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SKYLAB 1/4 TECHNICAL CREW DEBRIEFING

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PART I

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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 P00. 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-emphasize 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, El2 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.

C/RR 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.

P)GUE 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, any-time 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.

PCGUE 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.

8.0 CSM POWERUP AND WORKSHOP DEACTIVATION, STOWAGE TRANSFER (FDF)

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

FOGUE (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 CWS 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 checklist 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.

POGUE 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 at 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 uncomfortable. I remember that it was a little close in there.

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

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.

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 detanking, 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 talk-back 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. Keyholes 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 altitude 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

PCGUE (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.

PCGUE 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 extra-ordinary 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 EFC 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 non-sense. 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.

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SKYLAB 1/4 TECHNICAL CREW DEBRIEFING

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PART II

PREPARED BY

TRAINING OFFICE

CREW TRAINING AND PROCEDURES DIVISION

National Aeronautics and Space Administration

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14.0 INFLIGHT EXPERIMENTS

14.1 Medical Experiments

CARR M071 - Mineral Balance: That includes food as well as food intake, urine and feces collection. We ought to talk about M071 and M073 together. I hope by now the ground has an idea of what goes on up there and that future missions do not have to go into the detailed testing that we've had to go through in order to completely measure the balance in and out. It's time-consuming and unnatural. The more naturalness we can get in our life at zero g the better. A wider range of menu choices should be made available. In the future we need to make allowances for changes in taste; if you're going to be up there for long periods of time, you need to have considerably more than six menu choices. You should have a rather substantial pantry available, so when you get tired of eating certain foods you can just set them aside and eat others. If somebody is trying to keep a balance on you, all you have to do is report. You shouldn't feel that you have to avoid certain kinds of foods just because they mess up somebody's experiment. I think the crew should be free to eat any food they want when they want to eat it. If it's required that they report it, that's no big thing. The freedom to eat in pretty much the same manner as you eat on the ground is a very strong requirement for the future.

CARR (CONT'D) Preflight Baseline Data: That area was laid out pretty well. There were many people supporting us gathering sample bottles. It was designed to be of a minimal impact to us and we're grateful that it was done that way.

Menu Deviations: It was reasonably well thought out. We did not object too much to the evening status report in flight. I hope future food systems and medical testing with metabolic balance can be performed in a manner more conducive to the normal daily regimen.

GIBSON I second that. I think from here on we're going to be sending up specialists. You may want to have people who are medical test subjects, but certainly the whole crew should not have to undergo this time-consuming exercise pre, post, and inflight.

POGUE I thought we missed a good opportunity to find out just exactly what foods a crew would prefer.

GIBSON We put some restrictions on ourselves with this experiment in the amount of different types of minerals one can take. For example, a high salt intake a couple of days before you come down to increase your blood volume would help in terms of cardiovascular effects when you get into one g. We never had a chance to really explore that one. In trying to get back to preflight values of hemoglobin. There's nothing we can take

GIBSON (CONT'D) now because of the requirements of this experiment. I agree that it's a worthwhile thing to be doing, but in the future we cannot have every body in the crew living under these restrictions.

CARR M074 - Specimen Mass Measurement: We never measured a specimen of food the whole time we were up there except one time when we had to take a picture of a crewman putting a can with some food in it in the SMMD. We just ate it all. If we didn't want to eat it all, we didn't start on it. The measurement of fecal matter presented a design problem in the SMMD; the bags were so large that you had to essentially force them under the blanket in the SMMD. The system failed and we found ourselves, the last couple of weeks, in a mode where we had to carry the bags into the wardroom to measure them. That was not an optimum situation at all. We did not have the time to fool around with the system and try to change equipment so that we could get our weighing done in the head.

Calibrations: The cal weights were lost, so we didn't do all the calibration work that should have been done. It's a mystery to us where those weights went. It was graphically demonstrated to us that that system is very sensitive to vehicle motion. If we were in a gravity gradient dump, there was no sense in weighing anything; you might as well wait.

POGUE If these measurements are that important, there ought to be a red light to indicate an amount of vehicle acceleration.

CARR That's a good point.

GIBSON You might prefer a meter rather than a red light.

CARR In summary, we think we did a good job of measuring feces. We were conscientious, and the information is good. There were no checklist problems with that.

GIBSON M092 Lower Body Negative Pressure: I think we spent too much time on the LBNP experiment.

POGUE The iris and the saddle interface was uncomfortable. A couple of times at minus 50 millimeters, I was in considerable crotch pain. If the iris is too tight, you can really get a painful pressure point on the pelvis which has nothing to do with the experiment per se. It's just a feature of the experiment. It's also difficult to put the cuff on the leg if you're going to do limb blood flow.

CARR In general, we have no great quarrel with the LBNP; we think the experiment worked out. It got terribly dull for us. Being the observer in one of those things was very, very dull.

GIBSON If we had had some better displays, we would have been able to actually watch the electrical activity of the heart. I think

GIBSON (CONT'D) we all would have become a little bit more interested. In flight, we had negligible feedback other than heart rate and pulse pressure. After a while we could almost predict what was going to happen, and it became a cut and dried routine. We felt like technicians rather than experimenters. Future experiments should use the onboard observers' capability more; allow them to contribute to the experiment as well as run the controls. Donning the electrodes was very time consuming and bothersome. The system of tapes and sponges has to be reworked. We need a faster, easier system. There were too many little pieces of materials to work with in zero g.

POGUE I agree. Embedding the electrodes in a piece of scotch tape or adhesive would be helpful.

CARR We showed there was a learning period on the LBNP. On the average, we could do an M092 in 50 minutes by the end of the mission; whereas in the beginning, it took an hour and 30 minutes.

POGUE I always felt uncertain about the subjective evaluation of power. Perhaps you could attach an IR device to the crewman's forehead in order to get an evaluation. We should have something that is more concrete than a completely subjective evaluation.

GIBSON We had to depend upon the comments of the crewmember undergoing the LBNP rather than his pulse pressure. The pulse pressure showed any abnormality but the crewman's responses told how he was feeling.

CARR M093 Vectorcardiogram: It was a simple experiment. We did not use an observer in that.

GIBSON An observer ought to be utilized fully, or not at all. An observer was unnecessary on M093. In M171, the observer had to hit the reset button every 5 minutes. That was an inconvenience and a waste of time.

CARR M171 Metabolic Activity: No problem with the stowage.

POGUE The drawers ought to be separated for zero g. It should not be possible for an item to float loose and jam the drawer above it.

CARR Setup and Checklist: Setting up the metabolic analyzer was a long, laborious process. We learned how to save time. The observer could set up during the M092, and get right into the M171. Future setups should be simpler and more automatic.

POGUE The human operator was not working at his optimal level.

GIBSON We had a problem in setting up. If we ever got a little bit out of step, we were hopelessly lost. We had to either retrace

GIBSON (CONT'D) our steps, or go back to the original configuration. Both alternatives were difficult and time consuming. This occurred because we never understood some of the steps.

CARR Checklist: The checklist was very complicated. Due to the path-finding of Al Bean, we relied heavily on cue cards. We found the cue card to be superior to the checklist.

POGUE Operation and Noise Level: The noise level could have been reduced, but it was not a major problem.

GIBSON Converting that energy to heat seemed very wasteful. We stored it in the bike device until it could not hold any more. Then they put operational limitations on the use of the bike. If there are more than three crewman, that limitation will have to be removed.

CARR Limb Volume Measurement System: That is M092. It was so delicate that it was always on the verge of not giving good data. It was too delicate, for daily use.

GIBSON Near the end we started having some noise, and problems in that system. It shorted out. We brought the leg bands back so they could figure it out what the problems were.

CARR Blood Pressure Measuring System: It seemed to be efficient. It did interfere with pedaling at 250.

GIBSON It was difficult to pedal and give good measurements simultaneously. I used my arms, and the muscle activity in the arms always obscures the data.

POGUE A double yoke system of restraints would have been helpful on M171. The restraint system we had was not completely satisfactory. I needed a restraint to hold my shoulders down.

GIBSON We needed something to hold the head and the shoulders. We used a pad on the overhead to hold ourselves down. I used it for a mount until the pad became a health hazard, and we removed it. We had the head on the overhead. It seemed to work, but a restraint is needed which operates on the head and shoulder.

CARR Calibration: It should be more automatic.

CARR Body Temperature Measuring System: It doesn't matter whether a thermometer has a mercury column or an electronic readout.

GIBSON The response time was so long that it rendered the reading inaccurate. I'm not sure that gave useful data.

GIBSON ESS: We used it and didn't have any big problems. The MA: I thought it was well designed.

POGUE One thing that is sort of important, but has nothing to do with the M171 experiment, is our displays. I'm talking about everything in the spacecraft. The displays ought to have neutral density filters, if we are going to do any television in the future.

CARR M131 - Human Vestibular Function: Stowage was all right in my opinion.

GIBSON We were not able to close that thing completely, and fortunately in zero g it didn't make any difference whether the door was a little bit open on the stowage container. One stowage problem which we had was with the device that fits on the litter chair. Tremendous energy was expended in stowing it in the container, and perhaps the stowage of that item was overstressed. The rotating litter chair worked fairly well. Some of the ones on the ground are probably a little worse than the ones in flight because they are too sensitive to motion. If you're sitting in the chair, especially for the OGI, and you move your feet, you can get a fault light and you have to go back and start over again. Perhaps that was put in there intentionally so that if you did get gross shifts of the chair for some reason or another, it could be considered in the evaluation of the data. But most of the time it was just a crewman shifting around that would cause a fault light and cause a little loss in the experiment operating time.

CARR After we had performed several runs of the experiment and had ceased attaining any new data, we felt it was time to terminate the MS, and fortunately the ground concurred. It was not our intention to short change the PI on his data but we honestly

CARR (CONT'D) felt that the experiment was time consuming and that it was not producing any new data.

POGUE I have one comment on M131. When you are adapting things to conform to the human body in zero gravity, you've got to be careful. We found that the body normally wants to assume a more or less erect, slightly arched attitude, and holding yourself in a chair was difficult. The seatbelt helped; although it was hard to adjust. The biteboard could have been better if it had one more degree of freedom. I was never completely comfortable. One problem was that the postural change made it very difficult to adjust the height of the biteboard properly.

GIBSON Regardless of the individual's shortness, we could never get the biteboard high enough in order to make it fit comfortably. We were on the ragged edge of it coming out of the strut which held it up.

CARR When I was stuck into the biteboard, I felt like a horse with a bit that's being reined in tightly with his chin being pulled down towards his neck and the back of the neck being somewhat arched. I always felt like my chin was being pulled down and in, and my neck was being arched. It was rather uncomfortable, and it was difficult to get away from that position.

POGUE What made it difficult to perform the experiment was reading the roll and the OGI goggles. I think the design made it easy to make a mistake even when watching very carefully.

GIBSON In contrast to that, I thought the readouts on the roll and pitch of the rod were exceptionally well done. That's probably one of the best readouts I've ever seen and one which should been used in the other readouts. Another thing we encountered while running the experiments was the fact that you tend to go to sleep. And I'm not saying that the observer began getting a little glassy-eyed around the third or fourth time we went through an OGI. I'm not sure what kind of observer's or subject's judgment you can put in there, but I did find that the OGI ramp up and ramp down times were so lengthy that you were sitting there waiting most of the time and doing very little, and that tends to make you both very sleepy. That's a problem which I'm sure effected your results.

CARR Does anyone want to make any comments about their controls?

GIBSON I thought it was very straightforward although you did have to go through everything in a straight sequence.

GIBSON M133, Sleep Monitoring: I noticed concern on the part of the ground that perhaps this experiment was being repeated too often. They seemed to expect a partially negative statement

GIBSON (CONT'D) about it so that the monitoring could be partially eliminated or reduced. But for me, the experiment was about as difficult as getting a job as a mattress tester. I didn't have any problems with it other than a couple of inconveniences. Since the PI was getting good data and it was a valuable field for exploration, why not press on and get as much as we could. Stowage was no problem. Cap fit: The only problem encountered there was that the chin strap had to be pulled down rather tightly to ensure the electrodes at the very top of the head made good contact. We should be able to find a way to get more uniform distribution of pressure on all those electrodes. Comfort: There was no problem other than the one I just mentioned. Once you got it on, you hardly realized you were wearing it. Sleep compatability: There were only two inconveniences. If you had to go to the head in the middle of the night, you had to unplug the cap. Getting the umbilical plug back in the control unit was not too straightforward when attempting it in the middle of the night when you're half awake. The other inconvenience is when you finally get up in the morning, you've got the electrolyte in your hair. Because in order to make good contact and not have to pull the cap down too tightly, you must put a fair amount of electrolyte in each electrode and you have big globs of this in your hair. Certainly this is an improvement over the type which pressed on the scalp. Controls

GIBSON (CONT'D) were straightforward. An exceptionally simple log book was no problem. I logged those at the same time I was up at the BMMD. The checklist was up there and I read them off along with the PRD so it was a very small amount of time consumed both pre and post operation.

CARR M151 - Time and Motion Study: Set up camera, location of camera and log book. We did not do any log book work. The only logging we did was on the decal on the film itself.

POGUE And in the film log book.

CARR M172 - Body Mass Measurement: Operation was no problem. We worked up until the last couple of weeks exactly as advertised and then we started having problems with the release trigger which caused us to try to solve the problem with two-man operations. We finally found that by gently locking it and unlocking it we could still use it in the normal mode. Calibration is probably the biggest single area that bothered us more than anything. It was time consuming and required a lot of bits and pieces from all over the spacecraft which was a real bother.

POGUE In the future there ought to be more self discipline in organizing that. Some problems necessitated operating in certain modes. But the biggest thing was little spring clips on the food trays which had to be taped to the rails.

CARR Calibrations should not take an hour and a half, and calibration on equipment should be rough estimates. Checklist: We didn't use a checklist but it was a simple thing to use. The calibrations checklist also was simple. It involved knowing what weights to put on and where to put them, and weighing the body. Once we understood that we were trying to keep the same body configuration, it was easy to do.

POGUE Displays: When we did the cals, we read the display upside down and that makes it prone to error. The display ought to be easily read when you're weighing your own body and also when you're doing the cal.

14.2 ATM Experiment

GIBSON S052 - White Light Coronograph: Door operation was no problem as far as mechanical operation of the door. The problem which we knew we would encounter from our training was the lack of an interlock. We would zap the TV from time to time when we closed the door without having the TV power removed. It did happen in a couple of instances. We did have two burn-in spots, one early in the mission and one quite late in the mission. They were up in the upper left-hand quadrant. My initial concern was that it had occurred because of the improper door operation. We were assured that it was not the case. This points out the problem which you face when you do not have interlocks built into the system. When you have a situation where you're concentrating on other features, you may have a potential hazard to the hardware built into the operation. That is a valuable lesson to the future. Nine guys operated the panel, each one highly motivated to do the job right and not to break gear and each one has made this mistake. I venture to say that anyone whether principle investigator in charge of operating the ATM or whoever he be would have the same human problem in operating the complex system.

Pointing System: Worked real well. The line pointing and the point-Earth sensor readout were great. I think we probably

GIBSON (CONT'D) couldn't got away with a smaller readout, but the panel design was the only one available. It was easy to fly to and to center the red dot. We did do just that. We just use a red dot rather than a cross. Actually, the way I worked it was just to use a red dot as a reference to remind me the numbers were 8 and 16 as opposed to centering on the dot itself. This system also pointed up a general groundrule that would be useful in following future systems. Here we run into the situation where we could not take data if the pointing arrow system was outside a diamond-shaped box in the point arrow system diagram. As it turned out, we're not smart enough to predict what the miss alignment might be when we finally got up there. It turned out that the optimium alignment fell outside that box; therefore, we had to take the data without being in the optimium alignment. If we could have selectively gone in via computer or some other mechanism and inhibited that one particular interlock so that we could have taken data even if we were not at the specified alignment or within the specified box for alignment, we could have gotten better data out of it. We would have liked to have done that. Use of the override switch introduced other problems in trying to get the data, also creating a hazard to the equipment itself. The door interlock was required when you are greater than 5 arc-minutes off the center of the Sun. We did not want to tamper with that using the override. We did on

GIBSON (CONT'D) occasions use the optimium alignment to take data. It had to be spelled out precisely in the pad to get it done. Even then, errors were made mostly because we were in the habit of doing thing a different way.

White Light Display: I was very happy with that. The intent of the display was to allow you to increase the quality of data. I think that has happened over the three flights. Lets talk transients, first as far as visibility of features. I was disappointed in our flight that we did not see coronal transients of the type that had been seen in SL-3; that is, the bubble type or the magnetic field, distortion of the corona. I feel certainly we will not see large features like that in your data. I think we could have recognized it very easily had they shown up on the TV. We did see the one very bright coronal transient which was essentially material moving up. There was some distortion of our structure of the magnetic field out in front and to the side. That was one all-associated event. Streamers appeared quite well. I think we ought to establish common ground and better understanding between the S052 people and ourselves as far what we would be calling streamers, rays, the type of streamers, their orientation and so forth. This was probably an oversight on my part in preparing. I would have given them words which were a little more concise and a little

GIBSON (CONT'D) more to their understanding. We ended up describing these features and perhaps in painstaking details whereas a couple of well-chosen words would have sufficed. You could see the streamer exceptionally well. I used an overlay that covered up the burn-in spot on the TV so that most of the exposure was actually made on the streamer structure itself. I better clarify that. The Polaroid camera had a cutout with a light sensor that would either stop the exposure after 12 or 14 seconds or when you had received an overall quantity of light, whichever came first. We could very often see small changes in the streamer structure from day to day, and sometimes in shorter time constants. Either you saw a streamer structure or you did not. Trying to make an association with coronal holes on the disk was not really done. We associated the streamer structure with active regions. The lack of a structure or the type of structure above the corona we did not consider. You can see diffraction rings very close to the occulting disk. It would be great if we didn't have pylon obscuration; but I see no way around it. We do not see any contamination visible on he occulting disk, but we did see external contamination. It usually showed up in the form of very small particles moving around, some not so small; most of them out of focus. They usually would coincide with some event such as mol sieve dumping, or something else going on in the spacecraft. Many times we could not come up

GIBSON (CONT'D) with the particular event that the snowstorm coincided with, but other times we could. We did do mode operation, JOP 7, a couple of times. One time we did it at high beta and we essentially went down to midnight where we still had the Sun just below the horizon. Then I continued up to the other side so you got some symmetry and a look at the Sun rising and Sun setting, to give you a little better repeatability and statistical results in your data.

Short exposures were accomplished with no problem. I'm not sure when you asked for a 1-second exposure how repeatable that data was. That was in the JOP 18. To release that START switch and then to hit it to STOP, with an accuracy of 1 second, you might have gotten plus or minus 1/4 second as a mean of variation.

TV observation has been talked about before. Whenever we were Sun centered in making an observation with S052 and the door open, I would always turn the TV on, so we could get a look at it. It was almost an automatic reflex that as soon as the door had opened on 52, the TV POWER switch went ON. So, we did try to keep a good observation program going on the corona, just to make sure that we did not miss transients. Other than the interlock problem, which I have already mentioned, there was no problem with that.

GIBSON (CONT'D) Building block 32's were very easy to carry out. One minute, however, is the length of time that you get impatient and start trying to do something else simultaneously. Yet, also long enough that you tend to forget that you've got something going. So, after missing the cutoff a couple of times, I chose to start a timer for 1 minute and used that any time I did a building block 32.

Film camera was straightforward. Of course, the only time we really worked with that was during the EVAs. We had no problem during the EVAs or any of the handling inside. The only problem that did come up was on the return when trying to get the right configuration for the bag. We only had one bag and two cameras. I hope that what we worked out was satisfactory.

Controls and displays were good. This was discussed at length in flight, two-thirds to three-quarters into the mission. In general, on this experiment, there was no problem with controls the displays, except for the lack of TV interlock.

S054 - X-Ray Spectrographic Telescope: The door was pinned open and therein lies some of the problem, because it cut out the READY/OPERATE light. We ended up with additional one. Very early in the game, I put that additional ready operate light on the panel, wired it to a couple of the wickets there, and it

GIBSON (CONT'D) held up well. My belief was that we did need that next to the door control so that we could make the same association that we had with other experiments.

Flare Detection System: Flare alarm and threshold settings, false alarms and suggestions for operation of the tone and levels. With the PMEC, we had discontinuous false alarms every time we would get in the South Atlantic anomaly as in the horns. I do not think that what we had in the PMEC is a satisfactory way to go in the future. We need something that is independent of the South Atlantic anomaly. It turned out that for our operation, we either ended up the PMEC turned off, or set to such a high value that it was not useful in picking up flares. We tried playing it straight for the first couple of weeks. The next result was that we either had the PMEC going off all the time, which was a continual distraction, or we ended up with it temporarily turned off. And, unfortunately, that would spread into the next orbit, perhaps over a couple of orbits, because we never had anything in our checks or habit patterns to make sure that we had that thing turned up all the time. The idea of a flare alarm was a useful idea, and had we been able to work one from some of the other cues we have on board, such as the BERRYLIUM APERTURE readout or the total voltage from that, it would have been exceptionally useful. Now that we

GIBSON (CONT'D) know what types of detectors are very sensitive to the South Atlantic anomaly and which are not, we can do much better in future.

What I would like to see as a flare detection device is a real-time magnetograph that really looks for magnetic field changes. It turns out that what we are doing in the X-ray is to tell you when something is already happening in the way of a flare. I would like to see something that told you that a magnetic field was changing from 1 minute to the next, and allow that to be your guide as to when you're going to start paying very close attention to the instruments for the possibility of a flare. This is all that a flare alarm does for you. I would like to see a real-time magnetograph, be able to scan the active region in less than a minute, and subtract that from the previous frame, or the average of a couple of previous frames. Then it would either display a difference or quantily it to the extent that it could give you a flare, or set a threshold and use that as an alarm. Before I would push that idea any further, however, I would get with the people that work with magnetographs to see how feasible that would be. Any time we're looking at the rise of the intensity of any emission - X-ray, XUV, H-alpha - we are already into the event. Hopefully, there would be some transients in the magnetic field that could be used as precursors

GIBSON (CONT'D) or an earlier indication, although the transfer of magnetic field energy into rediation, of course, is done with negligible time lag.

PMEC is primarily used as a confirmation that we did have a flare going. We also use the IMAGE INTENSITY COUNT as a confirmation. But, of course, the IMAGE INTENSITY COUNT comes up after you are well into the flare, so it is used as a note to say that you've got a good one going or that you don't; but not anything that will allow you to take initial action.

The X-RAY IMAGE display was not used as much as I thought I might, because we were using the XUV MONITOR, and we only had one good active region on the Sun at any given time that was the capable or producing a flare, that was usually true, but there was an instance when we had two active regions. But the one time we got a good flare, we were right on top of the flare, so there was no problem in determining where we should be pointed. The X-RAY IMAGE display is good, if you had several active region on the Sun and one is going to go off and you are not quite sure which one. That will narrow it down for you rather quickly. We never ran into that situation; therefore, during a time of flare, I looked at it, but only as an afterthought and never as a way of obtaining initial information about where the flare was located. The flares that we saw

GIBSON (CONT'D) were fairly bright in the X-RAY IMAGE display. Active regions could sometimes be seen, especially when they would start to become variable in intensity in XUV, as shown in the S055 oxygen VI and other readouts. The display shield was effective, I thought. We had it taped down and left it down all the time. We could not see anything in the way of coronal activity on that display.

The S054 timer was a useful backup. I would not want to employ that concept in any future design, however. I think the READY/OPERATE light ought to be keyed right to the START switch and not have separate like we were forced to do in that instance. Again, I was very happy we had that long with us. There was a lag of 13 seconds in the 254 [sic] mode, for a SINGLE exposure. Once we learned that there was that lag, none of us were bit by it. Probably the way we got bit the most was not starting the timer whenever we started the S054 mode, which I did on occasion. Then we were left wondering when the device was going to time out. I found that most of the time I not only started the timer but also asked how many exposures would be taken and whether it would be odd or even so I would know whether I would end up with an odd or even number in the frame count. That seemed to work quite well. Since the exposures were short at the beginning and long at the end, and you knew

GIBSON (CONT'D) roughly how long it was going to take, waiting for an odd or even number was quite straightforward.

Mode operation was not much of a problem. We used some modes in which we had not anticipated a heavy usage before flight; that is, the SINGLE mode where we would get a long exposure, in the SINGLE, 64 mode. Once that was worked by the ground, we had no problem in carrying that off. I'm sure there were a couple of errors made in execution. Most of the time it worked well. We did not work with the filter. That problem has already been discussed amply. I was sorry to see us lose the filter capability. I hope the capability we did gain of getting long exposures, however, might have made up some of the difference.

Controls and displays were fairly adequate. Again I refer you to that controls and displays discussion which I gave in flight as well as the comments already made for the X-RAY IMAGE device.

S055 - UV Scanning Polychromator Spectroheliometer: Door operation proved to be no problem at all.

GIBSON (CONT'D) High Voltage Detector Operation - Tripouts: Unfortunately, we did not experience many tripouts, because we did not have much activity that causes the tripouts. A couple of times we caught the tripouts. Other times, when we realized we were in that situation and in the flare wait in particular, we went to OVERRIDE and did not have tripouts. I'd estimate that there were three or four times that I did get tripouts because of exceptionally high values.

Grating Selection Operation - OPT and MECH REF, Off Limb Operations: This was the biggest problem that we encountered in the operation of S055. Each one of us took something on the order of 30 to 60 more laps around that grating than was required. I would say at least that. Maybe once every other orbit or so, when we were using 55 heavily, we ended up with an extra lap. In the future we should either find a way to back up to a grating value or to select the value you want to go to quite rapidly, say within 15 to 20 seconds on a readout, and then have the grating go up to that value automatically. I realize you have a backlash problem with mechanical linkages in trying to run it backwards. We certainly need something better than what we had here. On the ATM we ended up with a lot of lost time. I'm sure the previous two flights had this problem, also. Other experiments suffered, or 55 did. We bought this

GIBSON (CONT'D) in the design, and I was right in there along with everybody else. We just became a lot smarter once we started operating it.

Mirror Positioning and 0-Order Detection: This turned out to be no problem at all. I found mirror positioning associated with the readout to be an exceptionally useful capability to have. If we had not had the readout of the mirror position, I think we would have lost a lot of the 55 pointing capability. When looking at active regions, there were times when I would step the mirror around, have other experiments operating, pick a good mirror position by finding a maximum, and then do a grating scan of that particular position. That was a good flexibility to have. It allowed you to keep the canisters still and to obtain additional data for 55.

Maximizing and Minimizing: This is not as straightforward as you might think or at least as I thought it would be a year or two ago. Minimizing usually ended up with low counts, the noise would get to you, and it was tough to read something between 1 and 10 and figure out what the mean really was. We didn't minimize much at all. We usually ended up maximizing off limb - in order to look at prominences, look for loops - or maximizing on the disk. When we did maximize on the disk, sometimes it took me a little while to figure out what was

GIBSON (CONT'D) really happening. We had transients which would occur and very bright active regions which had a time scale on the order of seconds - five to ten seconds perhaps. We would be looking in oxygen VI, point around, and see a count of, say, forty thousand. We would step around that feature to make sure we were really on the maximum - maybe no more than plus or minus 3 or 4 arc seconds - then try to move back to find that count of forty thousand, and find that we could get only 20 or 25 thousand Initially, I thought that the problem was in the pointing, that the pointing was exceptionally critical. Then we would sit on one of these points and watch it. We found out that oxygen VI certainly was varying on occasion with spikes of that nature. It took us a little while to learn that. We wasted a little bit of time trying to find peaks that used to exist and which did not exist anymore; however, we all probably learned something there about the nature of those transients. On occasion we just sat there with the instrument in the STOP MODE and gave you some data on those which were fluctuating very rapidly.

Operation: This was no problem. It did take a fair amount of concentration to make sure you had the right number of detectors on. Occasionally we made errors.

GIBSON (CONT'D) MODE Operation: This was no problem.

Controls and Displays: These have been discussed previously.

S056 - X-Ray Telescope and X-REA - Door Operation: It was no problem.

High Voltage Detector Operation: No problem. We did not cycle those except when it was specified, and that was not very frequent; so we had no problem there.

BE Aperture Position and AL Counts: I think the BE aperture position served as a vote in whether or not we had a flare and was therefore a very useful thing to have. Without that, we did not have any real confidence when we really did have a good source of X-rays. As I recall, once I was talked into thinking I had a flare when I didn't. We ended up with a BE APERTURE that was up at 3 and did not step down to 4 automatically. We went into the South Atlantic anomaly. We saw the PMEC go up, saw the BE APERTURE of 3, and started in the FLARE MODE and on a bright point. I still think we were bet er off depending upon that BE aperture position because the times that it did go, it was a very useful confirmation. Aluminum counts, unfortunately, were too small, and they were usually after the fact; they were in the softer X-rays. I only wish that was the count that we had lost rather than the BE. We have done much more with the BE counts, had they been available to us.

GIBSON (CONT'D) Mode Operation/Hangups: We did experience some difficulties in trying to give you a long exposure, in turning the CAMERA POWER OFF and back ON again. Occasionally, the DOOR was left OPEN, and the only thing I can say here is that it was a mode that was foreign to the general mode of operation of all the other experiments and that therefore, occasionally, you would get distracted when you turned the instrument back ON and would not remember whether you had cycled the START/STOP switch in order to close the aperture. It took two steps to terminate the exposure. Everything else took one. It's not a feature you should purposely design into an instrument. We're glad to do it, however, if you believe you received some data from those long exposures.

Film Camera: This was no problem.

Controls and Displays: We've discussed these elsewhere.

I believe that if we had had a readout of the X-REA, as in the history plotter, it would have been exceptionally useful to us. There were many times when we had to call down and ask what the backroom was reading on the X-REA for the BE counts. It was useful to know whether it was going up or what level it had reached relative to background. Just for that purpose, we had requested an X-REA history plotter, and I'm sorry that the

GIBSON (CONT'D) system forced S056 into that overdesign. We could have had something as straightforward as a teleprinter to give us that or something a lot easier than what we ended up with, which ultimately bit us because we couldn't get into it to fix it. I do think that the history plotter was a good idea and that the next time we go about it, we should implement it in a much better fashion as well as take another look at what wavelengths ought to be presented.

S082A Door Operation: This was no problem.

Mode Operation: We used the TIME MODE in just about every instance, and that was no problem. I don't recall making any errors in the mode operation of the 82A other than having the wrong roll. That was during JOP 6, building block 1-A. We were very conditioned to doing 52 exposures at a ROLL of minus 5400. Anytime we knew we were Sun centered, doing 52, it just seemed like the natural thing to do. We did JOP 6, 1-A, so darn many times that we got into the bad habit of tending to trust our memory rather than to read the JOP summary sheet. In a couple of instances there, it bit us.

Film Camera: No difficulty. It was big to handle in the EVA. That was not a problem. Return stowage is probably the only thing we could say against the size of 82A. I would have

GIBSON (CONT'D) preferred that it had had more film and less size. I was glad we were able to get that additional one on board.

XUV Monitor Controls and Displays: These were no problem other than what I have mentioned in other controls-and-displays briefings, which were done on the scene and in a much more complete way than I could afford to do now, either timewise or memorywise.

XUV Monitor Display: I thought this was exceptionally useful, and I only wish we had not gotten so much filtering in there. The more I think back on that, the more I realize how valuable that display was for picking out locations at which to make observations as well as for flare detection. Had we been able to use that display as initially intended, I think we would have been able to put a little more observer judgment into the data acquisition than we were able to do here. The use of the persistence image scope that we brought up was a real good addition. Without that scope it was difficult to see many of the features we were looking for, whether it was active regions, bright points, coronal holes, or whatever we happened to be working on.

Resolution and Quality: I thought the resolution was fairly good, although I would have liked to have seen a little higher

GIBSON (CONT'D) resolution, as I believe it exists there and has been shown to exist there from actual data. However, resolution was not our problem. It was getting a readable picture - either with long integrations, using the persistence image scope, or with the Polaroid camera. That turned out to be, essentially, the bottleneck in the information flow from the XUV monitor to the observer.

