed us. That was the only item in deactivation that took more time than was allowed. We did not bring back all the FDF exactly the way they had laid out in the checklist. We found that none of the crew logs contained any technical data so we did not bring them back. I brought back my crew log because I had all my personal notes in it. Bill and Ed did not use the crew log for personal notes or for technical notes. In the place of a personal log, we brought back a copy of the Activation Checklist. I had made notes in the Activation Checklist and I thought they might be useful to us in the debriefing. We did not bring back more than one large note-book. This one contained all of Ed's notes from the ATM operations. The ground asked us to bring back the microbiology section of the IMSS. We brought it back but I still don't understand why, because I didn't think there was anything of value in that section. Ed sent back his notes on hemoglobin and urinalysis specific gravity counts; that data is back. We stowed most of those three pages in the cue card bag, along with the other cue cards that we brought back. We could not see a whole lot of sense in bringing back all of the overlays for the ATM, but they're here. I don't

CARR (CONT'D) really understand what use there is for those things, but they're back. I will never understand how anybody could look at all the film we took up and give us three little log books to log all the film for the Nikons and the Hasselblads. We ended up making our own logs by cutting up the booklets that you insert in the long pocket. We ended up hand-logging all that data. That was a time waster in that, every time we got to a new page we had to put in new lines to list all the data. In our haste to leave, we did not bring back one of our Nikon logs. It was left up there. It's still sticking on a piece of Velcro next to the wardroom window.

CARR WMC Filters Replacement was not done.

CARR WMC vent filter replacement was not done.

CARR General Housekeeping Tasks: They were not done for deactivation. We left the workshop pretty much in an as-lived-in state. We did not make any attempt to do any great amount of cleaning other than to remove our trash and garbage from the refrigerator and from the wardroom trash well.

GIBSON We emptied all of the trash bags also.

CARR That was it as far as general housekeeping was concerned. We made no effort to go about and biocide clean any areas or do any special cleaning procedures.

CARR SWS Closeout Photo Prep: Bill, that was you.

POGUE That was nominal. I think we did a real good job on the closeout photos. We took some extra ones. The reason I feel good about it is I was using the same settings I used to take those photographs of Ed at the ATM panel. That picture turned out well; so I'm assuming the rest of them are good.

CARR The Marshall photos were taken a day or so early.

POGUE I used the same technique and it's in that sequence I took the picture of the urine separator crust and crew stations.

CARR The next item is Review Entry Procedures: We didn't think we had enough time allowed us in the Flight Plan. We asked for more time and received it. We also took a little extra time during our free periods. I feel quite comfortable that we had plenty of time to review our entry procedures, and I think we utilized that time completely.

CARR Quiescent Panel Configuration Check: We must have done that three times. It's a time-consuming laborious process, but the reason for doing it is quite evident. You have to start from some switch baseline that's accurate so we have no complaints

CARR (CONT'D) about doing it. It went without a problem. I was pleasantly surprised to find on these panel configuration checks that we didn't often find a switch out of position. Any switches that were out of position were usually comm switches. I don't remember any other switches being out of configuration.

CARR WMC Dump Heater Activation:

GIBSON There was no problem. We left that dump heater on for about the last 2 days. I was dumping the squeezer bag, trying to stay ahead of the game, about once a day for the last couple of days, waiting to close it out. I think Jerry was the last one to use the squeezer bag. After his last use, we did close it out. But we left that heater on all the time.

CARR G&N Powerup was strictly nominal, with no problems whatsoever. The G&N just performed magnificently for the whole mission. I was very pleased with it.

CARR Plenum Bag Stowage: There was no plenum bag stowage required at the end of the mission. We filled and stowed our last plenum bag below about 2 weeks after Christmas, just after the first of the year. We never did generate enough trash items to put in the plenum bag after that, so there was none stowed.

CARR E-Memory Dump was nominal. PGA Donning PREP, I did, and no problems were encountered there.

CARR P51 IMU Orientation and the P52 Option: I had no problem with that. I think if we hadn't been doing all the nu_Z updates, I wouldn't have been quite as familiar with the stars that were available to us and I might have had a little more trouble finding them. At the time we had to do this sextant P52 work, we had a good bundle of stars available to us. We had Regulus, Denebola, Spica, Gienah, and Arcturus. Those were all real good stars and easy to find. Considering the limited field of view we had, there were plenty of stars available to us to get a good P52.

CARR Wardroom Windowcover Installation: Bill, you did that.

POGUE I did that. It was nominal.

CARR Wardroom Dump Heater Activation.

POGUE I did that and it was part of the deactivation water system.

POGUE One comment on the wardroom dump heater. There was an abnormally high pressure differential after the problem with the WMC and the wardroom water system. I reported it to the ground. The consequence of having a high pressure is that you may not get a good dump. I checked the purge fittings on the hoses and they were still sucking air after I had this high pressure

POGUE (CONT'D) reading. I knew that the systems had been purged. That pressure was still reading high when we left. It was up to 2 PSI differential.

CARR Solids Trap Replacement: We did not do that; did we?

POGUE No, we did not.

CARR Fecal Bundle Transfer.

POGUE I did that. I did the processed ones and Jerry did the last ones. There were no problems. We didn't require all the space that was allotted.

CARR Urine Collection/Sampling/Separation Flush: Collection and Sampling - we did not do a separator flush.

GIBSON I just put a cuff on each bag and labeled the bag that was in each separator. We put those in the command module when it was time to leave. We had no problems.

CARR Squeezer Bag Dump and Removal - That was you, Ed.

GIBSON That was straightforward. When we dumped it, we never got all the water out of the bag. The bag did not completely collapse. When we went to dump it, unless we left the bag on there for a long time so the water could evaporate out of

GIBSON (CONT'D) the bag, we ended up with a bag still partially filled with water. This bag had a very large mouth on it. When we took it off and tried to put it in another bag, we had all kinds of squeezer-bag water coming out. That was not a tidy thing to work with, but it was straightforward.

CARR Wardroom Deactivation.

GIBSON I did that. It amounted to just taking all the food out of the disposal well, making sure all the cans were cleaned, and all the items were out of the refrigerator. That was no problem and straightforward.

CARR Urine Separator Filter Replacement. We did not do.

Cat Ion Cartridge Deactivation.

POGUE We did not do it.

CARR Wardroom Water System Deactivation.

POGUE Nominal except for the large pressure differential which I mentioned earlier.

CARR Trash Bag Collection: There can't be anything abnormal about that. You just open a door and take the bag out. We had our big trash airlock orgy the night before entry day. The morning

CARR (CONT'D) of entry day we dumped three bags and we thought this finished all trash dumps. We generated a few more bits of trash so we elected to make another TAL dump. Just before we did our suitup, we dumped our last bag which contained a few overtapes, papers, things from the OBS kit and a couple of Kleenex. Trash airlock dumps were no big thing. We took the advice of the SL-3 crew and limited trash airlock operation to the CDR and it never turned out to be any kind of a problem. When we get into systems, later on, we'll talk a little more about difficulty in closing the top of the trash airlock once you put a bag into it.

CARR Sextant P52 Option 3. I covered that before. It's no sweat, particularly, if you can take your readings at night.

CARR WMC Water System Deact.

POGUE Same comment as above. I had the high reading on the gage. I remembered vaguely that they had the same problem on SL-3. I checked the purge fittings and they were still flowing.

CARR Caution Warning and Inhibit.

GIBSON I did that. It was straightforward. You throw a couple of switches and turn them all off on the inhibit panel.

CARR Urine Sample/Condensate Blanket Transfer.

GIBSON The condensate blanket transfer was no real problem. I went in the day before and cleaned off the window to make sure we didn't have an excess of water in there. I left a dry wash-cloth by the blanket and went in the day before and got that all done in 5 minutes. The urine sample was something else. I think that everyone is aware of the problems we had there. We had problems fitting all the urine drawers into the urine return container. The problem was two-fold. The drawers were frozen at a higher height than they should have been because the mechanism which we had in the freezer for holding the urine bags, sloshed against the top of the drawer. We didn't have enough force or enough spring in there. When you put urine samples in there, unless you really pay attention and try to force them down to make sure that you have a smooth flush interfacing, some of those urine samples could freeze at a higher height than desired. If one did it, the other ones would tend to freeze up close to that height also. You would get a cascading effect, where one would freeze a little higher than the next, on down the line. I'm surprised that the previous crews did not have the same problem in trying to squeeze things into the urine return container. The container is poorly designed. It does not have a low enough excess

GIBSON (CONT'D) volume in there above what the drawer would normally have. The metal sheets which we had in there did not help. They just meant that you could not configure the four urine drawers in a way which would allow you to take up the slack in one and the bulge in another.

The only reason we got those things in there as well as we did was, 2 days before I ran a fit check and saw we had a problem. From then on, I worked on it with the ground to make sure we had the best configuration for putting those things in. The last technique used was drive-it-home-with-a-big-hammer technique. We decapitated a few of the bags, but we brought them all back and the samples were usable. If we do something like this in the future, we ought to make sure that all the things will freeze at the right level and secondly, that the return containers have a little more leeway in them.

CARR There's no reason to design a container like the USC to the close tolerances they had. When you are fooling with ice cubes and things like that, it's difficult to control the size to which they will swell as they freeze. Working to those kind of tolerances is foolish.

CARR Water system closeout.

POGUE Water System Closeout: It went nominally except for the one item which was mentioned before and that was off-nominal gage readings in the head and in the wardroom. The pressure was pegged out full-scale high. In flight I recorded fluctuations on that gage from about a quarter scale to full-scale high. I checked the purge fittings on both the waste and the wardroom purges and the flow was good. I interpreted that as an indication that everything was working normally. I went ahead and proceeded with the water closeout and finally opened the lines to cabin pressure.

CARR SCS Powerup: I have no special comments. It went strictly according to the books and was no problem. If you want to include the entry check, that was done on entry minus 5 days. We had a problem with the ground seeing the THRUST ON light. This THRUST ON light came on twice, and it was caused by my inadvertently going to the entry test position on the rotary switch while setting up for the EMS delta-V check. Once we found the problem and everybody understood why we had the extra THRUST ON light, everybody was happy.

SPS/RCS Quiescent Termination: It was no problem. We were carrying and off-nominal quiescent configuration for most of the mission. PSM QUAD Bravo was left CLOSED and QUAD PRIMARY

CARR (CONT'D) Bravo was OPEN. I guess this was due to a leaky isolation valve in the PSM. It was no great problem. We made a few checklist changes and carried our quiescent configuration this new way. It was no problem at all as far as terminating the quiescent configuration and getting up into a configuration ready for a flight.

CARR OWS Panel Configuration: Was that yours, Ed, or was that Bill's?

POGUE That was mine. Ed had the ATM. Those were all photographically recorded. I went right by the checklist, doublechecked the panel configurations, and took pictures per procedures.

CARR The SXT P52 Option 3: We've already covered that. We were doing all the work with the nu_Z updates with the optics. The SXT P52, procedurally, was no problem at all. We had plenty of stars available with good star angle differences between the two 30 to 35 degrees of angular difference between the stars. We were able to get good fixes. The GDC align was no problem whatsoever. It went strictly according to the book. The drifts seemed to be quite good. I remember pitch drifts on the order of 4.5 degrees per hour. In YAW and ROLL the drifts were less than 2 degrees per hour.

CARR Waste Processor Closeout - Ed.

GIBSON There was no problem with the waste processor closeout.

CARR SPS Repress: No problems. We did that with the ground watching and had no problems whatsoever with that one.

CARR IMSS/Fecal Container Transfer:

GIBSON That one was no problem, but the only reason it wasn't is that I didn't do it on the time scale recommended. I should say the spelled-out time scale. The IMSS cans and the ED31 can had to be configured. I concluded early that there was no way to get that done on entry minus 1 day and entry day in the time allotted. I had everything lined up in the refrigerator that had to go into those cans. I had them well marked, and I ran a fit check on the cans to make sure that all of the ice which we had frozen to work as thermal inertias would fit into the can. I had to redo one of them in order to get it into the can. I had to thaw out part of it and redo it. If I had had to do that on entry minus 1 day, I would have been up quite late. On entry day, there was a lot of packing of the cans and wrapping towels around the cans. I did that about 3 days ahead of entry. I wrapped all the towels around the cans, put them in the freezer, and left them there. I found that this total process took approximately 6 hours when I figured all the work. There was no way I could get that IMSS wrapped up with towels and all put

GIBSON (CONT'D) together on entry day in the time allotted. I just moved it all ahead of time.

CARR This is precisely the kind of information that we wanted the people on the ground to send up to us several days early. I wish that this had been scheduled earlier. There is no reason why it couldn't have been, and it really should have been. Ed shouldn't have been put into the position where he had to go looking for things that were going to bite him and get them done early. The ground should have done this.

POGUE One comment on the containers: In the trainer during preflight and during flight, I noticed a lot of rust accumulation on the cans. I just mention this in passing. The aesthetics of the situation were such that it didn't look professional.

CARR Maybe we should not have used tin cans. We probably should have asked for aluminum cans.

CARR Caution and Warning Check in the CSM was certainly routine.

CARR Power Source Transfer to Internal: Bill and I effected that without any problem.

It doesn't look like the battery Alfa problem is going to arise unless we bring it up now. I would call this an anomaly. Maybe this should rightfully be shown up in section 7 as anomalies

CARR (CONT'D) and unusual activities. Every 7 day housekeeping check in the command module, I would go up and check battery A, battery B, and battery C voltages; and they were all normal. We never put a load on those batteries. In the process of checking out the command module EPS system and getting ready for a power source transfer to inernal, we suddenly found that punching in BATTERY BUS A circuit breaker would give you BAT A voltage, but as soon as you allowed any load whatsoever to be placed on the battery, the voltage and the current would both drop to zero. The current would run up to 5 or 6 amps and then just fall off to zero, indicating that you had something pop open. However, the breaker itself had not physically popped. Apparently, it was just opening somewhere internally.

The data is all available. I'm sure it'll be laid out in detail in the systems report that will be given by the EPS people. We found, in the long run, that by holding the circuit breaker in with a considerable amount of thumb pressure, we could get it to carry a load. It seems that our problem was some sort of contamination or corrosion in the circuit breaker itself.

In the long run, what we finally ended up doing was loading the circuit and then closing and opening the circuit breaker 10 times under a load situation. We apparently burned away whatever corrosion or contamination there was in there. We ended

CARR (CONT'D) up with a normally operating circuit breaker. We did not have to do any special EPS power management procedures during the entry phase of the flight.

POGUE The anomaly was first detected when the A/C switch was thrown on in preparation for the SPS check. That was during the deorbit briefing on entry minus 5. Then Jerry handled most of it after that. Prior to the first SPS burn, the phasing burn, I put BAT C on the line because I was afraid maybe BATT A was giving us problems. It turned out that probably everything was all right with BAT A. That's all documented on tape. The reason that I did not get what I thought was a nominal indication is because the descent batteries were on the line and they had so much poop they were overpowering the entry batteries.

CARR After that, the CSM power source transfer to internal was strictly a routine maneuver as far as Bill and I were concerned. We carried it off without any problem and there was no requirement for ground monitor.

CARR ECS Prep: No problem on that. We went strictly by the checklist and there were no anomalies.

CARR ATM Panel Closeout:

GIBSON There were no problems there. I did a couple of additional things. We were also taking data on the XUV MONITOR right up to the end, so I had to power down a TV bus as well.

CARR Condensate System Deactivation.

POGUE There was nothing off nominal. I went by the procedure.

CARR S190 Window Protector Stowage:

POGUE Normal.

CARR Mol Sieve Closeout:

POGUE Normal. I disconnected the condensate lines, et cetera.

CARR LiOH Canister Installation: We did have an anomaly there. I found that on LiOH canister number 24, the plastic was slightly puffed out. There was an abrasion and a hole in the plastic on the bottom side indicating that cabin air had been allowed into the LiOH canister. I exercised the option of going to MDA locker number M151 and I selected canister number 34 to replace 24. We used that canister in the command module for return.

CARR Undock Prep Panel Configuration Check: We did that. Ed grumbled the whole time we were doing it because he had just finished doing it a day or so before. I was very sympathetic

CARR (CONT'D) with him on that. It was exactly the same as the quiescent termination checklist that we had done. It was a pain in the neck. This undock prep panel configuration check that I'm talking about was done while we were suited. We had already done one earlier in the morning unsuited. Grubbing around in the command module underneath the couches, trying to get to panels 251, 351, 352 and 382 in a suit was a bit much. We did it because, frankly, we were afraid we might overlook something and end up with a switch not properly positioned. I suppose that's exactly the reason that configuration check is in there.

POGUE I don't know why it couldn't be done before you suited up.

CARR We did it earlier that morning. It probably was a superfluous check and didn't need to be done. The first check, which I think this particular line item in the debriefing guide refers to, is the first one that was done that day and that was probably the right one to do.

CARR SOP Docking Load Strap Installation:

POGUE It was no problem. I question the procedure itself. It was in there, so we did it. I never have liked that design because you have to peel back part of the Beta cloth covering. It looked like the thing was designed for a bare, uncovered SOP

POGUE (CONT'D) and then it had to be redesigned to cover the SOP for the docking load strap to fit. I thought that was a poor design on those docking load straps.

CARR That was obviously an after thought. Our procedures were wagged by the afterthought.

CARR O_2N_2 System Deactivation:

POGUE Normal.

CARR STS/MDA Panel Configuration:

POGUE I put a lot of comments on tape regarding what I consider to be a poor layout design. Panels 200, 201 and 202, ought to qualify as three of the worst panel designs that I have ever seen. You probably would suffer an open fracture of the spine or the neck trying to read those things if you had to do it very often. It is absolutely ridiculous. I can't imagine a person in his right mind designing panels the way 200, 201, and 202 were designed. It's not me alone because there are procedures which have circuit breakers on UP called out on panel 200, 201, and 202. What this has done is square waved the whole world. It's different from everything else in the whole spacecraft. I made mistakes configuring comm, turning power off, caution/warning, and all during the flight. We tried to get it changed but we couldn't get it changed before flight.

POGUE (CONT'D) There is a 90-degree bend in there, so it's difficult to see the panels. They don't face any portion of the envelope properly. There were procedural errors made on that thing in every flight. The documentation supporting the procedures involving those panels had mistakes in it.

CARR Air Interchange Duct Stowage:

GIBSON It was straightforward and took probably 2 minutes at the most.

CARR OBS/CWG and PGA Donning: That's strictly routine procedure after four EVAs and the M509's. That was strictly a routine operation. We can make the observation that with a CWG, it certainly is easier and more pleasant getting into the suit than it is wearing an LCG. That is especially true when you're wearing an LCG that belongs to a guy that's bigger than you are.

CARR MDA/STS Lighting Configuration:

POGUE No problem on that. It went by checklist again.

CARR ECS Activation: I assume that means command module ECS activation and we had no problems. I became distracted in the middle of that ECS activation for some reason that I can't remember. I turned on the SECONDARY LOOP WATER FLOW and was supposed to have left it on for 3 minutes and then go to AUTO. I became distracted during that 3 minute period of time and ended up

CARR (CONT'D) letting it run about 30 minutes. It did not appear to have affected the system. The water boilers seemed to work okay as soon as we fired them up. Apparently I didn't flood them out.

CARR EMS Entry Check: This is the one that was done on entry day. There was no problem at all with the EMS entry check. It worked well. We had no problems with inadvertent activation of THRUST ON lights or anything like that.

CARR Umbilical Disconnect Prep: Ed.

GIBSON From the AM side of the house, it was straightforward, single point, ground back to the AM. A little switch was thrown and that was about it. You took care of what was in the command module. We had the umbilical disconnected after that.

CARR The procedures are well written and there is no problem whatsoever with that. All the deactivation procedures were extremely well done, considering the complexity of some of the systems. If you are going to make a mistake, it had to be a dumb one, an oversight.

CARR Command Module Final Stowage Check: That's kind of a motherhood, cover yourself, section in the book. It's a good thing to go through and read, but I knew exactly where everything was in that command module because I personally handpacked it. I knew

CARR (CONT'D) exactly what was there. I just read through the command module final stowage check. It wasn't a time user.

GIBSON Umbilical Disconnect: No problems at all. I just unhooked them, tossed them in the bag, and put the dust covers on; just straightforward.

CARR Bill, you did the OWS/AM/MDA Final Closeout:

POGUE That's correct.

CARR Probe and Drogue Transfer: That went according to the checklist. We put ourselves in a corner. It may have been a checklist problem, or we may not have been thinking; but we stowed the hatch underneath the left-hand couch, then we put in the URC, and then we strapped a transfer bag on top of A-5. As a result, the hatch was boxed in underneath the right-hand couch. There was no way to get it out without taking the transfer bag off again. The probe and drogue transfer was not a problem. We put them in and stuck the drogue on top of the URC under the light pan of the right-hand couch; and the probe was in the center couch. The command module was very crowded. We had three suited crewmen, a probe, a drogue, and a hatch. It was difficult to manage ourselves and all that equipment. There is no escaping it, but it is very inconvenient at hatch installation time. We had to crawl down underneath the couches and undo one of those fecal transfer bags in order to get the hatch out.

CARR Command Module Comm Reconfiguration: There was no major problem there. We just followed the checklists. Future systems should be designed with a simpler comm situation in the vehicles. The the comm system was probably the one system most susceptible to crew error due to misconfiguration of switches. It was easy to do. We were often getting ourselves into one difficulty after another because we had thrown a comm switch to the wrong position.

CARR Command Module Comm/ECS Umbilical Connection: Strictly routine with no problem at all. Tell Gunter Wendt that we remembered to turn off suit power before we made our breaker connections.

POGUE The MDA Hatch Close: No problem, very easy.

POGUE Tunnel Closeout: All I did was close the valves.

