

# SKYLAB 1/2 TECHNICAL CREW DEBRIEFING

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1.0 SUITING AND INGRESS

CONRAD I don't have any comments on at all on suiting and ingress; it was completely nominal. The same with the status checks and the countdown; I don't remember anything that was off nominal.

WEITZ Except I don't remember any sound in the launch vehicle sequence, I guess that is the only thing that I would say.

CONRAD No, the launch vehicle was very quiet during the count. Actually the launch vehicle was pretty quiet through powered flight.

WEITZ Yes, you are right.

QUERY Do you have anything to say about suiting and ingress?

KERWIN No, I was thinking about that when I was in there. It was well done, and nominal.





2.0 STATUS CHECKS AND COUNTDOWN

QUERY Anything on status checks and countdown on page 1?

KERWIN No.



### 3.0 POWERED FLIGHT

CONRAD S-IB ignition, lift-off, has been described as essentially the same as Apollo VII. As a matter of fact, it is essentially the same as the Saturn V, except I think it was a smoother vehicle.

WEITZ With the ignition at 1.8 seconds, you don't have much time to think about it. You hear it start rumbling and you're off.

CONRAD As far as launch vehicle lights, roll, pitch, rate change, max q, and the GO/NO GO's for staging, they were all completely nominal, and on time, as expected. Inboards were right on time; and shutdown was on time. Again, staging was a lot gentler than Saturn V.

WEITZ The inboards shutdown, outboard shutdown, were all very, very, smooth.

CONRAD The S-IB doesn't unload like the Saturn V does. We had the normal separation fireball, but a lot of debris was floating around.

SLAYTON You didn't have anything around max q's?

CONRAD No, it did very little steering. I don't imagine there was too much jet stream. As a matter of fact, the whole IB ride was pretty smooth.

QUERY Did you notice the noise level?

KERWIN It built up rapidly. The S-IV was nothing.

CONRAD Paul, you should comment. You weren't even sure it had lit.

WEITZ I was convinced that it hadn't lit. It didn't feel like one g anymore; I was convinced it didn't light.

CONRAD One CSM comment: Our g meter read minus about 1/4 g at zero g. This was reflected through the S-IVB light. I usually watched the g meter in the simulator to assure S-IB lighted. When it lights after 4 g's, it's only putting out about 9/10 g. It didn't look too good on the g meter, but we obviously had a light and we were going.

WEITZ The one other surprise I had that isn't on here was the PU/PD shift.

CONRAD Yes, we had a drop in thrust.

WEITZ I was expecting an increase in thrust, and when it dropped, I thought for sure we had flamed out.

CONRAD No problem on the launch escape tower or BPC jettison. There was a lot of debris, but no problem there, either. Communication was good throughout, I thought. Controls and displays:

CONRAD (CONT'D) All during powered flight, they were all nominal. We had a few CSM malfunctions later on in the flight with RCS temperatures and a few measurements out of order.

KERWIN Everything was nominal. The computer displays of  $V_{\perp}$  H-dot H were right on the chart.

CONRAD There was no pogo. The S-IVB was really smooth as silk all the way.

WEITZ The whole ride was smooth.

CONRAD So far as the time line, we separated right on time. It was 16 minutes, as I remember it.

KERWIN It was a tight time line, but we had no anomalies. We did it in exactly the same time as we did it in training.

CONRAD We had no service module RCS talkbacks of any type during separation. Everything stayed gray.

WEITZ This applies throughout all the CSM operations. If you watch fuel cell current and battery current when you are on the batteries, there is absolutely no question when the gimbal motors come on, as opposed to how they are in that simulator. When you turn them on in the spacecraft they jump about 15 amps and drop back to about half that. I think watching the current review is the way to go.

CONRAD As a general comment, we changed our procedures prior to May 15 in that we dropped Joe down in LEB, right after separation and getting the first systems checks out of the way. We dropped the center couch and put it under my couch right away, and got rid of it. Joe spent about an hour in the very beginning re-juggling all that extra stowage.

KERWIN I spent close to the rendezvous until NCC, after which I had to start tracking. In the LEB shipment stowage, we had just a little bit tied down with ropes. It took the whole rendezvous to get squared away.

CONRAD This was all primarily aimed at having a clean cockpit for SEVA operations and having everything organized for SEVA. We had enough time in the runthroughs and the 10 days before. It went pretty well; it was just time consuming. But everything did fit where it was supposed to fit and where we thought it would fit. We were in good shape; we weren't rushed anywhere, but we didn't power up the VHF for a long time.

QUERY Do you want to say anything about the pitchover in S-IVB observation?

CONRAD I think they got all that on the air-to-ground. The S-IVB was completely nominal. SLA panels, all four of them, deployed

CONRAD perfectly. There's no need to think about photographing that.  
(CONT'D)

You won't have any problem turning around and plugging  
into that thing.

WEITZ They're steady as rocks.

CONRAD Yes.

WEITZ Absolutely. You can see that thing venting. You can see for  
hundred of miles away on that thing; both the workshop and the  
S-IVB. We were a long way off from the S-IVB when we saw it.  
It went with a bang.

CONRAD Well, you are talking about TACS fire on the workshop.

WEITZ Yes, on the workshop, plus when the S-IVB was finished.

CONRAD Yes.





#### 4.0 RENDEZVOUS AND DOCKING

CONRAD Now NC1 burn was our only two-bank burn.

WEITZ Joe took that on the lockers.

CONRAD Yes. I was going to say Joe set the first standup SPS burn standing up on the lockers because we had the couch out and that was no sweat.

WEITZ No sweat.

WEITZ I would not recommend it on the reentry.

CONRAD Now, as I remember, you didn't take any sextant marks for NC2. We gave it up as part of our restowing.

WEITZ It was the wrong attitude and I don't think they had the lights on.

CONRAD Yes, we didn't have lights and we knew we weren't even going to try and track for NC2. We skipped that and just went on the straight ground NC2. We had one confusing point in there. I believe it was NC2, that I PROed.

WEITZ You said you thought it was NCC, double PRO.

CONRAD Yes.

KERWIN Double PRO. At the end of the burn, the thing was hanging there with the display that shows you time from ignition at 1645.

CONRAD Yes. 1640.

KERWIN Okay. And you PROed to get the NOUN 85 residuals to terminal. I frequently have been slow on this in training. I had been looking at the time from ignition, making sure we got cutoff. Pete comes over and PROes on it. And I thought this time I would be real quick. I PROed and he came right over and PROed and we were out of program. So we did not trim the residuals.

CONRAD I know. On the one burn I remember, that was NC2 or NCC, we reported that to the ground and the cutoffs were very good on the burns anyhow. Residuals like that don't bother you that early in the game. No harm was done. It was really my fault for getting at it. The thing wanders in attitude 1640; when you get back into NOUN 85, it holds attitude again. You are not really in ATT HOLD. We just made a little procedural screwup there. I accept the blame on that one.

WEITZ Another observation for PLT is there is a distinct lag between the time ball valves go open and the SPS lights indicate the opening. It just surprised me the first time they went open, and there is a part of a second until it lights.

KERWIN The first two parts that I tracked the sextant on was all daylight tracking, isn't that right?

CONRAD Yes, we had the rendezvous arranged so that our tracking schedules were in daylight because the SWS still was not in the proper attitude to see the tracking lights at night.

WEITZ The sextant was right on the SWS the first time I looked through it. The tracking was great, much greater than the star, easy to track and easy to mark on. If you had a screwed-up program, I don't know how easy it would be to find the workshop in the sextant. You cannot see it in the telescope. The P52s were also easy to do. A little dark adaptation helps. Chart TPIs to find your star field.

CONRAD To summarize the sextant experience, the training is adequate. There is no problem, if you know how to focus it.

CONRAD It was NC2 that was tough. We called up NOUN 85 to read what was left there and we had a 1.6, 1 per second.

KERWIN And we did not trim.

CONRAD Yes. And, for the whole rendezvous, the solutions were as they were supposed to be. The CMC did become prime when it was supposed to become prime and everything agreed very well; the ground solutions and the computer solutions. The computer was go all the way.

WEITZ        You used the computers for the midcourses, too.

KERWIN      Yes, no chart. Just for information, I did chart TPI solution.

WEITZ        I think it was in limits, too.

KERWIN      I bet I remember that the TPI was good and the midcourses were good; one, but not the other. What we did, I remember now, I didn't do midcourse solutions. I was just setting at the polar plot and just ran it on it.

CONRAD      It is in the launch book, the nominal TPI time. The first recycle through was something like 07021897 and second recycle was 065856 something and that is about right. We were about 4 minutes early.

KERWIN      It was ... once 6585633.

CONRAD      Yes.

KERWIN      The final burn time was 7034760.

CONRAD      Yes, and if I remember right, TPI was 705 something, nominal; but it is in the launch book.

CONRAD      Yes, prelaunch was 070256. So we were 1 minute late, which was good. There was another data point they wanted in here, whether we got VHF ranging, but we were way inside the nominal anyhow. I had written down somewhere what the range was.

CONRAD Written down here is 117.08 miles. That must have been the first VHF range. It looks like your handwriting.

WEITZ No, it is yours, because you make 8's with two circles and I don't.

CONRAD Okay. I kind of remember, they wanted that and I wrote it down. I think that is it.

WEITZ 117.08, that's right. NCC, we did. We got them down here; on NC2, we screwed up. After NCC, we tried VHF ranging; we didn't get it.

CONRAD We had a rather large second midcourse solution. The first one was really small; 3 or 4 feet in one axis, 2 or 3 feet in the other one.

KERWIN If that much.

CONRAD After having such a small one, I was surprised at the size of the second one, I remember.

WEITZ TPM-1 is 0.50, 0, and 0.3. TPM-2 is 1.1, minus 0.8, and minus  $4-1/2$ . I think your chart kind of confirmed your polar plot.

WEITZ I remember now why we didn't do NSR on charts. Because they are already locked into a matched pair.

CONRAD Matched pair, with the computer.

WEITZ That is right. So I didn't do NSR on chart execution.

CONRAD As I remember the final braking, we were a little slow all the way in there, in the beginning. I think we passed the 1-mile mark at about 28 or 29 feet per second.

WEITZ It felt good, though.

CONRAD Oh, yes, no problem. It was in a goofy attitude. We ended up coming up on the side of the solar panel that was gone. And we just stayed there.

KERWIN You can start to see detail in the sextant between the midcourses, as I recall. It started to go from a blob to a workshop. You could see the ATM solar panels come through.

CONRAD It was before that because I went down to the LEB and took a look at it.

WEITZ I did sneak down the LEB, and I am trying to remember what it way.

CONRAD Yes, it was when Joe first said he could distinguish the four solar panels on the ATM and everything. I thought that was before TPI.

WEITZ        You were busy and I came down and looked at it.

CONRAD       Well, you saw most of the flyaround and the first soft dock was just as it was supposed to be. Where does that take us? I can't tell you a lot about the photography. We took a lot of pictures. We will just have to see how they came out.

WEITZ       Well, you did. In trying to get detail with the TV, I had to completely dedicate window number 4 to a TV and therefore we didn't get any photography out of that window. Joe, you were taking some out of the center window.

KERWIN       I was taking some Hasselblads. The angle isn't as good out of that center window.

CONRAD       Yes. I goofed again. I was late getting the camera on the braking phase and I forget when I turned the DAC on, but it got away from me. We had something come up about the time we were supposed to do in the checklist and it disappeared somewhere. I screwed up on that one. I did the same thing when they held us on the undocking I broke my chain on checklist. I undocked late and didn't turn the DAC on until late in the flyaround. We should have good still pictures of the flyaround.

CONRAD Now, I really thought I got a compliment for Scott Millican and those men. The SEVA prep card and those procedures went right as advertised. We had no trouble other than me clearing my ear. I really blew the mucus up in my ear, and it is still plugged up.

WEITZ You want to say anything about us hanging off on that angle?

CONRAD Yes, I am wondering if that may not have caused our second docking probe problem. Everybody said it is okay to hang on the probe soft. The vehicle tracked down and to the left of the absolute maximum; just stayed, completely bent around down to the lower left side from where we were docked and just seemed to set over there. Now, I don't know why and don't know whether that would have bent. Did we ever figure out which one of those capture latches it was? The ground knows.

CONRAD I don't know which orientation it was in either, but I think it would be interesting, because I think if anything caused the problem or scored or did something to that probe which we could never find out, it may have had something to do with hanging on the soft dock.

WEITZ May have stressed it a little, so that it was sticky.



CONRAD The question has come up several times why we couldn't put the cutter on that strap from where we were and cut it. Unfortunately, as we talked it over later, perhaps we could have done that had Paul been able to see that the strap did stick out enough from the side of the SAS panel. But it wasn't until we got all done and were discussing it in the vehicle, a day later that I realized that he couldn't see it was sticking away from the side. I could see it from where I was, but apparently he couldn't. He had a more direct front look at it and I had more of a side view. I tell you that was a busy job. I mean we flew pretty close to that other vehicle. You'd be in a better position to tell me how close we actually were.

WEITZ It surprised me. When we went down to the end of the wing and I got that big hook on the bottom of the <sup>wing</sup>~~wind~~ and heaved on it, I really pulled the two vehicles together. Apparently, it pulled the workshop off, too, because the first thing it did, the TACS started firing right at us. Then it took off the other way, and the hook was hooked under the wing.

KERWIN Almost took Paul with us.

CONRAD Yes, we nearly bailed the pole and hook out.

KERWIN We almost cast loose.

WEITZ        It struck me as sort of a crude procedure, trying to use strong forces when you are hanging out the hatch. Pete, it is quite a job, I don't care what you say, it is quite a job flying that command module.

KERWIN       Pete, I would say that typically, the point of the probe was 2 to 3 feet from the beam fairing.

CONRAD       You can do that kind of stationkeeping, and you obviously can do work out of a vehicle, if you have to. But, he pulled enough to upset the control system of the SWS, and to start us going together. Then he said, "Back up," and I gave her a mighty blast aft and that's when he was hanging on and by the time I got a mighty blast forward again, the SWS was coming back at us, and he didn't know whether to bail out of the pole or what. You could get in trouble. We didn't really get anything here. He got a little nervous there for a second. I wasn't sure whether we were going to bang into it. I didn't want to goof up the probe. And we were pretty close. And I could tell he put a lot of a strain on the wing. You could see the wing move out from the body of the vehicle. He was exerting plenty of force on it.

WEITZ        That was no problem.

CONRAD Yes. But later on when we got out, it was obvious there was just one screw that had driven all the way through. The others had scratched the aluminum surface, but one screw on the other side of the bolt, about that much of it sticking out of the bolt and had just managed to penetrate it. It was the very end screw of that whole strap that had wrapped around. It had penetrated the skin of the SAS panel. That was what was holding the whole show.

WEITZ That strap was laying flat on top of the beam fairing. Joe had shifted from the big hook to the double-pronged bronze hook. I could barely get that in. That strap was laying flat tight against the top. I could barely get the points in by kind of chopping at it. But I finally got the two points under it, and I heaved on it hard as I could, and couldn't. It was surprising when he said there was only one bolt through it. I couldn't pull it this way and then I couldn't get it back out that way, either, for a while. But it was my distinct impression that where it came over the edge, there was not enough room to get the jaws of the bolt cutter in there, although it's obviously strong.

CONRAD Well, you're not wrong in the sense that if you think of the strap as running up at the side of this panel, which had a slight bulge in it from the command module, he would have had to take the jaws and put them through this way. And when Joe

CONRAD put the jaws on, coming from 90 degrees away, he could put  
(CONT'D) the jaws on where the edges could pick the side of the surface.  
So, I'm not sure he could have gotten the jaws on that, from  
the orientation we were in in the command module. Then we  
went back.

CONRAD I have to say something for the docking light on the command  
module, which really illuminates that vehicle. In retrospect,  
if I had to do it again, I would never have gone back to the  
nightside to try to redock. We were in a little hurry,  
because we had about 5 to 10 minutes to go. I knew I'd been  
using a lot of fuel, and I really wasn't sure how much I had  
to use. I decided I better get back there before it got dark.  
Once we got back in the dark with the docking light on, it  
was obvious that I could have continued to stationkeep along-  
side the vehicle with just the docking light. We could have  
stayed out on the SAS panel and worked with it for another  
day pass. Then when we got back, it wouldn't dock. The  
second docking attempt, or the first docking attempt of that  
pass, was completely nominal like the first one. I just  
didn't understand why it didn't engage. I really didn't say  
anything to the other guys, because they were cleaning up the  
spacecraft. I just backed off and came in again, this time  
making sure I had a good seven- or eight-tenths of a foot

CONRAD       per second. We spronged in there and I gave her a little  
(CONT'D)       shot to hold it. Then I let go of the translation controller,  
                  and we spronged right back out again. Then I realized  
                  something wasn't really right. So I got Joe, and we checked  
                  the switch configuration.

KERWIN       We thought for half an hour that there was something we'd done  
                  wrong in setting up for it.

CONRAD       I backed her off one shot. I gave her a real blow, because  
                  there's one real dent in the drogue. I must have hit it  
                  going about a foot and a half per second. I was convinced  
                  that I just wasn't getting in there good enough. But then I  
                  realized that this was about the fifth time, and I said,  
                  "Okay, we have to start reading data procedures." Then we  
                  contacted the ground and continued stationkeeping. We went  
                  through all the procedures, and finally resolved it by pulling  
                  the hatch out.

KERWIN       It was something. We got it all squared away; we got that  
                  hatch back on, and you moved on in. You were holding your  
                  plus-X there and Paul was saying that he didn't think it was  
                  working. Meanwhile, I had counted up to 7 seconds. And it  
                  just had to settle at exactly the right attitude.

CONRAD     What you don't realize is that, as you're thrusting and holding the probe in the nose, it is retracting at its proper rate, which is very slow. It just seemed like I was thrusting and we were retracting forever and getting closer and closer. All of a sudden, all 12 of them banged in. They ripple-fired and there wasn't a latch it didn't make.

WEITZ       It was square enough, but it didn't sound like 12 to me.

KERWIN      Perhaps three.

CONRAD      Well, it worked, and that was the end of a long day. Now, we went right ahead. We pressurized the tunnel and checked the latches. We went to bed that night, and I think everybody slept very well in the command module.

KERWIN/  
WEITZ       Much better than I expected.

CONRAD      And we were quite comfortable even though we had all the extra material in there. We left it pressurized, and it was tight.

## 5.0 WORKSHOP ACTIVATION AND CSM POWER DOWN

### 5.1 Mission Day 2

CONRAD I think the key thing here is when we pulled the probe, that one capture latch was still flush. And I'm trying to remember what we did when it popped out.

WEITZ You and I were just playing with it. You were pushing the other two in, and I just touched it, kind of hit it, and it came right back out. After that, we'd push them all in, and sometimes it would stick in and sometimes it wouldn't.

CONRAD Okay, now. We can go right down this thing. Secondary glycol evap dryout went just exactly as advertised, and Joe did the TDI/CO sampling.

KERWIN The TDI/CO sampling was routine. It went just like the book. The TDI sampling takes a long time to do, because you have a 15-minute wait to let the colors develop. The color didn't develop. I think Dick Johnston's personnel who developed that TDI sample deserve a kudo, because it saved us a lot of very time-consuming and arduous procedures to be able to couple that to the MDA port and to sample through the vent valve. It saved us from having to ... the command module with helmets and gloves and all the other gear on.

CONRAD CM suit circuit deactivation went fine.

WEITZ On MDA hatch opening, I can't say enough about having high-fidelity trainers. We could have been in a trainer during activation, as far as that's concerned. It was strictly nominal. The forces were the same; the motion was the same. The light switches were right where they were in the trainer, and I even put them in the right direction this time. I turned them on and they all came on.

KERWIN I have nothing to say about drogue and probe stowage.

CONRAD It was just as advertised.

KERWIN As Paul said, many times, in those few days when we really appreciated having a good trainer over here and personnel who kept trainer up to date, it seemed they even put in the failures and the sticky parts. The parts in the flight vehicle that didn't work right, we were prepared to fix.

WEITZ That's right. The things that were hard to work in the trainer were hard to work in flight. Do you have anything to say about air interchange ducts (AID), Joe? Were you missing a Calfax on that?

KERWIN That's the one that has the noncaptive Calfax. I lost it for a minute, but I found it again.



WEITZ Entry's nothing. As far as debris is concerned, I think, for the volume we were looking at, the debris was probably nominal. At the time, most of it was the pulled-off ends of blind rivets. I'd say there were three or four rivets and a few pieces of lint and a couple of things like that.

CONRAD But as soon as fans are going in there, that circulation system causes everything that's floating to line up on a fan screen someplace.

KERWIN This is a very good design point in the vehicle. You don't lose things. If it's properly closed down and you have good fans, everything winds up on a screen.

WEITZ That's right. We agonized a lot, especially Bob Overmeyer on those closeouts in the MDA. But it was worth it, because it kept stuff from getting lost back there.

KERWIN Window protector and SOP/SOMA worked just like in training.

WEITZ There are no pertinent comments on circuit breaker panel configuration or switch configuration. SIA location was the same as the trainer.

CONRAD In fact, all the CSM stuff went as advertised. There was no problem with any of that. The evaporators dried out just like they were supposed to. They actually dried out faster. If you

CONRAD just stayed on the time line and, go back and pick it up where-  
(CONT'D) ever you are supposed to, the things were ready to press on.

KERWIN The umbilical connection was routine. That was a good example  
of a well-written checklist, because the way you handled the  
umbilicals, the dust caps, and the bags left you perfectly set  
up for deactivation. Twenty-eight days later, everything was  
exactly where you wanted it.

WEITZ No comment about circulation activation. That's just turning  
on fan switches. Caution and warning: Seems to me I had a  
surprise about caution and warning. I put it on tape. I don't  
remember what it was now; it was a minor problem.

WEITZ Well, we have the caution and warning activation, and checkout,  
and then test; and I don't remember which of those phases it  
was. We were still on A at the time, I think.

CONRAD That would be day 2.

WEITZ Yes.

KERWIN ATM C&D activation was one of those deals where your training  
is completely out the window, because the checklist was com-  
pletely rewritten in the 10 days, and then it was rewritten  
again before we got up there. We had a lot of pen and ink  
changes to make, and I was pretty much following the ground's

KERWIN  
(CONT'D)

leads blindly. I was using red tape on circuit breakers and switches that were left in off-nominal configurations and not to be touched and not to be closed. We didn't have any trouble at the time. It bit us later, because all of our cue cards for normal ATM operations were invalid. It took us a long time and many changes to figure out how to power up and power down the ATM for operations. In effect, we went through two complete sets of cue cards and wound up writing our own before we got back to something near nominal. I just hope the next crew doesn't have to do that. I will say that the ground handled our rate gyro problems very well without having to have a lot of help or input from us. There were a few occasions on which we helped them out, but most of the time they helped themselves.

SPEAKER We're holding here, Pete, for CSM/SWS basic comm configuration.

KERWIN Jumping way ahead, on aft lock entry, I followed Paul in and did some more sampling. I did another TDI sample and another carbon monoxide sample. Then we did that first checklist, and the results were negative. There was a terrible smell in the workshop - indescribable. I think Al's crew will smell that smell when they open up some of the dome lockers getting out the food. It's a burned smell. Burned what, I don't know. Just probably cotton, polyurethane, or something.

CONRAD You were talking about caution and warning, Paul. I couldn't find anything.

WEITZ Yes, that's right. I looked in the checklist again and, as I remember, there is nothing off nominal.

CONRAD The CSM/SWS basic comm configuration went exactly by the checklist. The checklist was absolutely correct and we had no comm problems.

WEITZ AM ground disconnect: nothing. SPS comm activation and checkout: nothing. Joe, ATM foot restraint? You did that by yourself.

KERWIN I've already covered that, and I've covered the next one.

CONRAD Yes, you had a bunch of major power changes to the ATM C&D panel activation.

KERWIN I've talked about that.

WEITZ  $O_2/N_2$ : nothing. Bed 1 bakeout went per checklist. SOP/SOMA, did you cover that, Joe?

KERWIN No, I covered configuring it. You're the one who transferred it.

WEITZ That's where we got off nominal. I need the flight checklist, I guess.

CONRAD That's mine.

WEITZ Yes, I know. But at least it has the changes in it.

CONRAD While he's looking for that, I have one general comment. It seemed to me that, later on in the mission, we found out that there were some blocks in the Activation Checklist that just went down the crack. They were minor things, but they caused us some perturbations of the time line later on, simply because we didn't get to them. Such things as high-intensity lights, portable lights, and some of that other minor stuff that weren't activations.

WEITZ Items in the workshop. I never got to my photo prep, and that hung you up later on. We cancelled the M516, and I never did prep for that. The SOP/SOMA transfer was a nothing. I don't remember if I strapped it to my leg with one strap or if I just held it by one hand. I think I held it. It wasn't worth the bother of unhooking the strap the way it's tied around your leg. I think I just held it in one hand. The aft lock entry was done per checklist. Since the OWS hatch apparently leaked, the write-in said inspect it for damage. As I reported at the time, I couldn't see anything wrong with it.

CONRAD CSM caution and warning went per checklist, and CM O<sub>2</sub> configuration went per checklist.

WEITZ Dmc entry went per checklist. OWS fan activation went per checklist, no surprises. Caution and warning checkout.

CONRAD That's AM.

WEITZ This is where we started changing things around. Water separator plate wetting and servicing. It went well, although we weren't sure at first whether we were getting good wetting, but we obviously did.

CONRAD You and I fiddled around with it for a while.

WEITZ If you do it right per checklist, it works out. The steps weren't clear, and the secret is, when you take the adapter off, you can't tell if the chamois is wet. But the thing you do is look for little bits of water on the plate of the adapter. If you just see that it looks wet, then all of them are wet.

CONRAD I had the CSM condensate blanket installation, and it wasn't really a good fit, but it was no big deal. It never has been a good fit. The command module evaporator reconfiguration, again, went per checklist.

KERWIN Okay, I covered that TDI/CO sampling.

KERWIN The M168 relocation fits in with water separator plate.

WEITZ That's right, and with the juggling, it was out of sequence. You had it all loose, and we couldn't move it because the spare condensate module was still hanging on it or something like that.

KERWIN So I waited around for awhile. Actually, doing it was no problem.

WEITZ Teleprinter spares were per checklist. AM window vent sealing: what's to say? You crank four knobs. MDA launch restraint removal: There must not have been anything unusual. Nothing sticks in my mind about it. Solids trap replacement, I think we did not do then because they weren't dirty enough. There was nothing in them. They're just like fan screens. You can tell by looking at one of them if they need changed. VTR activation; did you do that, Joe?

KERWIN No.

CONRAD I think I did, but by the checklist. It obviously worked.

WEITZ Condensate system activation went per checklist.

CONRAD Well, that got a little bit goofed up. You and I went down and moved the big condensate tank, in order to do the parasol deployment. Then I pulled the vacuum on the big condensate

CONRAD tank, and I think we got the little condensate system running  
(CONT'D) first.

WEITZ But that's not what is condensate system activation. Condensate system activation is hooking the hose to the holding tank and just turning the valves on the condensate.

CONRAD You had to pull a vacuum on the big tank first.

WEITZ But that's not part of the thing that's labeled condensate system activation. Condensate system activation in the checklist comes after tank relocation and holding tank prep, which includes pulling the vacuum. Why don't we go ahead right now and talk about moving the tank. We did that out of sequence to get it out of the way of the airlock. It was a nothing, a piece of cake. It's the biggest blivet we had to move, and it went the simplest. Those blue restraints for your knees worked great.

CONRAD Joe, I guess you put the EVA hatch window shield in. It's in there now, and there's no reason for anybody to mess with it. We just took our time with the parasol and worked per checklist. We had to pop in and out of there to cool off about every 15 minutes. It was pretty hot. We used our gloves and we wore our jackets and our coats and it was extremely dry air, so other



CONRAD than the fact you were just beginning to build up heat, it was  
(CONT'D) kind of funny. It was extremely hot in there, but it really  
wasn't bad working in there. And if you just popped up to the  
MDA for about 4 or 5 minutes, or even less, you'd cool down and  
be ready to go right back in there again, and you could work for  
15 or 20 minutes.

WEITZ I tried it for a while without my jacket. Actually, your jacket  
served as a thermal barrier against the radiant heat from the  
walls. I took my jacket off and, after 15 minutes or so of that,  
I put it back on. It's more comfortable with the jacket on,  
which is documented, I think. The only oddity we had was the  
Teflon flaps on the end. They weren't right.

CONRAD We had to reorient those Teflon flaps. It was not packed right.

WEITZ But we received real-time clarification from the ground on that.  
That was a prime example of somebody having done it on the  
ground. Obviously Hank Hartsfield had done it, and he happened  
to be CAP COMM at the time. He had the answers right away, so  
there was no delay in getting that clarified and squared away.

CONRAD You might talk about what you saw, Joe. I'm still not clear  
in my mind, even after looking at that thing on the flyaround,  
exactly what's not deployed right. I almost had the feeling  
that two of the poles on one side, a front one and an aft one,  
aren't deployed right, but I can't swear to it.

KERWIN I remember going up to the command module with the TV and seeing the thing sticking up out of the airlock. You could see maybe the top two-thirds of it. You were counting down to release it, and then it went "sproing," and flopped down very fast to where you couldn't see much of it any more out of the command module. I didn't really know what to look for, but the pole stuck out a good deal farther than the material, and the material seemed to be crinkled on one side. You pulled it back down. I could not tell at that time what the configuration of it was. I couldn't tell until we looked at it during EVA. And of course, we've got good descriptions and good pictures.

CONRAD We oscillated the pole up and down and tried to get the wrinkles out. It did do some good.

KERWIN It did seem to do some good. It was quite wrinkled and, as we saw it later, it was still all wrinkled up on the lower right-hand side as viewed from the command module.

CONRAD Yes, but it did the job.

KERWIN I don't know how good that TV was.

CONRAD Potable water chlorination went as advertised.  $O_2$  fuel cell purge was no problem. We had a few changes on the CSM quiescent panel configuration. Because of the power configuration, we

CONRAD  
(CONT'D)

turned BMAG 1 all the way off rather than leave it on warmup. We went to a lower power configuration. We did go to one inverter, and then that was too low a load; things started to get too cold. Then a little later on, they had us put the other inverter back on the line. So we just made a few real-time changes to that quiescent panel configuration. Otherwise, that stood for 21 days until the fuel cells went out. Then we made the standard switchover to the "fuel cell off" power up by workshop configuration, which really concerned mainly fuel cell switches and it was all correct. Who did the first condensate tank dump?

WEITZ I don't know, either you or me. But it must have gone all right.

WEITZ Mol sieve activation was done per checklist.

### 5.2 Mission Day 3

CONRAD Well, let's see. Did I go down and get the plenum bags?

WEITZ Yes, you wound up doing that.

CONRAD That was day 3. We slept in the command module again that night, didn't we?

KERWIN Yes, and the next night.

CONRAD We were still eating command module food. We hadn't activated the wardroom, so we rehydrated food and everything in the command module and that wasn't any big deal.

WEITZ It was a little bit different than planned.

KERWIN It was getting a little old.

CONRAD Somebody did take the urine down and sample it.

WEITZ I did. That was per checklist.

CONRAD Then we had AM/OWS VCS duct installation. The only comment I have on that is, the two center Calfaxes don't engage. You have to plug in at the OWS end and you have the four Calfaxes that hold the other end on the airlock module duct. The two support Calfaxes just don't fit - just like in the trainer. Yes it was fit-checked apparently at the Cape, but I think there's some normal distortion. It's no big deal, though; it works fine.

KERWIN I did the H<sub>2</sub>O tank iodine. As I recall, the reading was low, but the procedure was fine. There wasn't any problem there.

WEITZ Vent fire extinguisher configuration, I did per checklist.  
Circuit breaker and switch configuration, per checklist.

CONRAD      Wardroom activation went just exactly like it does in the  
              trainer.

KERWIN      I think I can say the same for the waste management compartment  
              activation.  And I can say the same for film vault activation  
              and ...  That was just a matter of packing the plenum bags  
              with trash, and it filled up the same number it did on the  
              ground.

WEITZ       TCS activation was done per checklist, as modified.  Water  
              system activation, again, per checklist, as I remember.  Trash  
              lock.  Did you do that or did I?  Did we split it up, or what  
              happened?

CONRAD      Everybody was pulling bolts out of that thing.  You finally  
              wound up getting the main part of it done.

WEITZ       Yes.  It was a nothing.

KERWIN      Film vault activation was routine.

CONRAD      I did the rest of the OWS SOP/SOMA activation.  That was a  
              nothing.  We stored them where they were supposed to go.

WEITZ       Urine collector.  We each did our own, didn't we?

CONRAD      No, somebody activated that system.

WEITZ Oh, I did. Yes, per checkiist. Just like in the trainer, except there were three of them instead of the one. OWS lighting. What's to say about that? We turned the switches on; the lights came on.

CONRAD The only taing there was we operated for 2 weeks turning those lights on and off all the time just to keep power usage down.

KERWIN We were working in the dark most of the time.

WEITZ Food container transfer. You started doing some of that early, didn't you?

CONRAD We kept catching that as we'd go by doing something else.

KERWIN It was easy to move the boxes.

CONRAD I think we can make the comment that any of the things we said were two-man tasks all turned out to be one-man tasks, really.

WEITZ That's right. They could have been very easily. Joe, you wound up helping me with a couple of the food boxes and a couple of them you were off doing something else. The only change I did make is I did go to the McCandless mode of undcing them. I got the speeder handle and all extensions in the

WEITZ  
(CONT'D)

whole vehicle. That puts the handle above the top, and you just do them that way, and that really makes it go fast with the triangle shoes on. They work quite well.

CONRAD

That's where we got off the activation checklist. All that stuff was done without doing the camera stuff that was supposed to go with it. That's part of what put us behind the power curve on our first orbital operations because they came along and said do M151 and other things, and we had never configured any cameras. Nobody realized that and that really put us down the tubes on day 5 or 6.

KERWIN

I'm looking at suit drying. As I recall, we did not actually turn on the compressor at that time to dry the suits. I'm looking through this checklist, and we did all the business about relocating items, stuffing desiccants in suits, activating the system, but we didn't turn it on. The desiccants dried the suits. It worked out okay. The suits did not mildew or come apart apparently.

CONRAD

What did we do with the suits at the beginning? We did tie them across the tunnel, right? We didn't like it. We only had two of them there while we went through this long exercise before we really got the suits dry. Then when we finally

CONRAD did do the drying, that's when we decided to stow them some-  
(CONT'D) place else and came up with our other stowage locations up in  
the MDA. I think we sent Al some television film on where to  
stow all those suits. We did show him. It's obvious when you  
look at it. It's all much better than what we had originally  
planned.

WEITZ UCEA sampling was done per checklist.

CONRAD CM food transfer, again, went per checklist. That was our  
first attempt at loading food in the food trays, and it was  
no big deal. It took a little time, but there are a lot of  
bits and pieces in those packages. It was not as easy to do  
as handling the normal food packages that we did later, but  
it was no big deal.

KERWIN Wardroom water purge.

WEITZ I'm trying to remember what it was.

CONRAD Well, you had to do some sampling or something, didn't you?

KERWIN I had the OWS/AM VCS duct launch support removal, which was  
just unscrewing a bunch of bolts from that stuff overhead.  
Let me talk about MOY4 and get it out of the way. The mass  
measurement devices were both activated normally. They both



KERWIN  
(CONT'D)

performed normally on this day. When I went to calibrate the waste management compartment unit on the next day, I found that the MASS/TEMP/OFF switch was in the MASS position, which says maybe I left it there after activation and that the unit was inoperative and remained so.

WEITZ

The wardroom water purge. Step 1 of the procedures said "verify the bellows in water tank 1 had moved about 2 inches. If it moves about 1-1/2 inches, do not continue and notify STDN." I notified STDN that it moved about 1-1/2 inches, and they said "continue." Apparently, the system worked normally after that. So I don't know what the distinction is between 2 inches and 1-1/2. Water purge, fire hose activation, and portable water tank restraint removal went per checklist. Shower activation was all right and electrical panel support relocation was okay. Throughout the mission we never really used the heaters for fecal processing. We couldn't afford the power at first, so we started drying them in a vacuum. We used the top four ovens for feces; the other two for desiccants, and we rotated. We marked on the door the day and the time that the sample was put in there. When a new sample was put in the oven, the one that had been in the longest was removed. After the sample had been in there a couple of days, it was plenty dry. We missed film/dosimeter transfer.