Bright Spots, Filament Channels, Coronal Holes: We could see bright spots quite well. I used the aligned electronic crosshairs on XUV monitor 2 for the center of the display. That is, on several occasions I had a line to a bright spot as in S055, maximized S055, and aligned the crosshairs on monitor 2 to what I saw in the XUV monitor; and it worked out quite well. Also, quite rapidly, with the integration, I would go over and point to an XUV target. Filament channels were quite evident. If I were really after filament channels and coronal holes and things that existed for a long time, I'd take a picture in addition to the ones that we took every morning and sometimes in the evening. This was done in order to give you a permanent picture in you mind of what the whole structure of the Sun was like in XUV, and then you could home in on specific features, using the XUV monitor in real time.

GIBSON (CONT'D) Prominences: I can't say I saw connections between active regions. On a couple of occasions I could see brightness connections. This is as far as I want to go now and as far as I wanted to go at that time, in specifying what we really see. These brightness connections did not extend all the way across. We could not see loops on the disk or even a straight line - no matter how faint it was - connecting one active region with the other. You could see leaders reaching from one active region to the other but never the center point. On a couple of occasions, I tried to look for maximums and some of the S055 lines along those suggested interconnections, and I could not find them.

I might as well back up a little bit and talk about using S055 to map out either what you'd see above the limb or on the disk. It was an exceptionally time consuming task to look for loops above the limb or in these interconnections or other features and to try to plot them out by slewing the canister around, plotting intensities versus readouts of the fine Sun sensor. You could get a gross idea of what was going on quite rapidly, but to actually pinpoint something well enough to start taking observations usually required a good fraction of an orbit and therefore was not done very frequently. The couple of times I tried to get either polar plumes or loops above the limb and

GIBSON (CONT'D) plot them out, I concluded that I could work, at the most, two altitudes and hoped that the bright features that I saw at one altitude were extensions of the other. I think the one time we had a chance to talk with the ground on it and they were able to get one of the observatories to look at what we were seeing above the limb in coronal loops, it turned out that that association was not correct. What I would have liked to have seen on S055 and the XUV monitor as well was easier automatic readout of the raster or the capability of putting filters into the XUV-monitor-type display. Then you could get that information through filters, although they would have to very wide band, of course. S055 allows you to look at single wavelengths, and the XUV monitor covers broad wavelengths. I think that type of observing capability would have been exceptionally useful.

Brightness of Sources and Flaring Region: We got the one flare by homing in on the most active region we had on the disk at times when it was giving transients in the S055 readouts as well as fairly high values in bright points. Then we just watched that point in the XUV monitor. I usually turned the monitor down so that the bright point we were considering was just barely visible. If all of a sudden it became very visible, you knew you had something going.

GIBSON (CONT'D) Flare Location: This was an excellent way of locating a flare. It turned out that anytime we had a flare go off of the disk, it just jumped out of this display.

82A XUV Dispersion Clear Operation - JOPs: There our roll was usually specified as the zero or 10,800. Not too frequently were we taking photographs where we had to worry about clearing the XUV dispersion. On occasion, I did do that, however, and it was a relatively straightforward task. I would have been much more straightforward if we had had a continuous XUV monitor display rather than dependence upon the integration feature.

S082B - XUV Spectroheliograph - Door Operation: This was no problem.

82B Sequencer: The auxillary timer that we put in there was a real useful addition. I'm glad we had it. I think in the future you may want to design this type of capability right into your system and put the exposure time, sequences between exposures into a digital computer. That way, as the mission progressed and we got smarter about what exposure time should be, we could change it; or if we desired to have different observing programs, we could change it. It took essentially two flights of working 82B, in order to figure what the proper exposure times were, and even then they started to want some different

GIBSON (CONT'D) times towards the end of the flight. I was glad we had that sequencer in there. It saved us an awful lot of manual work, and I'm sure it gave everybody else, including 82B, a lot of good data. We used the auxillary timer for getting short exposure time. For example, if you wanted a 2-1/2-second exposure or a 10- or a 40-second exposure, you just used the short, NORMAL, and long mode, respectively, on that. I guess it was 1/4, NORMAL, and TIMES 4 modes.

XUV Slit Display: I was very enthusiastic about it when we first got up there; however, as the days went on, it tended to degrade. Towards the end, it had degraded so much that we could not use the display for the operation of the LIMB SCAN mode and the POINTING mode.

Resolution: This appeared reasonable when we first got up there, relative to what we expected initially.

Sunspot Visibility: I expected that I would neither be able to see sunspot umbra clearly defined nor be able to detect penumbra even if it were there. That was not the case when we first got up there; both were very evident. We had to operate, of course, with a low intensity or low contrast in order to do it.

GIBSON (CONT'D) Uniform Emission for Slit Position: The XUV slit display was not the best way to judge that. The slit was good only in giving you an estimation of where you were, realtive to a sunspot or relative to the limb. It could not be used for anything else. Again, I would wish that we had had a good display up there such that we actually could have seen granulation.

Percentage of slit filled, on the average, is a tough estimate to give you, and I think we have to take it case by case. Most of the time that we were taking anything with the slit, we either tried to get uniform mission along the slit by the intent of the initial pointing - that is, at the limb, for example, making sure we were tangent to the limb or parallel to the limb as we stepped outward - or by trying to get something that was so bright that it would completely dominate anything else coming in from any other part of the slit, whether it was a bright point or the result of just dipping one end of the slit down close to the limb. And there, we would just have to talk specific cases. I can't really give you an average number for the percentage of the slit filled.

Mode Operation - AUTO HOLD Operation: I'm not sure we actually did that. I cannot recall doing the HOLD operation other than in training; however, it was a straightforward operation, and if we did it, we had no problem with it.

GIBSON (CONT'D) Film Camera: Same as 82A's. Only drawback was in the return stowage volume. I wish we had been able to take up a second one of these for changeout.

H-alpha 1 and 2 Telescopes, Door Operations: Door operation on 2 was no problem. That was left OPEN all the time. H-alpha 1 and 2 displays - Let me get into the operation of H-alpha 1 before I forget it, and that is, we always tended to foget that instrument in changing modes or getting it going; and the problem there lay in the use of the OVERRIDE switch or the AUTO/MANUAL switch on the panel. That was in OFF, nominal mode. We got into that when we came into an orbit without H-Alpha 1 operating for some reason. Rather than recycle all the doors closed and open and going in and out of EXPERIMENT POINTING mode, we chose to use the switch in order to allow us to operate. In order to avoid taking data with the door closed, the override switch should be designed to operate only if the door is open. A continuous day signal or continuous night signal could be another solution. There are other ways around that particular problem. A resolution of H-alpha 1 was exceptionally good. We were able to see exceptionally fine features on and above the limb. Prominences really stood out. We could not always see individual spicules. We could always see the large ones, but we could not always see the details of the spicule forest.

GIBSON On the disc we had exceptional clarity. The fibrous structures stood out as well as they do in many of the photographs from some of the better observatories. The image tended to degrade with time. It was low contrast, low resolution and an exceptionally poor display. The problem may have been in the video system itself; we can't be sure; but we did know that once when we turned it on first early in the morning, after an EREP pass, or any time after it had been idle for 3 or 4 hours, the display was exceptionally good. Despite turning the display off between orbits, the image degraded after 10 or 15 minutes of operation. In terms of the display clarity, H-alpha 2 could not compare with H-alpha 1. Ed Reeves, Allen Tuttle, and the other people who worked on H-alpha 1 did an exceptionally good job. I recommend that we keep a display with an interference filter and a 0.7-angstrom band pass. It allowed us to see flares and the fine detail structure in the coronasphere at center-line H-alpha. I would like to be able to shift the band pass, but I'm not sure that this could be done mechanically. From the operator's standpoint it would have been useful to be able to shift off band into the red and blue wings in order to find specific features. This would have been useful in detecting motion in on-limb features and studying chromospheric network or surges.

GIBSON (CONT'D) Network cell and prominence visibility - H-alpha 1 was excellent when it was in good form. Flare location - Standard H-alpha told us as much about the flare location as the XUV monitor. H-alpha 2 was useful for a good overall picture of the sun, rapidly finding filaments and active regions, etc.; but not for the fine pointing. H-alpha 1 and 2 both were exceptional at flare location. The H-Alpha almost always gave an indicator when we had a flare going on.

Sunspot Umbra and Penumbra - Penumbra did not show up very well, but umbra showed up fairly well. We did not always have a one-to-one correspondence. We could see the larger ones in H-alpha, but not the smaller ones. Looking at the XUV slit and the H-alpha display simultaneously, I could see that of spot detail which we could just not pick up H-alpha did not pick up the spot detail as expected. Some of the larger umbra did come through.

Active regions on the limb and the visibility of structure and surges - H-alpha 1 display was exceptionally good for this. Once we found some unexpected surge activity at the north pole, but the magnitude was only - 10 to 20 arc seconds. Even so, it was very evident in the display. I'm glad 55 was able to correlate that with their data. We were able to see surges of a magnitude as small as 5 arc seconds, but we never made very

GIBSON (CONT'D) much of them. Usually a magnitude of 10 to 15 arc seconds stood out quite prominently. We usually stayed on the limb in the location of the surge whenever we saw one. It recorded a little observer time. We could not actually see the motion. We could tell that something was present above the limb, but we could not tell whether it was a very small prominence or a surge. Having a band pass would allow shifting back and forth. Several displays with different band passes or, switching different filters in and out would allow looking for Doppler shifts. This would have been an excellent way to pick up surges on the limb. It would have been much faster than the methods we used.

Surges on the disk - not quite so easily done. In a few cases I was able to see absorption features which had not been there before and were best interpreted as surges. These features usually accompanied something else on which we were taking data. Consequently, we never followed them up with a building block 10.

Filament Changes - Unless the operator is watching closely, he will not see filament changes. Those changes are relatively subtle. If the whole filament starts to disappear, its disappearance can be picked up on H-alpha 2, but in general, filament changes were difficult to see. I usually concentrated

GIBSON (CONT'D) on some of the small, detailed features of the Sun and did not have time to monitor the changes in the overall structure.

The H-alpha 1 and 2 reticles in the movement - No problem. I rarely had to make any adjustments to these reticles when we did the alignments. They were usually reported as a very small tweak, and the control for the reticles was perfectly adequate.

The zoom operation was useful. We did not use it as standard practice, but occasionally I would zoom in on H-alpha 2 or out on H-alpha 1 in order to get a better look at something. H-alpha 1 zoomed out with a very clear display of something; for example, chromospheric network which we did not explore very much but if you wanted to find out what the overall aspects of active region looked like, for example. By zooming out in H-alpha 1 I could see the overall features of the chromospheric network or trace the magnetic neutral line of an active region. I could then zoom in and look for some of the finer details.

Controls and displays were perfectly adequate with the exception of the degradation of the H-alpha 1 image.

H-alpha 1 film camera: No problem.

Polaroid camera, frequency of use - At the beginning of the mission we used it only once at the beginning of every day.

GIBSON (CONT'D) When we started running low on film, we had to use it sparingly again. During the middle of the mission, we used it at the beginning of the day and many times at the end of the day. Occasionally we used it during the day if there were specific features to see. Some of the film may have been exposed to radiation because it was washed out. Halfway through the mission I found some of it and realized we did not have as much film available as I had thought. We had to cut down our rate of usage. There were 10 to 12 packs which had been exposed to radiation.

Film quantity desirable: I would like to have taken more pictures, but I did not have the time. It took time to line up and do the integrations for the XUV monitor. The features in the XUV changed more than the features in the white light coronagraph, so we used the XUV in the middle of the day. However, when we had activity on the limb, we were also taking white light coronagraph pictures quite regularly. The Polaroid camera was useful in looking for changes in the corona. If the corona did not change much during the day, we did not take a second picture. We then just had the 24-hour observation period of the white light coronagraph with the Polaroid camera. The Polaroid camera should be included in future missions. The shield should be more light-tight and easier to use. We were forced to tape

GIBSON (CONT'D) over a number of holes and still did not eliminate all of the lights. Some light always leaked in at the bottom because the Velcro was attached at four points rather than in a light tight continuous strip. I tried the Polaroid camera on H-alpha on a couple of occasions and did not get desirable clarity. Therefore, I did not use it when feature was available in H-alpha. I could usually either remember the location of the feature of use the 55 instrument to relocate it. This was preferable to taking a picture in H-alpha. It was exceptionally useful for the coronagraph and the XUV monitor. I used the coronagraph in conjunction with the Polaroid picture to get an estimation of what had happened overnight. At the beginning of the mission when I took a picture early in the day, from the middle of the mission on, I marked out the features in the TV display and the white light coronagraph. That way I could remember what I saw and report it to the ground. All the features visible on the TV display did not show up in the Polaroid camera. The finer features on the TV display usually washed out on the Polaroid camera. By using different lengths of integrations I could get the type of picture I wanted on the XUV monitor. I usually used 2 seconds of integration for picking out the very bright active features, or 3 seconds integration for picking out overall features such as filament channels and coronal holes.

GIBSON (CONT'D) Solar Radio Noise Burst Monitor: I did not have much use for this. To calibrate, I turned the gain up full and set the level at the background level on the pad. I then set the threshold slightly above this. If the timing was not proper, the monitor would switch off. When we came up on the day side, we would be involved in setting up the instruments and not turn the instrument on at the proper time. I do not recall this ever being the first flare indication Occasionally it did go off while a flare was in progress, but it was usually after the fact. This type of monitor needs improvement, but I would not discount it altogether. False alarms usually occurred because it was not turned off at the proper time.

GIBSON Manual Pointing Control - pointing characteristics such as stability, capability to point in 1-arc-second increments: Stability I did not find to be any problem, but pointing in 1-arc-second increments was time consuming. Converting from an octal to a decimal in the pointing control was problematic. The hardware is implemented in octal, and the readouts is in decimal. Some numbers are unattainable, and they confused the observations. We ought to have a mechanical readout which looks at decimal and reads out in decimal. The gain on the MPC was a little bit too high for pointing in 1-arc-second increments. A very small tweak was all that was necessary. We

GIBSON (CONT'D) needed a gain times 10 switch for maneuvering at a slow rate. It would have been useful for the S055 data. The S055 readout could be substantially changed by making 1-arc-second increment changes in the pointing. We needed finer adjustment in the pointing.

GIBSON ATM Operations Boards and ATM Chair: We didn't use the chair at the panel because it was a constraint that we didn't need. I preferred moving around and getting some exercise. Being able to lean back and stretch while at the panel, was a good way to stay mentally alert. Had we been strapped to the chair, we would have fallen asleep. The operations boards were a good idea. I would change their implementation slightly, but the concept itself was good. Without them it would have been difficult to handle all the paperwork associated with ATM. The clips which were used on the boards should be changed. Once the spring clips were sprung, they were useless. All the clips should have been the squeeze and release type.

On the left we had three boards. On one we kept all of the primary DAS codes which were on one JOP sheet. On the center board we kept the JOP 3 summary sheet. On the one on the right we kept the JOP 8 summary. We kept the schedule pad on the side of the board on the far left. The solar activity pad was kept on the lefthand side of the board on the right. The other

GIBSON (CONT'D) star tracker pad was kept in a separate location. We had a fourth board, which was about half the size of the others. It was kept to the right of the three ATM boards. It was one which was intended to be sprung onto a wall or clipped onto a wall. I secured it to the handrail and kept it to the right of the panel. On it we kept Polaroid pictures and ATM related items.

GIBSON ATM Schedule Pad: Observing Time For First Pass of Day - Before I went up, I thought that the additional 10 or 15 minutes we added in there would do it. I found that it took the additional time just to take the Polaroid pictures or to look around at the overall activities of a couple of active regions that may be on the disk. I found that I could have spent the whole orbit looking for features of interest, using XUV monitor and H-alpha then following it up with 55 readouts. We can't afford that type of time. We can't afford to have instruments with those capabilities sitting idle for that period of time. From the observer's standpoint, I could have used that time and made myself just a little bit smarter on what was really presented in front of me. As it was, I'm sure that there were just new prominences or new features that were merging which I missed because I really didn't have the time to go around and look at the new features. It takes quite a little while really to look the Sun over in detail and the more information you

GIBSON (CONT'D) have available to you about what's going on, the more detailed look you want. It's sort of never-ending thing. A way of having automatic operations carried out at the same time you are able to maneuver around and look at the Sun would have been an ideal combination. That was not quite possible with the way we had the ATM designed. I was glad to get that observing time at the beginning of the day. We certainly needed it. From the observer's standpoint, you need longer than what was available. I would like to temper that with the understanding that you've got to start getting some data; you can't spend your whole time looking. There is really no complaint there about the length of time that was given.

Observing Time with Shopping List Items Indicated - The most satisfying part of the on-orbit operation was the observing time at the ATM. That's when it was most challening and interesting. To have shopping list items indicated, that's fine. That gives me the indication of what the people on the ground wanted. I think perhaps the most challenging day of all and the most interesting formula was the day I essentially had the ATM given to me with recommendations and suggestions from the ground on the types of observations they would like done as well as those observations which had to be done at specific times for NASA purposes. That I think closely approaches the way we will be working in the future and the detailed specification of pointing

GIBSON (CONT'D) in modes which we have on ATM. I found it to be more useful to get a total orbit's worth of observing time as opposed to breaking out of observing time up in two or three orbits; simply because it sometimes takes a third of an orbit or so just to get set up to make an observation to where you're sure of what you are looking at. One of the better things to be looking at on the disk is that you've got yourself properly pointed and rolled and that you've thought out what experiment modes and sequences you want to run and have it all fit mentally into a time line. That does take a little while to get lined up. I found a third of a daylight pass was not unreasonable for that, 15 to 20 minutes or so. Changes to BB - No problem. The more we worked up there the more we were a little hardnosed to the changes of things. Probably that served a useful purpose before we launched to get people to think clearly about what they really wanted so we would have something to which to train. Once we got in orbit, my thoughts turned to getting the best possible data and suggestions from the ground on how to improve the data. I was all for it even to changing the mode of my experiment. I did not find it to be a difficulty at all.

SAA, Horn, Momentum Dump Suggestions - SAA, I would like to have on board; that goes along with something in the world of

GIBSON (CONT'D) visual observation. I would like to have something on board which is like your plot board which you have down in the MOCR, something that shows where you are in orbit relative to the landmasses and to the South Atlantic anomaly. I think that would have cleared up our South Atlantic anomaly problem. You might think it's a little strange that you could be in orbit and not know where you are. But unless you're looking out the window and following yourself along a ground track, you don't. When working inside for an orbit or so, you don't realize where you are over the ground. You know whether it's night or day and that is about it unless you make some special effort to find out, which usually takes awhile for pulling out a plot board and figuring it out. That takes 3 to 5 minutes that you don't have. So rather than putting times down on a schedule pad I would like to see a presentation to describe where you are over the landmasses. Momentum dump never really turned out to be a real problem. When beta angle got high so that momentum dump was limiting the daylight time or observing time we knew about it. I think the indication of when we went from one transition to another would have been useful but in no way mandatory. That is indicative of when we went from limitation of 40K to a limitation of momentum dump as definition of the daylight side.

GIBSON (CONT'D) Solar Activity Pad: Pointing Coordinates for Active Regions, Filaments And Prominences - They were usually the up/down and left/right rolls given as precise coordinates. They did not apply to active regions unless we were doing 55 superrasters or pointing off the limb with 82B. There was a good purpose for it and it was straightforward to carry out. They try to give you a precise coordinate for a particular type of feature which you're going to observe in an active region or the most dense part along a prominence or a filament, which is perhaps not best done. We never fell into that mode and the people from the ground never tried to do that. They only specified the active region or the other feature which they wanted us to observe on the JOP summary sheet to tell you the story on pointing with some additional words from the ground. I found that to be a good way to work it. I thought was very satisfactory.

NOAA Summary - I found exceptionally useful. It kept us aware of what was really happening on the Sun which we may not have observed or could not predict beforehand. Magnetic information of the type that they gave us occasionally was exceptionally interesting. I think it served to give us a good understanding of what is happening on the Sun and whatever we had the observing time helped us make better use of it. I think the Vela people overall worked in exceptionally good during the mission, GIBSON (CONT'D) and I was very pleased to get anything that they chose to send up. It was always valuable information I don't think we every got enough of it. There was always a little humor thrown in there too which made the work a little more enjoyable.

Experiment Hardware Paragraph - When that was sent up, it was useful.

PI Comments - Useful.

Flare and Coronal Transient Guidelines - I would have preferred to have gone along with constant guidelines. The same as previously. Then if the guidelines change from one day to the other, have only the applicable words changed such as threshold setting or the sequence of operations to be done for a limb flare or for a corona transient. Each time we had to peruse that pad to make sure it wasn't the same as before, or if not, to determine what had changed. It would have been nice if the mode had not changed frequently. That method would have been an easier method from our standpoint. I recognized that part way through the mission, but it was not worth the paperwork change and all of the associated problems to try to get that implemented.

Voice Updates - These were exceptionally useful when they did come. We had a good effort put forth by Bill Lenoir to give us

GIBSON (CONT'D) some visibility of what the ATM world was thinking each morning. We had orginally requested a PI or his representative do this, not realizing the Bill Lenoir had the time and would be able to put in the effort that he did. I think he did an exceptionally good job. For our mission, he did just as well as many of the PI's could have done. Discussions of specific experiments, interpretations of data, and the type of data desired with each experiment is best done by the individual PI. The overall operations of the ATM, explanation of activities of the day, and the intermediate areas between each individual PI group and us in flight were handled exceptionally well by Bill. Whether that would be a procedure in the future or not depends upon how close we come to an ATM-type operation. I think another way of working in the future would be to have a separate loop on which the ATM world could work or a separate loop for any other experiment discipline if required. We want loops limited to the ATM world, focusing on the ATM world as an example. Many times information would have flowed better had people on the ground not broken into the operational flow to give auxillary scientific information. I would have preferred to have had another VHF frequency which was called up for us parallel with the operational ground frequency where we could have talked to people in the ATM world freely without bothering the operations. By operations, I mean those things having to

GIBSON (CONT'D) do with other facets, whether it be evening status report, a call to throw a switch in the command module, a request to change a pad or whatever it may be. I think a direct line to the ATM backroom would have been useful and would have accomplished more than the situation which we did have. However, I think that the solution of using Bill Lenoir and the morning conference was better than I anticipated. This is the whole area of voice updates. When something of significant importance was happening on the Sun we usually got those voice updates. I think if something of smaller importance would have happened like a surge on the limb, a flare about to go off, or things of a more subtle nature like changes in magnetic activities, and changes in the X-ray, they could have been called up and been useful to the crew as well. The whole list of things called out here are things that were not really called up very frequently.

The frequency of solar information, Filament Darkening, Surging Prominence or Filament Motion, Blue and Red Shifts, Radio Bursts - Things of that nature would have been useful to have been called up as the observatories around the country produced observations. This information could not have been called up because of the local limitations of the ground contact. This limitation speaks again for two things in the future. A

GIBSON (CONT'D) long-duration mission like we had ought to have a continous communication with ground via satellite. We ought to have a second channel on which we could talk with the people in the background to get continuous voice updates on this particular type of phenomenon to help the observatories as well as for us to speak to them and give them some of our observations. The calls that did come up were useful. I cannot think of any particular call that ever came up that I discounted and did not consider useful.

Procedure Changes - Frequency, Content, Format, Suggestions for Handling Extensive Changes of new JOPs - We did not have too many of those. We had no problem with the ones that were called up. I don't think people really changed things a great deal. I would have been even more flexible when we did do things during the mission for creation of new JOPs or descriptions of new pointing changes. Again we were limited by the amount of voice contact and time for explanation. I think the morning science or ATM conference worked well for that purpose.

Daily Discussions - Content was good. Duration of discussions was usually adequate for the time but once you began operating something and actually got into the need of operating the ATM, you found that you had other questions and that other comments from the ground would have been helpful. Even so, GIBSON (CONT'D) many times we ended the ATM conference with a minute or 2 remaining without anything specific to fill that time. This situation usually occurred because we were not engrossed in the ATM at that particular time.

ATM Scheduling - In general, that was very well done. There were a couple of instances where we had to be making a maneuver at the same time they had us running the ATM. That was only once or twice. It was handled exceptionally well.

Building Block (BB), Prep Time - I found that putting a little bit of observing time in the schedule really was a fudge factor. Sometimes I could get ahead of the building block and sometimes I would fall a little bit behind and use the observing time. I could usually get ahead when the JOP Summary Sheet had allowed for a pointing change but the pointing did not have to be changed and by going from one building block to another. In such a case I was able to move rapidly and pick up 3 or 4 minutes per building block, leaving as much as 10 minutes at the end of the orbit. In some instances the pointing changes were so straightforward that they took only 15 seconds. Many other times, however, I found that to put the proper judgment into the observations and the pointing, I would fall behind initially and have to depend upon some of these other schemes to catch up or have to use observing time during the orbit.

GIBSON (CONT'D) JOPs Which Should Be Started And Completed By The Same Crewman - We will not go into that now. We did not have many JOPs with that requirement. The long-duration studies of the chromospheric network was one of the few. The hyporaster was no problem. We just checked off the blocks that had been done by the previous crewman. We were able to follow that along rapidly.

Suggestions for Scheduling Guidelines - Maximum Number of Passes The Crewman Required - I got a little saturated by the fourth or fifth pass I would do during the day whenever I got that opportunity on days off. I wasn't able to get to the ATM that much. When you run four to five passes a day you put in a good 8 hours of hard mental work, you're capable of doing other work but not something as demanding as the ATM. I think I put in six or seven passes on a couple of days and I must admit that I was somewhat of a vegetable mentally when I finished the day. I purposely put observations that did not require very much judgment to the end of those last couple of passes.

Activity During The ATM Night Side Passes - I usually found that when I was between passes there were always enough other things to keep me busy, things from meal preparation to housekeeping. I could always make use of 15 minutes in the cluster.

GIBSON (CONT'D) Visual observations did get some of the time, but of course, on the night side we had only night time observations and I think it was only when we were at very high beta angles that I could use that momentum dump time, if you will, for visual observations.

Science Conferences - I found them to be exceptionally useful. I wish we would have had more of them. I appreciated the feedback that I got from those principle investigators. You can feel somewhat isolated up there, although Bill did an exceptionally good job and we were probably much better informed of what the ATM world was thinking than were the previous crews. The crew felt that the personal contact with the PI's and getting their firsthand information on their particular experiment is exceptionally useful. I do not want to in any way diminish the importance and utility of what Bill Lenoir accomplished.

ATM Experiment Reference Book - I found it to be useful to give workers information in particular experiments, for example S055 wavelength or grating information. Occasionally I would look at the experiment summary if I had a question about experiment hardware operation. I don't think I ever used it to read and study a specific JOP that I would be doing the following day. I usually looked at the JOP summary sheet for that. I

GIBSON (CONT'D) had written many of those summaries, along with Al, and I pretty well understood their intent and did not require them. Some of the individuals that were not intimately involved with the JOPs before flight had a different outlook on them. Studying the JOPs before flight was a useful aid to organization.

JOPs Suggestions on Format, Size, Tabbing - We picked a good size for the summary sheets. If they had been any smaller it would have been difficult to fit in all the information on them. I was glad to see that we kept the building blocks on the JOP summary sheets so that the building blocks could be tallied to that particular JOP. The JOP summary sheets were very satisfactory.

Teleprinter JOPs - We did not use them. We did not have a teleprinter fail case. We were always able to compute our values and grating selects to put into the time span that might be open in observing programs.

ATM Systems Hardware And Operations: The Attitude Pointing And Control Subsystem, Cluster Stability - I doubt that we had the correct drift numbers when we were doing our JOP 18. I say that because as I observed the comets position from one orbit to the next, on the dark side we stayed allegedly at the same spot. The compensations calculated by the ground and

GIBSON (CONT'D) what I observed were different. We used the figures we had on board. Sometimes I had a chance to check back and the onboard figures seemed to be doing a better job. I'm not sure where the problem lies. Probably a number of factors were involved, but I will not speculate right now. Overall, the cluster was very stable for performing Sun work. We did not experience any difficulties except when we gimbaled on the stop. Of course, with the two CMG's, we went off the Sun and it was very disconcerting. We happened to look out before we got the one flare with the early rise. I found that the use of 3-minute maneuver time and selecting solar inertial worked about as rapidly as could be expected. I would have liked to have been able to anticipate flares a little earlier so that I would have been able to plan the observations, allowing for any possible difficulties. This did not occur frequently enough to cause a big problem.

EREP Maneuvers - No real problem there. It took a while to get into the swing of those maneuvers although they were straightforward. I still found that it was possible to make errors if you rushed. In non-EREP maneuvers you would make errors by no selecting CMG ATT HOLD. You knew you were in CMG ATT HOLD on the Sun. It was natural to assume that any attitude changes would be executed from solar inertial; however, it was very easy

GIBSON (CONT'D) to forget our 5.1-degree limitation. It seems the only way to avoid going beyond a set limitation would be to design a system without a need for such a limitation. Going ZLV for one or two orbits to save TACS was useful, but we lost observing time on ATM or other instruments by having to do that. Obviously, I'm making another pitch for magnetic desaturation, using magnetic torquing or the Earth's magnetic field, to desaturate control moment gyros. If we had had that capability, we would not have to go orbits in ZLV to save TACS.

JOP 13 - Included in that is JOP 18. We thought JOP 13's were very important early in the mission. We did JOP 18 so many times that I became used to that time line. We did much more in that area than we ever anticipated. Pointing was achieved best by using JOP 18D, which included as many steps as we would ever use. Instructions were to either omit it or the information for it was given in the pad. It just took time to go to the pad to be sure you fully understood everything. JOP 18 pointing stability and accuracy in pointing to the comet are difficult assessments to give. It is difficult to try to assess the center of the 52 occulting disk where the crosshairs are aligned then put the overlay on that without any parallax or any other problem. Another associated problem was getting in the correct roll so that when you made a maneuver, you

GIBSON (CONT'D) always maneuvered along the white line. Also we had a mean 300-arc minute bias in there. The actual comet location reading on the overlay could be done in 1 to 2 units depending upon the parallax. In order to point to the center of the comet, the scale factor perhaps was nonlinear in relation to the motion of the cluster. All of those things combined so that we may not have been any closer than 0.03 or 0.04 degree when we finally maneuverd into alignment with the comet center; possibly it was a little lower than that, I hope so. A cluster was never designed to do such things. We did our best under the circumstances. In the future, however, we need instruments like telescopes where all the filtering can be taken out. If we could remove all of the neutral density filters in the white light display, we would have had an excellent field for pointing. This type of flexibility should be designed into the system. It will always be a problem if it's not a specified mission requirement 5 or 10 years before you fly. Simply stated, we need flexibility.

Star Tracking System - It was great while it worked. I had no problem with it. The updates were always a bit of a problem because they were time consuming. An automatic star tracker would have been more efficient. A star tracker capable of filtering out bad star lock-ons and finding correct star lock ons should be developed.

GIBSON (CONT'D) Momentum Dump Operations - We rarely had anything to do with these operations; they were all handled by the ground. No problem. The ground should take care of the whole thing and not try to have the crew working it simultaneously.

Control and Displays - We had a reasonable way of working that as entering DAS codes in order to make large attitude excursions. However, for small attitude excursions, I preferred something like the MCP which I found could point to the comet. But we really had a cumbersome system. It was cumbersome to put precise coordinates in both the control and display. We should have had a direct visual feedback to where we wanted to go and manual pointing control and just gone there. Anything else, say 5 degrees, would have been a much easier way to maneuver the cluster. In terms of controls in going through a DAS, you ought to specify where you want to go. I thought that was a very cumbersome system after getting used to the command module system. I like working directly in decimal values, being able to specify the attitude you want, entering the decimal, and going there. I thought that would have been much better. The use of the maneuvering time was a good concept; it worked well.

DAS Operation - That was no real problem. I punched the DAS frequently, many times just to get very small pieces of

GIBSON (CONT'D) information. For example, as we were making corrections for drift and JOP 18 or a whole multitude of entries that had to be made, the fingers on my left hand really got a workout punching in DAS codes. I used it to make small attitude excursions as I was chasing the comet and trying to get it to precise location. Twenty different key strokes were required to make one maneuver. That's excessively high. Obviously, the system was not designed for maneuvers.