CARR Donning Helmets and Gloves: No problem, strictly routine.

GIBSON Suit Check and PGA Integrity Check: It took a little while to get it done, but we understood what we were doing.

CARR Actually, we did not do a PGA integrity check; we did the suit circuit integrity check. I suppose we should have done a PGA integrity check, but I was worried about getting behind. I had confidence in the suits and their integrity, and so I

CARR (CONT'D) arbitrarily skipped it. That may have been a bad thing to do, but it takes approximately 5 or 6 minutes. By skipping it, we kept things from being too rushed.

CARR Docking Latch Release: Strictly routine. I watched every one of them as I pulled them off. I ensured that the hook lifted up off the rail, off of the docking ring, and pulled back in the retracted position. Every one of them worked exactly as advertised.

Tunnel Hatch Installation was no problem. It was nominal, the only problem being that we boxed that hatch in underneath the right-hand couch and ended up having to do some untying to get it back out.

CARR EMS Delta-V Tests and Null Bias Check: This data was recorded. This was the second time that this test was done, and we were very pleased to see that the delta-V countdown to 21.1 feet per second was identical to what it was in the rendezvous phase. And the null bias was identical to what it was on the rendezvous phase. So, the EMS system remained quite stable during the quiescent period.

CARR Doffing the Helmets and Gloves: No great problem.

RCS Thrusting Prep and the Hot Fire Check: They were strictly nominal.

CARR (CONT'D) Sextant P52: No problem.

GDC Align was no problem. The command module performed beautifully for us. We had ourselves a good vehicle. It went through tests in beautiful shape with a minimum number of problems and performed in flight the same way it went through testing. We were pleased with it.

9.0 SEPARATION AND ENTRY

CARR Command Module Separation Checks and Undock Checks: We had no problems. It was strictly by the numbers and we had no anomalies.

GIBSON We went straight through the checklist on those two items; no problems.

CARR Undocking: The first item that we need to talk about is the undocking. Everything was strictly nominal up to that point. During the undocking, the checklist indicated that we should hold the EXTEND RETRACT switch until we were sure we were undocked. Ed threw the switch and the probe extended. I saw movement and how hard we were coming off. Ed let go of the switch just a tad too soon. The capture latches grabbed, and we ended up twanging out on the end of the probe instead of coming off like we'd planned. We were all surprised. I didn't expect to see that much movement just with the probe.

GIBSON That was something you never run into either in the training or in any of the discussions. Once you're on the way out, you continue. That is not the way I understood it would work.

CARR Yes. We got caught with our britches down on that one. We threw the switch up again and released the capture latches. I threw some coal to it and tried to set up approximately a 0.4-foot-per-second opening rate with only the RCS thrusters.

CARR (CONT'D) This meant I hosed down the workshop a little bit, but I really didn't feel too guilty about that. We had a good separation from the workshop. The first check indicated that our rates were a tad slow, so I gave it a little more minus X. What's the first check?

GIBSON 3 degrees at 3 minutes 50 seconds.

CARR 3 degrees at 2:50. We got there a little early.

GIBSON Yes, a little early.

CARR That meant we were a little fast. No problem. We were satisfied with that. I let it go at 1.3 degrees on the docking port to a measurement on the COAS. I went strictly by eyeball. I roughly put in the plus X and the minus Z, and we got good rates on the flyaround. Bill started taking his pictures.

Flyaround: The flyaround itself was like the docking evolution and braking. It was easy; I had full control of the spacecraft, and things were happening slowly enough that there was no disorientation. It was easy to maintain the proper distance and to discern when an opening or a closing rate started. It was also easy to feel tangential velocity around the workshop. At no time did we feel uncomfortable. The first 90 to 100 degrees of the flyaround were done slowly to get plenty of good workshop photographs on the Sun side of the workshop. As we got

CARR (CONT'D) approximately 100 degrees above the Sun side of the workshop, I ceased to worry about distance from the workshop. I let our distance open, and I was using mainly minus Z thrust to increase our rate for flyaround. I began to concern myself with getting into position for the separation maneuver.

Stationkeeping or the problems involved with the flyaround and the maintenance of our relative position with the workshop were minimum. The simulator causes you to expect a much tougher job than it really is. It's a simple thing to do. I can't emphasize that enough to crews who haven't seen this sort of thing before. If you can do in the simulator all the docking and flyaround and stationkeeping that you need to do in the simulator, then you'll have no problem whatsoever.

Photographs: We took DAC number 2 in with us. I loaded a 140-foot magazine on it. For some reason, that DAC would not run at any speed except 24 frames per second. I was concerned because we had only 140 feet of film to cover the flyaround, the fireball photography, and the parachutes. As that thing was grinding around, I became uneasy. So approximately 20 percent of the way through the flyaround maneuver, I checked to see how much film was left. I was dismayed to see that we'd already used half of the film photographing backing out and starting the flyaround. Because we could not get the DAC to

CARR (CONT'D) run at any speed except 24 frames per second, we had to satisfy ourselves with taking short 2-second bursts of data at periodic intervals. We had the same problem with the camera in window number 4, so it was not a window-peculiar problem. Apparently, it was a problem within the DAC itself.

POGUE OWS Photographs: Two general areas as far as problems are concerned. The first is we had the coating outside the windows. This was not homogeneous. There was a linear streak in the window, and I kept moving the camera around trying to get the best field of view. So we still have window contamination problems to contend with.

POGUE The second major problem area is that we did not have a field-of-view viewfinder on the Hasselblad. The best we can do on the Hasselblad is use the ring sight. If I had it to do over again, I would have brought a ring sight with me. But a ring sight is not the solution to the problem. The solution is to have reflex capability.

There are several advantages to the reflex capability. First, you see what the camera sees. When I was moving that camera around trying to get good shots of the workshop, I was never sure whether I was getting too much of the contamination or the structure in the field of view thereby obscuring a good photograph. This was a problem down to the last photograph.

POGUE (CONT'D) I would like to put in a plea for reflex viewing capability and viewfinder capability for all the cameras. When you see what the camera sees, you avoid focusing and aperture errors. If you have the wrong aperture setting on the right kind of reflex camera, you will see a gray, dim picture. If you have it too wide open you probably won't notice that, but it still helps. I have taken some pictures in flight where I had inadvertently changed the aperture and the focus. This is possible in the Hasselblad because of the little ears on the end of the levers. So, as far as the photographs on the OWS flyaround, I did not know what kind of pictures I was getting. I was agonizing and wondering whether I was getting a full frame picture, of if half of it was obliterated by structure. I was delighted to see that some of the pictures were good.

CARR One thing I might add on the flyaround is that it was helpful to have the GDC ball aligned to the workshop coordinates: that is, 0, 215, and 0. That was very handy, and I'm glad we did that.

Separation: Separation was done on time. It was a good burn and strictly a nominal situation. We had no problem at all. As I remember, we weren't exactly on the attitude. I should have done a VERB 49 and placed us exactly at the separation burn attitude, or I should have maneuvered to it. The sep burn

CARR (CONT'D) attitude was 180, 129, and 001. As I remember, the attitude at which we actually did the separation burn was 177, 129, 003. I burned the NOUN 85's and P41, and it probably worked out okay anyway. It wasn't what you'd call a precise job of burning a separation.

GIBSON I think we actually burned before we got completely around on the X-axis of the vehicle. We got almost all the way down, but figured that being off a couple of feet wouldn't make much difference. So we just had the right attitude and burned on time.

CARR The workshop was well within our field of view all during the burn, so that was no big problem. We did watch the workshop as we moved away from it. We were comfortable the whole time. We saw the workshop moving through the horizon, which indicated that we were dropping down below it.

GIBSON During the flyaround and also during the separation, I was surprised that we did not see the sails flap around a little bit more than they did, especially the twin-pole sails. We did see them flutter a little bit, but not a great deal; not as much as I'd seen from the SL-3 movies.

CARR We did see that part of the twin-pole sail where the fold had opened up. That apparently occurred between EVAs 3 and 4, because I did not see that white area in one of the accordion folds in

CARR (CONT'D) the twin-pole sail during EVA 3. However, it was there on EVA 4. Bill got a fine picture of it with the Hasselbald during the flyaround, so you can see just exactly what that looked like.

GIBSON Sextant Star Checks: As I recall, both of the checks that we did for both major burns were within the reticle pattern itself; not just within the field of view, but within the cross itself.

CARR I was dismayed to see that the horizon check for the shaping burning didn't work out. We were about 7 or 8 degrees off. The horizon was ... supposed to have been on the 17 degree window mark at T_{ig} minus 3. As I remember it was about at the 25 degree window mark at T_{ig} minus 3. I had no reason to believe that there was any problem with the G&N. We had a good IMU check and a star check. I know my head was properly positioned because I took pains to make sure that the line on the inside window and the line on the outside window were lined up to remove the parallax problem. I had approximately 8 degrees of error in the horizon check. All I could decide was that the 17-degree value was in error. I felt very confident about our G&N and I wasn't going to go SCS when I had all that confidence. It looks like I made the right decision on that.

CARR GDC Align: GDC align was no problem.

CARR (CONT'D) TVC Check: The TVC check was nominal. It was during this TVC check that Bill was not sure that we had a good BAT A. That's when he threw BAT C on the line. I think that was the way to do it. We didn't have time to fool with it. We went ahead and did our burn the way we'd been trained, and then we talked about it later. It worked out just fine.

SPS Thrusting: All of our checks on the P40 burn card, in preparation for the burn, went nominal. We felt very good about moving into the burn. We were not rushed. We were prepared for the jolt we were going to get during the shaping burn. All three of us pumped our suits up to 175 psi on the hypotensive garments. In spite of pumping the suits up we all felt a certain amount of dizziness. We did not feel like we were graying out, but we felt the effect of the g situation on our otoliths. It made us acutely aware of the gyros in our heads.

GIBSON I think this is the wrong term because there was no tumbling or rotation associated with it. It was just an awareness in your ears that there was something going on without any flickering of your eyes or anything indicating rotation.

CARR It was a physiological cue that was telling the brain that something was going on. All three of us were very glad that we pumped our suits up.

GIBSON Yes. I was too.

POGUE Yes.

CARR All three of us got out of our suits between the separation burn and the shaping burn. That was a blessing. We were glad to get out of those suits and be in shirtsleeves for the shaping burn.

Shaping Burn: We don't have any notes here in our checklist concerning anything special that happened during the shaping burn. The burn went on time. The delta-V counter was reading minus 14.8. The NOUN 85 residuals were trimmed to within 0.1. We did not record what NOUN 85's were immediately upon termination of the burn, but we had a little bit of X that had to be burned out and a little bit of Z that had to be trimmed out. In X it was 1.1 or 1.2 feet per second; in Z it was 0.5 to 0.7 feet per second. It was a good burn. The thrust vector was extremely solid, and I don't remember seeing any transient in the initial burn. I wasn't watching the gimbal position indicators; I was watching the error needles and the FDAI number one ball. It was solid as a rock. The chamber pressure was approximately 93 psi and looked very solid.

One anomaly prior to the shaping burn was the fact that we did not have properly indicating FDAI attitude error needles. We

CARR (CONT'D) went through the malfunction procedures and came out in a box that indicated that we had either a procedural problem or a software problem. To clear it up, we had to ENTER VERB 38, reload the DAP, and do a VERB 46 ENTER. From then on, any other attitude error needle problems were procedural.

Suit Integrity Check: This was done in the beginning and never done again.

IMU Align, and GDC Align: Nominal.

GIBSON Activation of the Water Evap System: That was nominal, straightforward. We got good steam pressures and everything seemed to be modulating at the right temperature ranges; no problem.

CARR We moved the DAC over to window number 4 and Bill set it up; there's really nothing to debrief on the setup procedure for that. Command Module RCS Preheat was unnecessary.

Final Stowage: Ed took care of that. Between the shaping burn and the deorbit burn we had plenty of time to clean house and have a bit to eat. By then, all three of us were extremely hungry. We ate all the food that was in there, except that Bill didn't bother with the veal and barbecue because it was cold and too messy to eat. We drank all the fluids; we're glad we did that.

GIBSON We drank up everything except the grapefruit juice. We all had three or four drinks when we were in the command module.

CARR I think the food situation on R plus zero day was bad because there was a 6- or 7-hour period between breakfast and lunch.

GIBSON Just the day before that, we had packed three meals into an 8-hour period. We should have saved one of those meals for the following day.

CARR That might have helped. But, at any rate, after breakfast, we waited 6 or 7 hours to have lunch. Then we waited 10 hours for dinner. I was so hungry that I had a headache. My metabolic system must have been all mixed up on R plus zero. I'm sure my stomach was convinced that my throat had been cut.

POGUE We need special packaging for food and drinks in the command module. It is inconvenient to eat in there because the food and utensils are so hard to handle. I knew that the veal was too messy to be eaten in the command module, but I took it in there just in case I got very hungry.

CARR Final Stowage: Ed did most of it. There really wasn't much to be done. We just made sure the urine bags were up against something solid on the aft bulkhead and got all of the trash put away.

CARR (CONT'D) Pyro Bat Check: After final stowage was complete, we did a pyro bat check. It was strictly routine; no problems.

Command Module RCS Activation: During command module RCS activation, we and the ground realized there was a problem. We blew the pyros on both command module RCS rings, and immediately the ground noted a gradual loss of helium pressure in ring number 2. It was easy to see on our gage, too.

GIBSON The ground couldn't tell whether it was a propellant or helium leak. My concern was that we might have propellant leaking somewhere into the shell of the vehicle and that upon pulling some g's, it might show up in a bad area. We just didn't know, and there was not much we could do about it.

CARR It was about this time that we began to see ice crystals come whistling by the left-hand window number 1, some of them in large batches.

GIBSON We had seen those crystals before we did the RCS activation. I think that was what convinced us that we were not really seeing any propellant. We were really seeing the water boiler. It did make us think a little, though.

CARR There was an element of doubt. I think the ground, in watching the helium situation so closely, managed to convince themselves that we had a propellant leak. But I don't think they reached that decision until well after the deorbit burn.

Loading of P30 and related items was no problem whatsoever; very nominal. We did it as early as we could in order to minimize the rush at the end. We got a preliminary deorbit burn pad which was adequate, although it was not updated to final.

The TVC Checks: They went well, promptly, and with no surprises.

The Separation Checklist: That was also straightforward. We whistled through that. Bill watched bat A rather than bat Charlie. We have no notes in our checklist indicating any anomalies. We went to the burn attitude as early as possible. Ed did an optics check and an IMU check, and we came out in good shape. Because our sunsets were all running 15 minutes late in the entry phase, we did not have an early, leisurely nighttime to fire up and take a look at the stars prior to our burn. Had we waited until sunset to look at the stars, we'd have been right up against the burn. So we took a look at the stars about 5 minutes before sunset. The IMU was so well aligned and drifted so little that Ed did not even have to look into the telescope. We would drive the optics to the star we selected for boresight and Ed would find it in the sextant.

GIBSON It was straightforward in the sextant. I usually looked in the telescope and could sometimes see the star right at the origin. But the final check was always made with the sextant.

CARR TVC Check: No problem.

Deorbit Burn: It was done on time. We trimmed the residuals; I don't remember what they were on NOUN 85 prior to trim. My general impression was that the deorbit burn was more precise than the shaping burn, having less residuals that needed to be trimmed out.

This time I was quite pleased with the preciseness of the horizon check. I carefully made sure that I had the parallax out by lining up the inner and outer lines on the window, and this time the horizon check worked, whereas last time it had not. I had no doubt that I was looking at the horizon because our burns were close enough to sunset time that we still had plenty of airglow. I wasn't looking at any false horizons, nor was I looking at any terminators.

Deorbit burn went very nicely; it was an 8 second burn. And Bill was calling the on and off times. It was right on the money, as was the shaping burn. I never felt that I was going to have to do any manual backups. We managed to control ourselves and keep our NOUN 85 up so that we could call down

CARR (CONT'D) VERB 82 first. We didn't get rushed to the point of closing out average g, NOUN 85, before we took a look at our entry parameters.

We did not record those, but the shaping burn entry parameters were approximately 240 by 96. We called those numbers down to the ground. On deorbit, we burned down into a minus perigee; I can't remember the number. No problems there. The entry parameters were good. We did our VERB 82, then looked at our parameters and were well pleased with them. We went on to a VERB 66 ENTER. Bill and I took our scop/Dex at the first desirable time, approximately 18:40 PET.

GIBSON I took mine just before the deorbit burn, 19:40 or thereabouts.

CARR It was approximately 20 minutes before the burn when he took his scop/Dex.

We then did the RCS check, which presented no problems. We did not check RING number 2 because of the problem with the helium. By the time we got to this check, I think the HELIUM was down to about 2200 or 2300 pounds pressure. The MANIFOLD PRESSURES were up; everything looked good.

GIBSON Jerry did not enable RING 1 in the AUTO RCS. So later we also closed the propellant ISOLATION valve of ring 2. But initially we had it cut off only by the SELECT switches over on the AUTO RCS.

CARR You pressurized RING 2; then we saw the problem. You put the command module RING 2 switch to OFF and got a barberpole there.

GIBSON That was not done initially.

CARR It wasn't long after that. They told us that's what they wanted us to do.

GIBSON There was a time period in which you had not enabled them on the RCS; you had not enabled ring 2.

CARR Yes, we had a helium leak, so the ground advised us that we should not test out command module ring number 2 and that we should leave the command module RCS switch number 2 off. They said that number 1 switch could be left on. This was done before the burn. After the burn we got into the command module RCS check. The only ring that was checked was ring number 1. While we were in the command module mode of operation, I did not have the AUTO RCS thrusters for ring 2 selected; they were off. We did only half of the check. But the check on ring number 1 went okay; we got firings. We could hear the solenoids

CARR (CONT'D) popping in the command module RCS. It was night time, and we could look outside and see flashes from the firing jets.

We did the next step: YAW LEFT, 315 degrees for the separation attitude. We were at that time, I believe, in CMC-3, and we made the procedural error of not going to spacecraft control SCS. We stayed in the CMC-3. We we were yawed off to the left, a yaw angle of 315 degrees, and we exercised the option of entering P61 prior to going to P62. We jumped into P61 and loaded lat and long, and heads up/down minus 1, and we took a look at NOUNs 60 and 63. We were interested in seeing what gamma EI was, and it was about 1.7 something.

After we looked at nouns 60 and 63 we proceeded, got into program 62 and the CM/SM sep requested routine. We continued through the checklist. That's where we began to find we had problems. There was no doubt whatsoever on separation. It was good pyro action, a good bang, and we were without service module. As soon as we separated, I began to throw in some hand control movements to begin moving us toward the entry attitude. At that time I became aware that I wasn't getting any response to PITCH and YAW. We went ahead and held that one in abeyance while we got the docking ring done. We got rid of the docking ring; and, again, we got a very strong pyro action. There was no doubt that we'd gotten rid of our docking ring. I was not

CARR (CONT'D) looking outside at the time, because I was getting very concerned about my attitude control situation. I didn't get to see any flashes. I could see no visual cues that would indicate loss of the docking ring and the service module.

I was becoming very concerned. We had a pitch rate going, and we were heading for zero degrees pitch. We had a yaw drift that was heading us toward gimbal lock, and we had roll control. I was in the CMC-3 with the three SCS MAN ATT switches in MIN IMPULSE. I immediately went to SCS and tried it. I got no firings in PITCH and YAW. I tried SCS RATE COMMAND and got nothing. About that time, Bill shouted, "We'd better go direct," but I was already moving toward the direct switches. I turned roll CONTROL 1 and 2 to DIRECT. I stopped the pitch and the yaw rates and headed us toward the entry attitude using direct. We were doing a lot of talking at the time. We do not think we got automatic transfer when we did separation. We don't think we got transfer over to the command module control system.

GIBSON We got no firing at all, so I switched to comamnd module. Then I think we got firing in roll, but not pitch and yaw.

CARR I don't know if that's really true. It could be that I never did try roll. We may have gotten auto transfer and just didn't have pitch and yaw.

GIBSON When I hit the transfer to CM, I thought I heard a relay go.

CARR I noted that the RCS entry DAP was functioning; however, it was just as sloppy as in the simulators. I think that exonerates the auto coils, because, if the RCS DAP was functioning, that means the auto coils were also working. Five or 10 seconds after loss of the docking ring, I went to SCS and still got no results. Finally, I switched to the direct coils in order to get control of the spacecraft and move it into the entry attitude.

POGUE I cannot believe it was a configuration problem because everything worked in the test.

CARR However, it didn't work in rate command either.

Communications blackout: We had ARIA before going into blackout. The ground tried to pass us some data; however, we couldn't read it. They reminded us that ring number 2 was available only in an emergency situation; and, that if we lost ring 1, we should go ahead and spin up. The ground's best guess was that we were losing propellant from ring number 2 and should be figuring on a rolling reentry if we lost ring 1. They also tried to pass some word to us concerning oxygen, and we could not understand what they were saying. We found out later that they were trying to tell us that we should put the SOMAs on for entry.

CARR (CONT'D) They were concerned about RCS fumes coming into the command module when we hit the water. However, the ARIA was completely unreadable. A lot of our time was taken up trying to understand what Crippen was passing up to us. We never completely understood it. That's one of the problems of this comm system. In the future, we should either have a good comm or not depend upon it. It's disturbing to know that the ground is frantically trying to tell you something and you can't understand it. It's disturbing, because you wonder what has been forgotten.

After we separated and gained control of the spacecraft, we jumped into P63. We were wondering what was wrong with the RCS mode. At RET 0.05g minus 5 minutes, we did the scheduled checks. Then, at 0.05g minus 1 minute, we did the horizon check. The horizon was right where it was supposed to be, and that relieved our minds a bit more. At precisely 27:26, 0.05g, we went to EMS MODE, BACKUP VHF RANGE and got the EMS rolling. We got the 0.05g light and threw the ROLL switch; 0.2g came along on time. The down-range error check also came out nicely.