CONRAD All the stowage transfer was worked out extremely well. There was very little confusion on that. There were many changes that had been made, but they kept excellent track of that. All the changes had been written in the stowage book. I guess I made a mistake on that trim burn because they wanted it to be a two-quad trim burn. They didn't really send up a very detailed checklist, so I just left the fuel off on two of the quads and actually fired four quads with no fuel going to two of them. I guess they didn't like that, but it doesn't do anything. It just opens the valves and puts some heat on the coils, but they asked me about it afterwards. They see valve actuation on their data, and I think they thought for a while that I might have made a four-quad burn. I just hadn't bothered to shut off the switches. I just had the fuel off on the two quads. The next time they sent me a very detailed pad on that quad burn.

WEITZ During water servicing equipment transfer, I transferred the spare condensate module down to the workshop and left the water servicing adapters right on M168 because that's where they are used. That's a good place to stow them, so I figured we might as well keep them there. That's all on channel B. That was a real time change to stowage. Wardroom window activation went per checklist. Did Joe do M172 activation?

CONRAD Joe did the M172 activation, which was really no problem. I did the cal the next day, which we'll get to.

WEI'UZ I have no comment on vacuum cleaner activation, portable fan activation, and return water container fill/transfer.

CONRAD I did those, and there was only one problem with the return water containers. The people on the ship that were supposed to figure out how much water we drank didn't know how those containers had been filled. After I told them how much water was in them originally, they did all right. Aside from the difficulty in getting water out of those things to rehydrate a drink, which we'll come to on reentry, the containers were fine. I remember one other thing. I think I made this remark on B channel. Al better carry some fresh iodine pills to put in those containers. They turned completely to powdered iodine. I had a lot of difficulty in getting them in the container. They're little tiny gray pills. I guess they'd gotten too hot, and they really had almost turned to dust.

WEI'UZ I've never done this S149 container transfer before. I didn't ever know it had to be done. The checklist was well written, and it went off all right. I have no comment on vent cover release. The PCU/LSU configuration was simple.

CONRAD We didn't have any trouble with the TV until the one camera quit running, and I'm convinced they will find out that's the power supply. It just stopped. So whatever it was was very basic to running the machinery.

### 5.3 Mission Day 4

CONRAD I'm really not clear on the suit drying. The ground's probably clear on that subject. I guess we never did activate the suit dryer. We put four desiccants in each suit and put them away. We didn't really activate it until we did our day 14 EVA. I think I can speak for Joe on the M092/M093/M171 activation in that it went per checklist. The comment that Joe made at the end of the flight was that the Biomed Checklist was one of the more outstanding checklists, along with this activation one we had that was well written. It had very few changes in it. It worked extremely well for all the biomed experiments. You and I did the plenum bag stowage, and I think that we actually wound up putting four plenum bags down there right off the bat. We had four full plenum bags, and we stowed them in the plenum right where they're supposed to be stowed. And we wound up filling two more before the mission was over.

WEL17 Yes, one of which is in the plenum, and the other one isn't quite full. It's still up under the plus % of the T027. Fecal

WEITZ  
(CONT'D)

collector filter removal: That's the one we had the big question about whether it was working right or not. I was not aware that in order for the urine system to work properly that a fecal collection bag had to be in there to get enough Delta-P through the urine system. It sucks it all through the hole in the fecal collector. So we did that a little out of sequence, but it was per checklist.

CONRAD

Enough has been said about the M172 calibration over the air. I think everybody understands that trying to put all that paraphernalia on there just didn't work. We brought all the things back that I used the day that I did it per checklist, and they did not get a good cal. And I brought back all the extra tie-down equipment, and the command module people that took the things out of the command module now have the piece of Mosite, the strap, and a few other things like that that I had to press into service there. And I guess they got all the M074 calibration. You calibrated it one time, and Joe calibrated it. I think it got to be very repeatable, didn't it?

WEITZ

It didn't for the one time I did it. I think it was a question of the sensitivity of that system. I'm not so sure that in the real world you can get the kind of repeatability that the checklist calls for.

CONRAD      Let's talk about food overage transfer. The food overage is transferred, and it's on top. There are three packages on top of the food lockers. That is, the food left over from SL-2 is stored in 550. The cans are all labeled. Locker 554 right now is the trash locker.

T003 activation - I did that - was a nothing, and all that data is brought back in the machine - one of the few smaller machines that ran correctly. It ran fine throughout the whole flight. I never could make any heads or tails out of the data because it read all types of different numbers every time we ran it, but I guess maybe it'll mean something to the experimenter.

I guess I did the ATM C&D coolant loop activation. I also was the one that did the filter changeouts on it and the filters are so identified. The filter that was lost and replaced has one red band on it, and the filter that was replaced at the end of the mission that was returned has two red bands on it. I annotated that on B channel, and I also informed the command module stowage people on the ship. When they found those things, they didn't even know what they were, or they didn't even have it in their list for some reason. They thought it was extra gear we brought back.

CONRAD M092/171 operations - I think that we found out the sponges  
(CONT'D) had too much juice in them. We'd take a piece of Kleenex and  
sponge or squeeze a good bit of juice out of each sponge, so  
we never really had too much trouble. And I think our runs  
wound up running about an hour and 45 minutes.

WEITZ They were pretty much nominal. We had less time to run, but  
more time to clean up than they allowed.

CONRAD All the M151 operations went okay. I guess the film will tell  
the story.

M110 - Joe may have some comments about the equipment, but as  
far as us running it, it took about the amount of time we fig-  
ured on the ground.

WEITZ Well, we ought to have Joe's comments on this. He put on  
B channel that he had to leave the ASP on the vacuum until he  
was ready to use it.

CONRAD Yes, he couldn't hold the vacuum. The first time we did it,  
he pulled the vacuum on all three ASPs, and then by the time  
he went to put blood in the second ASP, it had lost its vacuum.  
So we'd stick one ASP on the vacuum thing, draw the blood, pull  
the ASP off the vacuum, put the blood right in it, and then put  
another ASP on the vacuum and leave it on there while we were

CONRAD  
(CONT'D)

drawing the second blood sample, and so forth. And he's documented all that.

Systems housekeeping. It seemed like there were 8 million systems housekeeping tasks, but really, most of them were pretty logical. I think that the best thing that we could do with the systems housekeeping is sit down in the debriefing with the Flight Plan people and go over those individually. There must be a 100 or 75 of them.

WEITZ

I don't think the minor ones need to be scheduled, such as towel module resupply, wipe, and tissue. Whenever they called those things up there wasn't time to do them anyway. And those are things you know. If you run out of wipes or towels, you go get some more. It's good to have them in a book as a memory jogger, but you don't have to try to schedule things like that.

CONRAD

TV. Let me say the guys did a good job with the TV OPS Book, except we really did spend considerably extra time on TV setups, because the clocking of the workshop 4 in a trainer is about 6 degrees out. And the 6 degrees out means that the TV was very tight on not looking at lights. We would find that we just couldn't set up the pointing angles and run the TV. We'd have to sit there and put it in and read the book



CONRAD      and refresh our minds on what exactly it was that they wanted  
(CONT'D)      in the scene and then kind of juggle the camera around.

WEITZ       I'd just as soon we did away with those X, Y, Z settings in the  
TV OPS Book and just put the center of the scene in it.

CONRAD      Yes, put the center of the scene in it and let the guy point  
it.



## 6.0 ANOMALIES AND UNUSUAL ACTIVITIES

WEITZ Okay, you can take paragraph 6.0.

CONRAD I would like to comment on some anomalies. I don't know what happened to the CO<sub>2</sub> sensor. It temperature sensor, but that thing bombed completely. In the very beginning we had a lot of little gear that was really bombed out and CO<sub>2</sub> sensor was one of them.

WEITZ S019.

CONRAD The S019. What was it that jammed that up?

WEITZ Well, I debriefed it on B channel. You had to take all that clank mechanism off and they had a flat sheet metal protector around one of those little gears, and it had been pushed into the gear instead of keeping stuff out of it. Our TV and the stuff that they had squeezed in around there had forced the protector down into the gear.

WEITZ Oh, the tripod. The minus-Z SAL tripod.

CONRAD Yes, that was the mirror image. They figured that out, though. They know what that is on the ground. The gear didn't fit the minus-Z SAL location. And they drilled the whole sphere image on the upper plate on the triangle when they mounted it. But,

CONRAD (CONT'D) we worked with that thing for 2 or 3 man hours and finally had to unscrew some bolts out of the grid structure somewhere to make some jury rig bolts. It might be a smart idea for Al and his crew to take 10 or 12 nuts and bolts along. Didn't we want some nuts and bolts for something one time and we didn't have any?

WEITZ For something else, I don't remember what. We had a lot of bolts, but no nuts.

CONRAD The other thing was some of the EVA gear. Maybe I'm a little finicky, but I came up with some better ways of putting it together than the way they did from the ground. We worked with a lot of the throw-away stuff inventing better ways to make tethers for hammers and tape lens brushes and all the things we carted out on the EVA. We got in trouble on day 5 and 6. There were really three things happened that caused that.

## 7.0 ON-ORBIT DAYS

### 7.1 Mission Day 5

CONRAD I would like to start out with mission day 5, where we got into trouble because the items were left out deliberately for one reason or the other on the activation days. The camera stations weren't rigged; the lights weren't out. We were generally getting a feel for the vehicle, and we ran behind the power curve all day. We went all day long on that. A good example of that is S019, I forget exactly how I was scheduled, but I got S019 in there all right and I got in a hurry trying to make the night pass, and wound up not taking any pictures. I guess that was day 7 or whatever it was. On days 5, 6, and 7, we were really learning our way around. It was mainly just getting the thing really completely configured and getting us just use to running around the vehicle doing everything.

Transfer of items: As we learned, you had to put a little thought into that. Like the day - 27 transfers for return, they were scheduled for 4 hours of my time and an hour of Paul's time, and it actually took 8 hours of my time and about 1-1/2 hours of Paul's. But we were well aware of this situation, so I took care of my early 4 hours by starting on day 26 at night on my own time doing it. That was the only big job later on in the flight that took a lot of time. We

CONRAD  
(CONT'D)

had been up there long enough to know that one was coming and we were well aware of it. But we weren't aware of those things on days 5, 6, and 7. We had worked hard for 4 days before that and we were tired; we needed to slow down. It took us until about day 7, I guess; it's all in the air-to-ground and B channel. They were asking a little bit too much of us. We were trying to do all of it, and by trying to do all of it we were getting inefficient by rushing. I guess this is the simple thing. We made mistakes and we also had all this gear that wasn't right. S019 had problems and we had to take time and troubleshoot the next day, and Paul got it fixed. It took us until about day 7 to get things put together.

WEITZ

I thought they brought us on very well. They started out with easy jobs and gradually went into them. I thought the whole plan of attack on the ATM, from my point of view anyway, went really very well. I think it is entirely up to Al's crew's working with the PI to decide what they want to do on changing those JOPs. That's not my world, and Joe may have a lot more thoughts on it, but I didn't have any problem running those JOPs. Any mistakes I made were just mistakes, and I think we did our best to point out where we knew we made mistakes on B channel so they could pinpoint that when they see the films and try to reconstruct it. Basically the JOPs were laid out,

CONRAD and the way we had our things laid out on the ATM panel worked  
(CONT'D) very well. I really enjoyed running the ATM. I think we all  
did.

#### 7.2 Mission Day 6

CONRAD On day 6 for the contamination D'TO: by the time we looked  
around at most of the windows, I think we gave you a fairly good  
description of what contamination we had. I think we have it  
sufficiently documented on film the way they wanted. The film  
will tell the story on that. They can see what was contaminated.  
There was no reason to beat the wardroom window to death. We  
said plenty of that over B channel and over air-to-ground.

#### 7.3 Mission Day 7

CONRAD We talked about M110 and M131. I don't have any comment for  
day 6 about that. Joe will comment on M133. On mission day  
7 while we were doing M092/171, it was still pretty hot down  
there. You know the problems we ran into with M092/171. When  
we finally discarded the restraint system completely and went  
free. I think that started that one back on the right road  
again.

#### 7.4 Mission Day 8

CONRAD We needed mission day 8. We enjoyed our day off. Starting  
about day 9, I think things were pretty organized. We had our

CONRAD  
(CONT'D)

EREP-2. I guess that was when I made the CDR, DS checklist card. I left the S190 window closed. The layout of the checklist was difficult to follow. It was hard to put that checklist together. It had all of these powerup and powerdown procedures as add-on items. We finally got smart and used the little time line up in the front of the book, which really was, in effect, a cue card. Like MO92/171, EVA prep cue cards, etcetera, really smooths out an operation up there. A cue card is an easy thing to handle. If you are familiar with the gear, and we were, and had the reminders on the cue cards, you would not miss anything. The cue card was the fast way to do an efficient operation up there. I think if the next guys just take an EREP cue card along based on the time line that is laid out in section 1 of the EREP Checklist, they will not have any trouble with EREP at all. We didn't after EREP-2. We were organized on that and on all those EREP passes. After that, we did not make any mistakes.

S183: I'm still not sure what happened on S183, whether that was a foul-up on the film canisters or what. That film slide was stuck in there. I returned the film slide, and it's taped to the film cassette, so they have that to analyze. I'm sure they will find out what had happened to their experiment. We ran S183 later in the flight with the other film canister, and it worked fine.



#### 7.5 Mission Days 9, 10, 11

CONRAD Mission days 9, 10, 11 I though were very nominal days. I don't remember making any mistakes. I think we had plenty of time to get the work done. Things were going pretty smoothly about then. I think the M487 people have all their comments on B channel. That little checklist worked very well.

WEITZ It was a well-written little checklist.

#### 7.6 Mission Days 12, 13, 14

CONRAD We began EVA procedures on mission days 13 and 14. We put a lot of time into putting that EVA gear together. I'm sure you can lay it out really easily on the ground. But putting that stuff together up there took a lot of thought, and I'm glad we took the time to do it right because the gear did work right and the procedures were well written. I think the guys did an outstanding job on that. That made the flight go really quickly for about 3 days. We were still doing regular work, and we were all talking about and thinking about putting together this EVA gear. We worked on it a couple of nights and then we got into EVA. The EVA, post and prep, really went well. We did have trouble with that coolant loop freeze-up; I'm still not sure what happened on that. We really need to sit down and talk to the systems people about that. I don't know whether we drove the valve full over by doing something wrong in the procedures, or what. I don't think so. We were

CONRAD (CONT'D) pretty good on the checklist and cue cards. All I remember is that whichever one of us put the coolant loop on, I think I had coolant flow and Joe didn't, or I didn't and Joe did. We put them on when we were supposed to, then we realized that one of us just wasn't getting the coolant flow. You are the one who fires them up and you do it by the checklist, but I think it did it by itself. I still don't understand why.

WEITZ There're a lot of oddities about that system. I'm not sure why you don't get an EVA warning when you fire the pumps.

CONRAD I did the systems housekeeping checkout for that and the EVA caution and warning worked on those pump loops just the way it was supposed to. From the time I completed those checks, it never worked right on either system after that. I still don't know why. However, doing the last EVA with all three of us on one loop, they thought I was probably stowing a little heat towards the end. The only reason was that I got hot doing the add-on tasks which are the most difficult ones to do. Putting that piece of JSC sail around that strut was a real Dick Gordon-type operation. I was really flailing away out there trying to hold on until Paul came down and put his feet on my shoulders. Then I could hold on with my legs and I finally got that sail cloth on. That's when they called and said I was storing heat. As far as doing the normal ATM/EVA, there were no heat loads involved in that. I changed the film.

## 7.7 Mission Day 15

CONRAD It took us almost all of day 15 to do what they asked us to do plus clean the place up, put it back into shape and pack up all the gear. The Marshall sail and all of its equipment is stowed over the film vault in a command module sleeping bag. If they want to use it, it is there and ready to go; it's all stowed in that one location. My personal observation after doing those two EVAs was if they want that sail up, it will go up with no problem. I don't think there is any need to talk about these missions days anymore. Do you, Paul?

WEITZ No, I'm looking over each one to see if there is anything to talk about. Isn't there something odd about S073?

CONRAD Yes, it got stuck. You had to use a shorting plug to get it back in.

WEITZ No, we had to pull it in; that didn't work. We had to pull it in and rap it on its side. If you remember, you got into the last hole, we bumped it up against the side, and whatever was wrong, that freed it.

WEITZ That's all in conversation with the ground; it's on B channel.

CONRAD That brings up one point. They have to get a faster response if they want troubleshooting done on gear. S073 is a good example. After we had the trouble, add 4 or 5 days and

CONRAD (CONT'D) ground recommended we put it out for Sl49 which is part of deactivation. We put it out and they came up with a lot of troubleshooting procedures they wanted us to do on it, which meant if they really wanted us to do it we would have had pull it back in again. It got a little frustrating to us on some of these troubleshooting procedures. If we had a problem we would ask for some clarification, and we would not hear from them for 4 or 5 days on some of the questions. I don't know why the response time was so long, but it was.

KERWIN I know two or three things that we got a little frustrated about. For one, the medical data on the Evening Status Report. Early in the flight you kept being dunned for it and it wasn't showing up for days.

CONRAD That was because the doctor was asking for it on private comm. I kept saying it was on B channel, and he kept saying we were not getting it on the B channel. I could not understand why, because I was putting it on there every night. I don't know whether the right people didn't know where to look for it or what. It was obvious that it took them a little while to get organized on B channel. It seemed that if it was something they really wanted off the B channel they would find it right away. If they really didn't, they would start asking us questions about it, and we would get a little frustrated

CONRAD  
(CONT'D)

we had already put answers on B channel as to what we had done. As a matter of fact, we would get the same question three times over a 9-day period, and we would answer it repeatedly.

WEITZ

Concerning the questions from Al Bean on EREP training: within the hour of getting them, I answered them on B channel. At least 3, and maybe closer to 4 or 5 days later the CAP COMM called, asking for the answers. That's double time; the system was not working.

CONRAD

Also, you need to take some notebooks along, to put teleprinter messages in, as a permanent file. When a reference was suddenly made to message 2315 Bravo that came up 5 days previously, we realized that we had better start keeping some of the records. Another problem was that they did all their messages by number. When they later referred to a message number, we would not have the least idea where to look for them. A different numbering system needs to be worked out. We have to have some way to categorize these things differently, so that when they refer to something you have an immediate clue of where to go and find it. That got to be a real problem, especially toward the end of the flight when they started referring to all those message numbers, and old checklist items. Then they would send up changes they call one-time changes done

CONRAD  
(CONT'D)

by pen and ink. Later, some checklist pages became so cluttered with changes that we got confused as to whether we should follow the original or the pen and ink changes. It's something that has never come up in the SIMs because we didn't run consistently. This is just something that needs to be worked out. Al should work it out with flight control to arrive at a better bookkeeping method and stowage method, that will keep track of those teleprinter messages that are important and might be referred to later.

## 8.0 CSM POWERUP AND WORKSHOP DEACTIVATION

CONRAD I could sum up the whole of section 8 by saying that the CSM and workshop deactivation went right by the checklist. I can't say enough about Gary Doerre's group on the both activation and deactivation. Those checklist really worked well, other than the fact that it took a little longer to handle transfers than we expected. I just think a little more time needs to be allotted to SL-3 to handle their film transfer and stowage. I hope the pictures come out. I got pictures of nine full disposal bags trailing out behind me, heading for the command module with film that went into nine different lockers. That was the way it was handled and it just took time but it was well organized. It just took a little longer than it did here on the ground. Getting that stuff to those lockers was wild though. That's the one place you get into trouble. Anytime you are handling a lot of little pieces of stuff, you really have to take your time or you will loose it. The way the circulation system was blowing air into the command module, if something got away from you and you didn't see it, it would quickly be up in the middle of the MDA. This was because the airflow was out the tunnel. The duct blew it down the side of the tunnel and ducted it in. There was a nice little flow down the bottom and right back out. If something got out in the middle of the command module, you would look out and that thing would be 15 feet down there in the MDA heading for the workshop.

CONRAD Stowage/transfers we have talked about, waste management filter replacement and OWS lighting check, there were no problems. Frozen food transfer, we didn't have any to transfer. General housekeeping went okay and we had a good handle on keeping things clean at that time. We kept the vehicle clean at all times. We never let it get away from us so that didn't present any problem. You got your interior SWS photography done okay.

WEITZ Yes, help on that was configuration stuff, like the Marshall sail stowage, S149, was getting that general stuff done the night before which I think was the way to do it. Then all you have to do on closeout day, when you have configured the panels, is just take the panel pictures and you are done.

CONRAD I hope the movies come out on suit donning and all that stuff. That's really slick up there. You get around just so much easier than down here on the ground. Suit donning and preparation and those procedures are well written. There was no problem with that.

CONRAD The urine collection went very well at the end too, I thought. The bags worked out. We shut the system down and used the cuffs, got the water system shut down, making up the extra drinks and everything. We had plenty of water, and drinks even though we



CONRAD  
(CONT'D)

had secured those systems for deactivation. We left the center couch under the CDR's couch until I got into the day 27 transfers. Having to get into lockers underneath there, it wasn't until day 27 that I took the center couch out from underneath the CDR's couch and re-installed it in the folded position up against the hatch. I recommend that they leave it the way we did. Leave the center couch under the CDR's couch for all orbital operations. There is no need to put it back. It still takes up a lot of room in the CM when you put it up against the hatch. It is really out of the way, under the CDR's couch. I think that is the way to leave it. The center couch installation is no problem.

CONRAD We did not have any trouble with the fecal bundle stuff either. That work out good. The over's worked well; all that stuffed worked right. It all stowed well; it all fit in the bags.

WEITZ Condensate system dump did not go as I expected it to. You can't just open that thing up and let it dump. If you believe the numbers that they gave us on waste tank pressure, you have to turn this thing off and on, off and on, or else you get the pressure up to a triple point. So that took longer than anticipated.

CONRAD Replacement of the solids trap and charcoal canister were nothing.

WEITZ Only when it came time to dump the charcoal canister.

CONRAD I think we could show them a way to tape up those urine separators and get rid of those things. They will go through all right. All you would need is to take two small food cans and tape them on either side of a urine separator and it will go right out the trash airlock. It won't hang up. They might not want to press the subject because they were nervous about it but you can obviously get rid of them all right. The charcoal canister, you could get rid of all right too. What we did was take gray tape off stowage cans and we just made bridges over the projections. We just made it a smooth thing over the projections with the gray tape. Then the next one just whistled right out of that trash airlock.

WEITZ Well, the major factor was: putting the EVA gloves and just keeping the pressure against it. It was forcing it to one side.

CONRAD The disposal of all trash bags was no sweat. Nobody used their trash bag for trash in the sleep department. As a matter of fact what we used those for, well at least I did, was that I

CONRAD  
(CONT'D)

used it to keep personal gear in. It was very convenient to keep music tapes and odds and ends, pencils, and so forth in the trash bags. The only trash bags we used were in the wardroom and in the waste management department. We didn't use them in any other locations. We did not use them in the upper experiments department and we didn't use them out in lower experiments compartment.

You and I deactivated the cat ion cartridge. I read you the procedures, that was no problem putting the iodine in it. Closeout of the wardroom water system was no problem. Deactivation of the waste management compartment water system was no problem. On the G&N/SCS powerup, there was nothing to that. CM/SM RCS was nothing. Terminate power transfer went right by the checklist.

CONRAD Realign was nothing, GDC align was nothing - right by the checklist. H<sub>2</sub>O/waste/radiator activation - we had one little problem with the secondary loop heaters. They had just a couple of simple changes to the checklist which handled that. The transfer of the urine samples was no big task; condensate blanket is back where it belongs in the MDA. We didn't have an IMSS, so we stowed in two food overcans and tied that down by A-9. That worked okay. S190 window protectors stowage, that's

CONRAD nothing. SOP docking load straps are all where they belong.  
(CONT'D) So far as water system closeout, we closed it out. Configuration OWS panels, was per checklist. Did they have some real-time changes for that?

WEITZ No, I made real-time changes on my own in order to keep the heat exchanger fans running until the last minute.

CONRAD Yes, that's correct.

WEITZ That was because I knew as soon we shut them down we were going to start getting hot again.

CONRAD We really would start to get hot in a hurry at that high Beta angle. MDA closeout went well. Suit donning is tight time line, but we had enough experience to handle it. We ran about 15 minutes ahead. We didn't have a lot of extra time, and if we'd run into any major problems, we wouldn't have made it. But we were just holding our own on that one. I was surprised. Nobody was rushed, but everytime we thought we were going to get ahead of schedule on something, we found we were running just about 15 minutes ahead all morning.

WEITZ Yes, 15 to 20 minutes, not much more than that.

CONRAD ECS fired up in the command module without problems. The EMS entry tests were good; it was good all the way. CM final stowage check was poorly done in the book. That was the one thing that was really not very good. We need to organize that one better. That took us a little more time than was necessary. OWS/lock final closeout was nothing.

CONRAD Umbilical disconnect: by the time you've transferred to internal power, all you're doing is killing the comm. Into the workshop, and taking the umbilicals out. That was nothing. Joe and I did that. Probe and drogue transfer went right as expected; we had room to handle everything. Installation of the probe and drogue went as advertised as did MDA egress. Suit integrity check went well, just like running the altitude chamber one or any of the others we did in flight. Docking latch release: we ran a check. We had valid check on that with latches 3 and 7. We got our barber poles. We took our time on that. Joe unlocked them and I checked them off, while he reverified that all 12 of them were in the right position and unlocked, and put the hatch in. The hatch integrity check takes a fair amount of time, 10 to 15 minutes. That was it.

WEITZ We happily undocked from the MDA.



## 9.0 SEPARATION AND ENTRY

CONRAD Well, we got exactly what we were supposed to get. We got 0.4 foot per second when we undocked. And of course they held us. I dropped down the crack on the checklist. We were waiting and waiting and we were behind. When they said "undock," I undocked and I forgot to turn on the camera, unfortunately. That was right where I was when they told us to hold undocking. Let me tell you about the flyaround. Because we flew up over the top of the vehicle, I was beginning to get a little bit behind on the flyaround and I started thrusting towards the vehicle and minus-Z thrusting. That doesn't aim any thrusters at the workshop. But the attitude control forward-firing thrusters go a long way out. We got over the top of the vehicle, about a 45 degree angle in front of the dipole antennas which were the things farthest away from me. When I would fire min impulse to hold attitude and the right velocity, it would rattle the antennas and rattle the ATM panel so I know I was spraying them. I just didn't force it, and we did about 90 degrees of the flyaround correctly. And after that I just started letting it drift further and further away.

CONRAD We got all the good pictures that we needed, and we just wound up not doing the complete flyaround. When we got around

CONRAD  
(CONT'D)

to about 180 degrees, we were about 700 feet away from it, I guess, and I just couldn't see feeding away the fuel and drenching that thing with any more propellant than I had to while I was over the top of it. We got good still photography of it. It really stands out against that dark sky, the black background with no Earth in it, where we had undocked. Okay, we did the Sep burn while looking at the OWS. That was the one thing that I never did understand. They kept saying the OWS should be between me and the earth, and that never made sense to me and we discussed it. Finally when we burned, we were below it and behind it. To me that was perfectly safe because that said I would start moving out in front of it and lower away from it. I was happy with that. We never saw her again after that except for one little glimmer.

WEITZ I think it was after SPS-2.

CONRAD Yes. It was after deorbit burn. Then you've got a lot of time. As a matter of fact, who started getting out of his suit when?

WEITZ Joe started getting out of his suit while we were still docked.

CONRAD We assumed that we had all electrical checks passed for undocking and all the latches undone. We saw no reason to stay in the suits. Joe got out of his suit before we ever undocked. That gave us one long time period of nothing. We really cooled



CONRAD  
(CONT'D)

our heels for a long time on reentry. You never get good checks like the burn pad horizon checks in the simulator. The horizon checks and everything were right on the money. Sextant star checks were right on the money; we had a good platform. SPS burned as advertised. We had a good GDC. Everything was normal: the gimbal drive checks, the shaping burn, the suit integrity check, the docking ring check. All IMU aligns, GDC aligns were right per checklist. The evaporator came on line right when it was supposed to. The only thing on the DAC was we didn't change settings for the parachutes. Were we supposed to?

WEITZ Yes.

CONRAD So what have we got, overexposed or underexposed?

WEITZ Underexposed.

CONRAD Underexposed. You know, if we tell them that, they can push that section of film.

WEITZ If they can find it.

CONRAD Well, it's in one magazine labelled "reentry and chutes."

WEITZ That's what I mean. They'd have to find it to push part of the film.

CONRAD Yes. I might call John Holland on that.

WEITZ It wouldn't be a bad idea. I've been thinking about that.

CONRAD I might do that. You can talk about the rest of these just as well as I can. It all went perfect.

WEITZ Yes. Those things I gave you to give to George. Tell him not to open them, to call me and I'll talk to him about it. Set up DAC, we just talked about. CSM RCS preheat. Thruster 9 Bravo needed preheat. We put it on for 5 minutes, I'd say. It came on up to the required voltage and then overshot a little bit. All it took was one shot of preheat. Final stowage - Pete mentioned before, went smoothly per checklist, except for the final check. It's really hard to tell whether you've really got everything in there you're supposed to have. Pyro batteries were good. RCS deactivation went all right. You can really hear it when you activate that, too. You can hear all those valves opening. And they don't all go at once. You can hear them rippling all the way around the command module. External Delta-V separation checklist. We went right down it. Burn attitude and star check were good. TVC check was good. Deorbit burn nominal. Entry parameters were good. The sounds of the RCS were not unexpected. Don't really know what they are looking for there. You can see that thing warming up there.

WEITZ  
(CONT'D)

Communications blackout - I never noticed it. You either had people talking to you or not. And it's a moot point whether you have blackout or not. Ionization first showed up - We were in the excessive daylight all the way. We almost got a sunset and I thought we were going to wind up with part of it in darkness. We wound up going almost to sunset, and then we'd come back into daylight again. But even at that, the computer g-level was between 0 bouncing and 0.01g.

WEITZ

I noticed this pink, rosy glow all around the whole vehicle. You get that first, right off the bat, which surprised me. I didn't think it would come in that early. And that ionization wake, I was not ready for that. That is dense and it is bright. I couldn't look at it. I had sunglasses on and it was so bright I could not look at it. It looked like the biggest, brightest neon light in the world looking down there. Plus a whole lot of flame coming around that thing. I thought just cinders and sparks and pieces would come off that. But you look out that side window and there's a solid sheet of flame out the side windows. The control modes, you've got to talk to Pete about that. Visual sightings and oscillations. I did not see the docking ring and the probe go. Joe, from the center couch, saw a shadow cross inside the command module; so it must have passed between us and the Sun some place. I did

WEITZ  
(CONT'D)

see the fairing over the top of the chutes, the apex cover, go and the drogue chutes came out right on time. I didn't see the mortars go but I saw the drogues come out, the one drogue. The one on my side had a little hole in it. It looked like it had one of the ribbons torn up near the top. It wasn't very big; it never got any bigger.

QUERY

Have you got the Reentry Checklist to help you with settings that was taken where it should have been taken? Here you go.

CONRAD

Okay. Paul covered the drogues. The drogues were right on time, and we came right on down. At 17,000 feet, we had the cabin start to fill, and right at 10,000 we had main deploy; we had three good mains. I couldn't see anything wrong with them. I think somebody mentioned one little tear in one, but they got all the mains back, so they'll be able to tell that. They got the mains and the apex cover back. We didn't get the drogues back. Did he cover communications blackout? We did hear Dick through the ARIA and I gather he got us okay one time. I answered him every time he called. We had good comm with recovery. We're very, very stable on the chutes; much more stable than we were on Apollo 12. On Apollo 12, we seemed to have that rotation that you get every once in a while. This time, we had no rotation; very, very stable on the chutes.

## 10.0 LANDING AND RECOVERY

CONRAD It was an easy splashdown. We must have hit just exactly right because it was very gentle. Again, we hit like a ton of bricks in 12, and I thought it was a very gentle impact. We had no problem right immediately after impact. I called for the main chute breakers and hit the release. We remained stable I, went right into the postlanding checklist, and the vehicle was cool. We got the PLV running right away. And it was cool enough that we didn't bother to get the PLV ducts out or anything. The choppers were right there. The swimmers were in the water. And we went right down through the checklist and wound up in the proper configuration for being hoisted aboard. And I guess I ought to let Joe talk about getting seasick, because that's what happened to him. Joe whistled right into the LEB. That was a mistake. The second mistake was taking the cherry drink, which he said hit his stomach like a ton of bricks. By the time he realized he was getting seasick, it was too late. And he got back in the couch and he looked bad, from my point of view, from being seasick. I wasn't concerned about him any other way. We all took our pulses and so forth. They were all fine. I asked them whether they wanted the uprighting bags because they were already rigging the collar, and recovery asked for them. I asked them

CONRAD at the end of the 10-minute cooldown because we were stable I,  
(CONT'D) and you don't put them out until you've had 10 minutes of  
cooldown. They said they wanted the, so we inflated them for  
the proper amount of time. They all three inflated all right.

CONRAD I believe, other than Joe being seasick, we were all comfortable  
in the command module. We each had enough time. Paul and  
I both got down in the LEB and stood up in the tunnel, just  
to test our sea legs a little bit, to see how we were feeling.  
Other than the normal lead feeling in the legs, we were in  
pretty good shape. I think we all were very aware of having  
a gravity vector back on us again. And I would like to  
straighten out this dizziness business. I never experienced  
any dizziness at any time from splashdown through the  
recovery operation or afterwards in the SMLs. I was very  
much aware of the gravity vector. In the beginning it gave  
me a feeling of vertigo when I made head movements, but no  
nystagmus or dizziness. L and R communications worked well.  
We were completely aware of what recovery was doing at all  
times. When it came to hoisting us onboard, from the  
commander's couch you can see the hoist, you could see the  
rope, you could tell when the crank attached. You could see  
exactly what they were doing while hoisting you aboard.

CONRAD  
(CONT'D)

The recovery procedures were all worked out as far as the other people were concerned. I thought it was a very smooth, very fast pickup. And that's really about it for recovery.





## 11.0 COMMAND MODULE SYSTEMS OPERATIONS

### 11.1 Guidance and Navigation

CONRAD ISS modes all worked as advertised. I saw no anomalies in the systems. We did have a little drift in one gyro, which the ground updated. I know they did it during rendezvous, and they did it again during reentry; but that's standard to do update gyro drift. The computer worked fine with the exception of a couple of 405s doing alignments when there were no stars available, which is normal alarm. I saw no anomalies in G&N controls and displays. All our checklists, procedural data, P20s, VERB 49 maneuvers, 82s, 83s, and everything worked as advertised. The command module SPS TVC thrusting went pretty well. We had much smaller residuals during the rendezvous burns than we did during the reentry burns. As I remember, the reentry burns, both times I shut down and they were long burns, were shut down with about a foot per second remaining, plus-X to go, which is a little unusual for this system. It usually cuts off a little bit better than that. The burns were no problem, but I do remember that they were a little bit larger than our original burn shutdowns, especially on our long NCl and 2 burns.

### 11.2 Stabilization and Control System

CONRAD The attitude control system worked fine. Thrust vector control system worked fine. Displays and controls functioned normally,

CONRAD  
(CONT'D)

except the service module RCS TEMP B went off-scale high, and we had to inhibit that on the 201 panel. Otherwise, the displays and controls functioned normally.

### 11.3 Service Propulsion System

CONRAD

Everything was normal with the Delta-V thrust switches. Engine thrust vector alignment was good. I didn't notice much steering; the trim settings were obviously good. Delta-V remaining counter worked fine. Rocker switch. We had a 1 foot per second bias in our EMS. It was a plus bias on the check, but all I did was hold, turn it on EMS DELTA-V counter for 30 seconds rather than 1 minute to minimize the effects of that bias. We didn't use the direct ullage button; didn't use the thrust on button. SPS  $P_c$  indicator worked fine. PUGS was inoperative. One thrill that Houston failed to notify us about was when our SPS oxidizer, SPS pressure low warning came on right at the end of an EREP pass. We were going over the hill for about 30 minutes. It had been coming on for a long time, and because the tank was getting cold, the pressure was dropping. Houston didn't tell us about it, and I thought we had an oxidizer leak. That would have been a "jump in the command module and come home" situation. Houston could have stalled that little shot of adrenalin by giving us a clue the day before

CONRAD  
(CONT'D)

to let us know that it would eventually trip. Once we got the word as to what had happened, we disabled that caution and warning parameter. Add that to the checklist for powerup prior to reentry.

#### 11.4 Reaction Control System

CONRAD On the SM/RCS I guess quad A ran hot due to thermal control, and we have plenty of conversation on that from the EVA. I looked it over at Houston's request and mentioned some blistered paint. I think they have plenty of description on that. The command module RCS system was fine. I think we mentioned that we had to use the RCS heaters because of one RCS temp being cold. It was just barely out-of-spec cold. I checked those several times during the flight and they were very steady. One stayed cold the whole flight.