Structures and Mechanical Subsystems - Rack, Experiment Canisters, ATM and Solar Array Deployment - We had no interface with those items other than on the EVA and all worked without any problems.

Electrical Power System - We let the ground do most of that. We've already touched on the electrical power system for the ATM. There were the problems of being unable to get to the CBRM to make mechanical repairs and being unable to allow one solar array to go through another CBRM which would have been desirable.

Control And Displays - These were a nightmare to interpret where there was a fault in a given system or whether there was a DAP problem or low voltage. This troubleshooting onboard required extensive chasing around through rotary switches and two- or three-position switches

GIBSON (CONT'D) That was an exceptionally cumbersome system to work and if we had it to do over again we would have designed it differently. We worked ourselves into a corner when we guaranteed that there was only going be one CBRM failure and then we could in no way inhibit any of the fail inputs into the logic which controlled those controls and displays. It was very evident in throughout the Skylab missions that we would have been better off if we had had a parameter inhibit capability, a thermal control subsystem. It all worked well and we never had any reason to be working with that system at all. If you do start having problems, however, you might get involved with those controls and displays and a little bit more.

Instrumentation and Communication Subsystem: TV Monitors - I found the TV monitor to be a fairly straightforward task which required a fair amount of care. I'm glad I got the chance to do it on the backup unit down at Huntsville because there were a couple of errors made at that point, and I was able to make sure that errors were not made in flight. I think that speaks well for having either one exceptionally good simulator or a backup unit on which those type of hardware training sessions are made. The TV monitor that we took up with us was far superior to the other one. The white one was exceptionally whiter; the other TV monitor was almost a yellow, in comparison.

GIBSON (CONT'D) The contrast was much greater and the resolution of the monitor much better. Tom Barnes at Marshall should be commended.

Alert Light Subsystem - I found that the alert light occasionally comes on and you never notice it, so we did have a slight problem. If you were looking for something like a scan spect alert light, which I was on occasion, you would see the alert light come. But there were a few times that I mentioned before when we had S055 tripouts that the scan spect alert light came on. It went unnoticed for a period of time then all of a sudden I noticed that we had a different alert light on than we had before. I would rather have some type of a tone associated with that to call attention to the fact that something changed. The visual cue at the top of the panel was not enough.

Lighting Subsystem - On the ATM panel I was sorry to see that we had to operate in the fixed mode on two out of the three controls. It took away some of the flexibility I would liked to have had. The variable mode was useful, and it should be designed into the future control and display subsystems. Lastly we lost the integral lighting I found that before we flew I was somewhat of a skeptic on the utility of the integral lighting. I felt that it was a nice thing to have but not mandatory. However, I was no longer a skeptic after we lost it because in the darkened atmosphere in which we were working

GIBSON (CONT'D) it was quite difficult at times to read the panel, and some mistakes were associated with not being able to read the panel. I still forget the nomenclature on switches as well as I knew that panel nomenclature. That is needed on future C&D systems where you plan to work in a darkened atmosphere which we certainly did on the ATM. ATM crew operations. First JOPs I will comment only where a significant comment or change is recommended.

JOP 1, Chromospheric Network Cells: We did not do this very much; it was called up very infrequently because the PI's figured they had gotten enough information on this subject. I found it interesting to use the 55 detector to try to look for enhancements along chromospheric networks, boundaries, and vertices. But I did not spend a great deal of time at it because it was not necessary. We could, I think, with the beautiful H-alpha 1 display, very easily select good cells at the center of the disk. We could also see large individual spicules on the limb when the H-alpha 1 display was good. We had to turn the contrast down to around 3 and the brightness up, but it worked real well; we could not see individual spicules of the smaller size, however. By large, I mean at least 3 to 4 arc-seconds. But that's a guess based on my memory of the scale of those features that we could see on the limb.

GIBSON 55 Mini-mar Procedure for looking at the Coronal Transition Region: We did not do that. I thought it was a great idea and a good way to get improved spatial resolution for 55, but apparently there was a problem there which I did not appreciate before flight. I'll certainly take the word of the 52 people that they were getting better data through other observing programs.

JOP 2 - Active Regions: It was easy to pick up active regions near the limb on the XUV monitor. You could see them coming around the limb, of course, just before they were visible in the H-alpha. Many times, you could just go 5 to 10 arc seconds above the limb with the 55 instrument and then roll about Sun center, looking at oxygen VI, for example, to detect the presence of a region. You could easily pick up something coming around the limb or something which had already gone over the limb. So active regions near the limb were no problem.

Neutral Line Visibility - We had no problem picking up the overall neutral line location; that is, the lead-ins to the neutral line and to the active region filament channels, filaments, and occasionally a fibral structure. But I found that in several instances, possibly due to a lack of clarity in the displays once they had become degraded, I had a tough time finding out exactly where the neutral line was. I don't

GIBSON (CONT'D) think this really slowed us down a great deal. We were able to pick out the greatest spots of the active region and follow those. I think I positioned out the slit so that we had a good chance of getting any breakout of activity covered by that slit. We would have been a little better off had we always known where the neutral line was and been able to make sure that the slit was crossing a possible ribbon flare. So I was not very happy with that one particular area, and I did not do quite as well in flight as my preflight experience had led me to hope I would. We all had worked with Pat McIntosh and other people on neutral line recognition, and I thought I had become fairly proficient at it. I think it must have been the display itself which did not allow me to get as many identifications of neutral line details as I would have liked.

Changes in Active Region Structure - Probably the most significant ones were noted for their intensity and location of their bright points, especially with the 55 detector able to qualify that. Whenever we started to get changes in the locations and the intensity of the bright points, as well as fairly high readings in the bright point information, we knew we had something picking up. Sure enough, that's usually when the flare would start to occur. At the appearance of such reliable signs, you could get spring loaded to the flare position.

GIBSON (CONT'D) Ellerman Bomb Observations - I tried in a couple instances to pick up Ellerman bombs, and I found them as elusive up there as they are down here. It was very hard to determine if you saw a bright point out there along the edge of the penumbra, that you were really looking at an Ellerman bomb. Granted, they are usually clustered around the penumbra. But I don't think we saw a cluster of bright points anywhere near what would have been the edge of the penumbra that I could have said were Ellerman bombs. Perhaps they were there to observe and we were just not looking at the right time. The fact that little emphasis was placed on those observations may account, in part, for our failure to see any.

JOP 3 - Flares: The one on the rise that I spoke of was probably about the best we could have gotten with the equipment we had. We knew that we had potential flaring not only from the ground's callups but also from the precursors which I have mentioned: bright points changing slightly in location and magnitude, and becoming relatively high in intensity and oxygen VI - that is 20,000 to 40,000. These were rather definite indications of flares. So I think that before the flight I probably placed too much emphasis on the neutral line and not enough on bright points. One of the reasons that might be true is that we do most of our observations down here with film which has a limited dynamic range. I think if people had done more

GIBSON (CONT'D) H-alpha observations down here on the video they would have appreciated this correlation of flares and bright point magnitude and time and space variation; thus we might have been spring loaded in a slightly different direction. However, it all worked out because it was very obvious as it was happening.

So we were accustomed to looking for flares when this particular phenomenon occurred. Again, there were only two good active regions for us, two good rotations of the favorable longitude for solar activity. Therefore we did not have a great many passes at it, but I think we had enough to get a good feel for it. When we did pick it up, I was staging on an active bright point and watching in the XUV monitor, which I had turned down to the point where the brightening was just barely visible. I was also looking at the oxygen VI readout so that I had the 55 detector on it as well. As soon I saw a small brightening in the XUV monitor which was confirmed by a slight rise in oxygen VI, I went with the flare mode and looked at it again. I think all of the details are recorded on tape, which will give you a more accurate account than I could give now from memory. So I am referring you to those, but I'd be glad to go through the tapes with you and try to give you some more explanations.

GIBSON (CONT'D) Flare wait precedure - It worked as well as possible with the equipment we had available. But again, I would look for improved equipment in the future: real time magnetographs and good XUV monitor displays with filters that could be changed, and X-ray readouts which are not susceptible to the noise of the South Atlantic anomaly.

Tone light switch philosophy - That was simple; the darn thing was such a constant problem that we usually had it either off or very high. We put it to the point at which it would trigger when we got a rise in the XUV only when we were not in the South Atlantic anomaly or were very far removed from it. That was not too often, and we didn't always remembered to do it even then. When I used the PMEC, I usually set it to about 100 counts lower than the pad called for. I can't think of one time when it went off during an actual flare that I was not alerted to it by another means. About 90 to 95 percent of the times that it went off, it triggered the South Atlantic anomaly, maybe even a higher percentage than that.

JOP 4 - Prominences and Filaments: Prominence visibility was great in H-alpha 1. By turning the contrast down and the intensity up, and especially by maneuvering the disk of the Sun off the display so that the AGC would allow you to really bring out prominence intensity, you can get excellent visibility

GIBSON (CONT'D) of a prominence. We saw some beautiful ones. I recall a quite extensive one that was associated with the first passage of a very active longitude.

Pointing within Prominences and Filaments, 55 Detector Peaking - I found that it worked quite well on prominences. Most of the time we were looking at Lyman beta line in 0028 grating position, detector 3; that seemed to work very well. Structural Changes Noted - There were very subtle, but detectable changes in the prominence from one orbit to the next. I believe I tried taking one photo with the Polaroid. But that did not turn out too well, unfortunately, and I had to depend pretty much on memory.

JOP 5 - Constant Latitude Studies: The 82B mini-limb scan worked very well. I thought the procedures were relatively straightforward. I was sorry that we lost the limb scan readout. But I'm glad we had it as long as we did, because I was able to calibrate zero limb offset by eyeball as it appeared on the white light display. It turned out to be the point at which I would guess that the inside edge of the slit was just tangent to the limb. Before flight I would have guessed it was plus 1 arc second or so off the limb, maybe even 2. However, it turned out that it was the one which gave zero limb offset. I assumed it was probably because we did not see the Sun all the

GIBSON (CONT'D) way out to its true extent, and also that the curvature of the Sun caused the limb offset to extend a little bit further then you might estimate, with the slit covering up that curvature.

JOP 6: Very useful. I'm glad we put a lot of emphasis on it in our flight. Because of the duration of our mission you will get a lot of useful data on at least two solar rotations. Long Term Changes Noted on the Display - Of course we could follow the white light coronagraph changes quite well, as the ground could with the TV pictures that came down. All long term changes were obvious to us; no problem following them. We could visualize the rotation from one day to the next as we saw things appear and disappear on the disk in XUV monitor and the white light coronagraph and in H-alpha as well.

JOP 7 - Atmospheric Extinction: I don't think we experienced any problems there. One thing I do regret is that we did not give you as much data on that as we could have. I personally did remember to do that at the conclusion of an orbit, but many times I would be setting up the pointing for the next orbit so that we would be lined up for upcoming operations. Or sometimes it would occur that I was making observations in the X-ray right on down to maybe 2 minutes remaining and therefore would not have time to set up for getting useful information on the sunset portion. We were well into the mission when I

GIBSON (CONT'D) started getting in the habit of doing that so you would get something on he sunrise. Even there I don't think I did it nearly as much as I should have and that's probably one fault in the procedures that I did follow during the flight.

JOP 8 - Again an H-alpha transient is very difficult to notice unless it's a flare. XUV - Let me go back to the XUV MONITOR because it involves looking for structures on the limb but not transients. At one point I was looking for coronal loops on the limb, by using the XUV MONITOR. I actually did see some of these but I think the first time I thought I had seem them I was really misleading myself and everybody else. What I was looking at the first time were the tick marks on the XUV MONITOR DISPLAY obscuring the limb brightening of an active region. These marks can cause you to think that you are seeing a loop or a brightening that is separated from the disk by a dark location.

We had never worked with the XUV MONITOR, other than at Sun center in the intergrate mode. The tick marks just don't stand out to you, but they did in that one particular instance. I thought it was very confusing. It wasn't a mistake I made the second time, but the first time sure made me believe I was actually seeing loops. Now, the other time I think I actually was seeing loops was when I saw a brightening above the limb without a great deal of decrease in intensity as we went down

GIBSON (CONT'D) to the limb. There was some decrease, but not a real sharp definition of a loop. It showed up best in 55. Incidentally, by loop I really mean arch structure. We did see loops eventually in S055 readouts, but they were not picked up on the XUV MONITOR. I think we did see an arch system that was only 30 or 50 degrees, but it was not as obvious as I would have like to have seen in the XUV monitor.

Lets get back to coronal and disk transients. H-ALPHA, XUV, and X-ray transients were seen only in the white light coronograph display. We did not pick up any transients; the ground had to call those up. We picked up long term transients and emphasized coronal observation when we could see changes there, but we did not pick up short term transients. It was a disappointment to me,but a fact of life. We saw surges on the limb when we did the observations on those surges. We did some BB 32's before and after, but we did not go into JOP 8 for those surges. When we observed the white light coronograph after going sun center, we could not see any detectable change, and contented ourselves with the building block 32s at the beginning and end of orbits, in order to try to pick up whereever our transient may have occurred.

Suggestions for Observing H-alpha and XUV Manifestatious of Transients - One possibility is a filter which could be tuned

GIBSON (CONT'D) off-band or rotated through on a polar filter wheel. These would be at different locations in H-alpha and would allow visibility into transients which doesn't exist at present. When you take a quick look at an event on the limb, it is difficult to tell what it is. If you had a clear idea of its velocity along your line of sight, you would have a much better estimate of what is happening. Using photographic substraction you could subtract one side of a line from another, but that may be getting a little exotic. XUV manifestations of transients would be another hard one. Again, a subtraction technique is the only thing I can think of which might allow for that. However, that's not from the inside of one line to another, but from one minute to next if you stay pointed at the same location. You would then have to subtract one XUV frame another and display that result. Perhaps those techniques will be better understood and much easier to implement when the time comes for another mission; if so, I would certainly recommend putting them onboard. White light display transients have already been touched upon. We did not see the characteristic shape of transients at all except for the one time we got the bright transient. We all wish we had gotten more transients but at least the one we got was spectacular and made up a little for the ones that we didn't get.

GIBSON (CONT'D) Ground Detected Transients - Adequacy of Information - I can't say enough for the coordination on the one we had. The fact that the observatory could pick it up and we inflight, just a few minutes later, could be observing it speaks well for the whole system. I thought it went exceptionally well. The call from the ground about the bright transient could have been clearer. We should have started at Sun center with the coronograph, rather than doing BB10; but that was no problem. We did lose some data, but not much.

JOP 11 - Chromospheric Oscillations and Heating: We did not do very much with that, but what data we did take was no problem.

Calibration JOPs: These were no problem. The 82A slew calibration was no problem. I think I was able to stay within plus or minus 30 arc seconds quite well by using the two reticles on solar features in H-alpha. I would slew the feature back and forth between the electronic crosshairs and the mechanical crosshairs. This proved to be a superior way of looking at digital readouts.

JOP 13: I've already discussed most of that.

Timeline Suggestions: There were no real problems in carrying out the JOP 13's. Toward the end of mission, we used the 18D time line for JOP 13 because of its flexibility.

GIBSON (CONT'D) Fine Pointing Using Matrix Calculation: I used the HP35 and arrived at the right answer very rapidly. We had no prob lem doing that. If I had arrived at the wrong answer, I would have gone to solar inertial, zeroed the biases that were in, and calculated new biases.

JOP 14, Solar Eclipse: I don't recollect the details of that very well. It was done quite early in the mission. I do know it would pose no real problem. I'm not sure we did it in an optimum way from the standpoint of S055, but we certainly had enough tries at it. I hope we did get some useful information out of it. Procedurally it was not too much of a problem, but it was not the kind of thing you could train for very easily. I did not feel too far on top of it when we did it. I think there's a lot of on the job training.

JOP 15, Coronal holes. I think it was best carried out by having the ground call up in general what coronal hole they wanted investigated as opposed to a precise coordinate. Then let the crew make the final decision in pointing. Between the XUV monitor and the 55 readouts per magnesium 10 I think it worked well. I think we, on board, were capable of coming up with better pointings for coronal holes by looking at the XUV MONITOR and the photographs which were taken. Usually the

GIBSON (CONT'D) sharpness of a boundary would show up very well there. We used the persistent image scope. We would take a polaroid picture and then use the persistent image scope with the intergrations on the XUV MONITOR to get us where we wanted to be. Visibility of coronal holes was excellent. I used a little longer intergration on the XUV MONITOR of around 3 seconds for the polaroid and I guess around 3 seconds in using the persistent image scope. That showed up coronal holes and filament channels very well.

JOP 17, Coronal Bright Spots. Now here we had a problem. We wanted to get bright spots which were not associated with any activity. I really had a tough time finding bright spots with these qualifications. In almost all instances any bright spots which I saw in XUV monitor and went over and peaked up using 55, oxygen 6, or just got close using the XUV MONITOR, I usually concluded had H-ALPHA manifestation. This would be a small brightening, sometimes a vertices of chromospheric networks and I usually moved on to a new one. There were a couple of times when I did JOP 17 that took me quite a little while to come up with a suitable bright spot. I'm not sure that the one that I came up with and did the observations on was below the threshhold of observation in H-alpha and was not really of the same nature as all of the others. It could have been a

GIBSON (CONT'D) small magnetic diapole associated with activity, as opposed to bright spots which are not associated with activity. I think that one required further exploration and I wish I had more time to do that.

JOP 18: Observing the comet was one of the more satisfying things that we did on the mission. I think we got some very good spectrographic data. I sure hope so for 82B as well as 82A. I'm not too sure about the other experiments, but I think we got some good data there. With the capability of the 82B instruments to resolve lines, I'm very excited about the potential of that experiment and what it might show up in the way of constituents of the nucleus, and the coma, and the tail. I was sorry to see that it was so dim though. A lot had been said about how bright it was going to be and we, along with everybody else, expected to see a real show. We were quite disappointed by not seeing an exceptionally large and bright comet, but it was large and bright enough to do the job and scientifically we got a lot out of it.

JOP 18A: Experiment pointing near perihelion, comet appearance, and change. The appearance of the sunward spike was exceptionally fascinating. I found it always to be pointed almost directly toward the sun near perihelion and a couple days on either side

GIBSON (CONT'D) of perihelion. The tail obviously was swinging around. We could see that happen near perihelion passage. I did see the sunward spike first on the white light coronograph display in some pictures. I brought those pictures back and I think that when you look at them you see that there is evidence of that sunward spike. It became abundantly clear when we were out EVA and were able to see it on subsequent sightings inside the spacecraft. We were able to follow the sunward spike through perihelion into post-perihelion and see it die out. After 3 or 4 days we couldn't be sure we were actually seeing it at all. Then the appearance of a very long tail occurred. I shouldn't say the tail really appeared, the tail did not really grow. Perhaps it was the fact that we were seeing it more from a right angle to the tail and were not looking at it from an oblique angle any longer as it swung around the sun. As it got a little further away from the Sun we were able to get better dark adapted and see its finer features. As it went away from the Sun we saw an increase in the amount of violet in the tail. The tails were always superimposed one upon the other. I was unsure in flight if we were looking at the dust tail or at a gas tail. I expected to see the two separately. I'd be interested to see how the photographs come out.

CARR Ed, if you've covered the auto interlock area, that's an area that Bill and I were concerned with, and that 55 grating was problematic for all three of us.

GIBSON I gave a rough estimate as to how many extra laps each man took.

POGUE It's too easy to do.

CARR It was much too time consuming.

POGUE Did you cover the possibility of changing the sensitivity of detectors?

GIBSON Not of the detectors, but about changing the XUV monitor so you can look at it with different filters.

POGUE I guess the change of sensitivity in the detector would be a pretty ticklish operation.

GIBSON You might be able to change the electronics, the scalefactors, and the readout changes, but I'm not sure.

POGUE Couldn't you put a filter inside it? We were getting a lot of restriction on the operation because of the design of the system.

GIBSON That's true. Maybe there is a way of putting something in it to cover Lyman Alpha.

POGUE You'd think there'd be a way of tuning the position of the detectors. You're dealing with straight alignments and calibrations.

GIBSON Position spacial or wave length?

POGUE Geometric. I mean the actual physical position of the detectors, as well as the moving the grating for fine tuning.

GIBSON You're talking about 0.2 angstrom which is what one step was. Maybe you could do it, but I'm not sure.

POGUE You have a filter over a detector and a slit.

POGUE There's a lot more flexibility available and extra protection for the instruments.

CARR The next time somebody uses this type of equipment in space it going to be a scientist like you, Ed, so he will need more flexibility in order to do more with it.

POGUE You had seven detectors and some of them were wider than others.

GIBSON They were sized because they didn't specify exactly where they could fit them.

POGUE It would be good to have a way of changing aperture or adjusting aperture.

POGUE The X-ray, beryllium, aluminum has shown us that it sure is nice to have backup readouts. The fact that you were cascading through the various steps enabled us to use those detectors when the monitor readout failed. This points out that there should

POGUE (CONT'D) be some kind of basic readout from the detector, as well as the organized electronic on because that is what failed.

GIBSON That failure was related to the switch.

POGUE One little single point there.

GIBSON We should have a good X-ray readout for the threshold, and not one that's so sensitive to the South Atlantic anomaly.

CARR The South Atlantic anomaly really cried wolf a lot. It got so that you didn't even want to turn the flare threshold on. You're just setting yourself up to miss something. My biggest problem while operating the ATM system was the grating position. The rest of the step I felt I could cope with pretty well.

GIBSON How about your ability to work some of the JOPs and particularly the pointing required? We should talk about the training which you received, the whole overall effort, what you thought of feasibility of yourself operating the ATM, whether you enjoyed it or not, whether you felt it was a constructive way for you to go, what you would like to change if you could do it differently or had to do it over again.

CARR As far as mental facility or knowledge of what I was doing, I was probably as far as I was going to get considering the time I had to spend learning. I was just about as intelligent as I

CARR (CONT'D) could be in the area. I think that it was wise to relegate a lot of the routine items to me. I was not in a position to be as creative and innovative during observation time as Ed was. I did not feel I needed the observation time. I didn't have enough background to get really innovative. I knew enough about oxygen VI to use S055 to do some survey work, but it was very rudimentary. I enjoyed doing the ATM work. I thought it was a good break or change of pace from the other kind of work that we were doing. The work that was assigned to me for the most part was commensurate with my capabilities. I very much enjoyed doing it. I felt really more like a technician than an experimenter.

GIBSON If you had to do it over again what would you change in the training?

CARR I don't think I'd change any of the training because every bit of training I received I had to lean on at one time or another. I don't think I could have taken much more because it would have required going back and getting into more fundamentals and spending a whole lot more time dealing with the fundamentals of solar physics. We just didn't have the time to do that. I felt I knew fairly well what the equipment was supposed to do. I came down to you when I had a question and got the answer. I felt pretty comfortable with it. Bill, why don't you give your views on it?

POGUE I was assigned to a lot of the routine tasks. I enjoyed working ATM. I enjoyed the training. I think we emphasized far too much the intricacies of logic and attitude pointing control system. When we finally got up there the contingency procedures as related to ATM, were much simpler than all of the training we were given in the simulator. I would have much preferred taking a lot of the time that we spent on the logic and spent that time on operational training. I don't think operating the 82B step function manually, was an optimal design at all. It fell in the same category as the grating steps for the 55. What would have been very useful for me is stylized graphical display of the present solar situation with the active regions displayed on a teleprinter tearoff and placed on a device that rotated with your experiment roll. I was always taking the sketch and turning it sideways to make sure I was actually looking at the right region. On my first flare I got the flare but I was calling it with the wrong number and because I had misinterpreted the pad, I made my sketch incorrect. It didn't affect the observation but it did embarrass me. But I feel I wasn't really completely on top of the total systems. If they had told me to create my own JOP, I think I could have taken the data, but it probably would have taken me half an hour to set up and look at the Sun. But I feel I could have taken some useful data. I never was comfortable with neutral

POGUE (CONT'D) lines. I felt ill at ease in doing limb studies unless I could actually see something on the display or they gave me the pointing cooridinants. This was partially because the display varied in sensitivity or in resolution from time to time. When it was first turned on it looked better than when it had been on for an hour or so. I felt fairly comfortable doing the JOPs. Sometimes it was a bit sticky because I didn't understand the instructions. JOPs were fairly complex. I felt comfortable doing everything except the maneuvering JOPs which Ed took care of. I would have felt ill at ease had I been given JOP 18D.

CARR I was given a JOP 18D about the time I'd taken my pack off and decided I wasn't going to have to worry about it anymore. It was a horrifying thing to realize that I was going to have to go through with it after all. I did a lot of hustling. As I remember, I made one or two mistakes, but I got through it. I think Bill fell heir to more of the dull routine stuff than any of us. I felt fo/him because he wasn't having as much fun with the ATM as Ed and I were. I got a few interesting things that were enough to keep me real interested and involved with it. I think I got probably 50 percent more ATM passes than Bill got. Future solar investigation systems should be designed so the guy who's using it can use his creativity and get you maximum data.

POGUE A stylized or graphic display, relative to the Sun or star fields, would be of enormous help in finding your way around the Sun and also finding Mercury or the Comets.

CARR I don't know if you guys have read Dick Truly's comments on how he thought Skylab went from the CAP COMM's standpoint. He thought the next teleprinter should have a graphic format on it so that you can send up better drawings. I think that's a good idea. That would have been valuable in this area.

GIBSON Sure would have. Anytime you have to stop an operation and then come back in order to finish it later, you're just asking for problems. If you have anything which does not time itself automatically you're asking for problems because you always get engrossed in something else once you start that given function. I think this a general ground rule for future design. Any function which you perform on a control and display panel should be timed out automatically.

CARR I think that's a good idea.

POGUE Each instrument ought to have some kind of time event signal that you can activate for that particular instrument to let you know that it's timed out so that you can go ahead to the next function. The clock on the ATM, the one that you set up on the upper panel, didn't work too well. It was hard to set, as is typical of spaceflight timers.

POGUE They're all equally sorry.

CARR A good timer ought to count down or count up, whatever way you want to do it. It ought to be easily set without having to hold it while it counts down from 9 down to zero or something like that.

POGUE You ought to be able to just reset it to zero.

GIBSON At minimum you need a reset to zero.

POGUE But you ought to have a timer signal for each experiment that you can set to light a light or ring a bell or do something at the end of so many minutes and seconds.

GIBSON Well, that's what the ready operate lights were intended to do. Of course, we had so many many failures there that it didn't turn out to be optimim.

POGUE You might want to be told just before the thing is ready to go off, or something, to see the filter cycle or something. There's always a use for a timer for each instrument.

POGUE You could set this in a central computer console, or you could give a code for S054 then specify the moment for time-hack activation.

GIBSON We ended up timing exposures in one way or another for every experiment that used film.

CARR We had more timers going than you could shake a stick at. You almost felt like you ought to wear two wrist watches.

GIBSON I had the egg timer, the event timer, and the pocket timer going.

Okay. 18B and C, Solar Inertial Offset Pointing: I found no real problem with running that one. Timeline - No problem. We had lots of time in there to get it done. Comet Overlay Use - It was a good kluge for pulling something out of the observations, but it's no way to go in the future. We certainly ought to have a telescope. You should be able to look at objects in white light and to steer the spacecraft with the manual pointing control. You need a nice feedback system, closed loop, which will enable you to get right on target.

CARR If you're going to be fooling with the spacecraft, pointing and doing things like that, then you folks who are designing future systems better go talk to a good military or FAA radar operator about some devices that would eliminate the use of the overlay. There are bezels and there are marked plates that fit very tightly right over your scope. If you need that sort of thing in order to maneuver the spacecraft to something, you should have well designed equipment. We shouldn't have to play the acetate overlay at all.

GIBSON Yes, that's a good point. I was going to try to eliminate it altogether for this type of function, but use of such devices as the bezel would be good. And you will end up using them on some displays. I think having to tape things on turned out to be a problem.

CARR Oh, yes. You had a terrible parallex problem that you had to give constant attention lest it ruin your data. I know you were concerned with that.

GIBSON Location of the Nucleus Using the 55 Detectors - We were never able to see it. We would occasionally see some slightly high counts but were never able to go back and confirm that we had seen anything above noise. Comet Appearance and Change - I've already discussed the comet appearance and what we were able to see in the way of Sunward spike.

JOP 18D, Attitude Hold Offset Pointing: First of all, the Maneuvers - No real problem there. I think the JOP was well written, flexible enough that all the ground had to do was give the proper fillings or the omits for each step. Timeline - That was not rushed at all until you got on target. Once you got to the proper attitude, it always took longer than you planned to do a conscientious job of finding the comet, getting it at a given location, and then moving it to the center. I never really trusted the schemes we came up with for maneuvering.

GIBSON (CONT'D) For each roll and each attitude offset pointing, I would have liked to purposely maneuver the comet twice the distance we wanted and see where it would end up. From this position, you could be sure you got comet center by going back to your original point and dividing the errors in half. But there was just no time for that type of maneuver. So in that one instance we just didn't allow enough time. I'm not sure whether it was TACs consideration or what, but I would have like to get on target a little earlier. The PIs, in turn, wanted to be using that time for exposure, so we had a squeeze from both angles there.

Comet Overlay - I've already mentioned that. It was an awkward method, but I'm glad we had at least that. 55 Detectors - Again, we did not see it. Fine Pointing Using the Stars - We did not use that in JOP 18D. We ended up depending upon the visual rather than stars.

CARR We used Mercury once, early in the mission.

GIBSON Yes. An ideal way to do this type of thing, were there a second star close to the comet, would be to put the star at a given location in the field of view. Then you'd at least have some closed loop indication that the star was in the right position. You'd hope that the comet was also, although you'd still have the problem of whether your overlay was positioned exactly.

POGUE That's a very good point, Ed. If you had a graphic display, you would be able to call up an artificially generated map of a certain position of the celestial sphere. Then when you maneuvered the spacecraft you would see at least a star, maybe have one or two start matching up. This is what I meant by a stylized display.

GIBSON If you had an extremely accurate device of that sort, fine pointing would become relatively easy.

POGUE For the future, something like Marshall's large orbiting telescope would be real good for finding the right location.

GIBSON Suggestions for Procedure Improvement - I wish we'd had a closed loop system for pointing, that would have given us a little more assurance that we were actually looking at the comet.

POGUE Do you feel very strongly about being able to service a star tracker from inside the spacecraft?

GIBSON Yes, I would have like to be able to get to as much of the star tracker as possible from inside the spacecraft.

POGUE That sure would have saved us a lot of trouble. The assumption that outside devices would always work caused problems for us.

GIBSON You ought to build enough flexibility into the system to provide some recourse in case something doesn't work as planned, even though engineers have 99.9 percent confidence that it will. So darn many things built into the system were absolutely guaranteed to work but failed anyway. We were just up the creek when they went out. Star tracker was one of those.

GIBSON JOP 24 - Latitude Variation of Chromosphere Structure: the helium bands on the XUV monitor were not as clear as I had hoped. A couple of times at the south pole we saw the helium bands, the coronal hole, a bright band across the bottom, and then another dark band.

GIBSON Maxirasters: they presented no problem. The JOP Summary Sheets' format was especially helpful during the observing time, because it allowed for development of a maxiraster by telling how much to step it each time. 270 arc seconds one way or the other was usually a good number. Again, I would have liked a display on board which showed what those rasters were coming up with. It would have helped us innumberable times in coming up with detail pointing once we had done a maxiraster.

POGUE A display also would have improved the operator's efficiency by making it obvious that he passed line 13 on a miniraster.

GIBSON When we were really concentrating or had nothing else to do, we could deliver good minirasters. However, most of the time we could not afford to sit and watch the line scan. Given a little different readout, a visual display rather than a numerical one, I think we could have done quite a bit better.

POGUE If we had been given the ability to program the raster itself, we might have done a better job.

GIBSON If the operator were able to specify four points where the raster started in left/right, ended in left/right, start/stop, and up/down, then the instrument would be truly flexible. I would like to see much of the experimental electronic logic put in a digital computer and made inerasable. Then alterations could be made as design was improved. At the same time inflight changes would be possible. However, some discipline would have to be exercised so that the changes didn't get way ahead of the operator.