GIBSON Let's go back to the horizon check. You never were able to get that.

CARR That's right. I remember saying that the horizon was going to be right on the money. However, we were surrounded by the pink ionization cloud before we ever got to horizon-check time.

GIBSON The 0.05g check differed by about 10 seconds from both the time given and what the computer saw. We were building up right there, and it looked very good.

CARR Physiologically, I could feel 0.05g.

GIBSON The down-range error check and the beta check came out well. Minus 228 was the actual value, and the lowest we could have gone was 202. We were within the box on that. We were off by 50 as compared to 70 at the maximum. I was surprised that it wasn't better than that; however, it was still within the limits. So we took the G&N as good and continued the CMC AUTO.

CARR Sometime after 0.2g and the down-range error check, we decided that the G&N was good. I shifted it over to CMC. The next check on the G&N was the cross-range check, and that worked out fine. The command beta angle response came approximately 20 seconds early. However, it was no problem at all.

Ionization: we were enveloped in the pink ionization cloud prior to horizon-check time. I felt good about the horizon because it was moving in the right direction; therefore, I was sure that we were going to arrive on time. The cross-range check went well; 3 g's is about the most we pulled. We went up to 3 g's, backed off to about 2.6, went back up to 3 g's again, and held 3 g's for some time. I found no problem in moving my

CARR (CONT'D) arms around or reaching down and pumping up my suit a couple times. I was even able to lift my head to look down to see what my suit pressure was.

GIBSON It certainly did feel heavy, though. I tried to hold the check-list off my chest to read it; however, at 3g's, things were pretty heavy.

POGUE I was able to get up and turn the DAC on and off with no problem, but there was definitely a heaviness.

POGUE Concerning fireball photography, everytime there appeared to be a significant change in the fireball. I'd reach up and use 1 to 2 seconds of 24 frames per second. I did that six or eight times, and I got an end-of-film light. So we didn't get any main parachute photography.

GIBSON When we first saw the ionization, it was just a general pink cloud around the spacecraft. Then as we got down farther we started to get ablation of the heat shield. I saw three major areas where the bright orange particles were flowing by. One was on the right, another was up the center, and another was on the left. I'm not sure why we saw three distinct ones, as opposed to a uniform area, other than the fact that the pads where the spacecraft rested on the service module supports tended to burn off more. Those were open areas, and I suspect

GIBSON (CONT'D) that those areas were burning initially and the corners were burning off of those. Maybe that's what we saw initially as opposed to the total area across the ablator shield burning.

POGUE I'd like to get a resolution on that because that bothers me too. At first, I thought it was similar to an optical phenomenon you get when you're flying in a snowstorm. That is no matter which way you look, it looks like the snow is going away from you or coming toward you in that direction. You have three windows you can look out of, and every window you look out of, you see a concentration of the particles in that direction.

GIBSON I could look out and see the three distinct areas. I could also see the roll jets firing; they were visually distinct. So I could tell that we didn't have an optical illusion.

POGUE To substantiate what Ed's saying, I deliberately changed my field of view out of the number 4 window to see if I would see the particles concentrated in that area every time I changed my eye position, and didn't. There were distinct paths.

CARR I saw the same things too. It wasn't an overall glow that got brighter and brighter. There was a very definite streaking.

90,000 feet. Steam pressure. I got it right on the money, and the time was messed up because I said watch for 50,000 feet

CARR (CONT'D) and you said you were watching the altimeter. I was waiting for 50 seconds to come. You came off the peg at about 35, 38, 40 seconds, somewhere in there, way early. I forgot about the watch and went to my cue cards.

We came off of 50 K and we immediately started through our checklist procedures. We didn't have any problems at all with that. Ed would call out the step and whoever had to do it was calling back that it was complete. We passed 40 K without any problems. The spacecraft was very stable. I felt no desire to stabilize it with RCS.

GIBSON I did notice a lot of buffeting coming down through, I believe transonic. I'm not sure what altitude it was. It was the same type of buffeting as I remember on launch when we went through max q.

CARR Drogue Chute Deployment: There was one big bang, and, all of a sudden, I could see risers moving out in front of us. Pop, pop - I could see two drogues. They immediately grabbed us. We had a short period of oscillation that damped itself out after a while. The drogues grabbed hold of us and got us settled down.

POGUE Immediately, the pressure started filling the cabin. I was impressed. In our simulator, it seemed that there was a lag.

CARR I was also surpised that I didn't have to clear my head. I didn't have to valsalva or anything like that. I fully expected that in moving quickly from 5 to 15 psi I was going to have to valsalva, and it was not necessary.

GIBSON I was surprised at how much the drogues slowed us down. I thought there was a lot of deceleration associated with them.

CARR Then we got the pyro firings that came along with the main deployment, again, as loud as the docking ring deployment. We could see that the drogues had been released and the main risers were hanging out. I saw three beautiful orange and white main chutes start to blossom out in the reef position and it didn't seem that they stayed reefed long. It wasn't long until they disreefed and we were in fully blossomed main chutes. We had a nice, smooth ride from then on down. There was very little oscillation.

Communications: Communications were good. Ed was in communication with recovery and was reading them his lat/longs through 10,000 feet. We let the folks on the ground know that we were in good shape. All the procedures, from the drogues on, were followed without any problem.

Pitch and Yaw Entry-Control Problem

CARR As we all suspected, our problem was - more procedural than anything else. The situation was that prior to separation, in the separation configuration area, one of the steps is to pull four circuit breakers, two pitch and two yaw; pitch 1, pitch 2 and yaw 1, yaw 2. These were the gimbal motor breakers they wanted pulled. In our haste, we managed to pull the four SCS pitch and yaw breakers that are labeled a great deal alike. They are only a couple rows above the other four breakers. There are no excuses being offered here. We pulled the wrong breakers and got ourselves into a problem. We did the way we were trained, that when you find out one system or one area of control is untenable, you shift to your next tenable level or you retreat to your next trenches, and that's exactly what we did. We activated the directs and gained our attitude. We realized after separation that we had a roll capability on auto coils; it was just pitch and yaw that we did not have. Because of that, I felt no worry about giving it back to the computer, and I was resolved to continue with direct if pitch or yaw started to drift. So there are some questions now cast on what we said previously in our debriefing; that is, did we or did we not get an auto shift from service module to command module? Right now there's a big question in my mind. I don't know if we got a shift or not. I think maybe the data can tell. I suspect, now,

that we did get a shift but didn't recognize it because we had lost those two sets of auto coils.

GIBSON I would like to know when you do shift if there is a relay that you can hear thrown. As I recall, when I hit that switch manually that coincided with hearing a clunk over on one side of the vehicle. That may or may not be associated.

CARR We still do have a question in our minds as to whether we shifted over or not. I suspect we did but just didn't recognize it. The problem was not in the hardware or in the system; it was strictly in switch configuration. There are only two possible factors that need to be brought into this. Number 1 is that we were concerned about ring 2 problems and, as I remember, the ground was talking to us about ring 2 problems when we were pulling those breakers and that served as a distraction. Number 2 is that in human engineering we need to be careful about how we label things. The fact that we had two sets of pitch and yaw breakers labeled very much alike is a potential trap which we fell into. We're the first that have fallen into that trap out of many who have flown the command module. The fact of the matter is that it is a trap. I think that's a good thing for the human engineers to keep in mind when they are designing circuit breaker panels. It is a good idea to try to keep from naming two sets of circuit breakers with the same general names so that there's no possibility of pulling or setting wrong ones.

GIBSON Had we flown an entry on the day after we inserted, we would not have had that problem, other things being identical, because we were very familiar with the command module at that moment and everything was second nature. You can't deny that after 3 months of not going near that command module, a lot of things that used to be second nature required a little thought and a little search. When you get into a situation like we did, the thought and search time is cut down to a minimum, and errors like that will occur. I think we ought to look into systems that are well designed and that will eliminate this possibility from the human-factor standpoint. I don't know how we could have received more inflight training on this but that's what we required at that time.

CARR Again that's human engineering or human factors. Staying away from a system for a long period certainly does hurt your ability and your familiarity with it. I think that clears up most of the questions we had about what happened just after separation. I think it's all quite clear now exactly what happened. I think we can learn a couple of human factors or human engineering items from this problem. For the most part, we played the system the way it was meant to be played. When we made our error in configuration, we immediately retreated to the next tenable position and worked it. As those who have listened to the tapes will testify, we were certainly shaken when it happened but as

CARR (CONT'D) soon as we went to the next control system and had things under control, it was just a puzzlement more than anything else. We were puzzled all the way down; we didn't understand what had happened.

POGUE I went out and looked at the guillotine. The reason you pull the breakers, is to remove all possibility of shorts when that guillotine cuts. That guillotine surely did a good job. I went over and looked at them and they were just cleaved right off.

GIBSON I looked at them too. I was not looking for burn marks at that time, but nothing gross was evident.

POGUE You are disabling a system at a critical time in flight to cover up for another system. I question the wisdom of that to some degree.

CARR I remember thinking of that too, when I found out what the problem was. We probably really shouldn't have been messing with those breakers in the first place.

POGUE The point is, is there a way of designing the guillotine system so that you don't have to do that? You're playing with a vital system and after it's all over and done, the guillotine system should have been designed to preclude any doubt.

CARR We owe the people in Flight Control an apology for not letting them know what happened. It appears that most of the folks around here have found out about it from elsewhere, and that's certainly not the way to run an operation. We are guilty of not reporting the failure in the proper manner. We accept full responsibility for that. The fact of the matter is once the problem was behind us we were no longer concerned with it. We were more concerned with the problems we had at hand and that was getting our legs under us and getting squared away physiologically in a one-g situation.

GIBSON I always thought that since the ground had so much capability of looking into the details of the spacecraft via what was put on tape that this problem would have become abundantly clear to them within a matter of hours.

CARR It wasn't hours, it was days.

GIBSON Had I known that, we would have reported it. I thought it would have been clear. Our comments on the tape should have made it very clear that there was a problem. I'm surprised it took that long.

POGUE I was under the same misconception as Ed. It just didn't work out that way that time.

CARR I didn't feel any great urgency to report this. I thought about it once or twice on the water, but we didn't have a VHF that was working well. We had the keyed mike and I said, "Gee, we ought to probably mention this, but the guys will know all about it. They can see it by listening to our tapes." Unfortunately, those folks did not have any reason to believe there was something of urgency on the tapes that needed to be listened to. So they did as we did. They took their packs off and relaxed because the mission was over, the job was done.

PUGUE That's regrettable and I think that it's nice that you expressed apologies, but at the same time, I figured the system would take care of that.

10.0 LANDING AND RECOVERY

CARR Touchdown - Impact: We hit the water with a good, solid impact. It was a real jolt, but it wasn't one of those things that just completely disorients you. One bang, and it was all over; I was immediately oriented.

GIBSON There were no aftereffects in terms of disorientation or bruises. It was just a real sharp impact.

CARR Sequence and Procedures for Main Chute Release: Bill got one of the breakers IN immediately, and I got the MAIN RELEASE switch thrown. Then Bill got his other circuit breaker IN. All of this was accomplished within 1-1/2 seconds of the instant that we made contact. I'm sure we got the chutes off.

Stable I or Stable II - Uprighting Procedure: We went immediately into Stable II. I don't think it had anything to do with the late release of the chutes. I think it happened because of the way we hit and because of the motions we had when we hit. I'm very glad we got the training that we did, because we were perfectly that we did, over in building 260, because we were prefectly at home in Stable II. There were no problems whatsoever. We just calmly went to the Stable II procedures and got the breakers CLOSED and the FLOAT BAG switches thrown. It was just a matter of waiting for something to happen. The training paid off; I think that training time was extremely well spent.

CARR Postlanding Checklist -

GIBSON Those all lined up except for opening up the hatch. I wasn't sure how much was to be inside and how much was to be outside.

CARR Communications - Spacecraft Status: With regard to the radio situation, apparently the impact put us in a position such that we ended up with a mike keyed. Once we went back to Stable I, everything that we were saying was going out on the loop. Our discussions were mainly during that period of time and pertained to some loose items floating around the spacecraft - some that had been banged around when we put back to Stable I. We saw a white bag come by. It looked like an eight-hole, 35-millimeter-cassette bag. My first conclusion was that locker 84 had been left open and that all the film previously contained therein was out floating loose in the spacecraft. It had me very upset for a little bit. Bill assured me that he had closed it after he put the film in. By that time, we retrieved the bag and assured ourselves that it was not a cassette bag; so that little "tempest in the teapot" died out. Not realizing we had a hot mike, we lay there and just small-talked for a while. Heard nothing from the ground. I decided it was about time we said something to the ground since they apparently weren't saying anything to us. We all tried transmissions and go nowhere. At that time, Ed whipped into the alternate procedures for the case

CARR (CONT'D) in which you get no contact with the recovery. That's when we found we had a hot mike. Essentially what he did was to have Bill and I turn OFF our VHF switches on panel 6 and 9 and go to the RECEIVE position. That put Ed in a position to talk to the ground. When I wanted to talk to the ground, I just moved my VHF switch from RECEIVE to TR - using that as a mike button - and then moved it back to RECEIVE when I was finished talking.

CARR Battery Power: It seemed to me that we had plenty of battery power.

POGUE We were on the postlanding power setup. I turned the MAIN BUS TIE OFF at 800 feet or whatever it was and pushed in the FLIGHT/POST LANDING, BAT A, B circuit breakers on panel 5. All you were pulling off those batteries were the beacon, the VHF, and the lights on you side.

CARR The beacon finally got to us because it was making so much racket. We turned the BEACON OFF. That didn't seem to upset anybody in recovery; so we let that ride.

Temperature and Humidity: I don't remember having been umcomfortable. I remember that it was a little close in there.

GIBSON Got a little close, a little warm, a little humid, but not terribly umcomfortable.

POGUE Five more degrees, and it would have been bad.

GIBSON I didn't feel it was getting unbearable at the time.

CARR Postlanding ECS System: Adequate. It was beginning to get a little bit closer. Ventilation was fairly adequate. We did not have the PLV VENT valve open nor the elephant trunks deployed. There was not even a trace of seasickness.

POGUE I felt real good.

CARR We were very, very fortunate to have such nice, calm seas to land on.

Couch Position; Physical Comfort: I was not uncomfortable at any time. I was very, very glad that I had strapped myself in tightly. When we hit, there was no body rattling that I knew of; I was in tight.

GIBSON Physical Comfort: With regard to the feeling of one g, I felt as though we were still pulling 2g when we were on the main chutes. I knew we were just pulling one; however, for the first 15 or 20 minutes, I felt that we were still pulling 2g. What really surprised me was how much every part of me weighed - the arms,

GIBSON (CONT'D) the legs. It was really just an effort to move any part of my body around, to roll over and lean on an elbow. I had to pick up my whole trunk and move it around, and that was just a brute physical effort. I might add here that I was very aware of the weight of my head when we were in Stable II. I could really feel my neck muscles being strained. I never hurt my neck muscles; they never have bothered me. But I sure did feel the weight of my head by reason of the strain on the neck muscles. Sure means that you haven't been doing very much work with all your muscles for quite a little while there.

POGUE At 8000 feet I decided I had better get the Hasselblad out of U-1. I reached over the back of my head, which is not too difficult a maneuver while you are on mains. I got hold of the camera with both hands and started to lift it. I almost dropped the camera, it weighed so much. I felt it weighed about 35-40 pounds. Placed it right on my chest, took one picture of the mains, and figured that it really wasn't worth that much effort. Then I had to hold the camera right on through splash. I didn't think I would be able to get it back in before we hit. I was appalled at the weight of the Hasselblad while we were on the mains.

CARR Internal Pressure -

POGUE They repressed the cabin, which what quite normal. They kept mentioning the pyros' odor.

CARR That's a good point. We could sure smell the pyros.

GIBSON As soon as the drogues went out, I was able to smell cordite.

POGUE I'm not really sure it wasn't the heat shield.

CARR Well it may have been that, too. But it was that kind of an odor, like insulation burning.

GIBSON It persisted all the way down, until we opened up the hatch.

POGUE We picked up the odor the minute the drogues went out and we started to repress.

CARR S/C Powerdown Procedures: No problems. They were well written. We just marched right through them.

Egress; Crew Pickup: The ship came alongside. We could see it out of hatch windows number 2, 3, and 4. I must say, I really enjoyed looking up, and it was particularly plain. When we could see the United States flag flying from the mast of the carrier, that really made me feel good. I remarked about it. It made me pretty proud. They hoisted us aboard.

Let me say one thing about the windows. I wish we had cautioned the swimmers to stay away from the windows. All the contamination that we got in flight was on the windows. As soon as the salt water hit it, we got sort of a crazy effect. If you can, remember what custard pudding looked like when your mom made it. After it cooled, you got that film over the top of the pudding; underneath, it started shrinking a little bit. The thin layer then began wrinkling. I had a lot of that on window number 2. As the swimmers moved around the spacecraft, splashed, and put their hands up to the windows to look in, the contamination residue was slowly destroyed. It's too bad, because there was very definite contamination cloud around us up there. There must have been a lot of contamination floating around because there was very strong proof to us that there was deposition all over the spacecraft - all over the windows and everything. It looked like we had some pretty good samples of it on the windows.

We watched the swimmers hook us up to the cables, and we were hoisted aboard. We were all ready to go when we got to the egress situation. Ed will debrief a little bit on the hatch opening problem. The guys on the outside did have trouble opening the hatch.

GIBSON I skipped the one on GN_2. We got the other part of that hatch configured properly. I'm not sure what the other problems were

GIBSON (CONT'D) outside. I think maybe they made the pull before the nitrogen pressure got the door swinging open wide enough.

CARR There was a problem with the crank out there when we were trying to unload. While they were fiddling with the hatch and trying to pull it open, I noticed that the dogs on the hatch were not fully retracted. The first couple of times, it would open a crack, and the dogs would hit against the rim of the hatch. They would push it back down and try to open it again. Finally, the hatch opened, and we enjoyed a beautiful breath of fresh air.

The doctor came in and talked with us about our physical well being. They took our blood pressure. We did some maneuvering around, sitting up, and lying down in order for them to get some good blood pressure data on us. All three of us felt very good and extremely heavy; the vertigo was strong on all of us, particularly when we were in motion. If we lay quietly or sat quietly, the vertigo didn't bother us. As soon as we moved, we all three experienced it.

GIBSON Especially when you rotated your head. My translation wasn't too bad.

CARR The egress sequence was SPT, PLT, and CDR. No problem. We took our time. The doctor and the guys that were helping us out of the spacecraft were continuously admonishing us to take it slow

CARR (CONT'D) and easy, to lean on then, not to sweat about anything. We got out in pretty good shape. During the egress I never felt disoriented, although I did feel the vertigo on occasion. I always knew which end was up and which way the people were.

11.0 COMMAND MODULE SYSTEMS OPERATIONS

11.1 Guidance and Navigation

CARR ISS Modes: Nominal; launch through rendezvous, docking, and reentry. We had no problem with the ISS System. The IMU appeared to be tight. There was very little drift and what drift there was, the ground seemed to have a very good handle on.

CARR Optical Subsystems: I didn't look out the optics during the whole rendezvous sequence. The only time I used the optics was on orbit, when we were doing nu_Z updates. I had no problem with it. It work beautifully.

POGUE It was just like the simulator.

GIBSON Especially on orbit and the optics were stable. It was exceptionally easy to mark.

CARR The only thing that bothered me on orbit was bringing the telescope out of its storage container and mounting it. I found it was hot. That surprised me. It never occurred to me to expect that. I asked the ground and they told me those were the lens heaters.

Computer Subsystem: The CMC worked like a champ. You fed it good data and it came up with good data and everything was

CARR (CONT'D) beautiful on that. No problem on the CMC unless we want to call this attitude error needle problem we had prior to the shaping burn as being a computer anomaly.

POGUE You said that was covered by a program note.

CARR It was covered by a program note apparently, according to what the ground passed up. It appears that just reactivating the DAP fixed that one up.

G&N Controls and Displays: No problems whatsoever.

Procedural Data: No problems.

CMS SPS TVC: Everything was strictly nominal. I had no indications of anything the slightest bit off nominal.

11.2 Stabilization and Control System

CARR Nominal down the line. All of our tests went beautifully and I didn't see the twitch that worried people a lot on the SPS yaw gimbal number 2. People worried about this in test and CDDT. It was fully documented. I saw a tiny bit of that twitch, but it was nowhere near the magnitude that we had during the test. I don't remember at any time experiencing any kind of a transient. Everything was solid.

11.3 SPS

CARR Delta-V Thrust Switches: I complained about the Delta-V thrust switches in test. In the simulator, I got used to being able to slap those covers and get the switches turned off. In the spacecraft, I would slap the covers and it would turn the switches off, but the covers stayed up. That bothered me. I would go back and close the covers. It worried me that I hadn't closed the switch. Everytime I looked under the cover, the switch was off. That's one of the problems we have with the simulator. The same thing with the DIRECT O_2 valve. Valves get used so much in the simulator that they get loose and you think that is the way the real world is. When you get in the real world and all the switches are nice and tight and the valves are nice and tight, it becomes abnormal. We better work on our simulators and spend more money in keeping our simulators in as high a fidelity as we can. Surprises like this make you uncomfortable when you are in the real vehicle. The real vehicle is a place where you need to be comfortable. You don't need surprises.

Engine Thrust Vector Alignment: I didn't notice any misalignment.

Delta-V Remaining Counter and Rocker Switch: They worked just like the simulator.