#### 11.5 Electrical Power System

CONRAD Absolutely no problems on the fuel cells, batteries, bat chargers, or DC/AC monitoring group. We had no inverter problems; we never had any inverter warnings. Main bus tie switches worked fine. At the very beginning of the mission, the MAIN A dropped to 25 volts and triggered the alarm. I think the ground has traced it to the secondary coolant loop heater back in the service module. It looked like we had a solder ball on

CONRAD  
(CONT'D)

a switch and it was binding the switches in the command module. Nonessential bus switches: Nothing there. G&N power switch: Nothing there. Cryogenics worked real fine. Cabin lighting and controls worked all right. Split bus operations were fine. We tied busses, MAIN A and MAIN B, after our MAIN A under voltage and they remained tied for nearly all the mission. We had them tied together per Houston's request. No gimbal motor transients.

#### 11.6 Environmental Control System

CONRAD

Oxygen system and cabin pressure worked exactly as advertised without problems. The cryogenic bleed off worked fine. We left all the valves and orifices in the proper stowage position. That's documented. Cabin atmosphere was fine in the command module, both on its own system and being circulated by the OWS system. Water supply system worked fine. Water glycol, the only condensate I noticed was down where the glycol lines come in from the radiators, just at the lower left-hand side, back of the commander's couch. Every once in a while I would wipe it up. Finally it froze and became half water and half ice but it didn't cause any problems. Suit circuit worked fine and it passed all the suit circuit checks. We had a good tight circuit. Eating systems were good. Waste management system: We had to dump urine one time. I guess we all knew we were

CONRAD  
(CONT'D)

going to have to do that. We had to drain our UCLAs one time during the launch/rendezvous phase because we stayed suited. The first night I had to use the fecal bag and that all worked fine. We stowed it in the black waste container and used that to transfer all the stuff down to the OWS. CO<sub>2</sub> absorbers worked fine.

#### 11.7 Telecommunications

CONRAD Telecommunications worked fine. The monitoring was good. Individual audio center controls: We had no problems with any of those. VHF operation was good. Operation of the S-band: We didn't have high-gain antenna. Tape recorders: As far as I know, they worked all right. We used the box circuitry for PREP; that worked fine. We didn't use the USB emergency key. DSE worked okay. You know our problem with controls. The tunnel was all right. The couch struts were fine. The side and forward hatches worked okay.



## 12.0 SATURN WORKSHOP SYSTEMS OPERATIONS

### 12.1 Communications Systems

CONRAD Communications, Audio: We had a lot of trouble down in the workshop with feedback. We really were limited to one box operation, except for the bedrooms comm boxes, which could be left on. They didn't talk, but the wardroom comm box was the one we used most of the time. If any of the comm boxes were on in the medical experiments area, we had tremendous feedback, plus we had feedback with the SAL comm box right above the wardroom. It was a constant problem having to go up and down. Somebody would invariably leave the upper box on A channel and we would have a horrible squealing sound. The VHF ranging worked fine for rendezvous from the workshop point-of-view. It worked fine in the command module. As far as TM, I wouldn't know anything about them. We changed one tape recorder for them that went out of order. We also had one television camera that stopped operating. We brought that back. We're going to find out what's wrong with them. The teleprinter worked fine; we used only four or five rolls of teleprinter paper. They have enough teleprinter paper left up there to write the Encyclopedia Britannica about five times. Channel B: I gather that you could decipher B channel. The tape recorder dump worked okay. I have no idea how you did on data and experiments recorders.

## 12.2 Thruster Attitude Control System (TACS)

TACS system: It worked fine when it was needed. I was surprised that you could see the TACS fire. It puts out a white cloud every time it fires. You can also hear it fire when you're down in the workshop. It sounds like somebody fired a shotgun outside every time it goes off. It's not that loud, but it has that kind of sound. We got that confused with some other sounds. There's enough loose metal and enough oilcan-type metal on the outside of the workshop that it changed as our Beta angle changed. Everytime we went into dark it would crinkle and pop and crackle, and it took us awhile to get used to that; I got that confused with the TACS firing. Every time we needed to test performance or needed the TACS, it worked fine.

## 12.3 Environmental Control System

I can't say enough for the pressurization and gas distribution system. We had excellent environment in there at all times. The purge and venting went all right. We really didn't have anything to do with that, though  $N_2$  stowage, as far as I know, was all right.  $O_2$  and  $N_2$  distribution went fine; we never went out of tolerance on that. We never had any trouble with it. Only late in the flight were we venting our cryo oxygen.



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We built the total cluster pressure up to about 5.4. Our PPO<sub>2</sub> went up. That all came from pump and command module oxygen in the cryo tank. Thermal control loops: we had a lot of trouble with them. As you know, we had trouble with both coolant loops, but really the management of those coolant loops was pretty much out of our hands. The ground handled that most of the time and occasionally we acted as switch thrower for them and ran a few tests for them, and that was about it. Electrical heaters: we, of course, didn't use them in the beginning. After we got electrical power back, and as we got to a relatively cool vehicle, we started using the heaters up in the MDA. I say, "relatively cool vehicle" down in the workshop. When the workshop temperatures got down around 72, we started using the heaters up in the MDA, bringing the MDA temperatures up. But as the temperatures started back up down below, we stopped using the electrical heaters in the MDA. The MDA was fairly cold; it ran about 60 to 62 degrees most of the time. There were no obvious hot or cold spots, particularly in the MDA. You could very well figure out where the sail was covering the workshop by putting your hands on the wall down in the workshop. It would get quite hot in places where the Sun was shining on it and where the sail wasn't, and be quite cool 2 inches away. You could really draw a line; you could almost

CONRAD  
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draw the shadow by putting your hand on the wall. I thought that, all things considered, the thermal control was excellent. On the radiation surveys that we ran, we found the radiation to be very low in the vehicle. The ventilation and atmospheric cooling were good. We found out that it really helped keep the workshop cool by running that portable fan in the workshop hatch and directing the hot air onto the OWS heat exchanger package. That would give us about 2 degrees lower temperature when we were running that. The moisture removal was excellent. The biggest thing that impressed me was the lack of condensation moisture anywhere in the vehicle. Even in the urine separators, there was very little tissue to wipe it in the morning was sufficient in the urine separators. No place else did we find any condensation in the MDA or in the workshop. I was really surprised. CO<sub>2</sub> removal was good. Odor removal was excellent. Contamination control was excellent in that the circulation system picked up anything that was loose and then it eventually wound up on the screens, either in the workshop or in the MDA, including the things that one of us lost. If we lost something, we knew sooner or later it would turn up on the screen, especially in the workshop. We used to check the workshop screen once a day and return everybody's gear that they had lost. It would always wind up on EVA/IVA. The open loop O<sub>2</sub> system worked fine. The cooling was adequate even with all three of us on one loop.

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The hatch operation was smooth and easy. The refrigeration worked fine for us. I gather they have their problems ironed out now. I understand the loops are all back in normal operations again. I think Freda told me that they got the valves unstuck, now the Beta angle's gone back to where it should be.

#### 12.4 Crew Systems

CONRAD

Restraints and mobility aids: I think that we could skip all of this. It is thoroughly commented on by all of us in the 487 B channel, and it's all identified in there, including: stowage, clothes, food quarters, trash, food management, waste management.

#### 12.5 Instrumentation Systems

The controls in the vehicle were basically the systems that we knew we had to manage. We had plenty of controls with which to manage them. Those that the ground were supposed to manage, like refrigeration, we didn't pay a bit of attention to. The only thing I'd say in the way of control that's bad is that star tracker. We were forever having to lock that up for the ground. I guess it causes a lot of trouble with managing the vehicle while we're not there, not having control of that star tracker. We should have had a set of horizon sensors on the vehicle to give a second reference to it for the solar inertial operations.

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Power systems worked fine. When we got the solar panel out, the PCGs just performed exactly as advertised. I didn't have any problems with the PCM system as far as I know. Any time we used the experiment recorder, it recorded the telemetry just fine. They said that about the recording system and the transmission system.

#### 12.6 Digital Command System

Real-time command worked okay. We didn't have any problem with the ground; they never interfered. I think we had that worked out satisfactorily, and they told us when they wanted to update, when they were updating, and when they wanted dump. We had very little conflicts with that. It was something we worried about early in the game and I think we took care of that by just talking to one another before we went. Teleprinter messages worked well, and I already made the comment about managing those teleprinter messages. That's something that Al is going to have to work out with FOD. They need a better system than we had.

#### 12.7 Caution and Warning System (C&W)

Caution and warning: The CSM/SWS operation worked fine when we had a few warnings like SPS PRESS LOW; it sure lit off the warning in the SWS. It was properly identified in the CSM,

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so that worked real well. We had a couple of spurious fire alarms in the beginning that used a little of our adrenalin. Especially the one in the OWS heat exchanger package, which is the one place we could really have a serious fire. That was the one that went off twice. After the vehicle started to cool down, or maybe the system just got on the line for a while, we didn't have anymore spurious fire alarms. We had another one down in the crew quarters early in the game, too. I think we had three spurious fire alarms. We got in a good test on a rapid Delta-P whenever we repressed the airlock on EVAs. That always caused a rapid Delta-P. You're aware of the one where we had to secure the fire system in the aft lock for EVA because they were getting something in there that would cause a rapid Delta-P if we'd opened the hatch. I thought the rest of the controls and displays worked great throughout. We did have one problem in the beginning. I guess we got a little careless working around that STS section and we inadvertently turned off a fair amount of switches in the beginning, mostly with our feet. Those guards on the STS panel really wouldn't keep your toe from getting in circuit breaker panels or something. After we got a little better about managing our feet, we didn't turn too many of those things off.

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## 12.8 Electrical Power System

I can't say enough for the solar arrays, although the CBRMs, the total caution and warning system on that, leaves a lot to be desired. I guess both us and the ground worried quite a bit about that system as we went along. The ground probably got very excited on our EREP pass, when we almost lost all the batteries with the automatic cutoff. The PCG group worked great; we didn't have any trouble with them at all after we got the solar panel out. We played with the voltage regulation per ground instructions. They did the management and all we did was turn the knobs for them. It seemed to me that we had plenty of power and everything worked fine after we got that solar panel out. Power transfers went smooth per checklist. It was no problem balancing busses for power transfer. It all went as expected. The controls and displays were plenty adequate to do that, both at the SWS and at the CSM.

### 13.0 PRE- AND POST-FLIGHT EXPERIMENTS

KERWIN These are comments on the pre- and post-flight experiments with respect to: time required, physical discomfort, personnel availability, and ease of scheduling. MO78, the bone mineral experiment, went very well. They stuck to their time line. The gear worked well and there was no problem at all. I didn't think the time required or the physical discomfort was excessive. As far as M111 through M115 went, my hat's off to Carter Alexander and those guys who did an excellent job on that. The new method of using the tube went very well and it was run extremely professionally. Technically, the individuals who managed that effort were extremely competent. They did the job with a minimum of discomfort and a minimum of time. They were consistent with their schedules and were thoroughly professional in every respect. I still have some personal doubts, particularly in the post-flight period, as to whether the amounts of blood drawn are affecting in any way the crew's return to normal. We don't have the data to evaluate that accurately, but I know they are drawing a lot of blood. I know that we have some blood deficient and are trying to build them back up, and it's something to be considered. I don't have any other comments on the M110 series of experiments.





## 14.0 INFLIGHT EXPERIMENTS

### 14.1 Medical Experiments

KERWIN MO71 and MO73, preflight baseline data. The waste collection arrangements were very good preflight, since they were in combination with the quarantine. We didn't have to fool around with picking things up at home. That made it easier for us, but I thought they had the system down to something that was very easy to live with. The key point was that there were sufficient bottles and boxes that were properly labeled and all we had to do was fill in the time. I'm trying to think whether there are any improvements that we might recommend in the preflight phase. In the collection of waste I don't guess there are. The time required was reasonable. The physical discomfort was essentially nonexistent. Facility and personnel availability was excellent and we did a good job. That applies to urine and feces, but not to vomit, because I don't think any of us did.

The food is a similar story. It's a little bit different, I guess, because the food business goes back all the way to menu selection. We all had some problems in menu selection in that the individual foods kept changing between lots and quality and taste after we had sampled them for the last time.

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Hopefully, this is all water over the dam. I don't think we'll have another program with quite this kind of a food system. I believe we will in future programs go pretty much to cafeteria-style eating in flight, with only the barest guidelines as to what the individual must or must not eat. As a matter of fact, hopefully, we'll go to the plainer system that we originally were going to use on Skylab; that is, a system where the categories of foods were defined and the foods within a category were interchangeable, where you had an entree to eat in an evening meal, and it actually could be beef, pork, hotdogs, hamburgers, and so on. Then you just picked out one of them and were assured that you were getting the minimum requirements, and the system was flexible enough to handle moderate changes in the nutrient intake. Going with a diet that's fixed and very rigid does give an individual problems. I think we all found that there were foods that we did pick that were not palatable to us when taken repeatedly, partly because we just didn't eat that kind of food that often, partly because the food didn't taste as good as it should. Everybody has their own favorites or unfavorites. Personally I can't stand the bread.

WEITZ

First off, the bread was not the bread we were given for sample selections.

KERWIN      That's right, I still don't understand that. We sampled some bread that was really very good. We said, "Yes, that's good bread, let's have it," and we all arranged our menus to include that bread rather frequently. When we found that the canned bread we had was really very much different and very much worse tasting than the bread we'd sampled, it was too late to do anything about it, except in many cases to not eat the bread and suffer the consequences, in terms of pills. That's a general statement as to menu selection. The answer to it, if we ever had to do something like that in the future, would be to have the crew select the foods that are going to be eaten in flight as near possible, to have those foods then prepared so that the taste didn't change. Have the crew sample the menus in sequence, as we did, but with the real food.

In terms of the mechanics of administering the diet. I thought that was handled very well preflight. The people who prepared the food were sufficiently flexible as to when and where they served. They prepared it as well as such food could be prepared. They integrated fresh foods into our diets, I thought rather well, extremely well. With the limitations of the MO71 diet, they made it as palatable and as convenient as they could possibly have made it.

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Logging preflight and postflight was rather easy to do, because most of the burden was taken off us by the food people. That's as it should be. They did an outstanding job. Inflight collection of urine and feces. We were, of course, surprised and pleased that the inflight urine collection system worked very well. I personally had no mechanical hardware difficulties whatsoever with my system. The collection of urine was simple and effective. The measurement and sampling of it was a time block of about 25 minutes at the beginning and I worked that down to less than 20 minutes, possibly as low as 15 minutes per day near the end of the mission, as I became familiar with the routine. Volume measurement, the sampling and the placing of the urine in the freezer were relatively painless tasks.

Fecal collection again worked well most of the time. I think the basic method of using an airflow system for defecation seems to be feasible. I think that the details of the system could be improved. Possibly a greater airflow is required to assure separation of different consistency in the feces. The system basically worked much better than we expected. The time for defecation under these circumstances was very firm, probably a minimum of 20 to a maximum of 45 minutes, depending

KERWIN (CONT'D) on how much mess you had to clean up. Thereafter, the mass measurement, once we started doing it, after we changed out the electronics module in the head, was a fairly simple operation mechanically to do and log. Near the end of the mission the compartment holding that device became somewhat smelly. We biocided it before we left.

WEITZ It did not smell when I weighed my last sample.

KERWIN I had biocided it by that time already. There's obviously a potential for a lot of contamination due to spills, etc. When I biocided it, I was impressed by the fact that the device and the membrane that held the feces were not designed to be thoroughly cleaned. There were too many niches and crannies and holes. We were fortunate in that we didn't have a massive spill in that compartment. If we had, it would be useless.

WEITZ The sample mass measurement device dimensions were barely large enough to handle the fecal bag. It was a pain in the neck trying to get the thing stashed securely in there, get it down, stretched over and lashed in. It should have been at least 25 percent larger to handle the bag.

KERWIN The fecal bags tended to smell a little bit even after they came out of the oven dry. There was a unique odor. Basically, drying the feces is a reasonable way to go if you have to bring them home. In the future, I would hope that we would be able to dispose of the feces conveniently without bringing them home, except for special requirements. Logging became a matter of routine and it didn't bug us; it probably took 10 minutes a day to do.

WEITZ What was it, about 10 days into the flight, when I had to change that filter?

KERWIN It was about halfway through, I thought, might have been day 10 or day 12.

WEITZ Yes, somewhere in there. Which resulted in a changing of the urine filter in drawer 3. This was evidently about a day and a half sooner on a late evening with a fairly high flow rate, which exceeded the capability of the urine device to handle, which I attributed at that point to just that. Now, with hindsight and having tested it subsequently with similar flow rates, the system can, in fact, handle that. I don't know what to say, except that, after we changed the filter, the system worked fine. There was no obvious reason for the filter to be

WEITZ  
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clogged. By visual inspection, you couldn't see anything wrong with it. We disposed of it, put the new filter in and the whole system worked fine from then on. On fecal collection, my only comment would be that I would like to see a more pliable sealing device between the unit and the man. In other words, you had to get in the right attitude and you had to exert a considerable force in the proper direction to make a good seal around the edges of the seat. I would like to see a little more pliable and flexible so that you didn't have to direct a great deal of your attention to maintaining contact.

The largest single irritating factor in the food inflight was the membrane across the top of the thermostabilized food. We wound up heating the thermostabilized food in the can with the metal lid secure to avoid any ruptures that may occur during the heating. On the meats, in particular, when you take the metal lid off, the diaphragm would be tight as a drum. You could actually almost play a tune on it. It felt like metal, it was so tight. You then came up with the problem of piercing this membrane to relieve the pressure inside it, which we wound up doing by covering the whole lid with a wipe, a couple of tissues, which resulted in the loss - not significant, but enough to be messy amount - of the fluid from within the can.

WETTZ  
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Then came the onerous task of removing this stinking membrane from the can, which you wound up cutting around the edge or trying to, but it always seemed that you got to that last half inch or so trying to separate the membrane from the edge of the can and the juices just collected on it. They would wind up being a fairly large glob where the membrane connected to the can. When you separated it from the can, you flipped juice all over the place, beef juice, peach juice, whatever it was. Everybody complained about it. It is not the way to go, unless you make that membrane such that it is much easier to remove some way.

KERWIN

I think a key point in there is that we did want to remove the membrane more or less completely. We found that once we'd done that, the food was rather easy to eat in most cases. The only problem I remember having was with the big chunks of meat. As you cut them, preparatory to eating them bite by bite, the chunks that were left over would tend to float out of the can, if you weren't careful. I'm trying to make a positive design point, that you can eat food from cans with the whole top open in zero g. I thought preflight that the way to go might be just to cut a slit or an X in the membrane, and ease the food out through that.



WEITZ        The X or slit method didn't work. It would have been worse, because it flipped liquid every time you took a spoonful. The edges of the membrane where you cut it would spawn droplets outward. That's why we would remove the whole membrane.

KERWIN      The foods were very edible. Any thing that stays together the least amount is easy to eat that way in zero g. It's a nice way to go. We used that method with the rehydratable foods also by cutting large sections of the top of those inner bags off so that we had free access to the food.

WEITZ      I cut as much off as I could.

KERWIN      As much as you can. You kind of squeeze it down sometimes and you get a little bit of food in the cone that you cut off the top, but it's not a problem. The problem with rehydratables is primarily related to air in the water, whether it be air or steam. It's worse with hot water, so there's probably a certain amount of water vapor involved. It increases the volume of the bag so much when you rehydrate it that in many cases you couldn't get the tray lid back on. That meant that you could not rehydrate the food and then heat it, and let it sit in preparation for the next meal. That's unfortunate because many of those foods require long rehydration times to make them really palatable, things like the spaghetti, the macaroni.

WEITZ All the vegetables.

KERWIN All the vegetables, yes. Asparagus, beans, corn - you can't rehydrate those things. Even the potatoes, you'd wind up with layers of powdered potato around the bottom corners of the can that you really couldn't get with simple mashing, particularly because it's hard to mash those things when they're taut with gas. They'd balloon up like little Chinese pyramids if you'd get the water in them. That's a packaging problem that should be resolved for the future. Another packaging problem was that the spoonbowl packs did not work out well. When you rehydrate those and then knead them a little bit to mix them, the fluid tended to seep through the zipper opening into the place where you had to cut. When you cut, you immediately had a mess. You'd have messy scissors and messy fingers and messy napkins and whatever else. A mess and some loss of food were unavoidable. We were disappointed in the spoonbowl packs. I think that anything but a very thin soup would probably have been edible out of an open top bowl, if you devise a better method than the membrane to give access to them.

The drinks. We had some leaks along seams, in both drinks and rehydratables. I had a couple of nozzle failures in the drinks where the nozzle would stick open and spurt drink out as the

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container tended to contract from its built-in elasticity.

The other problem I had with the drinks was that little insert that you had to put into the nozzle and then push forward with your teeth to get the drink out. When you let go of that thing, you were supposed to pull back on it to close the flap again. That was hard to do. You had to pull back just the right amount to close the flap, but not too much or it would come completely out and then you'd have to reset it again. The upshot of it was that you'd either let go with your teeth and the drink would keep on coming out because you hadn't pulled it far enough, or you'd get air into the drink. Then the next mouthful would be 90 percent air and 10 percent drink. We wound up swallowing a lot of air in the drinks. We need a better drink container.

The other outstanding problem that I remember - the crackers are terribly crummy and you get a lot of dry crumbs around. They tend to break when you take them out of the package and they crumble. The biscuits, yes. Those are mechanical problems.

Palatability - the outstanding poor performers were the vegetables. I'm trying to think of an exception. The only exception we had were the tomatoes, which were pretty good. The rehydratable vegetables were uniformly crummy. They were bad

KERWIN  
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tasting, they were bad in texture, part of that was a rehydration problem, part of it was poor selection. The asparagus tended to be very chewy.

Food in general tends to be more tasteless up there than it is on the ground. And it's the same food. We all noticed post-flight, that the food tastes better and has more taste, even though it's from the same lot and out of the same can, than it does in flight. That says that the food should be properly seasoned and should have good definite taste to it before you ever send it up. This food didn't have much taste, and what it did seemed to be wrong. I had one other vegetable that tasted pretty good to me and that was sweet potatoes. I don't think the other guys had any. Since we were on a standard diet that we were pretty well forced to consume, we wound up at almost every meal with one or two items that we had to hold our nose and fight our way through to get to those items that were good, like the frozen foods, and the drinks. That's something that definitely ought to be fixed. I would certainly like to see for the last Skylab mission considerable flexibility on the part of the crew in selecting some of the things like vegetables out of overage. I think that acceptance of deviations from rigid mineral tolerances, we ought to be able to

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make those by that time. We ought simply to assure that the crew is getting enough of the essential nutrients, including vitamins, in a day's meal, and that the people on the ground keep track of that. One mistake that all of us, including myself, made preflight was not to pay enough attention to the vitamin content of the food. We were assured by the food people that the foods had enough vitamins in them. That is true, provided (a) that you eat everything in your particular menu with no deviation and (b) that the food is not subjected to heat stress. In retrospect, it's a great shame that we didn't have vitamin pills up there as supplements. And it's a shame in the period in which the workshop was in thermal difficulties that immediate attention wasn't paid to the very obvious fact that some of the vitamins are not thermostable. I don't know how much, if any, damage this did to our physiology during flight, but it certainly was an oversight. Fortunately, the estimated inflight caloric levels were pretty good for the three of us. We did not tend to leave a lot of food unconsumed once we were in the saddle up there. By the same token, we did not tend to need a lot of food over and above our diets. We existed on gray tape and butter cookies and made out okay. I still think that with the upcoming crew

KERWIN  
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you may have some problems with people who aren't eating all their diets everyday or with people who are demanding more food than their menu calls for. Certainly in the future, particularly for palatability and in part for nutrition, we ought to be feeding the individuals what their body tells them they need in flight, rather than a standard diet from which deviations are very difficult to make. Taking the supplements was no problem. I will say this, that the ground turnover of our dietary information and their supplement instructions were well done. They were prompt, the format was reasonably easy to follow, the pills were reasonably easy to take and that did not present a problem.

Our fluid intake didn't present a problem. The water guns are extremely convenient. They're easy to use. The fact that you have one gun for each crewman and all you have to do is log the water once a day makes it easy. The fact that there are some calorie-free drinks on board, if you want to take something that tastes better than water, is a good thing. The apple drink takes 12 hours to reconstitute. That's not a good one. The other drinks were okay.

I guess we ought to mention that in the future the wardroom should be so arranged that an individual's food stowage is

KERWIN  
(CONT'D)

convenient to his seat and place in the wardroom rather than everybody having to climb over each other in order to get to one locker.

MO74. We talked about it in connection with the feces mass measurement. We did very little mass measurement with food because we tended either not to eat an item at all or to consume virtually all of it. I mean within the limits of packaging. As far as I am concerned, the procedures for mass measuring food were never really spelled out as to the number of napkins you ought to use and it didn't bother me because I went that whole flight without ever mass measuring the partly consumed items.

MO92. Stowage: We could cover that for 92, 93, and 171 also. The leg bands had rather complicated stowage inserts. They were not convenient to use and tended to get the line tangled up. In some cases it was hard to close the drawer after you put the leg bands back. The rest of the stowage for those experiments was okay.

The setup for the experiments was reasonable. The checklist was excellent. The operation of the experiments was pretty much the same way we did it during training. As far as noise

KERWIN  
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level, I don't think that had anything to do with the conduct of the experiments. It was adequate.

The Limb Volume Measuring System proved as easy to use as it had been in training. It was reasonably easy to calibrate, it tended to drip somewhat during a run as it did on the ground. I think it gave some reasonable results, that is, reasonably accurate results, somewhat to my surprise.

The Blood Pressure Measuring System showed the same kind of problems in the air that it did on the ground. For example, during M092 it probably read low systolics occasionally, due to the noise pick-up characteristics of the microphone problem. But the problem wasn't any worse than on the ground, and maybe it was even a little better. In the M171 individual, you did get five false systolics occasionally, but, again, I didn't think it was any worse than on the ground. Let me make one comment on that. We'd been encouraged by the PIs to let one arm go limp during the conduct of the experiment to get better blood pressures. That proved, as far as I was concerned, impossible to do because the way we had to ride the bike required the use of the arms, either on the handlebars or on the forward strap of the waist restraint, which was the only thing from the waist restraint that we retained or on the ceiling grid



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overhead. To restrain the body and hold it down to the peddles while we were peddling, we didn't relax the left arm, and yet most of the blood pressures that we got were reasonable and consistent.

Calibrations during the conduct of these experiments were reasonable to conduct. My only comment on the Body Temperature Measuring System is that I think there are quicker response systems around and maybe next time we can have one.

The performance of the ESS was nominal, with no difficulties throughout the mission. An overall statement might be that the medical experiment and its supporting hardware were one of the best behaved systems, hardwarewise, on the whole flight.

Let me go back through MO92 and think about some of the other things. The LBNP had isolation problems during preflight, and we continued to have those problems inflight. If you touched a structure, you lost your isolation, and that's all there was to it. The saddle was more uncomfortable than in one g, but not as uncomfortable, personally, as I thought it would be. It was tolerable. We all found in zero g, that we had to set the saddle up higher than we had in one g in order to get the same effective relationship of our hips to the waist opening

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of the device. I think that's because as you ride up toward the middle of that thing in zero g, you ride into the hollow of it, and your body can slip down an inch or so farther. We all ran either one or two steps higher than we did preflight. We are talking pretty much hardware here rather than physiology, and I think that's as it should be. The lower body negative pressure device did pretty well. The ankle straps weren't of much use to us. They weren't very strong. In addition, we've made a terrible mistake on the upper leg strap by not noticing that it was all male Velcro on the inside. After a couple of very painful scratchy sessions on our legs, we coated it with gray tape to make it comfortable. Also the wedge that we used on the right leg to assure tight contact between the metal band and the leg was too thick and not tapered enough. We actually took scissors to it and tried to taper it a little better.

M093 Vectorcardiogram and the Sensoring. The problems there are pretty much the same as they are on the ground. The little sponges tend to float away from you. They were extremely wet in flight. That was probably an overkill reaction, because we had some dry sponges preflight. They were so wet that we had to change our routine to get a piece of tissue paper out to soak up some of the juice from them before we put them into

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the electrode discs. If you didn't do this, the juice would seep out under and around the adhesive portion of the disc and it would ruin the adhesion. The discs would then come off very readily. So, we had to partly dry them and there's an art to that. If you dried them off a little bit too much, then it takes you quite a bit longer to get good contact. You'll notice that in many of our runs, we started the M092 run with high impedences in many of the electrodes. We'd press on because the pulse rates were reasonable, and we'd always have good impedance by the time we got 171. The 93 equipment and the electrode kit. I thought they worked rather well.

M171 equipment. I don't think we have to debrief a lot on the waist belt and shoulder straps. The story of that came down on B channel. We wound up discarding that whole thing and simply using our arms and legs to stabilize ourselves on the bike. I strongly recommend that method. It is true that the handlebars are not in the ideal position nor of the ideal length to give you good support during the run. But, I think they're close enough that we can live with them for the rest of the program. We do recommend to the follow-on crews that they ride the bike, if the equipment for doing so can be made available, in the horizontal position to get used to the

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stabilization problem, and also, to get one crack at baseline data before flight.

M131. Stowage was adequate. The rotating litter chair really performed very well throughout the whole thing. The bottle pressure was good, the controls and displays were good, the chair was very smooth, we never had a runaway problem, and we never had a problem where it wouldn't start. We had occasional trippouts, due to body motions on the chair, and the one outstanding problem there is the restraint of the individual to the chair. You'd find that assuming a sitting position and floating into the chair, the waist belt is grossly inadequate to hold your behind close to the seat of the chair.

The eye goggles were as inadequate in flight as they were pre-flight. They're too small. They were made small so that we could detect color changes in the skin of the individual, and we overkilled the problem. They should have been larger and more comfortable, and easier to block light out with. But they'll do. The otolith test goggles, unfortunately, that whole system was not optimally designed. It is so sensitive to small changes in the angle between the shaft on the bottom of the goggles and the individual's bite board, that it proved impossible, I think, for any of us to bite into the tooth

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holes in the bite board comfortably and still get good proximation of the otolith test goggles to the face. I think it would have been better preflight to go to an elastic sponge or material kind of a bite board without individual tooth holes that you bite into, which would have given you quite as accurate a relationship between the subject's skull and the line of light. It would have avoided the significant discomfort that was involved. The other thing was, it was always very difficult to get the right relationship between your head and the otolith test goggles since they're on a rigid bar system. You always wound up with your neck either thrust forward or scrunched down or stretched up to the point of considerable discomfort. The problem getting to the same place in the seat of the chair contributed to that. I guess we ought to emphasize that we ran the M131 experiment, in most cases, without our teeth being firmly ensconced in the tooth holes of that thing. But I don't think that affected the data significantly at all.

The controls and displays on M131 were fine.

M133 hardware was well designed and well worked out. It was a simple system. The control panel functioned well, and the tape changeout was no problem. The - bracket for restraining was

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well designed. The arrangement of hooking up the power cable through the grid was easy. The only piece of gear that I was sorry to see up there was the fancy, superthick fireproof cap. The Spandex cap would have been a much superior device both in the point of comfort, and from a point of view of elasticity retaining the electrodes on the head. Almost every morning when I woke up from that thing, I found that the two forward EEG electrodes had lost contact because the cap just wasn't sufficiently elastic. I think that the cap did interfere somewhat with sleep. It prevented using the head restraint on the pillow. The cable connecting the top of the cap to the M133 was too short. It couldn't be restrained out of the way, and consequently, it slopped over a guy's face, so that if you moved or turned during the night, you'd brush up against it.

M151. The big thing about M151 is that it takes time to set up for it. Integration of the M151 procedures into the other experiment checklist was well done. The guys had enough time to find setups and lenses and angles and so on rather well. It just does take time to move those cameras around and set up those lights. We constantly had the comment that one of the big activities that M151 missed was that they should have had movies of setting up their own experiment. It was pretty complicated on some occasions.

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M172 was the BMMD and the routine operation was pretty good. The shoulder harness was difficult to learn how to lock, but I think we all did get the hang of it eventually and were able to cinch it down, get in and out of the mass measuring device rather quickly, and get reasonably consistent readouts. The body mass measurement device is extremely sensitive to spacecraft motions, momentum dumps, also, to body motions in regard to whether you were relaxed or tightened up. This didn't make too much difference in the daily operation, but calibration of the M172 was a very a difficult, frustrating, unsatisfactory kind of a thing, primarily because it it was a pickup, jury - rigged kind of operation using equipment that wasn't designed for that purpose, and it didn't stay put when you were calibrating the chair.

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I think that the system is too sensitive. I'd like to see them go to (once you're in the chair) five readings instead of three. I wouldn't have minded that. It would have cut out one cal and provided more assurance that statistically the data is more correct by taking five samples and accepting more scatter. I would strongly recommend that.

KERWIN      Regarding the consistency of our data day to day, what we didn't know about was the offset. Your data says you weigh 175.5 pounds plus or minus a quarter. That's good enough for medical reasons, but is that really 172 or 169, or what for those cal tests.



## 14.2 ATM EXPERIMENTS

KERWIN The first hardware problem that I recall in S052 was simply the poor centering on the occulting disk. I'm not quite sure what the PIs thought about that. It apparently was a simple misalignment between the FINE SUN SENSOR in S052 rather than an internal misalignment.

They never had us fool with D-4. You could always center the S052 by pointing the canister. They had us pointing to the cross-pointers in particular after awhile. Unfortunately, we couldn't correct for the misalignment, because if we did, we lost a READY light, and if we got outside the 20-arc second discriminator, we lost the READY light. I'm sure these numbers are on B channel, but in my memory, it took something like 40 or 50 arc seconds to do the job completely. We know that because we were running with those numbers after the S052 film canister broke down and we were no longer able to take pictures. It was my custom, when running JOP 6 to call up the S052 TV display, center it, then run JOP 6 in that position. That was on the S052 pointing error display. That was about right, 60; up, 60. It depended on roll to some extent. It was way outside the 20-arc second discriminator. We didn't care at that point, because we weren't taking pictures anyway.

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So the first problem we noticed was we had this difficulty centering. The second thing we noticed was the little scallop on the display which afterward turned out to be a foreign body on there which the ground noticed and asked Pete to correct when he did his film retrieval EVA, which I guess did the trick.

This may not be quite chronological, but the next thing I remember was that when we were looking at the S052 television, and we closed the doors, we'd get a wild psychedelic light-streamer effect as the doors closed. It looked as if light was getting into the vidicon past the disk. It seems to me that that was the point at which we mentioned this on the loop about day 5 or so, and they said, "Oh, well, that's all right." Then apparently they got a look at it on the TV down-link. I think we showed it to them a time or two. We pointed the thing, called up TV and closed the S052 doors and it went poof! That was when they said they passed up the little procedures that said to always turn off the WHITE LIGHT CORONAGRAPH TV switch before closing the doors. I guess the purpose of that was to avoid bruising the vidicon with direct sunlight. I remembered new additions to operating procedures better and better as the mission went on. Since going from JOP 6 to JOP 2A, for example, is not something you use a cue card for,

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you just shut down systematically and move on. I frequently found myself closing the S052 doors and then saying, "Oh, darn," and reaching over and hitting the WHITE LIGHT CORONAGRAPH TV switch, probably too late. It didn't seem to degrade too much.

I would like to make one general comment here for the benefit of the follow-on crews and also the training people. I found, in the ATM world particularly, that there was very little difference between operating the ATM trainer and operating ATM in the flight vehicle. The physical conditions are not so dissimilar as to make any difference. And any good habits you get into in the trainer, you'll carry over in the flight, and if you have bad habits in the trainer, you'll carry them over into the flight.

I think powerdown-type operations gave us problems throughout the mission because our cue cards were so changed as to be hardly recognizable. Many of the experiments had band-aides on them, problems of different kinds that had to be handled specially. It was difficult to do that in a rapid and routine fashion. We didn't have the right gauges. It wasn't very flexible.

Door operation: The procedure of powering the TV down before closing the door is something that has to be drilled into you preflight or you're not going to do it right.

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You might stick a note at the end of every JOP Summary Sheet that's got S052 operation in there, WLC TV OFF. The JOP Summary Sheet worked out beautifully. At the beginning of a pass, I'd get out the three JOP Summary Sheets that we needed for that pass. I'd put them in the middle of the three trays in order, and we'd use them just like we did in the trainer. You'd go through the one, and when you were timing out on the last one and you'd put that one away, the next one would be there. We wound up not keeping JOP-3 out because it was so convenient, we felt we could get it out in a minute. You don't need it the first minute, anyway. You're on the cue card until you're set up. Of course, we only have one real run-through on JOP-3, unfortunately.