GIBSON Superrasters: we all had a hand in the superraster, because we only did one of them. we turned it into a hyperraster by adding some extra points on either side to illustrate any brightening that might have been on the limb. We're looking forward to seeing the pictures, but it's not the type of thing we would want to do frequently inflight.

GIBSON Coronal Structures and Suggested Procedural Improvements: that one I enjoyed doing. The procedure we had was a good one considering the equipment we had.

POGUE I ruined one of those coronal studies, by using the white light display the wrong way. The scan was inoperative, and, while using the white light display, I put a tangent in at the wrong place. I interpreted the display incorrectly. That just points up again the advantage of having a stylized graphical display. When we put a stylized 82B slit tangent to the stylized disk, it is where the PI wants it to be. That would remove a number of operator errors.

POGUE Also, real-time information is essential if the primary data are filmed.

GIBSON The TV and TM sent down on 55 really helped the whole operation. The XUV monitor pictures, which we took each day, and the white light coronograph greatly aided planning, as did the 55 data on the transients and bright spot magnitudes. In the future we ought to include more of that type of instrumentation, in there, so that you do get a feedback real time. It enhances both decision making ability and the quality of the data brought back.

GIBSON One thing I mentioned previously which also applies to JOP 26 is coronal structure. We were never able to see the coronal structures really except for some indications of it at the base when we looked into the corona 1-1/2 solar radii out. If a TV display on 55 had been available, we would have been much more accurate in locating streamers on the disk and in the corona. We could have done a much better job of getting spectral data as well as spatial data had we had that type of display.

GIBSON JOP 27 - Velocities: I really don't have any comments on that. I don't think we did nearly enough velocities during this mission, but some of that due to equipment limitations.

GIBSON Comments on ATM/Shuttle Operations: DAS Functions vs Manual Functions - for maneuvers of over 5 degrees either the command module computer or the DAS is acceptable. However, I prefer to use octal all the time. For smaller maneuvers which have to be performed repetitively, such as the pointing for JOP 18D, we should use MPC with a visual view tracker which would help locate the target.

GIBSON Ground Support Required - for ATM/shuttle operations we should eliminate a large amount of the specification of details on ATM observing programs. The PIs should be concerned with the type of data they want rather than the details of its acquisition. The operation would be far more efficient if people who have worked with the PIs work with the equipment. The ideal program would involve two or three well trained observers who would monitor the equipment around the clock. That system would allow for on-the-spot judgment and deemphasis of over-planning by the ground. The present level of planning was justified for Skylab, but it would be overplanning for future operations.

Generation of ATM Schedule Onboard - my only effort at that worked out pretty well. I probably worked harder that day than I did any other day, because I wanted to make sure that it worked. I think you can generate an ATM schedule onboard given a rough outline of the work to be done. Once the outline is established you need only to fill in the details in order to make optimum use of the equipment and the available Sun. Active regions narrow your choices down rather quickly.

GIBSON Computerized JOPs vs Paper Version: I'm not sure what is meant by "computerized." More flexibility should be built into the JOPs, but some direction in flight and preparation beforehand is necessary. You have to start somewhere and having something written out explicitly when you go up there is great. If by "computerized" you mean a message which comes up on the teleprinter each day, then I'd have to think about it for a while.

GIBSON (CONT'D) However, there could be problems because of surprise situations. It would also be very easy to get behind in that sort of operation.

GIBSON Other Comments - ATM really doesn't lend itself to a shuttle-type operation without the working atmosphere available on Skylab. That is, the observer should be able to concentrate on the control panel for at least four or five orbits per day. If a solar observatory, other than the backup unit, is sent up, it should be a significant improvement over ATM.

QUERY Was there enough privacy while you were operating ATM?

GIBSON Privacy was not essential; however, distractions should have been cut to a minimum. The location of the ATM in a major work area was distracting for everyone. In the future the ATM panel should be placed in an alcove separate from the other work areas.

CARR The ATM work should also have a separate comm loop linked directly to a solar physics control room.

GIBSON There were a number of interruptions during ATM work. However, considering the situation, the interruptions were necessary. It would have been nice, though, not to have operated in that way.

GIBSON The ATM training boards on the handle were a necessity. Actually, I needed more than were available. There should have been a larger area for display of relevant information around the ATM panel. I had many of the teleprinter pads taped on adjacent lockers, but that was just an improvisation. In the future we ought to plan on something analogous to a bulletin board for display of this information.

POGUE We might also have some kind of video recording playback or single image such as is available on all of the video recorders that are out now. The ground could do an update 2 or 3 times a day on a strip of tape no longer than 10 feet that would give about 15 or 20 displays.

GIBSON It certainly would help if we could display data related to S055, for example.

GIBSON Shopping List - Use, content, Suggestions for Improvements and Use: the shopping list concept was an exceptionally good idea. However, I usually ended up creating my own shopping list, because it was more awkward to look for a shopping list which coincided exactly with my situation than it was to put each instrument into what I knew to be the desired mode. The other crewmen followed the shopping lists more closely. Future crewmen, who are more familiar with the subtlties of each JOP, may be able to do away with shopping lists.

GIBSON Suggestions for New JOPs or Additions to Others: this section applies more to previous missions than to Skylab 4. We could cover most situations with the JOPs on board. If anything, the ground should be allowed more flexibility in their planning of JOPs.

CARR Changing a JOP often disrupts another experiment. That was a majoy constraint on the ground's flexibility.

GIBSON Initially it was useful to force people into the JOP concept. It forced people to think about what they wanted, and it gave us a concrete concept of operation before the mission began. I had expected that once we were airborne more flexibility in the JOPs would come automatically.

CARR Unfortunately, once you allow for flexibility, people begin to expect too much. I wonder if the JOPs would have been as carefully planned had we announced our intention to relax the constraints once we were airborne.

GIBSON A stylized display would have been exceptionally useful in showing where the 55 aperture was relative to both the cross-hairs and the 82B slit. Everytime I pointed with the slit, I could distinguish 2 or 3 arc seconds very clearly on the display. I could never be sure where the 55 aperture was centered. A stylized display showing that information would have been useful.

GIBSON Co-alignment Operations - Suggestions for Improvement: I thought they went off rather easily. However, both the results and the drift were surprising. We were able to do each within an arc second, as requested. Conversion from octal to decimal introduced an error of 1.75 arc seconds, but there was no significant difficulty with the co-alignments.

GIBSON Video Tape Recording and TV Downlink: because of the criticism which arose after SL-3, we had rather rigid guidelines for use of the video tape and TV. Unless the pad called for it, we did not use the video tape. I hope that did not cut down the flow of useful information to the ground. We were usually able to fit the video tape recording into JOP 6, steps 1A and 1B. Normally I showed the white light coronagraph and XUV monitor at a roll of 1080 and then rolled, displaying the coronagraph as we were rolling. After reinitiating the experiments, I usually gave another shot of the XUV monitor. I was remiss about making a recording of the voice to go with the video.

GIBSON I was glad we were able to come up with as many TV downlink sites as we did. On the other hand, I did miss a few of them. At those times I was so engrossed in something else that I continued with the JOP rather than the TV. Had the CAP COMM mentioned TV downlink as soon as the station came up, I would have done them every time.

GIBSON Anyone interested in the control and display aspect of ATM for future operations should look at the information put on tape during the flight.

14.3 EREP Experiments

POGUE Control and displays: I think the major point on control and displays is that they were not laid out in numerical order, which made operating from a pad sometimes a bit confusing.

CARR I agree there, Pete took a marker pencil and wrote big numbers in the areas of experiments to make them more easily grasped at a glance. I think the fact that the controls and displays were grouped by experiment was good. The only problem was, since the experiments were not grouped on the panel in some sort of a order, that it was easy to grab the wrong one.

We've already talked about pad updates. For the most part, I didn't think the C&D or the VTS pad updates were too bad. The things that really bit us were the triple prints. That could really botch you up and make you lose visual sight of what the flow of time was.

POGUE There's one other thing that I would like to amplify on. The use of the legal or contractual designation of the experiment; that is, 193 ALTIMETER, 193 SCATTEROMETER, and 193 RADIOMETER. That is not the way to go. I don't think you should be constrained by a contractual designation of an experiment number. We had to stop when we were going down the pad during the runs to see 193A, 193R, this sort of thing. I think that

POGUE (CONT'D) it would be better to have experiment A, B, C, D, E, F, G, or something like that. Either that or some roman numeral. I felt that we were sort of slaves to a numbering system that somehow had occurred in contractual agreements.

CARR This was amply indicated on the dump tapes of our voices. Bill and I refused to call it 193. Both of us called them ALTIMETER, RADIOMETER, and SCATTEROMETER. That seemed to us to be the clearest way to vocalize what it was we were doing.

Checklist: The checklist was in excellent shape. We only had three or four changes to the EREP checklist the whole time we were up there. I was well satisfied with it.

POGUE The only objection I had to it was when I got bit during activation, when they had the installation of the filters during EREP verification, the ground instructed me to drop it when I encountered difficulty with the 190. I didn't go back, and because the original configuration was contained in the UF verification, we ran several EREP passes without filters on the 190. Philosophically I have no objection to that; practically, it was a bad thing, especially because it was not a verification on the first run. Cue cards were in great shape.

CARR The cue cards were in excellent shape.

POGUE All the work on EREP was very high quality.

CARR The checklist itself wasn't too bad. What really bit us was coming in with an off-nominal situation, deviating from the checklist and not making ironclad sure that we got back into the checklist at precisely the spot that we left it. That's what I think bit us more than anything.

S190 - Multispectral Photographic Facility: Film loading was straightforward.

POGUE This is what burned me on activation day. It was straightforward but it took time. I was not able to load that film exactly the way I was trained. Although eventually I learned to feed that stiff film in, the film was not the same degree of stiffness that I had learned the system with, and it put me behind. Film loading was not the thing to do on activation day. If you had sufficient time there was no problem.

CARR Any gripes about the marking we did on the filters.

POGUE There was an error made on the pad that made me feel a little bit better. We put the wrong filters on the wrong stations per instructions on the pad. We had to change it so that some of them were double marked. I don't think there is any problem there; they will be able to sort that out quite well.

CARR Tools.

POGUE We didn't need too many. There were a couple of them that we never used.

CARR We had a couple of spanners that we never had to use. They had already been used by the first crews getting things like desiccants loosened up. Everything else was finger tight from then on.

POGUE Fly the red flag on camera shields. Those little fasteners were terrible. They were always snapping shut when you wanted them to stay open. They were always difficult to close and to move from position to position, and the camera shields were warped. I assume that you are talking about the front and rear covers. Working with those was an irritation several times.

CARR They were easy to bind up. The shields themselves were flexible, bent out of shape. I dreaded getting to the point in the cue card where I had to remove and stow the front shield, and the rear shield. I didn't like doing that. It wasn't a free and easy thing to do.

I did the filter return container and it was a big nothing. That is the way to do it. That is superior to working with a special can that you have to drop those filters into. The

CARR (CONT'D) idea of screwing them all together and putting a cover on each end makes a container out of the filters themselves. It was an excellent idea.

The only stowage things that got in my way were those alcohol swabs for the recorder. M-130 is the place where we stowed everything. Filter stowage was no problem. Window shield stowage was no problem. That was a good place for it. You could put it up there and tighten it with one screw. The only thing that bothered us was managing those alcohol swabs.

The only thing I can say about controls and displays on 190 is that it would have been smarter to design your rear cover so that you could see your circuit breakers and film counters without removing the cover.

POGUE That's a good idea, Jer.

CARR If something goes wrong, you don't have time to open the rear cover. If we could have looked in there and verified that we had counters counting or that we had all nine breakers in, it would have been more handy. That's one area in controls and displays on S190 that would have been better had it been done that way.

POGUE There's another thing, installing cassettes into the camera. I finally got used to the technique there. But I always had a little trouble getting them in position and latched. It wasn't the cleanest thing. But it's no big deal except that one would expect something like that to be more positive and straightforward, not having to engage it, four or five times before you get it right.

CARR One, two, and three were easier to install than four, five, and six.

POGUE That's because you already had them in position. We got bit on it several times checking film transport to make sure that the camera was working. So that was more than a trivial problem. It would be nice if there were a mechanical indicator to show the film was moving.

CARR Malfunctions were adequately documented on tape and over the air-to-ground.

POGUE I would like to give credit to the people who worked the malfs up for 190. They must have gone to a lot of trouble because they were well written, and we never had any trouble going through them.

CARR Right.

CARR (CONT'D) S191 - Infrared Spectrometer: We really fell short on the VTS. From the beginning, I was disturbed by the fact that the focus got all screwed up when you came in, and that we did not have enough field of view at MINIMUM MAGNIFICATION. You felt that you were looking through a toilet paper tube, essentially. You couldn't see enough down there. I consider the VTS to have been a substandard optical system. There are better optical systems available than what we had.

POGUE I agree. There are two points to make here. One, that system was lousy. We were not given images to look at. We were given a resolution chart and were seduced into thinking everything was sweetness and light. Then, in fact, when we zoomed in in flight, we lost focus and this deprived us of a lot of visual acuity in discriminating the various targets in the sights. If we did shortchange the optical designers by not getting them a long enough optical path, then the program managers ought to take a long look at the criteria they give to optical designers. If they did not shortchange them, then we had a lousy system. There is no excuse for something being that bad and losing all that focusing capability. We could have recuperated had we had enough manual focus range. The way it was, you could move the lever through the entire range and it didn't seem to change anything. We can't accept a zoom system like that, that robbed us of a lot of capability.

CARR The EREP site book was an excellent book and well done. I got the impression that there weren't better pictures for us to have in our site book or we'd have had them. Some of the mosaics were confusing. Maybe we didn't have the best that was available. The max mag picture we had was usually good. I was pleased to see that the targets looked like that. For instance, I had no reason to believe Lavic Lake was going to look like the photo I had in front of me. I was delighted to see that it looked exactly like it. But some of your medium and max range things - the mosaics, the way they were stuck together - were so bad that it was difficult to pick the artifacts out of what you were supposed to be seeing. So the mosaics were a shortcoming of the EREP site book. But for the most part, I was pleased with the way the site book was laid out.

POGUE I'd have to agree because I used that closeups of Leeds, South Dakota, and found that target which I didn't think I had a chance of finding. The same way with that Rio Grande Reservoir. Regardless of how good that site book is, Sun angle will bite you. You may have snow, and the picture was taken when there wasn't any; or it was taken when there was snow, and you don't have any. There are many variables.

CARR The SL-2 and SL-3 people would have a site with certain things they wanted looked at, but by the time it got to us they were looking at different things. For instance, Walker Lake; by the time they got to us, they didn't want us just looking at Walker Lake. They wanted us to take so many seconds of Walker Lake, and then they wanted us moving up into Gaveral Gaps Valley and some other sites away from it for comparison. Site criteria changes are no problem if you train for them. If you don't train for them, then site criteria changes would be very disastrous.

POGUE You're taking a chance. If you're there to respond to real-time changes, then you can do it.

CARR Bill and I have fully debriefed this area, with the exception of the ETC operations portions of S190. Ed will do that now.

GIBSON I thought the setup and teardown of ETC operations were exceptionally easy. I learned to do that setup in 5 to 10 minutes, depending upon whether I changed a filter and whether I had the film close at hand. I think the M151 will show how easy that step became. When setup and timing of the clock was done, it was straightforward, as was voice recording of the clock time. I never heard any feedback from the ground, so I assumed that the information you were getting was in the

GIBSON (CONT'D) format you wanted. We usually left the electrical cord and, of course, the vacuum hose right there by the workstation. We never had to break it down and put it away and get it back out again, so that portion always went rather quickly. I do feel that we could have done much more with the whole operation by using the onboard observer's judgments in taking data. We did approach that method towards the end, when we agreed to turn off the instrument if we had greater than 3/4 cloud cover. I think that the capability of that device and the judgment which we developed onboard later would have justified a constant ETC setup, with the capability to squeeze single frames whenever we went over something really worthwhile. When we saw a Falkland Current, or weather phenomena, or some geology which we knew was relevant, just a couple of single frames with the ETC would have yielded invaluable data, probably more useful per frame than the data acquired many of the times that we let that thing grind away for 5 or 6 minutes. My only real reservation about the operation is that we could have come back with more data per frame than we did.

Visual Observations and the ATM were, for me, the most enjoyable parts of the whole mission. The only thing I didn't really like about visual observations was that the accompanying writing and debriefing cut down observing time. Sometimes when I was

GIBSON (CONT'D) at the window, with the camera right at hand, I would see something relevant and useful; but because I knew I had only 2 minutes, I wouldn't take the data. That was probably wrong; I should have at least shot the pictures. But knowing that I had to write it down and debrief it, which always tired me a little bit, I would be a little reticent to take the data. That was not true all the time, of course, as I did roll out a lot of it. Still, I would like to have seen that system streamlined a little bit more. I'm not sure how we would do it. We did about all we could to simplify the written and oral part, but it still did act as a barrier, I think, to all of us at one time or another, in taking data whenever we saw it.

The pads: both methods of updating were great. Scheduling was good. I think in future operations, though, this type of observation would yield more useful data if the spacecraft had a built-in dome, much like a bomber's, where the gunner sits in a hemisphere. This would allow you to get an almost complete 180 view of the whole earth as you went over. One observer, trained especially for visual observations, could sit there continuously and work at that full time. I think we all found that we became much more proficient as the mission went on and that any time we looked out the window for more

GIBSON (CONT'D) than 5 minutes at a stretch we would see something that was worth taking data on. I see no reason why the continuous observation method would not yield more data per unit of film than we were able to do. The observer's judgment capabilities would be significantly enhanced by long-term observation. He would also be able to give repetitive data, which we many times were not able to do. For example, we used to make three or four passes over the Great Lakes per day, watching cloud formation and or ice formation. But we were not able to provide the repetitive information that you wanted because we got engrossed in something else, such as M092, during some of the passes. With one observer assigned to this task, it would not have been a problem. That was one of the most enjoyable aspects of the mission. But I think we just made a dent in it; there is a long way to go in that area.

CARR S191: I always felt guilty about using 191's film or any of its data to take any target of opportunity I saw. The guys on the ground tried to make us feel comfortable about that and encouraged us to do what we wanted to do. But unfortunately, that message never got through to us in training. I already had a built in reluctance to use your equipment and your data to look at something that you didn't have planned.

POGUE If you had a video tape recorder on board you could do wonders. You could dump and use the tape over again. It seemed a crime to sit there looking at things that you knew were good, distinct, sites, with the tape recorder already running, but you're not doing anything. All you'd be doing would be putting intelligence data on there instead of having garbage going on the tape. It's a shame not to be able to take a few shots.

CARR I think that the next VTS-type system we have ought to have more consolidation of controls and displays. You shouldn't have three separate switches for IMC, one for zoom, and one for camera on and off. I think that on your swizzle stick that you use for gimbals you could have used a twist motion for zoom, or something like that. What you need is two hand controllers. I think you could have got all your functions into two handles.

POGUE The indication should be in your field of view. You should never have to take your eye away from the viewfinder.

CARR Amen.

POGUE You should know by looking at your field of view that you have IMC set, what speed you have set, that the camera's going, and that the camera's working. I'm for having a little bullet or something in there to tell you when you have the right forward, time, and everything. Maybe, a light comes on that says you're at your program points and maybe cut in the IMC automatically. Every time you take your eye away from that eyepiece, you have lost 10 or 15 seconds by the time you get back. What would be ideal would be to have a split image capability and have the map of the site available with a beam splitter so you can look at your site and superimpose it to some extent or have a split field of view.

CARR Superposition would be good.

POGUE I understand it's a problem with superposition because your angle is constantly changing. But it wouldn't have to be an active superposition if you could have a split field. Taking your eye away from that is bad.

CARR How about malfunctions?

POGUE Nothing. All we did was inactivate the switch and press on. We activated it at the end, closed the door, and that was it.

CARR The problem we had with temperature late in the mission, the malfs told us what was wrong, and we just coped with it. I thought the malfs were good.

CARR S192 - Multispectral Scanner: We fought and fought on alignments, and, finally near the end, we got a reasonable scheme for doing alignments. I hope that by the time we get to our next multispectral scanner we'll find some more straightforward way of doing alignments. Until you fully understood the system, the alignments were black magic.

POGUE I'm not sure I ever understood it.

CARR I'm not sure that some of the experts understood the operational implications of the alignment problem.

POGUE We developed an empirical technique for getting good indications. Ernie worked with us and got us to the point where he was reasonably confident that we knew what we were doing. I always had that gnawing doubt. Sure enough, the first day up there, I started doing the alignment, and I did not get the indication they wanted when I put that attenuator in. I always wondered if I did it right. You went back and checked it, you got the

POGUE (CONT'D) same number. Then we put the new cooler Dewar in and I got better thermal alignment, which apparently everybody was pleased about. I went through one sequence where I false focused the thermal at the end of the travel of the lens. We must have a system that's more positive in manipulation and in indication.

CARR Wizardry and black magic on alignments has no place up there when you have no experts around and all the peripheral equipment you need to make sure you've done it right.

Controls and displays: I have no quarrel with controls and displays nor with malfunctions. We never got into the malfunction procedures that I can remember. The biggest problem with S192 was alignments.

POGUE I left the switch in the alignment. I looked at it and I misinterpreted visually once. It's always nice to know that you're in the right configuration. If the switch is going to screw up the data, there ought to be some indication to that effect.

CARR Microwave Radiometer/Scatterometer and Altimeter: S193 antenna repair. My hat's off to those guys who worked with us on antenna repair. They tried to think of everything that was going to happen and all the things that we needed to do. We were adequately trained for antenna repair.

POGUE Whoever worked up that malfunction road map and the other procedures, my hat's off to them. That was an excellent job. They deserve a pat on the back. We never could have done that work outside without Jerry reading and seeing what was coming up next. It was difficult to follow that logic if you looked at it in a tabular form.

CARR For the most part, the antenna repair success doesn't apply too much to us. We just went out and did the dog work. The important thing is that the guys down here thought out their procedures, and it was a good, straightforward, logical procedure. And because it was that, we got what we wanted.

POGUE They deserve a medal. Too many times our procedures are worked out by people who never go that extra mile. Somebody did a lot of homework on that; everything was thought of. We very seldom get good, clean procedures that way.

CARR On controls and displays, the big thing in S193 was the antenna unlock problem, which caused us a lot of bother. But we coped with it fairly well. I square waved the ground 10 or 15 times by saying I was turning something off, when I really meant I was turning it to STANDBY. That was a personal hangup. Maybe you can human engineer that sort of thing out so that it doesn't happen. I know you guys reminded me a couple of times, and I

CARR (CONT'D) caught myself a couple of times saying, "SCATTEROMETER, OFF," when I meant SCATTEROMETER to STANDBY. What I meant was SCATTEROMETER out of operate, or out of ON. And off was the quickest thing to come to mind. So, this is something to think about in the human engineering of C&D panels. Other than that, the scatterometer was no problem; the radiometer was no problem. Mickey Mouse rules about this have to go on within 2 seconds of that. We're glad the Mickey Mouse rules were put into the C&D checklist so that it went automatically and we didn't have to remember all of those things. We followed it and didn't worry about it. There were too many anomalies or workarounds in the EREP system.

The altimeter was the only malfunction on S193.

POGUE The UNLOCK light, and we finally lost the READY light. That happened almost every pass.

CARR That was a fairly simple procedure. Bill and I will readily admit that we were not quick to cope with that problem on some occasions. Sometimes we'd get an UNLOCK light and then a READY off. If we were busy doing something else and we didn't get it.

POGUE We told them ahead of time we were not going to penalize a good instrument to make a bad one work right.

CARR So you lost some data because of that.

POGUE We did a good job, though, everything considered. We got on it fast most of the time.

CARR S194 - L-Band Radiometer: No problem.

POGUE We just turned it ON and OFF and let it do its thing.

CARR Tape Recorder:

POGUE I don't like that tape recorder. The hubs are the things that bother me more than anything else. If you're going to have to clean it every time, the pieces you have to clean should be accessible. We ended up twiddling with the ends of swabs to turn the roller so that we could clean the total surface. That is not a good design for space use.

CARR The head stacks could not be cleaned with a fuzzy little cotton swab because elements of the swab got caught in the pickup sensors. We should have had a little brush with bristles that we could get in there or something that did not snag on those sharp corners but could clean it. The other area was where the pinch rollers and the capstan were. These are the things that Bill was talking about. We had to use the swab to turn the pinch roller so that we could clean it. Access for cleaning was very poor. We should be very careful about that in the future.

POGUE Control of the tape was easier than I thought it was going to be. I always had misgivings about having 16,000 yards of tape coming loose in the MDA. That was no problem.

CARR We should have had a window in the lid so that when we had malfunctions developing in the tape recorder, such as a TAPE MOTION light flickering at us, we could have seen that the reel was still moving and that it was moving at the proper speed. As it was, we violated some rules; that is, when I was in doubt, I opened the cover and looked at it, whether it was running or not. We shouldn't do that sort of thing. But I didn't worry about whether the cover should be on or off. I opened it and looked. We should be able, with good design, to avoid putting the operator in that position. Not only that, it takes time to open the cover and if you had a window, you'd know in an instant the status of the recorder.

POGUE The 190A had a speed for the shutter speeds, so you could tell if you were in the proper operating band. We could have one on the tape recorder.

CARR The only tape recorder malfunction we had was a flickering light. Maybe we brought back enough pieces so somebody can figure out why the light was flickering.

POGUE We brought back the tape drive assembly. There is one other point. Any future mission that carries an EREP system should have a downlink capability. They should not have to carry back yards of tape. This would provide a lot more flexibility.

CARR In Skylab, we put our eggs all in one basket and because of that reason we knew that you guys on the ground were extremely apprehensive about whether or not your tape recorders were operating correctly, because that was the <u>only</u> source of data. If those tape recorders didn't function, you didn't get anything. I hope that you've scared yourselves enough, with this EREP design, so that you'll never again put yourselves in that position.

CARR Visual Observations:

CARR Voice and Teleprinter Updates: We didn't get many voice updates. We got our voice updates only during the science conferences visual observations and they were good. In the future, we need a few more voice updates. It lets the rest of the world know what we're doing. I think that's important. We should have done more visual observations in Skylab. We should have done more on air to ground to let people know what we were doing, so they could become interested in it. There was nothing more interesting to us than looking down at the Earth, observing

CARR (CONT'D) things, and seeing things. I think if I were an Argentinian, or an Australian, or New Zealander I would listen with great interest to anything said about my country because there is a wealth of information available. I'm not talking about provincialism, but the fact that somebody up there can see where you're living from a different view. When you're in a position like that, you're interested in hearing what he's got to say. Teleprinter Updates: We had no objection to handheld observations data updates being put in the details. When the folks on the ground wanted to shift it to a separate pad, we had no objection. The separate pad was just as satisfactory as the other. We did make the point that we thought that it would have been nice if we would have had more ascending nodes listed in more of a chronological order with the visual observations, but we didn't even think of that until we got back.

POGUE I see nothing wrong with having timely, that is orbit by orbit, updates verbally when you have less comm restrictions than we had in Skylab. In other words, if you're going to be going over Northern Australia and they've been having floods in the area of northeastern Australia, a suggestion to look along the coast to see how much debris is being deposited in the ocean, and to look for silt deposition, and to look for innundation of coastal lines is in order, as would be the suggestion to

POGUE (CONT'D) look back up the river 3 or 4 hundred miles to see the extent of the flood. That described timely orbit by orbit updates. In future missions, we're probably going to have some crewmen who are going to be flexible enough to sit there and listen to some kind of verbal up date. They are not going to be doing an S183 while the ground is trying to talk to them. I think we are going to have that luxury. The last pad format was very good. We need more orbital ascending nodes, per se, in the maps. In the area of visual aids, we need better maps. The maps just weren't good enough. In addition to having better paper maps, we need to work on some kind of optical display. I have some ideas how we could have onboard optical displays which would enable us to have zoom capability, within the instrument itself. We could look at a large area, zoom in on it, and have the same resolution of details we'd have if we were looking at that area with binoculars. In that same area television updates, we mentioned the use of television on board to get updates from the ground. There is no reason we can't get uplink television; where an visual observation expert would present a 15 minute program which briefs us and shows us visual displays concerning a particular geographic area. This type of direction would help us locate our sites of interest on our onboard maps. Part of the problem is actually

POGUE (CONT'D) finding these areas, a lot of the times. The use of on board visual aids, optical devices for observing the surface of the Earth, could be designed over the next 10 or 15 years. This could definitely enhance the operator's capability.

CARR Ease of Operation and Scheduling: The thing that aggravated us is that we didn't get enough time to look out. Probably the most enjoyable part of the mission was looking out and taking picutres. The smartest thing we ever did was spend those 30 hours in visual observation briefings. The return from this investment we invested is probably the best we made in the whole program, considering the return per unit time spent in training. It bothered us that we kept getting up dates from saying "You're coming up on a site of particular interest today." And then, unfortunately, when that time came around one of us was tied up in the M092 can, getting that work done, and the other guy was the observer and was busy changing settings, and no one could get near a window. The other guy was locked into the ATM or something else. It grieved us to miss all of what we considered to be ripe opportunities to look at things on the ground. We understand the scheduling problems involved, but it didn't make it easier for us to miss those opportunities. Opportunities, when missed, usually can never easily be recovered. A case in point was the Galápagos Islands.

CARR (CONT'D) I don't know how many good opportunities we missed to look at those islands. I would have given my right arm for a clear day over the Galápagos to get some of those picutres. We just never had any decent days to get the pictures we wanted to get. Finding a good day to get a good picture of the island of Hawaii, with no clouds in it, was like finding a half dollar in the sand at the beach. It was joyous and exciting to be able to look down there and see something that had been covered with clouds and get some neat pictures of it. We're looking forward, with great anticipation, to the debriefings with the visual ops people. I think it's going to be very interesting.

14.4 Individual Experiments

GIBSON D024: Our first problem was putting the samples out during the EVA. By way of apology and explanation, we predicted beforehand that attaching those panels with snaps designed for another purpose would cause difficulties, and we were correct. The voice tapes document the amount of time and effort that went into making that work. Some of the disks were smudged by the EVA gloves, because, rather than tape the experiment, a method which seemed unreliable, we struggled through and put it on with the snaps. However, a couple of panels were affected.

CARR In summary, the time required to install the D024 during EVA was much too long. The time allotted was not commensurate with the equipment. That was poor system design.

GIBSON This experiment was never intended for EVA installation.

POGUE M518: The M518 was extremely simple in design. With the exception of making electrical connections, it presented no difficulties. My only complaint is that the M518 control box was positioned on top of another box so that numbers and nomenclature were hidden.

CARR The furnace and all the equipment that went in there was very well designed.

POGUE Apparently there was a preferential orientation for placement of the little rods. The term "12 o'clock position" was used frequently; however, there is no 12 o'clock position.

CARR It was probably shown to us in training, but I forgot where it was.

POGUE We should not have been expected to remember that. It should have been marked.

CARR Data recording was not required. Voice recording was all we did. Although I was asked to transmit some of the readings 6 or 7 hours later, I didn't do it, because I was not reminded to.

CARR M479 - Zero-g Flammability: We were caught in a scheduling trap on M479. I was trained as Bill's backup on M479, but I ended doing most of the work. Anyone who is interested in M479 should go to the PI for data. I more than adequately debriefed that on tape. However, I would like to say a few words about extinguishment system. Apparently there were some serious design problems in the water coolant system. It simply did not work as we had hoped it would. I charged the system twice using all the proper procedures. For some reason there was not enough pressure to spray the water. It just drizzled out. In order

CARR (CON'T) to get the water nozzle to spray I had to pull the plunger by hand.

CARR Extinguishment by vacuum rather surprised me. That is, whenever I extinguished a substance with the vacuum, the first thing I saw was a flareup. As the items burned, they must have used up all the nearby oxygen and then became enveloped in their own vapor. Since convection does not exist in Zero-g, the remaining oxygen was unavailable for consumption. When the vacuum valve was opened, the atmosphere was disturbed and more oxygen circulated past the sample. The result was a flareup. As the oxygen level in the chamber finally fell and a truly evacuated condition approached, then the sample was extinguished. There was always a bright yellow-orange flash flareup that turned blue before going out.

The cameras and lenses were very simple, and I had no problems with them. When I used the water spray, I had to work hard to keep the lenses and window clear, but it worked fairly well.