CARR (CONT'D) SPS Thrust Direct ON Switch: I never had to use it. It felt just like the simulator when I used it during the test.

Direct Ullage Button: I never had to use it.

Thrust ON Button: I never had to use it.

SPS PC: It works just like the simulator.

POGUE PUGS: Never even worried about it. PUGS should be N/A.

11.4 Reaction Control System

GIBSON I was able to monitor it as we did in training. We had to bleed over between one system to another - the PSM and the main. The service module systems were good. The command module was something else. When we pressurized the CM it started to bleed down. Ring one had 3600 and the other had 3400. We saw this and so did the ground. It bled down to about 2000. Between 2200 and 2000 it seemd to slow down. When we arrived back on the ground, we found out it was not a propellent leak. On de-tanking, the tanks had exactly what they were supposed to have.

POGUE I didn't use RCS but monitored it during training. The gages and read outs are poor.

GIBSON Bill is right from that standpoint. It took a long time for me to understand the indicators.

POGUE The whole RCS system is poor.

GIBSON The talkbacks required a special cue card to decipher them. There should be an easier way to present this information.

CARR Human factor and control panels are a goal everyone in aerospace should be working on. The O_2N_2 panel in the STS of the workshop is the best. Everything is on the panel. These are no hidden functions of these switches.

The Reaction and Control System from the CDR's view: it was good to put in a hand control activation and feel something instead of looking at a rate needle. It was neat to receive a physiological cue when you moved the hand controller. It made me feel I had a great deal of control over the spacecraft. I didn't feel the spacecraft was light. I had the feeling it was heavy and dense. All three of us sensed the slosh of the propellants and all fluids in the spacecraft. When you moved the hand controller in pitch or yaw or roll I didn't feel a crisp acceleration or a bang. I felt like we ramped into our motions. I had the same feeling when we were in min pulse.

POGUE Like you're flying an elastic body.

CARR Now I can compare that with something like the ASMU, M509 where you put a bang-bang input into that thing and it jerked you around because you were light. You had a fairly low inertia

CARR (CONT'D) there. It was obvious, controlling the command and service module, that you were pushing a lot of mass around. But it was a good, solid feeling. It was a good, comfortable feeling. I felt that I was ahead of the vehicle and everything was well under control. The Reaction Control System I thought performed very admirably with the one exception. That was after separation. I wished we could understand what happened there. I might also add that in the command module RCS I could hear the solenoid valves banging and cracking. It wasn't just plumbing noise because you could hear the solenoid moving. It sounded exactly like the solenoid valves on the ASMU, M509; when you turned off the gas and cycled the solenoid valves to make sure they were working, you could hear the clack, clack as you opened and closed the valves. You could hear the same thing in the command module during the RCS checks.

11.5 Electrical Power System

POGUE The fuel cells operated nominally until they were shut down on about day 19 or 20.

CARR I was pleased to see that the fuel cells went longer than anybody expected. I am glad that about 2 years ago we decided it was foolish to dump those fuel cells early and that we should get as much out of them as we could.

POGUE The associated water storage was taken care of by the service module tank, so there is no problem there.

Batteries: We were quite concerned when we had the problem with BAT A. As soon as we found it was apparently contamination of the circuit breaker, then I was quite relieved. It appeared to be a problem that you could work around, and I'm sure that the battery people are very happy that their batteries lasted as long as they did. In conjunction with the batteries, I would like to put in a pitch for a more positive indication of functional configuration. When we throw bus tie switches, we have to monitor the bat bus or the main bus or whatever it happens to be that is supposed to give you the best indication. You have to watch gages and you are never quite sure whether you have gotten the bus tie or not. In actual fact, I think there are always ways you can confirm it, but when time is critical, such as just prior to a burn, you would like not to have to worry about a subjective interpretation of an analog meter. That's my point. Why don't we design something into the system which gives us a closed loop feedback of a proper configuration and not just that the signals have been sent out, but that the tie has been made. In addition to that, we have the other problem of the batteries up there for three months. Jerry was checking them every week, but they never had a load put on them. For

POGUE (CONT'D) long duration missions, you have to have something that you can make functional demands on periodically to make sure that you don't just have continuity established in circuitry, but that you do have a functional liability established.

Battery charger works with no problem.

DC and AC monitor were both just fine. At times I wasn't quite sure whether or not we had achieved the configuration that we had. For example, MAIN BUS TIE A/C switch: When I turned that on prior to the phasing burn, I was not confident that I got BAT A tied on because of the low indication. The voltage was down on BAT A to the point that it would not contribute enough to the total demand because the descent batteries, 300 amp hours, were handling all the load. When I tried to check the success of the bus tie configuration by watching the BAT A, it didn't work out too well. So I punched BAT C ON, and then I could see a good load established on BAT C. Ground told me that they were pretty confident that BAT A was ON and I had no reason to disagree with it. In any event, it all centers on configuration.

AC Inverters: Fortunately we never had an AC failure as we did in the simulators; so it was no problem there.

Main bus Tie Switches: Worked fine right up until they were turned off at 800 feet. I have already mentioned the problem that's related to those.

POGUE (CONT'D) Non-essential Bus Switch: I checked it out prior to the sep. I went through all the procedures with the special contingency cable, opened it up and saw where it hooked up, et cetera. I don't think I ever turned the switch ON.

G&N Power Switch:

CARR Regarding the IMU switch on panel 1, apparently somewhere along the line the screw was not tightened that holds the switch guard together and the castle nut on the end managed to work its way off before we got docked. By the time we got docked and were in the command module that night, the bolt had managed to swim its way out and the washer was loose; so we stuck those on a piece of tape. We never got around to fixing that thing, and on about day 50 to 55, I went down into the command module, doing housekeeping, and the IMU switch guard came floating by. I gathered all pieces I could find and put them on tape. Finally, during prep for packing up the command module on return, I found enough of the pieces so that I could put that whole thing back together. It appears to be a quality control problem.

POGUE Cryogenic System: We just used the hydrogen and then finally vented it after we killed the fuel cells. Then we just kept on using the oxygen until we could manage the pressure.

CARR I worked with the cryo vent valve and the poly choke and the rest. I didn't really worry about it too much. The ground was watching what was going on, and about every other day they would send me up the word to disconnect this or that hose or take that valve out or put it in. We probably could have gotten along very nicely without any of that stuff. We could have just powered down the cryogenics and forgotten about them and maybe never have had any problems. We only had pressure problems right at the beginning for one day, and then it all took care of itself.

POGUE Cabin Lighting and Controls: Everything worked.

Split Bus Operations: Everything was split bus and fortunately we never had to tie them together.

Gimbal Motor Transients: They did not exist. I had to look very carefully just to see the gimbal motors come on and during the gimbal trim check and MTVC checks as the change in current flow was very low. I saw no transients at all.

11.6 Environmental Control System

CARR Oxygen System and Cabin Pressure:

GIBSON I really found no problems. We had worked malfunctions so many times on the ground that I think I was personally spring loaded

GIBSON (CONT'D) for oxygen leaks and all kinds of things that might show up. But we never had anything develop. It was easy to monitor. The oxygen control panel down there in 350 - 351 was really no problem to get to, even in the early part of the mission when we had to do it after insertion to get the emergency cabin pressure regs on. We were able to do that quite easily in zero g and I really had no problems with the system at all. The only problem is that it is difficult to read the REPRESS PACKAGE GAGE. Other than that, the oxygen system was not too bad.

CARR Cabin Atmosphere: We never had any problems with that. Were we running a little on the high side?

POGUE No, just a little on the low side; on the low end of the band when we got in and it stayed about that way.

CARR Water supply system: We didn't hardly get to use the water supply system. During the launch through rendezvous we used it to rehydrate our food. We had no water gun. We had to use the food reconstitution panel.

Water Glycol System: The only problem the water glycol system presented to us up there in orbit was accumulation of condensate water on the panel right around panel 377 and resulting ice. I just kept a lot of towels in the area, and everytime I would come up to do my 7-day check, it would manage to melt most of

CARR (CONT'D) the ice. Then I would fill about 3 or 4 towels full of water, bring them down - ice cold and sloppy - to the waste management compartment to dry out.

GIBSON I never did like the idea of having that much water floating around in the command module. I don't know if there is any way around that in future designs. You are eventually asking for problems if you get water into the electrical component or it freezes on something else.

CARR The big problem with the loose water in the command module is that we had it floating around on the aft bulkhead when we got down. Some of it got into locker A-8 where we had film. Although the film was not damaged, the potential was there.

GIBSON After we made that first burn and I was down there by A-8, I noticed that there was some on the straps and my foot was in water.

CARR Entry day and the day before, once the water glycol system primary and secondary loop were cooking, the ice all melted and I thought I had pretty well slopped up all the water in the towels and the panel was pretty dry. But there still is a lot of space back behind the panel where the water collects and I found that wicking action is very good up there, ED72 experiment notwithstanding. It showed very poor wicking action with the

CARR (CONT'D) fluids they were looking at. If you take one of those towels, and lay it next to the water glycol panel down there, it will just pull water right out from behind the panel. But then we still have a water problem.

POGUE On the oxygen system and water system on panels 351 and 352 there was a problem in understanding when you had a valve on and when you didn't. The human factors design on some of the controls was very bad. When I look directly at a valve and I can't tell what to do with that thing or which little arrows mean what, then things are not properly labeled. Again, very bad human factor engineering on the lower part of panel 351 and panel 352. That applies to the big panel area, the glycol panel. You have to remove the Y-Y strut to get into it. You can be in there 6 inches with a flashlight, looking at that panel, and still are not sure you're looking at the right valve on that panel that is being called out for in a procedure. If you're that close and you still aren't sure, then there is a problem in labeling or nomenclature.

CARR The command module is relatively an old vehicle. The things we worried about in the command module are not too well human-factor engineered; I hope someone is paying attention and taking steps to see that the same thing isn't happening to us in the Shuttle vehicles. There is no reason to repeat these mistakes. We've

CARR (CONT'D) learned the hard way. For example, instead of using tool-E to check the valves, each valve should have a handle on it. It should not be something that you have to insert a special tool to turn.

GIBSON I concur with Bill's remark concerning nomenclature. There are some of those valves, even on the oxygen panel. For example, the dump valve, where you have A, B, dump 1 and dump 2 and all that. Some of the nomenclature made sense and then the other stuff alongside it didn't.

POGUE We are happy that we had a good functional vehicle. But there are things that could be improved. Just because this was a very successful spacecraft does not mean that certain undesirable properties should be perpetuated. That's the point.

CARR Suit Circuit: I think there should be an oder removal system in the suit circuit. I think the idea of having three men operating in the same suit circuit, suffering from each other's gas and everything else, is ridiculous. Future design of suit circuits should be modified in some way so that there is a decent way to scrub them because there's nothing worse than having a person pass gas and causing others to suffer through it. It definitely effects your ability to perform.

GIBSON Gaging System: Although you could read the gages, I was surprised at the space they took up on the panel. They were pretty much World War II Bowler-type gages. I expected a little more sophistication. They were adequate, but on the other hand they were not really compatible with the effort that had gone into total command module design.

CARR We need to design gages in which parallax has no effect.

POGUE The ECS half-circle gages are difficult to read. Sometimes it is not clear whether you are reading the primary or secondary ECS. It also is not clear if you are reading the in or out temperature.

GIBSON Both the RCS and the ECS gages are confusing to read. You are not sure what you are looking at when you look at one of those gages. It took me about 6 months to figure out what was going on. I feel at home with them now, but it took way too long to learn. We will not have the luxury in future spacecraft designs of being able to sit in front of the panel for 2 or 3 hours a day, 4 or 5 times a week.

CARR Waste Management System: We did not use the spacecraft waste management system. We used a portable system that bypassed the waste management, so there was no urine or fecal disposal problems in the command module.

POGUE CO_2 Absorber: You should never have to look for a grounding cable. The cable stowage should be an integral part of the system.

CARR I think the CO_2 absorber system is rather simple. The system we had was effective and I had no trouble removing or inserting new canisters. It worked properly. I'm sure there are better ways of doing it that are easier and less bulky.

11.7 Telecommunications

CARR Monitoring: We monitored switch configuration and AGC and that's about it. I don't think that is enough monitoring. This refers back to what we mentioned earlier; that is, you need some kind of a central communications panel or something that indicates the antenna you are using, or to whom you're talking. It could be a light indicating modulation of a signal being relayed to the ground and then maybe a different colored light indicating reception from the ground. It also could be a talkback or something. But it seems to me that you need a simple system that gives you a status of which system you are using, which system the signal was sending or receiving and also what is working. That includes everything from tape recorders to air-to-ground voice.

POGUE Often in selecting the best antenna, you have to bring in the hierarchy of the whole telecomm system to checkout one antenna. We should have a simple test circuit continuously active, which gives you a comparative indication of all antenna systems. That would permit you to select the best one for spacecraft attitude.

GIBSON You should have an automatic select. There's nothing worse than having to dial between antennas. That makes no sense at all. We have automatic selection in the T-28. I don't know why we can't put it in the command module.

POGUE If you have two antennas that are giving you pretty good signals, why can't you feed from the two antennas that are giving you half strength?

GIBSON There should be a better way than to have someone sit there and manually dial back and forth to get the best antenna.

CARR The only way to determine your status is to laboriously check your audio control panel, your antenna position, and AGC. There should be something to tell you quickly what you status is. VHF: The private comm received the heaviest use. On a scale of zero to 100 I would give an 80. For 230-nautical-mile distances, that's probably pretty acceptable. Most of my family calls on the VHF were good. Some were poor, but that's going to happen.

GIBSON It usually was a ground problem rather than the spacecraft.

CARR The only other time we used the VHF was during the entry-minus-5 checks in which Bob Crippen and I worked on VHF while the rest of the crew worked S-band. Unfortunately, we had more problems than usual with the VHF that day. We had to keep dumping into S-band and interferring with the routine operations in order to get squared away with some of the VHF problems. The S-band was outstanding. General communications, as managed by ground, were excellent. We had very few problems in calling the ground. Once was with Tananarive, but that was a ground problem. Key-holes didn't bother us up too much.

POGUE Occasionally you would have to repeat something, but that could be expected.

CARR Tape recorders, DSE. We said a lot of things on intercom we would not have said had we realized the DSE was running. We just forgot the DSE running all the time during rendezvous. It's the same old human foible. If two guys are talking to each other, they're going to say things differently than if they are talking to each other with the whole world listening to them. That's the way people are, so let's face it. The DSE was a great pain in the neck. And I can understand why a lot of people are all upset about Watergate, frankly.

POGUE You suffer some in communications. You end up with confusion. If a person is always on guard, you're not really going to get the information transferred as quickly and accurately as you would if you were free to say something completely open. It's just an uncomfortable situation to be in either way. People say they need a record of what goes on. Personally, I don't think that's so. I think the transcriptions that I read, particularly the transcription of the launch and rendezvous phase, are useless.

CARR I took that thing home last night and read it, and read it, and read it. There are very few completed sentences and I know that we don't talk that way. So, as far as I'm concerned, the idea of getting tape recorders and then making transcriptions and passing the transcriptions out to the world you do the crew a great disfavor, I think. The transcriptions have me saying things that Ed said, Ed saying things that I said, and has it mixed. In fact, there are a couple of cases in the transcription where I asked a question and Ed answered the question and I said something else. The whole three or four sentences were attributed to one person. That kind of record is worse than no record at all as far as I'm concerned.

GIBSON The transcription doesn't really pick up the information which was passed back and forth at that time. It just picks up bits

GIBSON (CONT'D) and smatterings of the words, and even we who have been there and went through it, come back and try to piece together what went on at any given time via the transcription and it just can't be done. I don't know how anyone else who reads it could make any thing intelligible of it.

CARR Well, not only that but the tone of voice is missing too and certainly the tone of voice has got a lot to do with what the person gets from the message. The only way to get the tone of voice is to listen to the tape itself. I'm sure if a lot of people had listened to our workshop tapes, on the dump tapes that we sent down the first 20 days of the mission, they could have heard our tone of voice rather than read the written word of the transcriptions they might have gotten a different impression of how we felt up there. At any rate, tape recorders are dandy and all that kind of stuff. We managed our DSE tape recorder very poorly the first part of the mission. We will reiterate the fact that tape recorders are inhibiting.

POGUE VOX Circuitry: Well, we got used to it and it worked fine. We had to make adjustments for EVA configurations and for EREP.

CARR It's difficult to find a sensitivity that works for everyone that doesn't get all the huffing and puffing, just gets the voice.

POGUE Also keying on ambient noises.

CARR USB Emergency Keying: We never had to use it.

DSE Operation: We tied that in with the tape recorders. The only other area of DSE operation is the high bit rate versus the low bit rate operation. That was INCO's problem, and he enlisted our aid in several areas to help save this tape so that he didn't use all his DSE tape unnecessarily.

POGUE I was watching it very carefully and I don't know how we did on it. We left it on just a bit too long after the deorbit burn. Ed was going through the checks and I was prompting him to get it off early because of the briefing that we had prior to flight. At least we made a noble attempt to help them out.

11.8 Mechanical

CARR Tunnel: I had no problems with the tunnel with the probe, drogue, and everything; the tunnel is nice and smooth. There aren't many projections in there to bother you. The only time I felt a lack of lighting was at the point where the probe and drogue were in and I was trying to put the hatch in, then the tunnel lights were useless. In this particular tunnel, if you could retrofit the command and service module, you could probably put some more tunnel lights in the area toward the

CARR (CONT'D) vehicle from the hatch so that when you're putting in the hatch, you've got some light, too.

Struts: Nothing on the struts that I can think of.

GIBSON I'm wondering whether they stroked it all?

CARR That's a good question. They probably didn't. The mechanising of the YY struts is pretty nice and it works pretty well if you understand it. I must admit it took me a long time to understand how to work the YY struts. It's a simple mechanical thing. The couches are not mentioned here, but they are a simple mechanism. We had no problem in folding or deploying the center couch. It was extremely easy in zero g, whereas I dreaded having to do it in one g because they were heavy and it was a real problem and dangerous from the standpoint that you could pinch or hurt yourself. In zero g, it's very easy to manage and lock into place. We did not have the fit problems as we did in one g where you had to juggle the YY strut to get the shoulders of center couch into the locking areas.

Probe: As I have said on many occasions, the probe is a mechanical engineer's dream. You've got all sorts of neat little cams and followers, ratchets and hooks, pawls and gears, et cetera. It is the kind of thing a mechanical engineer dreams about designing. That probe worked like a champ. Everything worked

CARR (CONT'D) as planned and I just can't knock the probe even if it is complicated and extremely hard to learn and understand.

POGUE There is no reason for anything to be unnecessarily complicated. During a training session, if the man who is supposed to help me doesn't understand it either, then I have very serious questions about the system. That happened to me on occasion with the probe.

CARR Side and Forward Hatches: Forward hatches are super simple from an operators' standpoint. We have no complaints on that. The side hatch was designed one way and had to be changed, but it also was a mechanical engineer's dream.

I sure liked the pip pins we used in the command module. It sure beats the other fasteners that are available elsewhere in the workshop.

12.0 SATURN WORKSHOP SYSTEMS OPERATIONS

12.1 Communications Systems.

CARR The squeal attenuator that was put on the left-hand couch CCU in the command module did an outstanding job of reducing the feedback problems; however, it did not completely eliminate them. And it plagued us throughout the mission. It is really a pain in the neck to throw a transmit switch or to throw an intercomm switch then attempt to speak and just be completely wiped out by an audio feedback squeal. We had this problem with air-to-ground as well as when the tape recorder channel was being used. We tried to carry out good audio control panel discipline, but, it was easy to walk away from one of those things and leave the speaker in the ICOM position. Then when somebody at a nearby speaker would throw theirs on and attempt to record, they would be drowned out by a big squeal. I think comm systems in the future ought to have this kind of stuff engineered out of them.

GIBSON One of the big disappointments of the flight was that whenever we would try to do anything with the TV and get audio at the same time, we either ended up strapping on one of those medieval space caps or we ended up giving you somehow degraded audio quality. I don't think that should be. The problem which we

GIBSON (CONT'D) had apparently goes back right into the design of the system. We were going to take up a portable microphone which was superior to the one on SL-3, but because of weight, that didn't get up. We tried wrapping some tape around a cap and making a microphone of that, but apparently the placement of the pickups in the microphone is exceptionally critical. And you just can't handhold that thing and expect to do a great job every time. It was kind of surprising to me that we'd run into that difficulty because you can go to any local TV station or any small town and purchase small mikes that you can strap onto you inconspicuously, a foot away from your mouth, and do the job quite adequately. But yet, the whole space community could not put together a good mike. I see no reason for it in the future. I think it degraded the quality of the video as well as a lot of the audio that we sent down, which we would have liked to have done not next to a comm box. We'd like to do it right at the scene. This is compromised by your having to make notes and then go on over and spew it into a microphone at a comm box. You certainly need something portable, and there's no reason for not having it for future programs.

POGUE Separation of the intercomm and the air-to-ground - it was not. There should be an indication on the comm box if it's going to have the combination of intercomm and air-to-ground. There ought to be some way of knowing how that box is configured.

POGUE (CONT'D) One of the worst ones in the spacecraft is the one over the ergometer. I'm sure I pushed the transmit button half the time when I was trying to get on intercomm, and I pushed the intercomm half the time when I was trying to transmit on that box. I never got them straight. The buttons required just slightly more force than you would like for a zero-g switch. All of us used the little switch protector as a lever opposition point in order to push the switch to the ICOM or transmit. I'm suggesting that we need a ring-type switch. I've got an idea of how we can design one. You can use a finger pinching action instead of a lever action to operate it.