The pointing system: Again, we never got into a backup mode of operation with the pointing system. We never used the DISK MANUAL at all. And we never used this DISK AUTO. I think we went to DISK AUTO once during a checkout. We never had to go to a backup. The internal alignment of the coronagraph apparently operated well and was, therefore, completely unobtrusive to us. I have no more to say about that.

The TV camera: I was a little bit disappointed that the detail on the TV presentation was no better than it was, and no better than the training films we have seen. Owen kept

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telling me how great you could see details when you rotated the canister with the TV display. I looked repeatedly for that and I never saw it display. I didn't see any fine details that would come out at that time. If people did on the ground, I guess it says that the TV display on board has less resolution capability than the camera's. Maybe the ground was getting more than I was. It's approximately like the trainer. You can see gross configuration. I did not see fine detail on the corona.

It may be that Owen is more capable of following and observing fine detail and the changes therein in the corona inflight than I was. We wound up letting the ground worry about that. We gave them the vidicon a couple of times a day. As far as I recall, they never passed up to us any specifics on fine detail. We never were told, "Observe the streamer on the northeast limb associated with active region so and so." Or, "Watch for any changes in the fine structure in such and such radius." So apparently they, too, didn't think it was very important to the guy inflight. I started out making sketches of the corona, which I dropped after several days because it wasn't helping me operationally to manage the ATM.

We never saw what could be classified as the bonafide coronal transient in the white light corona. We saw a number of things that were active surges, and active prominence on the limb.

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We could see moving material on the limb in H-alpha. Again, we reported this on a number of occasions to the ground. They never asked us to do a building block 17 or a building block 16. We never got into JOP-8 on that. We occasionally took a few frames of data on something, more or less on the side.

We got the strong feeling that the PIs didn't want us to go chasing these things. So we didn't do it. We got into the habit of observing, reporting, and pressing on. Either Paul or I tried about once a day to do a circuit of the limb and see what was going on in the prominence world, make a few comments on it on B channel, and forget it. Incidentally, I started out making free-hand sketches, and I'm not good at that to start with. It was fairly late in the mission before I felt relaxed enough up there to remember that we had the clear overlays, and to begin sketching active regions on the clear overlays. I think that is a much superior way to go than the previous sketches. Using those clear overlays, you can sketch an active region, for instance using H-alpha 1 FULL ZOOM, IN. You can detect changes from rev to rev from the beginning of the pass to the end of the pass, and the configuration of plage and filaments. If there is sufficient change from day to day in the corona, that also would be much clearer to a guy if he did a tracer using those clear overlays.

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We never saw corona transient. The streamers were there but the fine detail wasn't visible. The coronal holes are, to my knowledge, an XUV manifestation more than they are a white coronagraph manifestation.

I noticed that the corona holes we were going for tended to be near the poles. I was unable to define those, either on the white light coronagraph or the XUV monitor, which we will talk about later. The diffraction rings were visible. That's about all I have to say about it right now, to attach any mention scientific significance to.

Pylon obscuration: I'm not sure what they want me to say. It wasn't sharp, of course. It's not sharp in training either.

Contamination visible: Oh, yes, indeed. It amazed us, I guess. It amazed Pete when he looked at the real hardware and found out how small all the structures were, all the occulting disks and the pylon and everything, because it looks big on the display and you get the impression that the thing is about 1 foot long and 6 inches in diameter. It's a tiny thing. The contamination particles that were floating by, looked as if they were pieces of spacecraft about 1 inch in diameter when actually they were very tiny things. I think Pete's comment after the EVA was probably very valid, that he saw contamination coming out from the ATM itself in the form of insulation and white paint. A lot of that stuff

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we saw streaming by may have been ATM contamination rather than contamination from vents and other adjoining structures. Strictly in view of the location of that thing, that's probably the canister, but it was almost a very frequent, routine occurrence to see bits and pieces of stuff floating by the coronagraph orifice - in some cases, so bright as to tune down the vidicon and make the whole image go away for a second. If you'd had two guys running ATM and with time for turnover discussion, each guy probably could have kept up with what was going on, because the other guy would tell him. With three guys and so much else going on in this particular mission, frequently a whole day went by that I was not at the ATM. On those days I never knew what was going on up there. Al, Owen, and Jack may be able to do it better. I think another thing we didn't do was to exercise preflight training and preflight discipline in the use of the log. I tried to use the log myself to jot down things I thought were significant. It wound up being more a lexicon of hardware problems than of scientific problems. But, I think if they've been training on it using the log to write down observations and to pass those observations on to the next guy on the console, it would be a very useful tool and it would keep everybody up to date all the time to know what's going on in the ATM.



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Mode operation, again, was no problem in S052 until the camera failed. I'm not sure what the failure mode was. Again, without my channel B tapes, I don't even remember who found it onboard or what the presenting symptoms were. It seems to me that the OPERATE light never came on.

It seems to me that the final symptom was that the OPERATE light just wasn't coming on at all. We went into the flight with a deep suspicion of most of the frames-remaining counters on board, because of their tendency to either skip numbers, count down two when only one frame was advanced, or vice versa. So we were not in the habit of mentally noting all the frames-remaining counters at the beginning and the end of a sequence every time we operated a camera. Therefore, I would have missed the fact, in many cases, that the frames-remaining counter failed to decrement when it was supposed to.

We assumed that the ATM was going to operate pretty well normally. We wound up, in a couple of the experiments, in having only the frames-remaining counter to tell us that it was doing its thing. S054 was the principal case at point, and later on, S056. But in S052, I did not get in the habit of jotting down frames remaining and then comparing at the end of the sequence to see it was operating. The fact was it would come on after the first exposure. It seemed to me it

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stopped doing that later on. Then they told us the camera had failed and we were to press on and give TV shots for the rest of the mission, which was a great change.

Controls and displays, no problem. We made one small change in our cue cards that, in powering down, had us move the SCALE X1/X10 switch to the X10 position. We always wanted it in the X1 position when we were operating because X10 is too insensitive to really tell you anything. We would recommend that they leave it in X1 as long as the camera is operating, because then you can correlate the position of the needles with whether or not you have a READY light or not. I found that with it in the X10 position, I got buffaloed a couple of times and wondered, "Why don't I have a READY light on S052?" The needles are very close to center, but they were still more than 20 arc seconds off.

S054 door operation. Once again, with three of us operating the panel, I'm having trouble remembering the exact chronological sequence of the events that led us to the conclusion that the door was stuck closed. It seemed to me that fairly early on, we had an indication that the door was not behaving properly. We had a white talkback. The ground told us, "Our indications look proper. You are taking pictures; press on." And then it was another little while and they said, "We were wrong; the door is indeed stuck closed."

KERWIN      It seems to me that, 54 came on us kind of suddenly. I think Paul was on the console when he either actuated the door switch or came up for a run and noticed that the talkback was white. He reported it to the ground. We went through the malfunction procedure that indicated that the door was stuck. We opened the door then, using both motors. At that point, the ground said "We're going to leave the door open all the time rather than go back and try it again with one motor." It was my impression on board that we probably should have reconfigured to one motor and operated it for a couple of sequences to see whether it was a transient or not, but they never let us do that. Obviously, they were nervous about the door getting stuck in the closed position, although we could have gone EVA and opened it. So we operated for several days with the door motors disabled and finally went out and pinned the door open. The first ref l operated after that EVA, I went into the computer and I inhibited the door motors for 54 and 52, which are tied together. That gave me a white talkback on 52; then I enabled the primary door motor again. And that gave me a READY light and an OPERATE light on 54, which was great because then we had the normal clues to the operation of S054. But as soon as we went into the nightside and came out again, we were back in the state where we had no READY light, no OPERATE light, and a white talkback. And I should have asked the ground what

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the logic deal on that was and should we, on every dayside pass, have gone through this little routine of inhibiting and then enabling the motors, and would that have given us normal displays on S054? I think it might have. But we didn't do that and we ran the entire rest of the mission with the S054 talkback white, the door pinned open, and we knew it was open all the time. It was a nuisance, and it slowed us down, because every time we ran S054, we had no clue of the frames remaining. When you hit the start switch, you could see it go click, click, click, and then it would get into the long exposures, and the only way to know S054 was complete with the sequence was to count the number of exposures that it had taken.

It probably added an average of a minute every time I ran an S054. I should have written down the exact time that I hit the OPERATE switch as well as frames remaining to make sure it would time out. Some of the 256-second exposures did not get the full count because I thought it was stuck and changed to the next filter too soon. Frames remaining is the primary way of going. Timing is a backup way, but it is an additional task, which (a) slows you down and (b) you can't operate the way you did in training. You can't be observing the Sun and looking ahead to the next JOP and thinking about what you're doing, because you're constantly up there doing nothing but

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watching the clock and watching the frames-remaining counter. A simple countdown timer might be helpful. For much of the mission, we did not use the event timer on the ATM, because it was a power user. For the last 10 days or so, we were permitted to use it but it's a lot of trouble to set that thing up. It takes time, because when you get through with a time exposure you have to reset it. I would simply note the time remaining on the day/night counter. About 5-1/2 minutes after that, I would expect S054 to go. The problem is you don't always remember what that time was. They're going to count frames remaining and work it that way. It's going to take a little work. They might use the egg timer that is in the command module. The easy quick way that we use in training is to scan the thing and when the light goes from white to green, you know you're ready to move.

I think we should talk about the flare detection system at once. Flare alarms and threshold settings were a constant problem to us, because 99.9 percent of all the high PMEC counts we got were due to the South Atlantic anomaly. Going into the last week of the flight, we never had a flare. The flare alarm had to be turned off any time you left the console, because every time I left the alarm on, it wasn't 5 minutes until the alarm sounded. Then somebody had to break loose

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from what he was doing, go up to the ATM console, and turn it off. I felt the alarm was absolutely worthless. Of course, the one early flare drill that I got was something. I know the first line of the flare cue card says, "Check PMT count (not in SAA)." You glance at that, and your training takes over. Maybe we should have trained more with the South Atlantic anomaly. I never realized that it was so ubiquitous. Every rev we had either South Atlantic anomaly or horns.

I wasn't aware that the SAA would peg the beater like it did. It was very dramatic. That first time, not knowing what the displays were going to show, we saw an early bright spot in XUV MON, using integration and a bright plage in H-alpha that looked quite a bit like some flares we'd seen in the trainer. I had a bad feeling about it, because it wasn't very dramatic and because there was nothing on X-ray, but I went ahead and took data. Fortunately, we were very close to the terminator, or else I'd have wasted a lot of film. I don't know how Owen and his crew are going to handle the South Atlantic anomaly and the horns. They want to list both on the ATM schedule pad. If you list them on the ATM schedule pad, that takes care of you while you're at the console. It was my custom not to disable tone light when the pad said so. I just left it, eyeballed it, and when it went on through, I'd glance at X-ray and at the schedule pad. If the schedule pad said South

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Atlantic anomaly for the time period we were in, I'd know that's what it was. Then I'd turn it off. During many of those passes that are 15 or 20 minutes long, a visible peak in P MEC will only occur near the middle of that time. When you're on the fringe of it, it doesn't show. If you had a genuine flare during the time you were on the fringes and you had tone light disabled, you wouldn't even have a clue. It might be a help to look at the X-REA counts and the image detector counts.

Image intensity turned out to be an excellent correlation with genuine X-ray activity from the Sun. I think there were three occasions when I saw genuine flare activity. On each of them, the image intensity count was well over 100. It tracked up right with P MEC, and it never did it with the South Atlantic anomaly, which was an excellent correlation. In addition, the only time we ever saw anything on the X-RAY IMAGE MONITOR was during a flare, which is also a good correlation. You see it when you have a flare going, and you never see it in the horns. That doesn't help you when you're down in the workshop and it goes off. If it's going to go off 10 times a day, you get very blasé about it. The checklist had all the SAA with horns that we would see during the day while we were awake. Putting them on the schedule pad only means you don't have that in your pocket when you're walking around the rest of the vehicle. I

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asked for it separate from the schedule pad so that I would have it in my teleprinter message book, and then I would be able to leave it enabled. I wanted it in GMT rather than in sunset time, so that when I heard the claxon I could look in the book, determine that no one was on the console, and that we were in the horns. I could then forget it and tell someone to turn it off the next time they wandered by. It was a little bothersome leaving it on and having to turn it off - to interrupt your meal or something else you're doing. It's a very recognizable; you don't mistake the claxon for a caution or a warning. However, we really wanted a flare. We didn't want to miss one, and that is why I was leaving it on. I think it will bother the 56-day crews to have to turn it off about once every hour. And then someone has to turn it on again or it's not any good to you. They will have to make their own decision about what to do in between manned ATM passes, at the beginning of the day and at the end of the day. Once you're at the console and once you have a display or two like X-ray and H-alpha powered up, then you're home free, because you have the X-ray and the image intensity count that are perfect gauges. Because of the one flare, there will never be any doubt in my mind anymore about H-alpha during a flare. It does not look like bright plage. It's much, much brighter than that - an order of magnitude brighter. It's beautiful.



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On the postsleep checklist and presleep checklist, there's a line that says "flare alert," which is intended to remind us to go to the console to activate the flare alarm or deactivate it. I played that by ear. We only did this on the last several days of the mission. By that time, unfortunately, we had gotten out of the habit of paying much attention to the ATM notes on the presleep and postsleep checklist, because our cue cards were so garbled that the information on how to set it up was wrong.

I did see the note below the flare thresholds telling us to turn the tone light switch off during postsleep checklist. But again I wasn't properly trained to execute that part of it. I don't think we missed any big flares. But I think we were a little bit lucky not to have missed some. With three of us doing it and each of us doing it in a little different way, we weren't too well coordinated.

We had millions of false alarms, and we've already talked about those. We know how to tell the true ones from the false ones and handling it is up to the crew. My mental attitude when we were operating was that the cue card wasn't worth the paper it was printed on because it had been changed so much. I would turn on switches until I got some displays and cameras up just using my intuition for what was required. I think if

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we'd have gotten 90 percent of required data, we would have missed something. We were always missing something there on those unattended powerups and powerdowns. We'd suddenly realize the ATM console wasn't quite put to bed because we'd forgotten to go to 1 before we went to STORAGE on S054. That was a favorite one. For some reason, we just hadn't done that often enough. Also, it had been changed a lot. I would just throw switches until the panel looked right, and then I'd go away. From the time you hear the alarm and get back to the console and start throwing switches for a flare attended, it takes about 45 seconds if you are at liberty to move right then. I think it would take another 2 or 3 minutes to power the console up.

If you're in the middle of an M092 and the crewman is at the third stage of negative pressure and his heart rate is 100, you aren't going anywhere. If we hadn't caught a flare, I was perfectly willing to leave the tone light switch enabled during sleep, except for the thought of getting up five times during the night and finding it was a South Atlantic anomaly each time. I wish that the discriminating ability of that warning system was such that it worked on image intensity count rather than PMEC count; then it would give a genuine warning. The only problem is false alarms. If the crew thinks they can

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(CONT'D)

handle that, let them go ahead and do it, although in 56 days,  
I think they'll get enough flares.

On the powerdown unattended, we had enough time. On those last passes of the day, they gave us sufficient time to power down. The crew ought to be prepared to power down for unattended prior to sunset. They should make sure that, if there are any subtle differences between powering down prior to sunset and after sunset, that they know what they are. For starters, you have to close the doors manually; if you go AUTO DOOR to OVERRIDE, I'm not sure what happens. Somebody ought to run through that in the trainer though to make sure that the checklist works equally well before sunset and after sunset. You frequently finish that last JOP with 15 minutes of day remaining; you've got other things to do and you want to power down and leave the console then.

X-ray image display. The display we talked about was of no use to us whatsoever except for flares. We saw the cal source at the top. That was always present. We wound up running the thing always in 1, because we wanted to see something on it.

But we never saw anything on the X-ray image unless there was a flare going on. When the PMEC, during a flare, rose to 500 or more and it was confirmed by the image intensity count, then you could expect to see a brightening on the image display. What you'd see at all other times was a rather irregular

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splayed-out group of white dots at the top. You could see each individual filament; as it swept down, you'd see two or three other individual filaments laid out. They were never the same ones from sweep to sweep. We got used to considering it as noise in the system. When a flare happened, then you'd see another group of white spots that would be there on every scan. It was very definite. I would consider that a very useful flare-location device, but not useful for any other purpose. I never noticed any coronal activity on the X-ray image. The shield was fine. It's still on there. The Velcro didn't work, so I just taped it down with gray tape. It's probably required, too. You wind up leaving a window or two open up there because you want to see out from time to time. When something is coming in the window and bouncing off the mol sieve, it's very bright near the ATM console.

Practically none of the Velcro in the whole spacecraft worked. In zero g, Velcro is lousy, terrible, miserable stuff. You had to take the shield up and curve it around and then bend the little feet. There's a little memory in the cardboard that tends to unbend the feet. You plank it down there, and it just floats away, so we taped it.

For the rest of the SO54 mod operation, controls and displays were quite nominal except for the doors and the READY and the

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OPERATE light. The frame counter was apparently rather reliable. I think we did have a couple of double sequences, frequent, where the thing would keep on going, but they were infrequent and they weren't a problem. The filter talkback worked fine. 54 is simple to operate. We ran the whole flight in manual. We varied the filters as called for, and that worked fine. I never used it with grating in. I don't remember using any other setting except SINGLE except for the flare. Occasionally, I would forget at the end of the day to go from 16 to 256 for unattended ops. But no, I don't think there are any peculiarities or any traps in the operation.

We made a lot of mistakes in ATM operation. It's just a matter of training and attention. We never really got to buckle down into the ATM routine up there, at least not for more than a few days at a time.

S055 is a nice experiment. I made one mistake in 55 that I'll mention now because I remember it as being outstanding. It was near the end of the mission and we were doing a cal, one of those cal's where you run in the GRATING AUTO SCAN, no INTERLOCK. For some reason I let it go right by detector 7 without turning it off. I don't remember what distracted my attention. It went by 2150 and it was nearly 2400 or 2500

KERWIN  
(CONT'D)

before I yelled and turned 7 and 6 off at the same time. I think I confessed to that on B channel. I wasn't operating any other experiments; perhaps I was looking for a flare. If you have started other experiments and can just let them go, there's no problem. But any time you're doing that, you have to settle down there for 5 minutes and think about nothing else but watching that grating. Once you do that, it's easy. That means you've got to ignore your buddies if they call you; you have to ignore Houston if they call you. You just cannot answer.

High voltage detector operation really wasn't a problem. We did get these occasional, unexplained shutdowns on the grating. On most occasions, you stop, shut them all off, and then turn them on again one at a time. Then everything would be fine. Occasionally in the MIRROR AUTO RASTER mode, I got two or three consecutive tripout. At that time, I would shut down detector 5. Then the thing would run all the way through. The next day, you'd go up there and you'd run your MARS with all detectors and it would work fine. I don't understand it. It's just some little transient voltage in the system that would trip them out. There didn't seem to be any correlation between the tripouts and the SAA and horns. It didn't represent a problem because it wasn't that frequent, and most of the time, it worked just as advertised. I remember one or two occasions

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when I tried to turn the detectors on and I was in the wrong mode. It would trip out as soon as I hit number 4. I knew when a detector had tripped off because of the ALERT light and because I wouldn't get an OPERATE light. You could miss the ALERT light. They're blue and are rather unobtrusive. One or two of them were on all the time throughout the entire mission, at least on the power system. But you can't miss the green light going white. That's pretty obvious.

Grating selection. Again, I remember making a mistake once or twice when I had the GRATING switch in MECHANICAL and it should have gone back to OPTICAL. You can get bit on that if you're not careful. It would usually happen during or after a building block when operating near the limb, and you wanted it in MECHANICAL. Then you'd go back toward Sun center and forget to go to the trouble of switching a dot and counting it around. The ground would upset me now and then with their sequence of gratings. They'd give you 762 followed by a 550 or something like that. I was not as alert as I should have been to look at these things ahead of time. If a guy is really on the ball up there, as the last chip of the building block runs itself out and S055 is done, he can look ahead to the next building block and find out from the pad where the grating ought to be and start it going to get it back to reference or to a new position and

KERWIN  
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save time. If you don't remember to do that, and you're a little bit behind the curve, then you start into the next building block and you get to the time to start 55. Then the ground may call for all balls and it's at 0028. That's when you get frustrated and you have to go all the way around.

In regard to looking ahead at building blocks, I think Paul did better on that than I did. I wanted to keep my eyes on the 54 frame counters and other oddities built into the system before going to the next building block. If there was a big grating move, I would just have to take the time to do it. On occasional revs I would run out of time and not finish the whole sequence. When that happened, I would have to just shut it down, and say "We'll chalk that one up to experience, and we'll open it up next time around."

As the mission progressed, the building block set up times seemed better and better. It may have been that my level of training was also getting higher. I think you have to depend on feed back from the crew in real time. I would say don't make any major changes in building block times. If the crew complains that the rev was too crowded, then look at that rev carefully and allow more time for set up. Sometimes you don't finish. Often I would find that I would get to 55. I didn't get it set up. I took the time to get it set out, and would



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(CONT'D)

up with 55 hanging out of the end of the building block, running all by itself. When that happened I would let it run through one complete scan or raster into the next building block and be late.

Mirror positioning, no problem. The coalign position on the mirror is odd but there is nothing we can do about that. At least we know what it is now and it was extremely consistent. The intensity data display is quite easy to maximize, provided you are in a reasonable grating position to you get meaningful data on the detector 1 or detector 3. If, for instance, you're at REF, it is easy to maximize detector. You have changes in the order of 10X. It is quite sensitive to very small changes of 1 or 2 arc seconds in the pointing.

The network cell boundaries: you could peak up on them but the degree of change was very much less than double. We did exercise peaking up on them. It is a mushier thing but it can be done. The counts would be very low. We did all our network cells in quiet regions, which is too bad, because network cells are hard to find on that display and to find again on subsequent revs in quiet regions. Where you have an enhanced network near active regions, it would be very easy to do. Network cells boundary-scanned out beautifully when they are enhanced, but when they are quiet, they're all broken up. I commented

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earlier that the only way I was able to hack it at all was to back off on H-alpha and not to do it on full zoom in. I would back off about halfway to where I could see the forest instead of the trees and pick out the configuration. When you zoom in, it gets all jumbled, and it is difficult to see the overall picture. It is all chopped up, with bushy clumps all over the place pointing in different directions.

Operation and load operation, no problems. Controls and displays, no problems. You didn't have a chance to minimize any points. You can point quite a ways around in many cases without changing the display very much. If you point down to 25, it would slew around quite a bit, and then stay more or less in that area. It is not an absolutely steady display, but it didn't mention that in P MEC. The other thing that was different about P MEC from training was that it bounces around a tremendous amount. You can mentally integrate the display and figure out what the average P MEC count was because it bounces from zero to 400.

This business of detecting flare qual on the basis of two counts per minute qual or whatever, forget it - it bounces around too much. But over a period of a couple of minutes, you can integrate and tell whether it is decreasing or not. The higher it got, the steadier it got.

KERWIN  
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S056 Telescope and X-REA door operation. I don't remember any door anomalies on 56, nor on the detector operation. We wound up leaving them on during the South Atlantic anomaly. That was for the entire mission. The most shameful thing I did during the entire mission was to destroy the history plotter. I'll never forget it. I knew about the thing and reminding wouldn't have helped me unless you reminded me in that particular pass. I got distracted for long enough to let the thing go on through the back as I was slewing it back to review the flare. I looked back and it was stopped. I never should have bought off on it. I never should have let an intentional human-error killer like that in there because it came the first time I had a chance to do it correctly. I don't know if there's any way to salvage the assembly. The point at which the paper had torn in three places was checked. I wish they'd let them drill a little hole through that glass and poke it with a stick because you could probably get it unstuck. There are hundreds of feet of unused paper.

I'm not qualified to comment on the usefulness of Be-Al counts for general activity or for flares because we really didn't look at them that much. I think that they were somewhat sensitive to the anomaly. In the beginning they were red and pink in the anomaly.

KERWIN  
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I can't say that the history plotter showed activity during the flare; it would go through the anomaly in almost a straight line. That doesn't agree with what I said before, but I did notice that the Be and Al apertures would be a little smaller. We never saw anything useful out of the RNBM.

KERWIN

S056 Mode Operation - we had all those hangups, and I still don't know the cause. I expect from that little test that we ran there's probably an EM lineup because on the right side, we ran through those things beautifully without any trouble at all. It was the only experiment operated. There appeared to be a significant correlation of rasters. When we had 56 and 55 working together, we started 55 first in the hope that if there was a start transient, it would get it out of the way and then get 56 into its ACTIVE 1 mode. I don't know if it worked; it certainly didn't eliminate the hangups, but we occasionally got through all sequences without having one. We really wanted to get that data, but it's difficult because that's hard to detect. You really have to be following 56 very closely, know the exposure durations at each filter step, and time it. Watch it go to the new filter, and if it doesn't change and the time runs out, you know it's hung up and you go start again.

KERWIN  
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I think on Skylab 3, we're going to work around that in several different ways, by changing building blocks slightly and by going through them without starting over.

KERWIN

82A was the one that hung up on us earlier. We spent several days operating it in the secure knowledge that the ground had told us that everything was fine and the OPERATE light that stayed on was just an oddity. The fact that the frames remaining wasn't counting down, we could ignore that, too. Then Pete came back and said, that it wasn't working. We felt bad about that. We went ahead and changed the camera and film canister out during EVA and then it worked great. That is to say, the film remaining went down one every time you took a picture. The OPERATE light still stayed on until somebody was smart enough to figure out that it was the FLARE ENABLE switch. After that, every time we had a problem we just cycled it off and on and the green light was back. The only problem in operating 82A that's harder than it was in training is rolling to clear 82A, because you have to integrate. Integration became easier at the end of the mission; it was something we hadn't trained on. It's a little hard to configure because you know the longer you hold that switch you can get a complete white scope and it's a matter of judgment as to what integration to use and what degree of brightness to call a definite interference.

KERWIN  
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I was very impressed with the XUV MONITOR in that, with a half second or no integration time, it showed by bright areas the exact location of the active regions. You turn it on without integrating but with brightness and contrast full up on the scope, then gain position over number 7, where we left it the whole mission. You'd see all the active regions. It was a little harder rolling but it can be done. You just have to integrate approximately 1-second shots and just keep doing it until you get a feel for it.

KERWIN

The 82A door was open on the Sun side of the craft just about all the time. It went that way when we finally arrived in preflight and we didn't have any problems. The only other thing on 82A was that it faked us out on some flares. There was the one time I went into flare JOP, and there were five other times when one of us almost went into the flare JOP and we pulled ourselves up, at the last minute, by saying that we just didn't feel right about it. The PMEC count was high; we were outside the South Atlantic anomaly according to the pad, if only by a minute or 2. On one occasion, I think they actually missed a horn, and we were in that horn. We had a high PMEC count; we had displays that verged on being what we were expecting. But once we saw a real flare, it was most unique in XUV MON also.

KERWIN  
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It was a very small, bright one, very fine. It was the only time I ever saw anything like that, where the brightness gradient was very strong, and the brightest point was where you could actually back off a full brightness on the naked scope and still see a bright point in XUV MON. This makes XUV MON another good correlative display for a flare. If you get an M-class flare, you're going to see it on there. It's going to be bright and it's going to be very fine, like we hoped bright spots would look.

KERWIN

Again, I think the guys on the ground know as much about resolution and quality of the XUV MON as we do. With the kind of training and background we had and the dimness of the display, I gave up on bright spots, and I pretty much gave up on using the XUV MON for anything except rolling for 82A, using integration and flare detection. I had one small problem with TIME MODE. One time I goofed and left the TIME MODE run for about 5 minutes when all I needed was a 20-second exposure. For the most part, I had no difficulty with it. I did not make the mistake of not putting it in TIME MODE and leaving it in AUTO, but the others did. I managed to avoid that particular pitfall. I think it was a problem of going in and out of unattended ops, which we hadn't practiced very often. We wound up leaving it in AUTO when it should have been in

KERWIN  
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TIME for unattended and vice versa, but that's not a problem. would time the short exposures manually, with the START/STOP switch for a 10-second or 20-second exposure; it didn't pay to set up the event timer for that. I just watched the clock and 10 seconds later I'd shut it off. For anything over a minute, we used the event timer, and it worked fine. You'd hit the START switch, you'd watch the event timer start to count down, and you could ignore it. When you came back to it, the OPERATE light would always be on; the frame counter would have decremented and everything obviously was fine.

Door operation on 82B, no problems. The XUV SLIT display was quite disappointing to me. It wasn't a routine thing, but I think we gave you a few shots of it. It was extremely fuzzy; the resolution was terrible. It was extremely bright, and it was the opposite of the XUV MONITOR. With the XUV SLIT, you had to back brightness down to zero. You still had a rather bright display. You could see Sun spots on it, but the nice distinction between umbra and penumbra was not there. I had a feeling that we probably missed small Sun spots because of the poor resolution and the fact that there were blobs or tiny specks of black on the image that weren't Sun spots. You knew they weren't Sun spots because they were there any time you moved the thing. You could tell the moderate or large



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Sun spots or you could tell if you had a group of Sun spots, but you couldn't tell much about them because they were just big blobs of black. I don't think that looking at the H-alpha display will help you differentiate the umbra from the penumbra. I think you're almost going to have to do it geometrically. The center of the Sun spots is the umbra and that fuzzy kind of area around the outside has got to be the penumbra. If you think that's a Sun spot in H-alpha, you can go look at the white light display, and chances are you'll see it there.

Uniform emission for the SLIT was pretty much like training except that many of the features we were on were, as they are in training, too small for you to get completely uniform emission and in the SLIT. If it was bright plage, we didn't care. And if it was prominences off the disk, we just made sure that none of the SLIT was seeing disk. Then if some of it was seeing black spaces on the prominence, you didn't care about that either. I don't think there are any special problems there.

Mode operation, AUTO HOLD. I never had one of those. I gave those to the other guys. Pete had most of that stuff, and I think we got through it okay. I think that Pete started one that I had to finish. But we went through the checklist on it;

KERWIN  
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I was up there for part of the time when he was starting it. He gave me a good frame count on the thing; he got to the right point, and I think it went well.

Film camera and controls and displays on 82B were pretty trouble-free.

H-alpha 1 and 2 door operations. The only thing that bugged us a little bit on that was the H-alpha 1 AUTO, OVERRIDE business that we were doing. I think I goofed that a couple of times coming in and out of it because this is one case, I think, where you power down during daylight and then go back to AUTO DOOR to OVERRIDE. I'm trying to remember exactly what did happen. Oh, I know. If you power up after sunrise, - if you come out of unattended ops after sunrise, you don't get the door open unless you pay particular attention to it. If you just go through the switches and press on, you may not notice that H-alpha 1 wasn't operating. Then you have to go AUTO DOOR to OVERRIDE to get that sunrise signal into it to make it operate. Then when you come around to the dark side, it's going keep on operating unless you cycle AUTO DOOR OVERRIDE to OFF. And I got stuck a couple times and missed some H-alpha. Because you're late getting up to the console and the Sun is present before you are through the unattended ops checklist.

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Some of the cue cards assume that you're in the dark, and sometimes you're really not. I thought the quality of the displays was very good for the H-alpha. We had the one period of time after the EVA when we had powered off the thermal power, and the rest of the H-alpha looked terrible during the next day. It just looked awful, and I was really worried about it. I thought we had done something to it permanently. But the day after that, after we had heated it up for a while, it was right back to normal. So it had obviously drifted off.

Again, our impression was that H-alpha 2 was better than H-alpha 1, but that may be the fact that we never zoom in as far with H-alpha 2. When you compared the two at about the same magnification, we found that what you could really see, in terms of features, was the same on both. Most of the interesting things we saw were on H-alpha, but we didn't talk about it very much because we knew that was one thing you guys on the ground had in all the quantity and quality you wanted. H-alpha is a good tool for running through your JOPs and building blocks, pointing, and surveying the Sun. We could see the active regions just as soon as you could.

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I talked about network cells. They're hard to see in FULL ZOOM IN quiet regions on the Sun. And they're hard to follow, just as hard as they are tricky. I think the tracing might be better than sketching. The big clue is to find, if you can, a network cell which has some feature within the same field of view, whether it be full ZOOM IN or halfway. Again, I don't think there is a lot of scientific data in that log that will be missed because it was mostly a chronicle of why the red tape was over that particular switch on that day, what problems we were having on the experiment. It has a lot of sketches.

Because you were interested in the coalignment data, that log should have been on the list to bring home. It was Pete that collected all the flight data for that. It doesn't have quite all of it in it. I found about day 14 that my two cohorts were not logging their coalignments. We were putting it on B channel.

Prominence visibility - again, that's a matter of getting used to it. I came up thinking that you've really got to move the disk completely out of your field of view to see the prominences. Then Paul fooled around with it and found that, if you turn the contrast way down - brightness about midrange and constrast way down - you could see the prominences better, and you could stand having some disk in the field of view and still see the

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larger prominences. The first one I did, I found that I had to screw the disk completely off the limb, completely out of the display, see the prominence, and roll so that my roll was lined up. It had this all figured out. It was how to point the center of the crosshairs at the prominence you couldn't see. You have it on B channel. It works out very well.

QUERY

There was a difference in the definition of the network cells when we centered the limb.

KERWIN

Near the limb, what you're looking for are linear features rather than circular features. The bushy clumps do tend to line up nicely near the limb. This business of putting it at the base of a row of spicules near the limb is easy to do. That's no problem.

Flare location is no sweat if it's a real genuine flare. And it's extremely bright in H-alpha. It's no surprise. I don't think you need to change your training films. It might help if you could heighten the contrast because it looks like they've looked on H-alpha forever. The onboard displays are faithful.

Visibility of active regions on the limb. They're visible but they're very difficult to sketch, to determine neutral lines and that sort of thing because your viewing angle on it

KERWIN  
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is so low that you don't see much detail. They were bright enough, and they were confirmed by corona. They generally had prominences associated with them, and XUV monitor was bright in those areas. No problem. I had trouble sketching neutral lines through active regions because I just couldn't see the structure.

Surges. We talked about prominences. We did see movement in prominences, not to where you could sit and actually watch it move. But with 15-minute looks, you'd see some change. I did not see any on the disk. And again, I had the feeling that if you were very patient and if you were willing to spend a couple of sunside passes looking at H-alpha and looking at structures, and particularly if you were trying to hit a region in this kind of activity that was likely to occur, you might get lucky and see it. I looked at H-alpha during building blocks until my eyes watered, and I never saw any changes. I never saw any waves or any real dynamic changes except plage in active regions.

Prominences and disappearing filaments. We talked about prominences. Disappearing filaments, yes. I think it was active region 31 that had the filament that was constantly changing. It came around the limb with a great big black filament running south toward the boundary, curling to the east over the top and north of it. That filament was constantly changing.

KERWIN  
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There was one rev when Paul was at the ATM and I was popping up because every 15 minutes he'd call me and say that the filament was really disappearing in here in the middle. I'd come up to look, and sure enough, it would be a lot lighter than it was. Through the course of that day, the filament changed markedly. It was not a case of a filament weaking out. Unfortunately, it did not presage a flare. We watched that thing all that day and it never flared. But the filament over many minutes to a few hours changed markedly. It was easy to see on H-alpha.

My only comment on the reticles was that they operated normally. The ability to point them, the consistency of them once they were pointed was excellent. They were just as clear and sharp as they are in the trainer. They of course wobbled with the image.

It was something internal to our electronics because the image of the Sun and the reticles would both wobble with the same frequency and magnitude. And the electronic reticles of course don't wobble. That's what I meant when I said that the electronic reticles jitter. They don't jitter absolutely but they jitter relative to the mechanical reticles. That's really only noticeable in full ZOOM IN, on H-alpha. When you're on ZOOM OUT, the wobble is so small that you don't see it. The only unusual feature that I saw on the H-alpha zoom was this. When you brought up H-alpha 2 and it was in the full ZOOM OUT,

KERWIN  
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which is the normal way that we kept it, it being our survey instrument, it would blossom at about 1-second intervals. The vidicon would white out and then come back. I don't know if this was seen on TV.

It happened frequently, but not all the time. But it would happen frequently when you'd POWER ON H-alpha 2 and you'd get the display, you would get that blossoming. And it was solved by zooming in. You zoom in the 2 or 3 seconds worth on the switch, and it would immediately steady out. And then you could zoom back to full ZOOM OUT, and it wouldn't recur. And it would never recur the rest of that pass. The next time you powered it down and then powered it up, by which I mean the TV. Alpha 2 switch OFF and then ON again, it would frequently come back. I don't know the explanation for it. It didn't bother us.