I did not use the log book. It was much easier to discuss the experiment while it was operating. I used the log book simply as a debriefing guide. I did not bring back any written log data. I think that what I gave on the tape was adequate.

CARR M551 through M555: We did not do any of those.

CARR M487/M516 Habitability/Crew Quarters, Personal Hygiene, Cleaning Teeth: I found the tooth paste not as bad as I expected and I had no objection to using it.

POGUE The biggest thing about brushing your teeth was having to spit the toothpaste out and getting it all over your beard.

CARR There was nothing worse than getting tooth paste stuck in your whiskers.

GIBSON I didn't have that problem. The only problem I had with the toothpaste was that a couple of tubes were kind of hard. I thought they were all this way and I didn't realize until about halfway through the mission that we had some toothpaste which could actually be squeezed out of the tube, without getting white knuckles.

CARR Ed was the lucky one of the group. He selected the tube that was more like window sash putty than toothpaste.

CARR Shaving: Bill and I don't have much to say about that. We found that the brushless shaves gummed up the razors, and was more trouble than it was worth. I just went ahead and started growing a beard from day 1. Bill fought the shaving game for about 2 weeks and finally gave up and decided to grow a beard himself. And when you've only got a little bit of neck, and a little bit of cheek to shave or trim up, it became less of a problem.

GIBSON I shaved about every third or fourth day but no one would have noticed it anyway.

CARR Haircut: We all three used the trimcomb and it was a reasonable way to solve the problem, short of qualifying one or two of us as barbers, so that we could cut each other's hair. The hair length problem was not too bad. When it got too long, we just used the trimcomb on it. It was not what you would call a professional job but it kept the hair out of our eyes and ears.

GIBSON I did not really do a very sterling job on my own hair, but I thought it was adequate.

CARR Body Odor: If you didn't wash, after a heavy sweat, you could get a little body odor. Other than that we weren't plagued with it very much because we kept ourselves clean.

GIBSON I don't think the problem is as severe up there as it is down here. If you go without a shower here for 1 day, it really shows up; there, it would take a couple of days before it would be obnoxious.

POGUE I noticed my head smelled more up there.

CARR I noticed that, too. When my scalp started getting dirty, I could smell it.

GIBSON We had some deodorant up there, which will remain unnamed, which was designed for the guy who wanted to smell like an athlete but didn't have the energy to be one. It was gross. You would put that on and in 2 or 3 hours you were the worse-smelling guy in the place. It was instant body odor.

CARR In general, there ought to be some variety in deodorants. A crewman should be able to take up the kind he wants.

CARR Nail Clipping: I never really paid much attention to the nail clipping problem. You could locate yourself so that the clippings went up on the screen, either in a waste management compartment or up in the workshop. It wasn't until I got back, and the doctors started asking me, that I realized that my fingernails apparently did not grow fast up there. The doctor said "How many times did you cut your fingernails?" I replied that I had done it twice, whereas on the ground I cut them once a week or once every other week. Then the realization came upon me that my nails were growing very slowly.

GIBSON I had that same realization. Here, I cut my nails once a week and up there I cut them only about twice. I don't think I cut my toe nails up there. For some reason they seem to slow down in their growth.

CARR Feces and Urine Collection: I think we've covered that already.

CARR Bathing: We've adequately covered that. The shower is neat and a nice thing to have but the next generation of showers should be something less time consuming.

POGUE The vacuum head was no good.

CARR Yes, that was the biggest single thing. It just didn't have enough suction.

POGUE The shape was poorly designed.

CARR Washing: The full body wash was a time consuming thing but it was feasible. We have discussed the possibility of a canister for hand washing.

CARR Food and Water: The iodized water was not as unpleasant as I had anticipated; I found it to be palatable. I'm glad that we didn't have to suffer through the clorine problems that were experienced in the Apollo program.

CARR Food: We all agree that the food was good. There were areas where it could be improved. The frozen food was best and the thermostabilized food next best. We would certainly suggest that for extended missions, the rehydratable should be minimized. The food system was more than adequately covered in the debriefing.

CARR (CONT'D) Water dispensing was very well covered. As for containers, the spoonbowl was a disliked item and the conical pack was one of the more liked of the items.

GIBSON In order to increase the quality of food by including more frozen food on board, we should package three or four frozen foods in the same container, so they could be heated up together. This would miminize container space and volume for each individual item, frozen TV dinner style. If you know that you want mashed potatoes with your meat and peas, you could put it all in one big package, and heat it all together. This would simplify packaging and serving.

POGUE Garments and Personal Gear: All zippers should have little pull tabs on them. I believe in the kangaroo pouch for a shirt, rather than the little pocket on the chest because it works its way up to your shoulder. We don't have enough places to stow flashlights, pencils, scissors, or tools.

CARR Let me give you a word of caution. Bill says he likes the kangaroo pouch on the shirt. That doesn't mean that the shirts for the next mission should all have kangaroo pouches. The plea is for flexibility. If one guy likes kangaroo pouches, great. Give them to him. If another guy doesn't want kangaroo pouches, don't saddle him with them just because the crew of SL-4 said they like that type pocket.

POGUE The point is we should not be adverse to trying new things.

CARR Right. But on the other hand, we don't want to saddle every one with the same thing.

GIBSON One thing I have never seen anybody use was the strips across the top which were snapped to hold comm cables. I found those things were always open, or in the way. We never used the comm cable holders in zero g, and I would eliminate them from future spacecraft.

CARR Personal Gear: It was great to always have scissors with you and I wish we'd had a better pocket to put them in. The Swiss army knife was an extremely valuable tool to all of us. It had enough flexibility that we used it on just about all of the appliances, at one time or another. That is a good piece of gear to have with you at all times, and should be properly stowed on the clothing.

CARR I want to mention the food arrangement. Ed had to climb over the table to reach his food. I had the best position: next to the window and the food. Bill had a good position, but the food was not accessible from all positions at the table.

GIBSON The room was designed for one g. Things could have been located overhead or on the walls rather than in the center. That was true throughout the orbital workshop. We did not use the walls or floors as much as we should have.

GIBSON The concept of walls and floors is not applicable to zero g.

CARR I would have been disoriented without wall/floor/ceiling orientation.

POGUE I don't think it's a problem. There is no reason why we could not have used a ceiling for a food compartment.

CARR We are one-g animals, and we do have a favored orientation when addressing a panel.

GIBSON When you are addressing a panel this is true, but the whole workshop need not be a one g structure. Floor/ceiling space could be utilized.

CARR A compromise is necessary between one-g and zero-g space utilization.

POGUE Orientation is necessary in a large area such as the MDA.

CARR Restraint Devices and Mobility Techniques: Already covered. Communications: Already covered. Environmental - Temperature, Humidity, Pressure, Light Level, Vibrations, and Acoustics: Already covered.

POGUE I favor a low-light-level area for observations.

CARR Humidity bothered us at the beginning of the mission, but we adapted to it. The low humidity was advantageous. A high humidity atmosphere would have caused additional fungus and bacteria growth. We would have smelled more. The humidity level was good.

CARR Housekeeping: Already covered. Waste collection - I was pleased with the trash bags with the membrane. Small things did not float out of them, however, open-top disposal bags were not so secure.

POGUE The trash bags with the membrane should have quarter-of-an-inch overlap.

CARR Pushing the overcans through that membrane and into the trash bags was hard, time consuming work. A bag specifically designed for overcans might have been helpful. We could have used urine disposal bags if we had had enough of them.

CARR (CONT'D) M487/516 photography: Much the same as the documentary photography and M151. It was not new. The recorder worked, but I disliked debriefing into a tape recorder. It's hard to do, but it can be done. That is the only way to accomplish this experiment.

GIBSON It was preferable to debriefing in writing. It is relatively easy to sit down and discuss things as presented on an outline. I was glad to have things well thought out in advance.

CARR Log book: No problem.

M509 - Astronaut Manuevering Equipment: ASMU Structure. Too big, too bulky; but it probably represented the state of the art when it was designed and built. The next generation of the ASMU should be a lot more efficient as far as weight in space and inestia are concerned.

Propellants: Inert gas, I think, is the way to go. I see no reason for using a corrosive gas. The idea that we could refuel it by refilling ring the bottles was great. We have already said what we think of the recharge station: That it was a great concept, but some of the quick disconnects are real finger busters. The next time we go about this, we need to have safer and more easily operated quick disconnects.

POGUE One point on the propellant. I agree with the idea of cold gas. Unless you are going to operate far enough from the spacecraft, you might want an emergency system of some kind. Using monopropellants, or something similar, would give better specific impulse per weight. It is unfortunate that we did not have a pump to pressurize our bottles to the maximum 3000 psi. We had to get by with whatever ambient pressure was left in those two N_2 bottles.

CARR Attitude Control: An attitude hold mode is necessary in a maneuvering unit, and a rudimentary attitude control mode is very necessary. The CMG mode is very sophisticated and a very nice mode, and if I can have that mode with minumum weight penalty I'd go for it. But if it carries a big weight penalty and I can get more out of a rate gyro system with propellants, then I'll go for that mode.

POGUE I like the attitude hold control mode. The only shortcoming was the hand controller.

CARR In the area of attitude control, I definitely believe that we need translation in all three axes. That's another great advantage of the ASMU over the T020, the fact that we can translate in any one of the three axes.

CARR (CONT'D) The Electrical Subsystem. We need to invent batteries that carry more energy. We were really bitten on our first mission up there with M509 and we lost data because of it.

POGUE Arms. They were long enough and you couldn't adjust them well enough. They should be adjustable as to length, height, and cant, left/right.

CARR Hand Controller: I don't think the Apollo hand controller that we have is worth much. We proved that it was no good on the lunar Rover. I think we made a mistake in the ASMU in using the old tried-and-true hand controller. We should have exercised a little creativity and gone for something that was more adapted to the system we were going to use.

TLM Receiver and Antenna: That's for you men on the ground to debrief. As far as we're concerned, it worked okay. We managed to butcher it up a few times by not putting the right crewman I.D. in there.

Shirt Sleeve Versus Suited: No comparison whatsoever. I was quite pleased to see that the suited mode was easier in zero g than it was in one g. We were so short lived in the suited mode on the SOP, that the umbilical and suited mode is almost a waste of time. It is easier to take data from shirt sleeve and extrapolate that to suited, than it is to take suited data with an umbilical and extrapolate that to suited an umbilical.

CARR (CONT'D) Suit Drying Station: We had no problem with the suit drying station. We had easy access to the suits, and the locker itself was very handy. I thought that was a very good design, very functional.

POGUE We ought to have a better way of attaching the desiccants. There should be an attachment point perhaps in the suit arm.

CARR Desiccant drying could have been more convenient. The fecal ovens were a very inconvenient way to dry the suit desiccants, mainly because you had to fight the vacuum seal to get the exact right fit. It would have been nicer in the suit drying system if we had been able to set a timer for 10 hours and have the blower go off by itself. We let that blower run much too long, in some cases 15 to 18 hours when we got busy. We were used to the sound of the suit dryer blower running, and we forgot to turn it off.

Handheld Maneuvering Unit. I have very strong, negative feelings about the handheld maneuvering unit. I hope we have killed it forever. It's not the way to go. You can't translate without getting rotations, and it's just not worth fooling with. I don't think it's any good as an emergency or backup mode of operation either. I'd rather go with a different system built in, or redundancy built into our regular system. The handheld

CARR (CONT'D) maneuvering unit is extremely hard on your hand and arm from a gripping standpoint, and I don't think anything can be done to the handgrip to make it any easier to work. It's difficult to point. The suit interfers with arm mobility, and you wear out your right hand and right arm trying to thrash yourself around. It's extremely ineffective; for that reason, I don't think the handheld maneuvering unit is worth a nickel.

POGUE I tried to use it a couple of times here in one g, and I feel the same way.

CARR The Donning Station: It was fairly well laid out. It's bad that it was stuffed between the T020 and the film vault and up against the wall, because it was difficult for the observer to perform his function around the donning station while the other crewman was strapped in. It was crowded and we had an accessibility problem.

POGUE On an ASMU of future design, all circuit breakers, battery connections, instrumentation cables, and pressure regulator controls should be manageable from the one single position. Everything should be right side up with the nomenclature right side up and readable. And all the valves, connectors, and QDs should be facing you. You should also be able to do the complete

POGUE (CONT'D) changeout without having to reach around and throw switches on the operator's hand controllers. Somehow, you should be able to do that from one station.

CARR In the suited mode you couldn't communicate with each other. So the observer had to do the switch throwing on the maneuvering unit itself; turning off main power and CMG power and turning them back on again. And that was a bother. It points out the fact that it would not have been a problem if we had had a very easy and simple method of communicating with the man in the suit. We didn't have that.

POGUE I'm a real believer in decals for all those operations. Those decals ought to be facing the operator when he's doing that task. It should be very clearly designated.

POGUE That turned out to be a real point of irritation, and actually approaching a point of safety.

CARR Battery Charger: Very simple, once you understand where all the cables are going. I must admit that, early in training, the maze of cables connecting the power cable to the battery charger versus the external power position, was rather bewildering, until I figured out what the flow was. From then on, battery charging was super simple. I did not feel any requirement to use the checklist after having done it about twice.

CARR Noise Levels: Thruster noise was the only problem, and I don't know how that could be quieted down. The noise levels were high. We kicked a lot of garbage around in the workshop and worked up a lot of dust, and got things really stirred up, but these were just local things you've got to worry about in that particular case. For the most part, when you think about using this thing outside, where you're really going to use it, the noise levels are not applicable; so I'm not concerned about it.

CARR Stowage and Unstowage: No problems. The prep on this one was pretty simple. The only thing I can say is that you've got a dichotomy going here. If you're going to have decals that read right in the stowage position, then it isn't going to read right when it's strapped on the operator's back and the observer is trying to do the changeout. That's a problem that the designer has to cope with. I agree with Bill 100 percent. When you're doing something with the equipment, you shouldn't have to stand on your head.

POGUE In moving around to so many different places, it was awkward.

CARR Photographs: I think the dome camera was a good idea, and the other camera was good. It was a bother to try to do the TV and the Nikon work. We understood the requirement for it and we tried to do it, but it was a bother because it detracted from

CARR (CONT'D) the work at hand. It was much better to have your photography out of the way and operable from remote controls.

CARR Recorder: That's a ground function. We had no objection to being on ICOM/PTT and letting you hear all the noise and getting the voice comments as well; it's a good way to go. We overburdened the observer to a great degree by hitting him with a need for recording and photography, as well as a need for PSS and battery changeout.

Log Book: We didn't have a log book. I have no quarrel with the debriefing guide.

POGUE If a gage is worth putting on a piece of equipment, it is worth putting it in a position where it can be read without the observer having to look hard to read it. It should be 90 degrees to his direction of vision. That was not always done. Sometimes the nomenclature was blocked by the "T" of the translation hand controller.

POGUE I know that the operator was pinned up in a suit, but there is still no excuse for not having a portable tape recorder. This is applicable to M509 as well as a lot of other areas. We've already mentioned the fact that we should have more flexibility in our tape recorders; maybe lots of different types of tape

POGUE (CONT'D) recorders. It's a shame that we could not have had a self-contained battery tape recorder for the operator to use while he was flying this thing, because you probably would have gotten 50 times as much data. The same is true for the observer. It was very inconvenient for him to drag the cord around with him, but he did it. It would have been so much better to have a portable tape recorder in his pocket with a self-contained headset.

CARR S009 - Nuclear Emulsion: Stowage and Unstowage. Bill unstowed and I stowed the unit without any problems. Motor replacement was no problem. The procedures went well. That was a good demonstration of how a man can get in there and cut wires and do splicing, and do a good job. I was really pleased to be able to do that. The motor replacement and the tools that were available for that prodded me to make some observations on M487, in the area of maintainability and maintenance. To reiterate, the tools on a spacecraft should include the proper tools for crimping and splicing wires.

The data is all in the box we brought back. The setting up of the S009 was a very simple procedure once you understood how to do it. We finally got it out of our PSA and into the normal workday routine so that it didn't breakup our pre/post sleep routine. S009 was no problem. It interfered with routines, and once we got it put in a decent place, it didn't bother us at all.

POGUE S019: Stowage and Unstowage: The large AMS restraints did not hold that container down, and the vacuum hose tended to pull it out of the restraint clips. And I didn't think that design was too good.

CARR Closing the cover over it was also kind of tricky.

POGUE The lid interfered with the optical canister lid.

CARR Mirror Replacement: We did that early in the mission. I almost wish we had waited a few weeks and used the AMS the way it was for a while. We had to become fully capable of anchoring ourselves properly and that mirror replacement was pretty tricky operation. We got it done, but we managed to smudge the edge of the mirror; possibly we could have avoided that had we waited a little while and not rushed into mirror replacement. That's not an experiment problem, that's a flight planning problem. The setup for S019 was no problem once we got used to the routine of using the AMS and using the optical canister, we managed to whistle through that in very short order. I was the one who used S019 the first time and I forgot to pull the little mirror cell. I couldn't do the star verification work that was necessary and I was very embarrassed about that.

POGUE This is a place where a dark hood would have been handy.

CARR Yes, that's right. You wouldn't have had to dim all the other lights in order to do reference star work. SAL Door Operation: very straightforward. The SAL Door system was a very clean system; its only disadvantage was the long time required to depressurize the equipment. Perhaps a larger orifice for depressurizing could have been designed. The idea of having to wait for 5 to 7 minutes while it went from 5 psi down to zero was a bother.

CARR AMS Extension and Retraction and Tilt and Rotation: I guess we can discuss that together. The AMS really got overworked and I'm not surprised that we had problems near the end of the mission with tilt and rotation. It probably got 5 to 10 times more operation than anyone ever dreamed that it would get. The AMS was a workhorse. It was worth its weight in gold. It was a well-designed piece of equipment. The tilt, retraction, and rotation handles, the cranks themselves, were not handy to use. The little handles for turning the crank were unnecessary. We should have had more natural-feeling handles that stuck out a little bit better and were easier to work. Maybe you deliberately made those handles small to reduce the leverage that we could exert on it so that we could not damage the system.

POGUE But you would also damage your knuckles.

CARR All the luminescent material started coming out of the numbers before the system really began to fail. It was hard to read rotation because you couldn't see the unit digit.

POGUE I had to always use my flashlight.

CARR I would have rather had a flashlight operation and foregone the phosphorescent or luminescent paint. And then when it did fail and we weren't allowed to get into it and the big bugaboo of radiation got into it, that really got to us. I think your idea of using belts on there was probably not a very good design. You should have stuck with the strictly mechanical odometer-type operation.

POGUE The rest of that was built like a Sherman tank with that one fragile mechanism. We should have a backup optical viewport for this gouged-type alignmnent. It would have been nice if we had had a backup periscope to look at the mirror and see where it actually was. Perhaps the mirror could have marks which would enable you to go to some known alinement; a backup visual system.

CARR We're talking in the general area of SO19 and that problem doesn't exist in SO19 because you did have a backup viewing system. This is something that is peculiar to the AMS. There were other experiments put on there that did not have the backup viewing. You could just look at the gimbals for the mirror and see if they

CARR (CONT'D) were in the right place. Or you could actually have an auxiliary illumination device so that you could see it. It should have a little cross or something out there on the mirror or on the piece of the mechanism itself. Then when I am in that position and when I'm looking at that cross, then I can retract it. The other thing that continually bothered me was the friction increased on the locks as they were unlocked. It's a natural thing for me to think when I'm increasing friction, I am locking the knob. Instead I was unlocking it. That's a very good point in human engineering. If you're going to use locks, they should be something you don't have to look at to actuate.

POGUE One went up and the other went down and I was always getting them confused.

CARR Film Canister Hatch: No problem on the film hatch. The thing that got us was the slide retract and carriage retract positions. In the S019 film canister itself, the movement of the film into the aperture and opening of the shutter felt like Rube Goldberg. It felt as if we had a large handle connected to a very delicate mechanism and any misalignment would ruin it. Everything was reliable until we got to the film canister. Then suddenly we got into an area where we didn't know whether the film was actually moving or not. We didn't know when we had crushed a slide rather than putting it where it belonged.

POGUE One thing that I did not like about taking exposures with S019 was that we had to do quite a few complex tasks in a very short interval of time. The schedule was heavy for the time interval, not quite enough time between exposures.

CARR It was a paradox that while you insisted upon the spacecraft being quiet and that we not touch the S019 while the exposure was being taken, it took brute force to move it over into the SHUTTER OPEN position. It was a real thump and a bump to get it open. You start off your exposure with a big thump and it damps out during the first part of your exposure.

POGUE There was an anomaly associated with pressurization. Unless I followed the cue card, I never got it straight. Originally we were going to close the film hatch as soon as we got through and retract the mirror. We waited until after we repressurized, closed it, opened it again, went through the procedure. I think we did it right, but I always felt badly about that.

CARR Recorder: I don't think it was necessary for us to do all the recording we did on S019. We could have done a good recap and debriefing recording.

CARR S020: For our mission, S020 was strictly an EVA exercise. Bill and Edward were the two who did it.

GIBSON Stowage and unstowage was no problem because we left it out most of the time and did not bother putting on and taking off the EVA attachments. Setup was also no real problem. The only thing we ran into once was inspecting the filter for pinholes. There's a detailed discussion already on that. I believe it shows the best filter available. As far as the measurements outside, everything went very well. It was a very stable platform once you tighten down the bolts. For long time exposures I'm sure you had excellent stability; over a period of 5 or 10 seconds when you took your hand off the camera, it might have wiggled a little bit. The temperature measurements which were taken were all made using the thermal grease which we had in association with the M487 experiment.

GIBSON We used the SCI temperature instrument with a white thermal grease which came out of the material processing facility. I had large gobs of that material put on both the instrument and also on the S020 when we took it out that last time. I used that grease as a way of holding the instrument to the body, so when we were taking the temperature measurements we had a real good thermal contact. I pushed the thermometer right on the

GIBSON (CONT'D) back part of the S020, so that it was flat and parallel to the wall with a small amount of grease between it and the instrument itself if possible. The temperature measurements we were getting were accurate to within half a degree. It was difficult to read the instrument while they were affixed to the S020. You had to remove it quickly and press the button to light up the display. By watching how fast that display was decrementing you could tell how much of an error you had made in the temperature estimate. My rough estimate is that was half a degree, or at the most a degree that we were off. The alignments we have already given you and they did not change very much, during the measurements, unless you happen to bump it. On occasion that did happen, but I checked that thing frequently during the EVA's and found that we were just about right on what we had initially specified.

POGUE I have a comment on the EVA mount. The only thing wrong with it was that it jiggled too much. The thing had a little jerk to it when we tried to adjust it. Other than that, it was pretty simple to operate.

GIBSON S063 Activation: Our first problem was that Bill and I were trying to do the same thing and each one of us did about 49 percent of the activation of that, and that 2 percent that got

GIBSON (CONT'D) left over caused the difficulty. What we had left out was the timer battery.

POGUE I put one in, but I put it in the one he didn't pick out. I thought you were asking me how to do it, and I showed you how to do one. I didn't do the other one.

GIBSON I assumed that Bill had put the batteries in and we deviated again from the way it was intended to be done. That was our fault for not keeping up with it.

CARR Stowage and Unstowage: I would like to have left all that assembled. We could have use it in that configuration to get all of the ozone work, then all of the horizon photography. We had to break that gear down and put it up again several times, and with as many pieces as there were to be fitted together, I found that to be a real time consumer.

POGUE We had space on the top of the S063 locker where we could have put the assembled experiments, EA-1 and EA-2. There's no reason that we had to break that down and go through the erector set syndrome each time we assembled and tore it down. There may have been a reason for not doing that completely, but it certainly would have been a better way to operate.

GIBSON Recorder and Log Book: The log book we did not use very much. The recorder I found to be a little confusing, and I found no way around it. When we were doing Earth resources and EREP, you had the hackbird down there hacking away and you had the markbird up marking away. I think that was always confusing though humorous to the ground. One thing needs to be said about that total operation: we had too many different small pieces which fit together in an nonoptimum way and were put together in a non-precision manner.

GIBSON The net result was that things not only broke, we had trouble with the reticle light going out, but there were compromises in the data because of that lack of precision. On several occasions I taped some of those pieces together so it would be held against one stop, so that you at least had some sort of a rigid platform. I'm very much sympathetic with the objectives of it, but of all the instruments we took up, that hardware just didn't come up to the proper level to get the type of data we were after.

POGUE There's a point on testing to be made on working with S063. We had two switches, one on the timer and one on the sight. Both of those switches were low grade shorts to ground; when they were off, they discharged the battery. You should test all experiments with the switch in the off position to see

POGUE (CONT'D) how much they discharge the batteries. We finally took the batteries out of S063 to prevent discharge.

GIBSON S063 is one of the few experiments on which we were inadequately trained. We learned how to assemble the experiment in the one-g trainer, looked out the window and tracked the wall a little bit, and that was the extent of it. We never really went through a full exercise with S063. In flight it took about two to three sessions with it before I felt proficient. The problem with my hand getting stuck in the instrument existed solely because we did not go through that exercise many times. We had a long 16-second initial exposure in the ozone tracking followed by a short 4-second exposure. We did not go through that in training, and the net result was that I had my hand in the wrong location and could not remove it from the instrument at the end of the 16-second exposure. Thus I could neither change the filter nor allow the film to advance. Humorous as it was, it still wasted time and prohibited us from obtaining data on that particular point. There were other problems, not quite as obvious, which resulted from a lack of familiarity with the operations and the hardware in conjunction.

POGUE I would have been satisfied with somebody just moving a piece of cardboard in a dark room. In building 5 there is a large portion of a sphere which could be used for training on all kinds of optical experiments. It could have been used for S063.

CARR As a purposely uninvolved and unimpassioned observer, I must say that I heard more wailing and gnashing of teeth over S063 than over any other experiment in the entire system. The experiment is underdesigned. If you got good data, you're very fortunate, and it was only because Ed and Bill went out of their way to try to get good data in spite of their dislike for the hardware. The people who insisted that that hardware not be improved did a great disservice to both the crew and the PI.

CARR S073: it was very easy, very simple setup. There were no difficulties.

CARR S149: That was all EVA work, but each of us handled at least a small part of it. As far as I was concerned it was a straightforward job.

GIBSON Although I had never gone through that exercise before and had only seen the equipment once, 3 or 4 years ago, it went very well. I had to read every line and every word, but I had no real difficulty.

CARR All three of us were surprised to find that we were assigned a number of tasks which we had deliberately not trained for. The flight planners did not seem to be completely aware of the amount of specialization that we undertook in our training. What dismayed me about S149 was the collection during EVA-3. As soon as I touched the handles to start folding it in a half, a dozen little dime-sized disks just floated away. I was really surprised to see that happen, especially since I knew that was somebody's data disappearing and there was nothing we could do about it. The material just did not stay bonded. All it took was the slightest jostling, and it was gone.

CARR EVA Operation - I'm glad I didn't have to put the S149 bracket together. It was a big Rube Goldberg device forced on us by space and weight limitations. Nevertheless, it worked and we got S149 out, back in, and then back out again. I hope it will be picked up eventually, but I wouldn't hold out hope for anything still being stuck to the panels. They may have all floated off.

CARR S183 - Stowage, Unstowage and Pressurization: I thought it was a reasonable system.

POGUE We caught one mistake in the cue card.

CARR Setup was no problem. It was a bother to connect and disconnect the power and instrumentation and all the cabling. We should avoid wasting time plugging and unplugging all those cables and stowing them in a separate spot. Log book is an N/A. Alignment - Being able to look out through S183 and see reference stars was good. The optical system obviously wasn't the best thing in the world. But you could look out through it and verify your alignment. The big problem in S183 was in the durability of the film transport, film magazine, or carrousel system. The design was poor and resulted in lost data, except in areas where we made mistakes. The schedule was very busy in the beginning and we messed up a lot of data. If you had taken it very slow and easy at the beginning, I think you would have gotten all your data. I honestly do not feel we were a positive factor in any of the failures which occurred with the S183 carrousel. These were strictly design or hardware problems. I'm glad we were able to muddle our way through and get as much data for you as we did in spite of hardware difficulties. Recorder: I don't think it was necessary to voice record as long as we did. During S183, most exposures were so short, we turned off the recorder after we started the exposures. That was a better way to go.

POGUE The recorder caught me several times when I did not run the DAC, but I'd already caught that error and corrected it. We had some problems with the cue card on S019, S183, and several other instruments where we did not have good what I call "do loops" clearly delineated on the cue card. Also, a dark hood would have been helpful on S183. The only time I feel that I contributed the loss of data on 183 was when I broke a film plate. When I installed the carrousel, I did not turn the little shaft to the right position. I did not want to move that thing when I didn't have to. As it turned out when we took it out, we had lost the little washer on it, the restraint clip and that was the end of it. When you get all those things going at the same time, you're just really sort of hanging on by your fingernails.

CARR I couldn't seem to remember it was perfectly all right to pull the carrousel out of the SA. My first instinct was to quickly protect it from light and stuff the plate back in and close the film hatch. I did that instinctively before I paid attention to your procedure for removing the plate. That's a natural reaction when you're concerned about exposure of film. I suspect there was only one frame broken in that carrousel and all the separate pieces of glass that we found all came from that plate.

GIBSON T003: I did that just about all the time in the pre- and post-sleep. Post-sleep I got it just about every morning; no problem. Pre-sleep, I occasionally missed it because it depended upon what I was doing. I just wasn't as organized at night time and on a couple of occasions I did miss it. The only other anomally was stowage; with the data card there was no problem.

POGUE One comment on T003 which applied to all the experiments in the checklist - It would not hurt to retain censored background data from these experiments in the checklist and to add sketches to show us the various locations that the PI wanted. Sometimes I was a little bit in doubt about getting exact locations.

CARR I guess the only area in T003 in which there was any doubt about what we were doing for them is in T003-7, the shower dressing and undressing bit. They wanted that done at the shower location. We did all our dressing and undressing in our sleep compartments. I never understood that and we alluded to that a little earlier. I don't think your shower data are worth a nickel. Instead of dressing and undressing data I gave data before and after our first shower. Maybe that will give you a little bit of information but I think

CARR that that particular batch of data were useless. The waste management compartment data, T003-6, was good data. Of the food data, I doubt if your data is any good there because I think another bit of information we probably should have given you was how many people were eating at the time, because I'm sure it made a big difference in your analysis whether there were one, two, or three men eating.

GIBSON And what they were eating too. Although you probably had that data.

CARR T020 - Foot Controlled Maneuvering Unit, Stowage and Unstowage: T020 was certainly a lot more bother than M509. I think we've proved conclusively that a man cannot mount something like a unicycle with a large mass on his back without worrying about coupling and flexibility. A man's waist and body are flexible and he's going to introduce crosscoupling into the control system to render it less effective. As soon as we rigidized T020, it probably performed a whole lot better.

POGUE From an observing standpoint, I can testify to that, because when he did the non-rigidized system there was flopping all over the place.

CARR All those funny straps and cables that we came up with were really gross, but I wouldn't expect we'd have to do anything like that again.

POGUE There was a lack of understanding of zero-gravity restraint. We should never have to come up with equipment ties and over-hand knots and that kind of nonsense. That is really ridiculous.

CARR Shoe Plates: No problems with the shoe plates.

POGUE I adjusted them just like it said in the book and never touched them again.

CARR The Backpack Assembly: Reasonably simple. Again, the important thing there was once we rigidized, the whole complexion of the thing changed.

CARR PSS Propellant: Same comments here as was in the M509 - the cold gas type of system, is the best way to go. Power Umbilicals: I don't have any comment on that; no problems.

Donning and Doffing: Because of the complexity of the restraint system and all the straps and cables, donning and doffing was torture.

POGUE Head and Ear Protection: I'd like to comment, assuming that eye protection also goes in that category. There was a lot of visual distortion in the eye protectors. The little plastic ear protection devices felt odd. That was my fault; I should have gone back to the molded earpieces. The visual distortion bothered me very much.

CARR What bothered me was having the eye protectors steam up all the time, more than just visual distortion itself.

POGUE That's right. They did get awfully hot.