POGUE All kinds of little things about the SIAs were bad for work in zero gravity. All of our panels are designed for a headup orientation. They were not designed to be addressed or looked at from different angles. We ought to design them so that a particular orientation is not required. Some sort of central axis of symmetry so that you can approach that thing from any direction and knowledgeably configure and use that comm station without being afraid of transmitting when you want to talk only to another crewman.

POGUE Also, we need an end-to-end verification indicator on these comm boxes to tell us what our status is and if, in fact, we are working properly in that configuration. What I mean is a talkback

POGUE (CONT'D) so that when you push the transmit button, it says, hey, you are modulating and sending the signal out. The same thing for intercomm, so you'll know that you are configured properly. A lot of times we would spend maybe a minute, have to go off and configure other SIAs to verify that our comm box was configured properly. You really should not have to do that. We were running around configuring boxes. Usually you figured you were right and that some other box was wrong, which was usually the case. There should never be that doubt in your mind.

CARR In general, the quality of the audio that we got was very good. We very seldom ever had audio problems in our air-to-ground work.

CARR VHF ranging: It was nominal. We picked it up when we should have and it worked just fine.

CARR RF Telemetry: I think that's something that the ground should talk about. As far as we could tell, there were no problems with the telemetry and no problems with the digital command system.

CARR Teleprinter: Teleprinter was a fine device and it managed to survive the mission, much to the surprise of several people. I didn't really expect it to make it. I figured with all the traffic we were putting over it that it wouldn't ever live

CARR (CONT'D) through it. What we need to do regarding teleprinter systems of the future, if we're going to use them, is to design a system that is easier to load. We've got to design a system that's easier to adjust the pressure of the teleprinter head against the paper. We had little difficulties trying to load the teleprinter with a new roll of paper. The other thing was that, if you didn't jam the teleprinter in tightly against the printer head, you were inclined to get some pretty spotty looking printouts. It could have been a whole lot better designed. For a while there, we had some bad teleprinter work. We spent several hours fiddling with the system. We finally took the bull by the horns and cleaned the teleprinter head with alcohol swabs. We didn't tell the ground about it because we figured it'd probably square-wave them. We cleaned them with alcohol swabs, let them dry, and then put in another roll of paper and pulled it in tight. This immediately solved all of our problems. It appears what we should have had up there was some equipment for proper cleaning of the teleprinter head, because there were little bits of paper and paper surface materials stuck around the teleprinter head when we cleaned it.

POGUE Multiple line printouts. On the EREP pads, a lot of times we'd get multiple lines repeated several times with spaces in between. It wasn't just as if it were printed several times in a row. A

POGUE (CONT'D) certain line would appear; it would be a double space or a single space in the same line. There would be another double space or maybe there wouldn't be this time, and the same line would be printed again. I never could figure this out. I think it was some kind of telemetry glitch. But it'd be nice if the ground had some kind of repeater system so that they'd know we got this. They could count the number of lines that it actually printed and do a real quick number tally to make sure that we got printed the exact number of lines that they sent up. They would know then that there was a problem with that message. There needs to be a feedback check in future teleprinter systems. It may be that the message may be perfectly usable, but just so that I'd be able to tell people up there that they got a couple of lines printed double but don't worry about it.

GIBSON That really was a real source of mistakes on the part of operating from those pads.

POGUE That's right. A couple of times, I got caught in ATM pads with that double line printout.

GIBSON S063 pads: I got caught a couple of times.

CARR I think the television system worked pretty doggone well except for all the traps that are in the system. We managed to fall into every one of those traps, probably more than once. In the

CARR (CONT'D) beginning of the mission we just fell into one trap after another. There were a couple of television things we tried to do that we took three hacks at before we finally got it through the system. It was dumb things, like forgetting to put the wafer switch in the right position and having an upstream television station in the ON position, which blocked all downstream stations. You can probably solve that problem by designing your system with some sort of feedback like a light on the camera that tells you you're actually sending out a signal.

POGUE It's being received at the recorder and the VTR, or it's being received at the modulator for downlink.

GIBSON That's really what we need, some type of feedback. Many times we went through exercises and ended up having to go through them all over again. It's very easy to sit here and list the things that you have to do in order to make the TV work, like wafer switches. When you are actually doing TV, your mind is on the TV itself and what you're trying to accomplish with it. You don't need a lot of cumbersome procedures in order to make the mechanics of the TV function. Even though we understood it and we were bitten a couple of times, we still got bit again because we were always concerned with the content of the TV and not all of the idiosyncrasies of the television system. In the future, we need a feedback and something which is not nearly as complicated.

CARR It would have been nice if we had had a little bit more control over that video tape recorder. I think we could have put that to pretty good use. Areas where we knew we'd goofed something up, if we could have had a little better feel for how much we had to rewind, it would have been pretty handy - a foot counter or time counter or something.

GIBSON The other thing which I think we definitely need is control of the VTR from the station where we're doing the TV. We could have really saved you a lot of unusable TV if we had had that capability. There was an awful lot of things we did in the OWS that we wanted to just give you a short glimpse of, or practice a few times and then let you see the finished product. There was no way to do that because you had to run back and forth to turn that VTR on.

CARR Would have been nice if you'd had a remote/local switch on the VTR. When you wanted to control the VTR from a remote station, you just moved that switch to remote and it would take a signal from an isolated station and start and stop on that signal, very much the way the S190 camera system has a remote/local switch.

POGUE Another thing that would have been nice is the full size monitor for qualitative assessment of the signal that you were producing. Towards the end of the mission, I took a lot of television of M092/171 sequence on the CDR. Although the monitor looked like

POGUE (CONT'D) I was getting a real good picture, the ground said that I had left the wardroom window open and degraded the signal. They had been able to process it and prove it. If we had had a full size monitor, on the line of a 21-inch or something, we could have gotten a good gut feeling right away whether we were getting a good picture or not. That monitor was so bad that you always had a bad picture; so you really didn't know if it was good or not. Sometimes the ground would come back up and say, "Beautiful! Great!" And of course, the monitor was always cruddy.

CARR Some of the television that we sent down we'd just as soon have erased rather than send it down. However, the ground might come back with it was really good, which would surprise us.

GIBSON I wish we had the capability to send television up. I think it would have been useful not only for entertainment, but also operationally. For example, EVA, we found ourselves always getting into new EVA procedures and time lines during Skylab, during all three missions. I think we could have sent up some real valuable footage telling the guys onboard how best to do an EVA. That holds true for an awful lot of procedures which could have been uplinked after they had been worked out on the ground. It would have been exceptionally useful. I'm a little bit surprised that wasn't pushed harder, and we didn't have it onboard.

CARR I think that NASA will be falling way short if they don't work up a good cassette TV system for the next generation of spacecrafts. That is uplink and downlink television cassette type with high speed dump capability in both directions.

POGUE Tape recorders are not that expensive an item and every, SIA or comm station ought to have its own tape recorder with some kind of monitor playback capability if you wanted it. I'm not saying that we want to make it an unsecure box, able to get data without being able to control it. Obviously the ground was not completely aware of the problem of having to share recorders because they double scheduled us several times where two crewman would need the recorder at the same time. You should have local recording capability at ever comm station. Jerry mentioned earlier that we ought to be able to record on a cassette, change it out if we need to, and play it back later. We need an awful lot more flexibility on our voice recording capability.

GIBSON We had an awful lot of tape recorder problems during the mission. Two or three crewman would try and get at the recorder at one time especially during their experiments where the recorder was to be running for the full duration. Some of the airlock experiments you'd put the tape recorder on and every 30 seconds, report into it what type of an exposure you were making and what else you were doing with the instrument. That goes on for a full nightside pass or maybe a full dayside. Meanwhile someone else is trying to debrief an ATM pass, and someone else is trying to debrief on another one of the experiments. It really fouled up our time lines a couple of times. I'm also sure that you didn't get some data which was useful because the tape recorder

GIBSON (CONT'D) was not available at the right time. I think what Bill is saying is not just a lecture; it's a required item.

CARR Each man should have a tape recorder that could be plugged in at any SIA and get the timing signal through the SIA onto your recorder. What that means is your data recording for systems data would have to be on a separate ship's recorder. All the voice recording could be done on each guy's individual recorder. When his recorder's full, he could take the cassette out, put it on a dump machine, enable the dump machine, and let the ground dump the machine whenever they come over a station. You'd have it time tagged; you'd have uninterrupted voice without two or three different experiments going on at the same time. I think it'd be a lot easier for you folks to sort out here on the ground. The main point for voice recorders is when you start overlapping the recording requirement, you are just causing confusion.

POGUE I'm sure I missed several ATM briefings because of recorder assignment conflicts. Also there were a couple of funnies in the recorder system that caused the inadvertent actuation of the recorder. If we tried to start a voice recorder while ground had them tied up for dump and then we saw it was not coming on, we would forget about it. Then about 10 minutes later you'd notice that the green light would be on and you didn't know how

POGUE (CONT'D) long it had been running. As soon as ground gives the recorder back to you, your last command for "record" was then honored and it just started running the recorder. That's the sort of thing you wouldn't like to have in another system. I missed several briefings, I'm sure, during the flight. And there was data that was irrevocably lost because I couldn't get to a recorder at the time. But I just got tied up with another experiment, and by that time I was so tied up in a time line problem that I just let it go.

CARR Another area of tape recorders that was a bother - until we started screaming about it and then the folks on the ground made any effort to curb it - was the ground taking the voice recorder for dump while you were still using it. I had a hunch that the ground, if they would just look, could see that a recorder was in use. Probably they should be looking before they take over a recorder and start a dump. After we brought this to their attention a couple of times for that, the ground got real good about checking with us before they took it. The standard voice call they gave us - you were AOS Ascension for so many minutes and the tape recorder dump - you get so used to that verbiage that comes at you that you don't really even pay any attention to it. About the only words you pay any attention to are "Ascension," because that gives you an idea of where you are, and

CARR (CONT'D) tells you about how much time you've got if you want to say something to the folks. All the rest of the stuff you don't listen to because it's all standard verbiage and you just mentally dump it. We on frequent occasions, early in the mission, had the tape recorder snatched from us while we were busy recording data, and if you're not watching that green light while you're recording, you're liable to do a lot of talking to any empty mike.

POGUE The thing is, that if the crewman is wearing a Snoopy hat while he's recording, he'd never even hear the station call.

12.2 Thruster Attitude Control System (TACS)

GIBSON ATM Attitude Control: I think, in general, we got the job done satisfactorily. I'd like to recommend an addition to the way that the system works, especially when we started maneuvering for JOP 18's. I found I wished I had a little control stick where I could maneuver the spacecraft around for small pointing. I don't mind making large pointing changes via a computer, specifying the new attitude or the change in attitude. But I would have liked, for small changes in cluster pointing, to have had a little control stick in the same way we had one for the ATM canister itself. I think that would have been much faster and easier way of doing the JOP 18 which we encountered. As far as

GIBSON (CONT'D) the DAS interface, I found the use of octal in the system to be rather awkward, and I hope we never run into this situation again. That is, we had to figure out what maneuvers we were going to make in decimal and then enter them in octal. Fortunately, we were able to get some of the displays which calculated the maneuvers from decimal into octal, so we didn't have that problem. But then we ended up with having to do our arithmetic in octal. I think we ought to end up with a decimal system and let the computer worry about how to get that from decimal into octal. Those were the only two major problems that I encountered in working the system.

CARR Propellant, Thrusters, and Performance of the TACS: I would say, in general, it was nominal. Whenever the CMG's got in trouble, the TACS usually did an adequate job of manuvering us.

GIBSON We certainly could hear those things going off in the workshop.

CARR TACS: Worked the way it was designed and it was a good system.

GIBSON The one thing that was always hanging over everybody's head during the whole sequence of Skylab missions was the fact that we had a limited amount of propellant available. It compromised a lot of the science which was planned because you didn't want to blow the TACS on desaturating the CMGs when you get back to solar inertial or during the maneuver. In the future, we should find a way which is similar to magnetic torquing which you can use to desaturate CMGs and only have TACS required as a second backup. All the way through these missions, it's been demonstrated that things will come up which you can't anticipate initially, and that was certainly true in the early part of Skylab 1 and 2. I see no reason why we can't develop something like magnetic desaturation which has been used for other spacecraft and apparently considered for Skylab but too late.

CARR I still personally consider it to be a colossal design blunder in the TACS system that no check valves were put in the nitrogen system so that if you lost one tank you lost the whole system. I think it was also a colossal blunder that we did not design into our nitrogen propellant supply system for the TACS the capability of resupplying propellant. From a plumbing standpoint, it wouldn't have been any big thing to have done. We

CARR (CONT'D) would have lost the total capability if we had taken a meteorite hit or something on one of our nitrogen tanks.

POGUE And you should be able to service that from inside or outside.

CARR I think a very poor design decision was made. I think we're lucky we didn't lose it.

GIBSON I think what Bill said needs a little emphasis, being able to service from the inside. That's a very important thing. When we started getting low on TACS in the middle of SL-3, they talked about us taking a little squirter that we'd put out the scientific airlock which would have been no way near as efficient as just taking up another bottle of nitrogen and hooking it into the system.

POGUE (CONT'D) I am not convinced that you can't put check valves in there because it's a slight engineering change, that we can't do this that the other because it may be unsafe. Apparently everybody's idea of what was safe and what we needed and what wasn't needed was really not too correct. And I think a lot of credentials are in question now.

GIBSON One thing that we always used to hear when we were proposing any of these things when we pictured a contingency is, "Don't worry about it. The system is going to work as designed." You know for sure that some of the systems are not going to work that way and it's been demonstrated. You'd better have a fallback position. On many of these systems which didn't have a fallback position, we just about lost the whole thing. From here on, I think we should design systems that we can get to and work with in flight so that you've got some way out. That's true with the TACS and with the whole host of systems problems that we ran into.

CARR Essentially, what these two guys are saying is flexibility. The old maxim, if you can't find the justification, if you can't find a requirement for something, it doesn't go in is not logical. I think you should very definitely design flexibility into your systems so that they can be worked in many different ways.

12.3 Environmental Control System

CARR Pressurization and Gas Distribution - Purge & Venting, all of the items: As far as I'm concerned, this is one of the areas that was pretty well designed.

POGUE We noticed a definite change of sensitivity to temperatures at beta angle in our nitrogen system when we were servicing the bottles for the ASMU. This has to do with O_2N_2 stowage.

CARR I think, as we said several times in this briefing already, we were very pleased with the panel layout for the O_2N_2 system. I think that it was a very simple, very rudimentary system and it was well laid out. The panel was human engineered very nicely, and we just have no quarrel whatsoever with the pressurization and gas system.

POGUE With the one added comment that Ed brought up a minute ago, again servicing of the system should have been considered. Considering what we did with the EVA and some of the antennas, and with the ATM, it would have been much easier to take a QD over and stick some place and reservice tanks from a service module source.

CARR Thermal Control: Coolant Loop/Servicing: I don't think we need to debrief that too much. I think you got the television of it and you got our comments in flight about the servicing of

CARR (CONT'D) the coolant loop. It was very easily done. The only thing I can say here is, you certainly could have saved yourself a lot of heat and design problems and a lot of trouble if you had put some QD's in your coolant loop instead of having to play the saddle valve game, like we had to play. That took a lot of resources and a lot of men and soul-searching to convince yourself that it was a safe to put in a saddle valve and puncture a line. Whereas if you'd just brazed a quick disconnect in there early in the game with a safety cap on it, you would never have had a bit of sweat. You'd have been able to service it anytime you wanted to. Better yet, you could have launched the workshop with a coolanol servicing kit on it, fully charged and ready to go. And that's what I mean by designing flexibility into your system, instead of square-waving the system when the trouble hits.

POGUE It was impossible to convince people that this brazed coolanol system might experience leaks. When you design something like that, with a potential single-point failure you will have trouble with it.

CARR Electric Heaters: We did not use an electic heater during the mission. I'm pretty sure the radiant heaters never came on. Our temperature ranged from 71 approximately 81. During the high beta angle it did get pretty warm. The humidity was low, so the temperature really didn't bother us very much. When we arrived, the temperature was high, but it did not bother us as much then as it did later in the mission. Not much could be done about the problem of Ed's wall heating up. It's too bad that we couldn't have gotten a parasol or something over there to cool it off. But Ed's sleep compartment was really hot.

POGUE Thermal Coating and Radiation Shielding: The coating changes quality in performance as it degrades. Ed and Jer understand that problem a little better than I do because they saw that 149 stuff exposed out there. The coating on the spacecraft and on the outside of the workshop, and even on the service and command module turned brownish.

CARR I don't know if we could actually detect any difference caused by radiation thermal coating; what effect contamination had on that. But, definitely we can verify there was contamination on the thermal coating, so there probably was some effect.

POGUE As brown as it was you certainly had a subjective feeling that it was being changed.

CARR Yes, but there was no sensible feeling that we could detect at all.

POGUE Ventilation and Atmospheric Cooling: It was very good in the MDA and the airlock. The OWS experiment and sleep compartments were not so good during high beta angle. This goes back to the the condensing heat exchangers versus the OWS heat exhangers. The filters were not incorporated upstream of the OWS heat exchanger vanes, resulting in them being clogged. There was just no way of getting the debris out of there. Also we were getting degradation in there because of moisture collection in what was not supposed to be a condensate heat exchanger. Moisture removal in the condensate heat exchangers apparently worked great. The chamois were moist from the time we got up there.

GIBSON Regarding this subject, I would like to have the outlets in the MDA be directional. It turned out that the atmospheric outlets, or the cooling outlets, if you will, especially the ones in the MDA, only had a control knob on them which allowed you to vary axially the size of the angle of the flow. I would like them to be swiveled and point in any direction. That way it would have been most useful for cooling the rate gyros as well as cooling the crewmen at appropriate times.

POGUE I did not know why we couldn't have distributed some of the cool air in the MDA down into the workshop. We were always cool in the MDA but we could never transfer that capability down in the workshop.

I discovered something on the last EVA which may partially explain the reduced air flow in OWS. When I removed the OWS transfer duct, there was a small package of electrolyte sponges that we used for medical experiments, and some other objects down in there where it fits on. Apparently after an EVA, I had put that back in there without checking the inside area. It had blocked off about 15 percent of the screened area. This may account for the reduced flow from the OWS heat exchanger fan. I wanted to mention that in passing because it may help someone in the reduction of the data.

POGUE Anytime you have liquid and gas interface, it seems that you ought to have a capability of securing lines, throughout the vehicle. If we had had the capability of closing valves in the gas plumbing portion of the liquid gas separator, we could have saved many minutes, possibly hours, of effort on at least the second and third mission. We could have avoided considerable problem in troubleshooting.

CARR CO_2 Removal: We didn't notice any problems.

CARR (CONT'D) Odor Removal: No problems. The odor removal system in the workshop was outstanding. Odors just did not persist. They were very quickly removed. The waste management compartment odor removal was outstanding. There was no way anyone using the waste management compartment offended or bothered anyone else in the workshop. We were amazed how well the odors were removed and how good the workshop smell in general. I thought that we were going to have to get used to some very peculiar odors during our mission up there. When we entered the workshop, we were quite pleasantly surprised to find that there was no particular odor that bothered us. It stayed that way the entire time. I wouldn't guarantee that very much longer, because as we mentioned before, we left the workshop in the as-used condition, with little or no cleaning.

POGUE Contaminant Control: You had the solids trap and in addition to that you had biocide cleaning of surfaces.

CARR It wasn't a problem. The frequency with which we did biocide cleaning seemed to handle any problems which may have arisen. We just didn't have any trouble at all with contaminants of any kind.

POGUE Particulates were pretty well taken care of by the diffuser screen and the filters in the MDA.

CARR The diffuser screen was certainly a very handy item. Many things were dropped and lost, out of sight, and if you waited a few hours or a day, it would show up on the screen. The only things that did not show up on the screen were the very dense items such as the M074 calibration weights.

CARR EVA/IVA, open O_2 loop: It was no sweat. That is the way to go as long as you've got a lot of O_2. That system was designed properly. We had plenty of oxygen to use, so an open oxygen loop was appropriate.

POGUE There is one consideration. When Ed and I were out there working on that antenna, and we were removing part of the insulation in order to get to certain other parts, the O_2 system was really blowing the insulation if you were working in an area which was sensitive. If you knew you were going to have small pieces, that would be a consideration.

GIBSON That was a problem in the area of the ATM, for example, where people worried about you blowing in gas which had moisture. It turned out not to be a problem, but if things become a little more sensitive in the future, it could certainly be a problem.

GIBSON There is a single point failure in the mechanical design of the locking mechanism of the composite lock disconnect of the PCU. I'll try and show the people directly involved that we

GIBSON (CONT'D) do have a single point failure in the composite disconnect, in that you can take a rope with two motions, both of them being in the same direction, and pull your disconnect off. That nearly happened during the last EVA; EVA 4.

CARR Closed Chill Water System: That was a great system even though we had a few problems of leakage on EVA 2 and EVA 4. The system itself is an excellent system and it certainly is a boon to crewman outside under a heavy work load. It really keeps the body temperature down.

POGUE We had a continuing problem, apparently a design or manufacturing problem with the loop, and that was the liquid gas separators leaking. This caused problems on earlier missions by introducing gas down in the condensate system. There was a couple of things that were done right toward the end of our mission, trying to troubleshoot, that I didn't quite understand. More design work must be done on tolerances and QD's and gas liquid interfaces and that sort of thing. The system itself is great. I would hate to do a hard EVA knowing from the start that I was only going to have gas cooling.