The radio noise burst monitor. Again, we didn't power it up until rather late in the flight; once we got our power problems squared away. Then it was several days after that before we got a go to use it. We powered it up and calibrated it. It calibrated very well. The three calibration points were all in sync with each other; the ambient 845 and the 1840. This indicated that there wasn't any drift on that 1840 source.



KERWIN  
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I went through that. I then recalibrated it according to the Owen Garriott procedure, which is to crank the gain up as high as you can go to increase the sensitivity of the instrument. Then I set the threshold down to maybe two blips instead of just one blip above ambient because I found out if I set it very close to ambient, it tended to trigger at sunrise and sunset. If I cranked it up just a little higher than that, it eliminated that problem. But unfortunately from that time on, I never saw any significant increase in radio noise that was meaningful. I don't think we got one during the flare. I don't know if the ground detected anything. We didn't get an RF alarm. The RF portion of the alarm was not on. We were hoping for a nice dramatic swing but we didn't see it. So, I think that the radio noise burst monitor is still a potentially good instrument for giving you a little lead time on a flare, but it didn't work that way for us. We just weren't lucky. We didn't get that many flares. False alarm frequency. Once I learned where to set the thing, which was just a matter of a day or so, we did not get any RF false alarms.

In terms of volts, it was 1/10th of a volt.

KERWIN  
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I embarrassed myself the very first time, by calling down and asking for the ambient value forgetting it was on the pad. I think it was helpful, although we didn't use it much, except for the first time. It was just something that you would just glance up at the noise burst monitor and you would look for the number on the pad and they were pretty much the same. Of course, we would set it the same to begin with, so I guess for calibration it was useful. From then on, you really didn't care where it was because it was something you set. It was just a value above which you wanted to know, to trigger an alarm. In fact, the way it was calibrated, the numbers on the display were not meaningful. They weren't going to be real numbers. They were just going to be some magnitude above ambient.

Manual pointing control. As far as pointing went, press on with the trainer. It was just like that; just as easy to point; just as accurate. Occasionally you could not get it to the very arc-second you wanted. It would jump from 1300 to 1302 and you can not get 1301 to save your life. But we knew about that; no changes. Roll characteristics. Again, they were just about the way they are in the trainer. If anything, it wanders a little bit less during a roll than it does in the trainer.

KERWIN      Apparently, they didn't want us to use HIGH ROLL RATE TIMES 2  
(CONT'D)      anymore because it tended to jitter the whole canister, I guess.

QUERY        You didn't use it after they mentioned that?

KERWIN       I tried not to use it after that. I would use ROLL HIGH RATE,  
and they said to be very cautious about using ROLL HIGH RATE.  
Well, if you've got 90, or 100, or 120 degrees to roll, you  
can't get there at a low rate. It takes all day. But what we  
tried to do was to ROLL HIGH RATE until we were almost there,  
and then stop it, and wind it up with LOW RATE rather than with  
HIGH RATE, because apparently what they didn't want us to do  
was to bang the HIGH RATE ON and OFF. And I think, by mistake,  
I did that once or twice afterward. When you are not thinking  
about it your thumb hits the wrong switch. But we tried to do  
it that way. We used HIGH RATE for the long fall and LOW  
RATE to tweak it up. Apparently that works fine. You just  
have to remember to move the TIMES 2 switch back to TIMES 1.  
  
Line of Sight and Sun Center Roll. We used Sun center roll  
to roll around the limb looking for prominences, and that  
works fine.

KERWIN  
CONT'D)

ATM operations boards and ATM chair. I thought the ATM boards were super good. We very quickly got a place for everything, and we used the center board for the JOP Summary Sheets exclusively and that's all. I guess the only thing about the center board that I would have changed is that I felt that those little wire clip things were going to weaken as the mission went on. You would lift them up a little bit to get the paper in and out because if you just tried to jam the paper in, it would just crumple up. I was worried about them getting so weak they would not hold a piece of paper in them, and you would wind up losing your ATM schedule. It didn't happen to us. The clips that are on the two end boards. Now this is the way we ran it. The boards with the clips were on the sides, and the ones without the clips were in the middle. The clips were great because you could stick the log or checklist or something under them. I would have had a couple more of those on those side boards, rather than having any of the smaller ones. I realize that the virtue of the smaller ones is that they don't obscure the type on your summary sheets as much, but I like them better because they were easier to use. The center board was used for the JOP Summary Sheets. On the left-hand board, on the outboard side, we kept a stack of teleprinter messages referring to ATM

KERWIN system operations; those frequent gyro updates that we got  
(CONT'D) and the computer switchover pads what gyro drifts to set  
first if the computer switched to backup because you might go out  
of control if you didn't get the right drifts in - Messages of  
that kind. We would windup with four or five of them stacked  
under there at all times. We used the big clip for that.  
Then on the inboard side of that, we had the ATM schedule. On  
the right-hand board, on the inboard side or on the left-hand  
side, we had the SAP. On the middle, we had the star tracker  
pad and the maneuver pads, if any; the Z-LV maneuvers,  
primarily. On the outboard side I kept the ATM Log. So  
everything had its place. I even marked the things - where we  
put them - so everyone would see them up there. That generally  
worked out very well indeed.

WEITZ I used the ATM Log as scratch paper, because I wanted scratch  
paper sometimes. And that was the only place available.

KERWIN If I had a change to make to the ATM Log, I would have fewer  
circles preprinted, so you would have more free room to draw  
and make notes on. But that's a minor thing. We wound up just  
writing through the circles frequently, as you will see when  
you look at the log.

KERWIN (CONT'D) Concerning the clips on the board of a given wire clip, one side would be flush with the tray and the other side wouldn't. and you had to learn to slip your pads under the side that was flush; otherwise it wouldn't hold.

KERWIN The ATM chair. We finally arrived at a compromise setting for the chair that was acceptable for both Pete and me, with Paul kind of in the middle. I wound up not strapping myself in the chair all the time. You don't really sit at the ATM like you do in one g. Sometimes it was pleasant to strap your waist in and cinch it up nice and tight and stay that way for a while. It certainly gave you good reach and a nice stable point. But your muscles would get tired if you stayed that way all the time. It is not like sitting in a chair, where you move around a lot and cross your legs and keep your muscles loose. So sometimes we would be that way. Sometimes you would use the chair simply as a backbrace and you wouldn't use the belt at all. You would slide in, let your thighs ride up against the bottom of the tray, and your backside against the top of the back of the chair and work that way. And sometimes I would work hanging onto the back of the chair with one hand and my body floating straight out perpendicular to the ATM console, operating it that way. You moved around a lot.

KERWIN  
(CONT'D)

We kept the cue cards pretty much where they had been in training, and that was fine. Frequently, I thought about cutting out some little cue cards and putting one above each FRAMES REMAINING COUNTER, because we had to jot those things down so often. I never got around to doing it. I would write that down on the schedule pad. I would write "frames remaining" on the schedule, at the beginning of the building block. It would have been handy to have little cue cards there. I think we all have some general comments that if we had to build an ATM control and display console again, we would arrange it a little differently and the geometry of the panel would have been a little more zero g and a little less one g. Because your eye doesn't tend to be in the same position; it tends to be higher. And your head tends to be more perpendicular rather than parallel to the large part of the panel. The thing of having a panel that is flat and that has that big knee in it, is one g oriented rather than zero g. I think a panel with a more gentle side curve, and less of an up-to-down curve would have been better. But this one works fine.

ATM crew operations. JOP operations. Procedural problems or recommended changes. We probably commented on a lot of this already. Cell location difficulty, we talked about. The clumps are outstanding features, and they are very easy to

KERWIN  
(CONT'D)

see but their arrangement into super granules, or network cells, is difficult to see when you are close up to it. Bright spots are harder to see than we expected. And of course, since we didn't have any XUV bright spots, we are talking about H-alpha bright spots.

The 3- and 5-arc-sec stepping. The boundaries were diffused and hard to see, but we did do that. I think once you have defined a cell boundary for yourself, although it is a little bit shakey, you can do that; you can step across the middle of a cell. Let's see how the data comes out and whether the PIs get different spectra as they step across there. I hope they do.

JOP 2. Location of bright, dark, and background areas was simple, just like in training.

Points likely to flare. There's quite a brightness gradient between plage areas. You pick the brightest areas of plage as points likely to flare. What interested me was that a point that I would pick as a brightest plage, in an active region, and therefore a point likely to flare, and therefore you lay the SLIT on it and do your thing. By the end of that pass, it would be dimmer than some other area of plage in the same active region. There are fluctuations in the time magnitude of minutes, in the brightness of plaging in an active region. And this without flares.



KERWIN  
(CONT'D)

Changes in active regions. We have already talked about that one.

Visibility of active regions on the limb has already been discussed. The same for Pre-flare or other nonflare brighting.

JOP 3 flares. Flare location difficulties.

If you get genuine X-ray flare, it's no sweat. Time required to point to flare. Just as short as it was in training. No problems, if you get a real one. You've got the X-ray, you've got the XUV, you've got H-alpha. If you get it anywhere on the screen in H-alpha, it's going to stand out. There is no problem at all. We pointed right between the two brightest areas so that we could get both in the field of view.

Once we were there, we stayed there. We may have fouled up the SLIT a little bit, but my impression at the time was that we probably hadn't. We were looking at H-alpha, the SLIT looks in XUV. It struck me that the chances were that in XUV, the SLIT was probably on bright XUV in this unit. It looks higher. The features are more diffuse, and I think you probably got good data. So we did not move. We did not want to re-point at that point in time. Flare fall. We talked about the PMEC counter. It is steadier, but it still oscillates up there. You just have to integrate it mentally. It didn't give us a problem. We knew we were in flare fall.

KERWIN Flare threshold philosophy. That is a problem only as it pertains to the false alarm. The business with the South Atlantic anomaly. The South Atlantic anomaly will saturate the PMEC, so I don't think it matters where you set the flare threshold. Incidentally, I've always kicked myself for not putting this on B channel, but based on the PMEC count, we estimated that the flare we got was an M-4, which it was. I think that the numbers that they generate on the ground are accurately reflected by the PMEC count onboard, if you're not in the anomaly.

WEITZ And setting the flare threshold lower than trigger valve probably would not have helped in my particular case. You've got to keep in mind that it was the first one. Nobody knew what or where our flare cues were going to look like. It took me longer by looking all over the place to decide whether we were in a horn or the South Atlantic anomaly or not.

Setting it lower. I don't know. You would have to look at the rise. I think the rise was pretty fast. Having it set lower would give you 10 seconds more.

KERWIN Let me say that this gauge may be wrong, but let me offer it. I remember three flares that we looked at. The one "biggy" that Paul got. There was the one that I got, or that I picked up well into its progression as we came around the limb, that the ground already knew about and knew that we didn't take data

KERWIN  
(CONT'D)

on it. And there was one other that never reached the flare threshold that I got one evening when I was sitting there at the end of operations.

I snapped a couple of pictures of it. I think I reported that the PMEC count on that one went from threshold to about 500 and then dropped back. I think it was a subflare or some C class flare. In those three cases, the XUV, H-alpha, and X-ray manifestations of a flare were there to the extent that they were recognizable on board. I think that if the PMEC count is much less than 500, you may not recognize the flare reliably. You may go to a false flare, or you may not go to a true flare. I think setting the PMEC count lower than the flare threshold is a perfectly acceptable thing to do, if the crew wants to be alerted before they have to move. But I don't think they should set the PMEC count flare threshold less than 500 or else they are going to be confused by what they see on the onboard displays.

WEITZ You are saying that the ground should send up the value that they want you to respond on board.

KERWIN I agree with that.

If the crew wants to set it lower so as to get a lead on it, I would say go ahead. But don't set it lower than 500 because you are going to get confused.

KERWIN (CONT'D) But I think that if the count goes above 500, and you're not in the anomaly or the horns, you're going to get confirmatory evidence of the flare on your displays. It may not go high enough to ever take action on it, but at least you will see something.

Limb flares - 5-minute timing. I can't comment on it as we never had a limb flare.

That 5-minute timing is the time that it theoretically takes material to get into the view of the white light coronagraph. That's just likely to be true now as it was before our flight.

JOP 4. Prominences and filaments. Location of prominence visibility.

WEITZ You've got to go out and you've got to play with it. You've got to get the right setting on the TV monitor and in some cases, play with that automatic light.

There is only one plate on the monitor; one combination. If it's like roger's test where you've got to make the two halves to the colored circle the same color and the same intensity, and it was very sensitive to that, I thought.

KERWIN But once the guys find a prominence and play with it for 10 or 15 minutes with the displays, they will fall into it. What Paul discovered showed me, and then they won't have any problem.

There is no problem in coming back to a prominence, but I think you should sketch it through. There was one prominence that we did work on. It was a double prominence.

Two trees side by side. I made a little sketch of it and it was helpful to me to make sure I was in the right place.

WEITZ Let me just say for training purposes that it surprised me how rapidly the appearance of the prominences changed from pass to pass. I think you could re-point to the same point, or to a different place, but the appearance had changed much more than I expected it to between subsequent passes.

KERWIN JOP 5. Constant latitude studies. Latitude selection criteria. We didn't select latitude. We let the ground select the latitude.

JOP 6. Synoptic observations. - Long-term changes noted on the white light coronagraph and the XUV monitor. Again, I didn't make any discoveries on the XUV monitor about long-term changes. On the coronagraph you could definitely detect changes from day to day; however, without pictures to compare, and my

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drawings weren't that good, I did not keep in my head a file of how the corona was changing. I delegated all that to the ground. Owen may want to work it on board himself. It can be done. If he's going to take pictures of it, and if the pictures come out all right. They are going to have a Polaroid on board.

And they've got an image intensifier or persistence enhancer to be used with the XUV monitor. It's called a 4 H-alpha 2.

JOP 7. Atmospheric extinction. I ran a couple with the SLIT. That was the case where you've got to turn it off before you get to sunset or you'll break the instrument. Filter use. I'm not sure what is to be said. You run JOP 7 more or less mechanically and it worked out okay.

JOP 8. Coronal transients. I've already talked about our very limited experience with that JOP. I never saw any on the white light coronagraph and we ran very limited to no studies on the changes we did see on the prominences.

JOP 9. Solar wind. It's not something that calls for a lot of onboard decisionmaking. And JOP 10 is the same thing. I ran a JOP 11 and again, it's a fairly routine mechanical thing.

JOP 12A. I talked about my goof in calibrating SO55 the one time. And the other JOPs. The big thing one remembers about doing JOP 12 is slewing in a circle. It's a pain in the neck,

KERWIN but it can be done. Keeping yourself within a 100-arc-seconds  
(CONT'D) you tend to wander a bit.

WEITZ You always get a sloppy circle is what always bothered me.

KERWIN Yes, a 9-year-old child could probably draw a better circle  
than you can with that MPC. JOP 13. I was very disappointed  
that I didn't get to run it that one time. I was all prepared  
to do it, and then it came through and we canceled the thing.

But having had the one experience early in the mission with  
finding solar inertial, I thought we could always find it, if  
we had to.

Coalignment. It went very nicely, routinely, by the cue card  
in the front of the log. I didn't think it was a difficult  
thing to do. It took me about a week to find the H-alpha  
inner limb because it's a function of brightness and contrast  
settings on the H-alpha scope. If you don't set the contrast  
fairly low, you don't see the double limb.

WEITZ You can see it best with the best setting for prominences.

KERWIN Yes, as a matter of fact, you can. It's a good gage. But,  
I think our alignments were reasonably accurate for all of  
that. And you can see the double limb if you set the contrast  
properly. Coalignments. A piece of cake. It's very stable.

KERWIN  
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Video tape recording and TV down link. The only procedural comment I have on that was that I was confused on more than one occasion by having a TVD appear on the ATM schedule when what they really wanted was a VTR. At least one time it happened, and it didn't appear to correlate with the ground station pass. My understanding is that if it says "TVD" that is real time. If it's "VTR," you go do it on the VTR. I don't know whether it was a real mistake or whether it was just a confusion on my part but it seemed to me that we were in the middle of nowhere and suddenly they wanted TVD. It's quite convenient to do it VTR, but we are not permitted to go to the VTR routinely because the ground may have wound it back in preparation for dumping. And then if you put VTM over it you may be overriding something else. The guys might want to think about actually having a VTR schedule pad updated to them, if that's possible, so that they know the times that they cannot use the VTR. You see it only takes a minute or two to get good ATM data on the VTR. If you know that, you can use it. And a minute is really nothing when you're talking about the scheduled TVs of MO92, or bloodletting, or EREP operations. They don't even miss 30 seconds or 1 minute of operation. I think it's very nice if you see something on the monitor, to get a 15-second shot of it on the VTR. And I would have liked to know if there are "no-no" times during the day, and can I do that the rest of the time.



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Five minutes for VTR is probably enough. We've gotten an occasional complaint up there that we were giving them too much H-alpha and not enough of XUV.

Set up and shut down time for VTR operations and TV down link. The only scheduling problem that I ever had on that was when they began wanting white light coronagraph during a roll. There's one roll in JOP 6 when you roll from 10800 around to 5400, and that may or may not occur over the ground station, when they're all ready. And sometimes we wound up holding up that roll or trying to mickey mouse it around so that it came in right and that slows down your whole day-side pass operation. It would be much more convenient to put that on the VTR because then you could just do it when you got to it.

I think what we need is some time latitude for TV down link, on the building block. JOP 6 is easy. JOP 6, you set up and then it runs itself. If you're doing active region stuff, sometimes there are times when it's inconvenient for you to stop what you're doing and do a TV down link; especially if you're counting frames on S054 or doing one of those other things. It would be very nice if you had a period of 10 minutes any time during which you could do a TV down link. Then you would know you had arrived at a point some time in that 10 minutes that you knew was going to be convenient for you.

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VTR, you can schedule with the understanding that the crewman will do VTR at a convenient time, which is going to be plus or minus 5 minutes from the time scheduled on the pass. You can always get to it within some 10-minute flock of time. But if you want it right on the minute, you may not get it. But VRT is easier to do than TV down link because the geometry of the station pass and the ground setting up is not there. All you've got to do is reach over and turn on the VTR. We had some problems with the ATM mon 1 versus TV switch. I think we lost a TV one time trying to figure out if that switch was in the wrong position. We would do it differently if we had it to do over again. I think the way we would do it would be to put a green light on the TV input stations. All of them in the cluster. That was "green" when that station was potentially hot and "amber" or "off" when that station was not. And that would mean if the switch was in ATM you would have an amber light on your TV input station. You'd know on the spot that you had to go change it. We don't have it, so we've just got to remember. We wound up, I think, by the end of the mission, remembering that any time we had TV to do, from whatever location, we had to check that switch - that rotary as well as the VTR itself, to make sure that everything was GO.

The JOP photos and diagrams were very useful. I thought they

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were excellent. They were realistic rather than line drawings. As I said, we had the ATM Reference Book. It was an excellent book. We did not get much time to review it and look at it in detail, on the JOPs we were doing. I felt behind the curve just a little bit, almost the whole mission on ATM. I felt that in spite of all the training we did on ATM that maybe we didn't do quite enough or maybe not quite the right kind because we'd go in there and we'd review a JOP, and we'd get pretty familiar with that JOP, but not in context. But I think that the next crew is probably better trained than we were on ATM, and some of the things that were problems for us won't be problems.

Voice updates. Solar activity. That was fine. We got occasional solar activity updates and sometimes we were able to meaningfully synchronize those things with our thinking. Sometimes the data you gave us didn't seem very important. But I wouldn't stop giving it for that reason. For example, knowing that a certain size flare went off in a particular active region is good to know. It may or may not mean that that's where the next one may go off, but it's a general index of things going on the Sun. I think it's good to have. It's a question of where you write it down so that the next guy can see, or so you'll remember. I don't think we had too much solar information; I don't think we had too little.

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I think it was just fine. We didn't always use it, but that's okay.

Pad changes. It's nice to have notepad changes. I don't think we had too many changes. Procedures changes. Again, in the area of ATM experiment operations, I think the procedures changes were driven by hardware malfunctions in almost every case. And yes, when you give us changes in procedures, they cause mistakes and confusion. But there's no way around it. If the hardware is broken, you've got to change your procedures to account for it, and you've got to have all the information. There was a time when we asked for completely new cue cards, and we wound getting the old cue cards back because it turned out that they were good, now that we had enough power. They still weren't 100-percent perfect.

There were two occasions when I went to the famous Kerwin building block cue cards and dragged them out because an isolated building block had been scheduled, and it referred to a JOP where it was appropriate for the pointing and roll instructions. Or it referred to JOP "something" or step "something" but use a different building block. I thought it all that worked out fine. ATM scheduling. Some of the passes, I thought, were too crowded. Those were the ones I didn't finish probably because I got hung up on a 55 grating

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and I didn't get it changed in time. Once or twice I ran through the proper grating. You got a big change to make and you start the thing going and instead of looking at it all the time - you go and do something else. And then you find that you've missed it. There's nothing anybody can do about that except try and do better next time. Again, the further into the mission we went, the more it seemed reasonable the revs got. We were working very hard most of the time we were up there; except on those early and late revs when you had maybe a building block 6 or JOP 6 and a calibration. There were some passes that were obviously relaxed. But they were nice to have because they were the ones where you could spend a little time joysticking around the Sun and checking up on active region 33 and seeing what it looked like and looking for prominences and things like that.

Concerning the 5-minute observing time. Sometimes we found we used it for setup and review, especially if we found it was the first one of the day. We wanted to look through the solar activity pad and read it. You don't get a chance to read those things when they come down to you in the morning. You might think we would; all that 2 hours you got before you ever start doing ATM. Well, there's routine stuff to do all the time. Whether it's brush your teeth or put the pads around

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or check some temperatures. The first pass of the day, I didn't wind up getting very much observing time. I think we'll see what Owen says once he gets up there. I think that once a day you need a half a rev to observe the sun, where you're free to go and do what you want. Call up Sun center, call up the coronagraph, and look at that a couple of roll orientations. Of course, if you have a JOP 6, that'll suffice. And looking for prominences or looking at the different active regions. Taking a picture of them, if SL-3 is going to do that. Or making an overlay trace. I wound up doing that in bits and pieces. If I had a day when I had three or four revs at the ATM, I would get that done. If I had a day where I had one rev in the morning, and maybe nothing else for two revs, I often didn't get the survey work done.

Setting up time at the console, the 7 to 9 minutes was enough to run a rev. You're going to do it in a more or less mechanical fashion. And it depends what you want out of the observer. If you want him to run the building blocks efficiently, you've given him enough time to do it. But if you want him to play around and make observations, he's occasionally going to want extra time to do that. I guess I found that the major times I had to do that were in the evening, where one of those two evening passes would be a very light pass. You'd wind up with

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15 extra minutes of sunlight time. If you weren't too tired and your interest was still up at the end of a long day, you could go and have a ball. I guess it's up to Owen whether he wants to have that kind of thing in the morning when he's fresh. I did get the impression more and more, as I was up there, that kind of observing was being done in parallel by a lot of experts on the ground who were better at it than I was.

Activity during night passes. It is possible to grab a bit to eat, if it's lunch during a nightside pass. And it is possible to do some housekeeping during a nightside pass. It's not good to have time-critical operations during nightside passes, to actually go run another experiment that calls for time-critical operations. That gets tough to handle. On your nightside passes you don't have to stay at the ATM panel and shuffle paper and get ready. I think you need 5 or 10 minutes before sunrise. But once you've secured the panel, you can go and do something else. Go to the bathroom, et cetera. Actually I found that the way they scheduled the days, when I had two or three consecutive ATM passes, what I did in between passes, aside from getting ready for the next pass, was to catch up and get a little bit ahead on some of the things I was going to have to do later. That was valuable time. I

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wouldn't want to see it clobbered up with a lot of scheduled stuff. It's catchup time. It's the same thing you do during a regular day. I guess what I'm saying is, we wound up in the mission having pretty reasonable ATM scheduling. I wouldn't want to see a lot of extra scheduling laid on during the night because particularly on those long missions, you want to have a little latitude. You don't want the guy to have his nose on the grindstone all the time. He's going to get tired and stop producing.

ATM Systems Hardware and Operation. The ground knows most of the details of this operation, and we put a lot of comments on channel B and I'm going to tell you what comes off the top of my head.

Cluster Stability. Discounting the first few days of the mission, the cluster stability was excellent. We never had to go find the Sun for Houston after the first time. We were losing rate gyros all the time but the effect on ATM operations, in reference to that was minimal to none. I don't remember a single case where we had a fire drill based on Caution and Warning as to cluster stability, stuck thruster, et cetera.

EREP Maneuvers. They went very well. There was one occasion on which we loaded the wrong time for an EREP maneuver and



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fired some TACS and got into a bad momentum situation. But the reason for that was obvious. The EREP maneuvers were well padded. The one comment I would have on the EREP maneuvers was that the settling out time of the cluster at the end of the maneuver was under estimated and that the EREP operation frequently began before we were in attitude. By which I mean, that in Y we may have been as much as 0.7 of a degree off of attitude at time of EREP start.

JOP 13 we did not perform. I can simply say that it is my impression that JOP 13 is a feasible thing to perform, and we could have done it and I encourage the next crew to try it.

S020 Offset Pointing. We didn't do it. The star tracker. The one major problem with the star tracker is that it appears to be too sensitive to false lockons. I assume that these things are the bright particles that we saw so many of in the white coronagraph, contamination particles floating by the field of view of the star tracker and taking it off the star. That happened up to several times a day. It's a pain in the neck. You have to go back to repoint the star tracker, or your orbital plane error gets all fouled up, and your momentum starts to go to heck. The ground kept very good tabs on all this for us. I don't think the ground was unreasonable in what they were asking us to do. It's an inherent equipment

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problem. I can only hope that the contamination and off gassing of particles will be less on Skylab 3 than it was on our mission. Star tracker is easy to point. Procedurally, I found that I was using a slightly different method than we used in the trainer. In the trainer you point to the precise gimbal angles given you on the pad and then go to ACQ AUTO and let the star tracker lock on. We found that with our false lockons, and therefore rather large changes in orbital plane error, that the gimbal angles given by the ground were frequently in error by as much as 1 or 2 hundred arc minutes. I think the ground knew that, too. But the effect of that is that if you go to those angles, and then leave the thing go, you generally got an ALERT light and a star tracker 'failure to lock on' and you have to go back and start over again. The way to go is to go to exact inner gimbal angle given on the pad, which changes very, very little. And then sneak up on the outer gimbal angle from 3 or 4 hundred arc minutes away from it, sweep on through it, and go to 3 or 400 arc minutes the other side of it. Somewhere in that line, you're going to lock on to the star, and if you keep your eye on the talkback, you'll see it go to MANUAL STAR, and then you hit it to AUTO and then you're home. Just cycle it in OUTER GIMBAL angle back and forth manually, and find the star manually and then lock on. That's a quick and easy way to do it.

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Momentum Dump Operations. Ideally, rather than giving a particular time for momentum dump INHIBIT or momentum dump ENABLE, I would like to have time deadband. ENABLE MOMENTUM DUMP between such and such and so and so. It would allow the crew to do it when it was convenient and at the earliest possible time when they could do it without interfering with the dump in progress, or being too late for the next nightside pass when you need to have dump INHIBITED. You know that a momentum dump doesn't have to be enabled or inhibited at a particular second, but if it says that on the pad, you try and do it that way, and sometimes it gets forgotten.

Controls and Displays. No comments. DAS Operation. No comments. The DAS worked well for us at all times. It was our custom, based on the way we started out, to power down the DAS most of the time to save those few microamps of current. It was our custom to leave the DAS power switch OFF, unless we needed to use the DAS, and then we turned it ON, used the DAS, and turned it OFF again. That way the calls up from the ground, that we're going to update so and so, "Please stay off the DAS." All we had to do was go to the speaker box and say "Roger." The thing was powered off anyway, most of the time.

Structures and Mechanical Subsystems. I don't think we had any comments on the ATM structures and mechanics. You can see the canister rolling from the STS window, which is an interesting point. No other comments.

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Electrical Power System. The ground did most of the management on that, God bless them. Some confusion still remains in my mind as to exactly what was going on in one or two of the CBRMs, and why we had lights at given times. But I think those are details, and the fact that the ground handled the power system with very little assistance required from the crew simply allowed us to forget most of what we knew about EPS malfunctions in the ATM.

SWS Parallel Power. Again, the ground handled paralleling and had us set the transfer bus voltages pretty much by rote, from time to time, to keep the paralleling to where they wanted it, and that worked out very well.

Controls and Displays. I think the controls and displays are very awkward on the ATM in terms of malfunction detection in the CBRMs. The business of alert light, talkback, switch position, talkback going grey, going back to barber pole, not going gray when you powered the thing down - if there was more than one CBRM that was having a malfunction, the light would stay on. That's a complicated, cumbersome system, and I hope we won't design one like that again. It contributes to my own present mental confusion as to exactly what the status of the CBRMs was at all times.

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Thermal Control Subsystem. The C&D console thermal control subsystem never gave us any difficulty at all.

The canister thermal control subsystem didn't give us any trouble because it's not our system. It's handled by the ground. The controls and displays are adequate for the job we had to do. We had no significant malfunctions that I can remember, and I have no further comments.

The TV Monitors were in good conditions. They were just like preflight. We commented on the quality of the individual images, but the monitors themselves were trouble free and gave us no problems.

We saw no degradation in the TV monitors throughout the course of the mission. MONITOR 2 has a lot more time on it than MONITOR 1. They both look the same. The recorders were handled by the ground 100 percent of the time, which was great with us. And the telemetry system likewise.

The Alert Light Subsystem. I've commented on it in the line of malfunction detection in the electrical power subsystem. Other than that, I think it worked well. Of course, we taped over the DOOR OPEN light, because it was there all the time.

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Explosive Devices Subsystem. No comments. Lighting Subsystem.

The only comment I have on ATM lighting is that we never used the integral lighting on the ATM except for pointing a couple of times. The ambient lighting of the ATM is adequate to do the job. It's not as bright as you'd like to have for reading and writing, but if you made it that bright, it would be too bright for good observation on the monitors. So, we generally operated with two MDA lights on in the vicinity of the ATM panel and that's all. The integral lighting, under those conditions, was simply not necessary. It's beautiful lighting, but it's not required. One comment on the controls and displays that both Paul and I noticed. Under the lighting conditions we had, it was very difficult at times to tell a gray talkback from a white talkback. If you see first one, and then the other, the ambiguity goes away; but if you look at a gray talkback, you're very likely to think it's a white one, if you don't see a white at the same time. And I think in the future we should avoid those two colors on the same talkback.

### 14.3 EREP Experiments

WEITZ Let me just start with the C&D in general. The first time we powered up the EREP and the C&D, there were malfunction lights all over the place. We had a whole bunch of EREP malfunction lights, the S190 COVER CLOSED malfunction light being on continually. This happened any time we had power to the C&D panel, regardless of whether the cover was open or closed and regardless of how gently or briskly we opened the cover, within limits. I didn't try banging it open, because, as I remember, that switch is on the closed side anyway. But I did slap it and bang it open and shut a couple of times, and that didn't do any good. The light was on steady the whole time. Yes, as long as it had the capability to light, it would light, regardless of what we did to it. I didn't do it many times, because when I did, I'd always knock little pieces loose from around the door. That cover would open, and we could see the back end without any problem. You could also watch the S191. You see it very well out there. You can tell when it opens and closes out that S190 window. The controls were good. On the C&D panel, the time came up right every time, it was within sync. For some reason, when we turned on any of those clocks, they would typically come on all zeros, flash right away to some erroneous time, and flash again to the real time. All the digital display units, the one on the STS panel, the one down in the workshop, and this one, all behave the

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same way. It must be the way the logic is set when you turn them on to display the time. But it is not a problem. The C&D unit otherwise functioned normally. The decals were good. The one thing we were missing was our little bungee across the inside of the lid. We'd had that every time in training; we got up there, and it wasn't there. But we got one some place and put it on there. We did have occasion to use our little tape recorder failure decal. An interesting point that I wasn't aware of is that if you switch the 60 ips, and S192 is not putting data on the tape, you will get a tape recorder malfunction light. The primary reason we ended up switching to tape recorder number 2 the first time was that we had opened those S192 electronics box circuit breakers earlier and had not closed them again. Procedural error! The only other displays we had were in the VTS. They worked fine, and I kept them on low the whole time. There was only one other thing that I never noticed before: anytime I looked through either the flight or the training telescope, my right eye looked at the cross hairs. The align indicator, when I was doing an alignment, was right in the blind spot for my eye, and I'd have to move my head around in order to see.

Tape recorder: I mentioned the malfunction light at 60 ips about which I wasn't aware. Other than that, the tape recorders seem to function normally except for this anomaly on the



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on the blinking speed light on tape recorder number 2 at 60 ips. You're probably going to find out more about that when I look at that tape, if it's not a bad tape. We did two tape recorder changeovers per decal. We did not power down the C&D. Tape recorder loading was surprisingly easy. You can control that tape perfectly. It's got no memory; it doesn't want to coil up; it doesn't want to straighten out. You could set it and it would stay. The tape is thin enough that there's no bimetallic effect in which one side stretches and the other side extends. It's a piece of cake. You can load it easier in zero g than you can in one g, because it's not lying down in the bottom. You can put it where you want it, and there it stays. The stuff sticks to itself very well in zero g. You'd only have to take about one turn around the takeup reel. There's about a 6 inch gray piece of tape that I assumed was the cleaning piece. When I saw the gray piece, I backed it up so that the first time the tape recorder was started, the gray piece would be pulled through the head. But you really had to watch where the tape comes off that last compliance arm, the little double jiggy there, it was very easy for that tape to be high by about 1/16 of an inch. It would run out there fine except it would come against that collar and fold over the top 1/16 or 1/32 of an inch of the tape. You really had to watch it to make sure that the tape was lying right down in its proper

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place on the roller. When I cleaned the tape recorder, I got the impression that something that comes off the tape is deposited on one pinch roller, the one next to the capstan. I think it's called a pinch roller, and it's on the tape-in side of the head. That's the only dirty place in the whole tape recorder. The heads are always clean as a whistle. I could have used the same swab to clean the heads 20 times. Nothing else ever got really dirty. Except for that pinch roller, the whole tape recorder could have been cleaned with two or three swabs at the most. If you cleaned it immediately after running it, it wasn't too dirty, but I had the feeling you could go back that afternoon or the next day, and you could clean it again, and it would be dirty. I think we may want to consider cleaning that roller as part of prep rather than post-operate, or both.

While I'm talking about tape recorder cleaning, some of those packaged swabs that were up there already had so much alcohol in them that their wooden sticks were saturated in alcohol. They were as good as the ones we carried up. We opened one big overbag, and we used one we carried up. The rest of them are still up there. At the front end of the M130 stowage box, where the gloves are, next to the hinge line are all the swabs that we carried up in their foil packets. Since we had extra swabs, we saved all of the empty Beta cloth pouches; the swabs

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are stuck in there with them. On the other side of the glove box are six S190 desiccants in fecal contingency bags. As far as the tape recorder running hot, we ran the recorder one time for a while doing something and Pete felt the underside, and he said, "No wonder they got coolant on it," so it ran hot, or at least warm. A final remark on the tape recorder is that the plug changeover went just like the trainer. However, the dust covers are not color coded. I thought they were, but they're not. If there is a difference, we were fortunate enough, because at one time in our rapid change, Pete wound up with all our dust covers loose in his pocket. When we put them back on, they fit the first four places, so I assume that any dust cover can go on any receptacle. By dust covers, I mean the blue microdot connectors that go on the unused connectors that are placed on the tape recorder, when it's not in use.