CARR Shirt Sleeve versus Suited: We didn't do suited, so we can't make a statement except to say that I think it would have been much easier to extrapolate from shirt sleeve to suited than extrapolate from suited with an umbilical to suited without an umbilical. Maneuverability: I strongly feel that we should not go with a system that only has one direction of translation. We need all three. I think having only one direction of maneuverability greatly reduces the capability of the maneuvering unit. The thrusters displaced from the center of gravity also did a disservice to the system. You need is to get your thrusters close to the c.g. and still use your feet for inputs.

CARR	Suit drying station: I don't know why that's in there. Recorder: The comments for recorder on T020 are essentially the same as for M509. The observer certainly can do the recording that is necessary by going ICOM/PTT and it was no great bother to us.

POGUE	The only thing that bothered me was quite a few times I upset the operator by dragging the ICOM umbilical across the operator. We've already addressed that problem in detail.

CARR	I can summarize what I've said inflight and that is the concept of a foot controlled maneuvering unit was a good concept. It would be neat if we could devise a way to propel ourselves without having to use our hands on hand controllers. Propelling with our feet is the right idea. So that aspect of the T020 is good. The biggest drawback of T020 was that the FCMU had the thrusters too far from the c.g. and was limited to only one direction of translation. A good idea would be to combine the features of both T020 and M509. That would require a lot of work, but I think the next generation should be that type of maneuvering unit.

POGUE	T002: Manual navigation sightings - Stowage and Unstowage: It was no problem. We used the sextant quite a few times. I have thoroughly debriefed that and the main point there is

POGUE (CONT'D) the preferential orientation of the grips in relation to the degree of rotation which is required at times to align two stars. Although you can rotate the eyepiece, you have to rotate the case itself to align the stars, because the controls rotate with the case. That makes it awkward to make observations where the stars are not located one above the other as you hold the cage vertically in front of your face. That is the big problem there. You can do it the other way and apparently I got some reasonable results. I think you could do a better job if you had all the controls next to your hand the same way. When you have to rotate the whole case and put your hand up over the top of your head to reach the little control, it makes it more difficult to get good results. The big problem with the stadimeter was the fact that the horizon is nonuniform insofar as the delineation of the airglow or whatever horizon you're trying to use.

POGUE Star Charts: No problem there. Star charts are star charts and you always have to look at them if you had any doubts about the stars. Stopwatch - I did not use the manual mode because I had very little faith in it. There's a lot of attention required just to make the marks and I thought the use of the voice tape with time tags on the voice tape was the way to go there for time-critical observations. I think possibly

POGUE (CONT'D) there should be some kind of chronometer if you were going to use one of these on board. I think a chronometer should be built into it so that you can have digital display and freeze the digital display when you take a sighting. Window shield and hood: I don't like that kind of hood. I think it's too much trouble to put up. It should be simpler than that. We have addressed this problem elsewhere in the briefings where we think there should be some sort of dark hood and dark shades and maybe some which are universally applicable to certain windows. Also some which are specially prepared for certain scientific instruments where you have to have light shielding. I would have preferred a much smaller one. It's too much trouble putting it up and taking it down; also it interfered with the wardroom table. There may have been food heating there and someone else may have wanted to eat while I was taking a sighting. But that's a specific problem with specific equipment we had this mission. Star Sightings Through the Sextant and the Stadimeter: I did star values through the sextant, but I did not do star values through the stadimeter. The sextant was no big problem. I think I finally used up all the filters and I made comments on what I thought was the most desirable combinations of filters for the combinations of celestial bodies used; i.e., star/star, star/Moon, Moon/Moon.

POGUE Updates: Ephemeris would have been better. Recorder: I thought that was the way to go for this particular experiment because it simplified the recording. Log book: It was a very simple thing and if I were going to use ephemeris and use the readings I was taking with the instrument, I would specify and emphasize the importance of a chronometer display, preferably a digital clock which you could freeze when you took your mark. You should have a good window, one with the optical properties you desire and also a large field of view. You should have a dark hood which would not interfere with any operations and you should have an integral chronometer with the sextant.

CARR T025: The setup and prep were fairly simple, once they were done the first time. Bill did them first, and they were complicated. They took a long time.

POGUE I made the mistake of not using a handle. That cost some time, but otherwise it went as expected.

CARR It was time consuming, but we got it done.

CARR Cameras: We had problems with the long shutter speed and the long eye relief on camera number 1. It came off on the first EVA, and we didn't get the data. After that happened we used the Nikon number 2, and it worked well.

GIBSON The location of the camera on this device was a problem. It was at the end of a very long instrument. During the EVA work inside, it could be bumped very easily. When inside the airlock and hard suited, it was very easy to hit that. The camera was vulnerable and fragile. It could have been a problem. The camera should have protective bars around it that latched when the camera was mounted.

CARR Pieces of equipment such as the Nikon for T025 should be protected.

GIBSON Adjustments: Finding the Sun was difficult. With additional training on ground perhaps I would have known what to look for. I finally located the center and what I should have been seeing. Head position was a factor in the location of the orange ball relative to the total display.

POGUE We went strictly by the verbal description of the proper alignment.

GIBSON We could have run through that a couple times on the ground. It could have been done in 10 minutes, using the real Sun.

CARR We found an efficient way to do T025 EVA. I stood in the workstation foot restraints and pushed the button for the shutter. I held Ed under my left arm so that he could see, CARR (CONT'D) point and change the shutter speeds. It worked out very well, and we did the exposures rapidly.

CARR S201 - Stowage and Unstowage and Nitrogen Pressurization: The whole nitrogen was a troublesome. It was time consuming. We insisted that you give us the time to do it, which you did, and other than that, there were no problems.

POGUE I felt bad when I got off sequence during the rocket observation. I was 1 second too late there on something and I terminated a sequence early. Other than that, I think everything we did with S201 was correct and right by the book.

CARR Another big bother was magnetism. I hope in the future systems we don't find ourselves in the position of having to protect our watch work and around equipment.

POGUE As long as we have time critical observations and we have a problem such as magnetism on S201, why not have clock repeaters at all stations where a considerable amount of scientific work is done?

CARR I think that's a great idea, then you don't have to use your watch.

CARR T053: Earth Laser Beacon and Visual Observations: Not too much to be said about that. It looks like it was a very successful experiment. If you want to use the laser and it requires a visual observation before you lock up, green is the best for acquisition. Once you get acquisition, you can shift to a different color such as white-gold or white-yellow. It appears to me we could see yellow-white longer than we could see the green once we got acquisition. You can use colors to facilitate acquisition.

14.5 Educational Experiments

CARR Heat Absorption: We will not be debriefing because we had no active part in that.

ED-12, Volcanic Study: No active part. That's kind of falling out of the Earth Resources.

POGUE ED-21, Libration Clouds: That would be done with the normal ATM observations and a conorgraph.

CARR We had no active part in that. ED-22, we had no active part in, ED-23, none; 24, none; 25, none; 26, none. ED-31, Bacteria and spores, I think I adequately debriefed that on the dump tapes and I don't think I need to spend much more time on that. It's just a little time consuming operation where you activate the bacteria and put them up and take pictures at various times. I had no great problem with the ED-31. It went well. I think we got the data that you want. I hope the photographs are good, they should be and I think I adequately debriefed that on the tapes. ED-32, In-Vitro Immunology: I don't think we did that.

POGUE The operation of ED-41 was simple if you got the tape recorders set up right. There was a little bit of a pain to go up in the MDA to set up the recorder but that was no real problem. We went through it two or three times. It's simple, straightforward.

POGUE (CONT'D) Minimum amount of places to make errors other than the performance of the experiments.

GIBSON ED-41 was a fun experiment. I wish it hadn't required so much reconfiguration of the instrumentation system because I think we could have given you more performance. No real problems with this operation. I enjoyed it.

CARR It was a simple experiment. We gave it a lot of time, probably got more time than it deserved compared to the other experiments. ED-41 was easy and quick to do and once it was set up all three of us could work it very quickly. I think you got a lot more data than you expected. ED-52 - Web Formation was N/A for us.

GIBSON ED-61, Plant Growth, and 62, Plant Phototropism: No real problem though we did not get all the seeds planted. For some reason, one of the times I went to inject seeds I got nothing and doubled the seeds in another chamber. How that occurred I'm not sure. I went pretty much by the book. You have the growth information on tape. I did not see any evidence that a plant initially grew toward the light, or away from it. Once a stem got out towards the light, it would start to turn green. That, however, was not enough to prohibit it from making a U-turn and going right back towards the opposite wall. So it appeared that light

GIBSON (CONT'D) did not have that much effect on the direction of growth of the stems and the roots. At the very end I pushed the seed up to the surface and pulled the stem out and let them actually exist in the air in the spacecraft. Then they seemed to behave like a normal rice that you might see on the ground. The stem stayed outside pretty much immersed in the water, stayed green, and I thought looked pretty similar to one g. Had I given them a chance to turn and go towards the opposite wall they may well have done that. But I think it's as feasible to grow rice up there as it is down here. But it's going to take a little more manipulation initially to pull the stems out as they get above the surface and are exposed to water and air like they would be down here.

GIBSON 63; Cytoplasmic Streaming. Maybe we gave you too much sunlight for the plants. Some of the plants died at the very beginning. The other problem I had was in using the microscope and the DAC, whether or not to keep the lens in there. Again I had one training session on the ground and that's the way I happen to remember it. There were no words explicitly to that effect and I just did it incorrectly. I was hoping to go back and pick this one up at the very end with the rice seeds. But unfortunately no time was provided for that and once you get into that last

GIBSON (CONT'D) week you're pretty much geared to getting that command module put together and making sure you understand the command module. As it turned out, we used extra time there. I didn't really have time to perform this during that last week, as much as I wanted to. I did see some evidence of streaming by eye during that first time I looked at it. It was not of the same magnitude as I had seen on the ground but it was still there.

POGUE ED-72, Capillary Study: There were three wicks and two pieces of hardware. One piece had water, and one had oil. The time constant of the wicking was such that it took a long time to get results. We supplemented the DAC photos with sketches. That took more of my time than was alloted. Eventually I got around to doing the other two pieces. Both pieces of equipment for the capillary tube study were damaged when I removed them from stowage. The lever for activating 72 required tremendous force to pull. Even if I had done the capillary tubes properly, I would have masked very valuable data by thrashing and bouncing around trying to pull that lever. I was out of the view of the camera because I had to climb up the wardroom wall in order to have the force to activate that lever. About 40 pounds of force was required to activate it. By the time I activated it, the experiment was completely out of the field of view. There was a material failure of some kind that completely invalidated the two capillary tube studies.

CARR ED-74 Mass Measurement; ED-76 Neutron Analysis: All we did was collect the samples. We were concerned about the vulnerable position of sample Bravo. It was frequently touched inadvertently by members of the crew.

CARR ED-78, Liquid Motion: We did not do it.

CARR I have a general observation regarding the educational experiments observations which concerns the people here at NASA who administered the educational experiments. It was apparent to us that you were operating outside the training and procedures framework. Your procedures were not very smooth, your training was a bit rough and your checklists were not as good as the others. We got the impression that you were slightly out of step the whole time. Your equipment design was not as efficient as the design of the equipment for other experiments. The most dramatic example case was ED-72. Bill had trouble pulling the levers, and the other two that leaked. In some cases the equipment design was very, very good, but it was spotty. I am talking about educational experiments as a whole. We did not expend enough effort to ensure uniformity there. The quality of the data we took corresponded with the quality of your equipment. ED-41 got good data because the equipment was durable and fairly simple. Once it was set up, it was easy for all three of us to do it. It was just as easy to do it three times as one.

GIBSON The individuals I worked with in preparing checklists and procedures were capable and enthusiastic, but they had to do too much at the last minute. We were trained at the last minute. Another problem was that despite low priority of these experiments, the hardware required extra work and the procedure was not smooth. They required more time in flight. Unfortunately low priority items had small time allotments. The educational experiments did not include sufficient training, hardware, or time allotment. We had many problems with these experiments. We did not successfully complete some of them, and it's all related to those three factors.

CARR Involving the young people of this country in the space program is a very good idea. However, next time we ought to do a better job. We tried to understand a little bit about these young people and why they were proposing their experiments and what they had in mind, and then I think we kind of short changed them. However, this is the first time we have tried anything like this, and we should definitely try it again. Some of the ideas behind the student experiments were comparable in quality with ideas behind other experiments we have done. My concern is that the whole system didn't do the job properly.

POGUE The stowage was something of a problem. It was a real jigsaw puzzle. I understand why, but the point should still be made. Stowage locations of odd and peculiar items were often not called out in the ED checklist.

CARR The people writing the ED checklist were somewhat careless.

GIBSON The people I worked with worked hard and long on that. They were not given enough time and worked at a disadvantage.

CARR They all worked hard, considering what they had to work with.

15.0 TRAINING

CARR First of all CMS Crew station: I guess the big gripe we had about the crew station in the CMS is that long periods of time in those couches became excruciating and I think there have been some people who looked into the possibility of nerve damage from lying in those couches for extended periods of time. It flat did hurt, and we spend many, many hours lying in that CMS. The Fidelity of the crew station I thought was excellent, but, boy, I think maybe the fidelity was a little too high on those couches and maybe they should be redesigned.

POGUE If it wasn't for having to lie in the spacecraft on the pad ready for launch, I would vote in favor of a preferential one-g attitude in a CMS. In other words, I like to sit in a chair. I just don't think that you buy that much with your lying on our back the way we did for all those long many, many hours.

GIBSON It certainly could have been a lot more comfortable.

POGUE I didn't mind going to the CMPS. It was a low fidelity simulator, but I still think that's the way to go.

GIBSON Well, I think the couches themselves could have been made a bit more comfortable. The couches themselves did not have to be a high fidelity. We could have had high fidelity couches

GIBSON (CONT'D) that we could go and play with in order to understand how to manipulate them. And then work in something comfortable the rest of the flight.

POGUE Yes, slipping on stocking feet in the aft bulkhead. I fell several times and skinned myself. Again working under that couch with the coolant loop control panels was very distasteful.

CARR One of the things I was wondering about during all the time we spent on our back in the CSM doing that work was if we would still feel that way when we were in zero g up in the command module. I was wondering if maybe we wouldn't feel like we were standing up or going forward. I never felt that way in the command module. I always felt like I was in the CMS, as if I was lying on my back even though it was zero g.

GIBSON You spend so many hours with that visual presentation in front of you that as soon as you saw the same thing in front of your eyes in zero g you just got locked into the same feelings again. So I think that's "hats off" to the CMS. I think the fidelity was great. One area where fidelity was bad and I think we need to pay attention to that kind of detail - I touched on that before - is switch forces and knob forces should be really scrupulously kept the same because things like the DIRECT O_2 valve and the Delta-V, A and B switches did not work the way they did in the simulator. This kind of problem was unsettling.

CARR CMS Availability: Well, we had to fight for the CMS at first, then near the end when we were the "Prime" crew, we had more CMS than we could handle. It would have been better if we could have spread that CMS out and got a little more in the beginning and evened it out, I think.

GIBSON I think that would have helped a little bit so that we could have built up proficiency which might have lasted over a longer period of time. I felt very comfortable for launch. If we had a launch abort, I think we might have been a little behind the nominal time line. But I still think we understood what needed to be done and could have carried off a launch abort. However, for the undocking and flyaround at reentry, I felt very marginal in that area, because we had not done it in a long period of time. My reactions were not instinctive or second nature. I had to think about every small item which was done and was doing it in more of a cookbook fashion. I don't know how you get around that for a long duration flight as we had, other than having to fly the shuttle and can afford to take the time to keep themselves familiar with it all the way through the mission.

CARR Availability: Again let's talk about how the machine stayed up. We had a few bad streaks with the CMS where it fell down and was in bad shape, but I think when you look at the overall picture, we got pretty good availability out of the CMS.

POGUE I think they ought to mention the personnel involved here in the CMS. I think the people we had over there made the CMS.

CARR Yes.

GIBSON Yes, I think Lonnie and Roger and Dave and Tex and Roy - those folks that just really knew not only the command module but also how to get it across to the guys that were in there. They apparently had gone through this enough that by the time they got to us we were, I think, the recipients of some very good experiences. These guys were extremely motivated and extremely capable.

POGUE They also had a good gut feel for your learning curve because they did not try to teach you everything they knew the first time you came over there. They tried to lead you into it gradually. We saw this in some of the other areas of training work where they tried to shotgun you the first time you came.

GIBSON Put a mental rush on you the first time they saw you.

CARR The thing we would say about the CMS people is don't lose them. You've got a lot of talent and a lot of experience there, and for crying out loud, don't let them get shuffled off into other areas where you can't use their talents. You've got a lot of talent available there; let's take care of it and make sure that if they are in positions where their experience is going to do somebody some good.

GIBSON That's right. Some of the sharpest people I've ever run into in within NASA I've found right over there in the CMS.

CARR Visual Systems in CMS. They were terrible. That's right. I made the statement earlier that if you could fly a docking and undocking and flyaround with the visual system in the CMS then the real thing was child's play.

CARR Software: CMC software was just high fidelity.

POGUE It's the support software we had problems with.

CARR Yes, we had problems with support software. I think that the people who can really give you the right kind of debriefing on that is the people that are working on it, not us, because we were just the users.

SLS. The crew station: The crew station compartment should have been compartmentalized just a little bit more to make it a little bit more realistic. I think it would have been a whole lot better if we could have mechanized the crew station over in the one-g trainer and worked in more of an operational atmosphere.

POGUE I disagree slightly on that. I know what you're saying and I think it's a good point. To try to learn that STS in a one-g environment in the MDA would have been murder.

GIBSON It would have been hard to have an ATM section going on, an EREP and try to select the right roll so the guys would be in a reasonable attitude. What you are saying is desirable. Something bit us in flight because we didn't have that type of training.

POGUE The compartmental idea carried us to the point where we could have separated training. This would give more privacy and enhance training a lot.

CARR SLS. Fidelity.

POGUE Airlock and the MODE SIB fidelity was off because you didn't have to open covers to look in. In total that was a fairly good system. I did not have to stand on my head to operate it.

GIBSON I thought it was well done. We tried to get the ATM visual display up to par. There was no real comparison with the real thing. I never really felt I was making real scientific judgments on the ground in working the ATM.

CARR In the ATM SLS you never got over the idea, that you were playing "Let's Pretend."

GIBSON That's right. Part of it was the displays. They were good and I did not want to cut back on the fidelity of the displays. We never had a dynamic display on S055 as we had in flight. That

GIBSON (CONT'D) was one of the primary pointing tools. We ought to come up with those specifications again. That would be one of the primary things to put in there.

CARR SLS Availability.

POGUE We were shorted in training. At a period where we could have absorbed it best we got saturated.

CARR I'm afraid so, because of the late arrival of ATM section of the SLS and the fact that we had three sets of prime crews, 5 sets of crews to train. We paid the price for it later in rushing and having to spend time in the SLS, the ATM particularly. Time was not available. We were shorted in other systems, and other experiments because of that.

GIBSON Because of the shortage of time, that's true. We should have had that thing up six months before it was. The whole system would have benefited from it.

CARR I think the other two crews suffered from the rush-rush mode that they got forced into.

GIBSON Toward the end I was having to go over weekends and run through four sessions. That was no way to do it.

CARR Visual Systems: I guess they were just as bad as the CMS.

GIBSON I think they did their best in the way of the ATM, and I think they made a significant step forward. It was a good system relative to others, but still, it was nothing like the real world. I think we needed a little more correlation between the systems so that what you saw in XUV and H-alpha showed up on S055, but that was not possible.

CARR Software: Again, we fought the same kind of initial software problems that we did on the CMS. The debugging process on any complicated computer system you've got to work out. Software was fairly high fidelity once they got it running and we got exposed to all sorts of ASPS problems, but none of those problems happened up there. It was all different problems.

GIBSON They were all different problems. Of course, we didn't spend enough time on the two CMGs and associated maneuvering, but we understood the system and we could pick it up in flight.

CARR The two CMG situation really didn't develop until we were already up there and in trouble. Then people worked up a whole new scheme and the old schemes did not apply.

CARR One-g trainers: OWS, all I can say to that and the AM/MDA is that the whole thing is beautiful.

GIBSON I felt very much at home once I got into place. I was very surprised at how much I did feel at home, even though I did not

GIBSON (CONT'D) know a lot of the detail. I was surprised to come back down here and look at the OWS once again; then it really does look like a trainer after you have been in the real one.

CARR The only thing we regret is that we did not have more time in the one-g trainer doing minisims. I don't know if minisims will show up here. I don't see any thing other than trainer simulation. The big thing that bit us up there was the time line problem and learning how to cope with it going through the day's activity. We dreamed up the minisim and said we wanted to do it. We did it a lot, but it still wasn't enough. We should have spent more time minisimming because we got chewed up on the time line more than any thing else. S063 was a prime example. It was not of a high fidelity so that we could find out where we were going to get chewed up in time.

POGUE S019, and 183 were the same way. The problem is that we were scheduled for S019 in a minisim and we would go up there and go through the motions. We weren't really under the gun. That's what really hurts.

GIBSON I think that we ought to go through the total day's activity and make sure of every small step you have to carry out.

CARR Not only that, but your instructor in those thing has to throw malfunctions at you. The simple things forgetting the mirrors

CARR (CONT'D) cell on 3019 completely threw me up there. That's one thing instructors can do if nothing else. They can mentally drill you on what you going to do if this doesn't fit right or doesn't work right.

GIBSON I found this to be true in the transition between one thing and another, such as going to and from the ATM, for example, and getting the housekeeping chores completed and getting pre and post sleep accomplished. Even those things we understood in general what was to be done, until you rub your nose in it and go through it ad nauseum, you don't become proficient. You are just going to be inefficient at it the first few days. I had a general idea of how to go about it from the ground, but I was in no way proficient.

CARR Command Module One-g Trainer: No problem. I am glad we have something with a hatch in it so we could fool with the hatch a little bit. I thought that the emergency egress training was worth its weight in gold.

POGUE It was very good.

CARR The one-g trainer we have in building 5 was good. We got in there and plowed around some of that stuff and looked at stowage. We really needed to look at that stuff. I don't think we got too much of that and I don't think we got too little. We got just about the right amount of command module, one-g training.

CARR EVA trail. I don't think the EVA trail was that valuable. The neutral buoyancy training was the one that paid off.

GIBSON I thought it was useful to have the work station to look at in one.

CARR Yes, you can use it to see how something is going to work or look or point, but from a training situation I don't think it had that much value.

POGUE Except where we put experiments. That was the important thing we did. I made sketches and I knew where to put all those things.

GIBSON As long as we went through the EVA one time in one g, that was adequate.

POGUE In the future, if we know about it ahead of time, put chalk marks on the struts and other points. We need marks where we put the equipment. We got out there and turned around upside down and backwards and forgot where a clamp goes. We need all the help we can get on EVA.

CARR That's a good point. Of course, in this case we could not do that, but it would be a good idea, if possible.

Materials Processing Facility: Bill and I did that; no problem. In the flammability experiment everything was fine, once I got the rhythm and got to hustling. I could burn a sample in about 7 or 8 minutes. The training we got was good in that; unfortunately we had the water quench problem.

POGUE A couple of things griped me about the actual hardware, but not the training. That was the camera installation. Everything interferred with putting the DAC in the right position and putting the vacuum cleaner on. The trainer had those problems; that was good.

GIBSON Trainers, Neutral Buoyancy: I personally couldn't say enough for that whole effort, both from the standpoint of training and from the standpoint of evaluation and procedures development. Much of that went on during the Skylab mission as we came up with new EVAs. That was where all the action was and it was exceptionally well done. I can't say enough for the people at the tank and their motivation and capabilities. I hope that those people will be used in the future.

POGUE I hope we don't lose that facility.

GIBSON I hope we don't lose the facility and the people. That was an exceptionally capable group. If any group or any area deserves recognition for making Skylab work it is that group.

CARR That group deserves a group achievement award. They put their noses to the grindstone and worked for years; they never tired of being meticulous about what they were doing.

POGUE They sure were professional in getting you in and out of that tank. If they were slow in getting you in and out it would be painful, but they were always good.

GIBSON We worked for many years down there and there were some differences of opinion among several groups at the two centers. In working with that netural buoyancy tank there was never any difference of opinion. The primary objective was getting the job done. Everyone was exceptionally well motivated there. For example, the EVA to retrieve the film was a piece of cake. It was exceptionally easy. The reason for it was that so much effort had gone into the design and the procedures ahead of time.

CARR That's right. That was routine as far as we were concerned. It required no mental effort to remember how to do things because we had been taught how to do it right. It freed our minds to do the other things that came on later.

GIBSON The other EVAs that came up in Skylab - Pete started off with the wing deployment, the deployment of the twin poles and finally we ended up with S193 and a couple of others. I think

GIBSON (CONT'D) all that went well because of the efforts of people in the neutral buoyancy tank. Had that tank not been available, I wouldn't have given you a dime for the efforts of those EVAs ever succeeding. I can't say enough for those people. I think their contribution to the Skylab program was just outstanding.

CARR DCPS: I regret the DCPS was closed down when it was. That was a very valuable trainer. That's the only moving base trainer we had. It was invaluable.

GIBSON That's where Jerry and I learned the details of that launch sequence and aborts. When you moved over the CMS, even though it was good and you had higher fidelity runs, you just never could afford the time to continually go over and use the CMS for that purpose.

CARR CMPS.

POGUE For the effort involved, it's been a very good simulator and trainer.

CARR It was very good. It is a good way to get your procedures developed and get them in your mind before you get into the CMS. You waste a lot less of everybody's time if you have a CMPS type simulator to work with.

GIBSON I regret that we did not have as much reentry training in that area as we did on rendezvous. Everybody was worried about rendezvous because that came up first. In all areas we emphasized that much more than the reentry. This was one of those trainers in which we did that. We should have emphasized reentry an equal amount.

CARR EREP VTS. I was amazed to find out when I arrived that the VTS trainer had as high a fidelity as it did. (Laughter) It had the same focus problem.

POGUE The simulator was excellent, and the people were excellent.

CARR Roger Goodrum and the people that worked in VTS did an outstanding job. Roger and Ron Weitenhagen and the rest of the people that worked EREP VTS did a good job. I don't know why EREP C&D is not here. Those people did a good job, too. Dave Kelley and Ernie Lay worked C&D.

POGUE Both of them were real good. George Lasky worked hard pulling everything together and keeping people working together. They all were very conscientious.

CARR ATMSS.

GIBSON That was useful for the time period that we had available. It was good to get us up on the curve early before we had the

GIBSON (CONT'D) SLS going. I would like to have seen the SLS come in earlier. This was a stopgap and at least gave us something to work with.

CARR This was a CMPS of the SLS.

POGUE That's right.

CARR Part pass trainer was a good chance to get yourself polished up before you got in the sophisticated trainer.

GIBSON Once the SLS became available, I don't think you ever wanted to drop back and use the ATMSS.

POGUE Tony Calvello who was training us was the key to the value of the ATMSS. He had a good understanding of learning techniques.

GIBSON Tony took a personal interest in trying to make sure we understood what was happening. That was good. I think we all benefitted.

CARR CMS/SLS Trainer Simulations: We don't have any particular comment on that. What we did, we needed to do, and I don't think we spent much time on it nor do I think we were undertrained in that area. The integration problems that were involved with the simulation really caused people a lot of headaches and worry. I hope that in the future people will give more attention to the problems involved with integration - how you can simplify your integration problems and make it

CARR (CONT'D) easier to put two different simulators in an integrated mode and run them together.

POGUE That's a good point.

CARR The training was great; we had trouble with the equipment. Simulated Network Sims: They're worth their weight in gold. They give you a chance that to learn how to work with the people in the MOCR. They give them a look at your rhythm and you a look at theirs. You need to understand the rhythm or pace at which people work so that you can work well together.

POGUE It's nice to get used to the interruptions that are going to occur in flight.

CARR Egress Training: We have already covered that. Pad egress was necessary. All that egress training was good to have, and I'm glad we did it. At the time we felt we were pressed for time and it was very painful to do it. We certainly did recognize the need to know because if you ever got in an emergency situation and you didn't know what you were doing, you wouldn't know when you were going to impede rather than help the progress of the rescue operation. It's a good thing that we did it, but it was painful for us to have to spend the time to do it.

Fire drill: I've all ready talked about the fire drill, and I don't think we need to hit that again.

CARR Planetarium Training: We did no planetarium training for this mission. We did some early in the game that was Apollo in type, but I don't remember going to any planetarium as a crew and training. We always wanted to; we always thought about doing it, but we never felt we could afford the time to do it.

POGUE We scheduled it once and it was cancelled. Looking back on it now, the right planetarium set up would have been useful for S183 and S019.

CARR Simulator Training Plans: No quarrel. We must have changed our simulator training plan 20 times. I think that's the way it should be. You need to adjust your training plan. You make a training plan when you start and as you get smarter you realize that certain areas don't need so much attention. You have to have the flexibility to change and adjust your simulator training plan. We did it and did it very well. I have no quarrel at all with the way that was handled. I think people did a good job of keeping Bob Williams abreast of what we needed and Bob just worked his head off to get those items scheduled for us.

CARR Systems Briefings: Systems briefings are a painful thing, usually. They take a lot of time and they are sometimes pretty deadly, somewhat of an overkill. But it's the only way that we've found so far that you can get exposed to the whole spectra of whatever system you're trying to study. After you've had your systems briefing, you get into the detailed training, either with simulators or training hardware, and usually you need to go back and have a systems rebrief, which is much more abbreviated and focused in areas where the crew feels a little weak. Our systems breifing are rated from terrible to excellent. I quite frankly don't see any great need to enumerate exactly which ones were terrible and which ones were great. Probably, the instructor who did the briefing has a pretty good idea from our reception of his presentation whether or not he did well. The systems briefings that were valuable were the ones that were operationally oriented. The guy who was giving the briefing was not just doing a mental dump on us, but was slanting our briefing in such a manner that the main points were of operational significance rather than just technical or engineering.

POGUE As a guide for all instructors, Jerry and I worked up a sheet indicating a preference for operationally slanted presentations with emphasis on nominal and off-nominal operations - the way you monitored it, how much the ground could do to fill your

POGUE (CONT'D) modes, and this sort of thing. We had a list for these people and as Jerry indicated, some followed it and others didn't. We also indicated a preference for documentation of the often verbalized, but seldom written, "good words about my system." It was very difficult to get people to write these down because they'd look in-elegant in print. But this is the sort of thing that is very valuable. We won't go into a lot of detail except to say that we did work awfully hard with the people with some degree of success and a greater degree of failure.

GIBSON That covers it. Just emphasize operational approach; that's what's important in those systems.

CARR Experiment Training: We pretty well covered it in the individual experiments. There were some experiments where we got good training and others where we got either poor training or no training. There was a great effort made to insure that the training hardware was high fidelity and that was a rather successful effort. Unfortunately, we got some really high fidelity training equipment and that's where it ended. S063 is probably a good example of that. They have good, high fidelity equipment, but no real effort was made toward putting us in a dynamic situation with that equipment where we could really use it. But the trouble was we didn't really get the training we needed.

GIBSON There is a general thing which I seemed to notice, especially in the ED experiments. If the system tends to regard a experiment as low priority, then the hardware and the training, the effort put into the checklist planning, and the time allotted to perform in flight is usually less. What this usually does is put the full burden on the guy who ends up flying it and trying to make it work. I don't think that this should be. I think that once NASA commits itself to doing something, we ought to figure out what it takes to get the job done right and go ahead and do it. Having the effort proportional to the experiment's priority usually produces relatively poor results. We've seen that in a few cases.

CARR It's rather interesting to note that once you get the experiment airborne, all that priority stuff falls out the window. As far as we were concerned up there, one looks like it had just about as much priority as the other.

GIBSON That's right.

CARR That's the way we tried to treat them. When the time was given to it, we tried to do the best we could with it and sometimes we were ill equipped.

CARR EVA Prep and Post Training: That was quite adequate. We almost overdid it. But luckily we got control of the situation and

CARR (CONT'D) decided that we were overcommitting ourselves on EVA prep and post, and we cut out a lot of the training sessions. It turned out that that was a smart thing to do. We had quite adequate training and it paid off. I think it made our preps and posts up there fairly easy, and the only thing that made them difficult was some of the additions we got.