CARR Lock Compartment: We were stuck with the lock compartment just because of the nature of the beast. In the future, if we're going to have use a lock compartment concept for going EVA, that the

CARR (CONT'D) lock compartment should not be in the middle of the workshop or the vehicle. It should not separate two living areas when depressurized. It should be on the end somewhere so that if it were to fail open or depressurize, that it would not render the rest of the workshop untenable, essentially, for any period of time. The lock compartment ought to also be designed strictly for EVA stowage so that we don't have to go through the EVA prep exercises that we experienced. A lock compartment on the end of a vehicle could be prepacked, premission. It could have good stowage provisions for all the things such as scissors and tape, and all of your EVA equipment could be stored there. It would certainly cut down on the overhead time presently required in the EVA.

POGUE You're right, that is a very heavy traffic area. And, of course, you stood the chance of damaging the equipment.

GIBSON There should be a better way to stow those items which you're going to take EVA. The way we were set up, they were just hanging bare off the wall, and when you got in there with all your equipment, you found yourself thrashing around, kicking the ends of Nikon cameras on a T025, or kicking a DAC or a whole multitude of other things which were lined up in there. All the gear was thrown in there with the crewmen and you were left to flail around. I don't think that's an adequate way to go. The gear

GIBSON (CONT'D) should be stowed off on one side so it can be reached EVA but is out of your general working path while you are trying to get in and out of the lock.

Refrigeration, Food and Urine Freezing: The problem that we did have was the way which the urine icicles froze. We had those freezing at a higher attitude above the drawer than desired, and that system needs another look at it, if anything like that will be used in the future.

CARR Food freezing was fine. It was perfectly reasonable.

POGUE Except for the cleaning of it. Something must be done about that.

CARR The defrosting of the freezers was really a bother. We seemed to have a large area there that looked like a seal problem between the two freezers in the wardroom area. Ice was building up between the two and setting up an airflow path that seemed to snowball the whole thing. Once that ice built up, and got an airflow path going, then the ice buildup began to accelerate and we had a problem. You knew that when the freezer doors were beginning to get hard to open, it was time for scraping.

POGUE Not only was it hard to remove the ice and the frost but the little inner door made it impossible to really do the best job of cleaning. The need for cleaning obviously had not taken into consideration.

CARR I'm not sure what good the inner door provided, or what the function of that door was. It didn't appear to be too necessary.

POGUE We didn't have a tool either. We had to make do with tools to clean that frost and ice off. Any future freezer should have the proper kind of tool for cleaning and also the freezer should be designed to minimize that buildup.

CARR The stowage efficency of the freezers was very low. A different kind of packaging system probably could have gotten us 50 percent more frozen food into the Workshop; that's an important increase because the frozen food was by far the most enjoyable food we had and I very strongly recommend that, we move more toward frozen foods. Steak, lobster and ice cream were extremely pleasant things for us as were the stablized foods. They were much more enjoyable than the rehydratables.

GIBSON That was a good point. Concerning the packaging, by putting cubes or squares or rectangles or cross-sections, we could have gained about 50 percent more food than what we had in there.

CARR Food, Urine and Water Chilling: We had moisture buildup in the chiller which we had to wipe out occasionally. We put a lot of tin cans in the chiller with the IMSS equipment and those cans rusted; got corrosion on them. We've already mentioned that as being somewhat of a concern to us. We probably ought to use different can material. If you need a

CARR (CONT'D) chiller for IMSS equipment there should be a separate IMSS chiller. The food chiller should be left strictly for the food.

GIBSON We had so many things mixed in there, from penicillin to cans to heat sinks and all those should have been in a different chiller.

CARR There was no restraint system inside the chiller, either. You just had to open the door and put stuff in and try to keep all the other stuff from floating out. When you wanted to get in there to get something, you had to pick what you were looking for from among all the other floating objects while trying to keep the others in, so you need some sort of a restraint system in there.

12.4 Crew Systems

CARR Restraints and Mobility Aids: We should temper debriefing of this whole area of Crew Systems with the fact that we've already given extensive debriefing on M487 on these very things.

CARR Mobile aids in the MDA, relative to the workshop, would have the rating of about 4.

POGUE Handholds and footholds in the MDA were too few and far between for my way of thinking, in some places nonexistent. ATM was good and the EREP and C&D panels were good. There were

POGUE (CONT'D) none for the VTS operator. The one for the material processing facility I didn't use on the M518 sequence.

CARR For 487 I used the one triangle in the upper left-hand corner, because that was the closest one. It was poorly placed for the furnace work.

GIBSON I always wished that the ATM foot restraint were lower. We all found that we were hunched over when we started operating the ATM. We got a little better as we got used to having a higher head position relative to the panel but we always seemed too high on the panel. I would much rather have that thing gone down about 6 to 10 inches.

POGUE You tend to get a cramp in your abdomen from tensing, because all the work stations were set up for normal one-g work. Your body tends to hold itself erect, and even slightly arching the back, so you are always held away from your workstation. I thought the aids around the MDA and STS were very poor. It was very difficult to do some of the tasks which were required. In fact I put up long straps, and ended up tying my ankles to single handholds, in order to have a good stable body position for doing some of the early work in the Coolanol servicing loop in particular and for some of the EREP instruments' calibrations.

CARR There was just no way for restraining the cameraman for the television work in the MDA. In the airlock module, we just had a few handholds, but not much work is done in the airlock module.

POGUE The aft airlock was the big one. We had to charge the PSS and we had to vacuum the OWS heat exchanger vanes and remove the cover and replace it. Those were two tasks I felt were very poorly helped because of the absence of restraints. You just had to wedge yourself in and use body english, to hold yourself in position.

CARR Now in the forward compartment area, I was in general very pleased with the restraints and mobility. Of course, the grid floor is the greatest part. I found the grid ring around the bottom of the water tanks to be very useful. I was never at a loss for foot restraints while I was trying to get into any locker.

GIBSON I found that the walls of the OWS were not really used as much as they should have been. I would have liked to have seen not just the one-g design in that total structure, but a three-dimensional design which would have put restraints in the walls. In that sense, I like the MDA because we did use all the walls all the way around, although the restraints there were poor. In the OWS, I would much rather have seen a lot of the dome wall used, as well as down in the forward compartment.

CARR There was a lot of blank area up in the dome that could have been used.

GIBSON I would have liked to seen triangle grid up in all those areas; we could have done a lot of useful work there.

POGUE You mentioned it earlier, Ed, that the work over there by the food lockers was very difficult because so much of the triangle grid was occupied by hardware installation. There were really very few places where you could put a foot triangle.

CARR Let's have comments on the aft compartment.

POGUE The head was probably the worst.

CARR That was absolutely impossible, but the experiment compartment really was generally pretty good. There weren't many places where you needed to put your feet that you couldn't find a couple of triangles to lock yourself in. The proximity of the overhead, the ceiling, I thought was good because you could reach out and hold on with your hands, if you wanted to, or if you needed to lock a foot in the ceiling, you could do that. I think the experiment compartment was by far the best place to be, as far restraints were concerned. The waste management compartment was terrible.

GIBSON You were just like a ping pong ball inside of a little cup; you bounced around in there. You never really restrained yourself. You just ricocheted off the walls.

CARR Of all places, where body wastes are handled is no place to be unable to control body position. That was just absolutely ridiculous. The folks who designed that did a nice job of making sure that all the smells were retained, and that you had privacy. Unfortunately, when they did that, they eliminated all opportunities to properly restrain yourself.

POGUE The restraints that were in there got in the way when the urine drawers were pulled out. They weren't very good for really holding your feet in.

GIBSON We should have, at the minimum, had a triangle grid on the floor.

CARR In the wardroom, until we took the floors that go with the pedestal out, I considered that to be pretty much unsatisfactory, too, because for the most part we refused to use the foot restraints that were there. We would stand to the side of them or we would lock ourselves in somewhere else to eat. Once we finally found the time to get in there and take those floors out and get rid of them, the wardroom became much easier to get around in and lock yourself down. But there still was a pretty

CARR (CONT'D) high percentages of triangles that were unusable, even when those floors gone, because of the beams underneath that were supporting the pedestal.

POGUE Restraints and mobility aids need to be explored in regard to their being tailored for a specific task location, for example, around a SAL, around a film vault, around an area where you are going to do paperwork, et cetera. I don't want it to be interpreted that we think that is all that needs to be said about that area because a multitude of comments could be made.

CARR Restraints and mobility aids in the sleep compartment. There were enough triangles in the crew compartments to adequately give us any restraint that we needed in there. The sleep restraints themselves; I think you have three opinions on that. I found them to be quite good, and was fairly well pleased with them. We found on occasion that they would loosen up and get pretty noisy. Bill's particular restraint seemed to be broken to the point where we couldn't tighten it and keep it really quiet.

CARR Lighting System: I thought the MDA lighting was more than adequate and you could pretty well set up almost any way you wanted to.

GIBSON I found that we were continually changing the configuration of the lighting around the ATM. Each of us liked it a little different way. I liked it relatively dark and the other guys liked it relatively light and we were forever changing those lights. Even when you're working at the panel you'd find the need to see something on the display a little better and you would have to leap off of the foot restraints you were in and turn off a couple of lights. In that circumstance, I would have liked to have had control of the lighting around the ATM right at the ATM panel itself.

POGUE I covered this in an M487 debriefing, but I think that there is the case to be made for various and sundry types of dark curtains and shades, much as radar men use when looking at scopes. It would have been nice if there was something like that around ATM. This may affect the ventilation. I think, however, that there is a way of handling it. It would have been good to have a double curtain at the MDA forward hatch for the commentary photographs. Of course, no one knew ahead of time that we were going to be using those windows.

CARR In the airlock module area, the lighting was more than adequate. You had selectable, bright or dim, and I had no complaint with airlock lighting. I did notice that light bulbs were inclined to plate out. Apparently, the filaments would plate out on the inside of the glass of the bulb and pretty soon your light bulb that started out nice and bright, would get very dim and you'd have to change it out. I completely changed out the bulbs in the aft airlock one day because the lighting was getting so dim.

POGUE One of the things that bothered me a little bit about those incandescent bulbs was the covers. I know they were supposed to slide off but they were always getting knocked free. I would like to have a little more positive snap shut feature on those things so they wouldn't always come loose.

CARR In the workshop area, lighting was easily controllable and quite adequate. You could go from bright lighting in the dome area and the forward compartment to very dim lighting or no lighting, whatever you wanted. There didn't seem to be any great problem. One area where we did run into a few problems was when somebody using the antisolar airlock needed to have it dark. It meant that the whole workshop had to be darkened because one of the disadvantages of the grid floor was that it also lets light as well as air come through. We had to turn off the lights in the wardroom and the experiment compartment, and everyplace, in order

CARR (CONT'D) to get the forward compartment dark enough for dark adaptation for some of the experiments we were doing. This again is a good case for the idea that Bill proposed of hoods. It would have made it possible for a crewman to do a scientific airlock experiment without having to turn off every light in the house.

POGUE Before I forget, we need a wristwatch that has a real good night dial light. After the lights went out, the Accutron dial went out, too. We couldn't really use it in the dark.

POGUE Counter argument to that would be that the experiments were all ad hoc. I'll never see the day coming where we will not have ad hoc experiments. There will always be that last item that's thrown on board, where you do everything manually. We do need a good night wristwatch.

GIBSON Going back to the problems of the SAL: I think Bill proposed a reasonable idea with a hood. Two problems that we ran into there: one was the case where you need complete darkness, as in the S063 looking at the airglow, for example. You'd find that the record light on the opposite SIA would show up in the field of view and reflect into the instrument; something that small would interfere with the operation. Having a hood surrounding the whole thing would have eliminated that problem.

GIBSON (CONT'D) Another problem I encountered when running S063 on the day side was I wished that I had a small night light right next to the SAL, which I could have used to shine on the checklist and the pad. I would operate the S063 ozone instrument, look out in the Sun, down at the Earth, and then try to look back in and look at the pad and found out that I was completely blinded because I had nothing but sunlight coming in my face. I couldn't read it. I finally had to tape a flashlight, which I ran down during the course of two or three orbits. I don't think that was the way to go. I think we needed a little night light at the SAL's as well as something we may get to later, which would be a checklist holder.

CARR Lighting in the wardroom, the sleep compartments, in the experiment compartment.

POGUE Experiment T002 could have been performed in the wardroom if we'd had a way of blocking off light other than that enormous hood that they had, which was much too complex. That's not the way to go. We had a shade door on the wardroom and it was translucent. I could have darkened that area pretty well there if that would have been a little less transmissive of light. Partition doors are something to consider in the future. As far as the lighting in the wardroom itself, it was great.

CARR Lighting was certainly not one of our problems in crew system. There was plenty of lighting and it was flexible enough so that you could turn it off, if you didn't want it.

GIBSON Personal Stowage: I found no reason why we should have had a whole multitude of trash bags and other gear stowed in what should have been a crewman's personal stowage location.

POGUE Even the sleeping bags didn't need to be in there.

GIBSON That whole area for each crewman should have been opened up to his own personal stowage and not those of the ship. I think we had enough other dome lockers and locations around that we could have taken care of all those other good things that we had to stow in sleep compartments. I would like to have seen something also with smaller compartments that you could open. When you opened a large locker, you opened yourself up to everything that happened to be in there. In terms of personal stowage, you ended up with a host of many small things, with pencils, pens, eye glasses, and who knows what else in there. Every time you opened up one of the lockers, it all came out at you. I think we could have done a much better job in designing that. One thing we do need is a soft stowage, for film and all kinds of small things. The configuration of these small items cannot be predicted. The stowage needs to be something like a very soft foam that will grip whatever is put against it and that

GIBSON (CONT'D) will be very flexible. Something like that would have helped our film stowage, all the personal stowage, and every small item that you cannot predict ahead of time what it's configuration will be.

CARR I broached the subject for stowage for crew quarters in the M487 area. I proposed that at least one locker with a lot of pigeon holes be designed for personal use. The door of this locker should be hinged so that it opens downward creating a Ben Franklin-type disk, and it should be at an elevation that makes it compatible for reading or writing even if a crewman is hanging in the rack. Inside the locker there should be soft stowage provisions for things like pens, pencils, and any other small personel items you might want to store. I think that's definitely a requirement in a system like that.

Regarding stowage in general, I thought the stowage in the whole spacecraft, generally, was good. We have already pointed out some very definite problem areas. The most glaring example of a stowage problem was the film vault. That's been thoroughly kicked and I don't think there is any need to jump into that one any more. As we used equipment, particularly in the wardroom areas, stowage lockers opened up and we found them to be very handy for stowing items. Once we got into the free-wheeling food system where we had to select a lot of things

CARR (CONT'D) from overage, we found that the pantry system of stowing food was superior to the meal-type stowage. I think, maybe in the future, it might be a wise idea not to go back to the meal-type stowage; it might be well to go to the pantry system. Maybe a mixture of the two would be best. Use meal stowage strickly for the meals but do not stow overage with the meals; stow it separately, pantry style. The dome locker stowage, I thought, was good. I think, we probably should have had larger decals on the dome lockers. Other crewman should have been strongly encouraged to list the contents of the locker on the outside. As the stowage in the locker changed, the crewman shouldn't have felt obligated to find another decal, stick it over the old one, and bring it up to date. I think the cover of the locker should have been a writing surface. The stowage book was about a 50-50 proposition as far as I was concerned. I think the other guys have a lower estimation of the value of that book than I do. I think approximately 50 percent of the items that I was looking for I found by going through the stowage book. The others, I had to find by exploring and prowling around.

POGUE I have a couple of comments. I do have a rather low opinion of the stowage book, but I do not have a low opinion of the people who worked on that stowage book. I have some positive suggestions

POGUE (CONT'D) to make, which I think will improve it. First, I think the only thing that's really useful in the stowage book is the alphabetical listing. The stowage maps are nice; they serve the system more than they serve the crew. I can't argue with including them. If you go to a locker and look into it, usually, there's enough printed on the outside of the locker to tell you what's in there, or you could open it, look in, and find out. That really sort of preempts the value of the stowage map itself. However, I do not feel strongly about it; I think it's a good item to have, particularly, for flight planning. But my estimation of the value of the stowage book is in the alphabetical listing, but it should also have a classified system like a telephone book. It should list an item under every possible garden-variety term. The individual who is responsible for an item should also be responsible for entering that item under all possible terms of reference. We had items in the vehicle that were listed in certain callouts and some of the checklists that were not included in the stowage book. It should be the responsibility of the checklist manager to see that all items of equipment that he calls out are either referred to by stowage locations in his book or that there is reference them in the stowage book itself. That, to me, would make a stowage book very usable. Again, I want to emphasize the fact that I'm not directing this criticism in a destructive manner

POGUE (CONT'D) toward the people who worked that stowage book. I worked with the stowage people on some of the lists, and I know that a lot of good thinking went in on it. However, the final product could still be improved, and it was not all the fault of the people who wrote the stowage book.

CARR Okay, I guess one particular gripe we had (we made it on the tapes and I'll go ahead and make it again) was that I couldn't really care less what was stowed in E-699. Some of the stowage locations that were called out were so ludicrous that it was just ridiculous. Apparently E-699 was the waste tank down below us. We had items that were called out that were listed, for example, like 12 of them in the workshop and 9 of them in E-699 and there were 3 somewhere else. And I guess what that means is that 9 of them had been thrown away. I really don't care what's been thrown away. I needed to know what was available in the workshop for my use. All the items in the stowage book that were assigned to E-699 and some of the other odd stowage locations, I think, were really a disservice to us as far as trying to find something. There are some areas to which I don't think it was necessary to assign location numbers. I know we were somewhat instrumental in establishing the requirement that everything had to have a number, but somewhere along the line we should have tempered that requirement with common sense.

CARR (CONT'D) There were some areas where something was just not called a station 699, and it was really called a trash airlock. When you tell somebody to go to station 699, if he doesn't know what 699 is, he's got to go to a stowage book, research it, and find out what 699 is. If you'd have said, go to the trash airlock in your procedure, there would have been no question. There were several instances of that in procedures where we were directed to go to a certain station, and we didn't have the slightest idea what station it was, but we had a hunch. We'd go to the stowage book, find the number and, sure enough, it was a station or a location that was commonly known by a name rather than a number. I think our problem with stowage was that we worked so hard to make the listing computer compatible that we dehumanized stowage to a point that it sometimes caused us problems. We've got to be careful about that. Let's not let the computer system drive us to a point that we can't really relate to the human side.

Clothes: we've pretty well talked about clothes in M487. I think we were for the most part satisfied with the clothes.

CARR (CONT'D) I think Bill indicated on one occasion that the zippers should have had pull tabs on them. Ed and I agreed with him 100 percent. Those zippers were sometimes hard to locate in your pockets. If there was a little pull tab, it would have been much easier to grasp.

POGUE On our brown shirts with the zipper pockets, I planned on using that zipper pocket for a number of items and I never did. The way clothes work up your carcass in zero gravity, that zipper pocket was actually almost over my shoulder. In the future, if you have a soft shirt like the brown shirt, something like a kangaroo pouch in it would be nice. My trousers all fit too big because I lost some weight before flight. It'd be nice to have A little more adjustment capability on waistband would be nice, because you also have visceral, shift in zero gravity.

CARR Yes, that's something that the medics ought to really work on with the clothes people. In zero g, a guy becomes more slender and grows taller, and those things ought to be taken into account in clothing design. I think here we have a legitimate slap in the chops for somebody, and I don't know who it is in the clothes area. All those neat little extra pockets that we had put on so that we could carry our little folder books around and our pens and scissors and all that stuff were not properly sized, and we were unable to use them in the manner

CARR (CONT'D) for which they were designed, and it was a great big pain in the neck. I think somebody really goofed on that one. We paid the price with inconvenience. I think that was a very bad deal. The flashlight would not fit in the flashlight pocket, the scissors would not fit in the scissors pocket, and the book would not fit in the book pocket.

GIBSON And the knife would not fit in the knife pocket.

CARR So you found yourself putting things wherever you could. I'm the kind of person who likes to put things in their place and have them there so that when I need them quickly I can just grab at them. If I can't always put my pencils in the same pocket or put my flashlight in the same pocket, some time when I need them, it will cost me extra time and thought process to locate my pen, pencil, or flashlight. And that's the kind of time you don't need to waste. You don't need to waste time looking for something in your pockets. You ought to know where each item is, and you ought to be able to get to it quickly so that you can do the important things without delay.

POGUE I mentioned this once, I think, and the counterargument was that the garment people had been given that requirement and they had made all the clothes that way and we were stuck with it. A suggestion for future design is that something like cowboy holsters be incorporated on both sides of the trousers so that

POGUE (CONT'D) you would have a receptical for a zip-on pouch of some kind. This pouch could be made flat with little recepticals on it or that would incorporate whatever little pieces of hardware you wanted.

CARR In general, I would say that the clothes were good. I even wore the brown shirts near the end of the mission because they weren't quite as smelly as I had found them to be on the ground. I guess the main reason they weren't as smelly is because we didn't sweat as much up there.

GIBSON I personally liked the white shirts though. I didn't like the brown ones very much. They were a little hot and uncomfortable and itchy.

CARR A very pleasant feature that I found was the ability to zip on and zip off the legs of the trousers. I found that to be very pleasing and convenient, and whenever the weather was warm, I was quite comfortable in the short trousers.

POGUE One thing that would have made the trousers and the jackets nicer would have been if I could have gotten the legs on and off over the triangle shoes. It could be done but it was a problem. I liked the idea of having that sweat shirt fitting underneath. All my sleeves were too long. The over cover there was just a little bit too long and I ended up cutting

POGUE (CONT'D) those with scissors. I liked the idea of having that knit fitting on the arms and the legs but it would be nice to have a little more stretch.

GIBSON I don't think we should let the clothing debriefing go by without mentioning that we all got a little tired of looking at brown. I sure would have liked to have seen some different colors up there. I know the problems you had with trying to make fireproof clothing and the problems of dying, but I hope that the effort doesn't stop. Brown surely is a tiresome color, and I think something in the order of blue and green would have been most welcomed. We ought to push for it in the future and not just live with the drab brown we lived with during Skylab.

