MO-I GOLDEN

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# SKYLAB 1/4 SYSTEMS DEBRIEFING

## (COMMAND AND SERVICE MODULE/ SATURN WORKSHOP)

PREPARED BY
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SKYLAB 1/4

SYSTEMS DEBRIEFING

This document is a verbatim transcription of the postflight command and service module/Saturn workshop systems debriefing conducted by the Skylab 4 crew at the Johnson Space Center on March 6 and 7, 1974. Where possible, questioners have been identified by their last names. However, the attendees and questioners are too numerous to identify or list here. The astronaut participants are as follows.

| | | |
|---|---|---|
| CARR | Gerald P. (Jerry) Carr | Commander |
| POGUE | William R. (Bill) Pogue | Pilot |
| GIBSON | Edward G. (Ed) Gibson | Scientist Pilot |

The subjects for this portion of the debriefings are listed as follows.

Command and service module
- Electrical Power, Fuel Cells and Cryogenics, Propulsion, and Batteries
- Structures, Mechanical, Thermal and Docking
- Environmental Control, and CSM Crew Station
- Guidance, Control, and Rendezvous
- Communications and Television
- Operational Cameras and Photography
- Launch Vehicle and Emergency Detection System

Saturn workshop
- Instrumentation and Communications
- Structures and Mechanics
- Contamination
- Thermal/Environmental Control Systems
- Electrical Power System
- Attitude Pointing and Control System
- Crew Systems
- EVA Systems and Operations
- In-Flight Maintenance

A series of three dots (...) is used to designate those portions of the communications that could not be transcribed because of garbling. One dash (-) is used to indicate a speaker's pause or a self-interruption and subsequent completion of a thought. Two dashes (- -) are used to indicate an interruption by another speaker or a point at which a recording was terminated abruptly.

SYSTEMS DEBRIEFING

Morning Session

JOHNSON I'm Jerry Johnson ... on the sequential subsystem. To start off with, we thought you might be interested in looking at what we found on the circuit breaker.

QUERY Flip your switch and ... you get through.

JOHNSON We thought you might be interested in seeing what we found out on the circuit breaker.

CARR Okay, good.

JOHNSON The BAT A circuit breaker. I've got some photographs and X-rays here. These are X-rays of the breaker before it was taken apart. And here's a normal breaker and this is the CB-20, which is the BAT A breaker, and as you can see this bottom contact here is canted. It should be flat like you see here - -

CARR Oh, yes.

JOHNSON - - for the contact. And what happens is the top contacts are on a slant. Well, as the breaker comes down, it contacts on the outer edge; and then as you push it all the way in and it latches, it rolls over to a new surface area in the

JOHNSON (CONT'D) middle. Well, in this particular one, when you close it - I have the views reversed here - As you can see, it just barely makes contact here on this one little edge, instead of being flat or over in the middle on a bigger surface area. And another view of the pictures, of what that does on the contacts themselves. As you can see here, this is that contact. Normally, what you'd expect to see - here's a breaker here, is as you close it, it makes contact and then it rolls to a new area. In effect, it makes contact - a normal contact like over here, would make here an arc - you always have an arc involved. And then as you mash it on in, it rolls over to a new, clean surface area. Well, on this particular one, it was always coming down and staying in this one spot; it stayed right there. So it was actually always hitting on this - where the arc is.

CARR So we essentially did have contamination just - -

JOHNSON Right.

CARR - - because it didn't roll.

JOHNSON Right. Now this area over here - we found out what causes that is, when you push in additionally, like we were having you do, it would flex it on over here to a new area. See?

CARR I see.

JOHNSON That's what was causing that. And the reason we mentioned to you to - on the load test - Well, mainly, the reason we first mentioned the cycling is we thought if it was normal configuration you should have been getting some sort of wiping action. But that wasn't happening; so on the ground in a few of these cases when we put a load on it and cycled it, it was reasonably clear. Something - in terms of surface contamination or something. So that's the reason we went ahead and asked you to run a load test of 20 amps or so.

CARR Okay. Well, I'm sure glad you were able to find good proof positive of why we had the problem. That's great.

JOHNSON There was definitely a problem with that surface.

GIBSON When you cycled it and it finally worked, what really happened? Did you - -

JOHNSON The only thing I can think of is - what we think of is if you arc in here enough to - throw this material out of the way enough to finally get down to - -

GIBSON Good metal to metal, huh?

POGUE One side isn't enough, huh?

JOHNSON No. See, the current flows into one side and - -

POGUE And out the other, huh?

JOHNSON - - ... and back out the other. See? So you actually have to have both sides. So even though the one side was good, all it took was one of them being bad there to mess it up.

CARR Yes.

JOHNSON But you're right; we definitely found something wrong with it.

CARR Well, I guess our conclusion was that in the future, when we test batteries and things like that, that maybe we shouldn't be happy with just open circuit voltage; that we should make sure that a system will carry a load, and that maybe we should change our way of testing things in the future and make them carry a few amps too, as well just check and make sure their voltage is good. Because heaven only knows when that first got to the point where it wouldn't carry a load. It could have been on day 4 or something.

JOHNSON Yes, I think I agree with you, particularly in a long mission like that. And where we got the capability to

JOHNSON (CONT'D) charge the batteries back up, there's probably - it actually gives the battery people - they might want to comment, but it actually gives them a better data point here in the mission, too, I think, if that's done. Doesn't it, Bob?

BRAGG I would like to - -

QUERY Get a mike, Bob.

BRAGG I would like to make one comment; my name's Bob Bragg. Would like to make one - there is a reason that we - at least from the battery standpoint, that we have been looking at open circuit. And that is that for a solar-sync battery you can tell more about its status and what its status is by watching the open circuit than you necessarily can under a load test. And we - this was established pretty early in the mission, that this was how we wanted to do it. Now, to tell - continuity of a circuit is something else. And you're probably right; you do need - if there is a question that we will not be able to get a continuous circuit - -

QUERY Right.

BRAGG - - we'll be able to do something like that, I guess.

CARR Okay. So we shouldn't say when we're testing batteries, we want to carry a load; it's more to test a circuit.

BRAGG Yes, on the battery standpoint, that's right.

CARR Yes. Okay.

QUERY Okay, we do have a couple of questions here. One thing we want to know is, after splashdown - of course, we don't have any data on the DSC at that time, or any airborne data, because we killed the main buses. But we wanted to know, did you notice any - if you were doing any checks on the battery currents or voltages, did you notice any indication of a high drain or any indication of flicker lights, like a short or something, momentarily?

POGUE After splash?

QUERY Yes, after you were on the water, or like in stable II.

POGUE I certainly didn't do any checking, and I did not notice any flashing. Jer would have been in a better position than the - to notice flashing. You had the only lights on.

CARR Yes. I didn't notice any flashing at all.

QUERY Well, what prompted the question was that the engineers out at Rockwell had noted that on the circuits associated with the four SPS circuit breakers that the pins were either missing or just a corroded piece left. Of course, what

QUERY (CONT'D) happened is they had - they came off the battery bus upstream of the main bus and they still had power on. And in the salt water, there was probably a current drain on that circuit. Now it wasn't enough to open the circuit breakers, because they were still closed. But we just wondered whether you had see any indication on board of any current or something.

CARR I didn't notice a thing that would indicate it. It was such a bright, clear day that any - you know, the post-landing floods - you didn't even really know they were on.

QUERY Right. Okay. The other question we had goes back up around CSM SEP time and has to do with Ed - Ed made a comment; at the time he hit the manual RCS TRANSFER switch, he heard a noise. Was that more of a click or clack or just kind of a zip noise?

(Laughter)

GIBSON ... my choice?

QUERY ...

GIBSON Just a dull muffled thud which - I suspected at the time it was due to a relay closure somewhere. It may or may not be a - may have been something else.

QUERY Well, the reason for I was asking for kind of - the motor switches we have in the vehicle kind of give you a zip - you know - type thing when they get ... -

GIBSON No, it was more of a - -

QUERY Relays have more of a click or clack.

GIBSON - - ... muffled.

QUERY Okay. Well. in looking at the data, of course, it - we have indications that both of the RCS TRANSFER motor switches did transfer.

GIBSON Okay.

QUERY Because one of the motor switches gives you RING 1, AUTO and both SYSTEMS DIRECT, and the other one gives you RING 2, AUTO and both SYSTEMS DIRECT. And we saw on the ROLL circuit both RING 1 and RING 2 indications come up on the data, which indicated - right at transfer - we did get both RCS TRANSFER motor switches.

CARR That's auto transfer?

QUERY Right. Auto transfer.

GIBSON Okay. Must be - -

MS ...

QUERY Well, it looks like - I got with Chuck Finch, and looking at the data, it looks like - right at the time in the transcripts where you indicate you were throwing the switch and heard the noise, it looks like we picked up - an RCS engine valve being picked up for the first time. In other words, Jer always actually had operated the hand controller and picked up a valve, so that could have been a clank in the solenoid. And it looks like it's almost exactly at the same time.

GIBSON So as soon as I hit the switch, I heard something and Jerry got firing and I thought that was it.

QUERY Yes.

GIBSON Okay ... - -

QUERY It looks like ... what happened.

CARR Yes. We - after finally realizing what the problem was, why we didn't get that - those auto coils, then I was willing to back off and say, well, then maybe we misinterpreted the data when we decided we hadn't gotten auto transfer. And of course, the sound that Ed heard - -

GIBSON That was the only thing that led me to believe, other than the fact that he didn't get firings, that we did not get an auto transfer.

QUERY Right. Well, when we read that in the debriefing, that's when I went back very carefully to see that; because if one of those motor switches hadn't trasferred when you hit that switch, of course, you would then have transferred one.

CARR Yes.

QUERY And it would've been more of a zipping sort of noise like a real fast running ... Well, you've probably heard the motor switches go, I'm sure, in the command module; they've kind of got a little zip to them or something. But the data had indicated they'd already transferred, and then a couple at the back we located.

CARR Okay, that all sounds fine; that all sounds good to us.

QUERY Okay. That's all the questions we have on the electro-power distribution. Now the battery and fuel cell people are here too, and - but if there's any questions you fellows have -

QUERY Fine. Go ahead ...

QUERY Well, we don't have any more on the power, but we do have one general question on the RCS ... subsystem manager.

QUERY You got it.

QUERY One other question we want to address to you guys is of general nature. One of the things that always interests us with hyperbolic direction control system is contamination. This is a big concern in the Shuttle Program too. We're wondering if at any time during your excursions outside, or even inside at the windows or anything, you noticed anything on the order of contamination that you might have attributed to a RCS activity. We had a pretty good lot of it this time with big burns, we did. So it's a good data point to see if we actually got anything that was detectable at this ...

GIBSON Yes, we did. We could see on the outside of the total cluster a darkening of all the light colored surfaces. One was - we attributed it to two reasons: One was solar, and we could tell that by shadowing effect, and the other was some sort of a contaminant which was getting all over the outside of the vehicle. And we know it was a contaminant by seeing it on the command module windows. And that ... - -

QUERY It wasn't - it was permanent; it wasn't temporary in nature? It was permanent?

GIBSON Yes. It just increased as the mission went on. To try to associate that in time with the RCS burns we made, that we did not try to do.

CARR When I went out on EVA and went over the Sun end of the ATM and took those pictures of the command module, I definitely saw contaminants around the RCS quads. It looked to me like it was probably - had - you know, was definitely connected with the RCS quads.

QUERY Now we expect it in the plume shape ... That's more of a thermal discoloration than a contaminant. But you're differentiating those two.

CARR No, I wasn't.

QUERY Okay.

CARR But you could see what looked like - -

QUERY This is one of the pictures you took, and what I see there I would expect that - -

CARR Yes, there are some better pictures than that, Dwayne. I think that - is that a little bit fuzzy? I think what that

CARR (CONT'D) is ... 16 millimeter frame that's been blown up to a still. I got several Nikon frames of the command module with the 35-millimeter lens, which ought to be much better photography. And the exposures on that particular frame are not good. The contamination that you could see does not show up in the 16-millimeter film.

QUERY A better indication might even be the comment you made on windows. Something right around - -

CARR Yes. You got the word about what we saw on the windows in the water? We had film over the windows, and as they got into contact with the sea water, it wrinkled up, much like a top on a custard or something like that.

QUERY No, we didn't. That's interesting.

CARR And then after a while, as the swimmers moved around there and sloshed water up on it, touched the window and everything, all this contamination was gradually washed away or bunched up into sort of like ... - -

GIBSON It looked like there was enough left over to get a sample, though, and I'm wondering whether anybody did try to get a sample of contamination.

QUERY No, I looked over the thing pretty good. You know, we got it back in the hanger there, and there wasn't anything on it at that time.

GIBSON Is that right?

QUERY Yes.

QUERY Well, they might have even washed it down.

GIBSON Oh boy. We were hoping you'd be able to ... - -

CARR But the windows were very definitely - command module windows very definitely had a film of contaminant on them that we could see from the inside. When you got on low Sun angle you could see that there was sort of a tan or beige contamination on the window. And you could tell just by the reflection of the light.

QUERY It's a shame we didn't get some of that.

GIBSON That occurred quite early in the mission too.

QUERY Was there any particular change once - right after that - oh, your two longer burns, 80-second and 180-second burn?

GIBSON We didn't try to make that correlation; it would have been useful to do, but we didn't.

CARR I don't know how we could've made any correlation. It was just a gradual buildup, so that near the end of the mission you could look out the window and you'd say, boy, there's sure a lot of crud on the windows, and it wasn't that way in the beginning of the mission.

GIBSON We might have been able to take pictures at the same time, before sunset, before and after the burn.

CARR Yes.

QUERY Very good. Okay, that's all I had. Now you guys had some questions about all the things that transpired in the RCS system. We'd be glad to try and - -

CARR I think we've been pretty well clued in on RCS and what the deal was, the ring 2 problem, and of course, the one we induced ourselves that gave us a little trouble for a while until we got into the direct mode.

QUERY You got the story on the valves ...

GIBSON Yes. I guess one question I still have on the leakage we had on the helium. We saw it come down, and it appeared as though it came down to close to 2000 pounds, and start to level out. And this applied to the people on the ground as well as to us, if we really had a propellant leak as opposed to a - -

QUERY No.

GIBSON - - helium leak. That was initial decay?

QUERY Yes, it was almost an - exactly a theoretical orifice blowdown, a gas-helium blowdown. We plotted it later and - perfect curve all the way down. It ended up, actually, 600 when the guys got it on the carrier and bled it off. It was a - And we pretty well knew that, even in real time. And there were communication problems. Some of the problems we were sure you guys found ... you probably know about. But we looked at that thing; we said, hey, we're 95 to 98 percent sure that's helium. All the effects we saw looked like helium. But one thing that did foul us up: Every so often one of you would say, hey, there goes some more ice. And we were a little - -

GIBSON We tried to make that clear that we saw that before. We had - -

MS ...

CARR There was one place where you didn't hear us, and that was - -

QUERY So we got a little edgy ... what are the consequences, you say. And you just go ahead. We used ... rings all the time, because I know on the mode, the ... mode, you

QUERY (CONT'D) had the backup going. And there were no adverse consequences. On the other hand, if you'd gone the other way, there were some ... problems, so that I ... well let's just play it safe and not worry about it. And that's how the decision went. But it's unfortunate that the word got to you, obviously, later, that we felt it was a propellant leak.

GIBSON Yes, that just had us wondering about where the propellant leak was.

QUERY We had a communication problem over here, between this desk and over there. And then the problem with you guys - so we had little minutes here and there, and bad communications ... but we were just playing it fat and cozy, is what we were doing.

GIBSON Okay. No problem operationally on the STS. It was just that we thought propellants might be floating around - -

QUERY Yes, well if it had been ... it would've dumped them. It would've had to dump that whole fuel into that ... bag, which would have been a little problem handling. That's why we tried to get the message to you. You know, you might've wanted to put your masks on so you don't have to worry about fume ingestion, things like that.

CARR Yes ... - -

QUERY But that got kind of fouled up.

CARR Yes, we never got that word. We found out later that we had decided not to wear the masks. One question on the RCS system just occurred to me. We had you know that quad Bravo problem, PSM to the quad. What was the problem? It was never absolutely clear to me just exactly what our problem was. I was under the impression it was an isol valve.

QUERY Yes, the propellant isolation valve, the oxidizer, ran out or they filled on quad Bravo. That is, the propellant isolation valve was crosstalking with the manifold pressure early in the mission. It wasn't a gross leak, but every time the pressures would go up on one, you could see them reflected in the other and they were - there was a little bit of lag situation. So we knew it was just a leak, and we debated a long time on whether you really wanted to perturbate the procedures in doing something about it. The idea we finally came up with was, we could go ahead and use the PSM to quad propellant isolation valve which was holding good. Then we could still isolate all the quad propellant and saturate all the other quad systems

QUERY (CONT'D) from that quad; so if you developed a leak in another quad for instance or another - any place other than line, you wouldn't leak quad B propellant through that valve you thought was closed out.

CARR Yes.

QUERY It was just a scheme to positively contain all of our propellants and know where they were all of the times for propellant management. There was a - As it turns out, it was probably just a small piece of contamination - kind of leak and typical of the isolation valves. Then it wasn't a great concern and it caused a little bit of perturbation of procedures but that's all. That was all about - propellant management was what we were trying to do.

CARR Okay.

QUERY Any more on propellants?

QUERY We don't have anything.

QUERY You get the thermal and SMD?

QUERY ...

QUERY You have any fuel cells? No, that was propellant.

QUERY No, we didn't have any.

CARR We got an extra day out of those fuel cells, didn't we? It seems to me we shut them down a day later.

QUERY No.

CARR Didn't we?

QUERY No, we didn't. We got about 18-1/2 days; actually, a little bit less ...

CARR Okay.

QUERY You just had that one thermal question, P.D.?

QUERY Yes, ... if he has - he has another question ...

QUERY Like to pursue this contamination a little bit further. We looked at - -

QUERY Mike. Leave the mike open.

QUERY Okay.

QUERY We looked at that 16-millimeter film - -

QUERY You have to turn your switch on. There you go.

QUERY Okay? We looked at the 16-millimeter film and we've seen some things on this film frame, this one picture that we

QUERY (CONT'D) have a print of. We'd like for you to look at it and see if you could explain what we think we see.

CARR Our problem is that picture is so bad that it really doesn't show too much of what was there. I would hope that you could get the Nikon photography pretty quick here, and I'm told that the color on that is a lot better. Yes. That's the sort of stuff we saw.

QUERY Is this a charred section that ... black or could you tell?

CARR I couldn't tell. I didn't really have time to look at it closely, but I didn't have the impression that it was charred.

QUERY What about this section in here? Is that - -

CARR That looked to me like it was kind of oily.

QUERY Oily? And what about from here down through here? Looks like we have some dribbling of some sort in here.

CARR Yes. I noticed that too and didn't have a feel for what it was. But it looked like something had come out of that area there and was just kind of eating the paint.

QUERY Did it look like it had eaten the paint?

CARR Yes. There was - it was a stain or a smear on there that was covering the paint just like that photo shows you. That's a pretty good photo. It shows that stuff is there, but the coloring is wrong because everything is darker. All these white surfaces that you see are more gold or beige than you see there. These pictures - the 16 millimeters - apparently we just didn't have the f-stop right, and everything got overexposed and is much whiter than it ought to be. And like I say, I'm told the Nikon stuff is darker-looking photography and said if it's darker, it's probably more correct than the 16 millimeter. And I think I took two or three frames of the command module from that same position that that movie was taken from. That was - I crawled out over the Sun end of the ATM and just essentially let go and took as many pictures as I could before I had to grab again to make sure I didn't drift away.

QUERY On the same EVA as this one?

CARR Yes, um-hum.

QUERY Thanks.

QUERY That's the only question that we had. We do have the Earth landing system people and mechanical systems people in case you have any questions for us.

CARR No. The ELS just worked like a champ.

GIBSON What do the pictures show in the landing as to why we got the stable II? From us, subjectively, inside, it appears as though we hit and immediately went stable II. And it wasn't being - because we were dragged over at all; it was just the dynamics of the hit. I wonder if one of those pictures shows the same thing.

LANGLEY I'm Art Langley. We certainly didn't expect you to go into stable II, but it's not unfeasible if you hit the wave slope at the proper time. It's quite common that you can flip at that particular time.

CARR It sure had ... - -

GIBSON Did you see the motion pictures? Were they able to show anything, or was - -

QUERY There are not any available.

GIBSON Okay.

CARR In area structures, I must say that the folding and unfolding, the stowage and unstowage, of the center couch was extremely easy, much easier than one g. Of course, you know one g is - that's a hernia operation, and in zero g, it's just a piece of cake. And it was typical

CARR (CONT'D) of any high-inertia situation in zero. The large, massive pieces of equipment with high inertia are much easier to manage in zero g than are the little pieces. And the Y/Y strut, which is nothing but trouble over in the simulators just worked beautifully in the spacecraft. But everything worked well from a structural standpoint, you know, whatever structural pieces we had to fool with. The hatch worked just fine; it was sort of a snuggy fit, working it up into the tunnel and getting it in there. But again, that was no great problem either. The probe - is that part of your structural area?

QUERY Yes it is.

CARR Worked according to Hoyle. The drogue situation - Bill photographed it. Have you had a chance to see the photographs yet?

QUERY No. Not the drogue - photographs of the marks on the drogue.

POGUE I have not seen them either - sort have been interested to take a look at them.

CARR That drogue really took a beating. We're interested to know whether or not we added any scratches to it or

CARR (CONT'D) whether it was already there, because I really battered that workshop on that when we finally got captured. I wasn't about to drift back out of there again and I really rammed it.

POGUE Yes, but I don't think you hit it that hard, Jer. Anyway we got some good photos.

QUERY Any more questions? Why don't we give these to Gibson, the SPT.

CARR Okay. Thank you.

QUERY As long as the ... S people are on their way over they'll probably have some good questions from them.

CARR Do you know if the SWS systems people have been alerted that there's a good chance of starting early?

QUERY Yes.

CARR That's what you guys get for designing such a good system. It worked so well that there's nothing to talk about.

QUERY We like it better that way.

QUERY At the end of the - -

CARR Is your mike on there?

QUERY At the end of the deactivation and after tunnel closeout, Jerry mentioned that you were concerned about not doing the PGA suit integrity check. You were aware then that the CSM suit circuit integrity check - if you have a successful suit circuit integrity check, you don't need to do the PGA?

CARR That's what I thought, but reading the checklist indicated it and inferred to me that we were supposed to do one and then go back and pick up and do the other. And that's the way I read it and it bothered me because it seemed to me having done the suit circuit check we were sure - -

QUERY This then appears that we may need to make a clarification on the next CSM trip ...

CARR I wasn't about to do it anyway because I didn't figure the time and I thought the suits were good and tight.

QUERY We had a good suit circuit integrity check then. There is no reason to do the PGA itself.

CARR I guess the only other thing in ECS on that day that really bothered us was that doggone flapper valve that hung up. We had to throw on two suit compressors and then pop that - -

QUERY We have the CSM subsystem manager, Don Heives; he'll be here shortly.

CARR Okay.

QUERY Okay, could you speculate on what might have caused the damage to the overwrap of the LiOH element which was rejected. You know you changed out the - -

CARR Those two canisters were just rattling around loose in A-6, and we were putting pieces of equipment in there and taking them out all through the mission. And I think we just bumped it and scarred it. What we did was we pushed the plastic up against something sharp or hard inside. We just ended up lacerating it. And I wasn't sure - Well, the fact that the plastic was puffed out instead of sucked in tight like most of the canisters was enough for me to think about it. And I went over and looked in that locker 151 or whatever the locker number is. There was a thousand canisters in there and so I just picked a nice looking one and took it. I had so many things to choose from that I didn't worry about it. But I think all we did was - let's see, the Dewar cooler S192 was in there and it's got lots of sharp protrusions on it. That was rather rattling around in A-6 with these two LiOH canisters.

CARR (CONT'D) And the S009 was in there just floating around. So everytime you'd open that locker to get something, you'd bump those things. You know they play pinball machine for the next 2 hours, bumping into each other, and so I think that's the reason.

QUERY I would like to hold these other two questions in abeyance until they get here.

QUERY Okay, I only have two very quick questions to work out. In your technical debriefing you reported your problem involving the VERB 46 coming off the SIVB, and we were wondering how you achieved the plus-X translation or did you not have any plus-X translation when you came off? Because you shouldn't have had any if you were in CMC control without having done the VERB 46. You were still on the ... DAP and it wouldn't accept any plus-X translations.

CARR Good point; hadn't thought about that.

QUERY What did you mean when you say, "We pickled off." That's a new term to me.

CARR That's a close-air support pilot's term. That means we punched the button that fired us off. Pickling off the

CARR (CONT'D) bombs - There's a pickle on the top of your stick on your airplane. You punch the button and that pickles off the bombs or whatever it is you're shooting. So what we did is we threw the switches to sep from the workshop, I mean from the SIVB and I frankly don't remember if I had plus X or not; it's been so long ago.

QUERY You didn't use DIRECT VOLTAGE? You would have remembered that.

CARR Yes! That's right. But the thing is we did separate from the workshop - the SIVB. And I felt no problem there.

CARR And I don't even know whether I got plus-X or even tried to use it. But the thing was, when you're going to start the pitch maneuver, you're supposed to start it in ACCEL COMMAND and then throw it to RATE COMMAND when you got CMC AUTO to pick it up for you. The thing there, as I remember, was just to make sure that you started pitching in the direction that you wanted to.

QUERY Yes.

CARR And when I threw it back to RATE COMMAND, then CMC AUTO ground to a halt. And so the only thing I could think of

CARR (CONT'D) to do was to do another VERB 46 to make sure the DAP knew it was driving and it was going to pay attention to the VERB 49 data that I put in there. And it worked. So I assumed that what I had done was probably right; then the next time I did it, it worked perfectly.

QUERY We don't think that there was any sort of a problem with DAP or anything because it worked so fine the rest of the mission.

CARR Well, I don't understand why that son of a gun ground to a halt on me because - -

QUERY Well, it would depend upon several factors. We don't have the data to go through the sequence of events, the time line of mode changing, and so forth, but we attempted to reconstruct what might have happened that would have explained it, and if you had done a VERB 46 and then followed that after you get the maneuver started, follow that with PRO, PRO on your VERB 49, you would have to do them in that order because VERB 46 - If you had PROed on your VERB 49 first and then did your VERB 46, that would just put you into an attitude-hold mode and it wouldn't attempt to drive you back in anyway. So you would have had to do the PRO, PRO after you'd done the VERB 46. And then that would depend upon what sign of attitude errors

QUERY (CONT'D) you had at the time. If you had a positive attitude error, then it would attempt to pitch you up and you had just commanded the pitch down maneuver; so they would be then in opposite directions and would stop the rate and attempt to drive you back the other way. So it would be a function of what the sign of your attitude errors and how many errors there were at the time. Of course, we have no way of knowing.

CARR Yes; well, that must have been it.

QUERY But procedurally, you can cause a ... to occur.

CARR Kind of off of that thing, the VERB 46 should have been done way back around tower jett. We put VERB 46 in twice in the boost card.

QUERY Yes, and your checklist prior to sep, called for it again.

CARR Yes. And then, we called the undock DAP, don't we, prior to sep? We set up the undock DAP and we're supposed to do another VERB 46 and that's the one - I figured when it did work right, I figured, well, I must have forgot to do a VERB 46 after I loaded the DAP. So I did it and started over again and everything worked.

GIBSON When we finally turned around, we were pretty far out, so I'm sure we got some plus-X. How we got it in there, I'm not sure.

CARR Yes.

QUERY You may have very well done it twice then, especially if you had any appreciable separation distance.

CARR Yes. We had good separation distance. There was no question that we were well separated from the workshop, I mean from the SIVB.

QUERY Okay. That's kind of a tricky procedure and there's several things that you can do that can dork [?] it up.

CARR Yes.

QUERY We've had a problem with it before.

CARR It was no big thing, you know. I was prepared to just go ahead and do the whole thing in either ACCEL COMMAND or MIN IMPULSE, but it was kind of a surprise to have it grind to a halt after I had already set up the rates.

QUERY Okay.

CARR And then I was willing to accept - Just doing a VERB 46 solved the problem, so I was willing to accept that possibility that I had probably forgotten to do a VERB 46 after I loaded the DAP.

QUERY If you could have remembered whether or not you had gotten plus-X, that would have told us whether or not you had done the first one or not, but it's kind of academic. The only other question we had: We would like to verify, if you can for us, there was no other TRACKER fail light that occurred during the mission other than the one you had during the rendezvous sequence around the NC-1?

CARR Man, I'd forgotten we even had that.

QUERY Well, you made no mention of it.

CARR The data's so bad and the tapes are so bad during the rendezvous - You know, we tried to do the tech debriefing, and we can't remember the rendezvous very well. It was apparently so nominal. And so we asked them to bring us over the tapes so we could listen to them and they were so lousy we couldn't figure out what had happened there either; so I'm sorry to say the rendezvous is pretty hazy in our minds. And I knew something else

CARR (CONT'D) was - we had a problem and that's it - the TRACKER fail light - and I don't think we ever had it again.

QUERY Okay.

CARR If we did, I'm sure we would have told you.

QUERY We didn't see any evidence of it in the data, but, of course, there's a lot of periods we don't get clearly when the G&N is OFF.

CARR I don't remember seeing another one.

QUERY All right. G&N guys just now walked in so unless they have any other questions, I guess we're through.

QUERY You had something about the CU fail. Do you happen to remember when you had the TRACKER fail - You may not be able to recall it, but when you had the TRACKER fail, did you ever go back and see if the T packs really read zero at that time?

CARR Yes. I'm pretty sure. Isn't that one of the steps in the malf procedures?

QUERY Yes.

CARR And I remember we got the malfs out and went through them very carefully.

QUERY There's a question in our minds. You thought you did and that would help us solve the problem?

CARR Yes. I do remember that one thing - making sure that the T packs went to zero and we called NOUN 92 I think it was to make sure that the CMC was commanding to zero, as well as the T packs being in zero, and it seems to me, Ed, you were down in the hold then at that time and I was having you verify those things to me.

GIBSON Yes. I remember that.

QUERY The call went up when the problem disappeared that you were in the process of doing a 52. I believe you recall that you do not know when it went out, when the TRACKER fail light went out. Is that true?

CARR Yes, it must be. I can't remember.

QUERY Okay. Thank you.

GIBSON A long time ago.

CARR Boy, I'll say. It's pretty bad when you can't even remember the anomalies.

(Laughter)

QUERY We appreciate the good words about the G&N system in your tech debriefing.

CARR Well, it worked like a champ the whole time and when we flunked that horizon check on the shaping burn, I was supremely confident the G&N system was GO, because we had just gotten finished doing a start check and Ed said he could probably mark on the start without even going to MANUAL. And I was supremely confident that we had a good G&N; I'll tell you, the guys in Flight Control are still scratching their heads as to why we didn't - why we missed the horizon check by 8 degrees. Doesn't make sense at all, but it happened.

QUERY If you're interested, I have that strip chart of the separation problem prior to entry if you'd like to look at it, but that's all I have.

CARR I think we understand pretty well now just what happened there. I might also add that when we were using the system for the trim burns, it was really nice. We could call up NOUN 56 and take a look at the rates, and it's really pretty nice when you can finish up a burn with the command module driving that whole big logging truck and you're reading four balls and a small number for your rates. The old CSM DAP was just doing a magnificent job.

QUERY That's the last on that? Then let's get back to ECS.

CARR Go ahead.

QUERY On the ECS secondary coolant loop checkout at ... to insertion, the evaporator steam pressure dropped to lower limits. In an attempt to obtain a satisfactory operation, you noted that twice you obtained steam pressures of 0.15 to 0.16 psi by going to the RESET position of the SECONDARY COOLANT LOOP, EVAPORATOR and RESET switch, but you were unable to sustain the proper pressure or cause the evaporator outlet temperature to come down. During these attempts, do you recall if you returned the switch to EVAP or OFF position after each of these partial closing of the back pressure valve?

GIBSON First - As I recall, we went back to the EVAP the first or perhaps the first two times; didn't get it to work. And then went to the RESET to close the valve and then went to OFF and that's when I recall it working. That's pretty hazy recollection.

QUERY What we're trying to ask, did you leave it in the OFF or the RESET position for any length of time?

GIBSON We didn't leave it in RESET position for a long length of time. What? 58 seconds it says. Oh, that's for the

GIBSON (CONT'D) primary. It's close to that for the secondary, I guess, so it'll drive it full scale.

QUERY But it only operates in AUTO mode when you're in AUTO and - -

GIBSON Yes.

QUERY - - and the RESET only closes the valve and shuts down everything else and OFF shuts down everything and apparently what happened when you left it in OFF, it dried out. Or did you leave it in RESET for any length of time; that's what we really - -

GIBSON On the order of a minute or two at the most.

QUERY Because in the RESET, the water flow valve is inhibited and it cannot drain.

GIBSON Okay. It was only in RESET for on the order of a minute or two at the most.

QUERY Okay.

GIBSON I think that was - Now I don't recall the explicit action of doing that, but I remember that's the way we were trained and that's the way we understood the system.

QUERY Yes.

GIBSON Whenever we went to - -

QUERY Well, the primary works when you can control it in the manual position and the secondary cannot be controlled in the manual.

GIBSON Yes.

POGUE Yes; we knew that.

GIBSON Okay. I'm giving you the best guess of recollection; that's more about the way we were trained than - -

QUERY Your training was in the primary mode at the Cape in the chambers?

GIBSON Yes.

QUERY And evidently you thought you could do that with the secondary.

GIBSON Yes, probably so.

QUERY I had to look it up to finally realize you couldn't do it. (Laughter) And then number 2 was during ECS systems reactivation, the water glycol evaporator servicing procedure. Apparently, it was interrupted due to the flapper valve operation with the CDR's suit flow control soaking valve, and our ground data indicated that considerable excess water was added to the primary evaporator. And that after the flapper was sticking, the secondary evaporator was serviced nominally. Your self-debriefing indicated that the SECONDARY EVAPORATOR WATERFLOW switch was left in the ON position for maybe 30 minutes due to interruptions.

CARR No, that was the PRIMARY.

QUERY Yes, that's really our good question.

CARR The SECONDARY was left a little more than the 3 minutes, but it wasn't significantly more. But the PRIMARY was right in the center of that big flapper valve flap, if you'll pardon the expression. And 32, I started the det and it was reading 32 and I remembered that we should have turned that switch to the other position.

QUERY We did experience quite unusual startup activity on the primary coolant - -

CARR I would expect so, with that much water in there.

QUERY I think that's because of your pipe - pipelines.

CARR Yes. I thought about that when we saw the ice. I figured that that's what the problem was - was why we have all this ice because that water valve was on for so long.

QUERY Of course, at that time I think most people thought it was from the RCS.

CARR Well, we did not make it clear on the air-to-ground that the sparklies started by before we activated ring 2. Now the folks on the ground just didn't realize that, but we knew that what we were seeing going by was very likely the - -

GIBSON We made that statement once but I think it was not understood and we should have made it again when we realized that people were misinterpreting fireflies and their source.

QUERY You have any more questions?

QUERY There was one question I had, Ed. It wasn't clear in the debriefing here as to whether you actually activated the postlanding of the ventilation system. You say you didn't deploy the ducts or anything. Was that activated?

CARR No, it was not. As I understand it, we were instructed not to do so. It was mainly because people were concerned about the propellants in the area.

QUERY You got that part of the instructions, but the part of the instruction about the oxygen masks and that sort of thing?

GIBSON All we heard was something about oxygen, and it was only when we were listening to the TV station in San Diego that we realized we had decided not to use it.

(Laughter)

QUERY That's all the questions we have. Do you all have any?

GIBSON I'm wondering a little bit about the amount of water which we finally found down there in the LEB of the CSM.

GIBSON (CONT'D) Jerry, as you know, used to take towels and towels full of water out of there and during the on-orbits day and before we came back, we tried to get as much water out as possible. I was just wondering how much can be accumulated up behind the panel that you just can't get to. Because after the first burn, I was moving around down there in the LEB and put my foot in a big puddle of water. That's when I realized we might have a fair amount down there, and apparently they found some in the equipment. I guess S201 was concerned about getting water on their film. They said it was a possibility.

QUERY Well, I guess this was - this suspicion; it wasn't any colder than previous Skylab missions. The lines are insulated, but like the valves are not. So you are going to get condensation back there, and previous crews have experienced the ice become condensation. And when you do a burn from Apollo coming back from the Moon, whenever they do a burn, they have to get down and mop it up. It all congregates down there on the floor.

CARR Yes.

QUERY I can't really answer your question, assess how much. We tried to do that and we really failed.

GIBSON There was no way for us to get down there and mop it up because there's so much equipment stowed down there that Jerry couldn't get to the surface where it was all congregated.

CARR But every day I did - Everytime I did the housekeeping, HK7, in the command module, every 7 days, we'd fire up the secondary loop; and that would melt the ice down there next to panel 377, I think it was, the BYPASS valves down there. It would melt all that ice, and then I had about four towels full of water that I could get up out of it. And so I really conducted a neat wicking experiment for the student who lost his other working experiment down in the workshop. But you could just take that towel and lean it up against those lightning holes that are over to the left of that panel. There's little - about 3/16-to 1/4-inch holes back there. You could just push a towel up against that and hold it. And you could almost hear the water slurping out of there and into the the towels. And it worked pretty well. Prior to - Well, during the deactivation phase, I tried to get as much of that water out of there as I could. I tried to get it all out through wicking action. But you - obviously I didn't get it all because Ed discovered it down in the aft bulkhead after the first burn. But it was there and lots of ice. There was a patch of ice about that wide

CARR
(CONT'D)

and about that long right down that vertical bulkhead, and I think if you look at the - look at the spacecraft, you can see where I did some battering on it to - to break some of the ice off. And then I got smart later and found out that if I did my water sopping right after the 7-day housekeeping exercise, I didn't have to chip ice; it would all melt and go into the towel. And - so I started doing it that way. But there's a lot of paint chipped off the command module right there. I might also add for, I guess, the structures people or somebody that we had corrosion. You might take - Walt you might tell your people to look at the left girth shelf, right by the - the water glycol panel, 326 I believe it is, and at the inside edge of the cabin relief valve handles. There was considerable metal corrosion underneath the paint, and the paint was lifting. And it was white, powdery aluminum oxide underneath. And this was the only area that I saw this, but it was right - right around that area. It looked like it probably hadn't been properly treated before they painted it. And there was a good amount of corrosion under that. But down at the area where I was chipping ice, that was - it looked like it was well Ilodyned [?] and the paint would come off when I'd bang it, but the metal underneath looked pretty good.

QUERY Okay. Are there any more ECS questions?

QUERY No.

QUERY Okay.

QUERY This next area will be comm. We don't have any specific questions so you ... CSM comm?

CARR On the CSM comm? I guess the only comment we have on comm was that I hope that next time we build a - a spacecraft or any sort of a space station, that we should think simplicity in comm. The command module comm system is a complicated system full of traps that - that put you in a position where things come down on the air-to-ground that you didn't want to come down, and on the others - the other side of the house, you try to talk down air-to-ground and it doesn't get down. Or things get recorded when you don't want them recorded and vice versa. And then you take a complicated system like that and plug it into another system that grew like Topsy in the - in the SWS. The whole system was just a great big bag of snakes and you could see the first few weeks of all three missions, we were all screwed up on comm until we finally got it settled down. And then all the comm problems would settle down, and then only occasionally would you embarrass yourself, with some dumb thing happening. But it's just that you had so many different ways to configure the system and it - it just bit you; every time you turned about you got bit by the comm system. And -

QUERY Can you attribute that, Jerry, to - to - to design rather than to procedure?

CARR Simplicity of design is what you've got to go for, and - and a lot of people will come back and say, well, if you want flexibility, you're not going to get the simplicity that you want. And to that I say hogwash. You can design a system that's flexible and - but you've got to design your - the - your panels - the - your man-machine or your man-panel interface so that you know what you're doing when you're throwing a switch.

GIBSON The largest problem I saw in trying to understand the comm system from the operator's standpoint, is you can never follow the flow of information - -

POGUE Six, 9, and 10.

GIBSON - - never sit there and say here's - here's where it comes in the antenna, here's the power amplifier that goes through here, and follow the flow and - and see the controls and displays that go with that flow. It was just a hodgepodge of switches sitting in front of you with no way of reb - or groping at it. It was kind of like grabbing an elephant; you just didn't quite know where to start.

CARR But another good thing about comm systems, too, is - is some indication of your modulation, whether or not you're -

CARR (CONT'D) you're modulating, getting down and getting up - little gain meters or lights or anything, I think are good. And they ought to be designed in comm systems of the future. If you're going to tie your tape recorders into your comm system, you ought to have a little - little idiot lights that tell you either you are or are not recording. And of course, we only had a little bit of that, and that is the green light in the service - in the SWS that said, yea, verily, you're recording.

POGUE We had talkback, of course, but it was only visible from one panel.

CARR Yes.

GIBSON But that really goes back to our own inputs many years ago. I mean we - we asked for it so -

CARR We got it.

GIBSON Yes, we got it.

CARR But, we're convinced not that your recording capability ought to be completely divorced from your comm. Our - our idea is that you - in a - in a space station sort of thing of in Shuttle, that each guy ought to have his own recorder - tape recorder with him. And when he fills up

CARR (CONT'D) a - a tape, then he can put the tape in a dump mechanism and throw a switch that tells the ground that there's a full cassette sitting on the dump. And the ground can dump it and clean it, and then they'd turn on another light that tells the guys up there that this tape has now been dumped and cleaned and ready for use. And you just need a few extra cassettes, and you'd have a very, very simple communication system where you could get your voice data up and down without getting messed up in the comm. And, of course, this would be separate from your data - your data recorders, which are ship systems.

QUERY I got a question.

CARR Yes.

QUERY I'm really with the workshop ... but ... I guess I don't understand what you mean by completely separate. You mean have separate mikes for the recorders?

CARR Sure; carry around your recorder on your hip with a mike. And if you need time-tagging on your - your thing, you could - you could probably have a jack or something that you could plug into whatever workstation you're working at, so that you could - you could time-tag your data. But -

QUERY You mean the - the SIAs in the workshop?

CARR Yes, they're confining. We're going to talk about that some more in just a minute.

QUERY But - but you're saying that it would have been much better if we had had tape recorders that - individual tape recorders, some way or another we'd dump those - -

CARR Right.

QUERY - - and they have their own microphone and that sort of thing?

CARR Right.

POGUE We certainly did not have enough flexibility in the workshop comm - recording.

QUERY Yes, I realize. Okay.

CARR Well, I'll tell you I was never confident just exactly where any signal was going when you - when you talked. You got channel A and channel B in the workshop and three audio panels in the command module and capability to inter - interconnect and change over and all those different antennas.

POGUE Indian-wrestling with the ground when you came up on AOS.

QUERY Any more comments?

CARR No, that's it.

QUERY Okay, the operational cameras and photography.

GIBSON Hello.

QUERY Okay, we have a few questions to ask you about cameras. Realizing that we had a number of problems, we'd like to try to - to get a few answers to help us solve problems for the - for the future. Okay, first of all, were you ever required to reindex on 140-foot film magazines, 16 millimeter - to reindex the film in the aperture to the little orange lens?

POGUE It was always right on.

QUERY It was always right on? That sounds good. Okay, early in January, we sent up a couple of procedure changes on 400-foot magazine operations, you know, delete putting it into thread mode when you remove it from the camera. So that we got the impression from the ground that after we deleted these procedures, that some of your problems cleared up? Is this true.

POGUE That's correct.

CARR Yes. When we quit messing around with those cameras and running them at 24 frames per second and thread and then go on to operate and all that stuff, we immediately reduced the number of failures that occurred.

POGUE I think that the failures that occurred after that were random and, occasionally, maybe one or two problems due to the fact that the selection was inadvertently to - Was it single frame - time - whatever it was?

QUERY And exposure, yes.

POGUE Due to that. The - You're aware that - I know that we're all supposed to know, when you move that lever around, where it's supposed to be pointing, but you are aware of the - -

QUERY Right.

POGUE - - optical distortion that exists there.

QUERY Okay, when DAC 06 blew the fuse early in the mission, was that the first time you had attemped to use that camera?

CARR Golly, I can't remember. I don't know.

QUERY Okay.

CARR That's just too long ago and -

QUERY Okay, you were - it was a procedure that was instituted to remove 6 feet of film from each canister before you tried to thread it. Okay, we gather that you did that. Do you recall if any of the film that you removed looked curled or disordered?

POGUE Discolored is the best word on -

QUERY Was discolored?

POGUE Yes.

QUERY Okay, what about - -

POGUE But only about the first 3 or 4 inches.

QUERY Yes, okay. Did it feel sticky?

POGUE No, never sticky, always hard, brittle maybe, but the only - I would say that any character change was restricted to the first few inches.

QUERY Yes. Okay, pertaining to the DAC 08 failure, do you recall having any kind of difficulty interfacing the magazine to that camera at any time?

POGUE No.

CARR Can you review what our DAC 08 failure was?

QUERY That was the one that you suspected had a claw problem; that it wasn't pulling film, it -

POGUE I think that was you again, Jer.

CARR Oh, that's right. No, it seemed to be perfectly normal as far as the interface between the - the - the transporter and the - and the camera itself. But it just seemed that no matter what magazine you used, the claw would just rip holes in the - in the perforations.

QUERY Yes, well we found the - the problem was not with the claw but rather with the little drive coupling. The foot had been bent over on that little coupling, and we were trying to determine, you know, how that might have, you know, some difficulty with making a magazine or ... That's the reason for the question.

CARR I don't remember any problems with mating any of the magazines. You - you - There was always the possibility that you'd put a magazine on, and if you didn't get it locked in just perfectly, it wouldn't - it wouldn't mate in. But the thing is, you wouldn't get the green light then.

QUERY Normally that - that should - that should occur. You shouldn't be able to operate the cameras if the thing isn't ...

CARR That's right, and we found that interlock system to be pretty doggone reliable.

QUERY Okay.

POGUE The only trouble we had on that was that one transporter did not have an end-of-film light that was operating, and we reported that a couple of times. We went ahead and used it.

QUERY Yes, that was - that was one of the other cameras. I don't recall which one, but we - we found a problem that was happening to it. It was - Okay, during the last EVA, in the flyaround and reentry using DAC 02, when did you notice the failure?

POGUE You mean that stuck in the 24 frames a second?

QUERY Right.

POGUE Jer - -

CARR Oh, let's see. I'm not sure, but it seems to me it was one of those nervous times when I decided, well, I'm going to check this camera one more time and see how it's running, and then - then's when I realized that it was running at 24 instead of 12. It was one of the pin firings that I had done.

QUERY You don't recall - -

CARR It seems to me that prior to undocking, isn't there a place in the checklist prior to undocking where you - you recheck or where you make sure the camera is set up properly with all the - the right settings?

QUERY I believe that's true.

CARR That's - I'm pretty sure that's the time when I realized that that son of a gun was running much too fast.

QUERY Yes.

QUERY Okay, it - it appeared from looking at the film that - that the EVA turned out okay. But your flyaround and reentry was the one that looked like ...

CARR Yes.