GIBSON There was one occasion where I had never worked the closing of the hatch and a few other things that showed up on the first EVA. But we got it figured out and pressed on. There were one or two open holes like that, but I think that it was more of an individual problem than it was an overall systems problem in training.

POGUE I agree with that.

GIBSON I think Scott Millican and all the other folks that worked on that just did an excellent job. For the amount of time we invested, we learned quite a bit.

POGUE I hated that one-g work, but I guess that's the only way to really go through all the motions in the one-g area. I thought that was an awful lot of lost motion to work in a suit, but when it came time to do the EVA I think we went through the EVA preps and posts in fairly good time.

CARR EMU Familarization Chamber Training: I think that was adequate. We had a little tendency there for a while to cut out some of that training. I'm glad we decided to dig in and have that second session in the chamber. It was very good. The EMU mockup simulator training, PCU training and ALSA training we got was very valuable.

GIBSON That was exceptionally good.

POGUE Yes, it was good. Considering the money spent, that was probably the single best bargain we had.

GIBSON I think the chamber is well worth the effort. Especially the first time through I found that just getting confidence in the whole system that you're working with really helps you in flight. You know you've been there before andd it's just a matter of being careful and proceeding.

POGUE There's a point to be made on this PCU simulator. We harped on quick and dirty simulators for little bits and pieces of training. For instance, for the S063 or the S019 or the S183, we didn't get anything. Now, if anyone wants a good example of what can be done if a person's creative and ingenious, the PCU trainer is a good example of very good training for a minimum of expenditure. And that's the sort of thing that can be done for the S019, S183, S063, T025 and all the others. There was

POGUE (CONT'D) not a lot of money spent and yet there was very good return for the time invested in the training.

CARR Right.

POGUE It can be done.

CARR I think the peace of mind we got from it was worth the expenditure of the time. Knowing that you understood the system, you had no concern with it.

CARR Mock Ups and Stowage Training.

GIBSON We got bit on stowage quite a bit in terms of transfers and just where gear was. I don't know how you do that one. I think they did an excellent job down there on the ground in keeping things high fidelity, but it turned out that when we got in flight we had not worked that one enough, I felt. We were not that familiar with what transfers go on, on what day in the activation we were to do it, and where everything's located. I just felt as though I was moving into a new house and I had to find out where everything is, even though I had a general idea.

CARR Photography and Camera Training: We have equipment coming up later, so this is just the training aspect of it.

GIBSON I think the most valuable training we got was when people would give us the cameras and let us go away with them and shoot pictures and come back and see what we got.

CARR It was valuable when they criticized our pictures and told us which were good and which were bad and why.

GIBSON I really never felt comfortable in working with a camera, and I always made mistakes the first couple of times. You can't expect to read it all out of a book and have a guy demonstrate it to you on a table a few times. You have to go out there and try to take a picture. Allowing us to take these things home and work with them, I thought, was an excellent way to go and was relatively cheap training. It was done on our own time and I would hate to see that eliminated in the future.

POGUE I would like to have seen a few cameras that had been beat up in training and that had built-in malfunctions so that they were stiff and difficult to operate. We had problems like that on board. It may even be worthwhile to deliberatley create a malfunction in an old camera when it's about worn out.

CARR Not necessarily that, but just hang on to old cameras. Don't get rid of them. Use them as exhibits for malfunctions.

POGUE Besides, the thing that was biting us was not the exotic malfunctions, but a simple thing like the little prism floating out

POGUE (CONT'D) when you change the photomic head. They showed us how to do that, but the first time it happened to me I forgot which way it went in. Loading the film in the Nikon looked like a pretty simple operation. It is after you get used to it, but there are several little traps in that. We should have been made to perform all those operations incorrectly, just to show us what was wrong.

CARR Planning of Training and Training Program: We were very pleased with the conduct of our training program. We think our training coordinator, Bob Williams, did an outstanding job. He always was enthusiastic, and I'm sure he spent a lot of time working with people who had trained other crews. He paid attention to the guidelines that were given and he put them to good use. We also found that Bob did a great job of running interference for us. He kept us from getting into a lot of time-costly situations, where we would just be wasting our time. Bob was very sensitive to our needs. He was forever checking to make sure that we were happy with the direction we were going, and if we weren't, he was willing to change things without hesitation and adjust the training plan to suit us. That worked out real well. I know we worked his rear-end off with a lot of the changes at the end because the situation was very fluid.

GIBSON I'll second everything Jerry had to say. It was very difficult job to be in because you had the requirements of all the systems' simulators in one hand and ours on the other, plus what the book is telling you you should get done. It's a real juggling act to make it all fit together. What it takes is someone with a lot of initiative and attention to detail along with willingness to do the job right. Bob did that and we were the benefactors of it, and we certainly appreciate it.

POGUE He never did forget when we asked him to do something. It always appeared on schedule. I was delighted with the whole operation. It took all the worry about schedules off our back, as well as the worry about someone doing what we asked of them.

CARR We should also take our hats off to people like Bob Kohler, Tex Ward, and Garry Hanisch. All of them really heaved to when it came to putting the training plan together. That was a real effort of many guys, not just one or two, although Bob Kohler was pretty much the spearhead of that. I think he did an outstanding job with the training plan, but the execution of the training plan belongs to the coordinator.

16.0 EMU SYSTEMS

CARR PGA Fit and Operations:

POGUE My fit was fine.

CARR My PGA fit snugly; it was difficult to get into and out of in zero-g in an LCG, but that's precisely what we wanted. I had the mobility I wanted and I was quite pleased with my PGA and the way it operated for me.

GIBSON Yes, except there were two problems. The first was the thumb on the left hand; it was a little long. I knew this when I went to ILC and got fitted. I was told it would be a problem to change, although I could have had it changed then. Looking at the film retrieval EVAs we were doing, I didn't anticipate much use of that thumb, so I did not change it. In flight, especially in the S193, I could have used a better fitting thumb. If I had the decision to make again, I would have had the thumb length fixed, because the job was made harder. The second problem was the joint in the left knee of my suit which was a little higher than the joint in my leg. Whenever I bent my knees I would get some chafing. It didn't slow me down and I had full mobility. The rest of the suit fit well.

POGUE There was a problem with the fit across the toe, in one g, but, in flight, I had no problem.

CARR Biomed Instrumentation: Bill had a problem when he tore the ground sensor off, but we used a backup set of biosensors that we found in the ESS drawers.

LCG: It was unpleasant to get somebody else's LCG, particularly one that had not been properly dried and evacuated before it was packed. It was very unpleasant the first time I opened the bags and found those moldy, smelly LCGs. We cleaned them and were positive the ground would not allow us to wear them. We were quite surprised to find the ground willing to let us wear them after we had biocided them. I wore Weitz's LCG. It was too big around the waist, and it made the suit donning and doffing difficult. Bill wore Owen's, and Ed wore Al Bean's.

GIBSON I had no problem with the fit. Other than the initial worries about fungus, I was not too worried about the LCG, but it did smell damp, like an old basement.

POGUE Mine was too small, but it stretched out well enough so that it didn't bother me once I got in the suit.

CARR The LCG is a beautiful piece of equipment, as far as body cooling is concerned. The EVA work would have been difficult if we had had to go on gas coolant.

GIBSON I had gas cooling at the end, or near gas cooling. I had to turn the LCG all the way down because of a problem. It makes

GIBSON (CONT'D) a difference. It limits the rate at which you can get things done and your comfort in doing the job. It would not have been possible to carry out some of those long, difficult EVA's without the LCG.

CARR The Helmet: The defogging process is too time consuming. We have to find an easier way to do that.

POGUE I went by the instructions and I put too much time in defogging the helmet. We were trained according to some strict procedure, which I don't think anybody uses. I streaked mine once for M509 and then I cleaned it out with a tissue. I worked okay later. I disagree slightly with the training on defogging the helmet.

CARR SEVA Operations:

POGUE Thank goodness we never had to use the purge valve.

GIBSON The SEVA worked well. I used the full range of what was available when I looked at the comet or out towards the Sun, pointing close to the comet.

CARR Gloves: I have no comment on the gloves.

GIBSON In training, two gloves popped, at the same time, with 5 delta-P. This worried me, but I was assured that in flight the time to

GIBSON (CONT'D) worry was when I felt something soft inside the glove. Conscious of this, I felt for something inside the fingertips of the gloves. The inside always felt slick and hard, and I had no problem.

POGUE The bladder popped, not the ring.

GIBSON These were old training gloves, and they had been worn quite a bit. The viscous material inside the center of the glove came out to where the skin was, and then the outside popped. If this had happened in a vacuum chamber, it would have been a different story. After being very conscious of this and feeling those gloves, there was no problem.

CARR UCTA Operation: We did not use the UCTAs during EVA.

GIBSON When I was inside on one EVA, I used it after two hours. For some reason, the physical and mental effort that's involved in getting the EVA done seemed to shut off the bladder.

POGUE I went 6 hours and 40 minutes one time and over 7 hours the other, and I didn't feel the urge.

CARR All your body waste water was going to sweat for cooling, and there wasn't anything left to go into the bladder.

CARR EMU Maintenance Kit: It's a good kit, with lots of good things inside. We never had to use anything more than the antifog compound, the lubricant. The kit was adequate.

POGUE I liked the instructions that were included. Always keep them in there, because we forget them from training.

GIBSON Those instructions were worthwhile, especially those for anti-fogging.

CARR We'll skip the drink bags because none of us used them, although we brought them just in case.

GIBSON We never had the urge. I never felt thirsty out there.

CARR Antifog Compound: That's already been briefed.

ALSA/PGA Performance: Pressurization and ventilation. I sprung a leak in the composite disconnect on EVA-2. Ed sprung a water leak on EVA-4. Ed's leak is well documented. We do not know why we had the leak on EVA-2 because I did not open the lock-lock. It wasn't sprung open or shifted. It just started leaking.

GIBSON I'm not positive that the reason I had the leak went along with the lock-lock coming open.

CARR We told about liquid cooling and circulation. We could talk about Pressurization and ventilation from the M509 standpoint. It was a high beta angle day when we did our suited M509. The observer exerted himself that day.

POGUE It's awkward working suited inside the spacecraft without helmet and gloves. I tried to do fairly precise work on the DACs and ATM panel without foot restraints. When you have one suited man working inside, you want to consider certain provisions for him.

CARR I remember wishing I had triangles on the bottom of my shoes.

POGUE I always felt very uncomfortable moving around suited in the command module with the hand controllers up there.

CARR Connectors and Controls: The regulator control on the left-hand side for the integrity check was difficult to turn off and get back on. That's an off-nominal mode of operation, and it should be very difficult to turn off and easy to turn on. That's, essentially, the way we had it.

CARR Foot Restraints: I didn't find any problem with the EVA foot restraints. There was a tendency to drift out if you weren't properly seated into them. But if you put in a foot restraint for every way you were going to position yourself, you'd be up to your elbows in foot restraints.

I'd say they were adequate, outside, for the most part. There were areas when we wished we had had better foot restraints.

GIBSON For some reason, maybe it was body geometry, the left-foot restraint in the FAS workstation always seemed a little difficult to get into and stay in.

POGUE I had trouble with the right one.

CARR Maybe it was the right.

POGUE It did that in the neutral buoyancy trainer at Marshall and in flight.

CARR Perhaps it's the direction that you lean to do your work. It must have naturally unhooked your heels. We probably could have relocated that restraint some way.

GIBSON Overall, I think those foot restraints were quite satisfactory. They made the EVA very easy.

CARR On the S193 EVA, you tucked your foot restraint under your arm, and went over and installed it.

POGUE That was a lifesaver. I couldn't have completed that EVA by myself.

GIBSON I didn't think I'd be able to work on S193 in the foot restraint, but I did.

CARR Communications: I thought communications were good.

POGUE There was a configuration problem on the last EVA.

17.0 EVA

17.1 EVA Operations

GIBSON Translation techniques - are very straightforward. I think we worried that one a little bit too much in the design of the system. It's so easy to get from one place to the other out there. It doesn't matter whether you're going backward, sideways, or what. There's no problem translating yourself. Translating yourself with something tied onto your wrist is also very easy. All you need is one hand and maybe one foot to stabilize yourself and you can work your way along almost anywhere, if you go slow enough.

CARR There's one area that the folks in training imbedded into us and that was an innate fear of allowing yourself to get free and drift away from the vehicle. It caused us to restrict our operations a little bit and when I think back about it, I really don't understand why in the dickens we worried so much abou that. What's wrong with it? You lose time, but there's really nothing wrong with losing your grip on the vehicle and drifting out so your buddy has to haul you in. I guess that's the big disadvantage. For some reason, I had a psychological hangup about allowing myself to drift free of the vehicle and I used a lot of energy on occasions to make sure that didn't happen.

GIBSON In no way is it a safety item, it's strictly time. We all felt that you'd lose a lot of time getting regrouped and pulled back in. I don't think there is any problem with safety here.

CARR I somehow became hung up on the safety aspects of it. It would have been neat out there on the Sun end, when I had that camera in my hand, if I could have just kicked free and floated out there, taken the pictures and then had Ed reel me in like a fish and send me out again.

GIBSON After handling umbilicals and each other out there, that would have been no problem as long as when he kicked free he didn't start out with any large velocity. No matter what he clanged into, the side of the OWS or whatever, it would have been no problem.

CARR Boom operation - The booms just worked like champs. We found them to be superior to the clothesline operation because you didn't have the tangle, the intertwining problem, that you had with the clothesline. I think our modes of operation were the right way to go. The boom is the prime mode and the clothesline is the backup mode if the boom fails. The clothesline mode is a good mode of operation. It's quite usable but it takes more time and it's a little more trouble.

GIBSON The third method we had was just a straight, manual translation; tying your film casettes on your wrists and going. That I felt

GIBSON (CONT'D) was also feasible. So we really had three ways of going. If we had done that, it would have taken a little more time, not too much effort, but it could have been done.

CARR On the last EVA, a lot of people were worried about having to make too many trips out to the VC foot restraints and back. The most desirable method of operating T025 was a two-man operation. It was no trouble at all to whistle out of the VC foot restraints, go back to the VF station, and do the work. Going from one point to another with the handrail system we had was very easy and we didn't mind making an extra trip.

GIBSON Talking about clotheslines gets into what we encountered during the last EVA. That was the amount of clutter we had in the FAS workstation in the way of clotheslines. We had two clotheslines out in the stem. We had all the ATM film which was stowed back there which we had retrieved. WE had S020 out and T025, and a DAC out there and/or a Nikon, and two people up in that area working. I found it really did get crowded. We were able to get it all sorted out. I believe that's a higher level of mechanical and geometric complexity than you should put into an EVA. Also, that's when I got the rope from the clothesline hooked into my PCU.

CARR LSU management - I didn't see any significant difference between that and underwater.

GIBSON It didn't damp quite as fast, but it was no problem in management.

POGUE The only problem we had was that if you became entangled, it was like a dog-leash problem.

GIBSON When we were out on the first EVA Bill and I really got tangled up. Bill became tangled in my umbilical. All we did was have Bill stay still, I figured out what the problem was, gave him some directions, and he maneuvered himself out of it with no problem.

POGUE It was a lot simpler than I thought it would be. Especially after coming back from that 193 area and having been out there digging around.

GIBSON Once you see the problem coming up, you have to stop and take care of it.

CARR Lighting - I thought lighting was more than adequate.

GIBSON The only problem that Bill and I encoutered in lighting was working the 193, when we were using flashlights at night. We had a tough time holding them. We needed a flashlight which could have been mounted on a rail, which could have had a gimbal or a ball joint on it so we could have pointed it at our workstation. Then we both could have worked on it.

CARR A battle lantern would have been a very good thing to have.

POGUE That's a good thing to have. We should have the exterior of the spacecraft well lighted from at least two directions to avoid shadowing. We thought we would never do an EVA in that area, but sure enough, we did. In the future, you cannot count on doing EVAs in just certain areas outside the spacecraft and lights should be provided.

CARR One-handed versus two-handed Operation - Two hands are better than one.

GIBSON It depends on what you're doing. If you are restraining yourself, one hand is more than adequate. If you're trying to accomplish work two hands are better.

CARR Waist and wrist tethers are worth their weight in gold. I think we could have used six extra tethers any time we were out there.

GIBSON When I was trying to get D024 put in, although I had the tether the proper length, it would loosen up on me and increase in legnth as I was working. I don't know how we can avoid that. Maybe we could have the retainer mechanism spring loaded rather than work only against the tension in the rope.

17.2 EVA Prep Procedures

CARR Suit donning - The only thing really significant here is that the donning lanyard was useful. It's a good thing we had it and we found it to be invaluable in suit donning. We found certain techniques helped.

POGUE ALSA checklist - When you're working suited, you should not have to turn a cue card. Even if the card has to be extremely large, you should have only one card to look at. I missed a couple of lines once, but it didn't hurt anything. I saw what I did. When you have to turn a card over or handle clips while you're getting suited, that is asking too much. The cards were well done.

POGUE EV-1 and 2 suited translation between the workshop and airlock module - The traffic problem and the proximity of precision equipment was such that it emphasizes our previous comments about not having the airlock located in a heavy traffic area or have provisions for stowing the precision equipment.

CARR The time line - I have no comments. Comm checks - No comments. Coordination with the ground - I thought the ground was fine. They were always hovering near by whenever they were up and they didn't bug us too much with a lot of talk.

GIBSON I was pleased with the way things worked out on those long EVAs. The ground just let us press on with the job and was always there with some good comments, when required, and otherwise just left us alone. I thought that approach was excellent.

GIBSON Hatch Operation for EVA - In fixing the camera for S054, I thought the ground effort was superior in that Rusty and the troops had a camera ready to do the same things with it that Jerry was doing inflight. They diagnosed a problem which came up and had an answer immediately. That type of real-time approach to the problem was really heads up and was really good thinking.

CARR When the shutter or whatever that was closed and I damaged it, I thought the whole ball game was over. Because those people on the ground were ready and had the equipment ready, we had a recovery posture.

GIBSON Hatch operation for EVA - Airlock module hatch - I don't think we paid enough attention to the stowage location of the hatch as evidenced by the S230 collector getting caught in the breeze. That was just an oversight on our part and everybody else's part. We never considered what the onrush of air would do in repressurization to any of the gear in there.

POGUE We were following the checklist fairly well. We may not have followed it specifically but you couldn't. It was sort of a strict legal procedure because we were asked to do so many things concurrently. We were actually doing a management job. I don't think that made an error and mistowed it when we brought it in. We had to manage to do that within the time allotted. Another point in managing that EVA, take everything into consideration - the totality of the operation.

CARR There are a lot of us who didn't think about that. Maybe we should put some sort of deflector on the repress valves so they're not blowing straight in. Hatch operation - We've already talked about the problems on the first EVA with the workshop hatch. We really didn't spend enough time looking at hatches in training. So much for that. I don't think any of the hatch operation was difficult. The forward hatch and the workshop hatch are good hatches. They were easy to operate.

POGUE I don't think you should ever have equipment hidden behind hatches. We had two pressure relief valves that were hidden under hatches.

CARR That were hidden under open hatches.

POGUE When a hatch is open, it should not be hiding what I consider to be life-support equipment. Or even accessible equipment

POGUE (CONT'D) because you're going to cycle that hatch to get to areas and I don't think you should do that. The transfer duct and that orange and black plate, I never did like the idea of having that taped down there either . There should have been a recepticle for that. This has nothing to do with hatches. It was hidden by the hatch.

CARR That was an afterthought that should have been better engineered.

17.3 EVA Post Procedures

CARR AM Repress - We've already talked about this. You have to be careful not to position things in front of the repress valve and maybe it should have a deflector on it. Moisture in the suits - Suits became wet from the people inside and we dried them. It was no problem. I thought the suit-drying procedure was good. We've already talked about the desiccants in the ovens. That wasn't a very good fit and it was a lot of trouble getting it going to dry them out.

POGUE The CCA was supposed to have been a fitted item. I don't know if it streached or what, but if my ears had been about 2 inches further back on my head, it would have fit just right. During EVA, I was always listening with one ear. If you had marginal comm that's a big bother. I would like to have had a longer pull tab on the strap. I thought it was a rinkydink operation, adjusting that strap. I was hightly displeased with my CCA.

CARR It's time to move to another type of head gear. It was dandy for Apollo and Skylab, but why saddle the shuttle people with this?

POGUE Don't go back to that lightweight headset. We went back to that snoopy-type cap because people were supposed to be wearing that lightweight headset inside a helmet. That was really bad news.

GIBSON I think the problem I experienced with that CCA was that the mike position was just too sensitive. Of course, that's something that just bit us all the way through. Any time we had comm problem, that was it. Also when we tried to use the CCA for other purposes, that was a problem. I don't think that needs to be a design feature.

CARR Moisture in Suits, CCA, FCS, et cetera - It didn't give us much trouble. Once you dried it out, it stayed fairly dry and we didn't have any smell problems either. The FCS - None of us used an FCS. Suit drying - No further comments on that. It was a fairly simple procedure and worked well.

18.0 FLIGHT EQUIPMENT

18.1 CSM

CARR I wouldn't give you a nickle for the DET. I spent more time trying to recover from miscues on the DET than I care to think about. The one in the trainer was worn out and we had lots of problems with it. The one in the spacecraft was not worn out, but we have to go to a better timer. Bill and I have very strong feelings about this.

POGUE It's not just the CSM. All of the timers are terrible. Either they're hard to set but do give you precision performance, or they're analog things like the Accutron on the ATM panel, which was added as an afterthought and was needed. The event timer that we carried in our pocktes could not be reset precisely. It left you with a feeling that you weren't operating with a well-designed piece of equipment.

CARR The Apollo hand controller is not good for hard suit operation. It's good for unsuited where you have wrist action available to you, but the rotational hand controller is unsatisfactory. It's no good for M509. The next hand controller needs to be worked on more, and to be made compatible with the suit.

POGUE From an observer's standpoint, the next one should have more physical protection from dropping off because of poor latching mechanisms. If the hand controller itself can come loose and fall to the floor in a one-g testing siutation, that's too bad. It must go back to the factory to be fixed or to be checked out. Moving around suited in flight, too, you can ding the hand controller and you want to protect it. There ought to be some consideration given to providing extra physical protection.

CARR Crew Compartment Configuration:

POGUE There are several spaces in the command module where you can't see the circuit breaker that you need to reach or you can't reach it from the position in the couches or you can't read its nomenclature without getting under the couch. Controls that should be thrown from the couch position should be accessible from the couch position.

CARR Bill put his finger on the worst single problem we had come out of the module. As the system grew, we ended up having circuit breakers and ECS controls that require special tools and were not in easily accessible locations. It caused us a lot of trouble.

Mirrors: I'm not convinced that we need mirrors. I never used my mirror on my side of the house.

POGUE All we used it for was mounting the camera for comet photography.

GIBSON If you ever had a question on what was happening behind you, you might use it.

POGUE I would never trust a mirror. I would turn over and look.

GIBSON You could never get your head close enough to the windows in a suit. That's the problem.

CARR Couches: I have no squawk with the couches in the CSM; it was the simulator where the couch got to us.

GIBSON Yes, the CSM did well when we hit the water. We had a healthy impact but we came away without feeling a thing. The couch did its job.

CARR Restraints: I thought the couch restraint system was good, and it works just as well suited as unsuited. I was comfortable with it, and it had quite a bit of adjustment capability. I have no qualms with that.

POGUE I never have liked the way the seat pan and the leg thing worked. I always seemed to get it, but did it wrong the first time.

GIBSON You could have butchered a finger in there, in flight as well as on the ground.

CARR Your finger was close to the hinge line and away from the weight.

Inflight Tool Sets: Never had to use it much. I always objected to the idea of calling a hex wrench a tool A, B, or C, but I got used to it. Those tools should have had more descriptive names.

Camera Equipment: We already gave indications that we had trouble with one DAC. We were down to three DAC's at the end of the mission. Of the three, we managed to select the one that was going to break next. That cost us some good flyaround and fireball photography. The camera bracket for the DAC was a good system. It was easily installed and I have no objection to it. I was pleasantly surprised to see the DAC well out of my line of sight when it was in my window.

POGUE Yes, that part was great. The only thing I objected to was the connector. I always fought it trying to get it in. I got it in, but it never did work nicely.

CARR That covers the CSM. In general, we were pleased with the CSM. It went through tests well and flight with a minimum number of problems.

18.2 SWS

CARR Crew Compartment Configuration: We have covered that in M487 debriefings.

Clothing and Related Equipment, Restraint Systems, Thermal Control, Tools, and Camera Equipment:

POGUE The only thing I want to mention here is my shoe that broke. It was the one thing that broke we didn't have a replacement for. We had numerous shirts, trousers, and everything else, but we didn't have any spare footplates or shoes.

CARR We have debriefed everything in the SWS area except camera equipment.

POGUE In flight, we had many complaints about DACs. All the suggestions sent up by ground didn't help a bit. I'm sure the people working on this were working hard and had the best intentions, but their equipment was terrible. The DAC clawed film and ruined film. When we were threading the DACs, they would shove the film back into the supply reel. I felt ill at ease operating that. At first, I blamed myself for every mistake. In retrospect, I think I made very few errors. It was the equipment. You can't put the connectors on after you get a transporter on and little things like that which were constant irritations. The ground was saying that the constant

POGUE (CONT'D) cycling of the transporter on and off was part of the problem in causing the film jams. I don't think that's true, basically. The equipment was not flexibly designed. There were constantly new constraints to get the pieces of equipment to work in this mode. Of all the mini-sims we had, I think I had two mini-sims where I did the film threads according to the pad and did not have a film jam, a magazine malfunction, or a pad error. That was good training because in the first part of the flight the same things happened every day. We got that straightened out and we were getting good support from the ground towards the end. The idea of having one camera there for threading film was good. I have made my feelings known on the design of the film vault. One thing we were doing was stowing the DACs in the drawer. One transporter was stored in the back of the drawer. On two occasions, we had the side of the takeup reel come unscrewed. This jeopardized the film. I don't know if we lost it or not. This points out the inadvisability of providing poor stowage capability for a piece of equipment like that. On the surface, it looks reasonable to tape the transporter to the back of a drawer, but the force required to open and close the drawer was so great that it tore the tape loose and allowed the takeup reel to come unscrewed. Also, it would be nice to see numbers without having to turn the cameras over.

The Nikon 35 millimeter is a poor camera. It's difficult to load. It's easy to move the cassette out of line. I think Ed loaded a cassette in one Nikon and took a whole roll with the back not completely closed. It was a constant hassle to juggle lenses, filters, and films for the Nikon. I think we ought to have dedicated cameras if at all possible. I realize that may be a problem. We did not have proper stowage for the Nikons. The Hasselblad was no problem. I think the Reseau plate on the Hasselblad has to go to allow us to take night slides.

CARR The disadvantage of the Hasselblad is that we don't have the capability to look through the lens, and I think that's necessary for the future.

POGUE I do too.

CARR In summary on camera equipment, this equipment is old equipment that was designed years ago. There are newer and better designs by many companies. Hasselblad and Nikon must have better designs than what we're using. We would enjoin people to look at the new designs that give you increased camera flexibility and ease of handling and loading. I think that is imperative. We need to get new camera equipment and to move forward in camera development.

19.0 FLIGHT DATA FILE

19.1 CSM

CARR We worked hard on the flight data file, and I am completely satisfied with what we flew in the area of the CSM data file.

POGUE My system checklist was fine.

CARR We didn't customize it too much. We got used to using it and we're pleased with it.

POGUE There were a couple of surprises, but no big problem.

19.2 SWS

GIBSON ATM Books: I've already implied that we didn't use the ATM Reference Book as much in flight as we thought we might have. But we always found the information we needed in that book when we wanted it, especially on the ATM experiment system. We had no problem, with any of the ATM books.

CARR The Stowage Book: I used it more than the other guys and had more confidence in it than they did. They had approximately 30 percent confidence and I had 50 percent. We were burned more than a few times by trying to find something by referring to the Stowage Book. I've made a lot of my comments on the dump tapes and other areas about the Stowage Book. The trouble

CARR (CONT'D) was the stowage book was impossible to keep up to date. Some of the items they kept track of had no business being tracked. The prime example was locker E-699. It took us 3 weeks to figure out what it was. We found out it was the trash airlock and we could not care less what was in there. What we were interested in was what was available for our use.

The Updates Book: We never used it.

The EVA Checklist: It was beautifully done. I guess it was the changes to the checklist that bothered us more than anything else. I took care of most of the checklist changes, and it was a real chore. It's too bad we had to do it but I don't see any escape from it. The EVA checklist was changed by necessity and not because it was inadequate. It was a good checklist and the cue cards that went with it were good.

The EREP Checklist: A good checklist. Bill and I found it handy. The only area that got us in trouble was in the early part of the EREP checkout. You cannot blame our filter problems on the checklist as much as you can the system of allowing ourselves to get distracted and not getting back into the checklist at the right place

The Flight Plan: There wasn't a Flight Plan; it was a day to day thing. We never looked at the Flight Plan much. The only

CARR (CONT'D) value of the book was as a place where we kept a log of our permanent general messages. That's where we kept the shopping list. The malfunction log was in there, too.

Experiment Books: There weren't many experiment books.

POGUE That's right, they went to cue cards.

CARR We got rid of them and went to cue cards. The cue cards were an excellent way to go; not too many changes per cue card. In fact, we fabricated a couple of cue cards, one for S063 comet observations and another one.

POGUE I'd like to make a strong pitch on cue cards for repetitive operations. Have small, "do loops" to summarize concisely the time-critical switch throwing and observations that the crewman performs. Do not include the prep or the stowage, only the time-critical sequence for taking data. That ought to be delineated separately and highly visible, and it should be obvious how to recycle.

CARR There were a couple of cue cards that were vague on that. One was 201.

POGUE S019 wasn't so good. There was another one there that bit me two or three times but I can't recall which one it was.

CARR It was a special stowage procedure; we were using the T025 equipment.

POGUE The actual operation when you go back and start over on S183.

CARR Yes.

POGUE Leading you in and out of the "do loop," and then recycling you in the "do loop." Those were critical operations that were not handled well on some of those cue cards.

CARR S183 was one of them.

Log Books: We didn't have many log books because we used the recording system for that.

GIBSON Camera log book is the only one. We didn't have enough of them.

CARR The Biomed Checklist: We used that. We also had that backed up with cue cards. There were some logs in the Biomed Checklist for the limb volume measurements.

POGUE We had many cue cards in the bag by the minus-Z SAL. I'd like to have had a separate place to stow a cue card relative to its own experiment. It would have made it easier to find. We had to look through a big pile of cue cards almost as big as a book.

CARR Star charts: We made little use of star charts. There wasn't much opportunity to use them.

POGUE If you have to go to the star chart, it should be a good one. They weren't good enough for as many stars as you can see in orbit.

CARR Systems Activation and Deactivation Checklists: We can't say much about those because we butchered both of them at the last minute to make them fit the system. Activation was painful and we've discussed all those aspects. The ground did a magnificent job of cutting up the Deactivation and putting it back together with a teleprinted road map to follow. I felt uneasy at first about deactivation because there were many areas where we could make mistakes and forget something. I was pleased to find that all things got done. The ground did a very good job.

GIBSON I'll second that.

POGUE I will too.

CARR Systems Book: We used that book quite a bit. Sometimes I wished we'd had two, but for the most part, it's just as well we only had one. We didn't need two books. There were only one or two times when it would have been nice to have had two. That was a valuable book. The correlation cue card and the correlation section of the Systems Checklist were invaluable.

CARR (CONT'D) We could have gotten into trouble without good data one how to correlate the Flight Plan or the pads to the Systems Checklist.

POGUE A metal front page cover on that book would have been nice with the correlation section immediately following that.

19.3 Charts and Maps

GIBSON We should have something which is analogous to the plot-board display which they have in the MOCR. It doesn't have to be flat. If it's more convenient to make it flat, that's fine too. The crew in orbit should have an instantaneous display available to let them know where they are in terms of land maps, where they are relative to the South Atlantic anomaly descending/ ascending orbit, where they are going, and where they're going to be in another couple of orbits. Having to pull out a book to see where your EREP slider coordinates are, and then figure out where you've been or where're going to be is too time consuming. The net result was we rarely did it. On the ATM, if we knew where we were relative to the South Atlantic anomaly, we could have worked the problem of the false triggering more easily. We could have had more significant visual observations if we had known when we were coming up on something at a glance. As it was, it was useful to have the EREP slider on board but that's not the answer for the future.