Checklist Changes. The changes kept us quite busy. The EREP Checklist and the EVA Checklist were the worst ones because they were the most up to date. In other words, the powerdown changes were made to the EVA and EREP Checklists prelaunch in pen and ink. Therefore, there was no way to get rid of them even when they no longer applied. The EREP Checklist is a difficult checklist to follow because we have put the "sometimes" and the "maybe" things in the normal flow. Take the sensitometer advance, for example. You look in the book

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and it's not immediately obvious; we don't separate out. Had we made it better, we would have had these sections separated. You ought to have a nominal checklist with none of the "iffy" stuff; these little boxes that say "iffy sensitometry advance: go to page so and so." I don't know what the follow-on crews want to do. I would have suggested making the summary sheet from the checklist into a cue card, or tearing it out and using it as a cue card, which is what we did. Then I know where it is in the checklist. If I wanted to doublecheck and make sure that I had done everything under VTS PREP TV, I went to that part of the checklist. Timeline Pads: The VTS and C&D pads were all right. But, once again, you have to jump around on those pads. Some stuff is on Pete's operate pad. For example, the VTS operator is the guy who takes up the film. Every time he got a VTS, the operator had to call the C&D operator and say, "Which film drawer do you want me to take up and which DAC magazine?" S193 pad times and the S191 auto cal times were precise. Somebody just flat miscalculated ready out times on S190A a couple of times. Pete mentioned it. One time he looked up and observed almost a minute before the pad said the READY light was supposed to be out. It was already out, and after the pass, I sat down and figured it out, and the pad was wrong. Take the frame interval, times, number of exposures, and add 6 seconds to it, and it doesn't come out to the same time the

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pad said the READY light was supposed to go out. On the VTS pad, make sure that Jack Lousma reads all the remarks on the pad and is familiar with them. I didn't a couple of times, and consequently on some of the nadir swaths, they didn't get all the DAC camera run they wanted. That was my fault. I feel the information was there. This is just for Jack to make sure he reads everything. The VTS pads were not on time; they were 2 seconds off. On the easy sites I could distinguish that. The pointing was way beyond it. When I saw the site at about 45 degrees, I'd looked at the time and it was 2 seconds earlier. But the pads were generally good. We adjusted the reticle prior to each pass and checked the alignment prior to each pad and it never needed realignment.

Malfunctions: We had no real malfunctions. On S190, the first time you put the magazines on, I think it was despooling. There must be slack in there. On deactivation, the worst thing to handle in zero g is a lot of pieces. When you get more than two pieces, they're hard to handle. I had the holder, magazine, and cassettes floating around, but I kept them all contained. Suddenly I heard this noise from the floating cassette and the film was unwinding inside the cassette. I heard two of them do that. As far as other malfunctions, we got a periodic S193 gimbal light. It was always associated with changing the direction of scan of the antenna. You could watch the antenna indicator, and you could watch the torque currents. And it

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would go back and forth. I annotated it at the time, what modes it was going in. On the S191 malfunction, we went through on the READY LIGHT exercise. We pretty well documented that cool-down exercise on tape, we gave you time, et cetera. The whole secret is having the C-7 reading. If it was a 35 when you started as opposed to 30 percent, there was no sweat. Once it started off the peg, you could watch the cooler case temperature needle move. It wasn't a slow thing; you'd have to look at it every 30 seconds. We annotated and put on tape the value at which the READY light came on, and it came on at the same value every time. Whatever it was, 53 or 58. On S190, those desiccants are going to have to be changed very regularly. They don't last 2 days. From what I now consider, I'd say they ought to be changed every 2 days, and that means running with the two sets of desiccants. Say you change it today, and you put them in the fecal oven and dry them out. Two days later you change a set, because that oven works great. You pull them out of there in 1 day, and those things are as blue as you'll ever see them. You can tell when they're ready by putting them side by side. That's the only way. They go to nearly white so fast, there's no question they'll go nearly white within a day. The camera operation was normal except for the malfunction lights I took the magazine out and made the mark on the film, put it back on, and manually advanced them two more steps.



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get a hold of it, and help it through until that set part got through all the rollers. It seemed like it was almost acclimatization of the film of that environment. Some of it was worse than others. The thinner or more flexible the film, the worse it was, and the more set it would take. I mentioned also the distinct change in color where it was exposed through the opening. The filter there worked well. We mentioned that one was dirty; I also mentioned I had to clean a yellow one. It had water spots on it.

The only tool we used was the small spanner wrench to tighten down the filters. We wanted to make sure we got them tight because things back off at zero g. If you don't make sure threaded devices are tight, they will loosen. Ones you want to stay loosened will tighten. Things will move, and for a vibration-free environment it's amazing. I had no problem; no filter ever loosened. The camera shields were no problem. You tend not to distort them much. On the filter return container, no comment. It's still there. That's all I can say about it. When we weren't using a camera, it was in a stowed position. We never used an intermediate.

S191: On the viewfinder tracking system, the line indicator is in my right eye blind spot. I took the headrest off on the checkout, and never used it again. Both Pete and I used the



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eye cup; Pete used it one time when he ran the VTS and used the eye patch. I used it one time and didn't especially like it. After that I was about 50/50 looking through it with both eyes open, just squinting my left eye. I have something to say about sight acquisition. The later it got into the mission and to the U.S. sites, the earlier in the day it got, and since we were going from west to east, we were looking more up Sun and through haze. It became very difficult to see at 45 degrees. In many cases, I started just like in the trainer. When I couldn't find something, I just started the IMC on time, started looking and saw when I got the DAC film back. You can look and look and look, and Eagle Lake is no easier to find for real than it was in the simulator. On that day, anyway, with that 4/10 cloud coverage of little puffy clouds, I couldn't make out a thing, and I had the salt dome for the next site. After one more try looking for Eagle Lake, I said, "Okay, there it is, I'll come back and get it. I'll make one more try for Eagle Lake." I couldn't find Eagle Lake; I went back and I couldn't find the dome anymore, and that's how I missed that site. But it's difficult to see looking up Sun. When the sites get through nadir when you're looking straight down, things become pretty easy. It becomes very clear. The telescope does not have a large enough field of view to correlate the things you want. And I would not give up magnification to get field of view. You need the magnification for precise tracking. Of course, it

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doesn't affect us, but it may affect future designs. Also, when you get to maximum, you can hear the clutch slipping in the magnification drive. It changes pitch markedly. Lugging the whole site book up and keeping it at the VTS is not the way to do it. When you are looking for a site, you do not have time to take your face out of the VTS. I mentioned this once on B channel in response to a series of questions sent up. Three or four or five days later when another plea came, I gave the response to Hank Hartsfield in real time. You do not have time to cross check between what you are seeing in the telescope and what the photograph shows you. The value of those site books are as training aides, and as reviews in memory joggers before you start to pass. You've got to know the site and the landmarks, and you just have to keep your face in there. And I can not say how invaluable it was having looked at them from an airplane. From the value of looking at them from an airplane, you can get 90 percent of that value just by flying over them in a T38 and looking out the window. The telescope helps some. It gives that other 10 to 20 percent by letting you see a limited field of view. You still need the simulator. Therefore, they have to assign a priority. I think our subjective evaluation plus the simulator can tell you which ones are the difficult sites. Eagle Lake was difficult on the simulator. I didn't find it. The same way with the other ones. The deserts, the

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first two I shot, were easy to find. High contrast things are easy to find. On the DAC camera, when I turned the power switch on, the light would come on. I could hear the motor starting to the DAC, and it would take one frame, and stop. When I turned the camera switch off, it would cycle that one frame. When I turned the camera switch off, the camera light would stay on for a few seconds, and then go off. But it would stop pulling film as soon as I turned it off.

I said everything about S192 in real time and on tape. I can't say how frustrating those alignments were. On checkout, the visible was already there to some extent, but I lost it during the focus. The focus is very very difficult. Adjusting the focus completely messed up the alignment. More than once we lost the alignment completely. It just dropped off the bottom of the scale, and nothing we could do at the time could chase it with the alignment knob. You could make a pure couple, which is hard to do. It's an awkward place to reach and apply with your thumb and a finger, without loading the optical components on it right there. I documented all the information as best as I could. Plus I gave the micrometer settings on thermal alignment.

The best part of S193 was that you could look out the STS window and see that big antenna doing its thing out there.

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You could watch it scan. You could tell the way it scanned by looking at what mode it was in, whether it was doing a cross-track contiguous or whether it was off to one side. Pete did the first nadir align, but I'm the one that messed him up because he misinterpreted what I said. It started searching, and it became obvious to me it was not getting an align. It was just running all the way around the edge of its pattern. It was never getting an increase in AGC. I was watching the antenna position meters, and the roll and the pitch indicators. They would just do their thing. I told Pete, "This align is no good. Reject it." What I meant was, when it comes to the decision time, reject it. He misinterpreted that, and when I said reject it, he thought about it, and he decided it wasn't working and turned it to STANDBY while the READY light was still on. So it was his misinterpretation of what I said. But the thing that surprised me was we never tried another nadir align for about six more passes. We got gimbal lights sometimes; it's nothing to worry about. I think Pete got one overheat light one time. We had altimeter unlock lights, but I think then the guys on the ground started playing with the range settings, and we finally wound up to where we didn't get them anymore.

I don't know how Pete handled S194. I think that every time we turned 194 on, we got a malfunction light during the cold calibration cycle, before everything got up to temperature.

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After it had finished its 15-minute warmup, Pete would cycle it to off and back on to reset the malfunction light. We assumed that didn't hurt the equipment, because we said we were doing it, and nobody said not to. It functioned normally. We never got a S194 malfunction light during the experiment.

On the lunar calibration, everything went per checklist. The maneuver was good. We didn't have to do a fine maneuver on top of it. It came out within half a degree, as near as I can tell with the granularity of the telescope, of being right on where we wanted it. We messed up on S190, but we recovered from it. That was all given to the ground real time. That will have to be correlated with the sequence frames. Instead of getting two more on the Moon bonus, I shot about three more and a couple of high ones and a couple other things. I had enough time to do that. But you'll be able to correlate that with the DAC, assuming the DAC was right. The lunar calibration itself was a piece of cake. I remember something else, too. Whether it's optical zero or what, I mentioned this image motion as the telescope was zoomed where you've got the Moon relative to the VTS for it not to change its location in the reticle. At maximum zoom, you had to put it in the lower left quadrant. Then when you zoomed out, it was sitting down there. But if you start with the little Moon in one place and zoom in, the

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image moves on up, and I'm trying to remember now if it moved out of the field of view of the ground monitor or not. I think it did. I forgot what it's called. I never really noticed it before, because even when you're zooming, on the Earth, for ground sites, you're looking at the whole picture. I never noticed it doing that until I was playing with it. On our communication setup for EREP, we wound up using lightweight CCUs and lightweight headsets for each operator. Prior to the EREP pass, we would configure the STS panel to voice record on channel A instead of on channel B. And to get VOX keying in the command module on the pilot's communication panel, panel 6, we would go to VOX instead of intercom PTT. That was all; then we had real-time VOX to the ground from those two guys, and we were voice-recording the whole thing on channel A. It's as simple as that; two switches are all you need. If the Skylab 3 crew want to do it, I would suggest it be put in the checklist, coming out of the EREP configuration, just to make sure they don't forget it.

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S190B was one of the better-running experiments on board. There were a few crew interface problems, but in general, the camera operated completely nominally the four times that I used it. Film loading took a little bit longer in flight than it did in

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preflight training. The first time, I think, was due to a little "fumblitis" on the part of the SPT. And it didn't go much over nominal - 30 seconds or a minute. When I loaded the backup canister, it seemed to me that the film hung up on the takeup reel end of the magazine. It was very difficult to get the thing to come through the roller at that end, although I pressed the idler back. It hung up in there, and it took me several tries to get it to come on through. There may be a little tolerance problem there in that backup cassette. I think the other one's perfect. Unloading the film was easy and nominal. Had one little pad problem on there. In the first place, when I used the backup cassette, with the BW01 roll. I wasn't told where to put it afterward. And I put it back in the MDA film vault, which I assumed was correct. Then, at the end of the last run, there were never any instructions in the Flight Plan to unload both of the cassettes and put the film back into the film vault. But I went ahead and did it, because it seemed the right thing to do. Probably that ought to be mentioned specifically at whatever time it is to be done.

The first run was nominal. I believe it was the second run that I did my double goof-up there. I loaded the backup cassette, I inserted it into the camera, and I got the hissing sound that

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we talked about. And I said, "Well, I'll use the vacuum, but I won't use it until I'm ready for the run," and I disconnected it. Then, when the run started, I got into the checklist mode; I never did reconnect it. As you know, the second run with that cassette, I was directed not to use it, if it continued to leak, which it did. Afterwards, in the troubleshooting, I reported on B channel the details of that. I took photographs in an attempt to show that the connector in the film cassette where it joins the vacuum head on the camera seemed to be a little bit shorter in the backup cassette than it was in the prime cassette that got pictures. That may have been the source of the problem. I could find nothing else wrong. Also the operational goof-up I made on the second run with the black and white film was that I missed the first several minutes of the run, because I just had my head up in lock and forgot to turn my camera on. So I missed the first sequence there. That was not a hardware problem. The second run with the black and white continued to hiss and lose vacuum. We didn't run it with the vacuum on. We went ahead and ran it up, and ran it out. The last pass, using the end of the color film, went nominally. And there weren't any other problems with S190B. It's easy to operate, and the hardware is in fine shape, with the exception with that backup cassette.



#### 14.4 Individual Experiments

WEITZ M509 - Astronaut maneuvering unit. Unfortunately, the only thing that we got do to was activation which consisted of removing the launch bolts, of which there were a lot. The CDR charged the propellant stowage spheres. It went per checklist. As far as I know, there were no anomalies. The unstowing of the equipment went per checklist with no anomalies. We did not attempt to charge the batteries. Apparently, that's the whole reason we didn't get to fly it. The structure sound. On the check-out test, the propellant system acted as advertised. The attitude control, other than bringing the CMGs up to speed, was not exercised. As far as CMG sounds, there were several. You really had to listen to hear them. The CMGs came up to speed at approximately the right time. All light indications were normal. Control modes are not exercised. The electrical subsystem was primarily off spacecraft power and not EMU power.

WEITZ The arms. Adjustments were checked out. They functioned normally. The hand controllers functioned normally. Telemetry system. Had no data. Shirtsleeve versus suited was not applicable. Suit drying station was not applicable. HHMU was checked out. That was us to see that it worked. The handgrip fit all right. The shirtsleeve handgrip was the only one tried. It fit all right.

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Operations in the donning station were satisfactory. Battery charging was not attempted. Noise levels were nominal. It was a much larger volume and diminished air pressure; ambient pressure and the background noise levels were lower than I anticipated. They were lower than they were on the air-bearing table, but the noise levels of the thruster were quite high. I strongly recommend the use of the throwaway earplugs. The effect of the thruster plume extends quite a ways, and you do blow things around. I recommend some sort of ear protection for everyone.

Stowage and unstowage was no problem. It went as expected. There were no photographs taken. Recorder not applicable. Log book was not used.

S009 - nuclear emulsion. Stowage and unstowage went per checklist. Recorder was not used. Log book was not used. We had an anomaly in that it ceased operating. This was well documented in both real time and tape on the voice tapes during the flight. The failure mode was such that I went to S009 to reinitiate it, and the thing was stuck in the half open/closed position. I removed the package and checked it out. In going to the package closed position, it would stutter and hang up and not drive normally. The system was powered down and the S009 package was left in the frame in the open position and

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Beta angle adjustment was changed as required as directed by the ground.

S019. Stowage and unstowage was per checklist. Setup was per checklist. Scientific airlock door operation was nominal. AMS extension and retraction was in all cases nominal. AMS rotation during the first time it was attempted was difficult. It seemed to have steps in there which are precisely 1 degree apart. This got a little smoother as the mission progressed and apparently is of no concern. The tilt could not be operated at all. It was bound up fast and tight. On directions of procedures provided by the ground, which were exceptionally well written, the equipment was repaired. The film canister hatch worked normally. Recorder was not used. Log book was not used.

T027, S073, and S149. Stowage and unstowage is documented on the M151. Was per checklist. Was easy to handle. It is definitely a one-man task. You do not need two men for that. All you had to do was keep your rates low. Remember the inertia you're putting in to a piece of gear of that mass. It was quite controllable; no problem at all. Setup per checklist.

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T027, which applies to S073, also. For stowage and unstowage setup, control panel was no problem. Cameras were no problem. Recorder - I don't know what it means, and the log book doesn't apply.

We had the one malfunction on either T027 or S073 in which we could not get the thing back to the faired position so it could be retracted. In preparation for troubleshooting there was a time in the seven-rod extension mode in which we retracted into two rods. And in retracting to the second rod, it was gently, but inadvertently, retracted until we felt the photometer head bang up against the outside of the workshop. We went ahead and applied power to it again, and whatever was wrong with it, which would lead you to believe that it was some kind of freezeup, then it functioned normally after that. So we put it back to the trunnion and shaft position required for retraction and retracted it. For S149, the same stowage and unstowage comments apply. We did no monitoring, recording, or logging. All we did was extend it. That went per checklist.

CONRAD D008, radiation in the spacecraft. It was only run one time, and it was the back-to-back radiation measurements, and the checklist was well written. It was a relatively simple experiment, and to the best of my knowledge, I ran that

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(CONT'D)

completely on the time line, and annotated the B channel tape so that it should be self-explanatory and you all should have the data on that.

D024 was done on the EVA, and the retrieval of the panels and stowing them in the container went per checklist. My only comment is because there are no foot restraints down there, it was something that I just had to take my time doing. I spent most of my time hanging on with my left hand to the little guardrail around the D024 assembly, just moving slowly, performing all operations with my right hand, and using my left hand to hold my body and stabilize myself. That just takes time, because you've got to move slowly, so you don't get out of shape. I don't believe that I touched any of the panels in any of the places that would cause any problem with the experiment. I was able to pull the panels off and transfer them to the return container in a proper manner. The big butterflies on the return container made it simple to open and close.

M512 - materials processing facility. The mounting panels and the work chamber and the control panel and the battery control box and equipment stowage containers - all are exactly as the training equipment we used. The returned samples were identical to our final training samples that we ran, and the

CONRAD  
(CONT'D)

welding went extremely well. Camera and lens - we mentioned several times that we didn't think the camera was running. Everytime I manually checked the camera it ran. The viewports were the same as the training articles and easy to see through. So were the controls and displays, log book.

Vacuum cleaner operation did not work. There appeared some residual magnetism associated with the motor. I noticed that the sphere samples tended to collect on the motor housing. IVA helmet. Didn't use.

M551 went per checklist, except the number 1 specimen. I missed defocusing the beam once. I missed the 5 seconds of DAC time on before, and five seconds of DAC time on after the 15-second run on the specimen. Otherwise, the other two specimens were done according to the checklist. I noticed as soon as I took the aluminum plate out, the weld had cracked. I'm sure you've seen that on the specimen.

The mirror would not screw on on top of the gun. I finally concluded that the gun had moved out of the chamber slightly, and the mirror was hitting on top of the gun. So I could only screw one screw in because the gun had slid out just a small amount. It was also obvious when doing M553 and putting the gun cover on that the gun had moved out and that I couldn't

CONRAD  
(CONT'D)

get the cover on with the motor in and I had to put the motor and the cover in together to get all to fit. So, apparently the big G spike or the electron beam?

On M553, I started having gun trouble. It didn't show up right away, but on the first wheel, the first thing that happened, I believe it was the first sphere melted, and it was perfectly spherical on the end of the spike, and as soon as I shut the gun off it started to cool, it went pear shaped. Then the second ball just floated right off the spike. And the third one cooled pear shaped. I started having trouble, and you'll see it with all the different spheres. The sphere wouldn't melt completely. It would start to melt on the top and then it would either shut off, or the spike would retract all the way and let it float free and shut itself off. Sometimes the spike would retract and the sphere would stick on the ceramic. Sometimes it would melt all the way, and the spike would retract and the sphere would stick on the ceramic, and then it would harden with a flat side to it. You're going to see that with all the experiments. Along about the time we start having gun trouble, it also took a tremendously long time to get a vacuum and maintain it. Something was out-gassing, apparently in the gun.

CONRAD  
(CONT'D)

Whenever we opened the filament chamber valve, it just took a very, very long time to get a good hard vacuum in there.

Apparently the more we ran the gun, the more whatever it was was outgassing. I think you have most of those comments in real time on B channel. And we finally knocked it off, and brought wheel 2 home.

If we had not had the gun problem, I think we still would have some problem with those spheres forming. The second wheel seemed to form spheres better than the first one did on the hard stings. But you have those to compare. This is just my offhand opinion. That pretty well takes care of M512, 551 and 553.

M552 was done by Paul Weitz. However, I was there and it went exactly per checklist, as advertised, should be perfectly nominal, and you'll have to look at the return samples to determine how well it worked. But it worked the way the checklist indicated it should.

T003, Inflight Aerosol Analysis, went per checklist, and you have all the data cards back. The experiment operated completely nominally. Occasionally we would misinterpret the Flight Plan and take a reading in the wrong place.



CONRAD  
(CONT'D)

S183, UV panorama, the stowage, unstowage, and pressurization went exactly as advertised. So did the setup, the cameras, the alignment, the recorder, and log book. When I ran into my problem, I was taking a series of films, and I had gotten to the point where we were in the middle of an exposure. Per advertised, we were going out into the sunlight, and the thing to do to stop the exposures was to go to STANDBY. I heard the film start to click out, back into the cassette. It seemed to me that it finished doing whatever it was doing, and I turned the power off and went away. When I came back I discovered that it had not, in fact, retracted the film slider all the way. I turned the power back on. I was not at the next cassette number, and I didn't notice that on shutdown. Now, I thought, perhaps I might have shut the power off before the sequence had completed itself. But I'm assuming that even if I had, it would have gone ahead and completed itself when I turned the power back on. That may or may not be true. I may have caused the problem, or I may not have caused the problem. Anyhow, I went through your recommended malf procedures, and that did not take care of the difficulty. We finally had to open the film magazine from the camera, and there was a slider completely stuck there. The instructions said "Pull the slider out of the S183." I could not pull it out. It hadn't come far enough out. The gear teeth were all

CONRAD  
(CONT'D)

engaged. So, with the cassette removed, I simply turned the power on and it immediately clicked the slide the rest of of the way out of its own accord. I returned the slide to you. From that time on when we used the other film cassette and took pictures later on in the flight, the S183 ran completely as advertised.

#### 14.5 Educational Experiments

WEITZ ED76, a neutron analysis, was the deployment of 10 detectors. And at the end of the mission, there was a recovery of the four Alfa can detectors, and they went per checklist.

KERWIN ED31 was the student experiment on bacteria and spores. We fitted that in, and due to directions from the ground, the time line we ran on it was not quite nominal. I don't remember the mission day on which I started it, but it was something like 23. I broke it out with no difficulty, and the can appeared to be in good shape. The plates inside were all intact. The first little problem I noticed was that the yellow tape that held the lids on the cans simply wasn't strong enough to stand the strain of being opened and closed as the disks were loaded into the Petri dishes. When you closed it up again, it wouldn't hold. Of the six Petri dishes that stood out ambient, I used gray tape to keep three or four of them closed, because they kept falling open in zero g. Loading went pretty well. I didn't get any contamination on them. The first pair of tweezers or forceps that I used lost their Velcro, which peeled right off because the stickem wasn't strong enough to hold them on. And this is not peculiar to ED31. This is a problem we experienced with Velcro in zero g throughout the mission. It's crummy stuff and it's not the experimenter's fault that it didn't work.

KERWIN At that point, I broke out the backup forceps, and used them. I don't think we contaminated any of the plates getting them loaded. On the second or third plate, I got the disk partway down, and noticed it was backward, had to peel it off and turn it over. I don't think we contaminated it in the process. We put the nine in the incubator, and the six on the wall, and 12 hours later, I reported on B channel that I inspected all the plates and that if I saw growth on any of them that time, it was only on one as I recall, number 9. Just a very little bit of growth. The first five plates or so had considerable condensation on the interior of them, but no growth that I could see. The condensation remained pretty well throughout the photography portion of the test, and will probably obscure the surface of the agar, making it difficult for the PI to detect small amounts of growth. About 12 hours later, I reported a couple of plate worth of growth, and I was told to skip the next photography session, which I did. I did not inspect the plates at that time, because I felt it was better to leave them in the incubator at growing temperature. I did note that one or two of the ambient plates had begun to show a little growth, but I didn't voice log that. They did it in about 24 hours. I waited the requisite time until it was scheduled again. It was a little more than 48 hours - perhaps 60 hours - from the time that I had started

KERWIN  
(CONT'D)

them. I photographed each plate again, and put them in the chiller for storage. There was considerable growth on all the ambient plates but one, and on a significant number of the incubated plates. The first three plates or so didn't show any growth; I don't know why. I reported roughly the size, number, and characteristics of the colonies that appeared and put them away in the chiller. I subsequently returned them in the cans with one frozen heat sink in the can. Except for the Velcro incident and the fact that the Velcro peeled off one of the ambient plates, there were no significant hardware problems with the experiment. Photographing the experiment was not a difficult thing to do, with the exception of being sure that I was focused precisely on the surface of the plate. I used the cutouts in the filter paper as a guide to focus. The camera has to be held so close to the plate that it is very difficult to hold the camera precisely parallel to it.

KERWIN

Ideally, in an experiment of this kind, involving closeup photography, you'd want to have a little frame made that would hold both the camera and the plate, or that would hold the plate and have an extension for placement of the camera, to make sure you were precisely the right distance.



## 15.0 TRAINING

CONRAD CMS in the crew station: We had some problems for a while there with the simulator star up dates. Our problems were more with the sims. We had a little trouble with trajectory information. The fidelity of the CMS was its usual excellent self. Normally, when we wanted the CMS, it was available.

KERWIN The availability was good, very good.

WEITZ The instructors were very good.

CONRAD The instructors were very good. The software was probably the best I have ever seen on a new set of software in a simulator, and have it run as far as Skylark [sic] program went. My only comment on visual is that unfortunately the horizon visual simulation is very poor. But inflight, the burns checked with the horizon, the reentry attitude checks, and it's very straightforward.

The docking is extremely difficult in CMS and, of course, so easy inflight that it's ridiculous. I don't think it's important that we do flyaround-type stuff. The modifications they made were excellent. I'm sure we did a lot of extra jockeying around in the flyaround and it wasn't obvious how to simulate that. We didn't know what we were looking for, so we did a general flyaround. We used a reasonable amount

CONRAD  
(CONT'D)

of fuel in the extra stationkeeping when we couldn't dock. The preplanned flyaround was well learned on the simulator. The SLS, crew station fidelity was excellent. It really made it very simple for us inflight. Many of the airlock experiments were the qual gear. It was very similar or identical. The caution and warning checks are complicated little systems.

KERWIN

On the visual systems, with respect to the ATM, the H-alpha displays are perfectly adequate in the ATM simulator. If anything, they are not quite as good as the ATM displays inflight. The XUV monitor is not as good inflight as it was in the simulator. They have special equipment going up to try and solve that problem. They've got a Polaroid camera and they've got an image intensifier. It will give them a more consistent display and will allow them to pick out the bright spots in the coronal holes and those things that we had no chance to see. The X-ray image display, for our purposes, was useless except for flare detection. The point is, you see nothing until you have a PMEC count of about 500 or more.

CONRAD

It seemed to me the difference in the X-ray image was that there was absolutely nothing on that X-ray image until something was almost to the point of flaring. That was not true in what we saw in the simulator.



KERWIN The simulator problem was one of picking out a true flaring point from a simple bright point. That problem doesn't exist inflight. There's no such thing as a bright point in the X-ray image unless it's flaring. The rest of the ATM console was excellent fidelity. I assume it's been updated to include the problems, difficulties, and failures we had inflight. The S054 door stuck open. The S082A OPERATE light stays on unless the FLARE ENABLE is cycled through the INHIBIT position. The only real problems I had with operating the ATM was not doing the JOPs in the building blocks with the powerups and powerdowns. We didn't spend perhaps as much time as we should have getting those interfaces, powering up and powering down and coming in and out.

WEITZ I don't remember having ever performed the powerdown for unattended ops prior to flight.

KERWIN We really didn't understand the relationship between unattended ops and EREP operations. It was a surprise to me inflight. I'm ashamed to say that we powered down for unattended operations during the working day whenever we had one or more dayside passes and we weren't going to be at the console.

CONRAD I don't think it'll happen on the next flight. It was obvious that we were not getting the ATM time in order for them to do something that they weren't normally going to do. That was to run unattended ops during waking hours. The original plan was to run unattended ops only when we were asleep. That was to get rid of film, too. We thought we were fatsville [sic] on film, and then all of the sudden we wound up with everything running out. They had over 100 hours of unattended ops which was more than they had planned for. The other reason we got into the powerup and powerdown business, is when we ran these training SIMs, everybody got so tired at the end of the day, including the ground, that we usually gave up before we ever got to that point in the Flight Plan. The Houston computers went off the line at 6 o'clock and that would end the ground and we'd stop; we just never really banged through presleep. Which would have been exercising those cards.

KERWIN Presleep and postsleep checklist: I thought it was a very good idea. Rather than switching around from day to day, we fell into the habit of each guy doing the same things every morning and every night.

WEITZ It would have been nicer if they could have run integrated better than they did. I had the feeling that they never really did run integrated well - the CMS and the SLS, especially on the comm.

CONRAD One thing we found out about the comm was that the normal operating configuration was not to have the intercom powered up in the command module. That caused a lot of the problems in one of the SIMs when we were running, but that was our own fault in not understanding the switch settings. I spend more time in the command module during orbital OPS. Whenever I was in there, I went to the panel and turned the intercom on so I could hear you guys whenever you wanted me. Then I turned it off when I left. But that was to preclude intercom going the DSE.

WEITZ EVA trails: It was beautifully simulated both here and at Marshal concerning the problems. I don't know if you're coming over it or not.

CONRAD I have absolutely no negative comments on the one-g trainers. I have not comments for improvement; I thought they were excellent.

WEITZ The things that were hard to do when we were in the trainer, such as, panel 202 to get at that ATM C and D coolant loop, we always complained about because you could hardly get the calfax back in.

KERWIN Another little thing like that was hard in the trainer and equally hard inflight were those 310 and 311 LSU panels in the airlock. They were hard. That's good fidelity, but future programs should never forget that it's important not only to have a sufficient number of high fidelity mockups, but to have a sufficient number of stowage items and expendable items for those mockups, which we wound up having.

CONRAD I thought the material's processing facility was excellent. I feel that the training we had in that allowed us to get as much out of the gear as we got of it because of the problems we had with the equipment. Both Paul and I understood how to run that equipment mainly because we had ability to run the furnace here in Houston.

WEITZ I would agree that without the facility we had here, that is, without the vacuum pump and the whole works on it. I don't think that it got anything back as far as M553 went.

CONRAD Neutral buoyancy training at Marshal: Those guys did an excellent job of keeping up with everything. The Houston and Marshal people put together excellent EVA procedures. They were outstanding, including Rusty, all our office people,

CONRAD  
(CONT'D)

the people downstairs, and all the people at Marshall; I can't say enough for that. If you can do it in the neutral buoyancy facility, it works. But there's one place in neutral buoyancy that's the same as the airplane where you have to be careful. In every one of these places where we did not have good foot restraint, I think you can be misled when you can do it in the neutral buoyancy facility, but you can't do it inflight due to damping in the water. Wrapping the cloth around the strut they wanted was the highest workload I had in the EVA. Changing film out and doing DO24 was another difficult task because we didn't have adequate restraint. It was a difficult task in the water tank; it was even more difficult inflight. It was the same thing with hooking up the BET. I have the feeling that the water helped a little bit, because we were very poorly tethered out on that SAS beam, and there was a little bit of luck in both Joe and I getting that job done. We were very marginal on completing it.

KERWIN

That reinforces the fact that, on future vehicles, provisions should be made for attaching crewmen to structures for handholds and for places to put foot holes, even if you don't think you're going to need it.

CONRAD      There's a basic concept there. If ever you're asking a crewman to do something that requires both his hands, he needs a tether arrangement. In effect, it gives him a three-point tether. Two feet solidly planted on something and being held there by a third device, whether it be a tether, or a foot restraint, or whatever it is. If you do that for him, he can do almost any job you ask him to do out there in that suit. I can't speak enough for the suits either; they were outstanding.

DCPS does its usual good job of getting you in shape on all that abort procedutes, but again, the final workout is doing that in the CMS with Houston on the line. I think that it is an excellent step up, so that you don't waste time doing abort simulations. I can't stress real-time simulations with Houston enough on anything - rendezvous - I don't care what it is. The DCPS or aborts.

I used the CMPS plenty and I have alot of command module experience. It's been great training for them to get into software and to bring out procedures that require tracking. The docking stuff they came up with late in the game was good. I thought we were adequately trained to do either the JSC sail or any of the fly-around operations that we did.

WEITZ The EREP VTS, functioned well. It was a better indicator from what I considered to be poor training aids; that is, I thought the mosaics that we had to use on there were rather poor. But it surprised me as to how real they were. The sites that were difficult to find on the VTS simulator were difficult to find inflight. It was an excellent required piece of equipment. I would recommend for the follow-on crews that they train on the VTS simulator all the time with the haze light on and that they always have some clouds in there, because that's the way we wound up running.

CONRAD One of the things that made the mosaics not appear quite the way they did inflight was that most mosaics were picked because they were taken at the nadir, or close to the nadir, over the site that you were tracking. And when you'd move off to a 45-degree angle, you were still looking at a mosaic that was taken at a 45 degree angle. You were looking at a mosaic that was taken about the nadir. So you'd get a little different perspective. Paul did more tracking than I did, but it was particularly apparent to me in picking up Mono Lake and Wilcox Playa that I was now, in fact, for the first time really looking at the shot through the VTS in the real world, and I was looking at it at a 45-degree angle coming over the hill versus looking at the mosaic that was taken at the nadir.

WEITZ I didn't have that impression because, with the sites I saw, I had no impression of depth at all. I didn't have any surprises other than the haze, which bothered me, especially when we were looking up-Sun toward the end of the mission.

CONRAD Both Paul and I agree that the 902 T-38 is an excellent tool.

WEITZ In my EREP debriefing, I assigned a number of 80. I think they ought to look at every site they can. It surprised me that our subjective, off-the-top-of-the-head analysis of which were the most difficult sites, really turned out to be pretty good. You can, in fact, tell which ones that are going to be difficult by looking at photographs and charts. The follow-on crews ought to set themselves a priority, and they definitely ought to look at the most difficult ones from an airplane. I think it's desirable that it be the EREP airplane if they look through a telescope, but I think they can get from 80 to 90 percent of the benefit of it by looking out the window. Therefore, when they do go look at a site, if at all possible, it should be the two EREP operators, so both of them get the advantage of seeing that site.

KERWIN I think the ATMSS filled a gap in training. I don't care how many times you read the book on something like the ATM and the



KFRWTV  
(CONT'D)

ATM computer, there's no way to begin understanding that system until you've learned the grammar of it on some kind of trainer. We needed something like that early. The ATMSS was very crude, but it did a good job. You've got to have some kind of hardware to play it on. And the ATMSS and other part-task trainers filled that gap. I think they're very important. Once you're on the SLS, you never want to go back to the ATMSS because there you have a high-fidelity simulation, and it's not required anymore.

CONRAD

I can't speak enough for simulations, and I pressed for as many as we could get. We've already put one comment on there. They were about a half a day in front of us when it came to these combined operations, and we suffered a lot in shaking it out. I think that's kind of straightforward. There are many times when their understanding of what we needed to get out of a combined operation was not necessarily our understanding, and we found errors or holes in it that was not apparent to the checkout people. I think we were in that mode during our training, which I hope has been fairly well straightened out for the next crews, based on what they learned from our training. The simulated network simulations, again, are the real bread and butter of putting the flight together for all phases,

CONRAD  
(CONT'D) for launch rendezvous, orbital ops, reentry, anything you want to simulate it with the ground, the better they understand what's going on. With our launch, rendezvous and reentry run with the same team, Phil Shaffer's team, I think they knew exactly how we thought and we knew exactly how they thought. That was a very smooth operation.

WEITZ Neil Hutchinson coming over during our activation and deactivation mini-sim, helped all of us.

CONRAD There was much cooperation in activation and deactivation. Gary Doerre's procedures team interfaced extremely well with Neil Hutchinson's team. And both groups interfaced well with us. In the process of developing our activation and deactivation, we changed it around so much that everybody in the crew was cross-trained to do everybody else's tasks. That enabled us to get the job done pretty well on time by ourselves. We really hustled to get it done, and everybody knew everybody else's job, which really helped.

KOHLER You also learned very early that the day-28 sim wasn't very meaningful for MCC. Thereafter you elected to run almost exclusively, day-29 sims, from wake-up to splashdown.

CONRAD Yes. That was the one thing that went just about on time all the way through. We had no glitches and we just barely managed to stay in front of it. I kept thinking we'd get ahead, but it turned out that the timeline was a very realistic one. We ran about 20 minutes ahead all the way, and that was it. We didn't have any room for error on day 29, or we wouldn't have made undocking on time.

CONRAD I thought we had adequate EGRESS training, and pad and tank training. All the EGRESS training was well done.

KOHLER Do you need the west coast naval recovery training with the helicopter pickup?

CONRAD I think that everybody is satisfied that we're going to be able to relegate that to a lower priority, that we've had a successful ship pickup. The ship did an outstanding job on that.