QUERY That problem could have occurred - We were trying to, you know, pinpoint whether we had a - maybe a terminal problem during a EVA or - or what it was that might have caused this failure.

CARR Quite frankly, I don't remember noting any problem. I took that - that DAC down, and, let's see, I stowed 140-foot magazine in Bravo 3 or one of those lockers down there where the transfer checklist told me to put it. And then, after a while, I got to thinking. I said, that's ridiculous. I'll put the DAC in the window, and the film will be down there, and Bill will be suited, and we're going to need the film, and it's in the wrong place. So on entry day, when I was just closing out - doing the final closeout on the command module stowage, I decided, well, I'm going to get that film out and put it on the camera. And I did that and tested it. And I honestly can't remember noting at that time - apparently I didn't notice, if it was running at 24, that it was. But I

CARR (CONT'D) did make a test firing then. And then - then the next time I test-fired it was just prior to undocking when the - where you come to the place in the checklist where you check the - the shutter speed and the - and the exposure and all that. That's when I believe I said, oh, for crying out loud, this son of a gun is running at 24. And we're probably going to shoot our whole wad before we ever get to the flyaround.

QUERY Well, it looked like you got - got the flyaround pretty good but not much of the reentry.

CARR Yes. By the way, Bill got one good Hasselblad shot of the - of the chutes.

QUERY Yes, good. (Laughter)

QUERY And one of the helicopter.

CARR Yes.

POGUE Not so good.

QUERY (Laughter)

GIBSON What was wrong with the camera?

QUERY We'll just say from - from our point of view, but -

CARR What did you find with the camera?

QUERY That camera we found a blown transistor in the electronics.

CARR A blown transistor.

QUERY That's why we think possibly a thermal problem, but we're not sure.

CARR Yes. Son of a gun, we were down to 3 DACs and - and then we had to pick the one that was bad.

QUERY (Laughter)

QUERY ...

QUERY Okay, I have a curiosity question, Bill. You reported sometime fairly early in the mission that - was one of the 400-foot cassettes, that the tab had pulled back in, that you went into your sleep quarters and tried to - Did you have any success?

POGUE The reason was - you know I - I fully intended to go back and try it again later but never did have time. There's not enough room to get your finger in there or anything, to push that - -

QUERY Yes, that's true.

POGUE - - Lead that film back in. You know that this happened - The problem occurred twice, once with me and once with Ed. And - no, excuse me, the tab three times. That time I lost the - the leader completely, and I reported that I must have put it on the wrong side. But I couldn't see how I had done it. Then later, I became convinced I hadn't. I had the thing on right ... shoved it back in twice more. And I know that I had it on the right side because that - you know that it has the little orange marks only on one - on one side for lining it up, and if you could see the orange marks after you put the supply in, you've got it loaded right.

QUERY Right.

POGUE So I had it loaded right, and that thing was - and I - I think it was a different - -

QUERY Transporter?

POGUE - - A transporter each time. But that thing was shoving that tab back in there. The other two times, fortunately, I was able - it had enough left - I'd get the Swiss army knife or something and pull it back out.

QUERY Yes.

POGUE Really weird. Now I'll tell you this - it - I'd never seen that happen before, and I was convinced I had made some kind of goof-up the first time.

QUERY That is odd. Okay, I - I have no other questions. Jim has some on the 35 millimeter.

QUERY Okay, just about all my questions relate to NK 02, being as we had a problem with the - with the film. And I'd like for you to just discuss with me the - the problems you had loading the camera, getting the back closed. Was it an every-time affair, or was it just the certain cassettes?

POGUE Every time.

QUERY Every time? It just wouldn't close?

POGUE That's right.

CARR We never had that nice tight line. There is a picture right up there; we're showing somebody else what was - that line on the - the end of the door was - never looked to us like it was completely closed. It looks like the little cam locks, or whatever it is that pulls it in, just really hadn't quite pulled it all the way.

POGUE But it did look like the - the back was closed far enough that it - We had a good light seal and everything, and I had no reason to suspect that there was any sort of geometry problem.

QUERY ...

CARR The film ... seen here looked flush to us.

QUERY The film was not fogged, so you didn't have a light problem. The light wasn't getting in. Didn't - did it - did the back at all appear to be bent in any way?

POGUE Not to me.

CARR Like I was saying, it appeared to be flush, it's just at the end - -

POGUE The little - there were two little lugs down there.

CARR Yes.

POGUE They weren't working right.

GIBSON ... always engaged, except ... - -

POGUE The geometry in the back looked completely intact.

QUERY But you had no problem with NK 01? That was the other camera.

CARR No.

POGUE No, sir, just the NK 02.

QUERY Do you remember whether that happened on the first - The first film you shot in there was an IR roll, your body pictures for the medical people. And you even had it then?

POGUE As far as I can remember, I had trouble on it the first time on.

QUERY Something happened after - IR 01 looks good, and every other roll after that is completely out of focus.
Do you recall - you know what the pressure plate is in the camera? Can I show you a picture?

POGUE Yes.

QUERY Okay, and the question I have - I don't know whether you can recall or not, but was it there? I suspect it wasn't.

POGUE You know, I honestly can't remember.

QUERY Okay.

CARR I don't think it was, Bill.

GIBSON Well, now wait a minute.

POGUE How in the world can you lose a pressure plate?

CARR If it had gotten loose, it would have ended up on a screen.

QUERY ...

CARR If we'd have found that on a screen we'd have said, Man where did this come from?

QUERY That's right, but I don't know how it got out of there.

POGUE Just a second, let me look at ...

GIBSON You really notice the difference between that and Nikon 01, *** you notice the difference.

QUERY Yes, yes. I see a barreling effect of the film, which says the pressure was not in there holding the film in. And I see overlapping of - of - from frame to frame, either overlapping or not properly spaced, which says the pressure plate wasn't there. Now how it got out I don't know. It - it - it's ... - -

GIBSON What - what held the plates there?

QUERY It's held by four rivet-type things. You can - you can physically pull it and get it out. You got to pull it this direction and pivot it this direction to get it out. It - it's tough to get out, but it can - you can get it out.

GIBSON I don't know why the heck - how it would ever get out there.

QUERY Now, I don't know how it got out, but every - everything I see on the film says it wasn't there.

POGUE I'll bet you're right, because that would explain all that defocus and everything.

QUERY That's right.

GIBSON How the heck did it ever get out and where did it go? Where did it go?

QUERY I don't know, because we went back to the - SL-3 film and looked at all the film that we shot in NK 02, and it was there then, because it's all good.

QUERY ... (laughter) That little green Martian guy went in there and took it out between missions; I don't know.

QUERY That's what the film looked like to us, that it just flat wasn't there ...

CARR ... got to be in the same place as those mask weights are for - -

POGUE Yes, the SMMD weights.

(Laughter)

POGUE You can lose things in the spacecraft and never recover them.

GIBSON How'd it even come off though, Bill?

POGUE That's - that would require positive effort.

QUERY You - yes, you physically got to try to get it out; it just won't come out by itself, because it's caught this way one direction, and this way another direction.

GIBSON And that makes me think that, even though it sounds like a neat idea, a nice solution, but I don't think any of us ever worked on the cameras that - -

QUERY Yes.

GIBSON - - with that much aggressiveness to try to take something like that off.

QUERY No, you would have known; you couldn't do that by accident.

QUERY No.

CARR But I don't remember seeing ... - -

QUERY The only thing I can see that would have caused it - the only other thing - you could take the camera and just stretch it this way and that's - -

(Laughter)

QUERY Could you have pressure - pressured it in to where it was flat against the back?

QUERY It's strained steel and you can sit there and hold it all day long and when you let it go, it's going to spring back out. I even shot some film on - on one here on the ground, pulling one side loose, and it - still there's enough pressure to hold the film right.

CARR Have you tried removing the plate and taking some pictures and comparing them?

QUERY Yes, and it's very close.

CARR It is?

QUERY Very close.

QUERY That focus varies which also leads me to believe that the - that the film was floating in there.

QUERY Yes.

QUERY It varies; it looks like, you know, it's 3 or 4 feet, or sometimes 6 feet and it just - -

CARR I never felt like the back of NK 02 was loose when we were using it. It always felt tight, but it was just always disturbing to see that one seam there - that it wasn't as snug and - and clean looking as was the NK 01.

QUERY I even tried leaving the back completely open and just taping it with the gray tape like you had on board, and the film still is in focus. So the only answer I came up - We tried even putting ... maybe there was a spacer ring between the lens and the body. But that - that had nothing to do with it.

QUERY No.

GIBSON No, no we ...

QUERY We had - We had the problem before we ever put that K-1 adapter in.

GIBSON Yes, we used a whole host of different lenses, too.

QUERY Yes, I think you would have found it. You might have shot it once that way, but then you would have seen it. Not - not every roll.

POGUE Well, that's going to be one of the unsolved mysteries - -

QUERY That's right.

POGUE - - of Skylab, because I can not figure for the life of me how a piece of - came out of there.

GIBSON Do you recall whether the SL-3 guys had any occasion to work with that camera?

QUERY That - oh, yes. We shot probably 20 rolls with that camera on SL-3.

GIBSON To work on the camera, I should say.

QUERY Oh, to work on it? No, I don't think we ever worked on it.

CARR ... he says our first roll was in focus.

QUERY The first roll - -

MS ...

GIBSON ... whether they might have loosened it up by having to do any work on it, and it came off very easily. Because I know we never did any extensive work on it.

QUERY The thing that would really fool you, too, is that your eye tells you by looking through it that you have good focusing, but if the pressure plate's gone, you don't know where the film is; it's not holding the film flat anymore.

POGUE That's right.

QUERY And that's the only answer that I can come up with, that it somehow got out of there, and I don't know how it got out of there either. But that's the only thing I can see that would do that, because you could just about bend the back in half almost. Well, you have - you know, you'd have to have a space that wide before the pressure plate wouldn't hold it in there. And then you would be light fogged very bad, and there was no streaking - no fogging in the film.

CARR Wait a minute, now. We always had to really hold that thing down tight to get it to latch. There was something pushing that back open when we were trying to close it and latch it.

QUERY Which - which should be the pressure plate. The pressure plate should - you know, you should feel the resistance. It also springs out as you open it - As you pull the lever down those ...

CARR Yes, and I remember one time when you and I loaded it prior to an EVA. I was holding it down, while you were manipulating the lock knob. And it took some force on that knob just to hold that thing down there. If you let it go, it would just come open. So that tells me there must have been a pressure plate in there. No pressure plate, it probably would have just - -

QUERY Should have plopped right in place.

CARR Yes. No, we never had that. We always had to push that thing against some sort of - -

GIBSON Also holding a Swiss army knife also helped in order to get the - the back plate to hold down, which hit against the edge, and you had to put the knife in there and pry it back a little bit.

QUERY Pry it back so it'd go down. It sounds like it must have got bent a little bit, but that - even if it was bent a little bit, as long as you got it closed ... I don't

QUERY (CONT'D) know, I don't have the answer for that. I have one other one on the flash operation. Did you have any trouble with that flash at all, or - -

POGUE We changed the battery about a week before the end of the flight.

QUERY Is that right? You used the same battery all through the flight. So you had plenty of battery power.

CARR Oh, yes.

QUERY Okay.

CARR The biggest single problem we had was forgetting to charge the darn flasher. We'd take a picture without charging it, and then we would have to take it over again.

QUERY Yeah.

CARR But other than that, the flasher worked like a gem.

POGUE This is a very good unit. If you notice the - the pictures we took there at the end, where we - using the - the fixed settings for the strobe. You know, it just says manual, or something like that.

QUERY Yes.

POGUE Every one of those shots came out great.

QUERY Yes.

POGUE It's when you - when you started - well, I'd say - Some of the fixed operations with the K-1 adapter we had an awful lot of trouble with. You've seen those.

QUERY Oh, yes, yes.

CARR What about - what about some of those body photos that are so grainy and fuzzy?

QUERY Was that done with the flash?

CARR Yes.

QUERY I assumed it wasn't done with the flash. It - it looked like it would either - -

CARR No, no wait; it was done without a flash.

POGUE It was done without a flash.

CARR This is - this is the - the photos we took when we did an IR picture - the three views?

POGUE Yes, one-half of the stereo. It was stereo, otherwise it was the three views.

POGUE Yes. That's right.

QUERY And they were without the flash?

CARR Without the flash.

POGUE That's right.

QUERY Yes.

CARR They were rotten pictures.

QUERY I also assumed they were probably early in the mission.

POGUE No, we continued taking - taking them without the flash, because that's what the card said.

QUERY Yes.

CARR Of course, the stereo - we always had trouble counting down, and getting both cameras - or that they wanted the flash to go off a little bit before the - -

POGUE If they - if those worked out, it was just a fluke.

(Laughter)

POGUE Because that - that - that was really ridiculous ... that strobe ...

QUERY We had - we had ... something and we couldn't sell that, so I knew it would be a real pain for you. I don't know, that's the type of picture you tend to get without a flash. We lost more because of the radiation to the film, whereas you didn't see it near that bad on Apollo when you had a 10, 15-day mission. But as long as you were up there, the radiation really gets to that film.

CARR And the flash helps overcome the radiation.

QUERY Oh, yes. You're really supersaturated to begin with.

CARR Okay, so that's why those no-flash pictures are so grainy looking.

QUERY Plus, we're pushing the film a lot more without a flash than we are with a flash.

CARR Yes.

QUERY We're pushing it another stop or better, which makes it look grainy.

CARR Okay.

QUERY That's basically all we had. Do you have any other questions of us? We could - -

POGUE There are two - two comments I'd like to make. The photomic head is a beautiful piece of equipment, but because of our continual changing of - shifting of photomic heads and so forth, every time I picked a camera up, the little buttom had been pushed, and the little white ring was showing.

QUERY Which said the battery - -

POGUE Which said we were discharging those batteries like crazy. So about halfway through the flight, all of them were going out, and I didn't trust them any longer.

QUERY Right.

POGUE Which meant then you had to use a spotmeter. Because of my accommodation going down the tubes, I actually had trouble reading that spotmeter; Jerry didn't. I had to put my glasses on to read it.

QUERY I see.

POGUE So once you take - I mean, I don't know what can be done about that, but it's hard to read, and maybe just keep that in mind.

QUERY Yes, hopefully we'll have something different from now on. After ASTP.

POGUE The photomic head is the way to go. You know, the batteries are small; you just carry a handful of them up.

QUERY Right. We used - I think we sent up five ...

POGUE I changed all out. And - and I had one spare. And I - -

CARR He was really hoarding that spare near the end of the mission.

(Laughter)

POGUE We only had one, and, of course, you would like to keep that on the color interior, because that was the thing to use it on.

QUERY I think if we had it to do over again, on ... - one of the electrics we didn't fly with a photomic head, on account of weight, but I think we would so it would save you swapping heads.

MS Yes.

QUERY That was a real pain.

CARR And swapping the light, the flash unit, was a pain, too.

QUERY The flash ...

CARR Because you had to take that lens off to remove the foot that holds the - or you had to change the whole photomic ...

POGUE ... because there were medical photos and after post-flight - for postflight medicals, one of the photographers just put some velcro on his photomic head and was - was using it that way. And I thought, why didn't I think of that?

MS (Laughter)

POGUE Because that's all we really needed to do.

QUERY Right.

POGUE We wouldn't have had to keep unscrewing that thing.

CARR Yes. Right.

QUERY Well, when we started out with those cameras there was no - ever an intention of having a flash, and then that kind of developed so that a few did. The next generation of cameras will have a flash unit.

POGUE I'll tell you, I'm really impressed with that flash unit, because you notice, regardless of the distance, they all came out pretty good.

QUERY That's really good. Hopefully, we'll get one - the one problem with that one was that you only can shoot at 2 feet or farther way. If you got much closer you could wipe out something.

POGUE Yeah.

QUERY Now you could kind of get it away from the camera to do that. And hopefully, we'll have one in the next generation that will be where you can get a lot closer.

POGUE I did some where I held the flash unit over to one side.

QUERY Yeah. As - as I recall, those came out real good. On the - the - I forget the ED number, but the plant growth - the rice seeds [ED61/62] - now that was done with just a high-intensity light hanging on the side. And those came out real good.

CARR Yeah.

POGUE In other words ... - -

GIBSON What came out well was everything except what you wanted to see.

MS (Laughter)

GIBSON The rice seeds themselves were so blurred because they were emersed in that - that agar, which is translucent.

QUERY Right.

GIBSON So you really couldn't see the details. But all the numbers on the outside of that container really came out beautiful.

CARR Oh, yeah.

MS (Laughter)

QUERY Yeah. Well, I think this was what - you know - they were expecting to see, but at least they give you some idea what - how the other roots - I don't know.

QUERY I guess that's all we have.

GIBSON Are you going to, even on ASTP, have a reflex finder for the Hasselblad?

QUERY Not on ASTP.

GIBSON Because, boy, we look at the - -

CARR Why don't you get rid of that Reseau plate and put that reflex back in it?

GIBSON Boy, I'll tell you, we look at the pictures, and you can - for example, you're looking at a smoke plume, and you say why didn't I include the whole smoke plume in the photograph.

QUERY Yeah ... - -

GIBSON You just couldn't line it up; you don't know what you are looking at.

QUERY Right, that's - -

GIBSON That reflex finder is so beautiful.

CARR I'm sure you noticed in a lot of the pictures that the item of interest was in the - you know - not in the center of the picture. It was offcenter somewhat.

QUERY Right.

CARR And that was strictly because we were using - looking down the side of the camera. And we even tried the ring sight a little bit, but I'm not so sure that did a lot of good.

POGUE Really the ring sight still doesn't - it helps, but it still doesn't give you the - the full field of view you're getting.

GIBSON Yeah, when I used the ring sight - I remember the few times that we actually had it on the camera and used it, and it did help. But it still didn't show the full field of view, which lets you know what you're getting in the picture and whether you want overlapping pictures.

QUERY Right.

POGUE Well, also, for stereopairs it's awful nice.

CARR Yeah.

QUERY The - the one problem with that is, early when we first started flying Hasselblad we couldn't ever get the mirror to not break in vibrations. It sits there and flaps, whereas the Nikon camera - it locks down, has a positive lock that holds it in place. Maybe we can overcome that with the newer technology we have today, but -

POGUE Well, what's wrong with installing it in flight?

QUERY That's difficult to do.

POGUE It is?

QUERY You would never get it - you would never get it to line up properly. You'd have to keep the distance between it and the - the screen exactly the same as the distance

QUERY (CONT'D) back to the film plane. And it would be a real problem. That's a real precise alignment. You could never do it in flight, I don't think.

POGUE You could ... - -

GIBSON ... package it so you could take that packaging out during flight?

QUERY Yeah. That's possible; you'd cram it full of foam or something so that you could yank it out and have the mirror locked up. That's a possibility.

POGUE Uh-huh.

QUERY That's a real possibility.

CARR Well, I guess our message to the camera people is that the cameras we had were good for their day, but there's better stuff on the shelf down at the camera supply right now. And let's don't perpetuate the stuff we got just because it worked neat for Gemini and Apollo. Let's stay up with the times. And I know you guys feel the same as we do. We made the same pitch to the managers, and that is, let's keep up with the times with our photographic equipment. There's no reason to saddle ourselves with old stuff just because it was reliable and worked well in its day.

QUERY Right.

POGUE There's a couple of human factors and things, too, when you're going to select these new cameras, and that is - cables, for instance, have nothing to do with cameras as such, but they ought to all be coated. I think we mentioned that at tech debriefing.

QUERY Right.

POGUE And we ought to have cable caddies. You ought to be able to easily attach and remove cables with the magazine and transporter installed. And you can't do that. You just tear your fingers up trying to get those on and off because there's not room. You know, the little things like that that enhance the operational use of the camera. There was a continual sort of irritation when you were actually - had to take - the thing that was really bothering us was that every time we took a transporter, handled a transporter, we - we got all nervous because we had so much trouble with them. And so every time you touched that transporter, took it off the mag, off the camera itself, you figured you were flirting with disaster for that 400 feet of potential film.

QUERY Um-hum.

POGUE And you - but you had to take it off to remove the remote timer or to remove the power cable and then put it back on and then check it again. There for a while we were checking it again, too.

QUERY Um-hum.

POGUE Little things like that can sure make that operation go smoother.

GIBSON We shouldn't shortchange ourselves on the amount of equipment we take up, especially the small stuff. The - the manual release cable, manual timer - -

CARR Yeah, that was something.

GIBSON We had times where we had both people wanting to use it and you'd have the whole time line constrained because you only had one of them up there.

CARR Yeah.

QUERY And that thing weighed nothing, a tenth of a pound or something.

POGUE I always wondered - -

QUERY In a sense you would have been better off if you could have ...

POGUE You could carry 10 of them in a suit pocket.

QUERY Yes.

GIBSON One thing that would also help in the future that I think really slowed us up in taking pictures is the documentation of those pictures. Writing it down and then getting it into a voice recorder, for some reason that seemed to take much longer than taking the picture.

QUERY Yeah, I'm sure.

GIBSON And maybe we could find a much more efficient way of doing that.

QUERY Hopefully - -

GIBSON Especially for Earth resources, you could do a heck of a lot better.

QUERY Hopefully we'll have that data recording system which not only records the time but also the f-stop and the shutter speed as well.

GIBSON So all you have to do is then give some verbal description of what picture you took.

QUERY That's right.

GIBSON That surely would be better.

QUERY I think that would help. That's sort of ... - -

GIBSON We were inhibited in taking an awful lot of pictures. If you only had 2 minutes at the window you knew you could never take a picture and document it.

QUERY Right.

CARR Well, a couple of times I took my pictures during the day, and then finally at 10 o'clock at night I would try to sit down and document everything that I did. And that's hard to do.

QUERY Well, another - -

CARR It's better than nothing.

POGUE - - another thing, too, when you get a golden opportunity to take a long series of photographs, you start - first you see something that you've been waiting 3 weeks to get, you see, and you grab the camera. You start taking pictures and then all - after you've taken about 15, well, you don't - if you take 15 or not, you don't know when you started - what frame you started with, or whether the previous guy forgot to log his. And, boy, you're really in a mess.

CARR Yeah, there were a lot of ... positions, where we'd sit down and say, "All right, what frame did you finish with?" "Well, I'm not sure; what did you finish with?"

MS (Laughter)

CARR "I think I took six pictures." But one thing, you guys really shortchanged us on the little log. We had to make our own logs.

QUERY Yes, there wasn't enough on - -

CARR Oh, golly, yeah. You only gave us maybe 25 percent of what we needed.

POGUE We used 10 of those apiece.

GIBSON The guy who was last one to write on the page was the one who had to make out the next one.

MS (Laughter)

CARR Yeah. He had the problem ... - -

GIBSON So you'd find it - for half the day you'd find one line at the bottom and everybody was afraid to take pictures ...

MS (Laughter)

POGUE Either that or he'd draw another line between that ...

MS (Laughter)

QUERY ...

(Laughter)

POGUE Squeeze in an extra one in there.

CARR But we found it was - it was good for us, too, to try to be meticulous about keeping track of our pictures.

QUERY Yeah.

CARR But of course, unfortunately we left one little book up there stuck in the window which represents - I think it was about 22 pages of data.

POGUE Most of it is voice recorded.

CARR Little bitty pages like that, but about eight frames per page, eight pictures per page. But it looks like we're probably going to have to sit down and help Dick Underwood and those guys figure out what some of those pictures were. Luckily, near the end of the mission where we knew we had lots of film, we start taking great ... of pictures, and all you got to do is identify one feature and you just identified eight or ten frames.

QUERY Yeah.

GIBSON Have you seen any of the Nikon out-the-window stuff yet?

QUERY Unofficially. Yeah, I've seen it.

GIBSON How did some of the 300-millimeters turn out?

QUERY They looked good. I assume you used a bracket a lot on those.

CARR No sir.

QUERY You didn't?

CARR No.

QUERY ... much better than anything we seen previously.

GIBSON We used ... 1/1000 of a second and stepped the ... opened it up accordingly. And also, the bracket I didn't think was the way to go; I used image motion compensation. Look through that viewfinder and track a given subject as you're taking a picture. That seemed to be - otherwise, you're just sitting there watching the ground speed by and you know you're going to smear it.

POGUE Well, you sure can see it in that 300 lens.

GIBSON Oh, yeah.

CARR Yeah. The bracket was too floppy, too flexible. It would've been better if we'd just - if you're going to have that bracket, to design it to fit into the two holes that hold that big piece of bridge structure that goes across for S063.

QUERY For S063; right.

CARR And you could have had just sort of a lighter bridge with a camera hanging down there with some sort of a ball joint so that you could move the camera.

QUERY Uh-huh.

GIBSON But a bracket doesn't seem to make sense in taking pictures going over the ground. It only makes sense if you're taking pictures of something fixed inertially in space, when the spacecraft is fixed and you're taking a picture of a star or a comet. But taking pictures of the ground, you - you're best off following it with your eye and getting image motion compensation.

QUERY Well, you did a beautiful job because they're much better. The other pictures, the only reason they put that bracket on originally was to - to try to help some of this body motion you get in the pictures as well as being able to tell you, "Hey, at a certain position you're going to be able to see something come up in 2 minutes."

GIBSON I thought most of the smear which they had on SL-3 was due to the ground whistling by rather than body motion.

QUERY I'm sure it was. Plus, I - I'm sure they didn't shoot at that - -

CARR Well, proper body restraint helps a lot, too. If you can get yourself well restrained you can sure do a better job of taking a picture.

POGUE Another thing - yeah, and if you'd put the lens up against the window cover protector, a lot of times that would - and then just lever it. Pivot it on there.

GIBSON That's what we used to do: hold one end up against the edge and then just watch it and raise yourself up as you're going over.

CARR Right.

QUERY Well, they were very good; better than we've ever seen with the 300. And the EVA pictures are probably the best we've ever seen on EVA, both on the 16 and the 35. They were outstanding. Very good.

GIBSON Well, I hope we finally get to see them one of these days.

QUERY When the DOD releases them?

GIBSON Something secret in those EVA pictures?

MS (Laughter)

QUERY Every one of the CX films is tied up on the 35; they haven't been released yet. But they do look good.

QUERY Any more questions on that?

CARR That's about it, I think. That's all the comments we have.

MS Thank you.

GIBSON Thank you.

QUERY Okay, George McKay [?] from Marshall's here; he'll take over.

CARR Your locomotive has square wheels.

MS (Laughter)

GIBSON But don't tell the Chrysler people that.

McKAY Now I'm going to ask you to remember in great detail the first 10 minutes of this 3-month mission.

MS (Laughter)

McKAY It's going to be real exciting, I'm sure. Now, I guess the thing that - it's probably most obvious to everybody at this time that most of the excitement took place on the ground.

McKAY (CONT'D) And I guess the thing I would ask you was, do you recall anything that wasn't as you expected in terms of the sensations and sounds and what - what have you?

CARR Well, I don't think we were prepared - you know - for much of any of that. Having never done anything like that before, you never know exactly what to expect. And nobody can tell you exactly what it feels like. There's no way.

GIBSON And each guy that gives you an idea of what they thought it was like seems to describe it in different terms, very subjective. I felt we were on top of a tall building and the bottom floor exploded. You really felt - felt a lot of - initially I felt a lot of vibrations associated with isolated explosions, which were different engines lighting off and most likely to holddown clamps letting go. I thought I was going to be able to initially identify the holddown clamps going, and think I can get the general time frame but I don't recall that I was able to get the specific instances of them letting loose.

CARR Subsonic, it seemed to me we were getting a lot of the acoustic stuff and we were getting a lot of vibration. When you got ignition you got lots of vibration. And to my way of thinking there was no doubt when the holddowns let go, because then you immediately start getting the

CARR (CONT'D) acceleration along with all that acoustic and the structural vibration. I didn't recognize anything or know anything that felt like any kind of pogo or anything like that. But it was a good strong acceleration, and when we went sonic, or through sonic, things immediately quieted down. And then all we had left was what little structural vibration there was and, of course, the constant increase in g as we were pushed back into the seat.

GIBSON That buffeting sensation as you're going through max q, which was to me very similar to when we were coming back in and reentering and went through max q there.

QUERY Was that max q or transonic?

CARR Well, it was around the time ... - -

GIBSON Pretty close but it was - -

CARR - - pretty close.

GIBSON I think it was just about - -

QUERY Well, max q comes about 15 seconds after transonic.

GIBSON Oh, is that right?

QUERY Yeah, you get quite a - -

POGUE I think it was probably the transonic - -

GIBSON Maybe it was the transonic then. Yeah.

CARR Yeah, I think so.

QUERY I think one of the things that - well, one question I wanted to ask: did you notice a decrease in the acoustic levels, let's say 10 or 15 seconds after liftoff. Did you any significant decreases at that time?

QUERY It'd be about the time of tower clearance.

CARR Yeah. I think during the whole period of time, from ignition all the way up, it's - or all the way through the sonic - the transonic area. That is, the vibrations and the acoustic vibrations - structural and acoustic - are diminishing slightly. But it's very marked; once you go transonic and get supersonic and get out ahead of the noise, there's a very marked difference. But it's sort of a - I felt sort of a gradual smoothing out. The most vibration, the most buffeting and everything, is right at the pad. And then as you begin to get away from the tower and things begin to pick up speed, it's very slowly smoothing out. But when you go through sonic velocity there is a rather distinct change in the vibration feelings

CARR (CONT'D) that you get and I just decided that had to be because - the fact that we moved out ahead of the acoustic vibrations and now we're just feeling structural vibrations.

GIBSON But on the pad and close to it you do have a awful lot of acoustics, maybe because you're - -

CARR Oh, yeah.

GIBSON - - you're - things are so quiet now, all of sudden when it does cut loose it's such a marked change that you feel that. Maybe you get a little oblivious to it after you've experienced it for a minute or two.

QUERY I don't think there's any way that - -

GIBSON The first 5 to 10 seconds I thought was pretty noisy.

CARR I felt a lot of the bang-bang in the spacecraft that I felt and heard when I observed launches, both Saturn V and S-IB. You know, the bang-bang, pop-pop sort of thing. And I felt like I could feel and hear that while we were in close to the tower, and you know that's strictly the acoustic side of the house, but -

QUERY I don't think there's any way that you can properly describe this. I guess the first question - one of the first questions we ever got when the astronauts began to

QUERY (CONT'D) familiarize themselves with the Saturn equipment as opposed to brand X, that we - the first question we got was "What does it sound like; what does it feel like?" And of course we didn't know, and I guess we still don't know. But everybody describes these things differently. And of course the people who have ridden on the Sat V and the I-B both say that the I-B is much quieter and it's much smoother. So if you're so impressed with the I-B part of it, you know - -

(Laughter)

GIBSON ... satisfied ...

QUERY Like to. We've got some good ones left. But it's a very subjective thing. And we've never been able to get a good handle on it, and we've been asking these questions for a long time, mostly because the people have been asking us questions. And the only thing that we can say is it's normal.

(Laugher)

GIBSON Have you got it on the onboard recorders, the way - -

QUERY Yes.

GIBSON - - ... vibrations?

QUERY Yes, we've recorded many of these things and we continue to do so. And the results that we're getting now are quite repeatable from flight to flight. We've damped out all the little closed-loop cycles that we had inside the thing.

GIBSON I'm wondering if you would play one of those for us whether we could tell you whether that's representative of what we hear?

QUERY We don't ordinarily put them on tape. I don't think I've heard but one myself, and the -

CARR I don't think it would do any good to play a tape, unless you feel it while you're listening to it. I think it's a completely different thing.

GIBSON Well, I don't know - -

QUERY Yeah, a lot of it would be in the feeling region as opposed to the audio region.

CARR Yeah.

GIBSON Yeah, that's part of it, but if you really wanted to get a feedback from us as to whether you actually got anything of worth there - -

POGUE You know - -

QUERY Depends on what you're actually experiencing when we - -

GIBSON - - I think you could get something worthwhile out of it.

POGUE When you start getting down around 3, 5 cycles per second, or 3 to 5 hertz, you start picking up an awful lot of physiological response, which - if you just played a acoustic, or just a regular cassette-type recording, you just wouldn't get it.

QUERY Right.

QUERY So, if you're so impressed with the IB part of it, you know - -

CARR Holy cow!

(Laughter)

GIBSON Can you get us a Saturn V ride? (Laughter)

QUERY Like to. We've had some good ones left. But it's a very subjective thing, and we've never been able to get a good handle on it. And we've been asking these questions for a long time, and mostly because the people have been asking us questions. And the only thing that we can say is it's normal. (Laughter)

GIBSON Have you got any onboard recorders in the way of sound vibrations?

QUERY Yes. Yes, we've recorded many of these - these things and we continue to do so and the - the results that we're getting now are quite repeatable from flight to flight. We've damped out all of the little closed loop cycles that we had inside the thing and - -

GIBSON I'm wondering if you would play one of those for us whether we could tell you whether that's representative of what we hear.

QUERY We don't ordinarily put them on tape. I don't think I've heard but one myself and - -

GIBSON Okay.

CARR I don't think it would do any good to play a tape unless you - unless you feel it while you are listening to it. I think it's a completely different thing.

GIBSON Well, yes.

QUERY A lot of it would be in the feeling region as opposed to the audio region - -

POGUE Yes.

GIBSON Yes, that's part of it, but if you really wanted to get a feedback from us as to whether you've actually got anything at work there - -

POGUE You know, Ed - -

GIBSON - - in terms of what you actually experienced, at least, I think you could get something worthwhile out of it.

POGUE When you start getting down around 3 to 5 cycles per second or 3 to 5 hertz, you start picking up an awful lot of physiological response which, if you just played an acoustic, or just a regular cassette-type recording, you just wouldn't get it.

QUERY Right, and personally I have always felt that there was more of this pop, pop on the IB than there was on the - on the Sat V and the instruments don't show that.

POGUE Well, from my observations I would have said the opposite.

GIBSON I thought the first stage was relatively smooth and I thought I could feel a little chugging on S-IVB.

QUERY Well, it's sort of a softer thing. It's .. -

GIBSON It's softer, but I thought that the thrust was more intermittent, at least it felt - -

CARR Yes, these guys both said they felt like we were kind of going like this on the S-IVB, and I didn't have that feeling. I don't remember feeling that at all.

QUERY The - the - the words that we have heard all along that the SII when that thing was involved was even more of that and it's just a seemingly softer thing. It's not really a pogo or closed-loop thing; it's just a sort of a - the Atlas, I think, had much the same kind of a feeling to it and perhaps even more so than either one of these two and - but that softness tends to - to damp out the - the higher frequencies and it is very quiet for the most part. And the SII being the softer is the quietest one of the group.

QUERY On the J57 engine with the afterburner on some of the early models of it had the - the characteristic of what we used to call a hard light with a burner. A normal J57 afterburner light was just baroomph, and it went, but if you didn't get things tuned just right and your eyelids weren't opening just right, you'd get a - a bam, a sharp bam.

POGUE A choked flow temporarily.

CARR And - and I felt a lot of that on the booster, on the S-IB. Bam, bam, bam, and you could feel it going on. And, of course, I would characterize the S-IVB ignition as being more like the properly tuned afterburner on the J57. It lit in smooth; it ramped up and then just moved right on and I - like I said, I didn't feel this gentle sort of a pulsation that Bill and Ed felt.

Well, the H-1 is of a different generation than the J-2 and the plan was, back in the design days, was to ram the thing right on through start as rapidly as possible, because the period in between is relatively unstable, you don't have the pressure drops and the damping and so forth. And so it starts very hard in comparison to either the F-1 or the J-2, and it starts very easily too, as a matter of fact. And so as a result, you'll get the these shocks on start.

POGUE You couldn't feel all eight of them, but there was definitely a ripple effect there.

GIBSON Was there abnormalities from your standpoint?

QUERY We only had two that I consider to be significant. We had a little control helium leak in the engine, the J-2 engine which caused us to use a bit more helium than usual. The part of the engine cycle that was involved in this leak was terminated at the main engine cutoff, so it did not leak any more after that time and it was - it's interlocked with or interconnected with the stage helium supplies, so the stage helium made up a large portion of what was lost. And except for the fact that we really don't know where the leak was, we got it down to three - three possibilities, one of which I consider to be impossible and one has never happened before and the third was never supposed to happen again. And so we - we haven't accomplished very much on that thing except to go back into the 210 and make sure that none of those possibilities exist for that - for that engine. And then the other one we had which I consider to be significant was in the APS, one of the thrusters. The oxidizer side was partially blocked, apparently due to corrosion. If the valve has a little seepage through

QUERY (CONT'D) there, with the humidity and things that you have down at the Cape, by the time the propellant's been on there a couple or three days, you can get some corrosion which will block the system. This is the first time that we have seen that at all on flight hardware. We've sort of deliberately introduced that in times past, but none of these things were significant and without the data, I guess we never would have really noticed it.

CARR I don't know if you folks got in on the data that we saw it when you were blowing down the APS, I guess it was. But we could see the - the mustache on the S-IVB. When we - right after we'd done the separation from it and we were moving away, we saw the - the poof. It looked like it had a - had a handlebar mustache.

QUERY I don't think anybody mentioned that to us, but really the - the stage was quite controllable insofar as that 30 percent is concerned. I guess we could get by with - in most cases there, with at least two thrusters out and a part of another one in most of the combinations that you could get. So we had control all the way through, but we were well satisfied with mission. That was about as good a launch vehicle as we've had.

GIBSON Yes, it went right down the pike. I was watching on the DSKY and the predicted and the actual were right together all the way. I wish we could have done that well in simulations. (Laughter)

QUERY Yes.

GIBSON We never seemed to have a trajectory which matched the one we were flying on the simulator. So we never got used to seeing one that matched.

QUERY We - we've been well pleased in the more recent flights because just one right after another have all been like that, right down the center and the amount of propellant left at the end of the burn and everything was within just a very few 100 pounds of what would be predicted. And so I really think that you couldn't get a more reliable setup than what we have now.

GIBSON I got a - just a gee-whiz question and that's, when we are going through the region which gives us the contrail, what exactly determines the cutoff of that contrail at a high altitude? Is it a decrease in density? I guess, initially, it's a temperature effect that causes the condensation to finally come out in water vapor. What happens as you get up to a higher altitude and it cuts off sharply?

QUERY I wouldn't have an answer to that question. The thing that is involved there is there's all kinds of different flow regimes going on back in the back changing as you go. And it seems to me that you ought to be able to produce a contrail almost any time with all the huge amount of water vapor that's being generated there, but it would appear that as you begin to get the plume interference is when - when the thing dies out. As a the plumes begin to spread and eventually get to the point where you get flashback up into the boat tail-as the plume impinges, some of it goes back into the boat tail - and along about that time is when it appears that the contrail dies, when the conditions are appropriate to get one. That is one of the heating regimes, I guess, that we've watched the most closely. But we've never - I don't think we ever spent near as much time and effort in describing what goes on in the base region through the different flow regimes that you get during assent. I don't think we ever would have had enough time in the whole program to do that, because there's so many different combinations with all those engines back there.

QUERY Yes, I - that's very true because - in aerodynamics - I listened one time to some 15 different - -

QUERY Would you use your mike, please? Turn it on.

QUERY Yes, I think, from an aerodynamicists' point of view type of thing, that the description of a contrail is part of the base pressure, base heating regime where there are a great number of variables, both geometric and atmospheric in thermodynamics, that influence the plume and the base heating and the base pressures and that type of thing. And it wouldn't surprise me at all if you're never going to find out exactly when to predict something like that.

GIBSON It was essentially a temperature effect though, in other words these combinations of - of the geometry of the plumes and the thermodynamics involved would change the temperature to the point - -

QUERY It's a function of about 14 or 15 different things, of which temperature is one.

GIBSON Okay, I was just thinking condensation would end up being a function of temperature primarily and all those other things affect temperature, but I don't know.

QUERY You - we get several different pressure to pressure to pressure temperature relationships, one through - first one regime and then to another and to another all within

QUERY (CONT'D) the same operating period, you see, and our people have not really reached a good, firm agreement about how combustible are the products that are coming out of the engine after it's - after it's finished, you know, there's much less that type of thing. We had quite some arguments some years ago when we decided to put the bG exhaust products into the star area between the four inboard engines whether it would be warmer or cooler to do that particular job. And so it finally turned out it was cooler, but there are some people who still don't believe that. And then recently when we started flying the later versions where the thrust was up about 5 K per engine, which is really very small in terms of the total thrust there, we picked up some increase in radiant heat but no increase in total heat, and the increase in radiant heat was quite significant and we still don't have a real good explanation of why. We can correlate the thrust level, but that's all we can do and the environment is so complex and the - there is just no way that you can get enough instrumentation to say what is going on here is different from what is going on there. And I think it's - -

GIBSON Of course, we could see the contrail, but apparently it was a pretty clear day and most of the people who did see it always end up asking me that simple question and I can't give them a simple answer.

QUERY I think you can tell them very honestly that we don't think anybody knows. (Laughter)

GIBSON Nobody knows. That's a simple enough answer that people will understand it.

QUERY And we're not even interested in finding out.

QUERY I wouldn't say that now, I - I - but we'd certainly be interested in finding out and it would be a lifetime study for a large group of people.

GIBSON Sounds like a good graduate student project.

QUERY Yes, an excellent type thing for that.

GIBSON Good riding. We did enjoy it.

CARR Yes, indeed.

QUERY That's it.

QUERY Okay, I guess we're ready to go to the SWS systems then. Jerry, do you guys want to take a little break before we start?

CARR Well, we're kind of in the process of doing it now. (Laughter)

QUERY Okay. So we'll just start now.

CARR I just had mine.

QUERY What are we going to do, the I&C -

CARR Okay.

QUERY - - structures and mechanics and contamination today and we can start those now and go down through them.

CARR Very good.

QUERY We can ... after lunch or we can do that.

CARR Well we're - we're willing to - to give in on some of the lunch time today; we'd like to be able to walk out of here by about quarter of 3, if we could, in order to - to go take the first look at the movies that have been made now.

QUERY I'm leaving just as soon as - -

QUERY You guys did a nice job on the set of debriefing, by the way, but we've still got quite a few questions for you.

QUERY Oh, you sure did.

GIBSON It was satisfying for us.

CARR It's nice to be nice. We'll see you folks out there in May.

QUERY Very good.

CARR Mid-May, sometime. Around the 15th, or so.

GIBSON ... perhaps the most exciting part of it, that and the EVA. It all worked real well. It all worked real well.

QUERY ... (laughter).

CARR Well it, you know, it operated up there just exactly like it went through test and that was kind of nice to see. The one - the one you got sitting at the Cape now is probably going to be real clean if anybody ever gets to use it.

GIBSON What - Where's that going to end up? Do you know what's - -

CARR ASTP ... - -

GIBSON Our - our vehicle.

QUERY It's backup for 3 - -

GIBSON No, our vehicle that we came down in.

QUERY Oh, I don't know.

GIBSON Where are they going to - Is it going to end up in a schoolyard somewhere or -

QUERY I don't know - -

GIBSON - - can we put it in our backyard or is it -

QUERY - - You want it back?

GIBSON Sure. Over at Jerry's house. (Laughter)

QUERY ...

QUERY You ... Are you ...?

QUERY ... Blocks won't work.

QUERY Jerry this is Billy Adair on the end from Marshall who's responsible for the I&C systems so he'll - he'll ...

QUERY Okay. Jack Horner, here in the blue suit, is going to lead our discussion today and we do appreciate your technical debriefing and you covered a lot of material in there and eliminated a lot of our questions. There will be one or two questions, though, asked to clarify some points that you said in your - in your technical debriefing. And with that, I'll turn you over to Jack and the rest of the fellows.

HORNER Okay, the first system we'd like to touch on is the TV system in flight, for Jack Dougherty, of Martin to ask some questions on that.

DOUGHERTY You've expressed your recommendations for remote controls and display in the TV system and we'd like to ask - -

QUERY Is that mike on, Jack?

DOUGHERTY I think I have got it now. You've expressed your recommendations for remote controls and displays in the TV system, I would like to ask if the controls that were on the TVIS and the video switch were adequate within their functional intent. Were the switches located - -

CARR On - On the input station?

DOUGHERTY Yes, sir. Were the switches located and designed in a manner that you found suitable?

CARR Yes, I think so. It was only one switch - one switch and a ... plug.

DOUGHERTY And on the video selector switch, the selector switch itself?

CARR Yes, the only - the only problem there was that that was the only - the only switch and if you could access - if you could access the video tape recorder from different areas without all having to go through one switch, it seems to me it would be a lot better because you lost a lot of video tape recorder time just translating from having turned the switch on and turning on the recorder to getting down to where we were.

DOUGHERTY Yes. I understand.

GIBSON Yes. Not just the translation time - To dc video - to work the VTR, for example, the science demo down there in the OWS, you had to get yourself strapped into the - a headset and you had to get everything all set up around you so you were set to go and that might have taken a minute - minute and a half or maybe even 2, in some instances. If you had a switch right down there where you could turn the VTR on and off, you could have made it. Got all set up, turned it on, made the science demo, turned it off, and then moved on to the next one. As it was, you had to - you didn't want to waste the time going back and forth, so you then took the time to set up for the next demo while you were - had the VTR running. So there's an awful lot of inefficient use of that VTR. So many times we would have loved to be able to control that from down there; and, certainly, we would like to have seen a - a light that says "yes, it's really getting on of VTR" or "it's going out live." ... so many times.

POGUE And to be able to figure it locally too. But - I made that point but, it - We could have really been much more effecient. We could have gotten a lot more good data

POGUE (CONT'D) on the VTR. The way it was there was an awful lot of extraneous lead-in and TV of the guy leaning over - "Hey, Ed, would you turn off the VTR," and a bunch of this stuff and I - I've just seen this within the last 2 weeks. And it can all be eliminated by just having the controls at the place where you're doing the work and all the indicators, too, to let you know that you have got it figured correctly and you have - that last 45 minutes haven't been shot.

QUERY I think our next question is about the VTR and its control. And, again, taking into account your recommendations for the remote controls, were the switches and lights on the VTR adequate as they were?

GIBSON For what we had to do with them I thought they were.

QUERY Yes. I see.

GIBSON Well, the ground essentially controlled that thing. Other than us turning it on to use it, the ground said, let us control it completely from there on. So we never had to worry about rewind - completion of rewind or any of that.

POGUE One thing that would - I think would have been helpful on the VTR itself, assuming we have to manage in some fashion the way we were doing on this one, would be a - an

POGUE (CONT'D) indicator to tell us how much was left and how much was taken, or something like that.

QUERY Oh, I see - -

GIBSON That would have been useful - -

POGUE The ground is always telling us but - Another thing too, a lot of times you - you screw up - you start taping something and there was something wrong, you see, with the setup and you - it - it would be real nice if we had a way of indexing to start, or if nothing else, if you had a real accurate analog meter or a digital readout as to where you started, so that you could rewind and do it over, outside of ground contact. Of course, we hope that we'll have satellite coverage the next time but it's still - that's a good capability.

GIBSON Yes, that's a real good point. Many times we would start - we were out of ground contact and we didn't know how much time we had available and you knew you had 5 minutes, whatever it is, for a demon - demonstration or something else you wanted to do and you didn't know whether you were going to make it or not. That, plus trying to fit in whether you had enough time left over for the ATM which had its own requirements.