CARR I think that's a very good point. I think that future clothing design ought to be rather colorful and it ought to be varied.

POGUE Crew Quarters: The only point that I'd like to make is about the sleep compartment. I'd still like to be able to adjust air flow from inside the sleeping bag.

CARR Yes. Another item that we discussed in a group and haven't put on tape yet is the idea that crew quarters ought to be more spread out. The three crew areas were so close together that if a crewman did have a loose bed and did do any thrashing at night, he bothered the other two crewmen. If a fellow wanted

CARR (CONT'D) to stay up late and read or listen to music or do something like that, he had to be very, very careful not do disturb the others. Or if someone woke up early in the morning, he had to be very, very careful not to disturb the others. In future spacecraft design, the crew quarters ought to be separated as much as possible to give a person the opportunity to move around in his quarters and do things that he wants to do without constant concern about disturbing other people.

POGUE Also, the individual quarters ought to be away from the traffic flow to the head because that can cause a lot of noise too.

GIBSON I think the traffic pattern that we had was not very good. In a building here on the ground, you have a hallway with rooms going off on either side. Up there, essentially, we had rooms with the hallway going just about right through the rooms. If I went out to the head in the middle of the night, I went through their sleep compartments, and I don't think that was proper. I think you ought to construct all the rooms in the vehicle off of a hallway.

CARR We talked about the idea of having a personal stowage and a personal desk and the personalizing of the crew quarters, and I think that's important. In future space flight, when man starts staying up for long periods of time, each crewman should have a place to call his own. It's got to be a place that can be

CARR (CONT'D) modified in the way any individual desires. We should start thinking about that right now and plan for it.

CARR Trash Disposal: When we arrived, there were no trash disposal bags at all. The only bags available for use as trash bags were the trash bags with the membrane and the sealable urine disposal bags. The urine disposal bags were in rather short supply, so we used the trash bags almost exclusively and saved the urine disposal bags for the disposal of urine. We found the urine disposal bags worked well. We could usually get from three to five full urine bags into those bags, and we disposed of them through the trash airlock without any problem. Then about halfway through the mission we suddenly came to an impasse on that. We found we could only put two full urine bags into a urine disposal bag and dump it; more than two urine bags would swell, causing difficulty when the urine disposal bag was pushed into the waste tank area. We were worried about jamming the trash airlock when we were dumping only two urine bags at a time because even two urine bags would jam it slightly. We finally began dumping our urine through the urine dump system and then throwing away the empty urine bags. Even those were inclined to swell and occasionally caused us a problem with the trash airlock. Our final solution was to dump the bags, roll them up and put a piece of tape around them. That way, we could

CARR (CONT'D) get four or five of them into a trash urine disposal bag and dump it without any problem.

CARR Trash bags were beautiful. They held only that amount of trash which would dump easily at the trash airlock. We had no problems with the trash bags whatsoever.

Food Trash Disposal (overcans): We would remove those from the wells and place a herringbone around the outside of the can because that was the best way to dispose of the herringbone. Then we would slide the cans into the trash bags and dump them. When we had a full waste food compartment area in which the cans needed to be changed out, we would get trash bags and empty them. We needed some place to put the overcans as soon as we got them out of the wells. It was very difficult to find a place to anchor an overcan while waiting for a trash bag in which to put it. When we reached a point where we had to change the overcans in the food disposal wells, we would grab a trash bag from the lockers in the wardroom or the trash locker in the waste compartment and insert the trash cans into that through the membrane area. Fitting a large overcan into a trash bag was difficult if there were a lot of trash in the bag. We found that the best way to do it was to dump the trash cans first, then try to manage separate overcans.

CARR (CONT'D) We had been warned by the SL-3 crew that the operation of the trash airlock shutter was no longer a one-man operation. I could do it at the beginning of the mission, but apparently the system changed, warped, or was modified in some way because I couldn't do it later. It became necessary for one man to stand on it, brace his hands in the hatch on the floor above, and force the lid to the trash airlock downward, while the commander, as trash airlock operator, threw the latching handle up over the edge of the lip of the cover and locked it down. We have some movies and photos that will demonstrate the two-man trash airlock operation. On the average, trash airlock dumps were necessary only about once every 3 days. As trash accumulated, we would put it down in the well between the trash airlock and the floor of the experiment compartment until we had five or six bags. Trash dumps were usually done in the evening before retiring.

POGUE It would have been nice to have some kind of netting to hold the bags in there.

CARR A problem in the airlock operation was the lack of mobility restraints for the operator. If the well was full of trash bags, there was no room for the operator to anchor himself by putting a leg down into it.

POGUE Food Management: The human engineering of food management needs improvement. A principle was violated in handling the food, because each can was handled two or three times. There is a simple solution to this problem. Instead of removing each individual can with our fingers, we could have used the herringbone as a transferrable receptacle. If that had mated with our food drawers, it would have cut down food transfer time considerably.

CARR A lot of crew time was spent handling the ambient and frozen food transfer. The frozen food transfer was fairly easy. We would just take a bundle and put it in a nearby freezer. However, the system used in food transfer was more time consuming than necessary. Designers of future systems ought to consider this area and try to avoid a procedure that involves handling each can several times.

Freezer space utilization was very poor. The efficiency level was probably 60 or 70 percent. We could have stored 50 percent more food if we had had a different kind of packaging scheme. Frozen food was the best food we had.

Waste Management: I am pleased that we didn't have an Apollo-type waste management system. I was overjoyed with the waste management systems and the way they worked. We all had reservations regarding the efficiency of the fecal and urine systems.

CARR (CONT'D) We had some disagreements over this system as it went through development and testing. We made many changes at the last minute in order to make it work, and, the system worked quite well. We had a few problems, and designers of future systems should consider these problems.

The concept of the urine system is very good. Using a blower/separator system which moves the urine makes the act of urination a natural thing by eliminating cuffs. We had some equipment situations that probably were not optimal, but we have looked at the concept and we know it's good. The bag system is good if the procedure is to pool urine all day and take samples the way we did. The sampling system needs improvement. It is too time consuming, and time up there is too valuable to devote 20 minutes per crewman to obtaining urine samples. In the future perhaps we will not need to pool 24-hour samples. If that's the case, we could have a system that collects the urine in a separator. Once or twice a day a crewman could throw the switch that dumps the separator or the collecting system into a waste tank, and you need not worry about it again. If there is a future requirement for urine sampling, then we must find a much more efficient way to do it. We had some systems failures. I had two bags fail. The little boot on the bags that connects to the separator was the most common point of failure. Bill had one or two, and Ed had two.

CARR (CONT'D) This was a weak point in the system. That boot leaked occasionally, and it was very messy.

CARR The biggest single problem with the sample bag system was getting water, air, or gases in the urine samples. Very early in the mission we devised a way to solve that problem, but the solution was time consuming. It was also dangerous because it required that we take the entire bag, connect a sample bag to it, and then swing it. If you were not careful and you allowed that sample bag to hit anything, you would have a couple hundred cc's of urine floating around loose in the spacecraft. That would have been a very messy business to clean up, very distasteful. After working with that system of swinging the bags for 4 or 5 weeks, I decided that it was too dangerous, and I stopped doing it. Consequently, the people working with the urine system will notice that my urine samples have a noticeable amount of gas in them because I used the sampling system the way it was designed, and did not try to help the system at all. Bill and Ed were more conscientious. You probably got better samples from them, but I thought that you had enough of my urine samples that a little bit of air in them probably wouldn't matter. I saved 5 minutes a day by not using the swinging method. Forcing the urine into the sample bags was a dangerous business even in the nominal system. If the little

CARR (CONT'D) base plate inside the cutter crimper got caught, or if the skin of the bag worked its way over the sharp corner of the base plate, the system might leak. We were so short of sample bags that we could not throw a bag away and get a new one; we had to repair it. You have probably noticed that a few of the bags have gray tape on them covering leaks.

POGUE The urine system has serious hygiene implications. Urine spills are not only messy; they're potentially a health hazard. The drawers were all way back in an inaccessible area. It's true that you could remove the entire drawer and get back in there but it still was difficult. Lighting was not provided for proper inspection of that area. The lighting, which was all in the ceiling of the head, was inadequate for proper inspection of the urine drawers, which were at floor level. The system design was also rather inefficient. The connectors were all hidden well back in there; however, during training I had learned to mate and unmate the connectors by feel. One grounding strap on the urine drawer kept breaking off, even in normal removal and reinstallation. Another inadequacy of the urine system was the lack of a provision for securing items during the process of sampling and changing out the urine bags. Although retaining devices are necessary for proficient management, there were very few of them throughout the workshop. No thought had been

POGUE (CONT'D) given to the human engineering of the operation. When the procedures were written, it was assumed that the individual would somehow, between his legs and between his fingers, under his armpit, or wherever, hold all these loose pieces of equipment that had to be managed during a normal, day-to-day processing of the systems. Urine receptacles and bags and all kinds of pieces would frequently get loose and float into the experiment area.

POGUE Any part of a system that comes into direct contact with urine bags should have some kind of quick disconnect and an easy access for cleaning. The big base plate that received the urine bag for measuring total volume was actually bolted into the waste management fixture, and could not be quickly removed for cleaning underneath. Now, any time you're handling a urine bag, you're going to have urine leakage. I'm not talking about urine spill; I'm talking about the normal oozing of fluid from supposedly leak-proof fittings. You had to put the urine drawers into position on that big metal plate by putting the urine boot itself into a recessed area on the base plate. Almost every time you applied pressure to it, a few drops of urine, sometimes as much as half a cup, would leak into the area. It was not easy to clean those; I actually took a pencil and worked tissue down around the cracks of that thing when I got leaks. That's no

POGUE (CONT'D) way to work with a system. I'm sure that the biologists would really raise their eyebrows if they saw that kind of operation.

CARR I remember that we had to keep a pencil and a pen in the head constantly so that we could keep the spread down.

POGUE The quick disconnects that I mentioned are a must for all items associated with any waste processing system, even a washup, so that you can pull it out and wash the whole thing.

GIBSON The mechanical complexity of the separator's exterior made it impossible to clean, whether you could get at it or not. The only effective way to biocide that would be to dip it. There was no way of completely cleaning that urine drawer, with all the recesses that existed there.

CARR Good point. Fairing a complex system like that would make it easier to clean.

GIBSON It should be possible to clean that urine system quickly and completely every day, if the crewman choose. There's no way to clean the present system thoroughly, even in an extraordinary length of time.

GIBSON I don't think the system of swinging the bag was well thought out because it did not allow for the possibility of getting a little bit of gas in the bag. I evolved the system, which I

GIBSON (CONT'D) thought relatively quick and safe, but which proved to have at least as much apparent danger as did squeezing the bags. I don't think either of those was an acceptable way to decrease the air bubbles. We've got to come up with a technique that will remove gas more effectively and safely than either the manual swing or the centrifuge. Maybe a centrifuge can be developed that will work like the one we have for the blood separation. In any event, the systems that we had were inadequate. But I'll second what Jerry said initially, that my fears about the system were really unfounded. In general, it worked quite well. I did have the one-time anomaly that morning when I popped the drawer open and found about 200 cc's of urine floating up toward me. This is still an unexplained anomaly; maybe someone down here can understand how it could happen.

POGUE It would be nice if you had something like a mechanical tab indicator to let you know that the urine system was configured properly. It was possible to fail to push that urine drawer all the way in. It might look completely closed when the gaskets were not quite locked together. That happened to Owen, and I think it happened to me once.

CARR We ran into a case once where one urine system was not drawing well because somebody else's drawer was not sealed.

GIBSON We also learned rather quickly to make sure that the separator was on before using the system.

CARR In my view, the fecal system was an excellent system. The idea of using airflow to help move the feces away from you is good. It would have been a little bit nicer if it could have been stronger. The feces still attached to you and you still had to remove them, move them away from you as you get off the pot. The odor remover was outstanding. Again we have the same general gripe that we had with the urine system, that it takes too much time to process it. The paperwork takes three times the amount of time as the actual doing. I think the best time that I remember for the crew was about 12 minutes. For the most part, I would say that the average time for the use of the fecal system was around 20 minutes. For body waste management, we need to find a system that's at least as good as what we have here, and that is something that doesn't require 20 minutes of intense effort and concentration just to get the stuff processed properly.

POGUE There was one thing I pointed out in the M487 briefing about the solid waste management, and that is the actual posture. I found it awkward to have to straighten my legs out while sitting on the fecal collector.

GIBSON Couldn't you put your feet back up in the little notches?

POGUE I put them back in sometimes but most of the time I was in a rather awkward position. If the collector had had some kind of a 90-degree configuration, it would have been better. Again, I think our problem is not trying to improve the configuration as much as it is trying to keep the one that we've got.

GIBSON I did not experience that problem.

CARR I put my feet in the hole, back behind the urine drawers, and assumed a rather natural position.

POGUE I guess I did that a couple of times but most of the time, I found myself in sort of an awkward posture.

CARR A good design criterion is that it should be designed so that you can assume the posture that you're used to assuming when you go to the bathroom.

GIBSON One thing I found to be a big time consumer, which may not exist in any systems down the line but has in both the contingency fecal bag and the fecal bags, that we worked with, is the million and one pieces of green tape that have to be removed to expose adhesive surfaces. I saw no reason why we could not have one or two pieces of tape to be removed to seal that bag. It became obvious to all after we tried that thing a few times that even if we went to school on the subject, we would not become proficient bag folders and be able to fold

GIBSON them every time, the way they were designed. It was just an overly complex design that was not called for, and just consumed a lot of time.

CARR I agree with that 100 percent.

POGUE I got the impression that the designers went from Apollo fecal bags to Skylab fecal bags. And since they had all these little green pull tabs on the other bags, the system perpetuated itself, and what was good for Apollo would be good for Skylab.

POGUE Water System: I thought that the flexibility in the water system was great but that the management of the system was undesirable but maybe necessary to have flexibility. However, when you're building a system from scratch, I don't think it's a whole lot more difficult, or even more expensive, to put all the plumbing in there and then have some kind of central control or at least a local control which doesn't involve pulling hoses off. I always had some awkward hoses out, and it wasn't really the way it was supposed to be layed out, but it was the only way I could configure it. It seemed disorganized.

CARR The flexibility was great, but the complexity was a pain.

POGUE I think it could be a possible flight safety problem on a long, long mission, having all those hoses hanging around there. I weaved them in and around that blue foot ring like it said, but I always felt that the system came in late and that it was a make-do operation.

CARR We also have a few specific instances of improper or inadequate labeling. I think they've already been discussed in the WMC, so I think we don't need refer to those again here. I think we've made it known that certain connections and fittings and attach points were not well labeled, that they weren't clear.

Personal Hygiene: I think we kept ourselves extremely clean. It was one of the more pleasant aspects of the day. When we did our exercises, we worked hard, we sweated hard, and the opportunity to clean ourselves afterwards was welcome. It took a lot of time because all we had to clean ourselves with was a washcloth and a water squeezer, and that's a time consuming process. I think the shower, although it was a last-minute sort of thing, and sort of an add on, was an effective thing. It was very pleasant, but again it was a time consumer. We've already given, in M487, a lot of good remarks on the shower and what we think it's good for and where the bad points are. I don't think we need to spend any more time on that.

CARR (CONT'D) Let me just at least say that the drive to keep yourself clean is still with you up there. We found it's easier to stay clean up there because we didn't sweat as much. We found that one full body wash per day was quite adequate, and that one shower per week was quite adequate. In fact, you could get along without the shower, if you kept up with the body wash and did a good job with that. But there's no substitute for running water all over your body and getting it in your hair and a shower is a very refreshing thing, but again it's very time consuming.

POGUE About five times in the flight, I got a lot of urine on my hands. There must be some kind of hygiene wipe that is not a wet wipe that would guarantee a safe feeling in washing your hands without staining yourself with a dirty brown color. I don't think Zepharin quite does it. I would like something that has the power of the biocide but doesn't have that discoloration along with it. There's a subjective feeling that you're never going to get yourself quite clean even though you've soaked yourself down.

CARR I think the soaps that we had were quite adequate, but to this day, I'll never understand why we had to use soap that smelled like dog shampoo. I just don't understand why they did that to us. It doesn't make sense. It seems to me we could have had the same cleansing action with a pleasant odor too.

GIBSON I second that. I really didn't enjoy that, especially when we ended up working with it in the shower. That was really dog shampoo in there. One item which I wished I had along was a head massager. You can buy them in any store. I suppose the reason we didn't have them was that there were no metallic ones. Quite a few people wouldn't allow us to have plastic.

CARR We made these points in 487, but each man should have the opportunity to choose his own deodorant, his own shaving cream, and the hardness of his toothbrush. I think that the toothbrushes were too soft. We told the folks that before we left and we still feel that way. I was very grateful to get back to my good old hard toothbrush at home. Somehow we got locked into brushless shave. In the future we should not be afraid to use aerosols in space flight. Maybe there's something I don't understand about the physics of aerosol cans, but I proved to myself that foam works because the fire extinguisher worked like a champ. Nobody can tell me that you can't use an aerosol foam up there.

POGUE There's no reason why we couldn't build an aerosol can smasher.

GIBSON Or build an aerosol can holder which, if it does rupture while you're using it, only the business end of it would be exposed.

CARR That is a useful thing. It comes under general hygiene. I'd have given my right arm for some of that spray can formula 401 or Simonize or whatever those things are in the can that you can use to spray around. They smell good and have antiseptic in them and can be disinfectants for cleaning. That certainly would have been nice in the head and other areas where you see a urine spill on a wall and all you have to clean with is some biocide wipe. It would have been nice if you'd had a can of either a windex type with a plunger-squirter on it or an aerosol.

GIBSON We could have used a can and a half at the trash airlock.

POGUE The point that Jerry is making is well taken. I have read previous crew reports where the crew reported a strong subjective pleasure in noticing a familiar odor. Why is it that people are taking measures to deprive us of all the familiar odors? When things stink like a doggone john, it's nice to change that. One of the high points in the flight was when I put the antifog helmet compound inside my helmet. I got a distinct sense of relief and pleasure when I opened up that antifog compound because it smelled like Joy soap. If you're going to be there for a long time, you need to smell something that you like. Why they took all the odor out of that Neutrogena, I'll never know.

CARR Anything else on personal hygiene?

POGUE One other thing; in zero gravity, every time I was washing, the operation would be something like this: You'd take a washcloth and wet it down, get soap on it, and try to transfer it to your body. There were always spills in transfering the water by a washcloth or towel to your body. After you soak the body down good, then you have to get it off, and it's the same thing all over again. I realize that the shower is a way to take care of the body, but there's a good argument to be made for some kind of hemispherical enclosure with cutouts in it for washing your hands and face. That way, you can handle water and contain it within a certain volume.

CARR I made that point in a 487 debriefing one day. In garages where they do sandblasting, they have a device that you put the spark plug inside. Then you take your hands out and put them in gloves inside the device, turn on the sandblaster, and work. That's the sort of thing you could use here for washing. That is, you put your hands through some sort of sleeve that seals at your forearm. Then you could dump in a couple of cups of water and you could get in there and slosh around in the water.

POGUE It would be great to be able to do that.

CARR Bill and I had a problem cleaning our double-edge safety razors. There's just no way to do it.

GIBSON Probably, the only effective way to do that was to get it wet and then to belt the side of it against something where the impact would dislodge anything inside the razor. That kept it functioning well for a good period of time.

CARR Vacuum Provisions: I think the idea of a modern home where the vacuum system is built into the home is a valid idea for the next space station; that is, make your vacuuming more convenient. We carried that double high-power accessory cord around the spacecraft a lot to do vacuuming. It would have been good if we could have avoided all that. I would say the vacuum cleaner itself was on the edge of being unsatisfactory as far as the amount of vacuum it provided.

GIBSON In many jobs, it was inadequate. You couldn't get into small crevices with it.

CARR Yes, our vacuuming tools were not what they should have been. Bill did a good modification on the crevice tool that did the special job we needed. I think you need more special purpose tools for the end of your vacuum cleaner. There's nothing wrong with having plenty of flexibility on vacuuming provisions.

CARR (CONT'D) We found a vacuum cleaner to be a useful thing because 2 days was all it took for a screen to get clogged up. I'm sure the efficiency of that screen; that is, the amount of air it would pass, was rapidly reduced as the buildup proceeded. An idea occurred to me in flight for increasing the flexibility of the vacuum cleaner without a gross increase in weight or in the number of tools. Take one particular tool design that interfaces with the vacuum cleaner but have ends or faces that can be changed on the metal end of the tool itself. You could have one or two tools with soft metallic ends. Hard finger pressure would be used to change the end of the tool. Normal work wouldn't change the contour of it, but if you wanted to change the contour of the ends, you could use hard finger pressure to do it.

POGUE If we had had something like that, I think I could have gotten the OWS exchanger vanes cleaned out. It is not an unreasonable request to have lights on the end of the vacuum cleaner. We worked in some areas where I was holding a flashlight with my teeth and using both hands with the vacuum cleaner.

CARR I think the little cleaner bag was fine. It was the right size for the amount of stuff we were scooping up.

POGUE It also saved our vacuum cleaner a couple of times. I didn't realize I was pulling water out of the heat exchanger vanes at first. The bag saved the vacuum cleaner because it absorbed the water.

CARR The little interlock that won't let the vacuum run unless you have a bag in it is a good design feature.

Orbital Maintenance: Let's break it into two areas: routine orbital maintenance and some of the stuff that came along that we coped with. In general, the thing that we missed the most was a good place to put an item when we worked on it. The heat exchanger screen was probably the best place, but the worktable that was originally designed for Skylab, was a good step, and it's too bad we lost it. We could have eliminated many problems that had to do with having a workbench.