Concerning the fire drill during flight: we had a couple of real fire drills in the beginning, because the fire alarms went off. When we had the fire drills, all three of us walked the vehicle down and went through the rapid DELTA-P and the fire cards. Everybody knew what they were supposed to do. I thought it was worthwhile. We spent about a half an hour to do both operations. We sat down and went through that stuff one more time in flight. Everybody took their turn in moving the hatches,

CONRAD (CONT'D) just to see how that operation went. The one thing that everybody forgot was while we were running that SUS loop and had all those umbilicals going through those hatches, we could have caused a safety problem had something really gone wrong. We could only close the forward airlock hatch.

KOHLER Were the procedures as developed by MDAC proper in relation to the fire drill and the rapid DELTA-P?

CONRAD Let me make the comment that there's no way you can visualize here in the one-g trainer this whole stack put together. And it's just nice to take your time with those cards after having stood here on the floor and looked up at the ceiling. In the real vehicle the relationship of one thing to another just sort of runs through your mind.

KERWIN The planetarium was an excellent basic training device. I always wanted to go back before flight, but the closer I got, the less I wanted to. I think the final exam is the CMS. If you could find the stars in CMS, you can find them in the sky. There's one exception. We don't have a good simulation of the docked field of the view through the telescope. I did a P51 docked shortly after rendezvous and it's a different world. Even at night. Because you feel the view's restricted and you can't move the vehicle around to see the edges of the field to

KERWIN  
(CONT'D) find out where you are. I did four consecutive P51's and during each one, I made a different guess as to which star was Peacock and Antares, and it was no problem. And the last guess, fortunately, was the right one. I got five balls.

CONRAD If you do pick the wrong stars, it's perfectly obvious in the outcome. I had the same problems during the alignments. They gave me some stars which were good stars if I had been at the right time. I was getting ahead a little bit and I had to do some searching around, mainly because of the vehicle structure.

KERWIN In regard to vehicle structure: At the end of the mission, they were doing the P52s. Only way I could possibly have done that was to have a good platform. The computer pointed to star because the field of view was so bright. We were in perpetual daylight by that time. There was no way through the telescope to identify stars.

CONRAD We got pretty tight at the end. With the Earth being filled up about half the field of view and the other view was taken up by structure.

KERWIN That's right. The Earth, the antenna, ATM structure, and everything else. They were bright. I was surprized every time when I looked into the sextant and I could actually see the star. I think the crew would like to see a night display of their field

KERWIN of view locking out of the telescope with all that structure  
(CONT'D) in the way and what stars are available.

CONRAD Simulator training plans: I think consistently throughout our training, I continue to ask that the instructors keep Bob and myself apprised of our training in any areas that they found that were inadequate. And I assume that when we went, instructors, SLS and CMS, felt that we had covered the areas that needed to be covered. I think they did a good job just pointing to places where we needed training. It was valuable help to us. Systems training: You have a tendency to forget the early system's briefing because they happened so long ago. They got us off on the right foot, and I think that all the crews are past that point. We had the final system briefings by the Cape people and a few other people that came in. One of the things was the two crew logs that we kept, one on ERFP and on on AEM, which had all the funnies in it, which we've referred to as the "Funny Books". Those were a continuous system's briefing. As items came up in training, we got them cranked into us. I thought they did an excellent job. Ted Buras did an especially good job of having this cranked into the ATM simulator. As the various funnies came up in training that we were going to have to live with, Ted got those cranked into the SLS ATMs simulator. I don't think we saw any further

CONRAD Christmas presents that we weren't well aware of from that.  
(CONT'D)

At the Cape we spent 3 or 4 hours on systems, and it was useful. I don't remember exactly all the goodies that we got, but we picked up an item or two that was I thought were useful. I recommend that the other crews continue it.

Experiment training: I thought that went very well. The majority of flight crew operations engineers that had various experiments assigned to them did an excellent job with the checklists.

KERWIN Whenever I see a heading like that (Experiments Training), I think of how important it is to have some kind of simulator early in training. I think of all the time we spent on solar physics before we had any kind of an ATM trainer, and so much of it washes right out of your brain because we didn't really understand how the real hardware operates.

CONRAD There were some experiments that we saw infrequently, and although the checklists were in fact adequate and very detailed, I made some straight forward goofs in flight when I was in a hurry to make a sunset time or something and got off the checklist. I messed up S019 the first run through. I didn't get

CONRAD  
(CONT'D)

the first 11 pictures for them. It was strictly my fault. I was in a hurry. I got off the checklist. On Experiments like S019, I think the SL-3 and SL-4 crews have more time to cycle through those than we did. We spent obviously more of our time on getting it going and getting it shut down than we did on some of these experiments. It was strictly my fault for hussling around and making mistakes. I hope that I adequately debriefed that on B channel. I understand where the mistakes were made. It might be helpful to the other crews to see that, and I think we'll get to that as we walk through the vehicle with them. I compliment all the support people that were associated with the experiments training on the good job they did with both checklists and training

WEITZ

It's an excellent system. I think it worked well in flight. They had answers rapidly in most cases. You need the guy who is in the checklist writing and who worked with us in training, and who is available during the mission.

CONRAD

I have exactly the same comment for EVA Prep-post. It was excellent. Scott Millican and his people did their usual



CONRAD  
(CONT'D) excellent job. Our cue cards were good, and EVA was a pleasure to do, from beginning to end. The EMU training in the chamber was good.

KERWIN You guys worked with the PCU a lot more than I did. My position was unique because the other crews are mixing it up more, due to our originally scheduled EVA 1. But the simulator paid off because it was a long time ago that I had my chamber run. Just to stay up on the PCU familiarity curve, I thought that the little tabletop simulator (PCU malfunction simulator) was well worth it.

CONRAD I can't speak enough for the mockup and stowage people for the way they handled the changes in our stowage book. That was an extremely complicated thing. It was an area that, especially in stowage, I had harped on all throughout the flight. I thought it went well in flight. I thought that the books were well done as well as the way they kept those simulators up for us, especially as we rearranged the world in the last 10 days. We were well trained and my hat's off to those guys, too. Photography and cameras will speak for themselves. I understand that the pictures are good. I think all of us had a fair understanding of this area. None of us had too much on the Nikon, but I think we got the hang of that pretty good. The procedures were good.

WEITZ But it was primarily because we had a well-written Photo Ops Book we could consult. It had pictures; it gave you little descriptions like the operator's manual that comes with the camera. I had never really worked with the flight Nikon electric. You really need that information. I would've personally like to have had another session; another run through on the camera, not the DAC. We did enough with the DAC as part of M151 training. I would like to have had a refresher on the different Nikons, the Hasselblad, the manual Nikon, and electric Nikon, different lens arrangement, stowage locations, putting them together, etc. Like in the Photo Ops Book, it didn't assume that the crew knows how to do a supposedly simple thing. They put a good checklist in there. ED-31 was a good example. I had to put the adapter ring on the Nikon camera. They gave me a step-by-step checklist of how to do it, and I'm glad I had it.

CONRAD We used cameras that we did not train on. We used the S063 electric Nikon. Fortunately, the procedures were well written, as Paul pointed out, in the Photo Ops Book. We didn't really train on that camera. Paul went down and read the book, figured out how to load it, and unload it. He gave us a little lecture in flight and we went from there. That wasn't anybody's oversight. We weren't planning on using that camera at the time.

WEITZ        We had a good thing going; having detailed checklists onboard and also having cue cards to help us get through repetitive operations quickly.

CONRAD      I thought the planning of the training and our training program was quite adequate. I think the flight speaks for itself. I think you guys did a good job.

WEITZ        It was better than that.

CONRAD      Bob Kohler did an excellent job.

WEITZ        It was excellent.



## 16.0 EMU SYSTEMS

CONRAD I think we've all commented on the excellence of the PGA; the fit and operations. I have absolutely nothing to add except the word, super.

WEITZ None of the suit techs commented on the back of my suit being too short when I got fitted at the factory. It became more evident in flight. I had a lot less length in the back of my suit than you guys did. It was just difficult to get that outside zipper up.

CONRAD There's no doubt about it. You just can hardly pull yourself over far enough in zero g to get your head in and out of that suit. We had a two-man wrestling contest trying to get him in a suit. With Paul's tight fit in the back, it was definitely a two-man operation up there.

Biomed instrumentation worked fine until you put all that stuff in it. LCGs were good. I'm still mad about the biomed fit on the LCGs and our little mickey-mouse fix, but we beat that one to death. It worked all right.

WEITZ Helmet: I'm glad I wore my helmet protector during launch, because I sure banged around during that SEVA. My helmet was as clear as crystal when I needed it on EVA day.

CONRAD The SEVA operation went per checklist. We had adequate training, short as it was. The guys did an excellent job on the cue card, which was our Bible. Gloves: Let me speak about the outer gloves. I guess you used the protective gloves, right, Paul?

WEITZ Yes. Work gloves.

CONRAD Work gloves were called out for me to use on the deployment of the solar panel. The fingers fit all right, but I had a whole extra inch or so in my thumb. The thumb is the most important part, as far as being able to hold things or do an operation. I was torn between two evils. I wanted to have the protection, so I cut the end of the thumbs and refitted the gloves again. Even then, they restricted my hands. My final conclusion was that it was safer for me to go without the overcover gloves, which were not built for my gloves, than it was to use them. I did not use them even though I'd cut the thumb off to take off the extra length.

WEITZ You used the same work glove that I did, and that may have been the problem. I didn't have that much previous experience with the EV gloves. The work gloves did not bother me during the SEVA operation.

CONRAD I can't remember. We did dump the UCTA's overboard once during rendezvous, didn't we?

WEITZ No. We dumped them overboard after we got out of the suits. We didn't have any problems with the UCTA's.

CONRAD I had an opportunity to use some of the other gear in the EMU maintenance kit that nobody else did. And I got to sew up the cloth on the FAS strut. Joe lubricated the suits for both EVAs. I used the antifog as advertised. It worked well. That was a very good kit. We had an hour lecture on the use of it.

The drink bags: Joe and I elected not to use them at all. Paul Weitz launched with his. He drank a little bit out of it during the launch rendezvous phase. We never used them for EVA, and I didn't feel that I needed them. We had one long EVA of 3-1/2 to 4 hours. The antifog worked well. We had no fogging problems whatsoever. ALSA and PGA performance: in 5 psi, the pressurization cycle went well. We enjoyed having the ability to pressurize at our own rate with the PCU. The ventilation was adequate. Liquid cooling and circulation was certainly adequate. We had all three guys on one loop. That worked well. We had no trouble with connectors whatsoever. PSU performance was outstanding. The SOP performance was outstanding. The checks came on the line. All displays and controls

CONRAD worked correctly with respect to SOP and PCU operations. I  
(CONT'D) thought that was very good. The foot restraints were  
excellent. I used every station, i.e., the FAS foot restraints,  
the VC foot restraints, the VS, and over the side. All four  
foot restraints worked well. I had the Owen Garriott fix on  
my boots to make it easier. It's really not necessary in zero  
g. One other comment on the foot restraints. I noticed when  
I moved both my heels outward into the foot restraints, that  
there was a very definite bite. It took hold. It took a very  
definite bang inboard of my heel to get them unlocked out of  
there. They had no tendency to slip out whatsoever. It's a  
very nice tight fit. Our EVA communications were excellent.

WELTZ One thing about the ALSA. We never got a low flow.

CONRAD The booms were excellent.



## 17.0 EVA

### 17.1 EVA Operations

- WEITZ Boom dynamics were excellent. They were much better than I had been lead to believe. It was fairly rigid.
- CONRAD But you made the comment that you had to be careful retracting the boom because the package would oscillate on the end a little bit in roll.
- WEITZ That's right. Because when you let loose, it was off to one side. It was either H-alpha or SO56. It did oscillate a little bit. I never noticed any warping of the booms when they were in the Sun.
- CONRAD You had a little jerk in the water booms. But these just took off and ran off very smoothly and retracted very smoothly. They were really excellent.
- WEITZ You think the clothesline would have worked?
- CONRAD Yes. I think we handled enough lines out there that if you just take your time with them, understand how they're routed, and how they're supposed to go, you wouldn't have any problem with the clothesline.

WEITZ Handrails. From the one trip I made out there, a single handrail is a perfectly feasible way to get someplace. You have to go a little slower because you're keeping your body straight through your wrists. The double handrail is like driving the interstate highway.

CONRAD The double handrail was neat.

WEITZ Yes, that's the way to go.

CONRAD It's was much easier to transition off that handrail into the foot restraints over the Sun end station than in the water tank. You need something to hang on to about waist level to get into foot restraints.

LSU management worked well. You can see them well enough and work them either in the FAS or outside. We never did get them tangled as we had done many times in the water tank.

WEITZ There's a lot of stiffness to those things to keep them from wrapping around each other. Lighting was super out there.

CONRAD The lighting was excellent.

WEITZ It wasn't glaring. It was absolutely sufficient.

## 17.2 EVA Prep Procedures

CONRAD Suit donning. We have a little trouble bending over, but we found that in our practice we kept worrying about putting each other's foot restraints facing each other to hold ourselves in, and the man that was donning his suit got in and got his feet in the suit which was locked in the foot restraints. And the other fellow could wrap his legs around him.

WEITZ I liked your procedure which was to zip the zipper by floating around the other guy. You don't need the helper to be restrained.

CONRAD The ALSA checklist was excellent. We went quite by the cue cards and then transitioned into the EV-3 reading the checklist for those checks. We got all suited up and ready to go.

KERWIN Translation. I remember doing it once in the water tank at Marshall and thinking, "Boy, this is going to be hard." You've got to kind of hand-over-hand yourself from the foot restraints to the fireman's pole and up, and it seemed like a big workshop. In the real workshop it was a piece of cake. We had no hesitation about pushing off and flying up to the hatch.

CONRAD The time lines were good. I recommend one change in the cue card. I say take that cue card exactly the way it's written.

CONRAD (CONT'D) And the only thing is you pull out the antifogging of the helmets and stick it down to before suit donning, which takes place the next day. You continue to do the preps the way we did. You prep up to antifogging the helmets. No sweat on the comm checks. They went per checklist. There were no problems with coordination with the ground.

CONRAD The only coordination really was on the first EVA where we were trying to get out of the specific time to have daylight/darkness cycle right. It doesn't make any difference when you get out to do film transfer, because the lighting's so good.

WEITZ In the EVA we come to a point where it says turn off the airlock lights. I still don't know where that came from and why. We chose to leave them on, and I strongly recommend that you leave the airlock lights on.

I thought all the hatches went really fine. The only thing I would suggest is that we learned from the first time to use the mode that we used from the second repress. Upon opening the airlock forward hatch equalization valve, you then unlock the hatch. So we didn't get caught in there with a higher pressure in the lock than we had in the MDA, because we were pressurizing from the workshop and then you wind up having to cool your heels for a few minutes so you can open the hatch and it doesn't blow open in your face.

CONRAD I think they need to take an additional screen along to put over the airlock depress valve, because there's enough moisture in the air that we found out that ice built up and covered probably one-half to two-thirds of the screen. And you get down to about 1/2 psi and you're about equal between what you're putting out and what can get out that flow valve. We had to break the ice off of it both times. We don't like to do that, because it goes down through the screen. My suggestion is to put a second screen a little bit higher over the first one that ice could build up on and then you could just pull it off.

WEITZ They could take one of the cover plates, cut out the middle and put a screen over it, and then you can put it on and take it off as you wish.

CONRAD Once you get to about 1/2 psi, all the moisture is now frozen on that screen. You just remove that screen - and you have the original screen and a full open valve to go through.

### 17.3 Post-EVA Procedures

WEITZ AM repress. I suggest that, prior to opening the equalization valve in the workshop hatch and when you open the equalization valve in airlock forward hatch, you should go ahead and unlock the hatch. Then when the pressure in the airlock and the MDA

WEITZ  
(CONT'D)

equalize, you can then open that hatch and then open the OWS hatch equalization valve. Then you can be moving around in total forward volume rather than be waiting in the airlock.

CONRAD

Suit drying - there was no moisture; much less than expected. We didn't get to the kind of workloads where we were sweating up the suits. The suit drying worked well and the suits were clean as a whistle. They didn't smell bad.

KERWIN

That was true throughout the mission everywhere. We didn't have areas of condensation on the walls so our clothes didn't get wet, at least not in the workshop or in the MDA.

CONRAD

I think we were well aware of the fact that it was going to take us longer than the guys figured on the ground to manufacture the equipment in flight because we were in zero g. That's true in all the little extra things that we did, not only the SAS-deploy EVA where we made all that equipment but also in sewing together the panel to put outside. I spent about an hour and a half putting that panel together. You have to get good scissors, which were up in the EREP can in the MDA. You have to bring them back down, lay the stuff out, and restrain it. We were well aware that it was going to take us longer. And knowing that allowed us to get things done on time. We spent a good 6 to 7 man-hours putting together the SAS-deploy stuff.

KERWIN     Because we had to do it all our own way. We put stanchions 5 feet apart to measure our rope out and then we strung the rope along the 25-foot pole. We cut it off so it fit exactly. We worried the problems of tangles and things, and we deployed it a couple of times.

CONRAD     We were very careful about laying the lines out, and it took a long time to cut the gray tape and tape the lines to the original pole so that when it flaked out it came out straight, and all that just takes time.

KERWIN     We figured how to tape things to your suit and where to tape it to your suit so you can reach them in a pressurized glove. And we just worked all that out in real time.

WEITZ      The whole message is to let them work it out on the ground and then allow about twice that time in flight for the guys to do it, if you come up with an off-nominal, new situation.

CONRAD     Of course, we made some refinements that were obvious to us that the ground really just left up to us. What they'd given us was adequate to do the job. There were a few places we did make refinements on that gear. We used different equipment. Instead of using that safety wire for tether hooks we got spring steel out of launch restraint stuff, but it bent up rings. We just took a little bit more time to do the job right.





## 18.0 FLIGHT EQUIPMENT

### 18.1 CSM

CONRAD      Event timers and controls worked fine throughout the flight. I think we've covered crew compartment configuration. We knew where everything was because we kept up with the stowage, and it all worked very well. Let me say something about the crew compartment configuration and day 27 transfers. That took twice as long as planned. I could see that coming, and I spent 4 hours on day 26 in the evening starting the 4-hour stowage. We had 5-1/2 man-hours allotted to do that day 27 stowage, 4 hours for myself and an hour and a half for help from the PLT. He spent his hour and a half and I spent 8 hours.

WEITZ      It's a tedious job. It's bookkeeping. You have to remember where this was; put that there.

CONRAD      You just don't handle a lot of pieces of gear. We'd take bags full of stuff down there, and you just don't let them all out or you lose them. I took the time and it all went in the way it was supposed to go and it was well cinched down. I think the ship found it stowed exactly the way it was supposed to be. I used the drawing. I pulled all those cargo nets all the way out and made sure all the gear fit right. Then I snaked those cargo nets in and tied them down. Our training

CONRAD  
(CONT'D)

was more than adequate. I knew how they worked; I knew where the pitfalls were, and it just took time to do it, that's all.

I didn't use my mirrors too much. In the past, we've used mirrors for buckling up, suiting, and things like that, and we really didn't do too much of that kind of operation.

WEITZ

I did use the mirror for one thing. On the undocking and flyaround, I used it to hold the TV monitor up in a place where I could see it. I did it because there is no satisfactory way to restrain the TV monitor in the command module at a place where you can see it in the proper attitude.

CONRAD

The couches worked well, and I made a recommendation someplace else that, when you take the center couch out, you stow it under the commander's couch and you leave it there for the rest of the flight. On your final deactivation day, there is a very logical point in time, when you have to get under the crew commander's couch to get in those lockers. Then you pull that couch out, install it in the center position, and fold it up against the hatch. It's there for about 3 or 4 hours, and then you pull it out and lock it in. It's so easy to do in zero g that it's ridiculous.

There are no complaints on the restraints. All the buttons were in the right place to hold them so we could hook them

CONRAD  
(CONT'D) up when we needed them. I felt we had more than adequate restraint on reentry. We were well clinched down. This includes the heel clips, once we figured out how they went on out feet. We all put them on backwards the first time.

WEITZ Those heel clips are stowed in such a manner that you unwrap them, you look at the straps, and you put them on in a logical way. Then when you get to looking at them, they're upside down.

CONRAD The camera equipment worked well on the command module. All the brackets were right. The 90-degree bearers all worked well. We had no camera failures. We had a couple of loose nuts on the turnon button on occasion. It always happens whenever you get off the checklist. I forget when I didn't get it on. I remembered it, and then I didn't get it on for the approach in rendezvous and the point where they held us from undocking on the flyaround was right at the point of turning on the cameras. When they gave us the quick undocking late, I jumped into undocking and missed turning on the camera on and didn't get it on until late. That was strictly my fault. It was on the checklist, and I just didn't pick up the checklist in the right place.

WEITZ The thing that remains to be seen is what kind of pictures you get when you're trying to take Hasselblad pictures out of window 4 with the TV camera there. Well, most of the pictures

WEITZ (CONT'D) I got with the TV camera. It was not so difficult. There is really more room in there than I thought, even from going to mockup and trying it.

18.2 SWS

CONRAD The flight equipment in the crew compartment configuration. The beds worked great. Everybody had enough room for their gear. There was enough Velcro around. We would set the duty timer up for the alarm clock, and I'd Velcro mine at the dosimeter place. It would stick right on there. I know you had a lot of gear laid out in your room. Everybody fixed up their sleep compartment the way they wanted them. We had adequate places to hold the clothes.

KERWIN The thing I had about the sleep compartments, aside from thermal, which is completely off-nominal, is that it would not have worked at all to have had a staggered sleep cycle, because you were aware, in your sleep compartment, of any noise, any movement, any light that anybody made in the experiment compartment, the wardroom, the head, or the forward compartment.

WEITZ You didn't have your light barrier up.

CONRAD I think everybody that has seen the TV with voice on it has the impression that the vehicle was extremely noisy, because the noise is somewhere on the comm. The whole workshop is so quiet

CONRAD  
(CONT'D)

that anybody moving around, as Joe says, is going to wake somebody else up. It is really quiet in there. One other thing. When we shut off all our lights and closed the workshop window and the windows up in the MDA, that was real night in the vehicle. It was good and black in there.

The other comment is, if you get up in the middle of night to go to the head in that configuration, be careful, because you have no sensation of movement and you can slam into things or get lost. You don't realize that your body is pitching or anything else until you start moving around the vehicle. And the next thing you know you're in the wardroom against the wall instead of the head. It's really weird. It's also weird for the other guy who wakes up and this white apparition is sliding by his sleep compartment in the night, very quietly. I personally thought the sleep restraint worked very well. Surprisingly enough, it turned out that my geometry was such that as I was lying on my back and I pulled the three restraints in to straighten my body out, that pulled my head against the pillow. Completely relaxed, there was just a slight pressure, with my neck muscles barely pulling my head onto the pillow, and I really had the sensation I was sleeping on a bed on the ground with my head comfortably against the pillow. Then I found that there were ways that I could turn sideways in the sleep restraint and, by getting one shoulder a little bit past

CONRAD  
(CONT)

the 90, that also would do the same thing to my head. It would make it logically rest on the pillow, and I never used the overhead thing to hold my head on there. This is strictly an individual thing.

KERWIN

I used it sometimes and sometimes I didn't. I thought that if I had to redesign it, I would make it even lighter and even more elastic at the bottom, so that it was a very gentle restraint. I would have put one more elastic band in the middle. Those were of a nice elasticity. You could tighten them or loosen them just the way you wanted them.

WEITZ

All in all, I thought the sleep restraint was excellent.

CONRAD

Well, let me comment on one other phenomenon. I don't know if the other guys noticed it or not. I slept most of the time with just the net, until we got down to the 72-degree area for about 3 nights, and then I slept with a blanket partially up. But you have no convection. And the net would trap the air around your feet. I noticed this especially in the lower extremities. And then your body would heat that air up. And even though you didn't have a blanket over you, because there is no convection, you had this warm air ball around your legs. It was really weird. If you got hot, all you did was stir your legs, which would move the air out of

CONRAD  
(CONT'D) there, and then you'd reheat new air. But the air doesn't move. It doesn't circulate if it's not in the path of some blower air that's going through there. We had different thoughts about arranging the little duct in the bottom, which blew air up past your bed. I had mine off the wall, because if it blew it on my feet, I got too cold. But I could very definitely tell there was no convection there.

WEITZ I'm a little more warmblooded than you. For about 3 days there, I used the outer blanket, but only about up to the knees, just enough to keep my lower legs and feet warm. I never got under the net, because it was uncomfortable. I got too warm. Halfway through, I modified it with the scissors by cutting the net off and throwing it away. There was only a 3 day period that I did anything. I just slept with my shorts and a pair of socks on. That net is really warm.

CONRAD The Swiss Army knife was very handy. It would float out of the knife pocket, unless it was restrained. I never restrained mine; I carried it in a zipper pocket. You guys keep it in a knife pocket with a tether ring restraint on it.

KERWIN I cut a little hole in my pants to slip the big ring through and clipped the knife on. I thought the clothing was real good.

WEITZ I'm glad I had the box pockets. I like those. They give you a lot of room. You don't need as big a waist as we had because there is no gravity to pull your gut down, and your waist tends to shrink in.

CONRAD If I had it to do over again I would ask for a clean pair of socks every day. I had 12 pair of socks and your feet tend to sweat. On the second day of wearing a pair of socks, they were clammy. The gold T-shirt material is not very absorbent.

KERWIN I wound up having to ration socks and shorts and I wound up with extra T-shirts. It was a bit too warm to wear both the T-shirt and the soft shirt.

CONRAD That's right, we operated with the T-shirt or the gold T-shirt, but never both.

KERWIN Two coats were plenty. With four pairs of trousers I wound up not using one at all.

CONRAD The vehicle was extra clean. Working with any equipment, our hands really didn't get dirty. There was very little dust in the vehicle and there was nothing to get your hands dirty. We would wash our hands with soap, wipe them off on a towel, and see no dirt. We really did stay quite clean, and the clothes stayed clean. As Joe says, two coats and four pairs of pants



CONRAD for 28 days was adequate. The only thing I would like to add  
(CONT'D) was more socks and maybe a few more shorts.

WEITZ I had a change of shorts for every other day, which was good  
enough for me.

CONRAD When we changed our shorts, we kept the used ones to exercise  
in. Those sweaty shorts we would throw away. We got 2 days of  
normal wear out of them, then we would wear them for 2 days for  
exercise. We put the fresh ones on for working. That worked  
very well.

WEITZ In moving around the vehicle and stabilizing yourself you use  
your toes a lot. You drag your feet over the grid, you stick  
your toes down in the grid, you hook your toes under things.  
We mentioned it, we have some pictures of it, we wore out the  
toes on both shoes, both the triangle shoes (the ankle-high  
shoes) and the gold boots.

KERWIN I wound up not using my slippers at all. I used my triangle  
shoes from morning until night. I would change from the  
triangles for the bicycle to the little mushrooms for general  
moving around and working. My general comment is that it  
serves as a restraint system. Wherever you stop to do a job,  
you want your feet restrained. I'm awfully glad we had the  
triangle shoes and the triangle grid all over the floor.

WEITZ Yes, the triangle shoes were extremely useful.

KERWIN The side restraints worked out better than I thought they would.

WEITZ I used them all the time. I never used the foot restraints. In M487 we debriefed the over-the-top straps which were the same as the ones in the waste management compartment, essentially unusable, because they are too stiff, unadjustable, and have a preset. They have been folded over in the same place for a year. I didn't use the triangle because I didn't wear my triangle shoes very much.

KERWIN We hardly used the portable handholds almost anything serves as a handhold when you're arriving at a location. Foot restraints are needed at the work stations.

Thermal control - We didn't have any thermal control, we just lived with what we had. I thought I was most comfortable when the temperature was lowest. The 70- to 75-degree region was reasonable.

WEITZ When we started getting up to 77 to 78 degrees, we could really tell the difference. I think that's because I am sensitive to radiant heat. I could just feel the heat coming off the OWS circuit breaker panel and through the walls.

KERWIN I'm a believer in the comfort box now. If the wall temperature is warm you begin to get uncomfortable about 75 or 80 degrees; if the wall temperature is cold, you could probably live with air temperatures of 85 degrees.

WEITZ It made more difference than I thought it would to use a little portable fan to blow warm workshop air in over the workshop heat exchangers.

KERWIN I thought the MDA was too cold for comfort most of the time.

WEITZ It was quite comfortable when we had enough power to turn the MDA wall heaters on and until the vehicle temperatures started coming up to the point to where they thought they had to turn them off. Below 65 degrees in the MDA was cold. You radiated body heat to the cold walls.

KERWIN I'd go to my sleep compartment and get my jacket when I was going up to the ATM.

CONRAD Let me go back to one thing on the triangle shoes. I noticed on both feet there were ways I could put a load on those triangle shoes that made them come out of the grid work without unlocking them. I think you will see in the M151 movies where I will stop and turn the triangle up and reset the lock because I could pull my feet out of those triangles without unlocking the shoes. I never did figure why.

KERWIN Let me mention one thing that happened to me three times on the bicycle. I would change my mushrooms to my triangles to go ride the bike. If you don't cinch the wingnut down good and tight in those triangles, I found that they came loose while I was pumping the bike. Once the thing is loose there is no way to unlock it. You move your foot and thing doesn't unlock. I would up having to take my foot out of the boot, get off the bike, finishing unscrewing the shoe from the triangle and go get a screwdriver from the tool kit and wedge the thing until it unlocked it.

WEITZ I found the only way you could satisfactorily tie the triangle down is with a pair of pliers. You couldn't do it tight enough with your fingers.

We used most of the tools.

CONRAD We used just about every tool in the tool box.

WEITZ We are sure glad we had that extra set in the MDA. One ratchet fell part on us, and that ratchet is a valuable tool to have. We have a backup in that one torque wrench. It is bigger and more clumsy.

CONRAD Joe used the tool caddy for activation but I never needed it. I used my baggy pants pockets to carry the tools.

WEITZ I used the tool caddy on activation and found it useful. I never used it on deactivation.

CONRAD For orbit operations we never used the tool caddy although we used tools all the time, we never really needed the tool kit for the orbit operations.

WEITZ Camera equipment we have already discussed.

CONRAD Let me make one comment on camera equipment. There were some camera locations that we never used that were in the forward experiments compartment floor. They are little orange location markers and occasionally someone would stick his foot in there and lock his triangle in there and that was the end of the two camera locations in the lower experiment compartment floor. They were all mangled. We gray-taped them to their proper location. We never used location F-12 and a lighting one. They may be for M509.



## 19.0 FLIGHT DATA FILE

### 19.1 CSM

KERWIN You wind up using the Launch Checklist in a way in which it really isn't intended. I never look at the nominal launch part for the checklist. You have your fingers in the abort pages for  $V_I/H\text{-dot}/H$  and the various charts. But that's okay, I think it worked out fine. The time line from insertion on was good.

CONRAD There was a lot of lot of comments about the Entry Checklist. I didn't find any mistakes on the one that we had. It worked very well and I was glad that we had the big book with the explanations in it. I think that sometime between the entry sim and entry day both Joe and I and maybe Paul smoked through that thing. It was helpful. Now the entry checks on entry minus 7 was a good exercise. The entry sim in my opinion was absolutely useless for us. It was really kind of a day off except for popping into the command module every once in a while. We really didn't do a heck of a lot with that. That was more of a ground exercise. I recommend that you knock that day off or give the crew a day off when you're running it or if it's during a normal work day give them a normal Flight Plan to run.

WEITZ        How about the number of entry checklists? You know we bounced back and forth between 1 and 2.

CONRAD       I don't think we needed 2? Do you?

KERWIN       I never missed having one. Pete was the captain of that checklist and it worked out fine as far as I was concerned. The only time he didn't have the checklist was when he was doing a burn from the cue card and then I'd hold it and just follow it through.

CONRAD       You held it during the actual entry.

KERWIN       Yes.

              It was the same thing. Paul was doing the entry on the cue card and I was following him through on it.

CONRAD       In effect, Joe was the only one who needed the checklist because from the Entry Checklist my cue card had the proper times. It had 05G time which I wrote in. It had drogue time and Joe was there backing me up. I had all the data I needed in front of me on my entry card which replaced the SPS entry burn card. So I really don't think you need two checklists. That's crew option, I guess. The Rendezvous Book was super. We just checked that baby off right down the line and it had all the information in it we needed.



KERWIN You never had a desire to have an extra Rendezvous Book.

CONRAD No, you don't need it.

KERWIN That's the way you train.

CONRAD I think we used most of our cue cards. I know I used all of the ones I had on my side that I needed to use. Fortunately we did not have any bus failures or anything like that. I would leave them the way that they were.

KERWIN The Star`Chart is a super Star Chart in spite the fact that you don't use it much doing the actual rendezvous; in fact, I didn't use it at all. I'd like to retain the little Star Chart, the mini one that's in the G&C Checklist.

CONRAD Yes, I used that one.

KERWIN That's the one you really refer to.

CONRAD Let me say one thing about the rendezvous star chart. I wouldn't take it out. I remember very well us using it. It saved our neck on APOLLO 12, when we had to do a quickie alignment that we weren't expecting to do. We really didn't know which part of the sky we were looking in and you don't see a lot in that telescope so that's a good backup thing to have aboard.

KERWIN Did you have a little chart with the lines on it?

CONRAD Yes.

KERWIN It says this is the part of the sky that this window looks in on any particular day. That's a nice thing to have; I'd like that.

CONRAD We used a lot of things in that systems book we didn't think that we were going to use. We went through all of the docking procedures, backups, etc. The systems book was I thought was well written. I did all the fuel cells shutdown. I did it by the systems book. I did the dump water when we had to do the extra procedure of getting rid of fuel cell water by dumping it into our condensate tank. It had all of the things in it that we needed. I said that we used more things in it than I thought we were going to use, but by golly, they were there when we needed them.

KERWIN I debriefed the ATM books with Al Holt.

CONRAD I used all the ATM books at one point or another.

I used the checklist. I used the log for coalignments and recording data. I used the JOP book to refresh myself and I thought they were all excellent. I'm sure Joe had some detailed comments. I used all of them. Stowage books were excellent. I can't recommend any specific changes. One did have to take his time. We had a lot of pen & ink changes in it as a result

CONRAD  
(Con't)

of what happened to that book going from nominal to what we launched with 10 days later. Therefore, our book was hatched up. I'll say one think, there were very few mistakes in it. The ones that I found I commented on B channel. I found when we were going to do a big stowage day, there were two or three of those in the book, I took it out the day before and really went through it very carefully to make sure I understood exactly what it was telling me to do.

KERWIN The updates book were never used.

WEITZ Yes, I torn a page out of it for star tracker.

CONRAD Fortunately we didn't have to use it.

KERWIN We already talked about the EVA Checklist.

CONRAD And we throughly debriefed the EREP checklist.

We didn't use the time line in that Flight Plan that had the station passages. That really is unuseable. We had no desire to use it. The one the thing that we used in the Flight Plan that did help us and we did some things in advance on it was the shopping list, which was well done.

KERWIN Yes, and that one-page summary.

CONRAD Yes, We took that out and taped it on the refrigerator and we pretty much stuck to that.

KERWIN It was a source of considerably onboard discussion because every evening about suppertime, Pete would cross out the day and Paul would object that the day wasn't over yet. He should have crossed it out the next morning.

19.2 SWS

CONRAD All those books were excellent and in detail. However, for experiments like S019 and 20, which we didn't do, but I'm sure it applies and 73 and several of those others, I think they'd be better off if we used cue cards for actual operation.

WEITZ You need the checklist, but it would be nice to just pull out cue cards so you can stick up there with your pad.

CONRAD It should have the key points to prevent making little mistakes. The checklist is a little unweildy to handle, especially when you go from one page to another to do an operation, such as S019. A cue card lends itself to being put right in front of you and you can sort of mentally check. Joe used the log book for his medical thing.

KERWIN I used mine for those things that were not immediately pertinent to the operation of the spacecraft, and I did not do formal debriefing on my own log book. I used it for comments to myself.

CONRAD We kept very little logs of that type.

WEITZ We brought back the M131 log.

CONRAD Star charts. We did not use the star charts in the SWS.

KERWIN There were only a few occasions on which I had the luxury of looking at the stars out the wardroom window. Most of the time it's lighted and there's something going on in or around it.

WEITZ Systems activation and deactivation list. I think they are well-written books and they do the job.

CONRAD The systems books turned out to be handy. Especially for EVA. There was data and diagrams in there that we needed. Otherwise, those systems books were really there to handle anomalies, and we didn't have too many where we had to do much troubleshooting on our own. I notice the book that is missing there is the SWS Malfunction book and the Experiments Malfunction book.

WIETZ We needed all the books we carried.