POGUE And it would be another - Another nice thing to have along with that would be a warning device that was some - that did something to tell you when you were within 5 minutes or 2 minutes or 1 minute to the end of the tape. Then you'd know you'd have - you'd - well that, at least, would be a warning.

QUERY Are you talking about a ... or an audio?

POGUE Either one. Both. One that has both, because sometimes the audio would get back on your mike, you could - It would be nice to have both of them.

QUERY The next question has to do with the TVIS locations. And would you have liked to have seen more TVISs for different rotations or were your cables adequate in length?

CARR Well, the cables were adequate in length. I guess the locations were okay and the big problem with the cables was that they just got in the way and it would have been a whole lot better to have had cables on - on caddies or something like that, you know, these inertial reel things like you get at the gas station, essentially. You pull it out and you - then you let go of it and that goes back. If you could have one with an inertial locking system on it where you could pull out as much cable as you want and

CARR (CONT'D) then lock it like the seat belts on your car and then use the cable and when you're through with it, you'd give it a pull and let it go back. That would have certainly have been a lot neater organization up there. But, of course, I don't think that's your problem as much as it is people that are just designing the workstations. But things like that would certainly have made the TV system easier.

GIBSON I think I would like to have had one more station in the MDA. There was one adjacent to the ATM and I would like to have had one opposite - on the opposite wall, closer to the CSM. Because many - many times in doing TV in there you had to rig that wire and run it all the way around the vehicle. 180 around and then along the axis some way and if you wanted to leave the TV set up you had to really tie that thing down so someone - no one - someone else couldn't snag on it coming through.

CARR Yes, that's a good point. You probably could have used the one right there at the EREP area.

QUERY Yes. EREP activities.

CARR Yes, so we didn't have to string the cable.

POGUE And another thing, too, that occurs to me, first off, we used the zoom end to focus on - on the subject, to define focus. One of the things that bothered me, occasionally, was, did - what was my depth of field for the particular zoom end and I was - when we were setting up science demos it would have been nice if we would have had some little gizmo to - to put in - a sort of slider rule we could have put down that would have had two bars, you know, for resolution determination and - -

GIBSON To set up the camera, huh?

POGUE To set up your cameras. In other words, just a little assist to say do I yea, verily have depth of field to cover the objects that are going to be in this demo or this scene or what? Just a little crutch to use - to know, perhaps, what - what zoom flexibility I have that can still stay in focus.

GIBSON Well, there are lenses on cameras which have that built right into them. I wonder if it would be possible to have something like that built right into a TV, essentially the same opticals type of device?

QUERY Well, of course, there are all sorts of devices that can be used for that for closeup work to - in other words

QUERY (CONT'D) extremely critical. I - The viewing that I saw, I thought that you just did an excellent job on depth of field. The lenses are excellent, to begin with, and it seemed like the same content that you wanted was always in there and adequate, depth of field.

POGUE We spent a lot of time setting it up.

CARR TV setups were a very costly thing for us. It would have been easier if we had - if our TV system would have been designed for quicker setup.

QUERY Would it - Well, would it have helped, at all, to have had anything on the camera that indicated what the depth of field was for the particular focal after selected in the f-stop or do you feel it would have been better to have the actual physical depth of field indicator to put in your scene?

POGUE I - I was wondering how you'd have use it on - if you had it on the camera. I'm not quite sure what you mean by that. I know on the camera - -

CARR ... decal you're talking about on the side of the camera?

QUERY Yes, sir. I - I - I think you would, first of all, see how far it was to your subject - your point of interest,

QUERY (CONT'D) then for the f-stop you'd selected and the zoom that you'd selected for that activity. You'd then look and take off at the depth of field that you have.

POGUE That little chart?

QUERY Yes.

CARR That would have been good.

POGUE I - I like that.

GIBSON Yes.

CARR Would have been useful to help us kind of walk out a scene and how we were going to do it.

POGUE I'll tell you another thing I want to mention now before I forget it and that is that we need much better distinctive fields on the zoom focus in aperture. And also the - they need to be more - the friction needs to be better designed because one of them that was real loose.- -

CARR Was it f-stop? F-stop was awful loose.

POGUE We had to tape it down.

CARR You could just touch it and it would - it would drift around it was so loose.

POGUE So you didn't - you didn't dare really manhandle the - the camera when you were using it. But - And another thing, too, I was always grabbing the f-stop when I wanted zoom and you know if you - if I'm over here looking at something and I'm trying to zoom in on it, I shouldn't have to turn around there and look at the lens. And those - those do not have distinctive fields to them at all. And I'd like to have coarse sandpaper or something on the one that - you know something like that.

CARR Dimples [?] on one and nubbies on the other one?

POGUE Yes. Airplane controls are done this way. Mixed - you know, the old prop planes used to be this way so you didn't cut your mixture when you were actually trying to change the prop setting or something like that.

CARR Before I forget some things too, number 2, the next item that I think is important is the monitors. The little monitors were good but they deteriorated with time and got worse, and worse, and worse. And the ones - I got a question about the one that I said there's a little rubber grommet floating loose in there. I'm interested to know if you ever found out what that was that's loose in there? And the other thing, before I forget too, is that in the area of monitors, it would have been nice if we'd

CARR (CONT'D) had a large - say a 14-inch screen or larger where we could have taken a look at some of the stuff we'd done so we can get a value judgment as to the quality of this - the work we were doing and if it would be in color.

POGUE That's right.

QUERY On your first question, I'm afraid I can't answer it. The - The hardware involved is not at our center so we wouldn't - we weren't involved in that. And I do know about your desire - your comments on the larger monitor - -

CARR If you're going to do television productions, and that's what we were doing up there, it seems to me you ought to have all the right kind of equipment to see how you're doing and what you're doing and this could be part of the VTR setup. You should have the capability of playing the VTR yourself and seeing how something worked and if you don't like the way it worked, erase it and do it again, a little bit more independent television production capability because I think everybody now has seen the value of television up there.

POGUE We needed a - a better mount and steering capability. The mount, itself, the friction varied with the three joints that we had. So you - there was no sort of harmony involved

POGUE (CONT'D) there. You couldn't achieve a harmony in panning or even repointing. And another is that we actually reached down and grounded and used the pigtails to get the right mechanical advantage. We were actually grabbing ahold of the cable pigtails back on the back of the TV camera to steer this thing and particularly when we were doing these science demos when stuff was moving around slowly, but definitely moving, we'd - Trying to pan slowly was extremely difficult because you'd get the friction getter and would jerk and snap and it was hard to keep the stuff in the center of the field of view. It needs to be more professional, because by the - by the end there we were getting so, you know, we thought we were - we were cranking out some pretty good stuff. But it surely would have been enhanced if we'd had a little more professional approach to the mounts and the steering capability.

QUERY This is the SUM now - This is the SUM, this universal mount that you had to carry up?

POGUE That's correct.

CARR Yes.

QUERY Yes, sure.

GIBSON Yes, there was not a lot of locations to even put that universal mount, especially, in the MDA. For much of that TV I ended up taping their camera to some location.

QUERY Oh, I see.

GIBSON You ended up taping the front, the handle underneath, and the wires in back. And when it all steadied down - stelled - settled out then you could go ahead with the picture.

POGUE In order for that universal mount to have been properly useful too, it should have had a telescoping handle, because with that closeup lens that's an extraordinary critical setting adjustment and you either have to move your scene around to get it in the right position but all you have to - you have to have more flexibility in adjusting the - the camera itself.

GIBSON Yes. Going back to that TV lens especially, for use in the MDA, I would like to have seen a wider field of view. When we were trying to - In one scene, in particular, I was trying to work on the ATM panel and show the whole panel and I just had one heck of a time trying to get the camera far enough away from it and not such an oblique angle that you couldn't see it - -

POGUE That's a real good point.

QUERY Uh-huh.

GIBSON I just couldn't back that camera off enough to make a reasonable coverage.

POGUE I was taking pictures of Jerry up there and the EREP, too, and I was in back a good 10 feet and still having trouble getting an intelligent field of view.

QUERY Uh-huh.

QUERY We haven't got the cameras back yet, that why ... - -

QUERY Oh, I see.

POGUE Another thing that would be neat, we have the - I know we have that universal camera mount that the - the blade type thing mounted all over that camera, and still it seems like that you always wanted to turn that monitor in some direction that - that you couldn't achieve. And it would be nice to have some kind of swiveling capability and a little bit more flexibility on that thing because, a lot of the times, you - you are in the back there - you are behind the camera holding it and you got a great field of view there. Other times, you are in some sort of

POGUE (CONT'D) awkward position but maybe it's a maintenance thing that you've set up and in order to get the camera in position to take the field of view, you - you don't have any flexibility at all. There's just one or two places to put it and when you are in a position to try to do the work and look back and see if it's still centered in it, the monitor's pointed away from you and you can't see it; it'd be a little bit nicer if you had that greater capability to move that monitor and point it.

QUERY Once you have your camera oriented and you had your scene content developed, did it hold its orientation while you were tightening down the adjustments on the SUM, or did you get a shift in the actual tightening down activity?

POGUE I don't think that was really too much of a problem.

CARR No.

POGUE It would be nice to be able to take TV of the exterior of the spacecraft from inside.

QUERY That was a question we were going to ask you in - -

POGUE Boy, you had an IVA crewman in there with all kinds of time and just no capability. Could have gotten some real good TV of them.

QUERY We had some good schemes people were just beginning to look at. When it was way too late they were sticking the television camera out - out the solar - or scientific airlock and using the - essentially the lunar rover remote control device to sort of set up where you could sit inside and point the camera - gimbal the camera to a good position and take pictures and ...

QUERY As I recall, that was in the planning. Definitely in T - -

QUERY T027.

QUERY Yes. T027 had that capability. I - -

QUERY And we lost the SAL on the Sun side.

QUERY Some of the SAL was lost, too.

QUERY Yes. Well, our question also was one where we were interested in whether or not you felt a built-in capability should have existed beyond the T027 capability where you could have hooked the TV outside - shared the thing and - -

QUERY Above a window or something.

QUERY That's right.

CARR Oh yes. We could make all sorts of observations of contamination and things like that out there.

POGUE We're talking about things that are so nice to have and now they're becoming extraordinarily defensive and by - in later programs. Because - But it's just the sort of thing that just gives you tremendous flexibility in seeing what's going on outside. And I know just from a "gee whiz" there's Joe Schmo EVA type thing, but boy that's really good for maintenance, too.

QUERY I don't think we'll see that on Shuttle and maybe even spacelab, but when we finally build a good spacestation - -

POGUE I would just like to sort of stimulate your curiosity in this area. I think there are ways of doing this. The people - when you mention this, you say, "a periscope capability," they immediately, you know, think of the U-boat commander type thing, but what we're doing is addressing a capability. Now I don't know how - I couldn't care less how it's implemented or mechanized. So I think there - you know, there are probably many ways of doing

POGUE (CONT'D) this. Now, I know fiber optics still aren't there yet. That's the first thing that would suggest itself, but, you know, try to sort of think about this, because I think there are ways even of getting it on Shuttle, if we are clever enough. Now, if you start getting a big piece of folded optics that takes up 15 cubic yards of space and that kind of stuff - 1500 pounds of weight, your out - you know you are out of business. I still think you can do it; I don't know how to do it.

QUERY The next question we had was: Was lighting or the arrangement of lighting a problem for you during TV?

GIBSON It was a problem in the sense that it took a little attention - a little care, but you could pretty much figure out how to do it. I think especially in the - I was taking a closeup TV using the closeup lens. That was a little hard to figure out just what was a lighting optimum - what background you ought to use. Taking pictures of moth eggs, for example, do you put a black background or a white one or one which is reflective or scattering? That was just trial and error, where you put the lights.

CARR There's the spacecraft lighting where that low level TV would certainly zap it if you didn't pay attention to

CARR (CONT'D) what you were doing. But I thought that low light level TV was excellent.

QUERY Yes, I - that's kind of what I was interested to hear you say. I wondered if you were able to see the camera and the settings and so forth sometimes to just operate the system ... little by little.

CARR We didn't have to fool with that. We would set the camera up first and then the only thing we changed after that - hopefully, the only thing we changed was the zoom and the focus which you could look in the monitor and see how that was going. I just felt very comfortable with that low light level TV. I was pleased that we had it. Now every time we turned on the spots, the flood lights in order to get better lighting, I think it degraded the television, because there was so much backshadowing and everything from those rather directional flood lights that we resisted - -

GIBSON That would depend on what you were doing.

CARR - - we were able to resist using them. Now, yes, in the case where you are doing closeup work with a closeup lens, and you are right in there tight, then you don't worry about shadows, because you don't have them too much, but

CARR (CONT'D) you got better TV with ambient lighting than if you turned on a bunch of floods and try to get TV because you would have shadows all over in the background.

POGUE The only exception to that was that one sequence we took of the - of you and the EREP, and I deliberately did not use spots in the high intensity lights and it - they came back and said it was - they were working on it, but that they thought they could get some good film out of it, but that there wasn't enough light. And I think the reason there was, I was taking the picture into a lighted area with lights in the scene, although we tried to avoid it as much as possible. Other than that, there was always a problem of probably having too much light, like leaving the wardroom window open or something like that when you are taking pictures in the experiment compartment.

GIBSON Are there TV's which are designed specifically for out-the-window use, which if we had along, we could have done a better job on the earth photography. Apparently, whenever we got a cloud in the picture, it just completely saturated the - or brought the - that light level up and dropped the remainder so that you really couldn't see anything else except the cloud.

QUERY Well, essentially the camera that we had this time coped with that problem and that the ALC took over. And I thought that the out-of-the-window viewing, again, was very fine, some of the best television was the out-the-window - -

GIBSON Well, it worked pretty well, but apparently we got lots of feedback from the ground that whenever we came across anything with significant cloud cover, it obscured the remainder of the picture.

QUERY Well, I'm - I'm sure that can be - be worked, but I think it was the intent in this camera to have that capability in the ALC that was in the camera. Automatically cope with that high light level within the brightness range of the camera, which it certainly was. Brightness range with any one scene was 100 to 1.

GIBSON Yes.

QUERY The ... from the camera ...

GIBSON We - we could not judge that. We were not on the ground looking at them. But we did get that feedback from the ground.

QUERY I see.

POGUE There's another case where a monitor would have been invaluable, a large color monitor. We - we could have - we'd have felt a lot more confident about taking those out-the-window scenes.

QUERY I see.

GIBSON We'd also like to have the capability of having TV up, so the idea of a large TV monitor is really not quite as bad as you might think. We would have one for onboard use for both cassettes. We'd have on board as well as other information which would come up for entertainment and training.

QUERY On your closeup lighting, I just - I think your lighting for closeups was very adequate. The only comment I guess I would have was occasionally it seemed a little flat, and I think the only answer to that would have been a softer auxiliary light off to the side to give a little dimensionality, which you probably - I'm sure you didn't have to use.

GIBSON Yes, we had some.

QUERY Did you?

GIBSON Well, we could have taken the high intensity light and just turned it down low and used only one. Of course ... - -

QUERY With all the - -

POGUE Well, there's portable lights too.

CARR We also had the portable lights too. But see, not - you know, not being able to see the pictures, we didn't know how they were coming out.

QUERY A lot of the detail was there. All the content was there. Just a fine point. Could you comment on the use of the TV system for EVA? You did not use it on EVA. Do you have any thoughts about problems you might have had in such an application, or - -

CARR Well, the only problem would have been handling the cables and all, but we were disappointed that we weren't allowed to take TV out with us and get some shots.

GIBSON Is there any reason that was not used or suggested?

QUERY No, sir. I don't know the reason.

QUERY One of the thermal ... the camera was - -

QUERY Thermal problem.

QUERY Thermal on the camera.

GIBSON But on that last EVA, when we still had two cameras left over?

QUERY Well, the camera is - is okay for EVA application. The temperature must be monitored, of course. Maybe that was part of the problem.

QUERY The next question is one on general system operation. Apart from your express comments on the mini-monitor, you - you pretty much talked about your mounting and pointing problems with the camera. Another question on the mini-monitor: Were you able to discern spots or lens contamination using the mini-monitor? I noticed a scene or two where it looked like maybe there was a little lens contamination, not enough to be a problem, just picking out a spot on the lens, something like that.

CARR I don't think we could have. It had ... chunks.

POGUE The thing was too degraded.

CARR By the end of the mission, yes, they were both getting pretty degraded.

QUERY Did you notice any lens contamination at all in just looking at the camera in general?

GIBSON I think I cleaned the lens twice, I believe.

QUERY Do you know what the material was, or just general accumulation of dust?

GIBSON Once when I was doing the fluid mechanics experiments, one of the bubbles backfired and completely coated the camera.

QUERY Was that mostly through the VTS that you were seeing the spots you're referring to?

QUERY No, the - the spots that have been seen throughout the entire mission, all three manned periods have been - in the portable camera have been internal spots. And we do see those, and occasionally we've seen spots that felt maybe were contaminants on the outside of the field lens. Those spots internally have been - -

QUERY I know; we've picked them up during the EREP pass, and that's what I was wondering. I thought most of that was in the VTS system.

QUERY No, there are some in the VTS. I can't distinguish, but some are also in the camera as well. We see quite a few in the outer window viewing of the Earth because you're at a longer zoom and a smaller f-stop and it - for some

QUERY (CONT'D) reason that focuses them. The spots are contaminants on the faceplate of the vidicon and also on the back of the filter wheel is what I've been told. And I don't understand the mechanism whereby going to a smaller f-stop focuses them any better, but it surely does.

QUERY On the ATM, would you comment on the overall system performance on the ATM TV: the controls and displays and the - the camera performance, monitors, things like that, in general?

GIBSON Okay. Start off with the switch itself. That was no problem, you were always right at the ATM, and that switch was the only thing you had to make sure you had in the ATM position. Apparently that - I know on a couple of occasions you had it in the T - we had it in the TV or the wrong monitor; but I don't think that was a major problem, and not anywhere near the problem we had when we were working with the TV in remote locations. That was a different story. The monitor, two monitors we had on board, one we took up and one which was there. The one we took up was an excellent monitor. There for purposes of solar viewing conditions we could see things which we'd never expected to see in - in the way very faint emissions. We were looking at Alpha 1, for example, off

GIBSON (CONT'D)

the limb and see prominences just - with clarity which we never expected to see. I think that monitor was an exceptionally good one. Tom Barnes at Marshall picked that one out. An exceptionally good - good contrast, good resolution. It was white, which was a black on white, rather than a black on yellow, which monitor 2 was. Apparently, number 2 had degraded, turned slightly yellow. That seemed to make quite a bit of difference in the contrast which, you know, I could perceive as contrast. Then the other is we'd get into the vidicons associated with each TV system. And each one, as you know, had its own peculiarities and its own problems. If you want to discuss that here, we can. Is that part of your - your area? We can go into it if you like.

QUERY

Well, yes, I'd be interested to hear any comments you might have on the individual vidicons. The white light coronagraph, for instance, we know we got several burns toward the end of the mission, and we were wondering whether you'd seen any excessive light levels during the activities that might have explained those burns. There's other things that could cause them, but that would be one area ... - -

GIBSON The only way those burns - that we could see, could get in there - one is a continuous offset of the white light coronagraph. Its ... wasn't always right at the center of the Sun. That was because there were experiments ... misalignment, and they also had the constraint that they had to operate when their pointing error system was within certain constraint. So we ended up operating purposely misaligned slightly, which put a certain amount of light always over on that one edge of the vidicon, which in turn, they say over a long period of time could have caused the burned-in spot to all of the sudden appear. That was the explanation we got for the first burned-in spot. It also saw short transient high light levels whenever the door was closed with the TV still on. And that happened on our mission a couple of times the same as it happened on previous missions because of the no interlock feature there. That was - is you do something hundreds of times, you're - It was off and on where you're bound to make - make that error, and we did too. But the burned-in spot did not appear immediately after that any times which that happens.

QUERY Well, that wouldn't appear to be the cause then because - -

GIBSON From our standpoint it was not related, but that was a possible contributing factor to the total amount of high light level which I had seen. Once we did get the second burned-in spot, I thought the contrast of the remaining features went down considerably, and maybe that first one also had caused quite a bit of decreasing contrast. It turned out that we were not able to see transients in the coronal which people say did exist looking at the film, whereas they were obvious from the previous missions. Even the pictures - Polaroid pictures which were brought back from the previous missions, we could see transients there which were just obvious to us, and the Polaroid pictures were degraded quite a bit from what you saw on the TV. We went up there and looked at the TV, we did not - did not see any at all other than one very bright one. The real disappointment to us was in the H-alpha 1 vidicon. That appeared to decrease significantly in contrast, or I should say - I'm not sure, it's some combination of contrast and resolution.

QUERY Did the crosshair also decrease at that time, or did you notice? Could you tell any difference?

GIBSON I don't recall that being suffi - significantly degraded.

QUERY It's really hard to tell because it's - it's black and you can't see the degradation as readily, of course. And we couldn't see it at all on the ground.

GIBSON Yes. I could not see - did not notice a - an accompanying decrease in the resolution of that crosshair. But that was either a - I guess there's three things: either the filter drifts, the contrast goes down, or you just lose the resolution due to the optics changing. And I got - I think probably more of the latter.

QUERY Did you notice that decrease in resolution on both monitors?

GIBSON Yes. It did appear on both monitors, and it occurred maybe 10 to 15 minutes after you turned the vidicon on for the first time of the day and you'd let it sit - turn it off and let it set for an hour. That didn't seem to cure the problem. Even a couple of hours, as we'd leave it off during the Z-LV passes.

QUERY During the off time was the filter heater also turned off - or on rather. It was much - -

GIBSON No. The filter heater was always turned on.

QUERY On.

GIBSON There was only one occasion that was turned off, and that was inadvertently and that was H-alpha 2. H-alpha 2 just never was a - anywhere near the quality system in terms of what we could see on it as H-alpha 1. But I think that was more the - the filter itself and other characteristics of the telescope. It was good for overall pointing, but we never really tried to push that in terms of high resolution. The white light display - white light slit had its problems. Apparently that - the optics there degraded so that we could not get the limb scan or limb pointing functions to work, which depended on the TV inputs, right there towards the end of the mission. And also we could not see the white light features anywhere near as well at the end of the mission as we could at the beginning. Penumbra of sunspots for example, very good when we first got up there; couldn't see them very well at all at the end.

GIBSON XUV monitor: We would love not to have used that in the INTEGRATE mode. A longer persistence phosphor on the scope would have helped. We ended up using that persistent image scope in conjunction with the INTEGRATE. And that worked but it was a very awkward way to use it. There we were just not getting enough - apparently they're

GIBSON (CONT'D) not getting enough photons to the front of the vidicon - low light level vidicon. Now how they get around that I'm not sure. They had a couple of filters in there which they could have taken out but talking with Doc Tousey, he said that still wouldn't have done it. So maybe just the next generation of low light level vidicons might do it for you. Can't think of anything else.

QUERY Thank you. After having seen the ATM video downlinked, could you compare it with what you saw on your monitors?

GIBSON I haven't seen the downlink. I guess before I went I saw it and I don't think it's as good as what you can see on the monitors up there. Apparently there is some degradation of the signal but I don't know how to give you a quantitative feel for that.

QUERY It was a general question. On the first manned period, the comment was made that it was better on the ground than it was on the monitor and then I think the next period it was the reverse.

GIBSON Maybe that's because we had that H-alpha 1 - or the monitor 1 up there which we installed which was an exceptionally good monitor.

QUERY Well, we would expect it to be much better on the monitor of course because of the strain of the band width on the downlink.

POGUE Haven't done any reprocessing of the signal tc try to enhance the downlink signal?

QUERY No, not at Marshall.

GIBSON I guess a good - a good measure of that was when we saw the comet. On board we could see the sunward spike when we were at perihelion in the S052 coronagraph TV. Took a picture of it and we could see that - we tried to put a TV picture of a - or the picture of the TV tried to show that down. By that time we had lost all the evidence of that spike, but we could see that spike very well on board. In the TV which came down they could not.

QUERY Absolutely not. No, there was no sign of it.

CARR I think the next questions we have in television have to do with hardware oriented questions, on the MDA hardware and John Vega is going to ask those.

QUERY I just wanted to ask a little bit more about that ATM monitor, 1 and 2. You said that the ATM monitor 1 that you'd installed was much better than the monitor number 2.

QUERY (CONT'D) Did you notice any degradation from the beginning to the end of the mission between the two monitors and - you know, did you notice any degradation in the monitor number 1 which you installed?

GIBSON No relative degradation. I could not notice any relative degradation. Of course there's a wide range there which, over a long period of time, you might not pick up. But the monitor 1, when the vidicon in H-alpha 1 was working at the beginning of an orbit it was as good as - subjectively as when we first got up there. I should say that monitor 1 was used - was the best only in terms of looking at H-alpha 1. When we would put the XUV monitor or one of the other displays on it, it didn't seem to make that much difference. H-alpha 1 is where you try to get very subtle feature in terms of faint features off the limb or very fine features in the chromosphere. You're already pushing the resolution and that's when it would make the difference. In the corona, for some reason, it didn't seem to make too much difference.

QUERY One more question. Regarding that, we were talking about the sunward spike on the comm. Could you see that on both monitors?

GIBSON Yes, I think you could, as a matter of fact. I think it probably showed up a little bit.

CARR I thought it showed up better on 1 than 2.

QUERY That would give us a point though because on the ground we couldn't see it at all and it would tell us how much that one monitor had degraded. You could still see - you think you could see it?

GIBSON Yes, as a matter of fact I always used monitor 1 in looking for the comet, in all the JOP 18s we did. But I also had 2 called up at the same time, and as I recall you could see it better on 1. They usually appeared a little bit easier and you could -

CARR Yes.

QUERY Okay, fine. Let's go to John Vega then.

VEGA Basically, I have quite a few questions associated with marking and connectors and so forth which hopefully we can get your views on. Basically, the first question I have is there was an awful lot of use the TV system and disconnections and connections of the cabling and so forth. First question is what was the - you feel the condition of the alignment marks and identification markings on the

VEGA (CONT'D) TV is, the VTR, and the video switch? Were they still usable? Were they still in good condition? They didn't cause you any problems when you went to hook up your station?

CARR No, there were no problems. They were still usable and they're probably the better markings than a lot of the other systems had. I think you guys apparently pay a whole lot more attention to the markings and alignment marks.

POGUE We had that one problem on the TVs and - -

GIBSON I was just thinking of that one; yes.

CARR I think we must have just brute forced that one or something.

GIBSON I'm not sure what the heck happened on that one where we had the pin which was bent, and I was the guy who tried to put it in there and I just line it all up and put it in and it just didn't go in. And we finally ended up looking in, saw we had a pin bent and tried to straighten the pin and it broke off.

VEGA Okay. I'll jump over. I have a question on that one. Let me just ask you one thing about - did you recall at

VEGA (CONT'D) all on that pin, was it a solid or a twisted pin? See there is two different kinds of pins and there is a solid-type pin, and also the coaxial pin is a twisted - actually a twisted wire. And if it was solid - -

GIBSON It was solid.

VEGA It was a solid pin. Okay, then I know which one it was. It wasn't the coaxial pin. Okay, that's good because that identifies which, you know, identifies it to another area.

GIBSON I had a tough time figuring how that could have gotten bent, how one pin could get bent like that.

VEGA Well, there is a - along with - let me jump over the pin items since we're talking about that right now and that is that early in the program, in fact prior to the launch of the Skylab, there was a lot of problems associated with the connectors - the back shells, the identification markings and this. We worked the hell out of it to put it bluntly, and we got to the point where we tried to eliminate as many problems as we could with the alignments as far as getting the pins lined up so that they would go in properly. But there is a situation where due to the way the connectors are actually built that you can go in slightly cocked and you can get pressure on the pin. And

VEGA (CONT'D) actually if you push hard enough, you will bend the pin. It has to be - If it's aligned just perfectly, it won't happen; but if you're just a little bit off, you can have that happen. So what undoubtedly happened during the multi-multi connections and disconnections that you maybe opened up - There's actually three little guides in there. There's three slots, and you may have opened up the slot just a little bit. And eventually it got to the point where you were off enough, and it isn't very much, that you were able to cause the pin to be bent. And then next time around you - like I say, when you tried to straighten it, you broke it. You've answered really my second question: Are the alignment marks adequate and you said yes, they were. And the next question I had is really with the slop on the alignment, and I guess you're saying it was adequate and it really isn't - the marks themselves were pretty much aligned when you made the connections.

CARR Yes, I think they were pretty good.

GIBSON The marks would tell you where to make - where to get it roughly aligned to begin with and then you go the remainder by feel. At least that's the way I made almost all the connectors. Jiggle it around until it felt it was going to slip on and then you give it a little more force.

POGUE That's exactly what I did and when you're explaining that previous design in there, I was wondering why we didn't break more. I did exactly the same way Ed did. I'd wind up the little mark and sort of feel it - as soon as I got the slot in the guide, I'd push it in.

VEGA Right. And it is a little difficult to push in, too. I mean it isn't - So the feeling that you have when you push it in is good for is though - even if you're bending the pin, you might not know it because it is a little bit hard to push in. On the overall question of alignment marks, do you feel that maybe - did you have any general comments on improving these like color, size - -

POGUE Are you addressing a general problem or just related to the television?

VEGA Related to the television because that's - I can't ... rest of them.

CARR Design criteria should indicate that you should never have two of the same size that can be crossed, and that's just to protect against Murphy's law. You should always try to color code and if - whenever possible make two connectors be of different sizes so that you can't cross-connect them, if cross-connecting them will cause any

CARR (CONT'D) kind of damage to the equipment. And those are just overall, general desk philosophy of connectors. We don't have any special revelations on that. I think that most of that that's in the system right now is design criteria for connectors. Color coding is good; alignment marks should be as accurate as possible; and whenever possible you should try to change sizes.

VEGA All right, next one. Again, we're going back to the connectors and that is did you have any other problems with connectors within the MDA that gave you any kind of problems, as fas as mating/demating - whether they had standard pins or coaxial pins, as far as in the MDA?

CARR No. I think that there were a lot of people that were scared to death we were going to screw up the ATM when we were doing some of the connector mating and demating down underneath the kick plate. But - -

GIBSON To put the auxiliary - S082B auxiliary timer on, we had people all the way up the line worried about that one; and it turned out to be a very simple job.

CARR As long as you got time to be careful it's not too much of a problem. If you get in a big rush-rush situation that's when you starting banging up and ruining connectors.

GIBSON TV installation also had lots of connectors that had to be made and broken, some of those fairly fragile coaxes and that proved to be no problem.

CARR As long as you're careful. Care is the big thing. If you take your time and don't rush you can usually do a good job of connecting; you can do as well as a technician who does it for a living, I think.

POGUE Probably better. (Laughter)

GIBSON You worry more than a technician.

VEGA I think that answers my next question because I was going to ask you if you felt that things like this pin being broken could have been avoided if let's say that the way the actual connector shell or the way it was actually designed externally - what you have to see and what you have to hold are a little bit different?

CARR Externally, no, because the TV input stations were were high-use stations and frequently we were in a big hurry. Because we were running behind, we had to get the TV system tossed together and set up and running.

POGUE Now that thing could have been fatigued before we ever put that plug on there.

GIBSON I think the secret is to make something where the tolerances which will allow you to make any kind of a start of a connection at all will assure you that you're not going to bend the pin.

POGUE Yes.

VEGA Okay. Very good. Let me ask you one more question on that pin and that is before you went to plug it up, you didn't realize of course it could have been bent prior to then? You really didn't know that?

CARR We're not in the habit of inspecting the male and female side of a pin - connector before you mate it. You don't have time for that, but I'm sure that's a good procedural rule to do before you ever make it - make any kind of a connection; you should inspect both to make sure your pins are okay. That's just not realistic.

GIBSON I did that on putting the auxiliary timer together, but I think that's the only time I did that.

CARR Oh, yes. But that's a one-time thing.

GIBSON That was a one-time thing which I knew everybody was super-worried about.

VEGA Yes, I guess really sort of a summary area, basically saying that the - as far as future design of any hardware like this, all we really have to do is use some good design practices, and have good alignment marks, and ensure we have good tie tolerances and then from there it's up to the astronaut to do the job.

CARR Just be aware of the fact if you got a type of connector that's going to be frequently done and is likely to be done in the heat of battle or when you're in a big rush-rush situation you need to design protection into it. But if it's a one-time sort of thing where you know the guy is to be very conscious and careful, it seems to be just what normal, standard design criteria would hold. You have to kind of think about under what circumstances is the connection going to be made and broken.

GIBSON I had the feeling that those connectors on the TV were a little bit sloppier in amount of off-axis angle you have and still start the connection. It's not like some of the ones which really had to be precisely lined up before you could even insert it all the way and start turning down on the collar. It just seemed to have a little more play in it. I'm not sure whether that was a detriment or not. It may have been an advantage.

VEGA All right, that ties in with my next question a little bit, and I'll just try to wind these questions up a little bit quickly here, because I think you've summarized it real good. And that is, were there any connectors again associated in the MD that might have had any back shells or anything of these things come loose on you? Did you have any of those where actually you found that - -

CARR No, I think we hollered enough about loose back shells to where people got very ginchy about that, really checked back shells all over the workshop, but I don't remember having any back shells come loose on me? Do you? But we surely got a lot of them interested. We did a lot of hollering and people really turned to them and made sure it didn't happen on the flight vehicle.

GIBSON On one of the TVs we could - I noticed this especially when I working in the MDA and trying to back the TV up against the wall; you push those cables which came out from the TV and into the monitor; if you'd push on those cables, sometimes you would lose the picture, indicating we had some sort of a transient or some sort of wire there which was making or breaking either the wiring in the cable or the cable connection to be - That happened on just a couple of occasions and I could readily clear it

GIBSON (CONT'D) by just moving it away from the wall. It never turned out to be a permanent problem so I never really made anything of it.

POGUE That's right; I lost a monitor once. I couldn't get a monitor picture. You told me about that.

VEGA Okay; well, fine. That's all the questions I have on the connectors and I appreciate the answers.

GIBSON Thank you.

QUERY Okay, next we'd like to discuss the airlock communication systems and the Bill Wiggins with - of - McDonnel East will lead that.

WIGGINS Now the first - the first question I have is on the teleprinter when you clean the heads. Do you remember the mission day that you cleaned the heads with the alcohol? And did your problem clear up after this?

CARR Yeah, that was the day where they sent us up some messages and we said they were terrible and the we change the paper and they sent us up another batch and they were still terrible and so we changed, the entire head with a new roll of paper and they were still bad.

WIGGINS And then you cleaned it up. And then I cleaned it. This was probably around day 70 - -

POGUE Somewhere along there; it was pretty late.

CARR It was near the end of the mission. But the reason why I decided to clean it is because after we failed three times with different rolls and different heads, we got - I stuck my head down there and started looking at it and I saw little bits of - of white along the head, along the print, and it looked like some of the coating on the paper had rubbed off on the area there and was just deposited. And so I figured - Well, let's see. This thing uses heat to do it, and so if I kill the power and clean it with alchohol and then let it sit for a good time until I'm sure it's dry, it - it probably will be all right.

WIGGINS And you didn't have any problems after that?

CARR No, it - it - boy, it was immediate. It just worked very nicely.

POGUE One thing. It seemed like it would be real nice to be able to adjust the pressure with some kind of double-set screw on both sides of that head, because even though we pull down on the head when we're installing - when we change paper, we pull down before we tighten the Calfax.

POGUE (CONT'D) You really weren't doing all that much good because if you looked in there, there was physical restraint to prevent the head from pulling the paper against the head very much. It sure would have been nice to have an adjustment in there on that.

WIGGINS Right. Where you'd put it in there and have a lever that you flipped it up?

POGUE Or that with a predetermined pressure and then maybe some kind of differential pressure adjustment on both sides, because a lot of times there was one side or the other that was dim.

WIGGINS Let me ask a question. Just a minute. Lee, can you pinpoint that day, based on that info?

QUERY We can get it out of the logs.

WIGGINS Okay. I - I think we can.

QUERY Are you talking about the - -

WIGGINS The day it happened.

QUERY We went back and checked our logs, and we related it to mission day 19 or 20 when we really had a big, big flap going.

POGUE It was later than that.

CARR This was around - around 70 something.

QUERY 70 something.

CARR Yes.

GIBSON We might have looked at it.

CARR I think it was in the - Was it in the deactivation phase?

GIBSON Yes.

POGUE I remember it occurred on a day when it was a fairly slow pace at that point, because I was up there watching. We were all up there in the MDA diddling around there. I was just trying to - -

CARR I didn't figure we had much to lose by then. We were only a few more days left in the mission. And the teleprinter was really crapping out on us, and I figured I'd clean it. If it dissolved that - the write heads and would never write again, I figured, well, it's better than what we got. So it was worth a try.

QUERY Yes, well, much earlier, I guess, in the mission we had period of time there that we couldn't get the teleprinter pads up for the next day.

CARR Yes.

QUERY And the - we worked up a procedure of suggested steps to go through if you - if you - I think they sent messages time after time and they were printed real light. And one of the questions INCO had, I think, was - Well, they should clean - clean the head. And the - we make the recommendations, and we didn't really con - We said, well, we felt like it wasn't - it wouldn't do any good to clean the head itself but that you could just pick loose particles off the head, possibly. But apparently there were things that did stick to the head that you did clean in there.

CARR Yes, there was some sort of a white deposit on there.

GIBSON Yes.

POGUE Didn't we have on a whole extra head?

GIBSON Yes.

CARR Yes, but it was failed.

QUERY Yes, sir, but you had the broken drive roller on it. You couldn't - We did have the spare on board, but we never got into using it.

POGUE Oh, okay, because I trained to repair that.

QUERY Right. That's right.

POGUE Okay.

QUERY Trained to repair it, but we never had the occasion that - We decided that the head was bad, you know, and it just - it seemed to be - I believe the whole problem was that contamination, because early in the mission we had problems with paper. You know, put a roll on it, and it wouldn't work. And then you'd put another roll on, and that would work. Maybe that had to do with the pressure that was getting against the head, too.

CARR Yes.

QUERY But there's those two things we have noted, and - and we take those into consideration.

WIGGINS Okay, the next - the question I have is on the time reference system. On the mission day 27 at 12:15 GMT, the EREP day counter jumped to day 28 and remained one day ahead for the remainder of the mission. And then the question we had is, did the GMT clock also jump?

CARR On two occasions the - the clock jumped a day on us, and we went back and set it.

POGUE I think one time it jumped - -

CARR It was right around day 28, too.

POGUE Yes, I guess it was. I - I think I did that. I was up doing something with the system. And I put my hand over it as a handrest while I was doing something on panel 201 or 202, and I thought I hit a switch. And I looked over, and everything, you know, looked normal. And I think what I did is, I advanced the date one.

GIBSON Yes. And then a couple of days later, I think I went back and reset that one.

POGUE An - and reset it.

GIBSON And I think, Jerry, you reset the first one. When we first got up there, we were a date ahead.

CARR Yes.

QUERY Let's see. This particular one, do you recall when that EREP day counter was off, late in the mission there?

CARR No.

WIGGINS You don't? On SL-3 they had a portable timer mechanical malfunction. You know; those timers you carried around. Spring had broken on it. Did you have any problem on this mission with those at all?

POGUE That had red tape on it; we never used it.

CARR The one was red taped, yes. We left it in there and never used it.

WIGGINS You - Right; that was the one I was - The ones you did use, did you have any problem with them - malfunctions?

POGUE Yes, my battery was starting to go down, I think, but I never did change it; I had to shake it a couple of times, to get it to run - quite often there toward the end to get it to start. Another thing. This is a failure - sort of a failure mode that was a bit disconcerting and - That is, you got intermittent operation as the battery got down low. And a couple of times I got caught off because I set my timer for a key event; and if I didn't watch the second hand start moving, I could put it in my pocket and then it would just not run. It would - You know, it wouldn't do anything.

QUERY I see. ... get down to a weak battery should just quit.

CARR (Laughter) Those timers were just useless, though we've got lots of words in our tech debrief of what we think of the timing system throughout the spacecraft.

QUERY The ... timers or the - -

CARR All the different kinds of timers that we had available to us. They all stink.

QUERY We didn't - we didn't see that in the tech debriefing, did we?

QUERY Do you remember what part that was in?

CARR Probably under crew equipment.

QUERY Crew equipment.

QUERY Crew equipment.

CARR Someone should sit down and invent - develop a timer that has got versatility and flexibility for use by people working up there.

POGUE I had a presentation made up at one time which I never gave anybody, but - all the nice features that you'd like to have in a timer, including, you know, the feature - design features as well as the display features. But that thing had an awful lot of bad features in that - Well, one of the things was, you - you could set the timer to start running; and then you release the button, and may take several seconds before the thing would start moving. If you were trying to set it on an accurate digital timer, on that basis, of course, you - you - a couple of other things, too.

CARR Yes, we had no - The timer reference system in the spacecraft system, we had no objection to it. And we would like to have had more repeaters, a repeater at every single workstation that required time sequencing, for instance, around the SAL and things like that so we didn't have to bring wristwatches to do that work. But it's the portable timers and the event timers that we had to work with that were just terrible.

QUERY What if these displays had - had a stopwatch type of thing built in so you could hit them, would that have been - -

POGUE That'd be real nice.

CARR That's the sort of thing we were looking for.

POGUE And another thing is that a lot of times it's very difficult to set a clock for a key mission event. If there's some way - For instance, if you had one of these repeater stations, you can dial in to GMT and say down to or up from, and push the button. Then you start your display - in addition to the regular repeater, then, you have a display which starts counting down to this key event.

CARR It's kind of like a sports car that's got an odometer but it also has another little odometer right under it that's resettable each time.

POGUE Like when you fill the gas tanks up.

CARR You need that feature in a clock. You need the feature where you can say whether or not it's more convenient for you to count up from zero or count down from a number. And if you're counting down from a number to zero, you need also some time specified whether you want them to keep on counting on down, whether you want it to stop when it gets to zero, or whether you want it to start counting up again when it hits zero.

GIBSON We'd like to be able to reset the counter also very easily. We had an event timer on the ATM that was just atrocious. To reset it to a new number, you had to adjust each digit independently.

CARR And each one of them, each - it took a second each time for the digit to count. So if you were looking at 9, you'd wait, you know, holding the switch and waiting for it to count. If you missed zero, it would jump to 9 again and then you would have to hold it some more. It would be

CARR (CONT'D) much better if you could just flip in the dials and punch a button and it transfers it from that into your time register.

GIBSON Because of the problems with that portable timer, I only used it as an alarm clock on occasion. I never used it otherwise.

QUERY Yes, the previous crew said the same thing. Just to warn them that something had to be done.

POGUE Yes, that's right, general warning, not an accurate warning.

GIBSON Strictly an alarm - strictly a wakeup alarm clock. If I had had an operator I could have left a wakeup call with, I would have preferred that.

POGUE Some of the systems management I used it on, because you had to set things and wait 30 minutes, wait an hour, wait 2 hours, and that was handy in that respect. I tell you, I never did trust it because of the problems that I had with it. Another thing, too, is that you could not set - you could not depend upon that thing going off and ringing a buzzer within a minute of the correct time because there was a way of setting that second hand and that minute hand so that - that when that thing got to zero,

POGUE (CONT'D) it took another minute before it actually sounded the alarm. So I never did trust the portable timer for accurate timing at all. It could be at least a minute in error.

CARR Surely somebody's got the ingenuity to invent a timer that can be used accurately. We're just too hung up with getting things off the shelf.

QUERY That's right. Are you using something from a previous program?

CARR Yes. Okay.

WIGGINS The next questions I have are to do with audio, and you've already said quite a few things about the system. And we just wanted to get some general data like when you had this antifeedback network in the system, did you notice that you had to get closer to the SIAs to get good intercom or downlink? Did you notice that distance change?

CARR I don't think the distance was as large as people thought it was going to have - the change was as big as people thought it was going to have to be.

POGUE As long as you got to put your finger on the button anyway, it didn't make that much difference - the switch.

QUERY Even at arm's length you could still?

POGUE Well, you know, why be at arm's length? That's why it didn't make any difference. As long as you had to reach out and push the button, you just might as well be a little bit closer. We didn't even notice it. I didn't.

GIBSON A couple of times at the ATM, though, we were at arm's length and they could still hear you on the ground. I had a couple of calls that you couldn't hear too clearly, but - -

POGUE Yes, I guess that's right. But it sure wasn't as bad as the feedback.

(Laughter)

QUERY Yes, I adjusted those in the OWS mockup to come down here. That's quite a lot of twiddling.

QUERY I noticed in the TV that - it looked like sometimes you'd be hitting a switch and talking to the ground - that you were all 8 to 10 inches from the speakers usually when you talked.

GIBSON The whole thing of the use of those input stations - first of all we needed a very good microphone, several good microphones, not just the headsets which we had left -

GIBSON (CONT'D) we pulled out of the command module. But I don't know, we'd go out to any small town across the countryside and they've got these things here which work at this distance. Why we couldn't have something like this up there, I'll never know.

CARR Or the TV announcer's got one that he can stand out in the middle of Hurricane Carla and talk with, it's the ball with a little black sock over the top of it. He just doesn't need shouting. Here we were up there with these little mikes with the hole in the end of it trying to talk, trying to keep it a quarter of an inch from our lips and that's ridiculous.

POGUE What are these - everybody keeps telling me that you can't use these remote mikes, you know, with no wire on them at all. What's the problem there?

QUERY You can use those.

POGUE Well, why in the devil can't we get them? Because if the plumbers can use them - ...

QUERY ...

QUERY McDonnell made a pitch for putting them in there, and we couldn't sell it. So maybe the next time it'll go through.

GIBSON Well, you ought to put them in there because I'll tell you ...

CARR We ... strong operation on the tech debriefing.

QUERY Yes. Well, we read it; you didn't leave much in doubt.

POGUE Shuttle needs that.

GIBSON They sure do. Any time you're working on a panel and you'd like to describe what you're doing, you got both hands full and you don't want to wear a headset for a long period of time; you've got no choice. You really need something like that. We had many occasions like that where we were trying to describe what we're doing and there was data just flat lost.

QUERY We had a microphone, the other thing is programatic, but we were so pound conscious on the last thing. And we threw the mike off, and it's sitting there at the Cape. It's pulled out of the locker.

CARR Yes, we were - we were aware of that. We felt very badly about it and we protested. But there were just other things that people felt were more important to be sent up. Okay.

QUERY The next question is SIA number 131 that failed, and we didn't get to bring it back to check it out. And

QUERY (CONT'D) what we'd like to find out is some operation when you were checking it, you know, malfunctioning - checking the SIA. When you hit ICOM with the transmit, did you notice a speaker mute? Did that work properly? You know, when you lip up, it kills the speaker on the one you're using. Could - could you ... answer any questions like that?

GIBSON Oh, boy.

CARR That's so long ago, I don't know how we could.

QUERY How about the - -

GIBSON I'd have to go back to the voice transcripts and try to dredge up anything out of memory.

QUERY How about the switch, is it the same thing? Could you feel the tension? Could you hear it click?

GIBSON The switch mechanically seemed to - -

QUERY I noticed in the transcripts you could hear it key. So - -

GIBSON Mechanically it seemed to function all right, but just what audio cues you got with it, I can't recall.