GIBSON I demonstrated a couple of times by using that screen that you could make a pretty useful system out of that. In the use of the screen, we had several problems come up. If you put objects down with force, you can vibrate the materials, such as screws, you have on the screen off the edge. What you really need is a small enclosure in which to hold the small parts that you're working with. Other than that, I found that screen an excellent way to do any kind of maintenance.

CARR I would say routine orbital maintenance is not as difficult as people thought it was going to be. We were able to cope with a lot of small pieces by using gray tape or whatever things were available. The idea of having to play mister fix-it and fix things was no big problem.

GIBSON It's as easy up there as it is down here. The only problem we have is restraining items, and, as Jerry said, we used gray tape most of the time. We would take a couple of feet of gray tape, put small or large pieces or even tools on it and it worked well.

POGUE An area that would help more and could be corrected by proper early design consideration is the area of tools and fittings. We had many different sizes of screwheads and different sizes of hex tools that were required to service these things. What I would like to see in a spacecraft is a minimum number of graduated sizes of fittings.

CARR Good point.

POGUE That way, you can get two or three tools and do a job. The way it was, we had one little pouch of Allen wrenches and it sounded like the chimes at St. Mary's ringing every time you opened the tab on it because all these things just come tinkling out. I

POGUE (CONT'D) found one up on the air diffuser a couple of times and had to return it. You could minimize the number of tools that you need to do work. I realize that there are aesthetics of engineering and everybody likes to have the right size nut for the strength required when you can always overdesign it. There's nothing wrong with slightly overdesigning it, unless it's a gross mismatch and it affects the operation. You should try to minimize the number of tools and screw sizes.

The same thing works out with QDs. We had trouble with the leaking QDs. This is a maintenance problem. QDs have to be unscrewed. There ought to be places in enclosed fluid loops where you can turn off valves. You didn't have many of these. If we had places downstream or upstream of QDs where we could turn the valve off and replace that QD intact, the minimum of gas would be introduced into the line.

We could have saved problems in the condensate loop. That condensate loop cost us time, cost Beano and his crew time. If we could have changed a couple of QDs, it would have made the situation more tenable. The QDs were not foolproof.

Calfax fasteners are a root factor in maintenance because we were always undoing Calfaxes during routine maintenance. Some of the Calfaxes had a square fitting inside, some of them had

POGUE (CONT'D) a hex fitting, and some had no fittings. I don't like Calfaxes because the single point failure in the Calfax is a tiny washer on the other side of the business end of the Calfax. These things were always coming off and causing us problems. We were losing them. Unless that problem can be corrected, I think Calfaxes are bad things to have in a spacecraft. Also, they were poor to fit. We had a couple of places in the spacecraft where we never did get the pieces of hardware to fit properly. One of them was the ATM access to the coolant loop reservoir, panel 202.

GIBSON We used tape to hold that thing in place.

POGUE The other one was the cover for the OWS heat exchanger panes. My fingers were usually sore for 2 or 3 hours after I did that one. There's no reason for this to be that difficult. You should be able to close a door with minimum effort if there's a fitting or a fastener on it. This was not true, and we had trouble with Calfaxes all around the spacecraft. You ought to be consistent. If some of them are square tool receptacles in the center of the Calfax for freeing a stubborn Calfax, then they all ought to be square or they all ought to be hex.

POGUE Cam locks, the little wingnut in the water system and several other places, were difficult to operate. They were stubborn

POGUE (CONT'D) and an irritation to work with. You'd turn a cam lock wingnut with your fingers as far as you could turn your hand, and it always seemed like you ought to turn it another 10 degrees to get the thing to lock. You always ended up trying 2 or 3 times before you got the cam lock to engage properly. The idea looks good, but in practice, it turned out that they were an irritation to work with.

CARR You should avoid mixing different kinds of fasteners, cam locks, Calfax, and that sort of sutff; it is undesirable. Standardization is a watchword for the future because it does simplify maintenance and procedures.

GIBSON That's true. Even if you end up with one that does have some idiosyncrasies to it, you become accustomed to it and learn how to replace it rapidly. The way it was, we had so many different kinds of locks that when one malfunctioned, we couldn't have many replacements for it.

CARR The idea of using those little cam locks to hold the big heavy doors of the film vault closed is ridiculous.

GIBSON We needed something that was rapid, easy to use, but yet did the job. Those fell short of it.

POGUE The comments we've been making about cam locks applied to the Dialatches, too. The Dialatches had a very irritating feature in that, if the compartment had several Dialatches, you'd open all the Dialatches and as you'd start to pull the door open, the Dialatches would flip back over and catch again. You had to open them all up and hold them in position.

GIBSON I had that problem on the ETC box where we had seven or eight Dialatches. I usually ended up closing down one or two, but some of the other ones would become engaged anyway from time to time. It was a juggling act to open that box.

CARR I think hinge friction on that thing would have solved the problem, where you'd have to physically move it away and it would stay where you put it.

GIBSON That's right.

CARR Orbital maintenance is no big thing. It can be greatly simplified by having a decent place to work, a workbench where you can properly restrain items to work on them. Maintenance can also be greatly simplified by standardizing sizes of nuts, Allen head screws, Phillips head screws, and all that sort of thing.

As a mechanical engineer, I understand how you want to design your bolt holes and bolt sizes to the strength that it's going

CARR (CONT'D) to be, because it is not efficient to overdo it. But on the other hand, you've got to think about the operator, too. And in this case, I think operations may well overshadow the design efficiency.

POGUE We always wanted to use off-the-shelf hardware where we could. I agree with that, because that saves NASA money. But someone ought to look at the area of adapting existing fastener screws, bolts, what have you, to a standard size. Every fastener you can make captive ought to be captive.

CARR Right.

POGUE Just because you used a piece of off-the-shelf hardware to save money does not excuse us from adapting that to space purposes; that is, putting standardized fasteners on to replace existing fasteners or putting a false head on them that receives the tools that you have.

CARR Crew Safety: In general, the bird was safe from a safety standpoint. There weren't many fraps that I can think of where you could hurt yourself if you weren't careful.

GIBSON That's right. The only time I felt that design got us in a little bit of a crew safety problem was in the EVAs. People did not anticipate that we were going to be in certain locations

GIBSON (CONT'D) around the outside of that vehicle that we were in. This, of course, could not be predicted beforehand. But knowing the type of situation we got into in Skylab, the exterior of any future vehicle should be made with no sharp edges, and nothing that could cut the suit. There were some locations, along the edge of the SIVB, where we ended up translating along in order to get to the S193 workstation and the erection station for the solar array, that did have some sharp edges. I noticed them after I had been working around that area, actually putting my gloves in some of those locations. That's a very dangerous situation. All it takes is one good grab with your hand and a sharp pull, and you're out of business. Other than that, I agree with Jerry, it was a safe vehicle all the way around, especially on the inside. Any problems you ever ran into would be created by yourself rather than any of the gear that was in there.

CARR One area we got bit by was the film vault door being so heavy; the time that you banged Bill's foot with that door. That's a heavy door. You have the danger of locking your foot in within the envelope of that door, or doing it yourself, moving the door and not realizing there's a foot in the way. When you have the foot locked and the door's moving with all the inertia it has, it is dangerous. I'm surprised we didn't hurt somebody with that.

POGUE Panel 217, that access area where you had to remove the gas separator from the coolant lines, I thought was a poor design. It was also a crew-safety consideration in that there wasn't any way to get in there and do that operation without endangering your hands from hand cuts. I noticed this during training and, of course, I was very dissatisfied with the operation. There was no way around it; that hardware had already been built. There was a tool fashioned that could have simplified that operation, but for some reason, we did not get it. I ended up using connector pliers to help myself, but I always had hand cuts. When you have a chance of cutting your hands, then you increase the chance of a deeper cut. I was very careful and used the optical gloves for the EREP when I worked on that.

Around high traffic areas, like going down to the aft compartment through the hatch in the hexagonal hatch in the forward floor, we never hurt ourselves, but there was a possibility. I caught my finger a couple of times, but fortunately, I was not moving too fast. Any time you have a high traffic area, you ought to make a positive effort to avoid small apertures through which you can put a finger and get it caught.

CARR Good point.

POGUE That's just for high traffic areas. Other places, it may be very impractical. One other crew safety item is the location of the airlock relative to the other volumes in the spacecraft.

CARR Another crew safety area that bothered me was the radial hatch in the MDA. I worried all the time about kicking or disturbing some of the wiring, or something like that, around that hatch. It's too bad we didn't have some sort of a shroud or something that went over that hatch, a lightweight cover that kept us from sticking a foot in there, or getting it under the equalization valve. It always made me feel uncomfortable to work around that thing. During EREP, we had to do that a lot. You could see that it also made Bean and his guys uncomfortable because they did some taping jobs there and taped the handle shut.

POGUE Another crew safety item is the handle cranks for the STS windows. You could guillotine a finger right off with those if you weren't watching it. Boy, that was a very bad design.

CARR You had very, very poor mechanical advantage, so you ended up leaning into that handle to turn it hard, and there wasn't finger clearance all the way for full throw of that crank. You could really loose a finger or a bone there very easily.

GIBSON I think that was also a poor design from the operator's standpoint of having to open and close those windows a large number of times, and the amount of force that was required. To take good photographs of comets and a whole host of other things, having to open and close those windows frequently. I suspect I did it 6 to 12 times a day or so, being up in that airlock a lot. And it was a chore every time.

POGUE The PSS servicings is another place where there's a crew safety implication. There was a fitting that you had to put on to restrain the servicing umbilical. Those connections were hard to make; also there were so many little bits and rods and pieces of metal around there that it was awfully easy to hurt your hands working with that system.

CARR That was really one of the main problems with the servicing system in M509 and T020. You had several different kinds of quick disconnects and, though they were designed for super safety, they were not designed for ease of use. Because it took a lot of force and a lot of leaning and straining to make one of those work, you were in danger of lacerating your hands.

12.5 Instrumentation Systems

GIBSON The problem with controls is we did not really interface with this system very much other than to leave it in COMMAND or to throw the switch when called out by ground.

POGUE One of the things that's always bugged me, (and I'm delighted that the ground monitored the systems and provided us with information) was the fact that there were data in the spacecraft to which I did not have access, but which I might need for intelligent operation of the spacecraft. And it seems to me that they are treating you like a child to put you in a spacecraft and not let you have full access to the intelligence onboard. You can't have it callable in a computer, but that is what you would ask for, to be able to interrogate the entire system in totality and ask it for any piece of data that you are interested in.

CARR I don't think that's such an outlandish or difficult thing to do because the people on the ground can interrogate this system to get the data. All they need is a repeater up where we are. However, for the most part we didn't need it, but had the occasion arisen, we might have been in a difficult situation.

POGUE Not only that, but there are failure modes where you could possibly read it onboard and the ground still couldn't get it, so there's a good reason for having that capability onboard.

GIBSON I think in general, through, that having the ground run those systems is a good way to go.

POGUE Undeniably.

GIBSON You have got so many little things to do, you don't want to be chained to running those things down.

POGUE There's another point too to be made and that is, if you had this thing mechanized properly in the software, you would be told before the ground that there was something out of tolerance. Not a caution and warning necessarily, but a crew attention light, saying that there's something out of tolerance, but it isn't going to kill you, within the next 15 minutes, how about taking a look at it. Because that's the kind of thing that the ground gets when the bullets appear on their masks in the MOCR, they take a look at it and say they didn't notice it. They just noticed the bullet, and then the bullet tells them what's wrong. Another thing I thought was a good idea was being able to power up a system and power it down; you can save a little power and save the meters, particularly, the lights on the EPS display panels 205 and 206. That you could turn off those indicator lights was a good deal. We don't ever want to be without that, because in the first place, you'd have burned out all the lights. We burned them out in the

POGUE (CONT'D) simulators, and they were the same light bulbs, the same power and everything that were onboard. The status lights themselves would have created an untenable situation for doing comet observations.

CARR I think in general the instrumentation system was reasonable.

POGUE One other thing on systems - I spent considerable time trying to understand that the power supplies required so forth and so on and minus 5 volts and plus 5 volts and all that other nonsense. For instrumentation/caution and warning, I'd like to see the stuff broken out a little more clearly on the panels. And I know it's nice to put all the circuit breakers on two or three panels, but I made mistakes in throwing the wrong circuit breaker once on the instrumentation area. The mistake was easily made because part of the label was correct and part of it was wrong. The only other comment is in regard to the recording system. The recording system was fairly hard to understand at first but, after you got used to the switches, it wasn't too bad. I still think it could be a little simpler though.

CARR The whole recording system itself is just a big mixed bag that grew out of off-the-shelf equipment, Gemini, recorders, and that kind of stuff. I think everybody knew from the beginning

CARR (CONT'D) that it wasn't a good deal, but it was what we had available, and it's what we worked with and I'm sure glad the ground was stuck with manipulating that system and taking care of it, because I didn't want any part of it.

GIBSON That's right; I felt the same way.

CARR Yes, and I'm glad INCO knew what he was doing because I sure didn't.

12.6 Digital Command System

GIBSON I found the only problem I had with real-time commands was with the ATM. That was the use of the DAS when the ground had to call up to tell you they were going to put a command in when you were using it. I thought that was very awkward. I would prefer a much easier lock-out so that you could not have two systems getting into the same computer simultaneously. So that once one started, it would lock out the other. There were many times we had calls from the ground when all three of us were away from the ATM to ask us for the computer.

CARR I think that your idea of a lockout is good. You throw a switch that locks out anybody else and maybe even turns on a light.

GIBSON Or an automatic lockout that occurs when you send your first command in.

CARR Updates to TRS: All we had to do was keep the date right, and it skipped a day on us once or twice, but it was no big thing.

Teleprinter Messages: I think we pretty well talked about teleprinter messages.

GIBSON As far as the future, we've talked about getting TV up. We could very easily have a printed page come up on a TV and then have a reproduction made of it. We could do away with the teleprinter with all its associated problems.

CARR In other words, it's pretty much like the hard-copy system they have in MOCR.

POGUE There was a problem with teleprinter noise. As far as I'm personally concerned, it'd be nice if we didn't have a lot of noise, but if you put the cover down, there's no problem.

GIBSON Yes, I slept up in the airlock a couple of nights, and occasionally, when it would go off, it still didn't bother me.

CARR I think the guys on the ground worked hard to avoid disturbing us at that time.

GIBSON Yes, we appreciate that. But it turned out to be not much of a problem.

12.7 Caution and Warning System

CARR CSM-SWS: We've already talked about command module caution and warning, and I think the idea of piping across the master alarm and that system over to the SWS was right. If you got a CSM light, it set off the SWS system and then you had to go to the CSM and find out what it was. It worked fine, although it was a pain in the neck a few times. I also thought the ground did a good job of letting us know when something was imminent, so we didn't get too concerned about a lot of the alarms that went off.

GIBSON Yes, and we could inhibit those caution and warning parameters if they started to get out of tolerance, temperatures on RCS quads, for example.

CARR Let's just talk SWS caution and warning now.

POGUE Okay, there were two areas that bothered me. One was the procedures involved in checking out caution and warning and, two, finding a specific switch on the caution and warning matrix panel. Now that sounds like a dumb comment to make, but I actually wasted a lot of time trying to locate the switch, the ENABLE/INHIBIT switch on the caution and warning panel. There's got to be a better way of laying it out even if you put an

POGUE (CONT'D) ordinate and abscissa on the thing and say 1 comma 13, and you then know you're in the first row, 13th column, and could find the thing immediately.

GIBSON Yes, the switch was supposed to go along with the same geometry as showed above in the caution and warning display. But that was not as straightforward as you might think. And I agree with Bill that it was difficult to find those switches from time to time.

POGUE Also, again, it would save you the problem of confusing nomenclature. We had some nomenclature that was very similar. And I think I inhibited the wrong switch for an operation once. It turned out nothing ever happened but, when I went back and reenabled it, I saw that I had inhibited the wrong one. The other point I was making was that it was difficult writing procedures that were intelligent and intelligible to follow in making a caution and warning checkout. Again, there was a sort of semantic word saturation involved there. As you read the procedure, you became tangled and twisted up in the words.

GIBSON On that subject of checkout, I had the feeling that we were checking out much more than we were actually using. I would like to see a system in the future that doesn't take that long to actually check out.

CARR We did the fire system once at the beginning of the mission and then again at the middle of the mission, but the caution and warning, we only checked out one time.

POGUE We may have checked that out in the middle somewhere.

CARR Performance: No problem. It worked great. I think what they've done is they've worked all the bugs out of its performance. Systems that were not operating correctly were already essentially taped off or wired off and we just didn't have to worry about them. They inhibited them and forgot them. For instance, the condensate system, and several others. Those problems were solved before we got there, but Bean's crew and Conrad's crew both probably suffered from the caution and warning.

POGUE Telemetry Monitoring Points: Combined with the previous comment we made on locating valves in systems for no other purpose than maintenance and troubleshooting, I think it is well worth the trouble; in view of the problem Bean had with the condensate system, to have proper telemetry monitoring points. Had he had that capability, he could have troubleshot that condensate system in a couple of hours. Whereas the way it was, it took them 2 weeks, I think, to figure out what was going on.

CARR Yes. If you can compartmentalize or isolate parts of the system, you can really do the job.

12.8 Electrical Power System

CARR Solar Array: I, quite frankly, never had any difficulty coping with the solar array system in training and I felt that I had grown to understand it and it was a reasonable straightforward system.

POGUE The only comment that one could make on these power conditioning groups and the CBRMs is that they ought to be accessible from inside the vehicle, because we could have performed all kinds of maintenance if we could have gotten to the connectors, etc. from inside. Now, don't ask me how to do it, but that sure caused a lot of trouble.

GIBSON Yes. I think that's a real good point. We had problems with the ATM and, if we had been able to get to them, I'm sure we could have done a much better job.

CARR I think being able to get in and change things like voltage regulators and things like that would certainly have simplified a lot of their problems. If we would have just had access to go on in and change the voltage regulator that's giving you trouble or a battery charger, things would run smoother.

GIBSON Well, we at one time were talking about a task EVA which would allow you to get solar array power from one unit over to another CBRM and, had we been able to do that IVA, I'm sure we'd have

GIBSON done it right away and gained a little extra power. As it turned out, we didn't really need it because we had a little extra power in the system, but we're always better off designing it so you can get to it. In terms of the whole power system, I found that I thought I was overtrained for it. I spent an awful lot of time over there in the simulator working with bus shorts and all kinds of problems which I would never encounter in flight, because I was never sitting right in front of that panel watching things happen. I thought that in flight, I had negligible interface with that system, whereas I really trained a lot on the ground for it.

POGUE It was an interesting and intriguing system, and that's one of the reasons that we all three spent more time on that than we needed. However, I've looked into that system and I think that there are several lessons to be learned from the design. One is that when we mentioned the bus short, there were certain people in the design business who felt that we were questioning their integrity personally. But the point was made that you could not experience a bus short in Skylab. We were handed pieces of the buses encased in some plastic and told this thing can't short. Well, of course, what we meant was it doesn't make us any difference whether that piece of metal shorted or

POGUE (CONT'D) or whether a wire from that bus shorted. To them, it was a matter of professional pride, and certainly there was a misunderstanding there for a long time. This point is that we did have bus shorts in flight, and we were guarenteed prior to that that there was no way to short out one of those buses. However, we did train for bus shorts. Now, the CBRM, and the PCG systems - I did not feel that there was sufficient controllability over the configuration in either one of these two to protect yourself against an uncontrolled short and to take maximum advantage of the power-generating capability that you had. I think that this would not be a satisfactory system for going to Mars. We do not have enough control over this system in isolating shorts, and we did not have enough control over this system to take advantage of a perfectly good solar panel group which might have to be isolated because it was feeding a short.

GIBSON That's a good point. I remember the problems that I could picture us getting into and we actually did get into some with the CBRMs. I would think we ought not only to be able to transfer power from one solar array over to another CBRM but also be able to replace those components which are bad. And that goes back to our original plan of being able to get to it all.

POGUE We did not have complete - satisfactory monitoring of the status; we had to pull all kinds of shenanagans to isolate bus shorts in training.

CARR An example of the areas you were talking about was when we had a collapsed solar array; it had such a draw on it that it finally collapsed. We didn't know that; we had to ask the ground that kind of question.

POGUE Also, the indicators, when fed a real heavy short would reverse themselves and start indicating all over again, stuff like that was biting us, and that's the sort of thing that you want to avoid.

CARR Power Distribution: The only area here is the shunt regulator which was always a mystery. It took a long time to understand what a shunt regulator was and I wonder if that wasn't something that could have been dealt with differently in the design and made more clear. It just killed us in training to have to throw away a whole solar array group, because what it was feeding was bad and there was no way to move it to something else and take advantage of that power source. Maybe access to go down and put jumper plugs in somewhere would do it.

13.0 PREFLIGHT AND POSTFLIGHT EXPERIMENTS

CARR M078 and M111 through M115 fell into the normal medical protocol.

Time Required: We don't have anything to say about that.

Physical Discomfort: None to speak of.

Facility and Personnel Availability: The Skylab Medical Lab concept was a good method of organization. It kept activities pretty well concentrated so we weren't going from one place to the other to get things done.

GIBSON I think people went out of their way to make sure that they kept all problems to a minumum.

POGUE I think it was well organized.

GIBSON You do lose a fair amount of blood in the process of doing the blood work. I wonder if the quanity of the blood extracted might be obscuring some of the results. I know my hemoglobin is low. I don't think the amount of blood that has been extracted from me has helped the situation. Other than that, I thought those experiments went well.

CARR I couldn't tell the difference between M111 and M115. As far as I was concerned, the blood draw was a blood draw. What they did with it didn't make a bit of difference to me.