CONRAD Yes, I wouldn't take away any that we had.

KERWIN Even though the ground would take the lead in most of the malfunctions, that does not lessen the importance of having a correct and properly written malfunction procedure book on board. Sometimes you need it on your own, and when you don't it's necessary often for Houston to have you go through some part of a malfunction procedure. Rather than sending the procedure up, it's already there. We've talked about the timeline and the Flight Plan and how much we used out of it.

### 19.3 CHARTS AND MAPS

WEITZ        EREP site books. I think they're all right as is. We wound up selecting only two of the available pages per site for the EREP, but I think you want all of them that are there to choose from.

CONRAD       The U.S. map which related the EREP track and all it did was lead us to a lot of speculation about which sites we were going to get to the next day. We used that Earth map all the time. We commented about that on B channel and I'm not sure that it wouldn't be nicer to have it even bigger and more detailed.

KERWIN       This photography is very important, useful thing, as well as being a lot of fun. I would have like to had not only the big Earth map that we now have, which was terrific for orienting yourself, but a series of additional maps and cards, probably about the same size, covering smaller pieces of territory in more detail. Then once you knew the pass and if you're going to be over northern China or over eastern U.S., then you could break out that one, and you could track navigable rivers and bodies or cities and even major highways or terrain features.

WEITZ        You could indicate on there what you have photographs of.  
The biggest thing that fell down the crack was when we're  
passing over Australia or China, or some area, and we  
couldn't remember if we had gotten pictures of that the  
last time we were around.

KERWIN       That's right. I'd like to see in the same location a big  
foldout, hinged book, with four or five big cards on it,  
covering the different parts of the world.



#### 19.4 FLIGHT PLANNING/FLIGHT DATA FILE

CONRAD    Recommended changes.  I think the only thing that we recommend is the addition of the cue cards to those experiments that we did not have cue cards for, that lend themselves to cue cards.

## 19.5 PREFLIGHT SUPPORT

CONRAD

Availability. I think we had it within the limits of the system, about as much as we could get. Let's say we could have used some more, but I don't think it was available. The area that comes to mind is activation and deactivation. Again, Gary Dorrie's group got pushed pretty hard, mainly because these were the kind of things that required interaction of simulations and going back and revising the book and what we learned from those steps. I gather that the SL-3 crew is caught in that box right now. And I don't know what you do to get out of it, because you just don't add people because the people have got to understand the problem and be trained. So I think we're stuck with what we've got. I know we were working some people awful hard, but I know they certainly worked hard for us and we had very few mistakes in this system work. And I think our checklist, even though some we managed to keep on top of final pen and ink changes at the end, John O'Neil and company personally saw to the fact that we saw those changes as they went in, pen and ink changes, and I don't think we got any Christmas presents that way. And the coordination for that reason was good.

CONRAD  
(CONT'D)

We stayed pretty well away from change control systems. We were aware of changes that were generated from the outside that had significant crew impact and by the people that were handling these changes coming to us and of course, crew-generated changes, obviously because we generated them, we were aware of them. One thing I can say is, there were times when crew-generated changes, which we felt were going to be approved and incorporated, took, for some reason, an inordinate amount of time to go through the system. And then there would be a little bit of hard feeling about it, and it would come up maybe 6 to 8 weeks after the fact, and we would think that that was something we put to bed, and we would find out that it wasn't put to bed, and we'd have to do a little more rejustifying up the line or something. I'm not sure that that's bad. It's saying that things are getting adequately reviewed; however, the time span seemed a little great to me on occasion. Real time procedure changes. That's what we have already talked to Captain Bean about, and there's no doubt in my mind that we're going to have to revise the manner in which we send these teleprinter messages up. We're going to have to categorize them and split them up so that you know which messages to keep. We ran into the problem of cutting messages up

CONRAD  
CONT'D

and inserting them in the book for changes and then the ground would refer to a message number and it was meaningless to us. I don't think we need to get into a lot of details about that here in this debriefing. What we need to do is sit down with the proper people and work this out, so that it gets worked out satisfactorily on Bean's flight. We had a great deal of trouble, especially towards the end of the flight, handling this charge traffic and understanding it.

## 20.0 VISUAL SIGHTINGS

CONRAD            We had the normal visual sightings at staging and jettisoning of the launch escape tower. I don't remember, from Apollo 12, seeing debris coming from thruster firing, but it was very evident from forward firing thrusters, seeing material coming out past the spacecraft, when those thrusters fired this time.

WEITZ            During the flyaround, they were particularly noticeable. We weren't using forward firing thrusters during the flyaround. We were using Z-thrusters.

CONRAD            No, but you do for attitude.

WEITZ            How about the orbital visual sightings? Earlier, when we thought that we saw the S-II or SIVB, and we'd report sightings to the ground, they never came back up and said what they were. I wish they had. If we didn't give them enough information, they could have come back and asked us where they were and what they looked like. It would just be nice to know what the other objects are.

CONRAD            As you remember, before we went, we'd see the lab go by. There was a lot of debris, a lot of big pieces you could see from the ground. What they were, we don't know. I'm not sure the ground has any way of knowing.

WEITZ NORAD knows. They can go to NORAD and find out, I think. There may be some feeling of sensitivity about this.

WEITZ Well, then we should have been briefed on it preflight.

KERWIN At least they could have come back and said "No, it's not your S-II, because your S-II is here or gone or whatever. There's no secret about that.

CONRAD Entry, as I remember, was a different color than what we had returning from the Moon. It was extremely bright. I think it had to do with the fact that were basically in the dark most of the way in. To me, the flight pattern was much brighter on this one than on 12. The Sun was in the horizon, haze and atmosphere shining on us, and it really wasn't that bright outside to start with. It wasn't like we were in full daylight, kind of a quasi state of darkness.

KERWIN It was pinker than I expected. There was a peach color.

WEITZ There was just a soft glow all around the spacecraft and, as you say, it was bright. It was so bright that I could not continue to look at it for much more than a second out of my window.

WEITZ                   It seemed to have a vorticity to it. It was upset tremendously by firing of the command module thrusters, which disturbed the wake flow. Maybe it shouldn't have been a surprise, but it did surprise me.

CONRAD                  I was in the center couch on 12. On this one, I noticed out my side window, a real flame.

WEITZ                   I wasn't prepared for that. It didn't especially bother me, but I wasn't prepared to see that solid sheet of flame out the window. But I'm glad to hear you say it was out your window, too. Also, coming off the center top, out the center window, was this foot-wide continuous stream of sparks.

CONRAD                  And, of course, we saw everything go.

WEITZ                   We didn't see the docking ring. Joe saw the shadow of the docking ring.

KERWIN                  A shadow passed across the commander's face. I saw the apex cover go.

CONRAD                  We saw the apex cover and we could see the drogues clearly.

WEITZ I didn't see the mortars fire. I don't know if I could have out of window 4.

CONRAD I don't know either. I didn't see that. I saw the mains pop into view in the rendezvous window - drogues and then I was the main, too.

WEITZ Okay, I reported, at the time, that there was a small hole in the one drogue. The mains came out rather slowly.

CONRAD It takes a long time for them to dereef.

WEITZ It takes a long time for them to get going even when they're reefed. They flutter; then they're air reefed, and then they dereef. It takes a long time for them to fill. I didn't see any holes at all. The one parachute, which I would say was on your side of the command module, had a darkened triangular spot.

CONRAD I never did see that. But we got all three chutes. They didn't get the drogues back, but they got all three of the mains back.

WEITZ The only other sighting I can remember we haven't talked about was the SIVB.



CONRAD           Well, we mentioned it. We turned around and saw it, and the SLA panels were okay. And the other sighting was as we approached the workshop. I was totally amazed to be able to see the cold gas system in the workshop fire. It put out big white clouds every time the TACS fired.

WEITZ           They were very diffuse and seemed to be a cold blue color.

CONRAD           The thing that's got me buffaloed is what the difference was between that and the Agena. Gemini used a cold gas nitrogen system, as I remember it, and it was impossible to see those thrusters fire. You never had any knowledge that they were firing at all. And they were right where you could see them. They were down at the far end of the vehicle and I never remember seeing them or hearing any comments about it. That's why it surprised me to see these fire, because I just assumed you never see cold gas systems fire. I almost had the feeling that there might have been just a tinge of moisture in there or something, and you were seeing minute ice crystals.

WEITZ           On multiple pulses, you would see each pulse. Every one was as bright as the one before.



## 21.0 PREMISSION PLANNING

CONRAD Premission planning. It was well done and then it all changed at the last minute. Spacecraft changes, we're aware of. Procedures changes, we've covered. Mission rules, we understood and we had adequate time to get our inputs into that. That was done mainly through our CAP COMM.



## 22.0 MISSION CONTROL

CONRAD GO/NO GOs were all on time when we needed them. The only NO GO we got was on undocking, for awhile. During rendezvous, the updates were on time. We got the consumables pads, we plotted them. Paul kept track of them. We didn't plot them every day. What did we plot them, every 2 or 3 days? There really weren't that many changes in them. RCS fuel, we really knew very little about. We knew that we'd used a great deal of service module RCS fuel, and I guess maybe, in retrospect, I'd have appreciated a little more update on our RCS fuel. Command module RCS fuel, there was no way to do that. You'd fire it up and you'd start with a full propellant load, and you'd go from there. Real-time changes. Again, we had that problem with them referring to teleprinter messages, and we're going to work that out.

Communications. I really thought S-band voice was poor. It was poor for the following reasons. We would hear you locking up; Houston would call an AOS; we'd answer, and they obviously would hear us. And then we went into these large key holes. And I constantly had comm dropouts during a pass. And it just made for a lot of extra yakking. I don't know whether the antennas are such, but I think we ought to leave the VHF powered up and broadcast simultaneously both ways. I don't think it cost that much to keep the VHF up. Or you could keep it up during the day and turn it off at night. It's not that big a

CONRAD  
(CONT'D) deal. VHF is all transistorized. It's pretty little, and it's not a big power eater, I don't think. The only time it uses high power is when you're transmitting. It doesn't cost anything to receive. Have you any suggestions?

KERWIN No, that's feasible, if you could. The only other thing I'm thinking of. Houston occasionally would bug you, like coming up with flight planning things at random passes. There was almost no time during the day that they might not come up with, "There's a new teleprinter message or a new change we want to discuss with you," or something like that. And that should be pretty well restricted from certain times of the day during a long flight like Al Bean's. We ought to talk about it on a designated pass or two around the evening report.

WEITZ In this mission, it wouldn't have worked, Joe. We didn't have enough passes.

KERWIN Well, we were getting out of comm range all right. I think it got better and better. What I'm saying is, it's often inconvenient to drop what you're doing and copy a pad. If it's a rate gyro problem or something like that or the star tracker needs to be locked on, there's no question about. They would come up with it and you should do something. But if it's something that can be channeled at specific times of the day, I'd like to see it done.

CONRAD     I consider that the teleprinter is communications. It's something we asked to be done and it was followed only by certain teams. Whenever you sent a teleprinter message during the day and didn't inform us that it was in the teleprinter, we wouldn't get it, because as a routine thing the teleprinter is covered up. We don't pay any attention to the teleprinter. We pick up the messages in the morning or when we're told that there's one in there. Now this caused one real bad flop in the mission, when we didn't get one very important teleprinter message, because it came up right after the morning stuff came up, and we didn't know it was there. We were all off doing our work and Houston started referring to something that we didn't understand. And the reason we didn't understand it was because we didn't have the teleprinter message. That was the one that generated my comment several times that whatever messages were sent up, we should be informed that there was a message coming and what the subject matter was, so that we could go get it. And you all didn't follow that all the time, and that caused some problems.





## 23.0 HUMAN FACTORS

### 23.1 Preflight

CONRAD Preflight health stabilization control program.

WEITZ Well, we didn't get sick.

CONRAD Yes.

WEITZ For whatever reason.

KERWIN I don't know how hard it was on everybody else and on the world. I know there are probably chinks and cracks in that program. We mentioned from our point of view a couple of the chinks and cracks that were in building 5. The simulator trainer areas themselves were very well covered. But the hallway between the one g trainer and the flight crew office and where it goes by that tool room. There were always people standing around there without masks on and I don't know if they were prime contacts or not. I think that's the only place I can remember where we were exposed to the population at large. In other respects, it's probable that the health stabilization program over did it. I don't think we need to talk about that. From our point of view, the implementation of the intake and output program was very good. There was a lot of hard work done by a lot of people. How we felt about the diets, I have

KERWIN (CONT'D) already debriefed in the MO71/73 medical debriefing. And I've recommended that they look very hard - certainly for the SL mission 3 crew at opening up the tolerances on the minerals and letting the crew choose their own food in a real time with a great deal more freedom. Medical care was okay. We didn't need it. That is to say, we didn't get sick. As I recall preflight we had enough time for sleep. We made our own time for exercise.

CONRAD We stuck to that. We took our days off. We stayed away from night work as much as possible.

KERWIN Dr. Ross did a fine job. I'm talking about the 18 days before the nominal launch of channeling the medical exams into certain days. He filled those days and kept the other days relatively free of medical examinations, so that we could get on with the other jobs. He did a good job. It's a good idea, and it should be continued.

CONRAD All the people stuck to their time lines. They were ready for us and I thought it was done in a very professional manner, all experiments, blood letting MO92, 93, 171, and so forth. If they said it was going to take us 2 hours, it took us 2 hours and that was it. We were finished and they started on time and ended on time.

KERWIN I'm not sure what eating habits and amount of food consumption means there. We were given certain latitude after the SWS launch problem occurred. I may be the only one that went off my diet for a significant period of time, which was one dinner and one breakfast at Huntsville, when I went out there to work on the EVA.

CONRAD I don't think Paul and I got very far off.

KERWIN Certainly, for the last 5 days, we stuck to our diet rather closely. Like I say, if the program is administered as well as it was for us, it's not a big problem. We've got palatability problems, but we've already talked about them.

### 23.2 Flight

CONRAD Okay. 23.2 Flight, Appetite Food Preference. Appetite in flight versus 3 weeks preflight.

WEITZ I didn't notice any significant differences.

KERWIN I think the data will support that I had a decrease in appetite for about 7 days in the flight. It wasn't marked, but I was leaving items, and I stopped leaving items. I think it was about the first week.

WEITZ I left items, throughout the flight, but I think it's not appetite so much as it was palatability.

KERWIN That gets back to this point. There are items in that menu that are not palatable, that are not well designed. We talked about which ones they are. I'd like to see the on-going crews given more latitude to substitute for those items.

CONRAD Yes, that goes in the difference noticeable and food inflight versus preflight. I think we have to be extremely careful between changes to food because of the "eat" versus our change in taste. Having never eaten a preflight diet before, I would like to say that the foods that I did not like on the ground I continued not to like in the air. I choked them down though most of the time. Then some foods turned up that I really didn't like in flight that were a lot better on the ground. Again, I can't say for sure if it was because they were heated or desensitization of the taste buds, or what up there. A good example was the chili, and I think that was a heat factor. We all agreed that the chili got greasy, had big globs of grease in it, and I think it was due to the heat. We all got to where we didn't like the chili.

WEITZ There was a notable difference in the fact that everything is flatter.

KERWIN Taste and smell were dulled up there for some reason.

CONRAD Therefore, you tend to like the zippy foods.

WEITZ       The ones that were tolerable on the ground became less tolerable in flight, because of that reason. That kind of ties into the next one, the change in food preference. The foods I liked, I continued to like. The foods I didn't like, my dislike for them increased, primarily the reconstitutable vegetables I disliked them more and more as the flight progressed.

KERWIN      You didn't like the bread.

WEITZ       I really didn't like it, but I didn't dislike it as much as you did.

CONRAD      We have a couple comments on that. One of them was when we were restricted on the use of our heater. I think that one of the mistakes that we made was not letting some of that food reconstitute long enough and that added to the bad taste of it. I found out that if I reconstituted the peas, the beans, and the asparagus early, and then reheated them, I still didn't like them, but they were a lot easier to choke down than when I added the hot water, shook up the bag and then tried to get them down. They didn't reconstitute as well. There were several foods, the macaroni was another one, that needed to be reconstituted and let set. Spagetti and meat sauce was another.

WEITZ Most of the reconstituted foods, other than soups and potatoes, needed several hours of reconstituting. Chicken and rice is an example. You can tell by looking. The portions were still acceptable in flight.

CONRAD I got it all down, but I still think there were too many fruits. On the ground as well as in the air, there are too many pineapples, few too many peaches and things for me.

KERWIN I felt the same way Pete did, both in preflight and inflight. Put this down as personal preference. You have different sized stomachs and appetites. The system doesn't accommodate for those right now. I think the most acceptable foods were by and large the frozen foods.

GONRAD Yes, I support that.

WEITZ They were foods you liked before.

KERWIN Skylab not to the contrary, they were great.

CONRAD And I guess the favorite amongst us all was not a frozen food. It was German potato salad.

KERWIN Unfortunately, we used up all the overage in the vehicle, all four cans. I don't know if there's any room at all in Al's command module for food, but if there is they ought to look at

KERWIN        some of these tastier items that can be substituted for some  
(CONT'D)        of the poorer items.

WEITZ         You know what made the potato salad, it was a little zingy.  
                 It had just a little taste of vinegar and onion.

CONRAD        The bacon was almost too sharp on the ground, too salty, but  
                 we really looked forward to it.

KERWIN        We're eating a hospital diet. It's a bland diet, and it gets  
                 worse up there.

CONRAD        I think one thing we enjoyed in flight was the sausage, more  
                 so than on the ground and, again, it had some zing to it.

                 Now Food Preparation and Consumption. We've talked about the  
                 rehydration, but we have not mentioned the gas. Now, I think  
                 the gas was probably too cold. I think there was some in the  
                 packages, and I still think there was some in the water.

KERWIN        Yes, there was some in the water, and there was some water  
                 vapor that came out when you used hot water. It was worse  
                 with the hot water, than with the cold.

CONRAD        We deliberately took some films of bags that were filled with  
                 hot water, that expanded them to their fullest.

CONRAD  
(CONT'D)

When we got to the reconstituting, rehydratable hot food early we would have to let the air out of the package. We would have to go to the trouble to let the air out of the package so that we could put it back into the can and put the lid on. An example was the fruit tray.

KERWIN

Yes, you would have to let the air out of it, and that was not a terribly easy thing to do. In many cases we walked by and Pete's tray lid would be popped off, because he was heating some food in there, and it was too big for the slot. It was hard to get the tray on top of it. Something that was interesting to me was, when you reconstituted one of those rehydratable foods and it wound up with a lot of gas in it, it was a pyramid shaped package, with a big flat bottom, and a cone-shaped top. The air would pretty much concentrate in the top or cone-shaped part of the package. Now, that can't be gravity, so it must have to do with surface tension and the shape of the package. That's a point to keep in mind for future design, because you can make air concentrate. You got more surface tension around the sharp radius corners, where the food stuck in the bottom. That was lucky because it made it possible to cut the top off the packages, without losing a lot of food.



KERWIN  
(CONT'D)

The food temperature was good. The only thing along that line was, of course, that we could not heat our coffee. You had to put it in with hot water and then you had to drink it quick before it cooled off. It was certainly hot enough to start with. But those drink containers did not lend themselves to sipping a drink, and drinking over a period of 5 or 10 minutes, as you ordinarily do with a cup of coffee, because they tended to suck back air. They also cooled off very rapidly, and were a little bit difficult to drink out of. I think we need a better drink package for the future. We all thought that the water was reasonably good.

CONRAD Yes, I was never really aware of any iodine taste or anything like that in it.

KERWIN Use of the spoon-bowl package. We've already commented that the spoon-bowl package, was not fully satisfactory, because the food would leak through the zipper, up into the part you would have to cut. Which made it messy to open the package.

CONRAD Yes, this was due to that expansion again.

KERWIN Yes, the gas would form in there and this would force the food right on up.

Use of spoons. Super! Once you have negotiated the top off your package, and once you've gotten rid of that messy membrane

KERWIN (CONT'D) that is in the nonrehydratables, the fruits, meat, and so on, it was great. The food sticks to the spoon and it was easy to get.

Opening the cans. We had very few failures of the little pop tops. We had about two I would say in the whole flight. Nobody cut themselves on sharp edges. We did have a problem getting the membranes out, because they were messy, they would spawn big globules of juice up toward the ceiling and on the walls, and on you and everything else.

CONRAD Mainly, that was on the hot foods, though. It wasn't so bad on the fruit.

KERWIN No, it wasn't under pressure, and the fluid was a little thicker, and it wouldn't spawn so much, but it's potentially there. Opening of cans. Consumption from cans is very easy; consumption from the rehydratable packages can be very difficult. The liquid particularly sticks to the creases and the folds in that rather thick, heavy plastic, and you can't get all of it out.

Food Waste Stowage. Function of the Germicidal Tablet Pouch.

CONRAD We never used it..

KERWIN There were some germicidal tablets in the command module. People, we confess we never used them. We got rid of that trash quick enough, that we didn't have to.

CONRAD I resealed it over in the big plastic packages and we transferred that the next day, and it was gone out the trash air lock.

KERWIN Undesirable Odors. I think we already debriefed on this. The only time we got them from food, was in the garbage can slots, and from food sticking to the lids in them.

WEITZ I never smelled it.

KERWIN Fecal Container. Had we not debriefed the fecal container. If they mean the big black rubber bag, that works okay.

KERWIN You need it on reentry, and you might or might not need it on launch. It's fine. I debriefed on the urine system.

CONRAD The only thing there was the one clog on the urine system, and that was no strain.

WEITZ Yes, I debriefed that.

CONRAD Water. I wasn't aware of any chlorine taste in the command module and/or any odor. I already said we didn't notice the iodine taste.

CONRAD We ran between two and ten parts per million.

WEITZ I got nine out of one tank, but at the same time that's the tank that was feeding the table but Joe and I both read one at the chiller.

CONRAD That's right. You showed me that.

CONRAD I really wasn't aware of any physical discomfort from gas in the water. I guess the place I was most aware of gas in the water, though, was the coffee. It seemed to have the most in it, because it was hot.

WEITZ Everybody swallows a lot of gas up there. I think that if you're going to operate successfully in zero g, your body has to process that gas. You belch very little, therefore you pass most of the gas in the form of flatus. You have a lot of flatus, and that is just part of living up there.

WEITZ Did you belch at all?

KERWIN Yes, I did.

WEITZ I never did.

CONRAD I never did, either.

KERWIN I think it was the phenomenon we saw in the packages. I would get a gas bubble near the top, in the stomach and out it would come. You're going to swallow air and gas, and you have to pass it on through.

CONRAD We didn't use the gas separator in the command module. We never installed it. We didn't need it.

KERWIN We talked about the hardware and the sleep restraint. We all liked it.

CONRAD As to difficulty going to sleep, I think we normally worked enough and had enough physical exercise during the day. We did have different sleep-time patterns. Joe and I seemed to sleep the same amount; Paul a little bit less. I guess when you were ready to go to sleep you went to sleep.

WEITZ If I went to sleep early, I would wake up after an hour or so. So I started staying up an hour or two after you guys went to bed, trying to move quietly about. I just flat needed about an hour to two hours less sleep during flight than I needed on the ground.

KERWIN Let me make a point that might be a good one. If you're tired, you're going to go to sleep easier. I thought I needed less sleep up there, and I thought it was a little harder to go to sleep. It never proved to be a problem and I never felt that I was getting behind on sleep. But working out makes you feel good and makes you feel more ready for sleep. I think that if I had one thing that I could change in the routine daily flight plan, I would like to have my workout

KERWIN  
CONT'D

late in the afternoon, routinely, rather than scattered throughout the day. In our case, it just couldn't be done, but it sure would be nice.

CONRAD

Well, I sort of recommended to the other guys that they get a split period where they can work out twice a day. Of course, this is going to be an individual thing. Some like to work out late, some early, some in the middle. But I still think it does make you feel good if you can work out twice a day, even if you didn't do any more. I did 1500 in the morning and 1500 in the afternoon. I think I would have benefitted even more from it by splitting it.

KERWIN

Even just running around the ring lockers or throwing the ball around in the evening for 15 minutes makes you more relaxed.

WEITZ

I think that helped. The few nights we played around up in the forward compartment, I thought it kind of helped relax us. It gets you all ready for sleep. But that comes back to your comment. I wasn't really ready to go to bed when you guys were, and there was precious little I could do. If you went to bed, I always had the feeling that if I read in the wardroom, that would bother you. If the wardroom window was

WEITZ  
(CONT'D) open, that would bother you. And if I went up and looked out the STS windows, that lights up the whole cluster. I guess we need more private quarters.

KERWIN In a space station, you need more separation between sleeping quarters and the working part of the vehicle.

CONRAD You need better soundproofing between sections.

KERWIN We've talked some about exercise. We all exercised almost every day of the mission. I felt that it was invaluable and that, if anything, we weren't getting enough of it. I wished from time to time that we had had something like Bill Thornton's device in addition to the bicycle to work out some other muscles and allow you to exercise in a different way.

WEITZ That right. I tried the Exer-Genie or Exer-Gym. The rope is too short, and you don't have the right kind of handles. You need a wooden or Teflon cross piece, a 1-inch diameter foot-long piece of wood to use as a handle so you can do what's called a big four. And you could do a series of that.

KERWIN I've thought since I've been back, and especially since I've jogged now, that some compression jogging device might be helpful. It might not work. And then something like a bar bell with a resistive device in it that you can pick up and

KERWIN  
(CONT'D) down might be helpful. If it could get those arm and shoulder muscles and put a little compression into your back, it would be very good.

CONRAD The other muscle that the bike obviously doesn't work on is the calf muscle. That's the one that's been the sorest on me since I got back. We tried to figure out how to do that on the bicycle, putting it out on our toes and so forth, but it just didn't seem to work.

KERWIN So the bicycle's good, but it's not doing the whole thing. These comments aren't going to help for Skylab. For the Skylab crews, I'd encourage you to let them have plenty of time to exercise. And they'll do it.

CONRAD I do think that they need to take something else along, like a spring stretcher for the arms or something they can hook in the floor. That Exer-Gym, in my opinion, does not do the job. I would rather work against the springs than work against that system. Now, again, that is personal preference. I tried after the Apollo 12 flight to learn how to use the Exer-Gym right. And I never did like it.



WIETZ Closed mind.

CONRAD He's like Joe. Joe never lifts weights and he wanted to work something.

WEITZ If you had a bungee that could adapt besides doing arm exercises, you could do leg exercises. You could just sit and do a few full leg extensions with it.

KERWIN I'm a hater of weight lifting, and even up there I did not want a few maximum stretches or works of a muscle, I wanted a lot of moderate ones.

CONRAD It's the moderate ones of longer duration that really does the job for you rather than the max effort.

KERWIN Muscle soreness? I never had any during flight. How about you?

CONRAD/  
WEITZ None of us did.

CONRAD As a matter of fact, we were free from it.

KERWIN Postflight I've had soreness. It feels like the kind of soreness you get when you start to work out after a period away from exercise - in the feet, in the calves and some in the small of my back, but not much. It just tells me that these are the muscles that I wasn't using.

CONRAD Do you notice any tingling in the feet, anymore?

KERWIN No.

CONRAD I do when I first get up in the morning. It's the only time.  
It's gone almost after two steps.

WEITZ I haven't noticed it since the second day.

KERWIN Same here.

As far as muscles, I think the lower extremities, despite the bicycle, have a lot of muscles in them that were not used during flight.

Perspiration. You sweat up there just like you do down here. Only it beads up on you instead of running off.

CONRAD When we were down in the 70's in the workshop, it was noticeably less during excercises.

KERWIN The very first time we worked out on the bicycle, it was noticeably more. The temperature was so high then that you broke out in perspiration very early. I think we were undergoing thermal stress as well as exercise stress at that time. Even in the LBNP I remember one or two of us that broke out into a sweat, on that run, which I've never seen since.

Inflight Oral Hygiene. I thought brushing teeth up there was just like it was down on the ground. I didn't use dental floss.

CONRAD I did.

KERWIN Because I never use it in my life, and I'm just not in the habit.

CONRAD When we had the filet, I used it like I do on the ground. We had plenty of toothbrushes. I used one for 28 days.

WEITZ Sunglasses, I didn't use them even though I wear them all the time on the ground. I think it was a combination of factors. I had enough things in my pocket without carrying the sunglasses around with me. It didn't bother me that much to look out the window without them. Plus I am used to the grey ones, and it seems to me that the green ones just don't do the job, even though they probably do. The few times I tried to use them looking out the window, I felt that I always want to take them off when looking inside.

CONRAD I used them strictly for the rendezvous which I expected to use them for work coming up on the SWS; otherwise I never used them in flight on orbit.

KERWIN I carried my prescription specs around with me most of the time but I used them very seldom. Occasionally I used them for looking out the window and once, or twice at the ATM panel. They weren't required and I just didn't use them.

KERWIN Unusual or Unexpected Visual Phenomenon. We saw light flashes.  
(CONT'D)

I think all of us saw them. I saw them most often when I was in the sack at night with my eyes closed but awake naturally. They tended to wax and wane in frequency. Someone asked me if that was in conjunction with the South Atlantic anomaly. It may have been. I didn't have the pad with me at that time and I don't know. They were numerous at times - two or three per minute.

CONRAD Some of them to me were a spot or sunbursts. Some were streaks. The streaks, in my case, were less frequent than the bursts. Most of them were in my peripheral visual field. Very few in the central visual field. I don't know why.

QUERY You could isolate them to one eye, couldn't you?

KERWIN No, I couldn't.

WEITZ I would say mine were primarily in the left eye for some reason.

CONRAD You have to concentrate but you can determine they are in one eye.

KERWIN I did not. That was foolish of me but I didn't try. I'm sure they are in one eye.

CONRAD Sometimes I'd be lying there with my eyes half closed, and I'd see a fire sensor wink.

KERWIN And you'd have to be careful that you weren't confusing that with the fire flash. Once you've seen a few of each, there is question of which is which. They're not an hallucination.

KERWIN We didn't feel it was operationally necessary for anybody to know about it right now.

WEITZ I had a couple that I thought were cosmic particles. I saw an entrance streak and an exit streak.

CONRAD Yes, I did too.

WEITZ Where, bing-bing, it seemed like it was one side of the eyeball, and then the other side.

CONRAD One night I remember that there was a long shot then it was blank then there was a long shot in rapid succession, of course, but very definitely in and out - or across the eye.

KERWIN Medical Kits and IMSS. As far as adequate quantity of medication and supplies, I would guess we used about 0.01 percent of the available medication. I think this is something for me to sit down with the doctors and talk about. There is plenty of medicine up there for the Skylab missions. There is

KERWIN  
(CONT'D) plenty of supplies up there, some of which we will probably never use. Packaging, in general, was adequate for the mission, there are going to be improvements made over the years. As far as for instructions for use, I think we'll get a better debriefing on that from the follow-on crews, because I did not tend to break out the IMSS checklist. I just went ahead and treated it like a doctor's bag.

CONRAD Housekeeping. I think housekeeping is straightforward. It's very obvious what you have to do.

KERWIN We wound up changing the trash locks and emptying the fecal drawer, and cleaning up when it was necessary. When that housekeeping task came up on the flight plan, we said, "Have we done that in the last few days?" and if we had, we skipped it until we needed it.

WIETZ They don't have to schedule routine things like that. You know when you need to do these things.

KERWIN It acted as a memory jogger. You knew you were doing the right things, but you certainly didn't feel bound by the schedule.

CONRAD You still have to schedule things like biocide in the urine drawers, because that stayed very clean and there was no odor. The obvious things that we did clean was the wardrobe. You

CONRAD  
(CONT'D)

can see spots of food. We just automatically kept taking them off as we saw them. But the biocide is something you still have to schedule to keep that at the right frequency.

WETTZ

Shaving soon became relegated to an evening task because nobody wanted to take the time in the morning.

KERWIN

I planned on that preflight.

WETTZ

I had planned to shave in the morning.

KERWIN

The problem is serial time use of the bathroom in the morning. Everybody has to get in there and urinate, wash, brush teeth, and service their urine drawer, and tidy up in there. It takes awhile to get into a routine. You don't have time to sit in there and sing in the mirror. As far as the technical aspects of shaving, my opinion is that the windup razor does a poor but reasonable job if you use it every day, provided that the head doesn't get dinged and start to pull or tug on you. I went through one head in about a week. And I wound up borrowing Paul's razor to use the last week. It's more satisfactory, and more comfortable to wet shave. However, I used a Wilkinson razor and I found that the second shave with that blade was generally unsatisfactory. It was painful. I then spent a lot

KERWIN of time cleaning my last blade after I used it the first time.  
(CONT'D) I spent 10 or 15 minutes - with tissue paper really trying to get all of the stuff out from behind it.

KERWIN And the second shave went better with that. I don't think they're good for more than two shaves.

CONRAD Along that line, I used the double-blade Gillette, Track 2 and what I would do was put hot water on my face, let that sit for awhile, then wash my face with soap. I would put hot water back on there again, to try and soften things up. I put the shaving cream on and let it sit for awhile, and then take good hot water to take it off. I would shave with just water on my face, as a lubricant to move the blade. By shaving a couple of strokes, and sliding the razor across the towel gently that kept it from jamming up. But, it does dull the razor. I can get 15 or 20 shaves with a Track 2 on the ground, without that thing ever pulling hair.

KERWIN I can get 10 with a Wilkinson.

CONRAD I could get two or three up there. I used all my blades and then I got on the right frequency and rationed it out. I did the same thing you did. I shaved for 3 or 4 days with the windup and then I'd really give myself a good clean shave with the wet razor, when I had time. Then I'd go back to the windup.



KERWIN I agree with your technique. Lots of water and wipe most of the shaving cream off.

WEITZ I used a variation. I would put hot water on, let it soak awhile, and then put the shaving cream on. Then I slapped on some more hot water. So it was kind of gooey. And I didn't wipe it all off at once. I would take a tissue and wipe off an area and shave it, essentially dry. It worked quite satisfactorily. I just keep wiping the shaving cream off and shaving as I went. And, I just flat didn't try to salvage any blades. I had five blades and I shaved five times. I threw each one away.

KERWIN Radiation Dosimetry. I thought wearing the passive dosimeter quickly became accustomed to.

WEITZ Completely innocuous, so I didn't mind a bit. I wore it on my watchband with my watch, and you wore it on ...

CONRAD I wore it on a separate watchband on my other arm. It got to be habit to have it on there, and I never thought about it.

KERWIN Again, reading the personal dosimeters, putting them each in a specified place, reading them every morning, was a five-minute task. It was easy to do.

KERWIN  
(CONT'D) Carrying them around with you those first couple of days was a kind of a nuisance as well as collecting them in the morning to read them. I recommend that as quickly as possible that the crew would be allowed to stick them up on the wall and just read them every morning.

WEITZ Personal Hygiene, sponge baths. One custom, after exercising, just stripped down and washed off with a wet washcloth and a little soap and then throw that washcloth away. That was done every day.

CONRAD With two washclothes and one towel, we used all our towels. But we had 89 extra red towels that came up in the command module in stowage. So we split all those, equally.

WEITZ We did not use our recommended method of cleaning the shower with towels.

24.0 OPERATIONAL DTC'S

CONRAD Operational DTC's. The temperature dewpoint meter crapped out. I was holding the temperature; M489 did work fine.

KERWIN Radiation surveys. I did one radiation survey which must have been on a well selected pass. The results were most interesting. The first two stations that I went to, I got nothing. Very low readings, then I went down to the station in front of that radiation monitor, the VABD, and about that time she starting climbing, and I had to change scales. At that point, I hustled over to the experiment circuit breaker panel, also to the sleep compartment and the readings were pretty much the same throughout the compartments. They were hot and they quickly began to drop off. So there was some technical radiation in the spacecraft during the pass. You got the data on the tape and it would be interesting to look at.

CONRAD We really need to look at our sleep times, just to get any idea at all if there's any correlation between light streaks and the belt.

WEITZ The CO<sub>2</sub> crapped out right away.

CONRAD We explained that on B channel. There was some white material, like dried salt down on the base of that thing, especially out of one sensor area more than the other. It was out of the A-1

CONRAD or the B-1. I think the heat got to that thing. Other than  
(CONT'D) what we observed from our thrusters, we never observed contamination.

WEITZ Through the coronagraph, I could see contamination. Except every now and then I would see clouds of stuff, bright and unrelated to anything.

CONRAD I'm convinced the stuff we saw in the coronagraph that one time was when we vented the hydrogen tank.

KERWIN Most of the stuff coming out of the coronagraph was ATM paint flakes and maybe chips of Mylar insulation, loose insulation and paint that was wearing off.

WEITZ That's it; I looked out the window and thought they were stars. I was laying there in bed and my heart came right up into my throat.