CARR The only significant thing about 131 that made it so unique from the others is Ed had his comm umbilical connected to that thing all the time, and his little

CARR (CONT'D) kludgie microphone made out of a CCA was there. That's the only - that's - the only difference of the SIA with all the others is this thing had the CCU and CCA on it almost continuously. And it was being moved frequently from channel A to channel B, and I don't know how you can figure that into the - factor that into the situation. But that - that box had more CCU work than any other box in the - in the - -

GIBSON Yes, and talking about connectors being made and broken, gee, we used to take - I personally, about a half a dozen times a day, would change from channel A to channel B and back again, depending on whether you were ... going up to talk air-to-ground or talk with - on the tape recorder. So that really was a high use. And those connecting - never had a ... pin failure there, and they all worked great.

QUERY You know, you remember solving this ALC bypass cable to get rid of this 6-hertz oscillation on channel B.

CARR Yes. I was the one that did that.

QUERY Okay. Did you have any particular problems with the installation of it?

CARR No, I didn't. I only needed to use 1 CCU because the CCU that I used just worked perfectly. And what I did is, on the side of the box that the recorders are in, I took my hacksaw and my Swiss army knife, and I cut a notch in the side of the fiber glass. And when you stretched out the CCU, it had very mild tension on it. It was a straight shot from the SIA in the dome to that thing and the inside of the - the back shell just fit in the slot. It just - It was just a perfect fit. And so then all I had to do was go along with some gray tape and tape the CCU down so that it couldn't be kicked and stretched. And then the - Of course, the ALC bypass system was all put inside, and I got it pushed down and - and routed in order to minimize sharp bends in the cable and all of that. It was a very easy setup. No problem at all.

QUERY We ended up pulling that back out, though, because - -

CARR Yes, you did, because it apparently put an impedance in the system to where we weren't getting good voice recording any more.

QUERY Right, when you are trying these - -

QUERY Do you guys have something that you need to do that's time critical?

CARR Not until 3 o'clock. We've got to be someplace at 3:00.

QUERY We've got about two more questions; then we'll be through.

QUERY When you install this cable, you run a test where you recorded on tape recorder 1 where the cable was installed and used a normal system to put the voice on 3. Could you - Do you remember how close you were to the mike when you ran the test, what the - -

CARR Yes, I didn't change my mode of operation. My normal mode of operation was to be between 2 and 4 inches away from the mike.

QUERY I think where the problem was was back at the ATM; we started missing. I believe I remember that. This arm's-length operation, that's when we put this bypass in and it just wouldn't work there. We would miss those calls.

QUERY When we ran the tests, it worked beautifully; you know, when you were close to it. But it just wouldn't work at arm's length.

QUERY The last audio question I have is the one about problems of that configuration of the SIA. And, if you don't mind, I'll read from your technical debriefing. It says the same thing for the intercom, so you'll know that

QUERY (CONT'D) you're configured properly. "A lot of times we would spend maybe a minute, have to go off and configure other SIAs to verify that our comm box was configured right." Could you give us a more exact description of what you're talking about there?

CARR Well, I think the big thing there was somebody might use channel A for recording somewhere and then walk off or float off and leave the channel in A. And then somebody else would come up on A and flip it on to talk and you would get the feedback whine. Another problem we had was Ed's microphone up in the ATM; he was in the habit of using ICOM/PTT on that.

GIBSON Initially or - -

CARR And then he would hang that thing up and put it down, and you'd get all the rate gyro noise going into that hot mike. And then some guy down in the workshop would turn on channel A to start recording and you would hear all that hot mike noise. And that took time, to go correct the situation.

GIBSON It turned out to be much better later. I just left it on PTT and used it in that mode all the time, and it worked very well.

CARR But those are the kinds of things we'd have, where you would turn on a channel and get ready to record something and you would hear spacecraft noise somewhere. And what that meant was somebody had a CCU hooked up to channel B and it was in ICOM/PTT. And the two places where it happened the most we were at the SAL where you were doing data, and you wanted ICOM/PTT or up in the ATM. I don't mean ATM but MDA - two places up there. Either at the ATM panel, and usually right after an EREP pass, somebody would end up having to go up there and disconnect the headsets because either Bill or I would go off and leave it in ICOM/PTT.

QUERY Did you ever use the call switch on the box?

POGUE Never did.

CARR I did once or twice by mistake snatching for the switch and - -

QUERY Did it work all right?

CARR Yes.

POGUE There is another case where - that validates that comment. And that is, a lot of times or occasionally you go in a sleep compartment to do some recording, turn on channel A,

POGUE (CONT'D) ICOM/PTT, do the recording, go back, leave it on. See; leave it on channel A, and some guy going to work in the wardroom and getting ready to put some stuff on recording and taking photographs and he'd get this terrible feedback established. That was a bad one because you'd go all over looking for that hot box, and I tell you, that system - we got to come up with something better than that; that is bad.

QUERY Okay.

POGUE It's disconcerting, and you're just wasting an awful lot of time.

CARR If there is some sort of a feedback baffle that you could put out in front of -

QUERY We tried that. The only way you can do it is put your hand over it and push down, kill it. The mikes were too sensitive.

CARR All of that could have been solved by having a separate tape recording system that we carried on our person. And there is nobody to interfere with you that way.

POGUE It was instigated by a recording operation of some kind or another some place.

CARR And all you would have to do when you are at a given workstation and you've got to record what you are doing, you could just take a jack plug and plug it into a position at that workstation and put TRS data on your tape and then just talk. When your tape was full, you'd take it and put it on a machine and signal the ground with a lever or, you know, a switch that there's a full cassette sitting on the dump mechanism, and they can dump it. When they are through with it, they can light a light on the thing that says the tape that has been sitting here has been dumped and is ready for reuse. And that way you get off all that feedback problem and -

POGUE One of the things that I found very inconvenient about the SIA design in general was that you had the same switch for TRANSMIT and INTERCOM, which is fine if you're addressing the SIA in the one-g preferential posture. If you're trying to use an SI which was mounted above the ergometer, we were always hitting the wrong position in that switch. And this is why in the tech debriefing we suggested there be a separate switch, one for TRANSMIT and one for ICOM. And also the fact that the switch should be designed for zero-g operation. There was actually - It took enough force to hold that switch in

POGUE (CONT'D) position, you'd end up torquing your body around a lot of time. You would hold against the little side guard. You would actually hold that, and with the two fingers, you would end up moving your body around as you were talking. And this is the second reference I'll make to Popular Science in our debriefing, but my kid takes Popular Science Magazine, and they have a button in there - These were NASA tech briefs put in this little magazine now - This was an omnidirectional button which I thought I had invented in flight. But NASA's already got it in a tech brief, and the fact that you can move this button from any angle - all you got to do is touch it. Mine was a little different; you could pinch it from any direction, a ring-type button. But I would much prefer something like that so that you can approach this SIA from any direction. And you could reach out and there is no - you don't - it's not - You don't have a question in your mind as to which way I move that switch. You just pinch it on the ring or push the little knob.

QUERY That's all the questions I had. I'll turn back over to Jack.

QUERY Okay, I just had a couple of concluding questions on the instrumentation system, specifically concerning the OWS.

QUERY (CONT'D) I believe on mission day 25 you had difficulty determining the correct position of the EXPERIMENT 2 TELEMETRY MODE SELECT switch on the OWS C&D panel? I think you had to count the clicks or something to really know where it was set. And I just wondered if - if there was a significant difference in the indicator knobs between the EXPERIMENT 1 and EXPERIMENT 2 switch; there must have been?

CARR Well, yes. The knob was getting loose on the shaft is all it was. And if we'd kept on working them without being able to get in there and tighten the knob on the shaft, sooner or later it would have sheered, and you wouldn't have been able to do anything with it. And EXPERIMENT 1 was little looser than EXPERIMENT 2. But EXPERIMENT 2 was beginning to loosen up, too.

QUERY Oh, I thought it was EXPERIMENT 2 that was really loose?

POGUE It was, Jerry.

CARR Was it 2? Okay. One - The real loose one was the one we complained about and then the other one was not as loose but getting loose.

POGUE It certainly was ambiguous. Several times I went all the way back to OFF and counted the clicks because it registered right halfway between.

QUERY It was halfway between the marks then - is where, and you didn't know which one you were on?

POGUE No. Fortunately I think you came along and said don't change it; just always leave it 2 - -

QUERY Leave it in position B - -

POGUE Yes, B.

GIBSON That was confusing. We lost a little bit of data, I guess, because of it.

CARR But if we'd just had a tool where we could have gotten in there and tightened that thing on the shaft again, we would have been all right.

QUERY Yes, well - -

CARR That was pretty inaccessible.

QUERY Right. The tests showed that there was supposed to be plus or minus 7 degrees of play in the shaft, and you'd feel that on the knob. But apparently you had a lot more than that, because between the marks - you had

QUERY (CONT'D) something like 25 degrees between the positions there. So if you were just plus or minus 7 degrees, you would have know where - where you were; so if there were some other loosening back connected with the shaft there - That was a pretty complicated switch back there too and it was inaccess - unaccessible to tighten anything. There was a setscrew on the front that could have been tightened, but did you actually - -

CARR We saw that setscrew, but it didn't look to me like you could get an Allen wrench in there to do it.

QUERY Okay.

CARR See the whole thing was kind of recessed slightly and - -

QUERY Yes, yes. There was some procedure that the contractor came up with. I don't know whether it ever was uplinked but - -

CARR No, it wasn't.

POGUE Another example though where you have a feedback to tell you what you actually had selected, mechanical feedback is the greatest. I mean, if the switch had worked right, that would have been fine. But it's just another argument in favor of having a feedback to verify that you have

POGUE (CONT'D) selected what you want to select. Whether it's worth the trouble or not depends on what data you're working with I suppose.

QUERY Okay; well, just one final question. Were there any problems with the I&C system that haven't been discussed?

POGUE I think we hit that pretty hard in the technical debriefing.

CARR Yes. I can't think of any other areas.

POGUE Instrumentation and comm.

CARR We haven't made a big thing with you today about cassette TV and up- and downlink capability, but it's in the technical debriefing and we verily - -

QUERY We've read that and - -

CARR We also made the same pitch to the managers; we're looking for support in that area. I don't think we need to spend any time - -

QUERY One comment on the cassette TV: That was looked into pretty hard at the time we were trying to find the video tape recorders. And the design and the development at that time wasn't along - -

CARR Yes, it's - -

QUERY We couldn't commit a program at that time because it was just too - We would have had something like that for the video tape recorder. Actually the video tape recorder, we think, turned out to be an excellent machine; it was bulky, it was large. And you - -

POGUE Yes, we had the room.

QUERY Yes.

QUERY You carried up some pieces to fix the other one with, that had a failed part in it, but we never used that either. But I think that cassette TV would be - -

CARR Very, very powerful tool to be used in the future, I think.

QUERY Thank you very much.

GIBSON Thank you.

POGUE Can we get faster than real time though?

QUERY Well, that's a real problem.

POGUE Okay.

QUERY It's taken so much band width, it's going to be a problem through the relay satellite, too, to get that stuff faster than real time.

QUERY Okay, Jerry, we need to do a little planning here. You need to leave here at a quarter to 3:00, you said?

CARR Yes, that's about right, yes.

QUERY Harold, about how much time do you think you'll take in the structure and mechanics?

QUERY About ...

QUERY Say again.

QUERY About 30 minutes.

QUERY About 30 minutes, and Charlie in the contamination, about how much?

QUERY I'd say about 20.

QUERY 20. Okay, if we double that, that's about (laughter) - What do you want - How long do you want to take for lunch then, Jerry?

CARR Well, let's see; looks like we need about an hour and a half, probably, to dedicate to getting the work done

CARR (CONT'D) this afternoon, and if we want to leave at 3:00 - at quarter of 3:00, that's quarter of two -

QUERY 1:15 would be an hour and half.

CARR 1:15 - an hour and a half from now. I think that's reasonable. 1:15?

QUERY 1:15.

CARR We can even get some exercise in that much time.

GIBSON Sure.

QUERY Okay, we'll pick up again at 1:15 promptly.

Afternoon Session

QUERY Okay, we're going to pick up the stuff that's in the mechanical area, and Harry Smyly from Marshall has the questions; so I'll turn it over to him.

SMYLY What I'd like to do first is to start out and see if I can get some more observations that you made when you were outside the vehicle for our materials evaluation. On the ATM ... that's ... side, did you see any deterioration in the form of blistering, scaling, discoloration, or anything like that?

CARR On the solar panels?

SMYLY On the Sun side of ATM.

CARR On the canister part?

SMYLY Right.

CARR No, I did not - did not see any blistering. A great deal of discoloration was seen. Some of it was - showed indications of a shadowing, like the foot restraint and the shadow of toe. The part that goes over the toes on the foot restraint was - could be seen down lower in the

CARR (CONT'D) paint. The color that's on the zero-g fixture plate - the fixture cover that we brought back, if it hasn't done any changing, is the color of the entire Sun end of the - of the ATM canister.

SMYLY So that's a good - -

CARR Sort of a beige.

QUERY That's the zero-g plate.

CARR The zero-g plate - that's 5-, 6-inch diameter. We - I sort of mousetrapped on that one. I doggone near lost that son of a gun because nobody told us in the description of that plate that there was 2 inches of foam or whatever that material was behind that, and when I was trying to pry that thing up, it just didn't come up like a flat plate. And then as I got to prying it up, I realized there was more behind it. And one time as I was prying, it flipped. And I caught it in midair, or it was on its way to retrograde. But I did - do not remember seeing any blistering. And I do remember that when I got to the screws that are - that are - holding that plate down, I dug in the paint. I dug the paint out of the slots in the screws so I could start the screwdriver. And I could

CARR (CONT'D) see that the paint was still fairly white underneath, that the discoloration was a surface discoloration. It didn't penetrate too deeply into the paint.

SMYLY Well, did you notice that any of it would smear or rub off with glove, rather than with the metal screwdriver?

CARR I saw no indications that it would smear off. As I mentioned before, I - I did scramble around on the front of that thing on the last EVA in order to get pictures, and I essentially went across to the other side of it where there were no restraints of any kind and hung over the side of it, took pictures of the command module. And when I went back, I saw no indications of the scrambling that I had done and the places where I had already touched it with my boots and things. I saw no indications of smudging at all, which to me indicated paint discoloration more than a film - -

POGUE Surface contamination.

CARR Surface contamination.

QUERY So it did look different from what you saw down around the CSM.

CARR Yes. It all looked the same color.

QUERY About the same color?

CARR I shouldn't have said yes so quickly. It - it didn't look any different. The contamination was about that color too, and it could be that the contamination was in the roughness of the paint. You know, the paint on the Sun end is quite rough and doesn't lend itself too well to the kind of smudging and smearing that I think you're driving at. The paint is - was almost as rough as the stucco which you see in walls - the plaster you see in the walls around here. It's a very rough paint.

SMYLY Did it look uniform, other than for the shadows?

CARR Other than the shadows, it looked very uniform.

SMYLY While in that area, were there any indications that the seals on the doors stuck if you tried to open them?

CARR I saw no indications of it; however, the 82B door did stick. And it appeared to me that the reason for the sticking was not so much for the seals - due to the seals, but due to a warping of the door hinge itself.

SMYLY Yes.

CARR I tried to open that door on a dark-side pass, and it flat would not open. And so what I decided to do was just wait until the Sun came - Sun came out and then give it a chance to heat up, and hopefully the door would warp it's way back. But you could see the - Looking at the door - It seems to me, the door looked something like this. And this was the hinge line, and if this - this dimension here being narrower than this dimension here. And the - there was a hole here, the aperture. Actually, I guess it was in further, more like this. It looked to me like the door was caught. The hinge was cocked in this direction so that this corner of the door was jammed into the aperture or the sill, you might say, that the door closed in to. There was nice, wide tolerance all the way up here and around this corner, and it looked fairly wide here and got narrower and narrower to the corner. And it looked like the door was warped down into that corner. Now when we got to the Sun-side pass, I saw no indication that the door warped back. But once I did give it a little time to warm up, I was able to open it. But during the dark-side, I actually put my hand in here and pulled on the door a few times, because, you know, the locking handle is back here. I figured I got more leverage, more distance from the hinge line, by pulling here, and even

CARR (CONT'D) that didn't do any good in the dark case. But once we let - It warmed up, and what we did was - As you're looking at the Sun end of the ATM, the foot restraints are here. That door, for the normal case when I was opening it, was - was like this. And it seems to me, the other - the other door was about like this. This was the A door, and this was the B door, as I remember. And this door was at my left hand, which is my weaker hand, my weaker arm, and about here for pulling. Now what happened is, as we were waiting for the Sun to come out, I had Bill rotate the canister around so that the B door was right in front of me. And that improved the leverage situation, I think, because I was able to pull this way with both hands instead of just with my left hand over here. And also the fact that we put it in the Sun. You got two factors which probably helped us to open it. But looking at the seal, I saw no indication of the seal getting sticky or anything like that. It looked to me like a structural abutment right there at that corner, the fact that it was just warped right into it.

SMYLY Did you make any observations on the sail that would indicate deterioration, or the PBI ropes?

CARR I could look at it. I could see that it was still intact, slightly discolored. PBI rope looked faded. I'm trying to give you an example down here.

SMYLY You mentioned that there was a fold that had opened up.

CARR Yes, there was a fold in the twin-pole sail that had opened up, and we got good photography of that that shows you that. And it opened sometime between EVA-3 and EVA-4, because on EVA-3, when I was out at the Sun end, I looked back and could see no - No, I wasn't at the Sun end on EVA-3; so it happened between EVA-2 and -4. Wait a minute. Didn't we bring 149 in on EVA-3? Yes; so I was at the Sun end of EVA-3.

POGUE Yes, yes. Right.

CARR But I didn't see the open fold on the EVA prior to the one - to the last one. And then on the last EVA, I looked out there, and I was taking movies. And there was this fold open with a nice white area, and all the rest of the sail was discolored.

SMYLY What about the flag? Did you make any particular observations there?

CARR The flag?

SMYLY Yes.

CARR You mean the one on the - -

POGUE Docking end.

CARR - - docking end?

SMYLY Right.

CARR Yes; I saw no significant change in color there.

POGUE There was yellow around it. I didn't notice that the white in the white stripes had changed any - not as much, it didn't seem like. Of course, that doesn't get quite as direct Sun, either.

CARR Yes.

SMYLY What about the multilayer insulation in the forward OWS bulkhead? Did you notice anything there?

CARR I didn't.

SMYLY Did you notice whether any of the SAS diodes were cracked or looked like they may be coming loose from the potting or missing or anything like that?

CARR I looked at that fairly closely, and I could nave gotten a closer look at it if I'd had time to really go look at

CARR (CONT'D) it. But from the area where I was looking, it looked very much intact and very much unchanged. I saw no indication of any warpage or anything like - that might indicate that.

POGUE Are you - You look at the bottom of the SAS panel, you have this sort of funny looped-wire pattern, you know, where it apparently goes out and connects up with separate little strings of solar panels. Now is this what you're talking about? What would be evidence of what you're talking about?

SMYLY I'm speaking of the little diodes on the panels that absorb the rays themselves.

CARR Little 3/16ths by 1 inch.

POGUE Yes, those are tiny little things. What would you notice when one of them peeled up?

SMYLY Well, it would look like if they weren't uniform flat or any - -

POGUE We had some very good coverage on the flyaround, and there's enough highlights and sunglint on those panels that you ought to be able to pick it up if there's any problem with it.

CARR I also got the 16-millimeter stuff and some Nikon pictures of those panels, too.

SMYLY Okay.

GIBSON I looked at those also, and they looked pretty good. And I could never notice anything by eye. I always marveled at how uniform they did look.

SMYLY Okay. Were there any significant events that we left out that might support in evaluating the specimens - the two sail materials or the airlock ... seal specimen or the zero-g protective cover? Was anything significant in the way they were handled or that might help us?

CARR No, we tried to stay away from it as much as possible while they were out there. Let's see. You included in that the sample that we took off the airlock, which I cut off of the airlock hinge?

SMYLY Yes, if you have any comments on that.

GIBSON The only thing is, I tried to get another - I would have liked to have brought back another one which showed the effects of a light protector. You know, the little wire protectors that surround the lights we had outside. The shadowing of that was just - stood right out against the - the background of the type of materials we brought

GIBSON (CONT'D)

back. You can see the imprint of that, if you will, right - very clear, and that wire was only, you know, very thin; so the shadows are very sharp up there. And we only gave you one - one edge where we actually had a good shadow, and I think that still stands out very sharply. I'm not sure whether we were able to get any pictures of that one little effect of the shadowing of the light fixture. I would have liked to have brought it back because it's just interesting to look at, but there was just no way of cutting - cutting it out - -

POGUE

You know why one of the - This is certainly not personal. One of the fallacies of this type of question is, the time at which you're most sensitive to these unique events, like this printing of the shadows, the light guard on that, is when you first go out. On your first EVA you go out there, and you're just like a kid, you know. And it's at that point that your curiosity is peaked, and - you know - it's all over the world. Man, these questions - You could answer all these questions then, if you had them ahead of time. And now thinking back, it's awful hard if you try to remember, because you get jaded to it after an hour even.

CARR In handling the micrometeoroid shield, though, there was nothing special we could do with it while we were in the suits. But as soon as we got out of the suits, we rolled them up with the outside on the inside. I rolled them up and taped them. And I think that's the way you got them back, was with - the way they were rolled up, taped, right after the EVA, so that all the exposed area was inside and the part that we touched with our hands was what was inside the meteoroid shield, on the inside there. The - What was the piece of aluminized Mylar that was on the strut near D024, that I think the SL-2 group put out? Was that the SEVA sail sample? I tell you, we had so many sail samples there, we lost track of what was what. And when it came stowage day and they would tell us to put the parasol sample here and the SEVA sail sample over here and this sample there, I couldn't have told you for the love - life of me what was what.

QUERY I don't know what order they were in.

CARR But if you showed me the sample, I could tell you where I got it.

GIBSON Have you done any analysis to see what material was coated out on all that?

SMYLY No, I tried to get that the day before I left. It is still in the lab, and we didn't get any results. I tried, also, to get something on that coating and - -

GIBSON We had that on the command module windows. And we had the question this morning, "Was that RCS or - just where was it from?"

SMYLY We'd like to get some samples of that. We don't have any samples of that coating at Marshall, and we would like to get some.

GIBSON There must be some of it on the samples we brought back.

CARR Yes, it's got to be on those surfaces.

SMYLY There's some here, but we haven't got any there.

QUERY You're talking about - You're talking about something like that zero-g fixture, maybe, from the Sun end or the sail samples or something like that.

CARR Well, I think all over the whole place.

POGUE It almost looked like something was water soluble. It's already been mentioned. Probably a complex effect.

SMYLY What you are mentioning here sounds like it's very similar to the discoloration and the shadowing that was on the

SMYLY (CONT'D) camera that - I believe it was Apollo 11 brought back from Moon, the old Surveyor camera.

CARR Just strictly ultraviolet discoloration then.

GIBSON That's what some of it is, but ... on the command module windows was not that ... If we saw it on the command module windows, it must have somehow got over the rest of the vehicle, too.

SMYLY Do you have any - Excuse me.

CARR Go ahead. I was going to say that's the problem. That's what desimplifies this whole thing. And that is, we lay there in the command module on the water and watched contamination film on the window get washed off.

GIBSON Also, the part which was shaded up there in the airlock still had the tan color to it, not anywhere near as dark as that which was exposed to the UV; so there was really two effects going on there - one of the coating and one of the sunlight.

CARR I hate to complicate your life, but.

SMYLY Do you have any comments on the performance of the ergometer - from a mechanical standpoint?

GIBSON Other than the fact that I wish it could have taken a higher heat load, total heat load, because that constrained our operation sometime. I don't think any one individual any one of us ever ran into the problem, he alone starting from scratch putting too much energy into it. But we'd like to run consecutively, and sometimes we were constrained; we couldn't. I'd go put 8000 into it, and Jerry or Bill would hop on and put in 6; and that would be about all it could take.

POGUE The pedals, also, you've already mentioned in tech debriefing. Be nice if you could grease all the moving parts without having to work into them with a toothpick or something like that. We never felt like we really got the Krytox in the right pedal - into the right-side pedal.

SMYLY We learned pretty early that one of our mistakes was not designing for maintenance.

GIBSON One thing, I think that we all found that we tend to ride at a higher rpm up there. And I was continually bumping against 80 and maybe a little above 80. I would like to have had the capability of reading out and having it operate, say, up to 90 or so.

POGUE Without any constraint, too. I can't see that that should make any difference. It's just the way, I think, it turned out.

GIBSON I don't think anybody ever worked on it as low as 40. Down here on the ground you sometimes do, but up there you lack the weight and also being able to exert a pull on the upstroke; you just go the higher rpm.

CARR Seems to me all of us were about - riding about 10 rpm higher up there than we were down here.

SMYLY After you reserviced the airlock module coolant system, did you ever go back and inspect that saddle valve to see if there was any indication of leakage or seepage around it?

POGUE Yes, sir, I did. Many times.

CARR I did, too.

SMYLY You noticed - -

POGUE Nothing. I tell you, if you ever get anything like that again, we need more protection. This just goes to show - This is a good example of why you've got to over-protect. The thing was protected well enough in normal traffic. But we started taking photographs out of the

POGUE (CONT'D) STS window. And you'd go up there, and you'd get up there at night, turn all the lights out. And you'd be in there thumping around - you know, kicking and thrashing trying to get the camera in the right position to take a picture of the comet, and suddenly be aware of the fact that you were on top of that plate. So I checked it many, many times, and never did we disturb that plate. But once I got out of there, turned the lights back on and - in the MDA, and I just about had a heart failure because I looked up there right where I'd been and that's where the saddle valve was. And - -

CARR Of course, the thing is, if we design our systems in the future - I hope somebody's listening - for maintainability by the people there - in order to get your reliability - by having component replacement capability and module replacement and maintainability capability, then you wouldn't have things like saddle valves sticking up that you had to worry about.

SMYLY I'd like to discuss the shower a little bit. There toward the end of the mission, the power module, one of you said it sounded like it had water inside. I assume that it wasn't running at that time. Did you check the circuit breaker?

CARR Oh, yes. It - For a while it would try to run. You could hear it humming in there and trying to move the rotor - I assume there was a rotor in there - but it couldn't get up to any kind of speed.

SMYLY So you did run at the low speed.

CARR And then finally, after we kept fiddling with it, trying to get it to run, we let it dry out real well and tried it again. It was frozen up solid then.

POGUE Yes. I started trying to dismantle the vacuum cleaner, and that was bad news. That brings up a couple of points. One is that we got water irretrievably trapped in the vacuum cleaner, which suggests that you ought to have - The vacuum cleaner bag itself was a good trap, but it didn't protect the vacuum cleaner from a deluge. There ought to be some way of getting in there and getting the water out. I think we could retrieve that vacuum cleaner, but it was potted. The joints were potted and everything else. You know, you just can't take one of those apart very easy.

SMYLY All that was done because, you know, it had low suction anyway and we were trying to cut down on leakage and improve the performance.

POGUE It could stand all the improvement you can give it.

CARR Okay. It just flat died on us. And that filter that's supposed to protect it did not protect it well enough because we frequently after a shower would check the filter, and after just one guy showered, the filter would have three-quarters of it full of water.

QUERY Three-quarters.

CARR And sometimes it would have no water in it. But on at least two occasions, I checked that filter, and it was three-quarters full of water. And on one occasion, it was full.

POGUE Okay. The next question I'm going to ask, Jerry, is, Did we follow the sequence in the checklist? And the answer is yes.

QUERY Now the question I'm going to ask is, Did you ever use any of the Neutragena soap in the shower?

CARR Yes, when we ran out of shower soap, the last couple of showers.

GIBSON And that didn't make any difference.

POGUE Well, it can.

CARR Now you were saying this Neutragena soap would foam.

Oh, yes. And when it foams, then you pump foam into your bag. Then you get water in your filter. And the Neutragena soap will wet the filter and cause the filter to pass water. That's the way you got water in the power module. We feel that filter is good for about 10 minutes with the Neutragena, but it's good for maybe 10 hours with the Nairanol.

POGUE Well, that's a possible explanation of the problem.

CARR Yes, except we were having full filters before we ever started using Neutragena.

SMYLY The filter's good for 2 hours with the Naironol.

POGUE We only used Neutragena one time. We used it for one shower. And I got in and got ready to take a shower and turn everything on, and nothing was working. I had to get out and take a sponge bath.

QUERY But another thing the Neutragena does is, it stops up the little orifices in the collection box. And then you can't collect at all.

POGUE But if it had enough shampoo to fill a volume - Yes. But those big hypodermic things are way overdesigned. If we'd just had the volumes we devoted to them for the shampoo, we'd have had plenty.

CARR Yes. Boy, those were really overdesigned.

SMYLY In the collection hose, now, we understand you had problems picking up the water and the other crews did, too. Did you ever try taking the little collection tool off and just using the end of the hose?

CARR I don't think that would have been any better. What you needed was a nozzle - a rubber nozzle would have been good - something that had a narrower mouth on it and maybe was longer and was flexible enough to contour to your body better. But the thing was, you just weren't getting enough suction through that thing and - since it was a metal nozzle and you didn't have much contour to your body; so the only way you could go around your arm was this way, and - -

POGUE They were staggered, too. The lips were offset, which made it harder. And something else in that. It was really sort of hard to get the water off the side of the shower. You'd listen; you could hear the guy in there going around and around and around with that thing, trying to - You'd try to scoop it, and that wouldn't work. You'd think that you'd use it like a scoop shovel. And then you'd try it flush, and then you'd try a blower load up. It didn't work too well.

CARR But while it ran, it was sure nice to get in there and get water all over you and then get yourself cleaned up.

QUERY What was the use frequency?

CARR Once a week.

QUERY Did each of you use it about once a week?

CARR Yes. Once in a while one of us would skip it because of maybe a time consideration or something, but that was about it.

SMYLY Well, was the shower separator - Did it seem to be operating normally at the end of the mission?

CARR We had a little trouble with the switch. There near the end, you'd throw the switch and nothing would happen. And if you just moved the switch a couple of times, it would work. And it looked - Maybe we had an open or something in the switch. It didn't seem to have anything to do with the separator because a couple of times I'd throw the switch and if nothing happened, then I would hit the separator a couple of times to see if there was something in there that needed to be jarred and that worked fine. And finally, by just cycling the switch hard, taking the switch and really banging it down to off and then back to on again, it would start up; so it indicated to me the switch contact just wasn't making it.

SMYLY The washcloth squeezer - Now you rebuilt, reserviced that early in the mission. Did it seem to deteriorate any more through the mission?

CARR No, the ... seal worked real well. It seemed to squeeze the water out. The reason why we changed it is just because of the odors. It just got dirty, and we cleaned it up and put a new squeezer bag on it to collect the water and hope we just could eliminate as many sources of odor as possible.

POGUE On the washcloth squeezer itself, it should be as smooth - with few convolutes, angles, and so forth - as possible to - because it picked up all kinds of crud in there.

CARR Oh, it was awful with all those mechanisms.

POGUE Angle irons, 90-degree bends, and all that. And fine work in some places.

SMYLY Mechanically, it was - it did survive the use.

CARR Sure did. Yes. But we recommended in our tech debriefing that things like the urine drawers have shrouds or areas that are difficult to get in and clean, that they be filled in say, with foam or something, and then painted with a slick paint or something so it would be easier.

CARR (CONT'D) cleaning. And the squeezer is another example of a place that's difficult to clean, that is a collector of bacteria because of your wash water. Something like that should be designed in the future to have as few crevices as possible and be as easy to clean as possible.

QUERY The ice buildup problem you had on the freezer doors, did that tend to increase in frequency as the mission progressed, or did it seem to remain constant?

CARR I think that the frequency with - we had to clean those doors was about the same; so I don't think it got any worse. But once it got started, it really had an acceleration time, didn't it? It seemed like it accelerated. Once you got a little bit of ice around the door that opened a little crack or something, it really got big fast. And we ended up - Between the two doors, there seemed to be two paths, just vertical paths between those two doors, and you'd build a ridge of ice there. Once that ridge of ice got developed, the doors very quickly got hard to operate. Of course, when you couldn't hardly open the door, you knew it was time to clean the ice, because latch frictions were immediately - they'd go up exponentially just like the ice.

POGUE One thing that aggravated the problem, too, was that little inner door. You know, you had the big door, and then there was a sort of inner door that opened with straps. That thing was really an irritation - to work around that. You couldn't really properly clean it. The thing was - looked like it had been designed with some kind of spec guarantee that there ain't going to be no frost formed.

QUERY Let me explain why the front of that door is there. I saw your comments from the tech debriefing. The doors don't have coils in them, and that little inner door is the heat sync thing to transfer the heat to the outside walls to keep from having the heat short through the door.

POGUE They ought to be removable.

QUERY Well, we think - -

CARR Yes, it was hard to get behind it.

QUERY If we do it again, I don't think we'll have that door there.

POGUE I guess that was really the main thing; just that and the fact that we didn't have a proper tool for removing the ice.

QUERY Was there any other mechanical equipment that we haven't mentioned here today that seemed to become more difficult to operate or deteriorate in performance?

CARR Yes, the trash airlock.

QUERY The trash airlock? Would you comment further?

CARR We never were able to work that as a one-man operation. We had to use the technique that was used by the SL-3 crew, and that was a stomper and an operator. And we've got pictures, movies, I think, showing how we had to operate it. That was just to close it. During the first part of the mission, we could put three to four and five full urine bags into the urine disposal bag, put it in the trash airlock, and it would just go out clean as a whistle, just no problem at all. And about halfway through the mission, it suddenly started jamming; so we would remove the urine bag, and that would work a little while. And then it would start jamming again. And about three-quarters away through the mission, it was useless to try to put any urine bags that had urine in them down - down the trash airlock. It seemed like the urine disposal bags would just swell up and jam against the sides of the trash airlock. And when you'd pull on the lever to force it out, it wouldn't move.

POGUE It had so little mechanical advantage anyway.

CARR Yes, you had very poor mechanical advantage on that thing.

POGUE Scissors.

CARR Scissors thing had pushed it out, it appeared to me. And so what we ended up doing was dumping the urine through the urine dump system into the waste tank, and then we would take the urine bag and roll it up and put a piece of tape around it and put it in the bag. And that way you could dump a half a dozen of them at one time. But it was a time-consuming thing to have to manage your trash that way.

QUERY Jer, does that mean that from about mission day 60, approximately, on, you dumped urine in the waste tank?

CARR Yes. If you check back in the mission log, you'd probably find somewhere where we told the ground that from now on we're going to do that. I haven't got the slightest idea why it suddenly started doing that. There doesn't seem to be any rhyme or reason why to it. And we experimented to the point where we got ourselves in trouble one day. We decided we would relieve the pressure in the urine bags by opening the valves. We put three urine bags in a

CARR (CONT'D) urine disposal bag with the valves open and put it in the trash airlock, opened the door. It wouldn't go out. Closed the door, opened the lid again, and the - those bags had put urine all over the inside of the trash airlock. And that was the foulest smelling thing you ever saw. From then on, we were never able to adequately clean it.

QUERY Even when it was closed? Did it - -

CARR No. Once you closed it, you kept the smell away from you; but when you opened it to dispose of trash, you had to endure the smell.

QUERY Before you burst that bag, did you get any smell when you cycled the trash airlock?

CARR There was a faint smell in the trash airlock when we got there. It was a faint, urine-type smell. I recognized it when we really got the bad smell later. I recognized that as being an odor that was inherent in the trash airlock earlier.

QUERY Coming from the waste tank?

CARR Well, I don't know if it was that or whether a previous crew had had a small urine spill and it got deposited on

CARR (CONT'D) the TAL and was just kind of hanging over, because what we had really hung on and we went in there with - Ed and I spent time together cleaning it out with biocide wipes, and then two other occasions, I cleaned it out with biocide wipes, and we couldn't whip the odor completely.

QUERY Jerry, was that before you started dumping the raw urine in?

CARR Yes.

QUERY So it wasn't necessary - -

CARR That was the clincher when the bags - when the bags spilled urine all over the inside of the trash airlock, that we decided, well, we had just fooled with our last full bag of urine through the trash airlock and from then on, it would go out the - -

QUERY But did you have a period of time when you were still putting it in bags - What I'm trying to differentiate is whether it was the smell trapped in the trash airlock or whether you were getting feedback from the waste tank itself.

CARR I don't think we were getting feedback - -

POGUE No, that happened before we started the regular dumping, which brings up a point. Are you people concerned with dump heaters, probes, that sort of thing?

QUERY Yes.

POGUE Have you read the technical debriefing, our comments there? We think they're underdesigned and wonder if there's any way that - Seems like we've been bit on these things since early Apollo - Apollo 7, you know, having trouble - You know; have to leave them on a long time before you use them. You're always afraid you're going to freeze them up and that kind of thing. And it's - I - Apparently - Well, I'm asking a question. Do you use a low-power heater because of burnout problems and that sort of thing? Is it power or what?

QUERY Al, could you answer that? Well, let's just - -

QUERY The answer is real - really simple, actually. The heater does not really prevent it - prevent it from fogging while flowing. The heater is to unclog it in case freezing ever did occur inside. Basically in the testing that we did, we would not get freezing inside the probe. We'd get freezing ..., and the heater would clear it with ... But the heater is not big enough to keep from freezing - -

CARR Then why in the world did the procedures require that we turn on a heater and keep it on for 15 minutes before we ever dumped anything through the probe? That doesn't make sense.

QUERY From testing, that cleared the tip from the outside - -

QUERY When did you ...

QUERY We got big chunks of ice in the waste management.

QUERY Could you get to a mike, please, so the guys - -

CARR I think we are through - -

POGUE Well, I guess the question is that - since there seems to be a continual source of procedural problems, discussion and general backbiting - why can't we - think we could get a better heater or something like that? We were just talking about a flight - After this problem occurred that Jerry is talking about, we had a later stoppage - when we were - when we started our regular dumping. Boy, that really scared us, because we knew we had problems with trash airlock dumping the urine. And then we had a freezeup with the urine dump, and boy, we were shaking in our boots there. We didn't know what we were going to do. Just - Well, the comments are going to tell you ...

GIBSON A couple of those mechanical things - one is that - what held the T003 on, that mechanical - that snaps - just completely froze up one day, and we had to pry it off.

QUERY Both of you know that the - that the - -

CARR The foot.

GIBSON The T003 is suspended from its stowage container - -

QUERY Structural - mechanical structure.

GIBSON - - mechanical structure, and it's got a foot - -

CARR Photo mount.

GIBSON - - ... photo mount that we used.

POGUE Camera mount.

GIBSON Camera mount, if you will. And it froze up completely so you couldn't get it out, and we had to pry th - I had to take a part of the mount off of the instrument itself. How it froze up, I'm not sure; it just flat wouldn't come out.

CARR The dovetails, also, on one of the TV cameras - The dovetail mount on the side cut loose.

POGUE And there wasn't any way to tack it - -

CARR And that was aggravating because the screws through the dovetail were screwed in from the inside out, and we were looking at the end of the screw and watching it over a period of time back out as the dovetail got looser and looser.

POGUE And sometimes you wanted to use that shoe because it was the only way it would fit with the situation at hand.

GIBSON The other things we had problems with mechanically were latches.

CARR Oh, yes.

GIBSON Dialatches, but that's another long story.

CARR That's adequately documented in the tech debriefing.

POGUE You know - But another thing that they're maybe interested in was the freezeup on the wardroom window, the ice collection on the wardroom window.

QUERY Yes. We haven't heard about that.

POGUE Why don't you tell them about it, Jerry. Jerry did all the - -

CARR Well, we - when we got there, there was a little patch of ice in the wardroom window about the size of a dime. And then after about a week and a half or 2 weeks, it got to be about as big as a quarter. And we knew that the previous crews had coped with it, but we didn't hear what the procedures were; and so we talked to the ground, and they indicated how we should use the vacuum dump line from the water condensate tank to deac - defrost it. You could do it in about 6 minutes. Well, as soon as you hooked up the vent line and connected it to the scientific airlock and opened it for that, you could just see that ice shrinking down to nothing; and then it was gone in no time at all.

QUERY There was no lingering problem then?

CARR No, but in about 3 weeks it would be back, and we'd just have to do it about once every 3 weeks. There was a little water spot that looks just like a water spot on a glass, too, that was left behind when the ice sublimed and was gone. We had that little dime-size water spot. But we don't quite understand how the mositure could get in there, in that sealed window. And that vent valve that's right there next to the window, we kept it tightly sealed, and we never fiddled with it at all. But somehow moisture

CARR (CONT'D) managed to get in there. And on the days after the shower, when the humidity was high, was the time when you would see the little spot starting to come in; so somehow humidity was able to get through something to get to the inner panes of that window.

QUERY Did you have any objectionable noise or notice any noise - frequency changes as the mission progressed, from any of the equipment?

GIBSON Pumps up in the airlock, the - -

CARR ATM coolant.

GIBSON - - ATM coolant pumps. That one was - Well, the three of them - I guess one we didn't use. Bravo and Charlie both had their problems. And I guess there was air in the loop which caused part of it.

QUERY But after you cleared that up - -

GIBSON It would come and go - -

CARR You got used to it after a while.

GIBSON You got used to it. You'd get a high-pitched whine, and then you'd get a gurgle. And then sounded as though - Heck, what'd we worry about, the bearing? Yes, the bearings, though. I forgot the exact noise - -

POGUE Once there was a distinct change in the acoustical spectrum up there, and then they just started whining. And we really got concerned about it. In fact, we asked to turn if off in order to be - We figured it would keep us awake at night. And I went to all the trouble getting - breaking out M487 noise-level meter and frequency analyzer and took beaucoup readings of the pump on and off and couldn't notice any difference. But you sure could tell it subjectively.

CARR The noisiest single system in the workshop were the rate gyros - rate gyro six pack that's up there. And then the next noisiest was the ATM C&D coolant pumps. And then near the end of the mission during the EREP pass, when the 191 cooler started dying on us, it really got noisy. But, of course, that wasn't something that ran all the time; it was only during the EREP. It interfered somewhat with our communications, and that's about it.

QUERY That's all - that's all the questions I had. And back to that probe, in reference to the questions that you asked me concerning that. The best answer I can give you on the probe - During the initial concept for design, the name of the game was keep power use down to a minimum. And it was concluded that the power that was allotted to

QUERY (CONT'D) that probe would be adequate with the procedures as established. And that's why it was so low. I agree with you; it's my opinion it should have been higher.

QUERY Okay, other structures and mechanical questions. Any questions from Huntsville? Okay, Charlie, contaminations. Charlie Davis will lead the session on contamination.

QUERY The ECS guys ... questions on that ... change in that noise ...

DAVIS We've still got several areas we want to cover here, and David Checks (?) will start off by asking questions on induced atmosphere.

QUERY I have a couple of questions on - As you went out to retrieve stuff from the ATM unit, did you notice any changes, any - in the frame of light intensity from the QCMs that were on the HLC and NRL ...? Do you know what the QCM looked like?

CARR No.

POGUE Quartz crystal?

QUERY Okay, there's a picture right here.

CARR What is a QCM?

QUERY Quartz crystal ... Should give you a continuous thread of contamination. Here's what it would look like on -

POGUE That's - was where you were wanting - at one time talking about getting - returning one of those.

QUERY Yes. Right. We got a very strange effect. That is, it continued to lose mass or give some indication of losing mass continually.

POGUE Losing mass?

QUERY Yes, and we don't know whether it was a change in the crystalline form of the device itself or whether just continued. I guess it should not have continued to outgas that long. Did you notice any differences or anything on the - -

CARR Sure didn't.

QUERY - - on or around - -

CARR That's not an area where we were. The only time I was near that thing is when I was taking pictures of the command module, and I was using it for a handhold then, trying to wrap my legs around it or some way to hold myself over there. But both other - the three other times I was out at the Sun end, I was nowhere near this; so I didn't have much opportunity to look at it.

QUERY In connect - I have one question in connection with that water droplet before ... on that wardroom window. Did it - You say it stayed the size of a dime whenever the ice would disappear? Did that droplet increase in size over each time it was - -

CARR You mean the water mark, the water stain?

QUERY Yes.

CARR No, it seemed to stay about the size of a dime.

GIBSON It stayed the same.

CARR It was a pretty old stain, and maybe it'd been there - had gotten established maybe back in SL-2 or -3, because all - Little foggy area or ice crystal would start small and just grow, and finally - by the time it got to be about the size of a half a dollar is when we'd do something about it. And once you cleared it up, it always came back to the same little old stain.

QUERY Jerry, was it actually water moisture - moisture that was left or just a stain?

CARR Just a stain. Looked like a watermark on a glass.

QUERY Okay, let's pursue one other question. You mentioned the - on the command module windows this contamination that wrinkled up that was water soluble.

CARR Yes.

QUERY Did you notice that as you - did you notice that just after you'd come down, or did you notice that there was something - -

GIBSON ... - No - Well, no - -

QUERY - - on there prior to that?

GIBSON We knew it. We could see it on orbit before ...

CARR Yes, we knew our windows were coated on orbit. We could - Late in the mission, it was apparent to us that we had a lot less transmissivity through the window than we had early. They were obviously contaminated, because with low light levels - light angles, I should say - Sun angles, you could see the - -

POGUE Streaks - -

CARR But we also - -

QUERY So it was not - Then it was not uniform. It seemed to have streaks in it?

CARR I always thought it uniform; I would say more concentrated towards one corner of the window.

POGUE I had streaks on window number 4, I guess it was, but I'm not sure the streaking was directly associated with that contaminant coating. I don't know what it was, but I know I kept moving the camera around because I had a streak right across the middle, almost horizontal.

CARR I got the impression that a line that I had in my window was much like the line of shadowing that we had in other places on the workshop. But my window had a line in it that was a very, very straight line with two different intensities of contamination. I got the impression that maybe some of the shadowing on my window was protecting a little bit of it or something; the same sort of shadowing effect - -

QUERY While it was accumulating, it was shadowed?

CARR - - that I could see other places.

GIBSON When we got back down, we saw the effect of the water on it when we were inside the command module. Once we got outside and we came back down to look at the command module before they towed it away, I could still see it on the windows. Apparently, someone post that time washed

GIBSON (CONT'D) the command module down and, you know, made it look shiny and new again and completely ruined it.

QUERY That's unfortunate.

QUERY Jerry, when you have the shadowing effect on your window, could you tell whether the sunlit part had more buildup than the other on the ... - -

CARR All you could see was a line of demarcation. It was very difficult to see which had more or less than the other.

QUERY While we're on this window - This is window number 1 you're talking about, I beleive.

CARR Window number 2.

QUERY Oh, well, then this was not the window that you had - took photos of S233 out of, is it?

CARR Right. Window number 1 is the one that we took those pictures out of, and I - that window, as I remember, was more uniformly coated. I didn't see this line of demarcation indicating shadowing. You had to be careful looking at something like that for fear that maybe the lines you're seeing really was nothing more than just a shadow.