POGUE We need more precise maps. The maps we had were not good enough for pinpointing detail on the surface of the Earth. We could see greater detail on the Earth than we could detect on the maps.

CARR Yes.

POGUE Can we correlate this orbital track display that Ed's talking about, a moving map display, with an optical device to see in detail the area over which we're flying; something to enable us to zoom in on an area, look around, and then zoom out. We should, at least, have a map reference that will match the detail we can see.

CARR The reason for that is that we got into the Earth observations a bit late, and it was going to be very extensive and time consuming to get better maps. We probably got them as good as are available. We got enough data, photographic and otherwise around this Earth, that the cartographers should be able to put together some orbital maps. That would be useful in the future.

19.4 Flight Planning/FDF

GIBSON For flight planning, our biggest problem was in those first 20 to 30 days. Problems in flight planning, which were significant, were all encountered there.

POGUE I'm now a believer in onboard flight planning with ground support. I realize this may encounter considerable resistance, but the flight planning for almost a month was a dismal failure.

CARR That's probably the wave of the future. We ought to start thinking positively about getting the ground to relinquish a little bit of their detail control over what is going on. The ground should play more of a support and a monitoring role, instead of doing all the active planning. Flight planning by committee is inferior to flight planning by the responsible individual who has to do the job. The guys doing the work have got a better feel for how much time is required to do something than the guys on the ground.

POGUE Under that scheme, there is a strong sense of personal responsibility that apparently did not exist under this other scheme.

CARR Yes.

GIBSON The ground certainly ought to be responsible for figuring out where we stand in terms of total mission requirements, those accomplished, those to be done, and what we should concentrate on. But in terms of figuring out what you do with every 5 minures of your day, that's for the guys on board to decide. They can be more efficient in making those estimates. That's the way we should go in the future, especially if we're able to fly up to 12 people or so. One individual can be responsible for putting together an overall plan on board. He's there, he can see the onboard problems, talk to the people face to face and understand what is happening.

POGUE He also has minute-to-minute communication with them and can keep up with the traffic.

19.5 Preflight Support

CARR With the exception, I guess, of JOP summary sheets, I never got the impression that the FDF was running so far behind that it was hindering our operation during preflight.

POGUE The only thing that bothered me was some rather obvious errors on the S183 and S019 cue cards which appeared as late as a week before flight. And, again this was the case because we did not have a simulator to work with and it was not properly brainstormed. Other than that, I think that we had great support.

CARR Do you have anything there, Ed, other than just a JOP Summary Sheets where we went right down to the wire?

GIBSON I guess I really ought to mention that and the JOP Summary Sheet. Even though those things did come in late, we made a special effort preflight to get those things done on time and I think we probably did as well as anybody else could do considering how everything was being changed. I think the people that really worked that one. Al Holt in particular deserves a real note of credit for keeping that whole thing continually juggled and commensurate with everybody's requirements and, as well, making it work for us. Those things really helped us in flight; had it not been for his diligence, we would have been much worse off in terms of operating the ATM.

POGUE I don't see how he did all that work.

GIBSON He turned out an awful lot of work in a short period of time — only 6 or 7 months there.

CARR I thought they did a good job of getting the FDF updated. There were some last-minutes pen-and-inks and, of course, my pet peeve from the beginning was I didn't want to take any FDF with the whole bunch of pen-and-inks in it. We tried like the dickens to keep from making changes that would put us in a position where we had to do pen-and-inks at the last minute and I think that attitude on everybody's part allowed us to launch with what I consider to be a pretty good FDF.

POGUE John O'Neal is a good man and he's always done good work. I think our FDF was particularly good.

CARR Well, I think we can salute John O'Neal for his coordination efforts on the whole FDF thing and just getting it all run together. He and Ted Guillory and all the guys that worked on it, I think, did a very good job.

Change Control System: I've got no quarrel with it. I think that the CPCB was a good thing to do; it certainly did cut down on capricious changes. Because when you knew you had to clear it through a board of people, although it's a somewhat-bureaucratic method of doing things, it certainly served as a good filter and minimized a lot of changes.

POGUE Yes, it makes a guy think, do I really want to do this.

GIBSON Once in flight I found myself more open to changes because you're there and you realize what you can handle. I think you can handle a great deal of change in flight. So, I'm not sure whether that was too much of an inhibiting factor; it's too hard to tell until we find out what people really wanted to do once we discussed it with them.

CARR Let's make one thing clear here. We are not by our comments condoning the purpetuation of something like a CPCB in all phases of FDF development because I think one think that NASA has got to guard against and particularly in a procedures development area is getting a bureaucratic attitude. You can end up putting in so many filters and so many impediments that you can't get anything done right. Let's don't do that. Let's stay fresh and flexible and let's not lay the filters in until we really need them.

Real Time Procedures Changes: They were a painful, but they had to be done. If I got the feeling that changes were beginning to become too capricious, I'd have let the folks on the ground know. I must admit that a couple of times I was driven almost to the edge of hollering at the ground and telling them to know off all the chicken changes that were coming up; but for the most part I felt I understood why the changes were being sent up and I didn't fight them and the loss of time required to update out checklist was painful to me but understood.

GIBSON Watching Jerry and seeing what books we actually used, I was wondering whether it was necessary to be continually changing that many books. I think we ought to cut down the number of things which we expect to be changing in flight. I personally would feel that the whole mission would have benefited quite a bit more if Jerry had been over by the window with a camera in his hand rather than changing data files which we were going to leave up there anyway.

20.0 VISUAL SIGHTINGS

CARR Countdown: During the countdown, my visual sightings consisted of a triangle of light blue. I could see the launch crew working out around the vehicle but I can't say much more about visual sightings during countdown.

CARR Powered flight: As soon as the BPC went, I had a good visual sighting of millions of lumens of Sun power right in my face. I could hardly see the panel in front of me, much less out the window.

GIBSON I didn't see much until insertion and then I had to put my head back and look out the window and to see the curvature of the horizon. After that time, I had to look inside the cockpit.

CARR Sunrises and sunsets impressed me the most. I remember being very moved by them when I saw them the first time. I was impressed by the flood of light at sunrise and looking over and seeing poor old Bill on the right side in the dark. There I was shading my eyes and squinting, trying to see my instruments and he was busy reaching for the floodlight trying to get some light on so he could see over on his side of the house. We saw the SIVB when we turned around. When we came off the SIVB and did the transposition and looked at it, we had a distinct impression as pilots that we were doing a split S right into the ground. Then we watched the SIVB as it moved off and it looked nominal with the panels opening up perfectly. After the separation burn, we saw the SIVB moving off and we saw the APS venting down. During orbit we saw other satellites, bright flashing objects in the sky, either higher or lower than us. For the most part, I guess they were all higher than we were and what we were seeing was the sun bending off these things. Some of them were oscillating, indicating that the body was tumbling.

GIBSON One thing you certainly don't have in orbit is depth perception. Things are usually a good distance from your eyeballs and with only 3 or 4 inches between your eyes there is just no way of getting any perception as to where you are relative to that object. I realized this when Bill and I were working on the S190 and S193 antenna and chipping off bits of insulation which would go flying away with the gases going from the PCU. After 5 to 10 seconds, these things would be out there reflecting in the sunlight. Especially when we were at the terminator, I could no longer tell whether that thing was something else in orbit with us or whether it was the insulation or whether it was another star. You just lost all perception. It could have been only 20 yards away from me or 30 yards away or 100 yards, maybe miles. I don't know. But very rapidly you lost any concept of where you were relative to the object in distance.

CARR Landing and Recovery: The visual sightings were some beautiful drogues and some beautiful mains. Also some nice green water around the windows while we were stable II. I guess one of the prettier sightings was to look up through window number 2 and the hatch window and to see Old Glory flying at the top of the mast of USS New Orleans.

21.0 PREMISSION PLANNING

CARR We went into the launch time with things rather stable and I think when you have a rookie crew, it has to be that way. I think it would have made things very tough for us if we'd have gone in there with a lot of chaos.

22.0 MISSION CONTROL

CARR During the launch phase, the 1-minute reports by Cap Comm were very good. It was good to know that every minute you were going to hear something from the ground, and we had good comm all the way up.

Real-Time Changes: We had quite a few of those but they were done in an orderly manner and for the most part we did not find ourselves really hampered by those.

GIBSON Communications: We've already touched on the problem with ARIA, particularly during reenty, that was a problem.

CARR Communications through either ARIA or New Foundland, whichever that was, at insertion time was not very good.

POGUE You get the general impression that if you really want to have very much comm with the ground, you sure need more satellites.

CARR Looking back at the first 20 days, there was a communication problem. However, it was a human-to-human communication problem; it wasn't the system. Another area of communications is that we need to be careful to keep our lines of communication open and to say something when you're talking to each other. We should not let ourselves get buried in jargon, procedures, and systems and forget to be humans and understand the human factors of what we're doing. The early mission phase was certainly that. Let's not get ourselves into a position where you're legislating how you're going to operate by committee. There is no substitute for individual responsibility and initiative and it's got to be maintained.

GIBSON I see it onboard, people were not willing to allow the individuals onboard to make decisions to do things which might have involved a little flexibility in the way in which things were done, but nonetheless, from our standpoint done more efficiently. I think many people were so worried about doing things at the right time and in the right way that they never realized that in the process we were doing things completely wrong. NASA has a tendency to do that. We've got to make sure that when you finally come down to the end product, you allow humans to have flexibility in the system, both on the ground and onboard.

CARR Just because you have a system that works great right now doesn't mean that that system is going to work great in the next generation of people or equipment. We should not allow ourselves to be saddled by a system that has worked in the past. We should keep our minds open and keep initiative flexibile.

GIBSON We encountered problems the first 30 days during activation when we were hit with a high workload, and we weren't permitted to recover. The pace quickened and we never got the chance to become organized, rested or efficient. We were initially pushed into the back side of the power curve and held there. The sequence of events started before we flew. Al Bean recommended a day off during the first 6 days to allow us to catch up, rest, and get organized. This day off was eliminated before we flew. We should not have allowed this day of regrouping and reorganization to be left out, and the people on the ground should have recognized the value of the day off.

During the first part of the flight, we had fullness in the head which kept the crew from operating at 100 percent. Although the time line allowed for some growth in speed and efficiency, it assumed that the crew was learning at the rate of 100 percent. We could not do this the first week. We did the DTO's in the medical area but they got us behind. We worked several 18-hour days to catch up and were pushed into a higher level of fatigue and job inefficiency. We were surprised and disappointed with the philosophy of the Flight Plan. The objective of SL-2 was to set up shop and do survey work with the instruments on board. SL-3 covered all the areas with some emphasis on the areas from

GIBSON (CONT'D) SL-2. They covered everything that was to be worked on board. In the period of time between the first and second missions it was to our advantage to find out the fruitful areas of the previous missions and work them heavily. We thought we could use the experience from previous flights and our own judgment to get more selective data. Instead, it looked as though our workload was made substantially higher than what was anticipated before the SL-3 mission. The flight planners overlooked the fact that SL-3 was allowed to come up to speed at their own rate. The goal of the flight planners appeared to be the pursuit of high quantity with substantially reduced quality. The mission was being planned like it was the only Skylab flight and only 2 weeks long. Everything was packed in at the beginning, with no rationale. We were dissatisfied with the direction of the mission, overtired, and disorganized. We made mistakes that were expensive in terms of data and time. We got lower quantity and quality of data because we didn't start out at a slower pace and come up to speed on our own power. People are taking the wrong approach to those first 30 days. Another thing that bothered me was that there was very little trade of thought and original ideas the first 30 days. It was strictly a cookbook mission. This was a waste of all the effort to put man into space. Crewmen should be able to create new approaches to enhance the quality and quantity of the data returned, but we

GIBSON (CONT'D) cannot because of the press of the time line, and our own level of fatigue. We should have called a halt to the whole thing, and called for a day off. The flight planners should have given us some free time each day. This is a general rule to start the activation sequence. They should have given us a shopping list of useful items to be done, then we could have set our pace and remained efficient.

GIBSON Experiments or DTO's should not be flown unless the crew receives adequate training on the ground or very substantial on-the-job training in flight. The general philosophy of the mission plan should be discussed and understood by all of the crew, flight planners and the mission managers before flight. Unfortunately this was not done. We all regret the approach that was taken, and I'm glad we had those extra 60 days to recoup and pour it out.

CARR The mission plan and mission planning documents were sent to us and they all arrived on time. We didn't have time to go into those things and know them, nor did we have a good briefing, or sitdown man-to-man sessions with the people who were going to be directing us. We never got any discussion on mission planning, and the flow of last-minute mission training doesn't allow you to do much quiet thinking. For several months prior to our launch, I thought I told everybody I spoke to that the

CARR (CONT'D) SL-4 crew did not have any intention of running at the same pace that the SL-3 crew ran because we were going to be up there considerably longer, and we were going to have to set up housekeeping and exist up there in an endurance situation. I didn't think that we would be able to run at the same pace as SL-3. I thought I made it clear that the three of us are low-key people, less energetic than the SL-3 crew. Apparently that word was not as widely disseminated as I thought. Had I realized that people were planning on our producing 28 man hours of science per day, beginning early in the mission, I would have told everyone immediately that it was impossible. We did not plan to operate in that mode. The statements that Ed has made hold for the three of us. We were backed up against the wall because of a poor initial decision which put us on the defensive psychologically. Because we felt that we had to produce, we did not call the situation to a halt early enough. I promised myself before we left on this mission that if anyone started pressuring us we would protest very quickly, that we would move at our own speed, and that nobody on the ground would stampede us. Unfortunately, we did not put that plan into action up there; we allowed ourselves to be stampeded. I think science paid a horrible price for that as we fumbled through the first 10 to 15 days of the mission. People should realize that when you change a man's environment, it takes him time to physically

CARR (CONT'D) adjust to it. Those of us who live down here in the flatlands of Houston certainly should intuitively recognize that a person who goes to Denver on vacation or on a job must have a little time to become acclimated to the new environment. You should be able to extrapolate from that the impact of moving from a 14-psi, one-g situation to a 5-psi, zero-g situation. I don't know how in the world anyone could possibly assume that three guys could go up and immediately work at the pace of the preceding crew, delivering the same amount of goods in the same time. Obviously, the flight planners were not thinking. They were just coloring squares and filling in checklists. That is no way to operate a mission.

CARR (CONT'D) The fault lies with the crew as well as with the people on the ground. We did not properly assess the situation and do something about it quickly. I think there was too much pride on both sides. I must say that we had a very strong impression that people on the ground were making darn sure that we did not get ahead of them as the last crew had done. Apparently it embarrassed the ground that the SL-3 crew got ahead of them. We felt that we were paying the price and the penance for the so-called sins of others. Be that true or not, that's how we felt. All this happened because a lot of people didn't sit down and really think things through. What amazes us is how this

CARR (CONT'D) situation managed to perpetuate itself for 20 days before somebody finally did something about it. Again, we are as guilty as the people on the ground. We made some feeble protests on the dump tapes, explaining the reasons for our mistakes and making a few pleas for more time, but we never did anything definite about it. We were 20 days into the mission when I finally let loose on poor Hank Hartsfield, who was on CAP COMM, and somebody finally did something. But nearly 25 percent of the mission was shot before we changed our mode of operation. We need to go back, think that sort of thing out, make sure that we never get ourselves into that posture again. Bill, do you have anything to add?

POGUE You have covered it rather well. What appalled me was that the media analyzed the situation before our ground people did. I think that's mute testimony to a failure in the organization of our system itself. No one on the ground was responsible for saying, "I've been listening to these tapes, and either the crew is overworked or we're doing the wrong things. Let's have an assessment of the situation." It appeared to us that people were completely oblivious to the rather pointed comments that Jerry was making on the dump tapes at night, disregarding them as the blabberings of a tired crewman. We felt we were working with a complex, impersonal system in which no one had responsibility for total operation of the mission.

23.0 HUMAN FACTORS

23.1 Preflight

CARR Preflight Health Stabilization and Control Program: It was a burden on the crew; I hope that no other crew has to go through the preflight health stabilization program that we had to go through. We hope that we have gotten enough data for the food people so it doesn't have to happen again.

GIBSON I think it's a good idea to try to minimize your contacts before you go so that you don't end up getting sick just the day before launch. On the other hand, I think we found ourselves, especially over there in building 5, walking by people who were not primary contacts, who didn't have masks on, on occasion and yet still not being able to talk to a wife without a mask on. I didn't think that was a reasonable thing and I think we ought to get a little more consistent and maybe loosen up a little on the ability to see wives and other people.

POGUE The more responsible the individual was, the more he adhered to it and the less responsible, the less attention they paid to it. I find that to be almost universally true.

CARR Medical Care: I have no quarrel with the medical care. We've gotten all sorts of good medical attention. Our flight surgeons

CARR (CONT'D) did a beautiful job of keeping track of us and we had good cordial relations with them and we just have nothing but praise for the people who interfaced with us. In the experiments testing area, the people who drew the blood, the people who did the M092, M171, all the experimenters, all whom we interfaced with were easy folks and they were very solicitous of us and we appreciate that attitude on their part.

Time for Exercise, Rest, and Sleep: Preflight, no problem with that. We scheduled our exercise and we got it and we were in good physical condition when we left. I don't think that we were as badly fatigued as other crews have been when they launched. I think that we were in pretty good shape when we left.

POGUE I agree, but I still object to this last-minute flurry of everybody wanting to brief you the last couple of days. I think the last 2 days there should have been no briefings at all. Personally, I'm going to say this. I would assume that we ask for the ATM briefing down at the Cape, but I think that we should have used the time for ourselves.

GIBSON We could have moved it up a little earlier but at the time it seemed like that was the way to go.

CARR Medical Briefings and Exams: The medical briefing itself, I thought, was a rather empty formality - that closed TV thing we did. I thought that was a rather empty formality that really wasn't too terribly necessary.

CARR Eating Habits and Amount of Food Consumption for F-5 to 5-0: We were on a food thing and everything was pretty well rigidized on that.

23.2 Flight

CARR Appetite and Food Preference: Appetite inflight versus 3 weeks preflight. At the beginning of the mission, our appetites were diminished, but it didn't take long for them to get pretty much up to normal compared with preflight. But, by the middle of the mission until the end, our appetites seemed to increase beyond preflight levels.

POGUE Yes, mine was on the increase throughout there towards the end.

CARR Difference notable in food taste inflight versus preflight - I did not notice the big difference that a lot of people have noticed. I thought most of the food tasted the same inflight as preflight.

GIBSON I felt the same also. I was looking for that taste difference but it never showed up.

POGUE I noticed a change, but then I had more nasal congestions than you did.

GIBSON I personally felt I wanted food with more spice and I felt that before flight, inflight, and after flight.

CARR Yes, I think that was just in general the blandness of the food. Change in food preferences as the flight progressed - I would say it didn't make any difference whether we were up there or down here. I think that if we'd been right in one g and locked up that long, the change in preference would have been about the same.

GIBSON Now that we've been down for over 2 weeks, I feel the same food preferences that I did inflight. I liked what I ate up there and I just liked the same thing.

CARR Turkey and gravy gives you that same queesy feeling.

GIBSON That's right. I still don't want to have chili and go stand on my head anymore.

GIBSON Size of food portion and meal portions - I guess that I would say my eating habits outside of this tend to be that I eat a lot of one thing and not much of anything else in any given time. I found it kind of hard to just have a little smattering of three or four things in a meal.

POGUE Eating is a highly personal and subjective thing and you're going to get all kinds of different answers. I just didn't like the food; that's all there was to it.

GIBSON Well, the hardest part of that whole program was that you couldn't eat what you wanted when you wanted, even though you might end up eating the same quantity of food throughout flight. You didn't have any flexibility.

CARR Most acceptable foods - I think we can speak in generalities here. One, the frozen food was most acceptable; two, the thermostabilized food with the exception of the turkey and gravy was second best. The thermaostabilized fruits were delicious and when chilled they were really great. We really liked those. Of course, the last priority was the dehydrated foods.

GIBSON I liked the peaches and pears and the pineapple when you popped them into the freezer until they got a little slushy. Then they were great.

CARR Food Preparation and Consumption: Problems with rehydration (mixing, gas) - We had gas in the water. I don't care what anybody says, it was gas. After we worked the gas out of the water (I guess it was about 10 or 15 days), the only gas problem we had was the gas that was generated by the food itself when you added the water to it. Foods that did that were the potatoes and the barbeque veal to a small degree.

GIBSON I tell you, when you put hot water in potatoes and shake it, you ended up with a very tight drum. A couple of times, we did get an explosion and it was no fun to clean up. Potatoes were not too bad, but some of the others were terrible.

CARR Coffee and tea were both gaseous; I guess it was because they both had aromatics in them; as soon as you release those aromatics, you have a bubbling mixture that you had to do something with or you ended up drinking a lot of gas which was immediately evident to you and the people around you. Rehydration in general - we did not give the rehydration the time that it required. Most of the time if we rehydrated the food and ate it immediately whether it was prerehydrated or not. Sometimes your corn was a little crunchy or your veal was a tad crunchy or you found little pocket of powdered sauce in the spaghetti or veal that didn't get fully rehydrated. We just ate it anyway because we did not have time to fool with rehydrating early and putting it in the tray.

POGUE We couldn't do it because of the gas problem you mention early anyway. You put it in there and the food tray top would pop off.

CARR For future rehydration it looks to me like you probably ought to give up on this nicety of rehydration and let it sit for

CARR (CONT'D) half hour or 2 hours or something like that. You better start figuring right now if you are going to rehydrate food, it had better be instantly rehydratable in 5 or 7 minutes, then ready to eat.

POGUE Either that or buy off on more time on your schedule for doing all this. You need to go down and rehydrate the food 45 minutes prior to lunch time and this flight would not let you do that.

CARR Food temperture - The cold water was cold; the hot water was hot; the heaters maintained the heat if you could get it to the well in time.

GIBSON I thought the temperature of the hot water was just great for the hot food.

CARR I thought the cold was about right too. Effect of water flavor and gas content - Water flavor didn't effect the food as far as I know. The gas content was a real bother the first part of the mission. We somehow got rid of that gas. I don't know where it came from. I don't think it had anything to do with the quality of the water. During activation, it was in there and it had to work out before we could get into a stable water situation. Use of the spoon-bowl package - I think we adequately documented the fact that we don't like that thing and we don't recommend that it be used for any further flights. The conical

CARR (CONT'D) pack is by far the superior. What you should do is tailor your food for the use of that package. Use of spoons - For the most part, I found them a little too small. I used the big spoon. Opening of cans - We consider those cans to be rather dangerous. For the next generation of cans, we should find something better. None of us cut ourselves but the potential was there. I had half a dozen tab failures. Consumption from cans - I have no objections.

Food Waste Stowage: Function of germicidal tablet pouch - We never used them. We had them in the CM, but I think they are more trouble than they are worth. Undesirable odors - We did get some odors in the food-disposal area and we had some smell there. We already talked about how we needed to keep that area clean.

Fecal Container: I think we already adequately debriefed that. Urine system has been adequately debriefed.

Water: Chlorine taste and odor - I was not impressed by it. We only used the CM water 1 day and I didn't notice any problem. Iodine taste and odor - no problem. The gas-water separator was removed from the CM. Intensity of thirst during mission - That was no different than here.

GIBSON I wanted more to drink but I don't know why.

CARR Work-Rest/Sleep: Difficulty of going to sleep - We all at time or another experienced difficulty in going to sleep; in some cases, difficulty in staying asleep but for most part the problem stemmed from overfatique or heavy activity prior to bedtime which required time for you to unwind before you can get to sleep.

GIBSON It was like the snowball effect. Once you got behind the power curve, you could not take time off to unwind and it was very difficult to get back up.

CARR This is a case where onboard flight planning could adjust the work schedule for this type of situation without loss of valuable data. Duration and adequacy - I think that is tied in with the words we said before. Notwithstanding the remarks of the SL-3 crew that 6 hours of sleep was sufficient for a crewman in zero g. I'm not buying that I think we should allow 8 hours of sleep whether the crewman sleeps or not. I personally got along very well and I guess my average was 6.5 to 7 hours of sleep. That was adequate for me and the other quiet time was used to read or write.

POGUE The thing is, we're using the first hour and half of that time to unwind to get to sleep. If you remember, on the days off we had no difficulty in getting an extra hour of sleep.

CARR Restraints. We have already discussed the restraints. Sleep period programming - We just talked about that. Disturbances - We pretty well discussed that in the architectural section of M487. Okay, in the area of Work-Rest/Sleep, let me reiterate that man, whether in zero g or one g, should not be worked 16 to 18 hours a day. A man needs time to unwind and relax.

POGUE I would try ground flight training which would take one shift, working for a week, sleeping over in the MOCR. Keep the same guys there for a week. The thing is that it is not possible for three guys to keep up with three shifts of ground people. That's essentially what you've got. You got a competition going there. That's the way they look at it. When fresh troops come on duty, they feel that they have to get everything done on their shift. If they'd work a whole week and not leave the building over there and sleep over there, I'd say I'd buy the type of flight planning we have now.

CARR Exercise: I think the exercise thing has been thoroughly debriefed. Again, we can summarize that. We started out demanding an hour-and-a-half a day per man, and we would have liked to have had it unbroken and we finished the mission feeling exactly the same way. And I think we were right. Duration and quality - The extra quality of the exercise we

CARR (CONT'D) got was very good. The ergometer was great for the cardio-vascular system; the treadmill was great for one-g muscles. The Mark I and the Mark II were real good for your other muscles. We did not use the Mark III. Muscle soreness during or after flight - None of us complained of any significant muscle soreness during the flight. After the flight, none of us really complained much of muscle soreness until we began running. Bill and I had a bad complaint with the muscles in the front part of our legs. Those were the muscles that bugged us. Ed, I guess your complaints have been more concerned with the joints. Perspiration during nonexercise periods was essentially nonexistent. During exercise, all three of us perspired.

POGUE You know, there is an argument to be made for disposable paper sweatshirts.

GIBSON One of the problems encountered when working on the ergometer was that a layer of water built up on the body. I used to build up just a sheet of water across the back. You could really get some pretty big balls of water coming off of that, if you moved yourself around.

CARR Inflight Oral Hygiene: Mouth discomfort -

POGUE A little bit of bad breath.

CARR Brushing frequency - I think we all tried to brush at least once a day. My average was about once every other day.

GIBSON After the first 30 days or so, I was able to get close to an average of once a day; before that, it was like once every third day.

CARR It's pretty bad when you are so busy that you haven't got time to spend 3 minutes brushing your teeth.

POGUE Dental floss - I used it a few times.

CARR I didn't use dental floss. Toothbrush adequacy - I considered a soft toothbrush inadequate for my use. I use a hard toothbrush.

POGUE I used a toothpick and my Swiss Army knife and I wiped it with Zephiran wipes because the toothbrush would not get the food particles out of my teeth.

GIBSON I would like a harder tooth brush than the one that we had.

CARR Sunglasses and Other Eye-Protective Devices: We did not use sunglasses very often. I had a pair stuck by my locker behind my food compartment, and I used them occasionally. I think that it would be nice if you had a built-in receptacle for sunglasses by the window.

GIBSON The sunglasses did a reasonable job of reducing brightness. I wish we had had a small screwdriver onboard to tighten up the screws in the glasses. Mine always loosened up.

CARR Unusual or Unexpected Visual Phenomena or Problems: I don't see any need for us to debrief this at this time. The light flashes were covered on tape. The only visual phenomenon that I experienced beside the light flashes was that I was definitely aware of was the loss of visual acuity both near and distant.

GIBSON For some reason, I never experienced it.

POGUE My distant vision was great and my accommodation was already bad to start with and it was reduced even further, so I was glad I had the glasses. But remember that the fluid shift does pull your head, and causes the intraocular pressure to increase.

GIBSON For some reason, I never noticed that. I did a lot of close work on the ATM and I always wore my glasses up there, even with low light levels. And I don't think I ever noticed eye strain. I did have some problems initially with bloodshot eyes and the feeling that I had gotten something into my eyes. So, we've got three different data points.

CARR Eye focus during rapid aceleration/deceleration - I didn't notice it.

POGUE I didn't either.

POGUE Medical Kits: You know we almost got to the end of our Actifed. I think there were a half a dozen tablets, but I think they ought to go a little heavier on the decongestants. If you have problems there, you have to have enough to follow that treatment protocol.

GIBSON I think I got down to the last dalmain [?] there, although I could have looked around if there were any other ones, but it was the last one in that container.

CARR Other than that, there was more than enough medication. I figured we had too much, and we should have thrown away a lot of the SL-2 and SL-3 stuff.

GIBSON We had aspirins coming out of our ears up there, too.

CARR Packaging of drugs and everything in the medical kits -

POGUE Some of the drugs were hard to get to.

CARR Okay, how about the foil around the medical kit stuff?

POGUE I didn't particularly like it around some tablets you had to get out, but it was satisfactory. It was sort of difficult sometimes to push some of these tablets out after slicing off the end of the package.

GIBSON Tops that were pie-shaped were difficult. It was always a difficult thing to get the vitamins out in the morning.

CARR It would have been better if we could put the pills in a dispenser. Adequate instruction for use -

POGUE I thought the paramedical training we got was very useful.

GIBSON I think we were really prepared for a large number of things up there.

CARR Shaving: We've already covered that.

Radiation Dosimetry: No problem. Ed had a reading to put every morning on the recorders from the passive dosimeter. Bill and Ed wore theirs on their wrist; I wore mine on my right ankle.

Personal Hygeine: Thoroughly, discussed.

24.0 OPERATIONAL DTO'S

GIBSON Environmental Microbiology: I did most of the sampling there and it was no problem. I would suggest if we had the capability that we bring back a couple of crew-selected samples for microbiology. I had a couple of places from which to get samples, and I thought we should have brought back a couple of those samples, around the work stations mostly.

POGUE I'd like to comment on those bottles in the Med kit. I did the first of them. I did not like the container you carried the little bottle around in. The Velcro came off the bottles and they all came out of the container.

CARR Radiation Measurements: I did one early in the mission and Bill did one later. We had a lot of problems with the RSM and we were not sure it was working properly.

POGUE That's right. The reason was they did not give us a window and a time. One thing you needed was a proper time to take a reading. There was somewhat of an unrealistic reference to the RSM. I had to take the RSM up to the STS for every EVA. The checklist said to periodly monitor the RSM, and if the radiation level got above a certain value you were supposed to call the ground. I never looked at the thing again until I took it back down and stowed it after the EVA I doubt if anybody else ever looked at it. It was an unrealistic thing because you were so busy doing other things.

CARR Contamination Assessment: That was the work you did out the window with the Nikon, wasn't it Bill?

POGUE Yes, I took the pictures. I thought that somebody had not done their homework because there was a bad reflection off the inside of the window surface. I'm not sure how well the pictures turned out. I think the one of the wardroom turned out pretty well, but the ones in the STS were not good.

POGUE Water Sampling and Iodine Montoring: They were simple, straightforward and easy to use. I have no other comments.

CARR Carbon Monoxide Monitor: We both did that; it was a very simple thing to do.

POGUE The problem was that the monitor was already indicating a percentage of carbon monoxide before you did the test.

CARR Yes, that was rather bothersome.

Parasol Material: We brought it in and it was no big thing.

Taste and Aroma: It was no problem for us to do. It just took a little bit of time and we all managed to do it. We were rather surprised to see that our taste and aroma sensitivities were much higher than we expected.

GIBSON Yes, one thing related to that which we've talked about since we returned is that in the taste test all the paper tasted bitter, regardless of what odor or taste eventually came through. We were wondering, since everything was covered with plastic, if the plastic was the cause of the bitter taste.

CARR Food Package, AVC, and Girth and Height Measurements: Already been covered.

Sweat Samples.

GIBSON I think another method could be used to obtain the sweat samples. I don't see how very much data can be obtained from the samples obtained using wipes.

CARR Blood Flow in the Limbs has been covered.

Stereo Photogrammetry -

POGUE Trying to accomplish this DTO with only one crewman using a flash attachment was not the best method.

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