POGUE I got - Oh, by the way, I want to make a comment on photography of windows for contamination. You need to have a dark shroud or dark cloth on the inside of the spacecraft to minimize back inflections on the window. If you'd look at the pictures that I took of the S230 for contamination purposes, they're lousy pictures, because the light came in, hit the structure inside, bounced back on the inside of the window, reflected in the camera, and ruined the pictures.

POGUE So if you really want to get good contamination photographs, you have to make a - If I had had enough sense and presence of mind in flight, I would have rigged something up to - to minimize that back reflection. It ruined those photographs.

QUERY Okay. Thank you.

CARR I think back reflection had a lot of effect on the 233 photography too, just from starlight and moonlight reflecting into the spacecraft from back on the window. And then you just essentially made your - made your window nearly opaque, and especially if you are trying to take pictures also close to sunrise or sunset. You'd get that light on the window, and it would just look like it was becoming opaque.

QUERY Okay. Let me ask one last question. On EVAs I've no - I have no - I have read several comments about the white - white paints turning yellow or beige or brown. Was there any discoloration concerning other paints or, say, the bare aluminum structures that might have been in place? Or in touching some of the - -

GIBSON Colors seem to be a little washed out. If you take a look at the flag, we've got some good pictures which I

GIBSON think show the American flag painted on the MDA. Colors there appear to be very washed out, as well as the white turning yellow. The red and blue just seem to lose a lot also.

QUERY And how about any bare metal surfaces whenever you were around them? Did you ever notice any smudging or, you know, a layer of contaminant on there that would be -

CARR That's what I'm racking my brain on.

POGUE You know, there - that's - that's a point.

CARR Seems to me that - the aluminum took on a sort of yellow cast.

GIBSON It was not shiny aluminum, but I'm trying to figure out how - in what way it was degraded. It just appeared to lose its luster.

POGUE You remember, Ed, when you put the clamps on for the S020 - -

GIBSON Oh, yes.

POGUE - - and T025. How you scuffed - -

GIBSON . . .

POGUE It was really ... scuff marks.

GIBSON ... you could really see it.

QUERY Okay, so - -

POGUE Scraped away the top surface, you could see bright - much brighter metal underneath. Now this is on the ATM trusses, big structural ...

CARR Yes.

QUERY Okay, thank you.

QUERY I had just one question on the ATM experiments themselves. On the S052 TV quite often we would see particles on the downlink TV. By and large they were just a very few number of particles. But by chance, did any of the crew happen to look out the window during any of the S052 TV activity and ... those particles?

GIBSON No, we - we were asked that question the other day, and we could - most of the time when you looked out the window you could hardly see any particles at all.

QUERY Oh, but you did see particles?

GIBSON When you were looking out the wardroom window, you'd occasionally see one or two particles go by. And you might see it especially as a reflection in the sunlight when you're up close to the terminator.

CARR We had two blizzards that we saw out the wardroom window, just absolute flurry, and it was near the terminator both times. And it was just - huge flurries of snow particles or bright particles.

QUERY One of those, I recall that we could not identify it. I think the answer given - the only thing that happened was that there had been a mol sieve cycle change just a minute or two before. But that - that really didn't make sense. But now, the other one I don't recall what that blizzard was.

CARR One was rather early in the mission, and the other one was about two-thirds of the way through the mission. I think the second one is the one that you folks said that there had recently, just very shortly before that, been a mol sieve cycle change. But that's the only time we ever saw any huge blizzards of - of this stuff. It looked kind of like snow, and it was very, very beautiful.

QUERY You don't have any idea of what that other snowstorm was from?

CARR Haven't the slightest idea.

POGUE Well, a question that - that one might ask: you know in the trash - in the ops - locks tank down there in the trash airlock area - the trash area, if - if I remember correctly you had screen - big screens over the actual openings to the outside. Now, during your testing I assume that those things, if they froze over as they were supposed to freeze over and then subline out or something, I forget which, did you ever get any dump modes established when you were testing that, I wonder?

QUERY Yes, we did have liquids go into the waste tank C. But now, during the ground test we always stayed below the triple-point pressure. Now, during the mission there potentially is over three cases there, dumping free liquids into the waste tank. You may have dumped at such a rate - such a mass that you did just bump the triple-point pressure in the waste tank. And if that were the case, you could have iced up those screens and then sublimed off the screen or else clogged them up and blown them off.

CARR Could the screens do any sort of a - of a - oil can or something that might just pop them and cause a million little ice crystals to start off?

QUERY I wouldn't exclude that, but it's not that. I would think the next time you dump some material in that you certainly could have ...

CARR Yes, except that both times we saw these blizzards we were not doing a trash dump of any kind, because that's the first thing the ground asked us when we said we had seen it, did you guys just dump something down the trash airlock, and we said no. And then the next question was, well how about the SAL, and the answer was no to that. So then they researched and found on - on one case that the mol sieve had just done something.

QUERY Look, I have a couple of questions now in the area of experiments optics, and it's just basically did you observe any deposition on the handheld optics, for instance, the S019 articulated mirror? If you did, could you describe what these deposits looked like?

CARR No, we did not. Bill indicated some - -

POGUE Yes, on the - right near the end when I was doing an S063 when you could actually look through the window - you - you had a window mounted in the - I would say T025 adapter, was it?

CARR Yes.

POGUE I saw what appeared to be a very fine dustlike layer on the AMS mirror. Now this was, again, you had to have the Sun - the light just right before you could see it because turning it a little bit further you could - you could see the discone antenna, and that was just as - just crystal clear, you know. So like I - I - I wasn't sure what I was seeing - almost a frosted appearance. That was near the end; I don't know when it started, and I'm not even sure what I saw was entirely valid.

QUERY But other than that?

POGUE Other than that, no. It always looked - when we - any time that we took the AMS - a couple of times we ro - moved it out to make sure that we had it cocked right or just to check it. It looked very good, very good condition.

SPEAKER How about any of the windows associated with the SAL, the antisolar SAL, did you have any deposits on those surfaces?

CARR No ...

QUERY Well, from that then I assume that you didn't do any cleaning on orbit of any of the optical surfaces.

POGUE Just the EREP.

CARR The EREP S190 window, Bill did a cleaning job on that. But, of course, that was just the inside where we were.

POGUE We cleaned off the 190 window - interior of the 190 window once using the optics cleaning kit. Once I brought down some of the tissues and cleaned off the inside of the wardroom window and that was it.

QUERY So that's all of the window cleaning that you did.

POGUE That was just about it.

QUERY Okay.

CARR But we found that to properly clean the Nikon with the 300-millimeter lens, you had to put your hand on the window and hold the lens up against the window and then

CARR (CONT'D) track with the camera in order to get your image motion compensation. And so it dirtied the windows, and we found ourselves having to clean them, wipe them off on occasion. And that was - the wardroom window was - that had to be done too and also the STS windows on occasion, the command module window; that was finger smudges.

POGUE And mainly on the wardroom window, too, was the window protector that we were doing this to not the optic, not the wardroom window itself.

QUERY But most of these smudges you had to clean were from nose prints or finger prints.

CARR Correct.

QUERY I did have several questions on thermal control systems, but I think they have been beaten into the ground. But I do have one. Going back over previous debriefings, the two previous crew debriefings, one of the questions we had asked on ATM sunshield discoloration was the first crew response that it was clean, that the sunshield of the ATM was still white. But SL-2 crew, we picked up from them that it was beginning to discolor. Shadow effects were still light and door motion areas were a little bit dimmer, and then that exposed to sunlight was

QUERY (CONT'D) even darker. But then you all have come in, and then it's much darker. So, what I would like to ask is do you recall any difference in discoloration on these white surfaces between your first EVA and the last EVA.

CARR I didn't.

GIBSON The problem is - Yes, I was out there on the first EVA and then Jerry was out there on the last, so you have different observers. One thing I did notice at the first EVA I was out there, you could very clearly see the rib structure underneath which was supporting the front face. It looked like from squares - a square rib structure which is maybe 3, 4 inches or so in square size or linear dimension across it. And I forget whether that was darker or lighter now, but I made some - a big verbal description of it at the time of the EVA. If you are interested in that effect, it's in the transcripts during the first EVA.

CARR And what was interesting was that when we first saw the workshop up there and started moving in on it, the starkness of the white, the gold, and the black. It was just very stark, and the white looked very pure white. And then I remember thinking how curious it was after we got

CARR (CONT'D) in real close, nearly docked, and when we were docked that all the places that had looked white were now beige, or very light beige. And it's the same sort of effect as that 16-millimeter film that was taken - that we took on the EVA. That just makes everything look spanking clean white. And I deliberately panned slowly across the sun end of the ATM to show all the shadowing effect and all the tan. And damned if none of it came out. It was just pure white; looks just white as can be.

GIBSON I hope the Nikons show it better.

CARR I do too.

POGUE I hope so too.

QUERY But you did then take some photographs just to show discoloration.

CARR Yes, and unfortunately the 16-millimeter stuff was apparently overexposed. And in the processing they - the developing just - they - it was probably developed normally - an overexposed picture developed normally which ends up with beige looking white. And all the contrast, the shadowing, was gone, just gone white.

QUERY All of the surface colors that you all have a comment on, were those only on the solar side of the vehicle? During EVA did you get in such a position that you could see the antisolar side of the - -

CARR Well, the other side of the panels look pretty white to me. I didn't get the impression that that was as beige.

POGUE It wasn't, but it was turning. I photographed the underside of SAS panels when we came in for docking, and I think I got - I'm not sure I got pictures coming out or not, when we undocked. But, if you'll look at those, I think you'll see that it's well, I don't know if you can tell or not.

CARR You don't mean the SAS panel; you mean ATM solar panels.

POGUE I mean ATM solar panels. And they were not pure white. They had started to change.

GIBSON But in around the FAS area, which was not exposed to Sun except for scattered sunlight whatever small amount there may be there, that had changed color.

QUERY What was this, how that had changed color?

GIBSON In the FAS, the fixed airlock shroud workstation, where you had the part we - the pieces we brought back, as a matter of fact, that you clipped out. Part of that was a very dark beige and an abrupt transition to a light beige. The light beige is the part that was out of the Sun, and the dark was the part that was in. And the part that was out of the Sun which was light, that whole area was pretty much of a uniform light beige. I did not see any shadowing effects there as though you had reflected sunlight from a given direction. It was pretty much uniform. To me, that, plus looking at the windows in command module, implied we had something coating, some atmosphere around there which slowly condensed out on the vehicle. Whether that was really the source of that light beige, I can't be sure. But I'm sure, looking at the material itself and analyzing it, you can tell that.

QUERY Okay.

QUERY Is this - what was washed off the command module window, this material, did it wash off in flakes, or was it quite even as the water would hit it? I mean, it was part of the contour ...

GIBSON No, it tended to shrink up, in the same way, as Jerry says, the top of a custard pudding when it cools, shrinks up.

QUERY Okay. When it got wet, it would shrink up when exposed to water.

GIBSON It would shrink up, and you would see little bits of it around the corners, especially. And even after we got - as I said, after we were on the ship and the spacecraft was on the ship for 10 hours or so, we went out and looked at it, and it was still there on the windows. And I thought, well, here these guys have got some beautiful samples. I'm surprised that the system didn't make - take special pains to get all that.

CARR I guess we should have made a bigger thing of it while we were in the command module and mentioned the fact that these things were there.

QUERY I think that that's all the prepared questions we had. Do you have another one ...?

QUERY Yes, I have one. I have another one. It's on induced atmosphere. It's not particularly with contamination but with the meteoroid environment. Did you notice any - I know you talked about wrapping up the meteoroid shield

QUERY (CONT'D) and bring that back - did you notice on any of the EVAs like up on the ATM, any impact areas that were not associated with an engine or some kind of firing where paint might flake away?

CARR Sure didn't.

QUERY None at all?

CARR It looked very good up there.

QUERY Okay.

CARR Of course, all the windows - they asked us a question up there one time, if the wardroom window, or any of the windows we look out, had any pits or anything in them indicating micrometeoroid impacts, and they were just as clean as a whistle.

QUERY ... you had a few questions you were going to ask.

QUERY Most of them were answered, but did you use all the Coolanol that you took up?

CARR ... no.

QUERY How much did you use?

POGUE Golly, I don't really know.

CARR Well, didn't they say it was a 3-quart capacity or something like that, and we had 9 quarts on board or something? We serviced it once, whatever that is.

POGUE Yes.

QUERY ... Did you ever have any occasion that it leaked again?

POGUE No.

CARR Not to my knowledge.

QUERY ...

CARR No. And the ground, of course, has a better handle on that, and the guy, the atmospheric volatiles concentrate guy said that they had some hydrocarbons in there that indicated that it might have to do with Coolanol.

QUERY I think George Hobson and his people could probably answer those questions a little better - -

CARR Yes.

QUERY - from the data.

POGUE You ought to also ask him about the secondary coolant loop, too, because apparently about the time we undocked, we lost the secondary coolant loop.

QUERY When we started getting the warning light.

QUERY I think this does us.

QUERY Charlie, are we clearing now on this - I'm concerned about this film. It showed up on the command module window ... we are going to find out about that.

QUERY Are we clear if this was seen on any of the other windows, the same kind of degradation?

POGUE Yes, it was on number 4.

QUERY How about ... the workshop ...? Was it peculiar only to the command module?

POGUE Who knows?

CARR Oh, yes. Yes, I - in fact when they asked me about the pitting on the wardroom window, I said no, there was no pitting, but there was definitely what looked like water marks and stains on the wardroom window.

QUERY Well, that was ... surface, you mean.

CARR ... on the external surface, and it was more streaky looking.

QUERY Now, we - I think this was picked up on the first crew. And I think at the time it would have caught me by surprise. You know we did lose the meteoroid shield.

QUERY As Jer was commenting - the reason I asked, you commented earlier that you could - toward the end of the mission you started seeing degradation on the command module windows. I just wondered if you noticed this ...

CARR It was certainly more noticeable on the wardroom window. Now, the STS window, I didn't notice it, nor did I notice it on the 190 window, but of course the 190 window had a cover on, and we didn't open that cover very often.

QUERY STS windows did, too, so I think ... there; whereas the wardroom window had been exposed for the whole mission.

CARR Yes.

QUERY Your command module window for 84 days.

QUERY Did you keep the STS window covers on mostly or - -

CARR Most of the time, yes.

GIBSON Most of the time - the outside.

CARR That's a mechanical thing for the mechanical folks, and that's those windows on the - the covers on the STS windows were a great pain in the neck, because they were so hard to open. You had so little mechanical advantage on the crank you had to turn, and there were so many things close to that - the crank throw that you were just asking for broken fingers. We were always banging our knuckles up trying to open and close those doggone STS windows.

POGUE One of them in particular you could actually guillotine a finger to death.

CARR There was lots of profanity used on those windows.

QUERY Go ahead. Is that it Charlie?

QUERY That ...

QUERY Any other ...?

QUERY Just one ...

QUERY One more question? Okay.

QUERY When there were shadows on the bottom of the ATM sunshield, of course, the Sun couldn't have caused it. Evidently there was an obstruction in the way. Did you - any of you notice any of those, and if so, what was the possible source?

QUERY It looked like they were in the way of some emission that was coming towards that surface, and the structure shadowed it rather than the Sun as in so many other cases.

GIBSON I'm not sure what you're referring to.

QUERY On the underside of the supports of the ATM sunshield, the supports had a shadow on the bottom side of the sunshield, and we were kind of wondering just about what angle the emission would have had to come from to create that shadow. Evidently you didn't notice though.

CARR Yes, we noticed that. In face, I think we mentioned it on the EVA that it seemed kind of peculiar that you even had the shadowing effect around on the Earth side of the sunshield. That's a mystery to me.

QUERY That would sound like outgasing protection.

QUERY But it seems to be coming from a def - very definite direction, and that's what we were interested in, just where it might have come from if you find that out.

QUERY Okay.

GIBSON Are people going to run a chemical analysis of those materials which we brought back just to see what is deposited?

QUERY I'm reasonably sure that material is still ...

QUERY They're doing ... I checked on that to see if I could tell anything about it before I came down, and, no, they are doing that and they are - they just don't have anything yet to - -

GIBSON Okay.

QUERY - - pass on, but - -

QUERY ... got a couple of questions before we break up this afternoon. Now one of the - and they're general questions; they don't fit well in any subsystem - one of the headquarters offices that funds Kennedy, Marshall, and ourselves for advanced technology, advanced development, always asks after the end of the mission, what did we - what did we - what went wrong that we ought to fix way downstream type of thing, or takes a long lead time to get after type of thing. And to put that in context, the office that did the asking has finished and has been

QUERY (CONT'D) finished for a year and a half now of funding advanced development for Shuttle, so they're about the only group in the world that's finished working on the space shuttle so to speak, and so what are the things about the mission that may require long-term effort to solve at a hardware development stage or technology stage, or stay out of technology. You know, what are the half a dozen things that might fit that category that bugged you most about the mission.

GIBSON The things that we - as we just get a real cursory look at Shuttle, it's not that the technology doesn't exist; they are just flat not going to use it. Waste disposal system in Shuttle has taken a step backwards into using the Apollo rather than the Skylab. Some of the foods, I guess, are that way. Gee, camera equipment - -

CARR Camera equipment is a big one. Requiring a 4-year lead time to get cameras for Shuttle, I think is appalling why we have to have that kind of lead time.

POGUE The general overall de-emphasis of the - probably the best capability of man in that we - looks like we are going out of our way to deprive the human observer onboard from having a good facility for looking at the Earth or for even looking at the exterior of his vehicle. We've

POGUE (CONT'D) been continually bit by this inability to see the outside of our vehicle and having a good, well designed, purposefully designed Earth observatory for use both in the daylit side of the Earth, and on the nightside of the Earth, the capability to look, regardless of spacecraft attitude at the daylit side of the Earth or the nightside of the Earth. I can see that this is - we're going to go into the 21st century in space flight before we have that capability. It just seems like that we have established that man can do all sorts of neat things if he has the right kind of observing capability, but we just - somehow or another, we want to handicap ourselves, and we're deliberately going out of our way to emasculate the man's ability in space.

CARR I think it's very, very disturbing to see some of the trends that are headed - we're headed for with Shuttle; as Ed said, they are steps backwards. Waste management: if you're going back to sticking a bag on your backside to collect fecal matter, if you don't - that's a step backwards, I'll guarantee you compared to what we had up on Skylab. And the fact that they are going back to a lot of the Apollo-type foods and foods packaging is also a step backwards after the things we've learned. And it

CARR (CONT'D) looks to me - and quite frankly it looks to me like we're selling our soul in order to get a vehicle, and that's a very poor situation. I can understand, because it is probably a matter of survival of the program, of the NASA - the programs that we have going. We have to sell our soul because of economic necessity. But it sure doesn't make you feel any better to see us go out and learn something and then have to just put it aside and forget it and step backward in systems. It's really - it's just pitiful. And it just bothers the hell out of me to see us in a position where somebody says, "Well, by June of this year we have to have completely established our - all of our photographic equipment and get all of our - everything's cast in concrete." And I just can't understand that because, good camera equipment is available down at the camera store. And it - I don't see where you need a 4-year lead time on camera equipment. It just doesn't make sense. And - well we're sermonizing now, but - -

POGUE That's what he's asking for though.

CARR That's what you're looking for, as far as I know. We're going to have to rear up on our hind legs and say what we need and do the job right and quit going about it in a half-assed manner.

POGUE Well, one of the things about it, too, and it is a basic point of philosophy involved here, and I don't want anyone here to take offense, but I don't think spacecraft should be designed solely by engineers. I think that the operator should be in and should determine and levy requirements on system design. In other words, what - I'm actually saying that if you are considering a fluid loop then the man that is going to operate that and the procedures man that's going to design the malfunction procedures for that should have a say in where check valves are located, and not just where it's convenient to put them in there because there is a tiedown, a hardpoint, here for mounting the thing. That's what has been dictating in so many cases the - the layout of our systems. And that is why the command module - the LEB down there below the commander - actually on the left hand side - that is a big rat nest. Let's not let that go by. Now we're - we're very grateful that Rockwell can put out a spacecraft that can last 84 days. We don't want any - we don't want anyone to go away mad, thinking that we're not grateful. But to you - you're asking for a long-term look ahead. And we're going to have to face up to the time when the people who are actually going to be flying this

POGUE
(CONT'D)

vehicle and operating it, or at least their - their representatives are going to have a good strong say in how a - how the thing is actually laid out, how the wire runs are laid out and so forth, not just the structural considerations. Because if you start looking ahead at a Mars flight, the spacecraft now becomes your simulator. Now when - when - when that happens, you're going to have onboard maintenance capability, and you're going to have to have that thing laid out so that my kid can go in and fix it, you know. It's going to have to be very intelligently designed, not just from a functional standpoint in that - in that it meets engineering requirements, but from maintenance and repair. We keep saying, yeah, that's real neat, if we had the money we could do it; but darn it, we - at one time or another we're going to have to bite the bullet and actually design a spacecraft that way.

And following up from Jerry's point of view on the cameras, one of the things too that keeps biting us is that we - we've continually fought the problem and said, well, we - we would like to have lots of color exterior film onboard. Why do you want it? We like to take pictures. Why do you want to take the pictures? Well, we

POGUE (CONT'D)

just feel like that, you know if you look out and see something interesting, you ought to take a picture of it. Well, you don't have any justification. You know, you end up - so you end up short of film. But then we come back and we talk to - just last night and, well, and there are meeting goings [sic] on right - right now amongst people who are very excited about Earth observations, which is - which - which is - largely not even a conceived program a couple of years ago, I guess. So once again there, you - you have these capabilities that do exist. I mean, it's very difficult sometimes to - to substantiate a claim that we do need a lot of film on board for just sort of out-the-window photography. It turns out all that is pretty good and useful.

QUERY

Let me ask you another kind of generic problem with respect to the over - overhead and housekeeping percentages as a percentage or overall time, with the reason for asking the question being aimed at the degree of training that has to go to experimenters that would fly in - in a spacelab type of thing. With respect to your own training background and - and there being undoubtedly orders of magnitude - the difference between the - the training that - that - that a experimenter would

QUERY (CONT'D) get to be launched in a - in spacelab and the training that you fellows got.

GIBSON Well - -

QUERY In overhead time.

GIBSON In overhead time - -

CARR - - ... this one.

GIBSON Overhead associated with housekeeping?

QUERY Stowage, yeah, housekeeping, stowage.

GIBSON Yes. I think it ought to be in order of magnitude different. We all found that we'd become much better if we could specialize in any given field up there. When we tried to become a jack of all trades, we ended up just literally a master of none, and chasing ourselves around not learning to become proficient rapidly. That was one of the problems we had quite early in the mission, or that really went on for the first month or so, is we were going in so darned many different directions trying to learn tasks we had not even been trained for that we couldn't do the ones which really required competence and a lot of capability. We could not really train

GIBSON (CONT'D) ourselves on orbit except over a very long period of time, operating the ATM or EREP or doing some of the medical experiments for them.

CARR Yeah, we have to learn how to ferret out items or tasks that - that have potential large or high overheads involved with them. We've already pointed out one very high overhead thing, and that is whatever you don't train a guy for down here, you better be prepared to pay the price on orbit because the overhead is going to be excessive. And I think that is a true axiom right now. That if you - if you don't train me to do a given job down here or if it's impossible to train me to do a job, then you better figure about 200 percent or more time available on orbit for overhead while I learn how to cope with it in a zero-g situation.

POGUE Regardless how simple it looks.

QUERY It there - is there a statement there or ... that says, in a - in a case where you are launching X number of - of experiments, specialist type of thing in a spacelab, let's say, that you're going - you're going to need other people just for housekeeping type of thing?

CARR Either that or design your housekeeping for minimum overhead. Another good one here is - is the fecal collection thing on our - our mission. The fecal collector equipment itself is very good equipment and it's a great step forward, a ... jump over Apollo and - and systems previous to that. But the fact of the matter is, in order - to - to - take a crap, it's a 20-minute affair: 5 minutes are involved in the physiological function and the other 15 is the paperwork and the processing that goes afterwards. And that's overhead. When you've got a 3 to 1 overhead margin on a simple thing like going to the bathroom, you've got to start thinking ways to get around it because that time is too valuable to spend cleaning yourself up and weighing and marking labels and pulling stickyback tape off of the bag and sealing the bag and - and putting it into an oven and setting a timer on an oven and all that stuff, and of all the sudden you've shot 20 minutes. And some days it was difficult to find 20 minutes available. And when Mother Nature is clawing at you, and you know it's going to take you 20 minutes, you know, you - you either get constipated or you say, I'm going, to hell with the schedule; and then you're further behind by the time you've cleared out of the head again. And there ain't no way anybody

CARR (CONT'D) is going to schedule personal hygiene for you. When you got to go, you got to go; and it doesn't matter what's on the schedule. And that overhead will just eat you alive. Overhead time on food preparation has got to be reduced.

POGUE Trash management following food.

CARR Trash management overhead has got to be reduced. And these are things that it doesn't take an engineer to sort out. It just takes people that - that will get in and mess around with the nitty gritty of it and do it a few times and say, now how is a better way to do this? And you don't have to be an engineer to do that. And that's where you say that you need people other than engineers on the team working with you, people with that rare talent to rear back and look at the big picture without getting all caught up in the details.

QUERY What was the picture in trash management?

POGUE In trash, depends on what you mean, but after food preparation you had a lot of bulk to dispose of. Even if there was - It involved two stages: temporary management of the stuff right after the meal, and then periodic disposal of the bulk in the trash airlock.

QUERY What would make it simpler?

POGUE Well - -

CARR The can crusher, for instance. If you had a meal that involved six cans, maybe two of the cans were wet cans; that is, food that was not in a - in a packaging in the can, which meant that you couldn't crush that can or you would squirt garbage all over the place. So those two cans had to be put in the overcans in the disposal well. Any dry cans that you had, because of our need to - to conserve trash bags and stuff, we had to crush in order to make - make room. And so you find yourself spending a lot of time just managing your trash, making sure that this gets in its right place and that gets in its right place.

QUERY Have you ever tried the bean count, Jerry, or - or, Bill, Ed? What - what the overhead in your mission was timewise, the percentage of the whole. If you broke the whole mission down into sleep time, overhead time, and useful work time type of thing; what that split might be?

CARR No, we haven't. It would depend quite a bit on the - the phase of the mission too, the time. During what we call the period of adjustment, that period where you are physiologically getting used to your surroundings, the overhead time is tremendous. Once you become acclimated to your - to your environment and you are in a situation where you're up with or ahead of the schedule, the overhead time is greatly reduced. In our particular case, there was a period of time between when we got physiologically adapted and when we caught up with the schedule, and that was an extra 20 or so days in which we were always behind schedule. And then you get into the haste-makes-waste overhead where you make so many mistakes that you - you greatly increase your overhead just because you're - you're hurrying so fast and your making errors and causing - that causes extra work that has to be handled.

QUERY Let - let - let me pursue that just for a minute if - if I can, and I'm not a crew systems type so excuse the simplicity of the question. But with respect to your adaptation to - to flight after you get that type of thing, in recognizing the fact that many of the ... missions are going to have to be done on Shuttle in 7-days type of thing,

QUERY (CONT'D) how does - how does the - how do you - how do you dovetail the amount of that 7 days that it takes to acclimate yourself?

GIBSON I think that's what we were talking about earlier in that you specialize. If any one of us had to go up and run one task, we would have adapted much easier. If Jerry and Bill were going to run strictly EREP as soon as they got up there, they could have - after the first pass, I think, been pretty good at it, fairly proficient. If I were to run ATM after I first got up there, nothing else, and not tried to become a master of everything that was up there, spread myself very thin and try to learn 50 new tasks all in the first week, I think we all would have done much better. So for a 7-day mission, it makes sense, if you approach it from the standpoint of having the guys very specialized, trained for those specific tasks only and only require them to do those specific tasks.

CARR Yes, a real time-consumer is developing the techniques of - of coordinating a mixed bag of tasks. And if you reduce the number of tasks in the bag that the guy has got to cope with, he is going to get efficient a whole lot quicker.

POGUE And you will reduce the overhead, too.

CARR Yes. And so that's why we think in the Shuttle case where you got a guy that's going to go up there and he is only really required to do one main job and he might have just a couple of collaterals that are fairly simple, he'll probably accommodate a whole lot quicker as far as his personal efficiency. But what he's got to get over first is his physiological problems. The fact that his gut doesn't feel good and he's a little bit dizzy maybe, or maybe he's just got a headache across here because of the fluid shift that's just driving him out of his gourd. And a guy who does not have the experience or the - the access to experienced people that we've had, this - his personal well-being is certainly going to be very - foremost in his mind for a while.

GIBSON One thing that the Shuttle faces as a major disadvantage which everybody ought to recognize is that in 7 days, the best you are going to be able to do is to try to guess what the guy should be doing every minute of those days and flight plan it that way. And you are going to specify in detail what's going to happen every - every one of those 7 days. When you get up there and along around the 5th or 6th day these guys are going to say, gee, you

GIBSON (CONT'D) know we ought to be running these experiments in the following way; we could get our data a little bit better. We found this true as we went on. All the way through the mission we found that we could learn how to improve things and really make significant advances that way. I think in 7 days you're going to see very little of that. You are going to see very little growth in the abilities of guys to improve the way in which you get data.

QUERY Learning curve's got a shallow slope.

QUERY Jerry, we're about to run over. Do you guys need to do that?

GIBSON Pardon?

QUERY Learning curve has got a shallow slope in that case.

GIBSON Yes, 7 days just won't do it for you, and the problem that it's going to force you - that's going to keep you from doing it is that if it's only 7 days long, everybody is going to want something done that would add up to 8 or 9 days. And you're going to be trying to pack that mission so full the guy's not going to have a chance to think. And that's what you need, a little time to sit back and ... - -

POGUE He's going to screw up the first couple of days, and then he is going to try to do 9 days' work in 5 days.

GIBSON I think this 7 days is just a lousy way to use man in flight. You really ought to get him up there for a good period of time where he's got a - he can learn and the whole system can learn with him and not try to overspecify what he does. That's one of the problems that NASA has in general is to try to overspecify what happens. We found this true. Guys were sending up flight plans that just had way too much detail in them.

QUERY Thank you.

QUERY Okay, thank you very much.

GIBSON Okeydoke.

QUERY I'm sorry we ran over a little bit.

QUERY And we'll see you guys in the morning at nine, huh?

GIBSON Fine.

QUERY Jerry, this morning we were going to check the thermal/ environmental control systems, electrical power, attitude pointing control and then get into the crew systems. Ed tells me he's only going to be here for a few minutes and ... the APCS. And that's a very short one anyway; so I think we'll take it first if - -

CARR Okay, very fine.

QUERY - - if that's all right with you. And Chris Rupp [?] is here from Marshall to represent that, and I think we only have one or two questions. So, Chris, why don't you go ahead.

RUPP Yes. When the CMG went out, this made the APS - APCS a lot more sensitive to problems like gimbal stops - on the CMGs hitting to gimbal stops during maneuvers. And in an attempt to try to give you of the crew the - some cues as to how to monitor the APCS system, we came up with general message that you can use. And we tried to figure out how to word the general message where it would be suitable in just about all the cases we could think of. And so what we came up with was, you could monitor the

RUPP (CONT'D) the maneuver rates and also the - I think we put in there at one time, too, the capability for you to call up on the DAS to display an attitude-error parameter. I wonder whether you people might have some comments that would allow us to in the future maybe come up with a better scheme in monitoring the vehicle performance?

GIBSON Yes, I thought that that - what was worked up, considering how long you had to do it and that we never really had thought that serious about two CMGs - we thought about it but never really pressed our nose into saying, well, here it is right now - I thought that all came off real well, and I was very - very happy with all of the schemes that came up. The details - Well, first, I guess that's TACS attitude error you were talking about that is called up. We found that it took an awful lot of crew time to monitor these things during a maneuver. And in the future, if we do come up with a system which is so sensitive that you ought to be monitoring those parameters, then we ought to do it like all of the other caution and warning parameters and have a tolerance which is allowed - allowed. And if it exceeds that tolerance, then you get a - an alert or a caution. Particular, attitude error, if you're stable, or vehicle rates. Maybe there's a way

GIBSON
(CONT'D)

of sensing what the vehicle - specifying what the vehicle rates should be for a given maneuver; and when it deviates appreciably from that, whatever you consider is off nominal, put a - an alert condition. In terms of monitoring the - the gimbals, there's another one - especially when we're monitoring for - for solar inertial and you're working the ATM. There were several occasions, you know, where we got a momentum configuration which would put the gimbals on a stop and we'd deviate from solar inertial. And there again, it would be useful to have some way of predicting that ahead of time or at least giving you an early indication of it. I think we just lucked out on the one instances where we - one instance where we did get a flare on the rise, because right preceding that, we had gone off attitude and had put in a 3-minute maneuver time and come back. Had we known about that before the orbit began, we would have cleared that problem up before the - right at the outset of the orbit. So there, again, in caution - in alert condition we would like to see something which would specify the probability of getting a gimbal on a stop - if that really is a possible situation - or at least tell you that you're within 5 degrees of a stop, if you can't predict that well - can't put a scheme on board to predict it

GIBSON (CONT'D) because, I guess, it was pretty complicated down here to predict it. Your - your model down here was very sensitive, I guess, to all the venting and all other things that we've used in spacecraft all the time - caution and warning conditions and trying to get - get those parameters down so they tell you early enough that you've got a problem. In future systems, I'd like to see something like what we've talked about for a long time back in the old days, when we were flying this thing in late 68 and we didn't have enough time to change things around. That was in 66. We talked about magnetic desaturation, using the Earth's field, and react that against magnetic moment, which you could create on board by putting current through large loops of wire, which I guess is done on quite a few other spacecraft. But the need for that never became apparent. It certainly was during our mission and - and all throughout the whole Skylab, because the use of TACS just was a - a - really prohibitive. We were, as you know, really concerned about it in the first mission, SL-1, before they even got the guys up there and we had the EGIL special attitude - which really burned the TACS up - and in pointing out that - the real problems that you run into by trying to come up with a - a limited lifetime system

GIBSON (CONT'D) like the TACS, as opposed to something which is open ended like this magnetic desaturation would be. Also, we spent an awful lot of nightsides doing gravity gradient dumps from high beta when we could have been getting good solar data or good data with the scientific airlock. It was holding a fixed attitude and - and getting some of the other experiments working, I think, that's severely limited the amount of data we will be able to bring back with all the corollary experiments and the ATM.

CARR Oh, even at low beta. It really didn't matter about the beta.

GIBSON Well, for the - -

CARR Just the fact that we had such a long dump angle.

GIBSON Yes, I was thinking high beta for the ATM and all betas for the other astronomy experiments or even Bill Thornton's chair, BMMD. We couldn't do anything with the - with a maneuver in, and again, that would disappear if we had magnetic desaturation; so I would really make it strong pitch for that in the future. But, again, it worked real well, and I was really happy with the way that - that all information came up. We all learned along with you. The cards changed about - We had a cue card up there with -

GIBSON (CONT'D) We had it taped on there. And we have four or five taped one over the other, and it just got thicker and thicker. But we learned right along with you, and it worked out real well. We did more maneuvering with two CMGs than I ever anticipated we would do with three. And that goes to - That's a credit for everybody who worked on that one.

POGUE One of the things that's implied by Ed's comments wasn't mentioned specifically, and that is a limited - limit to three displays. And this, of course, is why he was wanting a caution and warning or some - some kind of indication when you're approaching limits. A lot of time, you call out the - Well, you can call any of three. You call - can call up three displays at any time. You may have attitude errors. You may have attitude or something else - rates, etc. So even though you have called about errors, you've got to keep switching back and forth. Then there's a good argument to be made for having something like a CRT, where you can display a number of parameters en masse, like it's in the MOCR. But that would of - It would have helped if you had been able to see all the stuff. We were always clicking back and forth or doing something there, trying to get the right displays up.

GIBSON One last thing - which - it was in the tech debrief, but I'll just mention it here also - on ACPS. When we started doing JOP 18D and we were really maneuvering the spacecraft around, it became obvious that there are two types of maneuvering that we were doing. One was large scale, getting over to the target, and there was a very - one was a very fine pointing. But once you get to it, you try to get on target. And trying to maneuver the - the whole vehicle to large angles the way we did, it was perfectly satisfactory. Put in DAS entries and make the maneuver and monitor rates of CMGs. But for the small maneuvers, where we are just maybe making a - a drift correction every 5 - 3 or 4 or 5 minutes in order to keep up with the comet or to try to locate it, center it, it took 20 key strokes every time we wanted to make a - a maneuver. And it became obvious that we were doing nothing more than what the ATM was doing on the Sun. And we ought to have a - a closed loop system - that is, a visual feedback - so you could see what you want to point at with a telescope, for example, so you can actually see the target. And secondly, have a little swizzle stick there - little control stick - the same way as we had on the ATM - which allows you to just move over there. And you just put step entries into

GIBSON (CONT'D) the - The stick could put step entries into the CMGs in the same way you do with the - through the - through the DAS.

QUERY One thing on the JOP 18D that - You just reminded me of - of it. The - One of the problems that we might have had was that nonlinearity in the television monitor, the - where a circle doesn't turn out to be a circle. And I wondered whether you had noticed, say on S052, when you were looking at the Sun and seeing it on the display, whether the occulting disk appeared as a circle or had some distortion?

GIBSON That slightly - appeared slightly oval. And we called this down and asked if people wanted measurements of it, and no one really ... about it.

QUERY It would have been - In retrospect, it would have been useful to have that measurement so that we could correct JOP 18D measurements that you made in order to - -

GIBSON Yes.

QUERY - - put in the bias maneuver.

GIBSON I never really felt too satisfied with that whole system. The only way - It always took me a little bit longer to do the maneuvers on JOP 18 than were allowed for

GIBSON because they usually made two maneuvers rather than one. I'd go down to - If you started with - at this point out here, I usually try to maneuver twice the amount over to here and yet end up over here somewhere. You see what that attitude error is. Get yourself right back into here and then figure half of that attitude error in. Hopefully, that would eliminate that. But, again, what you're pointing out is that maybe this whole thing is nonlinear from here to here. In other words, this distance which looks half here might only be 45 percent.

QUERY All the other TV display systems that really - you would want to make measurements, you have marks on the face of your camera, too, that would show up as, say, a black spot or a white spot on your monitor, and this would provide a calibration of any - any errors in nonlinearity you might have.

GIBSON Yes. What you're saying is, we should have had it on the TV itself, right on the - the vidicon.

QUERY Right on the vidicon.

GIBSON Right on the face - like you have a resolve lens on a camera.

QUERY Yes.

GIBSON Yes, that would have helped. Of course, the best thing is to have a telescope which gives you a - a closed loop feedback so you can just - -

QUERY Completely optical, rather than electronic?

GIBSON Yes. Well, it could be a - a vidicon again, looking through a telescope. But, of course, this thing - whole thing was put on at the last minute.

QUERY That's right.

GIBSON It was not designed for what we were doing; so I was pretty happy we were at least able to do something with it. But it was - You know, when you wanted that thing right down there to 0.01 of a degree all the time, right on the nucleus, there was no way we could guarantee we'd be anywhere near that close. I was figuring 0.02 or 0.03 is more like the nominal error.

QUERY One thing on the minor attitude biases, we found out really too late to do anything about. That quantization in the ATMDC made it where if you entered a 0.01, it would come out to just be something like 0.005; so this could be one of the reasons why we had some problems

QUERY (CONT'D) with making these bias maneuvers. Seemed like every - 0.01 was the worst error, 0.06 was very accurate, and then 0.07 would be real bad again. And 0.0 - 0.12 would be very - -

GIBSON Is this conversion of decimal to octal? Is that the - -

QUERY Something in there. I - I don't - -

QUERY We had to make all the entries, though, in octal. I'll talk to you more about that. I don't think it's necessary to hang up everybody in here, but that was probably on the same level of error as centering the display and reading it, too.

CARR Anything else, Chris?

QUERY You guys got anything else on APCS?

GIBSON No.

QUERY Okay, very good. We'll go to the thermal ECS then, and Bill Patterson will lead the discussion.

PATTERSON The - the first question concerns humidity level. Early-in-the-mission crew comments - and then again in the tech debriefing - in - indicated that the humidity level was lower than desired during the first part of the mission,

PATTERSON (CONT'D) and there was some discussion about using wet towels to increase that level. Did you ever really do anything like use wet towels to increase the humidity in the first part of the mission?

CARR We never had time.

PATTERSON Also, in the tech debriefing, the comment was stated that the humidity level was good. Was that good from a comfort standpoint or good from the standpoint that to - that moisture tended to dry up, you know, and not cause any problems in that period or both?

CARR Well, after we got used to it, it was from a comfort standpoint. But at first, when we got there, it took our bodies a while to adjust to it. We had a lot of cracking skin and dandruff. We had to take a lot of special precautions to keep the humidity from bugging us. And once we adjusted to that, it was - it was good from a physiological standpoint. And, of course, the other one is the fact that it dried up quickly. You didn't have the moisture that promoted the growth of bacteria and things like that. So we had enough fungus up there, and if it had been any - any damper up there, we would have probably had a whole lot more.

PATTERSON Thank you.

PATTERSON Again, from the tech debriefing, the comment was made that lint and condensate water was sucked out of the OWS heat exchangers during cleaning. There was only one time that we thought this occurred. This was on mission day 66 when we actually got - we knew we had water - or pretty sure we had water in those heat exchangers. The question is, did that occur, or did you notice that each time you cleaned them, or was that the only time you noticed that?

POGUE We noticed it each time we cleaned them after I made the special tool modification. And what it was - it was a regular crevice tool which I modified with the lid on a food can to make it so that it was perpendicular on the end.

QUERY Hu-huh.

POGUE And then I took some Mosite and wrapped around it so that I could mash it down against the - the vanes, cooling vanes on the OWS heat exchanger in order to create a fairly good seal. And that was - that was the first time that we had noticed water in the heat exchanger vanes. Now this was during very high beta angle.

CARR We never saw water in there, did we? You'd look down there and it just looked like a lot of lint.

POGUE Only after - after I got through vacuuming. If you looked down in there when you took the cover off, it looked fine. It looked - it looked like it was crudded up with lint.

CARR Yes, but dry.

POGUE But dry.

PATTERSON Another thing, we noticed that the dewpoint on mission day 65, the day before we asked, you know, about the cleaning - that the dewpoint went up a few degrees. Do you recall any unusual spills or anything that might have brought the dewpoint up?

CARR Well, there's - there's a few things that will bring the dewpoint up in the workshop. Number 1 is the shower day. Another one would be the day that I do command module housekeeping number 7 when I bring three to four sloppy wet towels down into the waste management compartment to dry out. The idea here was that we soaked up all the condensation water in the - in the command module and I certainly didn't want to leave the towels there to

CARR (CONT'D) dry out, or the condensate would just end up right back where it was. So I took the towels as far away as I could, and that was to the waste management compartment where we had some towel holders to stuff them in, and we'd let them dry down there. So you might check and see if - if the log indicates that I had just finished, maybe the day before, doing an - a housekeeping command module number 7. 7-day housekeeping - -

GIBSON What day was that?

PATTERSON Mission day 65.

GIBSON Oh, okay. It was a little later than that, towards the end of the mission, when we had the rice seeds growing. We took the cover off and - and then just put water on the outside. And it was about this size of a cover, maybe about this far across. And I took and put a bubble of water on there like this. And that would evaporate in about a day and a half. So we had an area of maybe 3 inches by 6 inches or water evaporating all the time the last week or so.

PATTERSON It took a day and a half to evaporate?

GIBSON Yes, it took about a day and a half.

PATTERSON That's - Okay.

POGUE It sounds like that's about the - that was on about a day off too. 65, that's days.

CARR Let's see, we had a day off on day 70, didn't we, or 71? Day 70 was an EVA, I believe, 71 or something.

POGUE Well, I remember - -

CARR That's about right.

POGUE It's about right for a day off.

CARR It's close to a day off.

PATTERSON Could have - could have been a shower day.

CARR Yes.

PATTERSON So, in summary, you do feel like it was water in those OWS heat exchangers that - - ?

POGUE No doubt about it.

PATTERSON Okay, that's interesting.

POGUE Because we had water in vacuum cleaner bags to the point that it degraded the operation. In fact, I figured out one of those - I didn't know it was getting

POGUE (CONT'D) water on - I noticed a distinct chilling effect on the - the metal part of the vacuum cleaner - the handle. And I wasn't aware that that was being caused by - by sucking water up in there, until it was too late. I got water in the bag; I got water in the hose.

PATTERSON The next question concerns the ATM C&D loop. You asked to turn the pump off during sleep periods at - when we had the high-flow rates and the question is, was the noise of the pump both - bothersome during normal working hours, or only when you were trying to sleep?

GIBSON I guess it was noticeable during normal working hours. I wouldn't say it was really bothersome. You had the rate gyros drilling away in your ears when you were at the ATM, and the other noise was perceptible, but not that much more annoying.

CARR When you're awake, noise levels like that, you get used to.

GIBSON Yes.

CARR For instance, that lousy 6-cycle-per-second radio tone that we had, just got terrible. But you got used to it. And this thing - this ATM coolant loop tone was a pain

CARR (CONT'D) in the neck when you let it - you know, when you listen to it and let it bug you. But after a while, you just mentally begin to block those sort of things out and you forget about them. But at night when you're not thinking and you're not busy, then noises like that begin to bother you, and that's why we wanted to shut it down.

PATTERSON Okay, the next question concerns the ventilation system. Results of previous debriefings indicated that the ventilation diffusers were not frequently adjusted. Were the floor diffusers adjusted with any frequency to attain comfort? And if so, what position were the diffusers generally left in?

GIBSON Sleep compartment, I think is the only ones where they actually changed. For myself, when we got to high beta, I used to direct the flow more up towards the sleep restraints. Other times, I'd have it just ad - adjusted to the minimum flow rate that I could get without getting a lot of noise associated with the turbulent air flow.

PATTERSON But as far as the circular diffuser, you didn't see - readjust those?

GIBSON No, I didn't change with those things at all.

POGUE I changed the one up there by EREP, I think, twice. To keep - It got pretty cool in the MDA and - working at the C&D panel for an extended period of time or even the VTS. At one position, I don't know which it was, but it blew right on your head.

PATTERSON This - we - We noticed the comment about the possibility of using a swivel.

POGUE Yes, that'd been nice.

PATTERSON Yes. Would you comment on your thermal comfort or general comfort throughout the mission?

POGUE We had plenty of control. Except for the - for Ed's sleep compartment.

PATTERSON That's where the hot spot was?

CARR Yes.

GIBSON Yes, I really got warm in there, but there again, it didn't feel that uncomfortable because the humidity was way down. But it was a thing if you tried to go to sleep for some reason where a little too high a temperature, you just couldn't go to sleep, and that's what I experienced. I didn't feel too uncomfortable

GIBSON (CONT'D) in there, but have you ever tried to go to sleep when the - out in the desert with the air 85, or whatever it is in there; a lot of radiant heat coming off the wall. It just was not possible.

POGUE That radiant heat was - I walked in there a couple of times and it was - it really impressed you as being very, very warm in there. Drives those - -

CARR There's a lot radiant heat over behind the workshop control panel - the instrument panel over there, panel 600 series.

POGUE Right.

CARR Lots of heat - radiant heat off those things - -

POGUE And the plus-Z SAL, of course and those wat - in the water tank area above that. Where you walk over there and do something and the - the - had the dry bulb temperature of so many degrees plus that radiant heat, boy, it would really build your body heat load up fast.

CARR It's amazing how sensitive the - your body is to this - these temperatures. I noticed, just as soon as we started up in the hot case, we all started having trouble getting

CARR (CONT'D) to sleep. When you get about, oh, something like 2 or 3 degrees above what's comfortable to you, it starts bothering you.

PATTERSON This - -

CARR You have to readjust.

PATTERSON You mentioned the plus-Z SAL and you - you also mentioned the water tank, directly above that on position - -

POGUE Actually it was - I'm sorry, it wasn't right above it. It was over - if you were facing the plus-Z SAL, it was over to the right some. Wouldn't that be water tank 3?

CARR Let's see. I guess it's more - -

POGUE Or 4?

CARR Wouldn't you say it's more over toward T020, M509?

POGUE That's what I mean.

CARR Film vault area there, which I think was right under the edge of the parasol and sail. I think so.

POGUE It must be over close to the edge of that - -

PATTERSON Yes, we would suspect it would be over at the end of the - the edge of the sail.

POGUE And Ed's sleep compartment's on the other end.

QUERY Right.

PATTERSON Did - while we're talking about hot spots, did you notice any other - or any touch temperature problems encountered following these EREPs and maneuvers at the real high betas; you know, where we turn the shield - we've got the Sun on the gold?

GIBSON I never noticed a touch temperature problem at all in - anywhere in the cluster due to any reason.

PATTERSON Okay.

GIBSON One where they worried about touch temperature was on - We turned the ATM coolant loop off and worried about the TV monitors heating up. And you could take one - have one monitor off and one on and just feel the difference between the two, and it was just barely preceptible. And that was having it off for half an hour to an hour. I gave the details on the downlink once. And I think we were really overconservative in use of that ATM C&D with the coolant loop off.

PATTERSON We touched on this question yesterday in the contamination session, but, again, did you notice any changes in the

PATTERSON (CONT'D) gold or the white paint, the gold paint or the white paint from the beginning or end, through the end of the mission; any Deltas?

GIBSON Hmmm -

CARR I don't think we could - think we sensed it. I sure didn't sense any change.

GIBSON No.

CARR I'm sure there was some. The change that I sensed was on the contamination that was deposited on the windows of the command module. As far as colors of the tape or the paint, that was awfully hard to do. I was just impressed by the fact that it was already tan or yellow when we got there. And I don't have a strong feeling whether it was any more tan or yellow when we left.

POGUE The only thing that impressed me - of course, I went out Thanksgiving Day and then later on Christmas Day, and I could tell a difference in the command module, white paint on the command module. But that's all. It was much more gold - or, you know, it was - it was white, obviously, the first week. We went out I guess about day 5 or 6, whenever it was, and then during - on

POGUE (CONT'D) Christmas Day it had definitely turned a much more brown - gold-type color.

PATTERSON The next question concerns the odor that was mentioned in the tech debriefing in the waste management compartment near the end of the mission. Let's see. You noticed that - well, what we were trying to do is trace the charcoal canister replacements, which - We only found one on mission day 55. And what we were thinking is maybe the canister was overused or something and allowed some odor, possibly, to get up in the motor.

CARR Didn't you folks get the word that we - in our - in our downlink tapes that we - we pulled the boot off the top of the charcoal canister and sniffed, and that it was - the odors coming out of the canister were good and clean. But it was out of the blower, is where the odors were coming from.

PATTERSON Yes. I guess we were - right. We - -

CARR So how can you even consider there's a problem with the canister?

PATTERSON Well, the reason being that it was scheduled for change every 28 days. We were just wondering if the canister

PATTERSON (CONT'D) was left in there a long time, could have - you know, been completely poisoned or something and allowed something to get up in that motor to give you the odor in the motor area?

CARR I don't know. You guys would know that better than we would.

POGUE But you're right; it was only changed out once.

PATTERSON Okay, that's - -

QUERY Okay, that's ...

PATTERSON There - they have a few questions relative to the refrigeration system. Doug Moss, ...

MOSS Okay. During the SL-4 deactivation, you guys were asked to go to panel 611 and close the PRIMARY LOOP circuit breaker on that RADIATOR BYPASS VALVE controller and to cycle the SECONDARY LOOP circuit breaker. Now, each of those motions should not cause any movement of the bypass valves or anything; that's just setting us up, you know, for postmission testing.

POGUE Right.

MOSS But at about the time these things were scheduled, we noticed a definite degradation in the primary loop at that time that we attributed to a bypass valve motion because our temperatures started getting hotter; our pressure dropped off just like you tried to go to a bypass mode or something, even though it shouldn't have done that. What we want to fine out - if there is a relationship between this apparent failure that we saw and the motions of the circuit breakers. And in listening to the loops, we heard that you guys were asked to doublecheck to see if you had closed those circuit breakers about an hour after we started seeing this degradation. The degradation seemed to be consistent with when you guys should have closed it. What were the results of that doublecheck? We didn't hear any words back.

POGUE It was correct.

MOSS It was correct?

POGUE The configuration was correct.

MOSS Okay.

POGUE I - I had a pretty good idea what you were talk - why you were asking it. I mean, I didn't know that you'd

POGUE (CONT'D) started experiencing degradation, but I knew there was a problem in this area.

MOSS Yes.

POGUE Because we had been fairly carefully brief - preflight.

CARR When was this done? Near the end of the mission?

MOSS Yes, during deactivation. Matter of fact - -

CARR It seems to me I remember we were fooling with the refrigeration system real early in the mission, too. Did we - didn't you folks have us do something early in the mission with the system? And it seems to me that your freezer temps all started up and people got kind of worried about it, and then they leveled off and went back where they were, sometime like the first third of the mission, around that period of time.

MOSS I don't recall right off. Bill, do you?

QUERY No.

MOSS But, basically, anything you guys did to the circuit breakers shouldn't have caused it. We're just trying to see if we can get a relationship, you know, for

MOSS (CONT'D) a subsequent check on that. I really don't recall. Listened to the contamination comments yesterday. You stated there was some difference between the apparent degradation of white paints or discoloration versus what was captured on film. Could you comment on that in respect to the radiator - refrigeration system radiator?

CARR Oh, we couldn't see that. We - -

MOSS Couldn't see it during the flyby?

CARR During the flyby, we may have a picture or two on that.

POGUE Oh, we do have.

MOSS I thought I saw some pictures on the thing, but they looked very clean.

POGUE Oh, yes. That - that aft radiator looked all right.

MOSS Looked good, huh?

POGUE Yes.

MOSS Okay.

CARR But, again, we were a good distance from it when we saw it.

QUERY Yes.

CARR Because when we went over the ATM, that - at that time, I quit worrying about how close we were and I let our range open as I was moving off toward the separation attitude. And this was - this was planned. We had decided that once we cleared over the top of the ATM and got the top of the workshop, then we wouldn't worry about the range any more or waste any more gas trying to keep it in tight. The photographs, in general, are have a tendency to wash out this thing. We took a look at the master print of the 16-millimeter EVA stuff we took, and that print is a whole lot better color - color definition than is the first print that we saw. You know, I - yesterday I was complaining because the photography washed out all that you could see. But I was pleased yesterday afternoon, when we looked at the master print, to see that there is better color in that. So it appears that the more times you copy one of these things, or the further down the copy chain it gets, the more of that definition you lose.

POGUE One question we should ask you, and that is, it was very easy for us, with the eye, to determine the degradation of, say, a white. But the radiator - the refrigeration

POGUE (CONT'D) radiator, that thing on the back end of the vehicle is, as far as I'm concerned, black body. Wha - How would we recognize the degradation?

MOSS The radiator itself was the S13G white paint, that octagonal shape.

POGUE Maybe it was a shadow, then. We were in SI.

CARR One thing about the white paint is that it looks white from a distance even with our eye. I remember, when we got to the workshop during the rendezvous phase, being so impressed by the stark white, the black, and the gold and how stark and clear they were. And then when we got docked, all the white was all of a sudden stained brown.

POGUE Gold.

CARR Gold, you know, sort of that - that beige that we've been describing.

MOSS So, looking at the photographs, it would be apparent that you guys were a good distance away from the radiator by the time you got around to where you could really see it ... - -

CARR I would say 250 feet.

POGUE But the photographs - there are photographs all the way around. What I suggest you do is the edge. You know the radiator come - is perpendicular and it's - it looks like it's about a foot wide; I don't know how wide it is. Is that white? Is that white paint there? If that is the same white paint that's on the surface of the radiator, then you've got a good gage to go by, because the other - -

QUERY That looked white to you, then? Would you consider - -

POGUE No, you look at the picture, and I think the pictures are fairly accurate; it was Hassleblad. I was not impressed with the degradation of color there. I mean it didn't catch my eye. It looked good. However, the - the flat portion of the radiator was perpen - was parallel to the Sun line so it was not illuminated. I thought it was black.

QUERY Okay.

POGUE So it'll appear shaded. If you'll take a look at the - at the Hassleblads, and there are beaucoup pictures as we went over the back side there, then you ought to - you should be able to compare it with the white paint on the booster pattern.

QUERY I get you. Okay.

CARR Yeah, you must realize that during this flyaround that I wasn't at all interested in any kind of detail. I was mainly concerned with keeping my - my vehicle from - in the right relative position to that vehicle, and I was looking at big things. Ed really didn't have much opportunity to look out at all, because he was supposed to be watching my instrument panel and doing some time checks to make sure that we were using - getting around on schedule. And Bill, in the right side, was not as interested in detail because he was busy getting photographic coverage. So it's awfully hard for us to tell you too much about the details of what we saw because we just weren't looking.

POGUE There is a good gage for whiteness in that the - one pole sail. I think you're familiar with our report that one of the folds opened up and exposed a relatively new white area? I suggest you use that as a sort of garden-variety gouge and gage.

QUERY Okay. I want to show you a sketch that I made here. It's a crude one. These are the - consider this as a food storage freezer with the three doors here. We determined kind of late in our design that we had some thermal shorts where these little X's are. And I think that's where - -

CARR You sure did.

QUERY - - you saw most of the ice buildup. We were aware of it ahead time. But what we did is run a little test program to try to satisfy ourselves that that wasn't going to be a problem versus, you know, a major redesign of that area. So I'm gonna ask you a couple or three questions as my last questions, and, if you would, comment with respect to that area as well as any other areas that might have ice on them, because I think there would be a significant difference in the thickness of ice and so forth. And - -

POGUE Are you talking about the chiller and two freezers, or is that the three freezers up in - -

QUERY Well, either one. I - you should have seen it between the two freezers ...

CARR Between the two freezers down below?

QUERY Right.

CARR You definitely did have the thermal short there, and the first ice buildup that you would get would be a line, like an icicle sort of thing, right there.

QUERY Sticking out between the doors.

CARR Right. And then as that ice built up, as it got bigger, it would begin, apparently, to distort the door a little bit, and that would allow ice to build up all the way around the door.

QUERY I see.

CARR And about the time the - the ground came up with a housekeeping assignment to scrape the ice was about the time we were beginning to have trouble opening the door because of friction in the - in the latch.

QUERY And that was - then the first time it became a problem is the next question I have, which is really kind of routine to you. It became a problem, I guess, about every time it was time to clean it.

POGUE That's about right. And when the power to close the doors - open the doors - -

CARR The symptom was you'd close the door, you'd slam the door, and it would close and then you would have to really fight with the button to get it to unlatch, because there was so much friction. You'd push on the handle of the door and push down on the - on the lever - on the handle in order to unlatch the door.

QUERY Okay, now one other thing on that, on the freezer I guess there was a piece of metal foil tape, you know, like so wide, that went around the freezer itself that the rubber seal stood against. Did you notice that previous crews cleaned this freezer or anything? That thing wasn't meant to be cleaned as you know. Did you see any apparent mechanical degradation of that foil? Was it torn, anything like that that might accelerate an ice problem?

CARR Yes.

POGUE Very definitely.

CARR And we did our bit on it, too.

POGUE That's right. We sure didn't help it any. And I would suggest that in future systems you have removable ones, replaceable ones. Either that or get a hot - have a frostfree or self-defrosting or something, because that was a real problem. It's hard to get to, too. I think we've already mentioned that little inner door there; that really presented a problem.

QUERY Yes, that's right.

QUERY That's all the questions I have on refrigeration.

QUERY That's all I have.

QUERY Anything else, Bill?

QUERY I see EGIL Steve back there. Steve, you got any questions you want to ask in the thermal/ECS area?

McLENDON Now, one of the - one of the things that was - that was brought up, I think, at the first - -

CARR Want to slip him the microphone there?

McLENDON One of the - one of the things that you were talking about there at the first that - you were talking about some stuff that we asked you to do in the first - I think it was about the first week of the mission, as far as the oil system went. We had you play around with it. I remember that fairly well, and what the thing here was is that we saw one of our chiller temps decrease about - I guess it was about 5 or 6 degrees. And all the other parameters looked good. The only way we could explain it as far as a rational explanation was if you - if you transferred something out of the freezers into the chillers.

POGUE And we hadn't done it.

McLENDON And we'd asked you about that, and to this day that ex - that remains a mystery to us, and we just don't know what happened there.

POGUE That was a clear-cut answer that we gave you. I looked in there, and there was nothing in there and no one had transferred anything in there, and we couldn't explain that spike anyway.

CARR That's right, that was that. Black magic.

McLENDON Okay, thank you.

QUERY Okay, thank you very much. I guess we're ready for the electrical power system then.

CARR Wait until I ... without ...

POGUE ...

GIBSON ...

GIBSON I'm sure we've got two or three or four other ones.

CARR Well, I can't think of any ...

QUERY Did you guys get coffee?

POGUE No, thank you.

CARR I'm good for right now, thanks.

QUERY Al Woosley from Marshall will lead the questions. Al, when you're ready, go ahead.

POGUE What about the ... acting ...

QUERY You can - It'll - the mike will lock up. There you go.

QUERY Push it in and raise it.

QUERY Push it in and raise it.

WOOSLEY These are the EPS questions. During predock and station-keeping, where we have reference to these questions, are the full lights on the discone antenna visible? And were they visible? And do you think that they were necessary to have lights on the discone antenna? Did you observe them?

CARR I didn't observe them at night, because about the time I could see it out the front window is when we pitched forward, so Bill, who was looking out the telescope, could probably comment on that. But see we were pitched up so that I couldn't see the - the workshop during the breaking or during the final terminal phase. And after I did the last midcourse is when we pitched up, and I could see it, and we were already in daylight. So - -

POGUE Yes, I could see the lights.

WOOSLEY You could see it?

POGUE Yes.

CARR I would think that for night stationkeeping that you would want those lights, because you need to spread out your target as much as you can at night and get your peripheral vision as good a chance as you can, because depth perception isn't - is nil at night anyway because the loss of - what is it the rods or the cones - I can never get it straight. But anyway there - -

POGUE Cones.

CARR The one - one type of visual sensor just doesn't work at night, and that's where you get your depth perception. So you need them.

WOOSLEY You would - even though you didn't use them, you would recommend them.

CARR Yes, sir. If I had to do any night stationkeeping, I'm pretty sure I would have been very thankful they were there.

WOOSLEY Are all of the colored running lights still burning on the airlock?

POGUE Couldn't say.

CARR Yes, I couldn't say either. See, we left in daylight. And -

WOOSLEY And you came up in - in the night.

SPEAKER But on rendezvous, do you remember?

POGUE I - it was a bunch of lights. I - I didn't have anything to compare it with, you know, I just - -

CARR See that was 4 months ago. There's no way we're going to remember that kind of thing.

QUERY Do you recall - -

QUERY There were - excuse me. There were some photography - some movies taken at that time and stills. You might want to check the photographic record for the specifics. You will be able to tell some of that, you know, from whatever photography is there.

POGUE Might be able to do that, because the - if I remember correctly, we got some - with a fairly good lens, we got some pictures of that during the stationkeeping and prior to docking. And the workshop was against night sky or the black. So if it registered - of course it was brightly illuminated, so it may have washed it out. But you can check it for that.

CARR We talked about putting the camera up to that telescope. Remember? And taking a picture, and then we never did get around to doing it.

WOOSLEY Do you recall if any of the AM EVA lights had burned out?

CARR No, sir. I don't think so. They were all right.

POGUE We had plenty of light at night.

CARR The lighting was excellent at night on the EVA trail.

WOOSLEY ...

CARR I don't remember seeing any that were dark.

WOOSLEY You commented quite a bit about the lights in the airlock, but I'm going to ask you, if you don't mind, a few more questions or one question. How many of the 10-watt and 20-watt airlock lights required replacement?

CARR I changed out every one of the lights in the aft airlock on one occasion and a lot of them were still working, but they were very, very dim because the filament had plated out on the inside of the glass and just completely wiped out the light itself. And I noticed that one or two lights in the STS area and in the forward airlock were about ready for replacement, but I never got around to it. It was just one day when I wanted the light. I was getting ready to service the PLSS bottles or the PSS bottles. And I decided, well, once I've started, I'll go ahead and change them all. It only took a couple or 3 minutes to do it,

CARR (CONT'D) but it was either burnt out or it was so degraded due to the plating on the inside of the glass that it required changing, but it was a very marked degradation of light, transmissivity.

QUERY Now is this the bigger - the 20-watt bulbs or the handrail lights too. Did they deposit - -

CARR Oh yes, the handrail lights had deposits on them, too.

QUERY Both of them?

CARR The ones on the aft airlock, it seemed to me, were the small lights, the 5 or whatever that amp was - 10.

QUERY 10 watts are the small ones.

CARR Yes. But you know, we saw a few of those light bulbs over in the trainer all plated out too, and we were kind of surprised by that and remembered the other crews telling us, yes, and you're going to see that in flight, you're going to see a lot of those lights plated out. And that's surprising to me.

QUERY I guess we missed out in the other debriefings; we didn't get a report. At least I don't recall ever hearing a report until we saw yours on this deposit.

CARR I wasn't surprised when I saw them plated out because we've seen them in the trainer all plated out, and I was surprised why we ever bought that kind of light if it was going to plate out on us.

QUERY Did you have any problems - did you encounter any problems in the replacement of the bulbs?

CARR No, sir; simple bayonet fitting, no problem at all.

POGUE One of the things that bugged me about those incandescent light covers was that they didn't seem to want to stay in position; they're always sliding out - out of position.

CARR They were very easily bumped free.

QUERY Now is this the ones on the handrails or - -

POGUE Yes, on the handrails.

CARR Those little ball detents just weren't strong enough.

POGUE They weren't strong enough.

CARR I'm surprised we didn't kick those things off and then kick a light bulb and break it, but we never did.

QUERY Never did break one?

CARR But we sure did bang a lot of those covers off and have them slide down the handles.

QUERY Now, let's see, the 20-watt bulbs had the metallic screens over the glass. Isn't that right, Dennis?

You had a screen over the glass on that large one. Did the tracking and the acquisition lights operate properly? The blinking lights?

POGUE Yes.

CARR We kind of figured there would be - it would make tracking a little more difficult having an occulting light. And, as I remember, you made a comment that by golly, just like the simulator, it made it a little more difficult to track when it was occulting.

QUERY Oh, it did make it more difficult?

POGUE Well, yes, the thing is, when you're tracking with the little control. You're ready, being ready to mark, and the period of the flashes is such that during the dark period, you don't know where the target is for control. So, everytime it blinks, you know you're - you're chasing it back to the crosshairs. So then when it blinks, if it's on a crosshairs, you mark real fast. That's the problem.

CARR The message here is that the occulting period of the light for tracking lights should be, I think, sped up.

POGUE Yes, it was like a strobe, you know, about 3 cycles a second. Even if it was only on for a thousandth of a second, it would enhance the tracking operation.

QUERY Give you a more continuous light so you could get your mark.

POGUE Yes.

CARR I guess the reason for the occulting, the flashing of the light, was to - so that we could tell it from a star at night, but the thing was we just had a - the frequency was much too - too low. And it was off too long and if you were trying to track that rascal into a crosshairs to make a mark, it would go out just as you were getting into a crosshairs to make a mark, it would go out just as you were getting into the crosshairs and you would say well, shall I mark or shall I not and if you don't it will almost always end up outside on the other side or something.

POGUE That's compounded by attitude control system thruster fire, the RCS thruster fires in the command module. So

POGUE (CONT'D) if you have a fire in - while the thing is off and you mark, you can - you could induce a large error in the solution. You got to be very careful.

QUERY Okay. Did any of your airlock status lights burn out much on the panels? We'll say 203, 416, 205, 206, those status lights?

POGUE No, we watched those; we kept them down and out, respectively, the ones that had the rheostats and so forth. So they didn't burn out like they did on the simulator.

QUERY Or like they did at the Cape, too.

POGUE Yes. Right.

QUERY Next question concerns electrical connectors. Which type of connector is preferred for connecting and disconnecting by the crew, the zero-g or the microdot airlock or the Bendix with the crew assist ring? Would you care to comment about connectors, in general, that you had to mate and demate.

CARR I personally preferred the zero-g.

POGUE The zero-g is almost impossible to screw up, but there's - there's a slight modification that would really improve that, in that if you were in an awkward posture, in other

POGUE (CONT'D) words, if I was trying to put it in that way and I was reaching around because of inaccessibility. It's - it's a little bit difficult to clock that thing and get it in right before you can start moving the lever, and there seemed to be a lock up feature because of the linkage. It would sometimes jam that - the lever that puts it in that position. We knew that before flight, but that appears to be a pretty safe connector and almost impossible to ruin, I mean, you know, to put on incorrectly.

CARR I'd say it's far superior to the other types. It's got a little way to go yet, but it's a far superior way of making connections than some of the others.

POGUE But it does - it should have those little - a couple of little things removed from it, that is, it's sort of difficult to get it in the right position. You know, you got to put one of the little lugs in and then sort of rotate it into the position.

QUERY Yes.

POGUE And then you got to push the - -

QUERY All the way up before you can operate the handle, if you had - -

POGUE All the way up. That's correct.

QUERY So I remember, I guess, if you operate the handle too early you - -

CARR Yes. You ... yourself up and have to start over.

POGUE But you can get it in the right position and start to move the handle to move the connector into position and it won't move. It sort of goes over center, locks out over center, and then you got to sort of lift it and play with it a little bit, and as soon as you get it out of the over the center position, then it pushes - moves in rather easily.

CARR Okay.

QUERY Was - I believe I covered the connectors - was meter lighting used in the STS? Did you use the - -

POGUE Meter?

QUERY Meter lighting?

POGUE Yes, I did occasionally.

QUERY Was it adequate?

POGUE Yes.

QUERY Is meter lighting considered necessary? Do you find that - -

POGUE Not in the STS. It certainly was necessary in the airlock, I would say, prior to EVA egress. Here, let me - the reason, now, is this, don't take that as the gospel. Because the reason I say it was all right was because there was enough ambient light in that area usually so you could read the meters.

QUERY Yes.

POGUE We really didn't need meter lights. I used them for general illumination when we were - a low light level illumination when we were doing comet photography; that's the only time I ever used them. But that isn't using them for reading the meters, however, if you had a dark area, you'd want a meter lighting, so that's why I say, I don't want you know, to be - want to be misunderstood on it.

QUERY Okay. Were the - this is airlock again - were the variable dimming controls for - provided for STS and meter lighting utilized? That's for the handrails, the panel, the forward and the aft lights had the variable dimming controls.

CARR Yes, I think we all used them at one time or another.

POGUE Why didn't we have variable dimming on the status lights? That would have been nice. You know the green-amber lights, if for no other reason than it would have improved lifetime in the bulbs. Of course, if - what I'm saying is, if one had to monitor systems manually. We didn't have to do that; we never faced the problem. Ground took very good care of this system. If we had had to go manual on EPS, we would have had a problem, because we could have always been turning status lights on and off everytime we went up there because we were afraid the bulbs would have burned out. It would have been nice if we could have dimmed them and preserved the filaments, assuming that would do it. I don't know if that would have worked or not, but I just think that putting lower power on the filaments would have increased the lifetime.

QUERY It may or may not.

QUERY What it would have prolonged the life, you mean?

QUERY It may not.

QUERY But he asked the question why we didn't have variable controls. You remember that? You got any background?

POGUE There's another operational impact and that is those are awfully bright lights. It's amazing what a tiny, bright light will do to distract you. We had one on a timer on the ATM panel and it would have been nice for that reason also, and again that's assuming manual control with EPS.

CARR Although the record light on the SIAs too.

POGUE Oh, yes.

CARR Sometimes you'd have to put tape over that when you were in there trying to do comet photography and you wanted it perfectly dark.

QUERY In this area I have another question, and that is - I think you've answered it - is it a desirable feature and do you even recommend it for consideration even for meter lighting, that the dimming control is a desirable feature?

CARR Sure.

POGUE I think it is. I think you get operational situations where it is going to be a necessity.

QUERY The next questions have to do with control and display. Any general comments about physical arrangement of switches and circuit breakers and the identification of switch - systems on the control and display panel?

CARR We covered that adequately in the technical debriefing. I don't think we need to waste any time at this meeting doing it. We really preached a sermon on that one.

QUERY I recall reading some of it about the nomenclature.

CARR The main thing that we said was that the C&D panel should have a design goal of giving the operator visibility into the system. And our best example of an ideally designed C&D panel is panel 225 in the STS. The fact that you've got all the pipes and the plumbing laid out and can see what the switch does when you do it, and that is a neat design goal; we recognize that you can't always attain that goal, but that's the goal. We got some panels in the workshop that looking at them gives you no hint as to what you're doing when you're throwing a switch. Sometimes even the words don't tell you a whole hell of a lot about what you're doing.

POGUE Sometimes they mess you up.

CARR Yes. But I think we've covered that pretty adequately, and we probably shouldn't use the time today to do that.

QUERY All right.

POGUE I would just like to emphasize where we've taken 200, 201, and 202 to task. The caution and warning is a case in point, though, where we could really have used some help with an ordinate-abscissa technique for identifying the inhibit switch. It was hard to find a switch on that panel. The ground would call you to go and inhibit such and such and golly, you know, it's like taking 52 cards and spreading them out on a table and say take out the ace of spades.

QUERY Maybe you covered this but I don't recall such illegibility of panel marking of switch and circuit breaker nomenclature under lighting conditions encountered during the mission. In other words, with the lighting that you experienced there, were you able to read, even though you didn't like the nomenclature and some of the arrangements?

CARR Seems to me we always had light available to read a panel with. I'm trying to think if there's any panels anywhere in the workshop where we had to worry about that. Something strikes me that we did somewhere, and I can't remember now where it is. But we always had lighting available that I can think of where - you could bring to bear on the panel to read it.

POGUE One thing that would be nice - airlock was a problem because we'd go in - we always kept the lights out in there most of the time. The light switch itself should be distinctively marked because it - it's, you know, like going into a dark room and finding the light switch if you don't know where it is. So you've got to have a light switch on before you can find a light switch. And that was not that much of a problem, but it was a little bit of a problem, because I remember several times, thrashing around in the air, because you could be clocked, see, when you went into the airlock module you didn't know which end was up and which panel had the light switch on it. It would have been nice to have a general illumination switch for an area, marked. Other than that, there was really no big problem. That's the only one I remember.

CARR Yes.

QUERY Switch and circuit breaker grouping versus task. Is the identification and grouping of frequently used switches and circuit breakers, adequate to preclude inadvertent operation of adjacent circuit breakers or switches?

POGUE No, it was not adequate.

CARR No. Again, that's pretty well called out in the tech debriefing along with our idea that you got to have visibility into the circuits that you are operating.

POGUE Yes, there were two problems. One is the visibility in the system was not provided and the other was ambiguous nomenclature and again I think we've gone into that.

QUERY I think you've covered that. For assessing the adequacy of onboard meter ranges and color banding.

CARR Well, there's nothing more impersonal on a meter than to read percentage if you don't have a feel for what it means. That is certainly an advantage from a design standpoint, because you've only got so many volts to work with and percentage is a lot easier, but it certainly does limit your visibility as to what you are looking at. If you have to remember that - that the 50 percent means 2 volts in this system and 14 volts in this system, and 7 psi in that system. That certainly does inhibit your visibility. Color banding - I have always been a proponent of color banding wherever possible if - if it will improve your visibility into a system. We played lots of color banding games with the lunar module and

CARR (CONT'D) the color banding that we used in the workshop in the 600 Series panels I thought was pretty good, but you have to be careful about parallax - is the biter there. And what we usually ended up with on a doggone color-banding thing is it's always an afterthought; it always gets put on the glass instead on the meter so you always have parallax and color banding just bites you. Same thing with airplanes today too. Somebody always decides to put the color banding on an exhaust gas temperature gage or a pressure gage after the thing has been built and so it depends on how you're sitting in the seat of the airplane whether or not you're in or out of the color band and you always have to worry about parallax. So there is a pitfall and the workshop have the same problems.

POGUE It was an interesting - -

QUERY Were you going to add something there with your sketch?

POGUE All right, let's say that because of the change in the acceptable parameters, this sounds contradictory, what Jer says but it doesn't have to be. If you could design something to - if you, for instance, if you had a green band hidden by two movable tapes which would identify a - in other words, the green would be blocked out

POGUE (CONT'D) everywhere these two tapes were, but left open where they weren't, then you could adjust for green-band operation. I'm really for green banding in a meter so you don't have to go interpret the meter every time you look at it. You can just see if the needle is in the green, you forget it. But it looked to me like we were - in some of the systems we accepted the changes in what were the acceptable ranges. And it would be nice if you could change those things manually for - for quick observation and then interpretation of the gages.

QUERY By some scheme of tape or something? Open it up?

POGUE Yes, but we had a fairly interesting scheme down in the refrigeration system in that there were staggered bands, if I remember correctly. And there was just a little bit of a confusion factor there on the staggered bands, but then I got used to it real quick. I thought it - overall it was a good idea it - but you had to watch what you were doing there; you could interpret a reading as satisfactory when it wasn't really satisfactory range.

QUERY Do you recall any nuisance circuit breaker trips? Any that popped open?

CARR No, usually when they popped there was a reason and I don't - we didn't lose many.

POGUE We - we never pushed a - I guess we never pushed a breaker back in without around - -

POGUE - - Concurrence.

CARR Yes, we usually got air-to-ground concurrence.

POGUE If we - I think we would have noticed that, that's what I'm saying and the ground would have - -

CARR We had some - -

QUERY I don't think we had any, but I've asked this question of each of the crews.

CARR Yes, we had a multiplexer problem or something with the communications about midway through the mission, and they had us cycling breakers and that's the nearest thing we came to having any sort of breaker problems. Finally after we cycled a whole bunch of breakers, the problem went away and I don't know if the ground ever figured out what it was, but it had to do with the communications and the way you folks were getting your data. One of those multiplexers or something was - -

POGUE I tell you one thing that was a bit of - not of a nuisance, but a sort of a pitfall, and that is you could throw those Gemini-type circuit breakers by touching them with a finger if you had happened accidently to use panel 200, 201, or 202 as a handhold. Just a very light pressure would flick it sometimes. I'm sure that would squarewave anybody if they were watching that system at the time. I did that a couple of times.

CARR I guess I don't really like that kind of circuit breaker.

QUERY My question really was for a tripping out, you know, from a spike or a current or something like that.

POGUE Yes.

QUERY Okay.

CARR I guess I don't even like that kind of circuit breaker, that little switch thing. They're just too doggone fragile. But I recognize that the other kind is awful beefy and takes up a lot more space.

QUERY Was - the solar flare alert panel - was it adequate?

POGUE Down in the workshop?

QUERY Yes.

POGUE We never really used it. That was actuated by a system which was not all that good of an indicator of a flare.

CARR Boy, I tell you, the South Atlantic anomaly was so much of a nuisance that we essentially killed the system down in the workshop in the experiment compartment because it was just a noisy nuisance.

QUERY The flare alert?

CARR The fire alert, no, we got a couple of fire alarms there.

QUERY I said the flare, the solar flare alert.

POGUE Oh, yes. We just - -

QUERY Because of the South Atlantic anomaly?

CARR Yes, and there's also some horns up in the Northern Hemisphere someplace.

POGUE Yes, that will really throw you off.

SPEAKER Come over Canada and get a flare and you know you'd look - it just bugged you and so we just turned it off and left it off. We could hear the one going in the MDA when it went.

QUERY Was it the radio noise that first bothered you?

POGUE No.

CARR No, the - either one. It was the either RF or - -

POGUE Yes, that's right; it would throw it off. We didn't set that up too much either, because that thing again - that would go off on the nightside for some reason or the other. You got an awful lot of RF on nightside of the Earth.

QUERY Did you - I guess I don't remember it - I got a question here on inadvertent operation of the switches and circuit breakers in reference to the guards. Were the guards - proper?

CARR Sometimes if you succumbed to the temptation of using a guard for a handrail, you were in danger flicking one of those little breakers. We did have a couple of instances of inadvertent switch operation in the STS area. One was the - what was the one you threw one time?

POGUE The timer, I advanced the day one flick.

CARR Yes, that's right.

POGUE I was up there doing something, working with the condensate system and I reached over and advanced the day of the year one.

CARR Also the guards restricted your visibility of the nomenclature on the switch or breaker and you find yourself playing this game, trying to check circuit breakers to see if any one was open or something like that.

POGUE It was hard to read the - -

QUERY We can understand that after looking at the closeout photographs.

CARR Yes.

QUERY For proper position.

CARR Yes, it was tough, but you've got to protect those dog-gone things and that looks like something you just kind of have to buy.

QUERY Were there any failures when lamp tests were performed?

CARR No.

POGUE No, I don't recall any.

CARR We did that; that was a periodic thing; it was a house-keeping task, I think. And - you go around and test all the lamps and report - report the anomalies and I don't remember reporting an anomaly when I did it, nor do I remember anybody else reporting anything.

QUERY Were any problems encountered because of the proximity of the rotating litter chair to the power and display console?

CARR No.

QUERY My next question here has to do with the digital address system. Did you use it a great deal or - the DAS system with the switch selectors, would its use - -

CARR With switch selectors, let's see, we helped the ground sometimes when they couldn't get to the switch selectors to turn the CMG heaters off and on. And we used it to help the ground once in a while when we - when they wanted us to cycle or inhibit doors and motors and things on the ATM.

POGUE Not much though.

QUERY You used it some for problem - troubleshooting problems?

CARR We didn't have to do much troubleshooting; things were working pretty well and only once or twice did we go into malfunction procedures. S082 A or B door, one of the doors.

We had a long pass between the door failure and when we could get to the ground and we went in with a malfunction

CARR (CONT'D) procedure and fooled with the switch selectors there. But really the occasions were few and far between. Most of the DAS usage we got was in relation to the APCS. We did a lot of DAS entry work doing maneuvers and things like that.

POGUE And monitor, but that's APCS though because we were monitoring maneuvers. Ed - Dr. Gibson's given a very good debriefing on the ATM panel which I'm sure includes the DAS. And if you have not seen that, I suggest that you read that because he's gone into great detail. There's about a 2-1/2, 3 hour debriefing on the ATM panel in general.

CARR This he did up there. It's on day of the year 19, I think. You might ask for those transcripts - very, very in-depth discourse on the ATM panel.

QUERY I have some questions, more on lighting again. Assess the adequacy of the control and illumination levels via control panel switches and light integral switches. This must be ATM adequacy.

CARR Well, they weren't too terribly adequate, because one by one they crapped out on us and we had to tape them over and we ended up with only fixed lighting available to us.

CARR (CONT'D) Fixed numerical, the fixed integrated died. We had neither fixed nor variable integrated, nor did we have variable numerics. One of the areas that we wished that we'd had some sort of a central control panel right at the ATM was MDA lighting because we found that each of us liked to have lighting at the MDA different when we were operating the ATM panel. And it would have been nice if we hadn't had to float around and one by one turn lights on and off at their stations because - -

POGUE The closest we had to that was a couple of switches there on the STS whereby you could turn - turn them on selectively in groups. We would like to have had individual control at the ATM panel.

QUERY Did any of the OWS and MDA general illumination bulbs fail? Any of them flicker? This is the fluorescent job.

CARR Not a one.

POGUE No, I was, in fact near the end of the flight, I remember thinking I expected them to go out and they didn't.

QUERY Well, I think a lot of people had expected it.

CARR Yeah.

QUERY I guess we've had a report of a report of one failure the entire 8-1/2 months.

CARR And the lighting in general in the workshop was very, very good, quite adequate. And in our M487 habitability debriefing, there's one question about the lighting and you can get some in-depth comments from -

QUERY I guess if there's a comparison from your previous answer on incandescent that, you - you like the fluorescent better than the incandescent?

POGUE I think so.

CARR Yeah, in general.

QUERY Assess the adequacy of the illumination of the OWS C&D panel.

POGUE Oh, gosh, fine.

CARR No problem. There's lots of light down there in the experiment compartment.

QUERY If the portable lights were used, any comments on ease of usage or the light output. Did you have occasion to use the other? I'm not talking about the high-intensity photo lamps.

POGUE Yeah, I understand. I used ... Did you use them any time?

CARR I never used them, but Ed did on - -

POGUE I did and Ed did. And the biggest problem was finding the cables, hooking the cables and stringing them up. And I think you had to hook the lights on to a universal photographic - photography mount. No problems. They worked. They - I remember they were sort of awkward. You bend it around and twist and everything to get the thing pointed the right way, but then we did that with the same - that was the problem with mount, not the light.

CARR Also, in the tech debriefing, we made a pitch for cable caddies, instead of fooling with all of those utilities cables that we had that had to be coiled and strapped. The - the cable caddy is one that you pull on that's got an inertial lock like a seat belt in your car.

POGUE And each one of them ought to be pattern coded, or color coded, so that you know whether you have a utility cable, a high-power cable, a television, a camera cable, et cetera, et cetera. Because they are all white, well, of course, some of them are bigger than the others, but it is nice to have them that way.

QUERY You'd recommend a color coding?

POGUE A color coding or a pattern coded.

QUERY Okay. Assess the adequacy of the portable high-intensity photo light.

CARR They were quite adequate. They were rather directional in nature, so they caused shadowing for photographing.

POGUE I got one big bug-a-boo about the high-intensity light. Functionally, they were great. The photography was good. But it - every time I turned those on, I got - was reaching over and getting a wrong switch and everything. In a way, it seemed like you always put the thing in position quick before you turn it on and you're always facing the front of it and the switches were always in the back, or hard to get to.

CARR Out of sight.

POGUE Out of sight. It would have been much nicer if the control would have been easily accessible from the business end of it. Because that's the end you were always facing.

QUERY Speaking of the switches, what operating modes - Do you recall what operating modes you used?

POGUE Always the high, on.

QUERY High stop put at half?

CARR Yeah. Both channels, both ...

QUERY Was there a problem of heat out of those?

POGUE ... heat.

CARR Yeah, but they sure did some - It sure makes beautiful light for a photograph. The documentary photos are all very well lighted. We were very well pleased. And the M151 people are very pleased, too, because the light gave them some real good data, particularly M092.

POGUE Along that line, another thing too, with these cable caddies and all, there should be central repository for placing and stowing these things. You know, like you'd have one locker dedicated for all these cable caddies and so forth. It was a little bit of a management problem, in that you didn't know who had had it last and he had left it - where he had left it and so forth. We had a sort of a system, but it was not designed into it. That should be designed into it, a locker or something like that.

QUERY Have some questions on wire harnesses and installations, any comments on any electrical equipment or wiring thereto that appeared to be an annoyance or hindrance to movement in the workshop.

POGUE Well, we had the - you had the - this thing that you did right near the end where you had the cable stretched to the airlock. When we were doing the 516, multipurpose furnace experiments, 556 and all, a big number of them, we had the cable stretched through from the OWS dome area all the way up to around the tape recorder. But the reason we had it for the video tape recorder was because we had taken the power out for the tape recorder and had hooked up 516 to it. That was a bit of an annoyance.

CARR Yeah, when we put the rate gyro six pack in, when Bean and his guys put it in, that automatically tied up one - one high-power outlet. And so what we had to do in order to get high power into the MDA for the things that we wanted was to run a big extension cord in from the dome.

QUERY Yeah.

CARR That was a bother.

QUERY Actually, this question was down in the workshop, but that's good to get those comments, too.

CARR Oh, I don't remember any annoying wire runs at all down in the workshop.

POGUE The only - we had to camera thread - the threading camera had to have a cable run from a particular position. Again, this would have been, I think, adequately taken care of if we would have had cable caddies, but we're thrashing around taking them out and putting them in and that sort of thing.

CARR The cable runs that bugged us the most are the ones we had to run ourselves.

QUERY Yeah, that'd be natural. Was - and again this was OWS cable - was any excessive fraying or damage observed to Fiberglas cloth covers or wire harnesses at penetrations in the floor or other areas?

CARR No, they were very well ...

QUERY One of the other crewmembers said coming out of the waste management area and something that they used one of the cables as kind of a handhold and that it did start kind of wearing somewhere down in - in the living area there.

CARR The only cable that I can think of is that one right there by the light switch there on the right-hand side of the door. And I didn't notice any problems. I didn't use that for a handhold. I used the ... itself.

QUERY That's where they come through the floor in the Fiberglas covers, you don't recall any damage to those?

POGUE No.

QUERY Okay. Did the convoluted boots come loose from any exposed connectors, in the workshop again?

POGUE No, not that I know of.

QUERY Any difficulty with the elect connectors for the food trays or the urine centrifugal separator?

POGUE No, except that I - the connector for the urine centrifugal separator - the power connector, way back in the back there, was sort of hard to get to and I bad mouthed that way early in the program, but, of course, in other words, dual connectors, and you only put it in one. It was changing from one bus to the other. And there was a little Dialatch, a holder for the cable, that was a bit of a nuisance, but as far as the electrical integrity of it, itself, there was no problem.

QUERY Was the clearance adequate for mating and demating of connectors on the intercom boxes? Again, this is the OWS.

CARR There's two intercom boxes that we played with, the M131 or SIA number 131 had to be changed out and then the other one down in the experiment compartment by M131. We disconnected and connected that up for a documentary photography and in those cases there were no problems.

QUERY Now a few miscellaneous questions. Assess the utility outlet adequacy, accessibility, number and location of utility outlets.

POGUE There's no problem with any of them. There was no problem with any of the outlets. It would be nice to have one more on the minus-Z SAL, because that's where all of our activity was and we ended up a lot of times having to un - disconnect certain things in order to connect other things up. That's only - -

CARR Well, see if you had a cable caddy right there for each one of the outlets - if it had just - was right into a cable caddy, then it would have been very handy because whenever you finish with it, you just let it go back into the caddy and what you would do is size your caddy so that it can make the minus-Z SAL or over to the film

CARR (CONT'D) threading station or places like that. And it would have been very - a whole lot more handy that way. The way it was - the way we used it, you had to string a cable and you hope that it would stay there and nobody would need it. But it never failed, somebody else always needed the cable and would take it down and use it. Then you - next time you wanted to use it there, you'd have to go find the cable and put it back in. And this is overhead time that you don't want to spend in space, stringing cables.

QUERY You have answered part of this now; I'll just give - Any problems or comments or problems with replacement of intercom boxes? I guess you discovered that you didn't have any - or heaters. Did you replace any heaters?

POGUE No, I don't think any of them ever came on.

CARR Yeah.

QUERY I know the duct heaters didn't.

CARR The only heater that we did - did anything to was that probe into waste - -

POGUE That's right. We took that out at first and then put it back in near the end.

CARR And we were prepared to change out the probe on the urine dump system, but it - it cleared so we didn't have to go through with that.

QUERY Any problem encountered with static discharge? You talked about it being so dry.

CARR Surprisingly enough, there was no static discharge.

QUERY We haven't had any report previously.

POGUE The only time that you got any indication of electrostatics was when we took off our shirts, you could feel the hair standing up on your arms, but I never heard any crackling.

CARR No popping or cracking or anything, but you could sure make your hair on your arms stand up and on your head as you pulled the shirt over the top, your hair would just go right up sometimes.

QUERY Was the OWS thermal control system ever checked out? It's on reference system checklist sheet 9 through 18. Did you ever - do you recall that you ever checked out the thermal control system?

POGUE I don't recall. And if it's not - if it wasn't in the checkout and activation - -

QUERY This would be the OWS now is what - -

CARR Yeah.

POGUE Yeah.

CARR Well, I don't remember ever - -

POGUE Not unless it was in activation.

QUERY When the Earth terrain camera was operated during EREP passes, the OWS bus loads increased more than the amount required for the camera. Now, we don't have any idea and we've got a question here. Can you think of any associated load that would cause this increase? I know that's a hard question for you, but - -

CARR This is down the OWS?

QUERY Whenever you turned the Earth terrain camera on, we always got a greater load than we had expected from just the camera.

POGUE Well, we've already mentioned that it sounded like a rock crusher, the shutter motor or whatever it was and we always felt it wasn't working right, but apparently it took real good pictures.

QUERY ... It might have been a bearing problem, increased the load because of friction? That might be - might be - -

POGUE Could very well be, because other than that, all that Ed did, that I can recall, is that he would just go down through the hatch and look out the wardroom window and verify the scene and go back up, you know, it's all - all just turn the switch on and off.

QUERY Might be the connection. How long before each meal were the food tray heaters turned on?

CARR Oh, that varied. We tried to keep it to just to one food tray usually. We would - breakfast and lunch very seldom did we ever turn the food tray heaters on. The only time for lunch that we did it is when somebody had chili or something - -

POGUE Macaroni, something that really required heat and in order to get it palatable.

CARR Now supper time, we usually managed to remember about 4 o'clock in the afternoon that we needed put our food in and do something about it. So we would take the three frozen items for the evening meal and put it in, usually in my tray and turn it on. And then that tray stayed on

CARR (CONT'D) usually up to and through the meal time and during the meal when we transferred, divvied up the frozen food, each guy would turn on his own tray that he put it into. So we did not use the tray heaters a whole lot.

POGUE Somebody got a mistaken impression from one of my M487 debriefings. And if that's still surfaced, I would like to put that one to bed. I never - apparently made the statement to the effect that we just turned the heaters in the food tray on and left them on, although I qualified it. The qualification apparently didn't get through. The point was what Jer was saying there, usually we were forgotten until it was too late we just stuck them all in there and turn all the heaters on, rather than put it in auto and set the timers.

QUERY This is not associated with something like that. This is a standard question. We've asked this all three times.

QUERY Yeah.

POGUE But we did not leave food tray heaters on continuously.

QUERY We didn't have it - -

QUERY Well, premission we kind of planned that you would leave, you know, put your breakfast in like before and set the timers and the heaters would come on - -

POGUE I think I remembered twice.

CARR We just never operated in that mode. Most of the rehydratable stuff, we rehydrated just before we ate it. Some of it wasn't too terribly tasty because we didn't heat it for a long time.

QUERY I don't suppose you noticed any degradation in the food tray heaters since you didn't use them so much you wouldn't have a feel for them whether it degraded or not.

CARR Sure didn't. No, mine were quite adequate at the end of the mission.

POGUE Somebody says the water heater was going to pot near the end. But we didn't notice that either.

CARR No, the water was nice and hot, but somebody said that it looked to them like the water heater was beginning to crump [?] out.

QUERY Were the portable circulation fans used during the mission?

CARR/POGUE Yes.

CARR We used one fan in the experiment compartment to blow on the guy pedaling the bike. He had the option of turning

CARR (CONT'D) that on if he wanted to. And we used another one up at the dome hatch to try to move air from the dome area on to the OWS heat exchangers.

POGUE And we, at first and at the - we had the one up there running on the - no, I guess that was just the normal diffuser on the rate gyro package.

CARR Then you had your rate gyro cooling fan running when we got there and when we left, we left it running. We set it up and left it running again.

QUERY It didn't run during the mission?

CARR No.

POGUE No.

QUERY Did you take it down?

CARR Oh, yes.

POGUE Yes.

CARR Oh, yes, it was in the way.

POGUE Mounted on ATM floor grid.

QUERY When operating the ATM C&D, was it noticeable if the MDA wall heaters cycled? Could you tell us that they were cycling by sitting at the ...?

POGUE I couldn't tell.

CARR I sure couldn't either.

QUERY When passing through the airlock, was it noticeable when the ATM wall heaters were on? Could you get a feel for the - -

CARR No, could never have told you if they were on. Did they ever come on? Does your data tell you if they ever came on?

QUERY The A ...

QUERY AM wall heaters did.

CARR Did they?

QUERY Oh yeah, yeah, they were on.

QUERY The AM we didn't have any street [?] on. The MDA we followed pretty closely, but the AM are, you know 15 different little heaters individually controlled. Sometimes when we'd inhibit them from the ground, like during the EREP pass, we'd try to watch the current and get an idea of how many of them were actually on at that time.

POGUE When you turn them on.

QUERY And it was very difficult for us to tell if they were ever cycling, but we expected them to kind of follow the same cycle pattern as the MDA's which we could track. But we never really could get a confirmation of whether they were burning or not. Relative to the small individual loads, the half amp each, it would be difficult to see one of them coming off and on, but we thought when we commanded them off and on we should be able to see it but we never ...

CARR We sure didn't know they were - -

POGUE You know it would be nice in the future when you have the sad thing was a little liquid crystal thing in a little parallel shunt line, something that just takes no power at all but gives a positive indication, low-power drain.

QUERY When you guys were working the EREP passes during the day, a lot of times we came to you and you remember the reg adjust box that were up there on the STS panels? A lot of times we would come to you and have you adjust those things twice a day ... after each EREP and sometimes even three times a day and we did this quite frequently and we had kind of a minor war going in the MOCR over this; but from your point of view did having to do this quite frequently - did that pose any kind of annoyance to you?

CARR It was a minor nuisance.

POGUE It was particularly an annoyance for Ed when he was working ATM.

CARR Yeah.

QUERY Yeah, we could have minimized that, but, you know, every time we called up to you you guys seemed so cheerful to do it. (Laughter) I don't know if you just - -

POGUE You didn't hear the background comment.

QUERY That's obvious.

POGUE No, it was no problem.

CARR It was a minor annoyance. I guess it bugged Ed more than us because sometimes he'd get into an ATM program he was working on and one day the CAP COMM would come up with a reg adjust and you could almost hear him grumble and a lot of times Bill and I would try to get up there and do it so he wouldn't have to get up there and fool with it.

POGUE The thing is, we were so delighted that the ground took such good care of the system, we didn't mind doing that kind of thing.

CARR Yeah, it was no big thing.

POGUE Here's one suggestion. It would have really helped and it's sort of a suggestion for future designs, to have a movable scale underneath this thing for rereferencing. Man, we had so many pencil marks on that thing, you know. We'd erase it. We got almost down to the metal. (Laughter)

QUERY That was my next question. How many marks did you guys end up with? I think every time ... mark it.

CARR We usually had about a half dozen marks on it, but every once in a while you'd just wipe the slate clean and start over.

POGUE Yeah, if you could have just had a little circular index under there that you could have rotated around, say now zero and now I said 30 degrees to the right well the thing is - or 15 degrees or 7-1/2. We never did - very, very seldom - we'd get it right the first time. If we'd had a very good scale down here, I think we could have minimized that.

QUERY For about the first week we had to ask you for re ..., but seemed like after that you guys kind of had a calibrated eye on that. You usually hit it right off the bat, the first time.

QUERY That concludes; thank you, gentlemen.

CARR Okay.

QUERY Okay, thank you, Al.

QUERY Now you guys can all stay if you like there is plenty of room and there is no problem.

QUERY What's next?

QUERY Crew systems EVA and inflight maintenance.

QUERY Okay. We have Dick Heckman from Marshall and Hoot Gibson, of course you know, from JSC. ..., you have some more questions you want to take care of ...?

QUERY Yes. I'll - I'll cover the crew provision - equipment first. The cuffs on the Skylab jackets - Do you all consider them necessary or they're just a luxury?

CARR You mean the knitted cuffs?

QUERY Yes.

CARR Yes, no.

(Laughter)

POGUE Now, wait a minute, now. I like - I didn't like the - the overcuffs. And the knitted cuff was too tight for me to get my watch through; that's the reason I didn't like it. I liked the idea. It just turned out, on my - -

QUERY ... too tight.

POGUE - - particular jacket, I ended up cutting - taking scissors and cutting the solid overcuffs. You know what I'm talking about?

QUERY Yes.

POGUE And then the sweat shirt knitted-cuff-type underneath, bothered me a little bit because of the - of the watch.

CARR I don't think that's something you really need to legislate. That's kind of personal preference. I know if you've got - got the capability of putting them in the design, just ask the crewman what he wants.

QUERY Okay ...

CARR But I - I liked them. It kept the sleeves from riding up too much on me and the trouser legs from riding up, and so I liked them. But these guys found them to be somewhat of a hindrance.

POGUE I was more put out with them on the trousers than I was on the sleeves of the jackets, because I couldn't take my trousers off without taking my shoes off, you know, undressing for PT.

CARR But let's face it. If you do them, somebody's going to bitch; if you take them off, somebody's going to bitch.

QUERY The other crews - the other crews took them off.

CARR Yes.

QUERY Second queston: That HP-35 calculator - Did you have to - ever have to recharge it?

POGUE He kept it plugged in.

CARR Yes, he kept it plugged in at the ATM all the time for use, and just - you know, the little recharge module? He just kept it connected all the time.

QUERY Hmmm.

QUERY Did he have - Did he have any troubles - any problems there with the recharge?

CARR Not to my knowledge. It worked - -

POGUE It's still sitting right there.

CARR ... - yes, that's right; it's still sitting right there. All we did was pull the plug on it.

QUERY Could you estimate about how many hours you put on that thing?

POGUE I didn't put too much - -

CARR Ed was probably pretty much the big user of it.

POGUE I counted my fingers testing the device.

QUERY (Laughter)

POGUE It was a nice device.

QUERY With respect to the hard toothpaste tubes, what resupply kit did you get those out of? Was it the one ... or was it one of the ones you took out of one of the other, earlier ...?

CARR Well, you didn't send any supply kit up with us that I know of. We - -

QUERY Okay. We sent one up on SL-3.

CARR Yes. And that's the one we used. It had about two or three tubes in it that were hard as bricks. And poor old unlucky Ed was the guy who would select that tube of toothpaste every time, and I couldn't understand why he was in there grunting and squeezing on the toothpaste tube. And I just worked mine ... - -

QUERY But it is the one we took from SL-3?

CARR Yes.

QUERY Okay. Garment pockets - You had a lot to say in the debriefing.

CARR Yes.

QUERY In the tech debriefing. Was there some unique problem in flight that we -

CARR No.

QUERY ...

CARR No, ... just as soon as we got them over in the trainer. Nobody did anything about it.

POGUE Specify which pockets you mean, now, Hoot.

CARR We're talking about ... - -

QUERY ...

POGUE Yes ... they were already made.

CARR They were already made and being packed in the workshop. It was too late to do anything. This was all done at the last minute.

POGUE Now, it was even earlier than that. When we first started wearing those over there in the minisims, the little pocket in the front which was really - would have been nice to use for a flashlight, we couldn't use it for a flashlight. And if I was - If I remember correctly, I asked the garment man about it, and he said that wasn't really made for a flashlight; it was made for pencils. And that that was

POGUE (CONT'D) why the flashlight didn't fit in it, because it looked just right for a flashlight, except the little cover - the flap wasn't long enough.

QUERY Okay. I think we need to get back and talk with y'all more in detail on design ... - -

POGUE We made beaucoup comments on ... - -

QUERY - - ... see it was my impression that we had not received any comments in that area. So, we'll - we'll get back with you in detail on that.

POGUE Okay,

QUERY Okay. Yesterday, you had - Bill, you had mentioned that when you - with respect to the goggles - you - put too much antifog on them.

POGUE The visor.

QUERY No, the goggles - the goggles; you know, on this M509?

POGUE ... No, I didn't put any antifog on the goggles. I'm sorry; I mislead you.

QUERY Okay. Well, there is some distortion in those goggles and I thought maybe it might've been from that.

POGUE No.

QUERY Is it - Was it just - -

POGUE That's just the way they were.

QUERY - - ... those goggles?

CARR Yes.

QUERY Okay.

CARR The darn thing would clog up on you too. You'd work up any kind of a sweat and your goggles would fog up. And if you - you look at some of the pictures and movies, you'll see I did a lot of the flying without them, or I had them up on my forehead. You'd get started and the darn things would fog in on you, and you'd just have to pull them up out of the way.

POGUE The - the subject could go - get by without using them. The observer - As a safety precaution, I've used them, even after I got a GO for taking them off when I was the sub - the subject to avoid getting dust in the eyes when impinging the thruster - impingement from the thruster.

QUERY Okay. Now the next questions are relating to the EVA and EMU. On your suits, how wet did they get during the

QUERY (CONT'D) EVAs? Did you - could you differentiate between the wetness of them before you put them on and then afterwards?

CARR Well, yes. I think they were all wetter, you know, when you took them off. There - It was a certain amount of sweating going on in there. I have always been the low sweater in our - in our bunch, and my suit was never as wet as the others. Ed always does the most sweating, and after an EVA, his suit was the wettest. The reason why I know all this is because I'm the guy that always did the suit drying and the suit - the PGA work in the post-EVA. Bill's was in between. It always impressed me that the guy who was EV-3, the guy who stayed inside, was usually wetter than when he went outside on an EVA. It seems that when you're in the closed suit and you've got the whole loop going, you stay drier than you do if you're just in the - in the suit with LCG running and standing at the ATM.

QUERY Do you think that the desiccants that we had would've been sufficient without the suit drying using the blower?

CARR I don't have any feel for that or not. I never - never - It never was clear to me that the desiccants did anything; the suit was already plenty dry before you ever put the

CARR desiccants in. And, of course, the desiccant - there was no color change or anything. They were all sewed in a opaque bag - little sausage - -

QUERY ... primarily to maintain their dryness.

CARR Yes. And - -

POGUE If you're saying would you - If you're asking could you have dried them with the desiccant alone, I'd say no.

CARR Yes. I couldn't say that. I wouldn't know - I don't know how good a desiccant you got. I - I couldn't make any judgment whatsoever on that. But I'll tell you one thing, those desiccants were a pain in the neck to put in the fecal ovens, because you really had to work sometimes to get a seal on the oven.

POGUE Another thing, too, that's - When you put the desiccants in the suit, instead of - It would have been nice to have a little retention device or something. I put them in there once and went to all the trouble of putting them down the sleeve and in the leg and - And then Ed came along and got that suit out and it all shaped around and realigned themselves down the feet or something.

QUERY Was there ever any noticeable increase in cooling - Well, let's see; this was to the - Okay. It could have been to you or Ed. This is concerning the - the water leakage that we had on the PCU/LSU ... Was there ever any noticeable increase in cooling when you were in EVA NORM and had noticed the water leak prior to diverter valve change?

CARR No, I don't think so, and I don't think Ed mentioned it either. We knew we had the leak, you know, and the water was gone, but we had never impacted - hadn't impacted the - the suit LSU cooling system enough to where we were being hurt. In my case, we found later, you know, that a lot of the water was gone out of the LSU system, but, apparently, we hadn't lost enough so that it affected my suit cooling. And the big thing that ... kept bugging me about was to keep - to try to keep my coolant loop cooler, because it appeared that I was - the delta-T across my gas loops was not what the medics liked. But we didn't notice any funny changes in the temperature in the suit at all. And on Ed's case, there near the end the ground said, get your suit cooling down to the lowest level, because we're going to - we're afraid we're going to loose the loop, and so Ed, essentially, put himself on gas cooling.

QUERY Did he notice his gas being cooler? Did he ever - did he mention ...?

CARR No, he said it was getting hot in there, and he - he - -

QUERY Okay. He didn't notice that his gas coming - coming over his head, just the direct flow there?

CARR I never heard anything about that from him. I don't think so.

QUERY Okay.

CARR Now I - I noticed - in fact, I debriefed this on occasion - on one occasion, and that is that - this was on EVA number 3, when I was the guy in the airlock module - I made - made one note that when I get into a big flurry of activity, you know, most of the time I was fairly quiet, but every once in a while, I'd have to do a lot of things, and I could feel my heat load building up. And then I could feel it get transferred to the gas, and I felt the gas was much warmer. And then - I felt like the thermal inertia of the system had a fairly long time constant, because I could feel - feel that I was storing heat and then I was transferring more to the air than to the liquid, and I could feel the - the gas in there with me was fairly warm.

CARR (CONT'D) And then after a few minutes, 5 or so minutes, things would have moved back into equilibrium again. But I seemed to have a - a heat constant that changed quicker than the system did. And I - made note of the fact that I could feel it. And I was asking - In fact, in one of the private medical conferences, I asked the doctors if they had any indications that - that I was storing heat and that the system was taking a little time to get it out again later. And they said they looked at it and they didn't - they couldn't tell too much about that at all. But I am a heat storer compared to Ed and Bill. Ed and Bill sweat quicker than I do. I seem to store the heat for a longer period of time before I break a sweat and start cooling off by evaporative cooling. I do that athletically around here, and I did it in the suit too. And that's why I think my suit was a whole lot drier.

QUERY Did you notice a change in thermal environment as you went from day to night, looking at it from a heat-leak standpoint?

CARR Yes, yes. You could tell.

QUERY You could?

CARR Yes. You could tell that things cooled right down as soon as it got dark. You could feel the - the radiant heating from the - When I was out on the Sun end especially, I could feel the heat - just like you stand out on pavement somewhere, when the Sun hits the pavement and reflects back on you - I felt the same thing at the Sun end when I was working there.

POGUE You can really notice it if you're in the FAS and moving your hands in and out ... contrast.

QUERY Did you know the FCS was used as a comfort pad rather than a FCS?

CARR Yes.

QUERY Do you feel like that you would need one for a 6-hour EVA?

CARR No, I went 7 hours and never needed one.

QUERY Would you feel comfortable in going out, you know, ... for a planned EVA?

CARR Yes.

QUERY Say 6 hours or 7 hours without that?

CARR Yes. I never - I never wore the FCS. I always - -

POGUE Never wore it.

CARR 95 percent of the time in training, I did not wear it, and I didn't wear it in flight, because I didn't need that kind of comfort. I had no crotch distress because I had a good suit fit. And I had no distress in that area that - that made me feel I needed the - the padding.

QUERY Did you ever notice any uncomfortable surface temperatures when you came in contact with the vehicle, in other words, with your hands or feet? When you -

CARR Not uncomfortable. You could feel hot places through the glove. You could feel that this one - this thing's a little warmer than something else. But there were no extremes that caused any discomfort of any kind. Did you have any?

POGUE No, same - same observation.

QUERY One time there you mentioned, in prep or some time earlier, that one of you had grown, physically - length - lengthwise.

POGUE Oh.

QUERY Did that seem to restrict your suit mobility or cause any pressure points?

POGUE Just getting in and out.

CARR Yes. It was - it was really tough. We had the same problem the other guys did, and that was bending - bending our trunks enough to get in. It - Up there in zero g, apparently, the back muscles all stiffen up some and you're not as limber, and I'm still having trouble touching the floor now when I've got gravity to help pull my trunk over. I'm still working on my muscles in the back of my legs and my hips and back to get limber enough to touch the floor with the palm of my hands like I used to be able to do. And we found it didn't take long at all until it was difficult to bend over enough to work your way into the suit. And, of course, when you've got to stress the suit that hard, we began to worry about the two ends of the zippers for fear we would damage those things. And the LPGs we wore were - Well, I wore Paul Weitz's, and Paul Weitz is a bigger guy than I am. And I had a lot of extra stuff in that suit with me, which was very uncomfortable. It got in the way, but pressure points due to the lengthening seemed to work out okay because it didn't catch me in the crotch. It was all heel-to-shoulder pressure. And as soon as we pressurized, the heel-to-shoulder pressure was gone and I felt quite comfortable in my suit. And my suit - with all the bulk of the LCG in

CARR (CONT'D) with me, I had a good fit around the chest, so I had good trunk mobility, I felt. I wasn't rattling around in my suit.

QUERY One final question. Do you believe that separate mobile legs on the EV suit are necessary for working EVA; that is, except for foot restraints, an attachment for the separate legs used during EVA?

CARR Separate mobile legs? In other words - -

QUERY Yes. Like - like we've got.

CARR Yes. In other words, the other choice is ... - -

QUERY As opposed to just a ...

QUERY A mummy-log-type thing.

MS ...

CARR Oh, heavens, yes.

(Laughter)

CARR I wrapped my legs around things and I straddled things out out there to hold on, especially on that EVA where I was taking those movies. I was doing all sorts of things then.

POGUE Not to mention all the body English you use. You use inertia of the legs a lot of times to torque yourself around, you don't even realize unless you're using them.

CARR Yes.

POGUE Man, don't ever let anybody ... for that.

QUERY (Laughter)

QUERY Legs then - legs then definitely do have a use in a ... - -

CARR Oh, yes. Yes.

QUERY Right.

CARR I did a lot of straddling, where I'd wrap my legs around something, then let go with my hands.

QUERY ... Do you have any more? That's all we have. Thank you.

CARR Okay.

QUERY On EVA, in the lock compartment, did you feel the ventdown rate in the manual valve control that you have is satisfactory? Any comments at all on that?

CARR Yes, I think so. I think that we - we wasted some time. It took - took a little - sometimes, I felt like it took too much time to vent down. The - Actually, the repress was the thing that I felt took too much time. The

CARR (CONT'D) venting down - I was kind of grateful that it went slow, because I - I had to work hard to keep my ears clear due to the congestion - the blood engorgement of my tissue in my membrane - in the nasal and ear areas. But I think we could probably go with bigger - bigger valves with more controllability, so that if everybody was clear and could do it, you'd go ahead and open it wide and do it fast, instead of wasting so much time just laying there while it, you know, dribbles out through a little valve. Of course, I think you'd probably - the bigger your valve, then you'd have to go more towards the - the screen routine that we had where you had one screen that worked for a while and then you'd remove it when the ice built up to a given level and go to the next screen.

QUERY Okay.

POGUE ... a good fix.

QUERY Do you feel that the foot restraints, such as we had for ATM, are adequate for the type of tasks that we had there, or do you feel that there might be some tasks where you might need additional restraints beside the foot restraints, such as a waist restraint or anything like that? Can you think of anything where the foot restraints wouldn't do - -

CARR No, the places where we used the foot restraints - they'd had enough work done on them so that they were in the right place. There was one restraint in the FAS that bothered both Bill and Ed. Their foot kept coming out of it.

POGUE I think it was my right one that kept coming out.

CARR It seemed to me Ed was having trouble with - -

POGUE I don't think that was as much a function of the foot restraint as it was of the individual body posture that resulted from trying to move yourself to face the task at hand. I think that maybe a little bit more work can be done with those foot restraints, but I don't know what. I can't suggest it. It seems like that it's such - it's a very, very close tolerance thing. I had trouble in the water tank at Marshall with that foot, and I had trouble with the same foot in flight. It's just exactly the same.

CARR It was really pretty much the same for me too, in the ones that I fooled with. The water tank was pretty much the same as in flight. I didn't have much trouble because I didn't have any - any work - much work to do in the FAS area.

QUERY The FAS area had much more of a reach envelope requirement - -

CARR Yes.

QUERY - - more than we intended because of the additional stuff that we were taking out too. I know Ed mentioned in the technical debriefing that the methods of transferring of equipment - why, we had the booms; we had the clotheslines; and we also had manual transfer. Do you feel that the manual transfer is a good method, and do you feel that it's satisfactory for something like, say, the S052 camera or 54 camera, one or the other cameras like that?

CARR Sure.

QUERY ... be okay?

CARR Yes, I think it's okay as a backup. I think - I think the boom was a - is a very good piece of equipment. It was very handy, and we could move gear from one place to another very quickly and smartly.

POGUE But I think in moving the foot restraint around for the 193 repair - that was a good test of that particular task.

CARR Yes.

QUERY Yes, for - for equipment like that there's no problem of damage - when you have lenses and things like that on camera - I guess that's one of the reasons we went to those, and do you feel that you'd be able to work with fairly sensitive equipment without some kind of a separation of the crew transfer and the equipment transfer ...?

POGUE As long as we had a good palpate for it, or something like that.

QUERY Okay.

POGUE I'd be - I'd be more concerned about ... antennas and stuff like that.

CARR Yes.

CARR We were - we were very pleasantly surprised by our mobility along the EVA trail, the fact that we could move so quickly from one place to another. I could make it from the center workstation into the FAS in less than a minute, just really hustling right along, and once we got rid of the buoyancy problem like we had in the buoyancy trainer, it was really very, very easy to do.

QUERY We spent a fair amount of time working on the tactile and visual feedback in, particularly, the ATM cameras, detents, flags, hardstops, and so forth like that; would you comment on that, perhaps?

CARR I think that was good work. You - you could feel when those cameras went home, and you could feel them latch in. And those are good feelings, because then you're willing to let go of it when you know that it - it's being retained. I think that that time was well spent.

QUERY Okay. You don't feel that we went too far?

CARR Not at all.

QUERY Did you find any latch or handle forces that you felt were either too high or too low? This is, again, mainly the ATM retrieval area.

CARR No. Again, you folks worked the trainer over to the point to where, when we got up there, there just weren't any surprises. The only surprise up there was that S082 door that hung up - the 82B. And - But as far as latches and handles and things, everything up there felt the same as it did in the water. The only thing that was different was the buoyancy problem, you know, that - that we had

CARR (CONT'D)

with the water. And we fought it all the time, and we knew it was going to bother us. And it was such a pleasure not to sweat buoyancy up there, that it made our mobility much better. You could move along the EVA trails just hustling - hand over hand, just like this. And you felt very comfortable doing it. You know, you hit the straightaway once you get beyond the twin pole sail; it was nothing just to whistle right on out there. And you remember all the trouble I had getting into the transfer workstation? It was nothing; you just swing right down and, clunk, your feet went in. And once you just got rid of the buoyancy problem, it was just a piece of cake.

QUERY

Okay. On lighting, could you comment on the - I think that we've got pretty good comments from you on the lighting at the workstations, how about the S193 area? And if you have any comments on the workstations, any additional ones, fine.

POGUE

The lighting was completely adequate. On the day - when the dayside - of course, that was supposedly on the shadowed portion, but plenty of lights. No problem at all. And at night, we even played with the flashlights trying to find this Mylar that supposedly jammed in this ... and

POGUE (CONT'D) trying to convince myself it was or wasn't in there and using the flashlight. It's amazing - what we actually did - That was a fairly good exercise and in - in - indicative of EVA capability.

QUERY Did you get much scattering from adjacent structure and from the suits on the Sun side into shaded areas? Was that - did that give you pretty good - into these areas where we didn't have lighting, particularly? Did you have ... - -

CARR Yeah, I don't remember there being any dark holes that I couldn't see into. There was always enough scattered light in there that you could see.

QUERY Thank you.

CARR These guys working on the other side of the workshop had so much earthshine, they had no problem at all seeing anything, either.

QUERY Bill, are you saying that you had plenty of light in the S193 area?

POGUE Yes, sir. That's what I'm saying.

CARR In the daylight.

POGUE ...

QUERY ... one of the debriefings where you didn't - you - you didn't have - -

CARR I think he was talking about night where we had - there were no fixed lights - -

POGUE There are no lights in that area.

CARR And our pitch is, don't ever lull yourself into thinking that there's no place that you'll ever go around the work - around the vehicle on EVA, because we've already proved several times that there's no way you can legislate that somebody will not go somewhere on EVA.

POGUE And it should - lighting should be provided, so that you can work full day/night cycle EVA in an - any area external to the vehicle.

QUERY But - yeah, we - I hope - I'm sorry if we gave you the impression - -

POGUE Yeah, that's too bad.

CARR - - that it's poorly lighted in that area during the daylight pass, because it was well lighted. It's the nighttime when they had to get the flashlights out and work.

POGUE Point ... was that it had been earlier legislated that there would be no EVA done on EREP. So then that justified not putting any light over there, and we said, don't ever do that again.

CARR Yeah - -

POGUE And that was our recommendation.

CARR - - ... don't legislate that sort of thing. They've already done it in Shuttle. They've already legislated that there are certain places you'll never go, and we said, hogwash. You can make it a design goal, but you better face the facts and put some lights in such a way that you can use them if you need them.

QUERY How about portable lights?

CARR Yeah.

POGUE That's - There's a good case to be made for them.

QUERY There's another - of course, it's something else to handle and take care of, and fixed lights would probably be better.

POGUE Oh, but what about putting them on your sleeve, and I can just envision all kinds of good space lanterns. You know,

POGUE (CONT'D) I mean, you would have one right up there. In fact, we had the - the medical (laughter) light for working in the - down in the scuppers - plenum area. The trouble is that you can't hold a flashlight in your mouth while you're EVA, otherwise - -

QUERY (Laughter)

CARR It kind of limits your suit integrity. I tried to scratch my nose several times ...

QUERY What you're saying is you'd like a suit-mounted, PGA-mounted light.

POGUE Why not? Why not?

CARR Yeah. Why not?

POGUE You know, have some kind of integral light in the helmet or something? I mean, I don't know. That's your area.

QUERY Have you - you been talking to the Russians again?

POGUE No.

CARR Either that or just put like jack plug boxes or junction boxes around the workshop or around whatever the vehicle is. But you go out with a portable light like you have

CARR (CONT'D) in your garage to put on the car. And you go out and you mount the light somewhere, and you plug it in.

POGUE There's only one thing about that - and remember that there are - you could always get yourself in a position, suited, where you're looking into the light. That's why you're always going to have a need for an auxiliary portable light.

QUERY Do you have any comments on handrails, handholds, any reach envelopes that we had, other than you mentioned, that probably because of some reach, you had some trouble with putting one foot in the FAS? Any other comments on general reach on the nominal EVA area?

POGUE Yeah, I have. The - You tried to standardize the geometry of the handhold. I don't think that was quite achieved. It looked to me like there was variations in the size of the handhold. That's noble target - noble goal; I think that's good. It screwed us up using the - the camera mounts. Some of the times it would make it flop around and jiggle. And sometimes you couldn't get the lock closed. That's a

POGUE (CONT'D) whole other area to talk about. There was one other thing. Oh, please give us great big numbers on the handholds. You're talking about F-7 and all that. You're looking all over; it takes 15 minutes to find F-7, for crying out loud.

CARR We could never remember where they were. We'd always have to go look for the number.

POGUE Great big numbers, for people that are over 40. No, it's just - there's just no sense, I mean, you got all that space there, why not put great big number there and put one, instead of putting that little tiny?

CARR No sense in wasting time looking for a handrail, when you're outside. That time's too valuable.

POGUE And another - another case finding it, the paint fades. It's got to be a very high contrast thing.

QUERY Which handrails faded?

CARR Everything out in the direct Sun, faded. Turned more toward green.

POGUE Yeah.

MS ...

QUERY Some of them were anodized. And - -

CARR Well, even the anodized ones turned toward a green.

POGUE Sure did.

QUERY Yes. They - they should lighten. We expected that they would probably lighten some.

CARR They sure did.

QUERY Because of the fact they were anodized.

CARR And if they're aluminum that was unanodized or it was anodized so that it still had a satin finish, it turned more toward a yellow. And that - that all stands to reason; you take blue and add yellow, and it goes toward a green. And if it's unpainted or untinted, it will go toward a yellow.

QUERY Do you feel you needed - that you lost contrast in the handrails and that that was not a good -

CARR Well, as far as finding the handrail, it was - there was no problem there. But seeing the number, the little F-7 or the F-5 or something on the handrail, was difficult. But the handrails we had, I thought were perfectly adequate. The EVA trail was excellent; we just - no problems

CARR (CONT'D) with that whatsoever. The trouble is, the EVA trail didn't go far enough; and when we had to go around to 193, that was a different ball game. And the guys that went down and pulled that wing out - -

POGUE Another thing that you might think about, Dick: you know that foot mount that I took down there for that 193. I - I watched Jer and Ed work in training, working the - Was it DO24? And this - there's a good argument to be made for being able to take the foot restraint and putting it around on trussworks and so forth. In other words, have some kind of universal mounting capability for a foot restraint, because watching them work on - on that particular one was just - You know, you'd just sit there, and it - you'd get a - build up a frustration case yourself, just watching the other guy. That's such a poor purchase on - in the area.

QUERY Okay. I think we've covered the clotheslines versus film-transfer booms in the tech debrief pretty well unless you have any other comments. You did get some entanglement which was - -

CARR Which can be dangerous, and that's - -

QUERY - - what we were worried about.

CARR - - the biggest disadvantage of the clothesline. It's not only a nuisance, but it can be dangerous.

QUERY You mentioned that you did have that sticking problem with the pin on the Sun-end clothesline boom when you handed ... - -

CARR Yes. It wasn't as bad as I had in the water, but my first yank, I said, "Aw, heck, here we go again, just like - This thing's just like the simulator." And then I got the other hand over there. And because I had no buoyancy problem, I was able to better position myself. And when I heaved a little harder on it, it popped right out. But positioning helped a great deal there.

QUERY There was some comment, and I think it was Ed that had some problem with the Velcro on the clothesline stowage box. Do you know anything about that, Jer?

CARR Oh, it was tough. He really had to pull on that. That was about all there was to it. He just - -

QUERY Yes. Just -

CARR You know, you get that old sloppy Velcro under water, and it gets real loosey-goosey and it comes right off. And up there the Velcro was holding the way it was designed, and he had to really yank on it.

POGUE Yes. I've got a comment to make on those umbilical clamps. I - I didn't - never did like those in the water tank. I didn't like them up there.

CARR They weren't any better up there.

POGUE You know, it's just like you - they'd come up slightly underdesigned - in size, geometry. And they'd just say, well, if they've got them, use them. That's - that's the impression I always got. The thing that - You'd open it up and get ready to put the hose in position, and the thing would slide back down on its own, you know. It was always a bit of an irritation to work it.

CARR Might have been better to go with a clamp - like you have the clothesline clamps up there, those clothesline hooks for pulling them tight. Just that sort of a broom-clip thing might have been just as good for the umbilicals. You never put that much strain on it - to hurt anything.

POGUE You'd want it to pull out, anyway.

CARR Yes.

POGUE Either that - What is it, a cleat? Is that a thing that's used on a ship or a boat?

QUERY Yes. That would get pretty big if you have an umbilical of any great amount.

CARR Yes.

QUERY With any radius in it.

CARR It looks like one time there was a clamp on the S230 experiment up there that was placed in a position to shadow - to shadow the collection foil and to give them a little sort of a calibration of shadow. And it appears that our umbilical at one time or another went by there and flipped that thing off, and we never saw it go. And it looks like it must have happened on EVA-3 because we have photographs of the clip in place and then when I went out to retrieve the clip, it wasn't there on the next EVA.

QUERY On the - Do you have any way that you think that EVA prep and post times would be reduced at all? That's really kind of -

CARR Oh, yes. Yes. By designing a spacecraft that - that is better designed for EVA, you can - you can cut that prep and post down a lot. We spent an awful lot of time putting tinker toys and erector sets together and lashing them down the airlock module and then after the thing was

CARR (CONT'D) over, taking them apart and putting them away. And in our tech debrief, we discussed the idea that the EVA lock should not be between two living areas. You should not isolate two living areas. It should be on the end somewhere. And it should be located in such a manner, designed in such a manner, that the stuff that you're going to use on EVA is stowed in it, with lockers and things right in there, so that you don't have to be taking things apart and putting them together and stowing them in a high-traffic area.

POGUE Reconfiguring ECS ducts, taking that elephant trunk out, putting it back in, and all that other nonsense; all that took time.

CARR Yes. The suits - There's a lot overhead in suit prep.

POGUE Stowage was the ... - -

CARR And stowage of suits. There's no good stowage area for the suits. You know, that - that game we had to play of moving the suits up into the MDA and stowing it underneath the foot restraints for the ATM panel in little nooks and crannies was not too terribly sterling. All that overhead time is just costly to you. The - That was really the main thing; we spent so much time putting things together and prepping them that -

POGUE I guess that - No. I was going to say that traffic - you know, getting ready, going to the sleep compartment, coming up, getting radiation dosimeter, and all that - I suppose there's no way to avoid a lot of that. But there's - just relocating the airlock would have eliminated a lot of the wasted time.

QUERY Okay. The S082A and B overcans, the big jerry cans, didn't have a lot of lead-in on the guides; they were a fairly close fit, whereas the S082A and B cameras in the canister had quite a bit of lead-in. Could you comment at all on - on differences or any difficulties in inserting the cameras into the 82A and B?

CARR There was no problem. I know in the procedures we always had a little comment in there about making sure they were flush before you tried to close the door, and that just never - never reared up. It was always straightforward; they'd just slide right in and you - they'd be flush and you could lock it up. No problem.

QUERY Visibility was good both places, and - -

CARR Yeah.

QUERY - - so you didn't really need quite all the amount of flaring that we put on the - on the 82A and B cameras, perhaps, and in the canisters.

CARR Yeah, that's right. But I tell you, it's easier to - to design your stuff with a good lead-in and flare and all that in the beginning than it is to find out it's a little too snug and you're going to have to redesign it later.

QUERY And I guess Ed was the only person that used the replacement workstation foot restraint, when he went up and got the clotheslines. And maybe we can catch him later and just see how that compared and what he thought of that typical - that particular method of restraining the feet.

CARR Oh, yeah. Well, he put one foot in it, and it came out again in a little while.

QUERY Yeah.

CARR Of course, I was right there, right next to his foot, watching it. It was no big thing; you really didn't need it. When his foot came out, he didn't worry about re-reinserting his foot; he just kept on working with the clothesline and got - got it out.

QUERY So it wasn't very positive, and it came back in. You mentioned that there were hot spots and you feel different

hot spots. Were any of - Did you notice any of those on handrails or any of the - like the tree or anything like that?

CARR No. For the most part, it was on white, white places that were reflecting the heat. I wouldn't even call them hot spots; they were warm spots, really.

QUERY On stowage and - and hardware restraints. Can you comment on any problems that you had with stowage containers, if any? Any that stick out in your mind at all?

CARR No, most of the trees and things worked; the trees and the pallets and everything worked.

QUERY We're moving now inside, too; so - out of the EVA area.

CARR Okay. Inside it was just a mess, a general mess. And of course, by properly designing an EVA area, you can - you can design a lot of these messes out so that you don't have all that foolishness going on. But we would do a real neat job of lashing down TO25 or something like that. And then on one case we used it - a pip pin with a chain on it; wrapped it around a piece of equipment and then stuck it back in its hole, forgetting the fact that a guy with a big gloved hand was going to have a hard time working that pip pin. And that almost caused

CARR
(CONT'D)

us to have to omit doing an experiment. The ad lib stuff, I guess, was the more dangerous of anything. We were thankful we had plenty of wrist tethers because the tools we were carting around out there, I was always afraid I was going to lose one. And when I was doing the S054 camera fix, it was a real pain in the neck not having a good place to retain those tools, because I would have the flashlight mirror flopping from this wrist and I'd have the screwdriver in my hand, trying to do the thing with the screwdriver when I was levering the filter wheel along. And I would have this other thing hanging on my wrist. It was very helpful to have Bill there holding me while I was doing that. The loose items - The tool caddy problem is a problem, and I guess it always will be. When I was trying to take the zero-g fixture cover off on the last EVA and I was prying, I had the gray tape on it as we'd - it said to do. But you know, gray tape when it gets hot or cold doesn't stick. And they forgot to tell me that under the zero-g fixture was a 2-inch block of some phenolic material that went on down; it was a plug. And I was busy prying, and I couldn't figure out why that cover wouldn't come off. And all of a sudden - pop - off it went; and I caught it in mid-air, and it was on its way. And I was just thankful

CARR (CONT'D) I was able to catch it, because I would have had to go find another cover and start all over again if I had lost it. Just those handy little restraint things - tool restraints.

QUERY How did you find that job of removing that fixture cover?

CARR No problem. I had to move that B-1 or whatever it is - that door. We had to pull the pin on that door and move it out of the way. And then I took the screwdriver, and I dug the paint out of the slots; and then the things came right up.

QUERY We were a little curious as to how that was going to go. We thought you'd be able to do it but it might be difficult because you had to maintain the pressure on the screws all the time because they were slotted screws.

CARR It wasn't as bad as I thought it would be. Once you got it loosed, you could reach down with your glove and go like that on the screw. And it would just keep going and just work its way out. Then when it got up about a foot, you'd take your hand and go bam, like that, and off it'd go. But it was kind of fun. Once you got the screw up to where you could get your fingers on it, you could just

CARR (CONT'D) give it a couple of twists like that, and it would just work itself up and just come spinning right up.

QUERY Going into the internal stowage and all, the restraints on the stowage - like in the ring lockers and so forth, like that - do you have any comments on any of the internal stowage? You made a number of comments about the stowage in the film vault; I think we've got all that stuff documented. Anything else that specifically comes up - -

POGUE Dome lockers?

QUERY Or anywhere else; the ring lockers.

POGUE The PCU that was stowed in the dome ring locker, the one that I had to get out to replace the one that leaked on Jer, that was sort of hard to get out of there. In fact, if I recall, the tool that was specified in procedure didn't work. And I'm not sure - I can't recall quite why. I guess the whole point in this is that when a - a consideration when designing launch stowage is removal and replacement. Just that simple.

CARR We got the definite impression on a couple of things there that people had overlooked the requirement to reuse lock stowage hardware, for nominal retention - -

POGUE Stowage.

CARR And you took care of all the bridgework, the civil engineering part, the heavy-duty stuff, in getting it off. And then when you had to put another piece in there, you had to kind of redo it. One case in point is the fans we replaced in the OWS heat exchanger. It was very unhandy to take the fans we took out and stow them in that dome locker, and we were reluctant to throw them away because we knew they were still working. And so - and I don't think anybody expected us - had planned on us putting those back in the same place. But the thing is, I think, if - you probably ought to figure on that kind of flexibility.

POGUE What would be nice - The ideal would be if part and parcel of the lock stowage seating was a loose friction clamp so that the rest of the civil engineering bridgework that held it down, you know - That would hold it for 50-g acceleration and all this other nonsense if you could - if those would come off and be removed easily and be color coded. But when I remove those, I still have a nice stowage for retaining the objects.

CARR Zero-g stowage.

POGUE Zero-g stowage.

CARR The one thing we all overlooked, which we were very, very sorry about, was the 230 experiment where we fastened it to a - the grillwork over a light. And none of us saw it when we were going all through training; was that location where we were stowing that S230 foil was right beside the repress - the repress valve in the hatch. And Bill opened that son of a gun up, and we had a 3-inch jet of high-speed - high-velocity air going right through the hatch ... - -

POGUE Just was in the right position.

CARR And it just flat shredded one of Don Lind's 230 samples.

POGUE The probability of getting that configuration by accident must be 10 to the minus 10. Boy, it was right there, just lined up, and air went right through it, just shredded little bits of it.

CARR So we felt very badly about that. And you know, everybody had looked at that thing, but nobody considered the repress situation, when you'd be really blasting that high-velocity air in there. And it really did it to us. So that's a point right there to put in your design

CARR (CONT'D) books for the next system, and that is, don't plan on retaining any equipment around the business end of that thing, especially anything that could be damaged by high-velocity jets.

QUERY If you take and put a deflector over it or something like that, why then 90 chances out of a 100, why that'll be what we have to go in and do something to, too.

CARR Yeah.

POGUE One thing that I would like to hit in the airlock module was the stowage caps, or whatever you call them, for the umbilicals, LCG connectors, and all that - that fiber-glass thing that's Calfaxed down. Those were very, very difficult to work with. Well, first off, it was designed to receive about six fittings; I forget what it was. I don't think anybody could put all those fittings on there and get that into position; in other words, it looked like from the start there was a design error. But the fix was, you don't put two of them on there; you leave two of them off, leave them dangling around and fit them in right. Well, that - you know, that sort of leaves you with a bad taste in your mouth, to think that they can't - you know, they give you something like that to work with. But even leaving those off, it seemed

POGUE (CONT'D) like that things were always twisted and bend around in, well, not a very satisfactory manner. And then on top of that, you had to use an awful lot of force to get into position. Calfax I don't like anyway, but you had to use Calfax. And you ended up actually putting an awful lot of physical force on those to get them into position; took two of us sometimes.

CARR I think the sphere idea of stowing those hoses was an excellent idea.

POGUE Good idea.

CARR But it's just that awful fitting on it that you covered it with, that you theoretically had to connect all the hoses to. You just put so many strains in so many different directions on it that it just became nearly impossible to close that thing. It would have been better if you'd just capped off each hose and stuffed it in the sphere and have one of them lanyarded to a loose cap that went on real easy.

POGUE Yeah, that's a good idea.

QUERY Yeah, the lanyard would have done the - -

POGUE Yeah. There was no need for them to -

QUERY Everybody was afraid you might lose the ends down in there and you'd -

POGUE Ahhhh.

CARR And a lanyard would have been good - a nice strong lanyard.

QUERY And I'm sure that we overdid the Calfax and had too many on there, too.

CARR Yeah.

QUERY Gives you more alignment trouble. On the various latches and fasteners that we had inside, did you see any particular ones that you'd like to flag as really good or really bad? You mentioned the dial latches and the Calfax in the tech debriefing ... - -

CARR The dial latches were just too doggone fragile. The Calfax were too fragile, too; you kept losing those little bitty washers, the grip washers, on - that retain it - the canister.

POGUE Not only that, but the alignment of a Calfax is extraordinarily critical. There were - The heat exchanger vane - OWS heat-exchanger-vane cover panel, I think, had four Calfax on it and then one hinged panel - one hinge

POGUE (CONT'D) line. There was one Calfax that - I don't know if any of us ever got that one in. And there was only one order of tightening which would work in attaching that cover, which - and I can't see that it's much different than it was when it left the factory. There was another area - This has nothing to do with EVA, but the ATM coolant reservoir, we never could get those to work; they flat - we just couldn't do it. But I didn't like the dial latches for that reason.

QUERY The Calfax is supposed to have 1/16 of an inch of slop around. And we noticed that most of the complaints are around that little ring that carried them on - -

CARR Uh-huh.

QUERY - - because it seemed to come off.

POGUE Cam locks also gave us fits.

CARR The most handy doors to open and close were those big lockers in the MDA that just had a - two big pieces of metal that closed over each other, and you ran a pip pin through them. Super simple.

QUERY The film vaults.

CARR Yeah. I don't know why you didn't have that on the film vault down in the workshop or nothing but just a plain old bar-over-the-hook gate latch to hold it shut. But those little Calfax, it - it ever swung closed while you were swinging the doors closed. And you'd hit it. It got inside - -

POGUE Fit tight.

CARR It just bent it. And then you'd have to straighten it out, loosen the screws that hold it, and readjust the whole thing.

QUERY Okay. How about the - Let's see. Internally - We didn't have any magnetic latches internally, really; we had some on the outside, on the ATM doors. The - -

CARR Yeah, if it doesn't screw up your instrumentation, those magnetic latches are a very good way of latching.

QUERY About hardware restraint methods, any particular comments on best or worst? Did you ever use the tool that was provided for removing screws, those special screws that were in the airlock around the -

CARR You mean the high torque?

QUERY High torques. Right.

POGUE Yeah. Well, I had to take some of them out when I was servicing Coolanol.

CARR Oh, yeah. But Bean and his guys had taken most of them out - -

POGUE Yeah, and they had the same trouble I did, in that those high-torque wrenches had paint in the slots and they'd been worked over a couple of times, and I really had fits with a few of those.

QUERY Did you use the little tool that was provided for yours, with the - that gripped around the outside of the head rather than in the center of it?

POGUE No.

QUERY Never used that.

CARR No.

QUERY Let's see. That's the one that was sent up to take the kickplate off - -

QUERY The kick plate off the C&D panels.

POGUE Son of a gun. I didn't even know it was there.

QUERY They didn't have to take the kick plate off.

QUERY No, we didn't have - -

POGUE I wish I had known about that, because that's a good idea. I had an awful time with those high torque - -

QUERY I believe you guys carried that tool up there.

CARR Yes, we did.

POGUE You see, I didn't ever work on the kick plate. I didn't know it was in there.

MS (Laughter)

QUERY I remember when we ... it up.

POGUE I could have sure used it.

CARR Specialization bites us again.

MS (Laughter)

POGUE One problem you had with those high-torque screws or bolts or whatever they are, and that is that it takes an awful lot of compression force when you're loosening on it. And I'm sure that's why you came up with that tool.

QUERY Right.

POGUE Because it - Boy, it was really giving me fits. I had my legs strapped to handholds and everything to get the right force.

QUERY That's probably why you commented on the lack of restraint in the airlock module and having to tie yourself to the airlock ... - -

POGUE Yes, I remember pausing quite a few times to reflect on that.

MS (Laughter)

QUERY Because we - nobody else has commented about the lack of restraint in the airlock.

MS (Laughter)

QUERY We forgot about that Coolanol servicing.

CARR Tools in general, I can - I'll just - we made a lot of comments in the tech debriefing on what we thought we should have had in the way of tools. We asked for a soldering iron a long time ago and didn't get it - a soldering gun.

POGUE Files.

CARR We asked for a drill; we didn't get it. We asked for files and didn't get them; luckily, we had a Swiss army knife that had a file on it. We asked for hacksaws and didn't have them. And we could have used all those items. And a crimper cutter - the type that an electrician uses or electronics guy does to put terminals on the end of wires and to splice wires together and all that kind of stuff - with a selection of splices - should have had all that stuff. And I don't give a dang whether anybody can in advance justify the use of that stuff or not. If you're going to go up and set up housekeeping somewhere like that, you need an adequate bunch of tools, because, as I said before, it's just like at home in your garage: You can do a job very quickly if you got the right kind of tools; if you don't, it takes you three times as much time and a lot of cussing to get the same job done.

QUERY I got a whole bunch of things here on inflight maintenance that I guess we'll get to a little bit farther on. So we can get in some more of them. Were there any mechanisms in stowage locations which you felt had accessibility problems?

CARR Oh, let's see.

POGUE Yes. Yes, I do. Panel 217.

CARR Oh, yes.

POGUE Yeah. If you could see your hands - All you got to do is just take a picture. I should have taken a picture of my hands after I got through doing the servicing in there, because there's no way of working in there - Well, I could use work gloves, I guess; I should have used work gloves. I used the photo gloves. But that should have been caught by ground safety, that's so bad. There wasn't enough room in there to make them - to make and break those QDs for the liquid gas separator. It was just a sorry place to work; there's just no two ways about it.

CARR The stowage in general - The biggest single problem with stowage is retention in the zero-g situation. We need to do a lot of thinking and get some inventiveness brought to play here on how to retain things - little things. Of course, the film vault is a prime example of that. But some of those big film vaults up in the MDA were just great big empty boxes, and it got to the point where you just pushed something in there and closed the door real quick. And then you knew the next time you had to open the door, you had to be on your guard. And little things

CARR
(CONT'D)

that we put in there, we would stick tape on them and tape them to the door because we knew that we were liable to lose them. In our sleep compartments there was no stowage for personal items. And there was no place to write or have your own little desk or to keep little things that you wanted to have. And there was no personal place. A Ben Franklin desk sort of thing would have been - could have been very easily designed into one of the lockers, you know, where you pull the locker door down. Instead of having the locker door go all the way down, just have it come down part way and stay level so you could use it for a writing surface. And have a module of something you could put in there with lots of little pigeonholes and cubbyholes to put small things that you might want to keep, because you gather things over a period of time. Like I had a couple of spare triangles in mine, and I had a little lanyard with a dog leash clip on one end and a ring on the other one. And I wanted to keep that because I wanted to have it when I was ready to come back and put it in the command module. And I had some items of a personal nature that I wanted to keep, and all I had was big open locker. And every time I opened that, I had to watch it because I had an airflow coming up from the floor. And as soon as I opened that locker,

CARR
(CONT'D)

I'd get a venturi effect in the locker; and all the small things would start coming out at me and - just because of the airflow that moved through the area. And I kept a logbook in there so that I could write notes. And anything that's small like that is just going to start coming out at you. And after a while, when you get a lot of stuff in there, you dread opening it, because you know you're going to have to fight it to the death in order to keep everything in and get the door closed back up again. I think all three of us ended up going into the tissue dispensers in those areas and removing the tissue boxes and cutting the spring out and using that little flapper door as a real handy way to get in and keep things in the small tissue-dispenser areas. And I ended up just maintaining one tissue dispenser, and I cut the springs out of the other two so that I had little pigeonholes to put personal items that I wanted to be able to get to - like the Swiss army knife and pieces of paper, things that I wanted to keep from the teleprinter - teleprinter pads and things like that. I think in the area of stowage that any habitable area, place where you got - that's your own, your own bedroom, there ought to be some sort of a personal area there where you can keep your personal items and do your writing and your reading and keep your

CARR (CONT'D) pencils and all that sort of thing. Just like you do, say, aboard ship, where you have a little stateroom. And in the - most all staterooms in a ship have got a little built-in desk.

QUERY That's it on stowage as far as I - -

POGUE I can go back to a couple of maintenance - routine maintenance and servicing ideas that caused us trouble. QD, the panel 217 problem, a lot of that was associated with affixing and - removing and reattaching QDs in a very-limited-access area, also where there were a lot of sharp edges. Another area where the problem arose was that for - underwater tank 9, which was just above the food lockers. We had to remove and attach the water QD there quite often during - let's say a half dozen times - during the flight, for water-servicing exercises of one sort or the other. The area was restricted in access and it was difficult to remove the QD and reattach the QD to the water tank. I should say that there's always going to be an area where it's - you have limited access for removal and attachment of QDs. At one time - Who's the little guy that worked over there and quit about a year ago? They had made a little tool - a QD tool. We had - I had so much trouble with panel 217 that the guys had rigged up a QD tool.

POGUE
(CONT'D)

My point is, I think there is probably an argument to be made for developing one of these tools to give you a better mechanical advantage and purchase in operating QDs in limited access areas. That's just sort of a problem area I identify because, again I - I actually cut my arm up there working that water tank 9 because you were working at arm's - at extended arm length, working the QDs like this along an axis like so, which wasn't too neat. The other area up in the MDA for servicing and maintenance that gave us a little bit of a management problem was the wetting of the water separator plates. You had so much hardware there all around us, with the water separator plate and the spare condensate module and all this other stuff - you might look at that one as sort of an extra - an example of a maintenance - that was a routine exercise that was part of the activation - which could have used a little thought as far as preparing work surfaces and areas, restraints. Oh, another thing. The plenum area should have been lighted. You know, we - that we worked down there occasionally, and there wouldn't have had to have been but a couple of lights down there. I was - we were actually working with - There were areas down there which were potential areas for maintenance, and that's

POGUE (CONT'D) where the heater probes were located. We didn't have any restraints down there and I don't think we really needed any. The - the little cables we had strung around there for the bags were great.

QUERY But you'd have liked to have a light rather than - -

POGUE Yes; I mean why - why carry the doctor's light down there on your head like a miner, you know. And just one or two light bulbs down there would have been sufficient.

CARR Yes, it's like having a house with a basement and no lights in the basement. If you're going to go down there to do anything, you probably ought to put a light - one or two lights anyway.

QUERY Okay. Were the friction and detent provisions on the stowage container doors and the hatches and all satisfactory?

POGUE No. The M131 door, the latch on that thing gave us trouble. In fact, I don't think I ever got that thing latched. We always pushed it up there in position. The T025 - When you have the cam lock latches on four or I guess three sides of the door, almost always one of

POGUE (CONT'D) them is out of view. And the thing has so little friction in the camlike hinges - the cam-lock hinges - that they would flip back and reattach themselves after you thought you had unfastened them.

CARR These were the Dialatches.

POGUE I'm sorry, Dialatches.

QUERY The Dialatch problems - We got that.

CARR Should have put friction in the hinge.

QUERY How about the friction in the - for the MDA film vault doors, the friction on those? They're pretty good?

POGUE Yes.

CARR Yes.

POGUE No problem on that.

CARR They'd stay where you left them.

POGUE But they should've - One thing that I didn't like about - Oh, I guess we've debriefed that enough - you couldn't - had access to both sides at the same time. Sometimes you wanted to - transfers from one to the other.

CARR That's in the film vault.

POGUE Film vault.

CARR He was talking about the MDA film vault.

POGUE Okay, OWS film vault.

QUERY Were there any indications of fraying or breaking of fabric materials in hardware restraints? In other words, a lot of fabric tiedowns and so forth, like did you notice any of them that seemed to be frayed or broken?

POGUE Yes, the - the tool box up in the MDA; you know, it had the pins on them, and they weren't captive pins, which is sort of a problem. We didn't go in there too often, so it really didn't give us that much of a problem. If we're going to use that very much, that would have been unsatisfactory. The - the - Those drawers had fabric overlays - -

QUERY Right.

POGUE - - and they were frayed.

CARR They were a real bother too.

POGUE Yes, that's - -

CARR We'd have been better off with Mosite inserts.

QUERY The - Did you have much trouble with the snaps - Velcro or decals that were bonded on coming off?

CARR Yes, we sure did. We had a lot of them come unbonded, and finally by the time SL-4 came around, Kenny Kleinknecht and people had beat the system down to the point where they let us take some glue up with us. And we managed to glue some of them back, and they held very nicely.

QUERY Okay, habitability, and generally, you covered a lot of this with M487. We've got a few general comments we'd like to ask you to consider. What changes in general acceptability of your surroundings did you notice over time? Any particular things?

CARR Well, one of the things is color. We got tired of the colors up there. There wasn't much variation, and our clothing was all the same color, and the walls were all

CARR (CONT'D) the same color. And it would've been, I think, good to have had some color - a little more color up there. And of course, the submarine folks are learning that lesson or have learned it. Atmospheric environment surroundings, once we got used to the humidity, we were quite comfortable. Color - Odor was another one. We got sick and tired of no odor. And we made a pitch towards that in the personal hygiene area and all of that. Doggone it, we should have disinfectants and we should have soaps and things like that that got the smells we are used to down here. For crying out loud! Why make everything smell like iodine or worse? And, of course, we provided enough smells of our own there that where a few bits of Airwick or something like that could have been awfully nice on occasion. And like Bill has said on a couple of times that there were - a couple of the more pleasant interludes was when it's time to defog the helmets. Everybody would come up and smell the detergent that we used to defog the helmets because that Joy really smelled good after all the other - -

POGUE Yes, it got pretty gross at times. (Laughter)

CARR Well, heck, deodorants and aftershave and Pinesol disinfectant to clean stuff with and all of that, we just didn't have it. We really missed that; we really did miss it.

QUERY Was there anything that you would have liked to change periodically? Or had the ability to change, just to alter?

CARR Let's see.

POGUE General area of habitability you're talking about now?

QUERY Yes. Provide more variation perhaps.

POGUE Well, I can't think of anything right off.

CARR The color changes would have helped, you know; if you'd have had maybe variations in color of clothing where you could - -

POGUE Well, I tell you; in a general area what we really would have liked - and it's not really the question you're asking, but it answers - it satisfies the requirement, and that is television for entertainment - and more tapes. That sort of thing. That's what satisfied that sort of craving for variety.

CARR Yes. The single best sorts of entertainment we had up there, as we've mentioned many times, was looking out the window. And that was constantly changing and it was very, very interesting to us.

POGUE And magnetic tapes were nice - the music.

CARR Yes, the music was great. We really enjoyed that.

POGUE Another thing would have been nice, would have been to have a built-in capability in each sleep compartment. The way it was, it was very inconvenient to - to move the tape recorders in there so that - I only did it once and that was for the light flash experiment, because I didn't want to go to sleep during the middle of the experiment, mainly. But that was the only time I really took it in the sleep compartment.

CARR William Tell overture with light flashes. (Laughter)

POGUE It increases the count anyway.

QUERY The - What are some of the things that you missed the most up there.

(Laughter)

QUERY There are a couple of things that's so obvious - -

(Laughter)

CARR I - I still - I'd - I think that NASA knuckled under to a very small but vocal area of public opinion when they wouldn't let us have any wine or anything up there. I

CARR (CONT'D) think that's dumb. For those who like it, I think they should have been able to have. For those who don't like it, fine; they don't have to have it. But, just a few little of the niceties like that, not overdone - -

POGUE Yes, in the area of food, if I'd have had some more candy up there I think I would have functioned at 50 percent higher level.

CARR Yes, Bill's a candy eater; he enjoys candy and gets a lot of energy from it. And that was - That sort of thing was not there. I think, again, the television would have been a very good thing; it would have been a valuable thing from a training standpoint. It would have been a valuable thing from a records and data-keeping standpoint and also very nice from an entertainment standpoint, because the three of us all like football and we would have enjoyed some of the football games. I think that kind of thing - the touch with the ground was probably the thing we missed a lot of. And, of course, the CAP COMMs helped a lot by playing music once in a while. The getup music was lots of fun because we never knew what old Crip was going to play next. And the little newscasts were very good. We

CARR (CONT'D) enjoyed very much hearing the news. And we always were disappointed when the guys would only pass up about two items of news, because we knew damn good and well there's more than that going on down here.

MS (Laughter)

CARR I guess that's the things we really - -

POGUE Yes; obviously the - you know, of course, being with the family in the evening, that was the thing that probably got us more than anything else, but that's all tied together part and parcel.

CARR Just connection with the folks back down home, the odors, the colors, the TV, the little things - -

POGUE Familiarity, yes.

CARR The familiar things that you like. You're so - It's such a sterile environment up there that you begin to get very detached. I think back on that thing now and I find it difficult to connect that part of my life with the mainstream of my life down here. It's just like you've been sort of schizophrenic for a while and you've got to - you've lived a dual life for a little while. And it doesn't have to be that way.

POGUE It's like you only have an intellectual appreciation for what was going on, although at the time it seemed like a very deep emotional involvement.

MS (Laughter)

QUERY What did you find the most satisfying up there, if that is different from things that you found enjoyable? You mentioned looking out the windows as being one of the most enjoyable things.

CARR That was the most satisfying for Bill and me. Ed's solar observations, I think, were the most satisfying for him, and then the Earth observations. I think the Earth's observations work was probably the most satisfying for Bill and me. And then I would say, what?

POGUE Well, I enjoyed the ATM and Earth resources experiment operations. Those had some type of creative operator content and contribution.

CARR That's right. I guess the big key word is creativity. You know, the Earth observations were a creative thing. All they did was give us cameras, film, and an introduction as to what sort of things they were worried about - not worried about, but what they wanted to know about. And they turned us loose, and we got pictures. And that was

CARR (CONT'D) kind of creative. And Ed's ATM was designed for creative use, and he got to use it creatively later; so that was very satisfying to him to be able to do it. The - -

POGUE The science demos too.

CARR The science demos were satisfying because we could be a little creative there. The stuff where you just followed the clock and threw the switch was not very satisfying at all, as one would expect. Being the observer in a medical thing was not very satisfying. It got very boring.

QUERY I'm going to scratch out some of these I think we've covered. Did you all - Well, you mentioned in the electrical portion that you had some bumping of those airlock circuit breakers and switching them off occasionally. And that was partially due to the switch and was that - the traffic area and the bar guard design, did that anything to do with it?

POGUE Yes, because you're tempted to grab the bar guard; that's how I got trapped in this, I think, when I reached over to grab ahold of it and it flipped the circuit breaker.

QUERY Do you think that the wicket type of guarding would have been better than the type of guarding they had on, or would it have made much difference?

CARR It might have been better because it requires that you get the finger in the - in between the wickets to throw a switch; whereas, if you bump it with a foot or something, it will protect it. But you've got an engineering tradeoff there because a whole bunch of wickets are such much heavier and space - use up a lot more space than just a bar across the top.

QUERY True. You commented in the debriefings on the ATM foot restraint position and the fact that it generally was too high for all of you by about 8 or 10 inches. Did you move the ATM foot restraint from its position and what position did you use?

CARR It was all the way down, as far down as it could get.

QUERY It was all the way down?

CARR Yes. See the thing is your natural posture is essentially - standing is just very slightly bowed, with your back hunched just a little bit, your legs flexed just a little bit. And what we ended up with was the eye level right at the top of the panel instead of where we had had all of our training where you're sitting in a chair and you're looking at the panel like this. You had to look at it like that. And the same thing in the food area too. You're not sitting

CARR (CONT'D) down, and so we shouldn't have put the food tables at the sitting down, chest level sort of thing. We should have recognized that people are eating standing up. And so the upshot was that at the food table and at the ATM panel, you had to hunch down in order to get a decent level and - -

POGUE Tense your abdomen.

CARR Yes, but your abdomen and your muscles tensed up and you just got tired of it. What we need to do is remember postural situation up there and the fact that it is quite natural to be standing up, so you might as well get all of your work surfaces and everything, your eating surfaces up here.

POGUE And the thigh restraint didn't help that any?

CARR Yes.

QUERY That's one thing, which crewman's restraint methods worked best and worst? Did you have any?

POGUE Triangle shoes.

CARR Oh, they were by far the best, yes. It took a little while to get that eye that you need so that you could come right down and put your foot in a triangle and snap it. You know, the first few weeks it was put your foot

CARR (CONT'D) down and fiddle around with your foot until you finally got it to drop in the triangle and then lock it. But you get an eye for it later on. You got to the point where 50 percent of the time you could float free right down the floor and hit the triangle and lock yourself in without ever having to grab something and make sure you didn't - And the other 50 percent of the time you missed the triangle and propelled yourself back up.

POGUE Yes, and if you have both hands full, you're off and running again; couldn't grab anything.

QUERY Do you have one that you selected the candidate as being the one that we shouldn't look at anymore?

CARR Restraint?

QUERY Yes, restraint types.

POGUE Straps. Those foot straps are no good.

CARR Yes, in the waste management compartment. Also don't ever cover up triangles for another kind of foot restraints.

POGUE Yes. The waste management compartment is the worst in the whole vehicle. I think that's even worse than the MDA/STS, if it could be.

CARR And the floor, you know the plates you had on the floor around the food pedestal? Once we got rid of those things, we probably quadrupled the number of triangles that were available to us to anchor ourselves in. And we still didn't have very many because of those intercostal beams that are in there that blocked off the triangles.

QUERY Bill, you mentioned that the M512 foot restraint was a little bit off for some of your work with the furnace, that you had just used one triangle I believe, and you felt the body position was a little wrong.

POGUE Yes; now Jerry, I think, used it all right.

CARR No, I had the same problem though; all I could anchor was my right foot. The other one was off - -

POGUE Okay. I ended up not even using it for the 516, because the 516 work was so limited. Now the flammability, that was another matter entirely, because that required the continual presence there at the panel, and Jer spent several hours doing that. So on 516, it wasn't even worth the problem.

CARR The work chamber, the furnace chamber was here. And the floor started here at my right foot and went off that way. So I could anchor - The most comfortable thing was to

CARR (CONT'D) anchor my foot in the forward left-hand corner, and then the rest of me was hanging out over the end, and I was working with one foot restraint. We just didn't have it in the right place, that's all.

QUERY Apparently they - when it was originally planned, it was organized for - -

CARR The C&D panel.

QUERY And for the activity back there in the back and the preparation and not actually for ...

POGUE Oh, for all that stowage and everything.

CARR Yes.

QUERY Yes. For handling all the other stuff. And maybe that is why, because of the particular type of experiments that were flown on your mission, we didn't have any comment about it on either of the other two missions.

POGUE You know, thinking out loud and not trying to redesign, but, I guess, really suggesting it; you could have something like that foot restraint there, but where you had different levels of the triangles that would telescope and slide out, giving you a longer - which could be rigidized by tethers, maybe. But the idea was excellent. The triangle - when

POGUE (CONT'D) that thing was moved around for C&D work, it was great when - as long as you were right at the C&D panel. But that's all it was good for. But it was excellent for that.

CARR Yes, we really fell into it, I think, on the triangle shoes thing and the triangle grid. That was - that just really came out beautiful.

POGUE Yes, that was really so convenient.

CARR Far and away the best restraint system that we have ever seen.

POGUE I used the mushrooms once. I think I would have used them more, except that you couldn't use them with the bicycle.

CARR And it was inconvenient to change - -

POGUE And it was just that simple.

QUERY Right.

CARR - - What you had on your shoes.

POGUE We needed two pair of shoes is what we needed.

CARR Yes.

QUERY You want to cover anything on this?

QUERY Could you give us a little information, a little more discussion on the comparisons of volumes between the sleep, the wardroom, the waste management compartment, experiment area, and the airlock? You know, just the - the adequacy and whether you felt that they were oversized or smaller; good the way they were.

POGUE I think the - -

CARR Well - -

POGUE Go ahead.

CARR Go ahead. That's all right.

POGUE I was going to say that I thought the worst area was the wardroom. Although I liked the wardroom, there were a couple of things about that and all of them are architectural. Ed did not have access to his food trays, and he was always either coming around float - he always felt like he was an interloper. In other words, he had to come around behind me or Jer, over the top of the food table when, if we were all eating together, was a mess. And it - a lot of times, if you want to reach over and get another drink or something like that, it wasn't convenient.

CARR It was very inconvenient for him. The size of the wardroom, I think, was reasonable for the purposes of having a place to eat.

POGUE Ed's already made several points regarding use of floors and ceiling for additional stowage, which I thought were well taken. And, of course, this has nothing to do with the wardroom as such, and, of course, we were delighted to have the wardroom window, but it would have greatly enhanced the usability of the wardroom window had there been a large radial area clear around so that we could have - with our nose in the window - we could have put our feet around a 360 degree swath.

CARR Because as beta angle changes, the horizon changes as it comes up and through the window, and it's most natural looking outside to look at your horizon this way, with sky up here and Earth down here.

POGUE You always move around to look that way.

CARR You can ... yourself around in the window to get that. It looks more natural, and that way the Earth is either moving away from you or towards you this way.

POGUE Strange thing, too, is that you'd recognize that there's, you know, an area, a land mass area down there until you

POGUE (CONT'D) moved around and got it so the top was up. You couldn't recognize it as easy even though the continent itself may be upside down.

CARR Yes.

QUERY That's interesting.

CARR Waste management compartment: Traffic was the thing there. The use of the - the fecal and urine collector and somebody washing at the same time really wasn't compatible at all. And as far as using the urine collectors, I had no objection to somebody going in there to use the urine collector while I was washing. It didn't offend me at all; and when you got three guys living together that much, it doesn't bother you at all. But the thing was, it was inconvenient because the guy standing there trying to wash himself really had to paste himself against the wall for the guy to go behind him or in front of him to get over to the urine collector. So you had sort of a traffic problem there in the bathroom.

POGUE That was architectural, too, because there was that pedestal, or that one column of equipment, stowage and the heater panel, and so forth there, the 800 series, was in the way.

CARR That's the only thing I had in the waste management compartment as far as volume is concerned.

POGUE The experiment compartment was great.

CARR Of course, we've already hit people over the head and shoulders about the floor and the fact that you had no foot restraints that were worth anything in there. The sleep compartments: if all they're designed for is sleeping, or reading a book when you're in your bed, or writing letters, or doing whatever you're going to do while you're in your bed, they were about the right size. But if you wanted it for a place for a person to go in anytime during the day and maybe sit somewhere or lock himself somewhere else besides in his bed, it weren't big enough. The only restraint system you had was the bed, so if you wanted to be by yourself in your room, you had to get in bed. One other thing that we recommended too from an architectural standpoint is that the sleep compartments be spread around the workshop, so one guy thrashing around in his bunk doesn't disturb the other guy. If you're just a thin aluminum wall away, it can get pretty noisy and bothersome. The - yes, experiment compartment was - no volume problems there at all.

POGUE The only thing that bugged me in there was having to remove the SOP, the secondary oxygen pack, in order to do the 131 chair experiments. And that was it; the rest of it seemed like it was pretty well arranged.

CARR Trash retention was a problem. When you fill a trash bag, and it's ready to go down the trash airlock, and you want to just stow the bag for a while until you're ready to open the trash airlock and have a dump, where you dump three or four or five bags, all we had was the well around there. And - -

POGUE Netting would have been nice.

CARR Once you fill that thing up, you know, it was time to dump the trash. But the problem is there was no place to put the guy dumping the trash. There was no place to get leverage or anything like that. And I had to wedge myself into the well, which meant I had to displace three of the bags in order to get myself in there so that I could operate the levers and provide back forces or counterforces to the forces that I was putting on the levers. And so that - really the working arrangement around the trash airlock was not too steamy at all. As far as volume in the forward compartment, I guess on occasion there was too much volume. If you ever let yourself get

CARR loose, got distracted and you drifted out of a foot restraint and you didn't notice it, all of a sudden you're out there by yourself and you could do nothing about it. All the swimming and fluttering and flopping did you no good, and.all you could do is swear and one of your buddies would come by and give you a shove and get you back to the wall. Otherwise you were doomed to stay there and free-floating for 5 or so minutes until you finally got close to something to grab. And it happened to all of us at one time or another.

POGUE Had a few midairs too. One guy comes down, and another guy goes boom. No way of making midcourses.

CARR Once you kick free from the dome or from the trash airlock down there, you're - there's no midcourse; and if the other guy doesn't look before he jumps, then you're both committed and every man for himself then.

QUERY How about the airlock/MDA area, any particular comments on volume there?

CARR I don't think the volume was too bad. It was just the lack of proper restraint up there, proper ways to restrain yourself while you're working.

POGUE Yes, and - -

CARR I think the VTS operator was shortchanged on restraints.

POGUE Right, and the work in even the aft airlock compartment on that recharge station - -

CARR Oh, yes.

POGUE There weren't enough restraints there, and, of course, the station itself gave us fits. And the other is forces required to put the umbilical storage plate cover back on.

CARR Yes.

QUERY On the - in the ATM/MDA area there, did concurrent experiment operation or experiment prep cause very many problems, interaction between people?

CARR Not too many. I think the noise got them more than anything else. Ed would be trying to work ATM, and Bill and I'd be talking to each other or we'd have that 191 cooler running, and it got awfully noisy up there. But the idea of having one guy working the ATM and another guy working up there doing something else really wasn't a bad deal; we didn't interfere with each other except we made noise. And when one guy said he was trying to talk to the ground or trying to record and somebody else was up there making a lot of racket, it's hard to -

POGUE It's distracting.

CARR Yes.

POGUE In lighting, while we're do - trying to do the comet photography, the lighting conflicts was a problem.

CARR You wanted the MDA black when you're looking for the comet. And if the ATM operator was trying to get in there early or late or stay in there a little bit late trying to either debrief or get in early and get set up for the ATM pass, and the guy that was in there was trying to do the comet work, it was mutually exclusive; because you didn't want any of the integral lights up. You wanted to put tape over the record light on the SIA, and you wanted to turn off all of the lights, all the indicator lights. The yellow lights on the recorder, when they would flash, it would bother you, and you'd want to put tape over them.

QUERY How about any other cluster areas? Can you think of where concurrent operations kind of bit you?

POGUE Well, working the SAL, minus-Z SAL, when there was a lighting constraint was a tremendous impact on other activities in the workshop. And we've already indicated that we think a solution to that is to use dark hoods and that sort of thing.

QUERY Yes, we got that in the transcripts.

CARR Yes, there were days when we had stuff with lighting constraints going on during the meal hour, and the guys had to stand out in the wardroom and eat in the dark while the other guy was up doing a minus-Z SAL experiment.

QUERY Okay.

QUERY Dick, before we go to - are you ready to go to another area?

QUERY Yes.

QUERY Maybe we'd better assess where we are here. It's 12:10; how much more time do you anticipate? I think some of these things that you have left have been covered already.

QUERY Yes, most everything but some of the inflight maintenance, I think, is pretty well covered. There are a couple of comments on waste management.

QUERY How much time do you estimate at the rate we're going at?

QUERY Probably another half an hour or 40 minutes.

CARR I'd just as soon finish up than quit and come back.

QUERY That's great. It's your call.

CARR Okay.

QUERY I guess one thing - about the only thing that I haven't seen covered on the shower was the shower foot restraint. How useful did you find that? And was it satisfactory?

POGUE Satisfactory.

QUERY Any comments on it?

CARR I think it would have been nicer if it had been a little softer. You kind of abraded your toes a little bit trying to come under there.

POGUE And I tried to use it to squeeze a - shove it under and squeeze out washcloths and try to soak, you know, pick up the water. That didn't work too well, but it is an idea - it gives you an idea of a configuration that would be useful. But for a foothold, I guess, it was satisfactory.

QUERY Do you think that concept of the type of restraint for temporary use would be adequate for other - -

POGUE Yes, make it - as Jerry said, if you could make it a little softer.

QUERY Yes, right.

POGUE One where you - you know you could feel comfortable about jamming your toes into it.

CARR Yes, that's not a bad system at all. I might mention one thing about the shower, and that is the QD's for the water were sure hard to work. That was a very, very tough QD to make, both in the water heater when you were drawing water out in waste management compartment, and also when you were connecting the water tank up to the shower. That was a pretty hard connection.

POGUE Yes, I had put my feet in - you know, when I was in the waste management compartment, I put my feet up on a wall over - if you were facing the lavatories, the basin, the one way over high on the left - I actually put my feet over there in order to get the QD on. That's how hard it was.

CARR Just like a lot of spring in the QD.

POGUE Yes, it just took a tremendous force.

QUERY On the waste management system, you originally were dumping the urine bags, and then you went to using the urine dump. On about day 50, you had a little problem with the urine dump system, and, as far as we know, it operated

QUERY (CONT'D) satisfactorily after that. Did you have any idea of what caused it to clog, or did you have any other problems that we didn't hear about?

CARR No, the only thing I can think of is we may have turned off the heater too soon on the previous dump, and we just ended up with a solid slug of ice in there, and it took 6 or 8 hours of constant heater operation to finally dislodge it so that we could start using the system again. From then on, we left the heater on forever, and it worked very nicely.

QUERY Did you have any difficulty obtaining half samples in the full sample bags on urine systems?

CARR No, that was no great problem. We had to use kind of a goofy system to get the urine into the bags without bubbles. It was kind of dangerous, I thought. We broke several sample bags.

QUERY Okay. Were there any problems - this is on the fecal collector - in maintaining the permanence of the seat airflow orifices of the bag seal?

CARR None whatsoever; it worked very well.

QUERY With the waste processor, could you give us some estimate of how long the specimens were processed?

POGUE 18 hours on my part, about 16 to 18 hours.

CARR I think the range was anywhere from 11 to 18 or 19 hours.

QUERY And I think we've covered a lot of the stuff on suit drying, but just what would you assess the suit conditions with respect to moisture on starting drying and at the finish of the drying with the blower and the system in there? Did you notice much difference?

CARR Well, the blue innerliner on the suit - on Ed's was always the wettest and Bill's was next and mine was next. And I always felt after 10 hours of suit blower operation tnat the liner was quite dry and that was on the first suit. And by the time we got to the second suit, its liner had already gotten dry just from ambient air. And the 10 hours of suit blower, suit drying operation, then seemed to be a little bit excessive, but we went ahead and played the game. None of the suits got smelly at all. The drying and the using of the desiccant seemed to keep them pretty good. Even the fact that we had those mildewed LCGs on - a lot of that mildew smell did not transfer to the suits as I had expected. It also did not transfer from the LCGs;

CARR (CONT'D) they smelled rotten every time we put them on. Surprisingly, it didn't bother you once you got in the suit with it. Apparently there was enough flow that you'd get used to what little odor there was and it was gone. But I remember every time I put that thing on saying, Oh, boy. I got to wear this mildewed thing again.

QUERY Did the blower get down into the extremities fairly well? Did it seem like they were - -

CARR Seemed to, yes.

QUERY - - fairly good.

CARR Right near the end on the last - well, actually after the third EVA when we were drying the third suit, it sounded like the blower bearing was getting ready to go. We started picking up a real high pitch noise. It just sounded like a high speed bearing starting to screech. And it settled down after a while and finished up in good shape. Then the - after the last EVA, we started drying again. When we first turned it on, we got a lot of the squeal; and then after it ran for a while it died out and ran. We got the drying done, but I'll bet you that a few more drying cycles and the bearing in the blower would have gone.

QUERY Okay.

CARR But it ran. It ran an awful long time. I would say the average, it was 12 to 14 per suit rather than 10. Because I remember, I left one running in the suit for about 17 or 18 hours. You get so used to hearing the blower, you forget it's running. And then one day, I went by and said, Good heavens, that suit should have been dried 6 hours ago, and it's still running. So I go over and turn it off. And the ground always wanted us to report start and termination of suit drying. But you report the start, and they sure didn't remind you when 10 hours was up. So I don't know what good the data was doing them. You know, I always figured they wanted to know when we started so they could remind us to turn it off.

QUERY On the water subsystem, could you tell us how the color compared or seemed to work? Could you distinguish colors well at the low end?

POGUE Pretty well. I never had any trouble convincing myself with - within one or two - within two of them. In other words, there may have been a choice between one or two; I always picked the low end just to be on the safe side. No, no problem at all.

QUERY Okay. Did you notice any condensation associated with chiller?

CARR Oh, yes. There was lots of condensation inside of it. It was always wet.

POGUE Now, just a second now. Do you mean the water chiller in the food prep table?

QUERY Yes, the water chiller in the - -

CARR Oh, I thought you talking about the chiller chiller, in the top box - -

QUERY No, not - no, just the water chiller - -

CARR - - in the - -

POGUE No, I did not notice any.

QUERY Okay.

CARR But the walls of the refrigerator - let's call it, the food chiller was always wet.

POGUE Yes, they were always wet.

CARR They were always wet. In fact, a lot of the dumb tin cans we kept in there got rusty. You know, the plain old tin cans.

QUERY On the washcloth squeezer, did you have any problems installing that squeezer bag?

CARR No, no, it was very easy.

POGUE Well, I would like to take exception to the design - -

CARR Well, you were the one - you had trouble when you first put it in, didn't you?

POGUE Yes. That little spread clamp or whatever it was - I'm not sure I ever figured out how that thing worked, quite. I think I did, but I had a lot of trouble with it in training. They were made out of a different kind of metal that galled. Anyway, we - I got it installed. I think there should have been a backup tool for moving those little ears - spreader.

CARR The big problem with the water - washcloth squeezer was there were too many nooks and crannies to catch dirty, soapy water and it got smelly after a while.

QUERY Was the bag fully expanded prior to dumping it? Did you fill it, in general, or did you just -

CARR Oh, it varied. Sometimes it was full; sometimes it wasn't. Sometimes I'd just skip a squeezer dump if it was scheduled and when I'd look at the bag and it was still

CARR (CONT'D) concave, I'd just leave it. Bill and I made pretty heavy use of the water squeezer and Ed didn't particularly care to use it too much.

QUERY Did you perform any maintenance on the trash lock at all?

CARR No.

QUERY You just cleaned it a few times?

CARR Just cleaned it, yes.

QUERY Do you remember how many times you cleaned it? Or about roughly - -

CARR Well, we cleaned it twice on a scheduled basis and then once when we had a urine spill inside the trash airlock, we cleaned it once and then again 2 days later and then again about a week later, and we never did get rid of the smell. But there was a regular housekeeping task that included biociding the trash airlock and cleaning it.

QUERY Right. Besides those, you had it for three times when you spilled that urine and that's it.

CARR Yes.

QUERY I think we got everything on the vacuum cleaner out of the debriefing. And you commented about the biocide wipes. How about the usage rate of the wipes versus the planned? Did you have anything?

CARR I don't really know what the planned usage was. We had to replace the unit once in the waste management compartment and that was it, just one time. I'd say we used about a carton and a half.

POGUE Did we have a planned rate or something?

QUERY I think there was a scheduled - -

CARR Yes, there's a habitability consumables page in stowage book that I'm pretty sure had it.

QUERY Right. Did you have any problems with planned inflight maintenance? Either scheduled or unscheduled? Ones that were - I think, basically you said you didn't have any trouble with any of the maintenance really, right? What was in your water separator ...?

POGUE 217 - that was the biggest buggaboo.

CARR That was the one he dreaded the most and that was the one that caused the most trouble.

POGUE One of the things, again - in the same general area of table caddies and that was the water servicing hose and the water system, the nomenclature on water system, I've already covered that in the debriefing. But the hose itself, that reel was not designed for zero gravity. It would have been nice if we had some kind of caddy device where you could unreel a - feet and have some facility or mechanism for holding the rest of it in the reel. I'd usually end up - the reel would gradually unwind and throw itself over to the side of the workshop and have all the spaghetti hanging down around in the workshop, and I had to come down and rewind the whole thing. We had a sort of an amusing thing. There was a thing called the water relief valve which was called - the nomenclature was - in the spacecraft was water release r-e-l-e-a-s-e valve - and this thing was - and I noticed in the trainer and I got all upset about it and turned out they were very faithful when they were reproducing the vehicle, because that's the way it was in the vehicle. The nomenclature was wrong in the spacecraft. And another thing that was - I've hit this before and I'd like to hit it again, and that is there is no excuse for not having the proper nomenclature on all these pieces, because the water system itself - the worst thing about it was identifying

POGUE (CONT'D) the various bits and pieces. One piece I never did find, or if I did, I didn't know it because it had serial numbers on it. I've already talked at length about that.

QUERY Yes. We noticed that you had a good bit on that in the debriefing. And we got the list of tools, I believe, that you felt should have been on board.

CARR Just on the tools thing, too. I don't know what it is that causes us to go galloping off and buy tools that are off-brand tools, real funny-looking things, but the first pair of dikes, wire cutters, we got were not much better than toenail clippers - -

POGUE Looked like manicure clippers.

CARR And so we said, all right, we want a new set of dikes up there. And the CCB says, get a new set of dikes and get a good set right off the shelf. And dadgummed! If they didn't get some off-brand thing that really wasn't a very good set either and it wasn't a whole lot bigger than the original set. And I don't know what's wrong with Proto or Craftsman or some of these good brands, but we got more offbrands of tools than I've seen and I don't understand why.

QUERY It's probably buying them by Federal stock numbers. I'm not sure.

CARR Probably is. But you know, we got some real good tool people in this country and we buy all sorts of other funny tools - wrenches with very heavy webbings and you know you'll never use that up there, open-end wrenches that are much too heavy for the kind of work you're going to do.

QUERY I think those wrenches were just off-the-shelf wrenches that they changed the coding on, however. So wrenches down here are designed to be beat on with a hammer, I think; so that's what you have - you get if you get one off the shelf.

CARR Oh another - another tool we sure could have used up there was a a rubber hammer sort of thing, a mallet.

QUERY A soft hammer?

CARR Yes, a soft hammer of some kind.

QUERY That's a good point.

POGUE By the way, anyone gives you an argument about having files and drills about - because of particulate, just refer them to the return procedure for sampling the

POGUE (CONT'D) charcoal canisters. Because that really contaminated the entire area when I'd knocked a hole in those with that big awl or whatever it was. So I mean we can live with that kind of thing.

QUERY How did that go? You say there was a good bit of - good bit of charcoal lost? Originally we had planned to put vacuum cleaner bags over the hole, slip through, and drive through that so that that would keep the material in.

CARR I don't think that would have solved it either - -

POGUE I don't think that would have done it.

CARR Oh, you start fooling with particulate matter that's as fine as that charcoal was and there's just not much you can do about it.

POGUE It was - it varied from powder to very small grain size, say 2 millimeters in diameter.

QUERY But you didn't see problem though - -

CARR We had no trouble whatsoever up there with the particulate matter getting in your eyes. We built that Christmas tree up there and we were popping all sorts of little aluminum slivers and things around while we were cutting

CARR (CONT'D) those herringbones to make the Christmas tree with and I did some hacksawing on Fiberglas with the saw and my knife blade. We did all sorts of things like that. And everything just kind of naturally gravitates up to the filters.

POGUE By the way - -

CARR It can be vacuumed off and it just doesn't bother you. And we can use some big - or some - various sizes of metal shears. We were actually using the surgical scissors for cutting metal. They worked quite well. You got a good mechanical advantage.

CARR Yes.

QUERY Were there any instances during the IVAs, just during internal action, where any special designed tools would have been desirable? I think a minute ago you said just use regular tools. Is there anything specific?

POGUE Well, the QD tool - -

QUERY QD tool, well - -

POGUE - - was the one that I mentioned. That's a kind.

CARR And of course the special tools we had done for the connector pliers. The one with the straight connector pliers and the other one with the 90-degree angle on them. Those are special kind of tools. I think for the most part if we needed a special tool, we probably put it down on the down tape.

QUERY You've mentioned a few instances when you didn't have a tool, like the ice removal, the tool you were talking about a while ago ...

POGUE Ice removal - -

CARR Yes, ice removal. We really had to improvise to get a good ice removal tool. That snap T-bar that the snaps were fastened to worked great until Bill discovered that the little clipboard worked better. The little kneeboard - -

POGUE Kneeboard - not the big one.

CARR The little kneeboard that we had up there was a piece of aluminum about about 4 by 6, something like that - 4 by 8.

POGUE Yes.

CARR Worked out very nicely.

QUERY How did those connector pliers work? Pretty well?

QUERY Yes, Ed used them on the S082 - I think it was S082B auxiliary timer. Worked out pretty well.

POGUE I tore the insert out of them along toward the end and replaced it and taped it in with narrow strips of gray tape.

CARR Oh, you're talking about about the regular connector pliers?

POGUE Yes. Were you talking about that special EVA - -

CARR I thought you were talking about the right angle ones.

POGUE Okay.

CARR Yes.

QUERY Because we never used them EVA after - -

CARR That's right, after Jack used his - used his for the rate gyros.

QUERY Right. But the stuff you used them on inside, they worked fine?

CARR Seemed to work fine.

QUERY Were there any - were the tools provided found to be inadequate? The dikes you mentioned - even the replacement dikes didn't seem to be too good - -

CARR They weren't very strong.

QUERY Anything else that you felt didn't really hack it?

POGUE You know you had some washers - some - you call them C-clamp washers, the kind we pulled off the 183 carrousel. We didn't have a tool for removing and replacing those things. But we had some of them in our stowage. Bottom - I forget what drawer it was.

CARR Let's see, inadequate tools?

POGUE So it's a C-clamp tool.

CARR No, most all the tools we had up there that we used, we had no complaints with. Other than that some of them seemed kind of cheesy, I thought; and I mentioned that.

QUERY Okay. Were there any instances where reaction forces presented any problems?

POGUE Yes.

QUERY On the high-torque screws you mentioned?

POGUE On that, on removing PCU, on removing just about anything from the dome ring locker. If you were high; you see you had the blue ring with the real nice foot restraints in there. By the way, they held your toes in a position so that you came out real easy. Oh, I was grateful for having them. I forget exactly what it was. But you were always coming out of them. You had to consciously hold your feet in the right - legs in the right posture to stay in them. But if the equipment that you were trying to remove from dome ring locker, assuming you had to use tool and high-torque grasp, you could come out - It was hard to get to. And one of those was the OWS heat exchanger fan.

CARR But it's the same old thing, that if you can't lock yourself in order to put torque on something, then you've got to use one hand for restraint or counterforce and the other hand - and it reduces the amount of torque that you can bring to bear when you've got to use one hand for countertorque.

QUERY Right. The - you mentioned about strength being required for your for that - for your Coolanol work and all extra restraints that you made up. Tool kits and spares conveniently located?

CARR No, I don't think so. I thought the tool kit, if we had located them more centrally, I think it would have been better off. I think they were kind of down in one end of the workshop.

POGUE Yes, I guess it would have been best - -

CARR It would have been better if we could have had them up in the dome somewhere, maybe all that big wall space in the dome, part of that could have been used for a tool box.

POGUE Yes, that was all wasted.

CARR And you could have spread the tools out more instead of having to concentrate them so tightly.

POGUE No reason why you couldn't had a pegboard just like you do in your own garage, or tool or workroom. We had them all spread out - with a lot of visibility because getting them in and out - putting them in and out of the drawers was a mess. I've already debriefed the drawers, too.

QUERY Right.

POGUE And restraint.

QUERY Stowage, launch stowage is, of course, one of the things that ... requirements between launch stowage and the other ... - -

CARR That's correct. You could have started out with launch stowage and then over a period of time you can begin to utilize your wall space better.

QUERY Did you see any need for tool tethers inside? Or any of your maintenance inside of the spacecraft?

CARR Yes, but I can't tell you what's a good design yet. The tool caddy didn't work well. We didn't like it.

QUERY Individual tethers on tools on - individually on tools - did you see any need for it at all - -

POGUE For your work inside, really I don't think you need it.

QUERY You need a good tool caddy?

POGUE That's right.

QUERY But the one we had wasn't so good?

CARR No, no.

POGUE It just didn't work. The idea, the motive behind it was good.

CARR We found that we'd just stuff them in our waistbelt or stick them to the wall near the work area with tape.

QUERY How about the Velcro that was on the tools, was that any use to you or did you find that it was just in the way?

POGUE I used it occasionally.

CARR Yes, I did, too.

POGUE It's particularly good but you have to have Velcro in an area where you're going to work. If you're doing work around the SAL, you're in business.

QUERY Were there any IVA actions which should have been anticipated and - Well, we've pretty well answered that one, I think. What onboard capability we'd have? We're going back to the same - -

CARR I might mention about tools and Velcro - Let's talk about writing tools and that's the ballpoint pens. They had little itsy-bitsy bits of Velcro hook on them and you couldn't get them to hook anywhere. Whereas the pencils - apparently somebody else in some other department put the Velcro on the pencils and and there was adequate Velcro so that you could stick a mechanical pencil where you

CARR wanted to and it would stay. But you had about 30 percent of that Velcro stuck on the - stuck on the pen and a ballpoint pen was difficult to retrain - retain anywhere. It was an aggravation to us to - -

POGUE We finally took a piece off of a food bag and put on the one that we had in the head for recording fecal weight and all that.

QUERY Can you think of any tasks which were unscheduled which really should have been scheduled? Or the other way around. Any specific things that come to mind. Ones that were not supposed to be scheduled that we ended up doing on a regular basis or anything like that.

CARR No, I can't. I can't think of anything right off hand. By the time you got to us, I think you had most of that stuff ironed out.

QUERY Was the failure detection and fault isolation a problem or do you have any recommendations for any improvement on that?

CARR Again, we didn't get involved too much in failure detection and fault isolation because the ground handled it.

POGUE This is sort of related. The condensate holding tank quantity - you know, you had to go down and get the little stud finder to find - to locate the position of the bellows divider. That - there ought to have been a printed decal or something to say where to put the stud finder because Al Bean had tracked this thing out. It must have taken hours to do it. But it was - it was a real wavy curve that you had to move the stud finder down in order to locate the - the bellows. That sort of thing, you shouldn't have to do that in flight. There should be a path for the - the metal detector inside.

QUERY Well, you made a lot of comments also about the need for feedback, Bill, which I think is related to this question. The answer - the answer that you've already given, you know, about if you could do something, some positive feedback that would tell you if you've had a failure or just what your problem is.

QUERY From the C&D standpoint ...

QUERY Yes.

CARR Right.

QUERY Well, any - anything like that then.

CARR I think the - the idea of trying to - all these different water accumulators, where we had to go look at them and see what percent full they were - They were terrible for ... - -

POGUE Oh, yes, you couldn't - Yes.

CARR You couldn't even tell with a mirror, some of those things, how much water was in them.

POGUE Those - That's a good point. Those were very bad.

QUERY All of those, their - It's apparently generic to the whole thing, the condensate tank and all the others.

POGUE The ATM was the easiest; but the other two, the LCG loop, were very bad.

CARR You couldn't even get your head in there to really see enough of it.

POGUE You had to reach - You had to hold the flashlight in and - and illuminate the right area and keep looking at a mirror here to tell where the - what the position of the billows was.

QUERY Should more detailed maintenance procedures - Well, you covered that in detail on the transcripts; so we won't discuss that much more unless you - -

CARR Yes, areas like this is where that - that cassette TV really pays for itself. If something breaks down, the folks down on the ground could do a repair job on one and televise it and then send it up saying, this is how you do it. It sure cuts your training requirements down.

POGUE One little area of confusion that we never did really get - get sorted out or - at least to get a satisfactory answer on - was the tape recorder changeover connectors. And there was inconsistency in the nomenclature and the color coding. Do you remember that? When you changed the cables over - -

CARR Oh yes, the - this is the EDDU, EREP tape recorder bit, when you change from tape recorder 1 to tape recorder 2. If you blindly followed the color dots, you were okay; but if you tried to - to hook P-5 with J-5 or something like that, you were all messed up.

POGUE Something like that. There was a mistake. We finally - In order to use the nomen - the J whatever it was, you had to cross connectors; and we figured that wasn't right. The color coding that - that time saved us the problem, I'm sure.

QUERY Were there any damaged or broken tools other than the - You mentioned you lost an insert on the cable pliers. Anything else that you can think of?

POGUE A bent screwdriver.

CARR Yes, the 3/16 screwdriver got bent. It was used for a prying tool and got bent, and I hammered that back into shape again.

POGUE I think we lost one of the little pinchbars. Never did find it.

CARR Yes.

QUERY Well, there was one of - One of those two was put - left outside on the first EVA, when we erected the beam.

POGUE No, no, this - Well, maybe it was.

QUERY And there should have only been one pinchbar - bar on board; so -

QUERY After these guys got here.

QUERY Yes, when we - when they got here. We started once with two, and one was outside after Pete's mission.

CARR The side cutters - the wire cutters that we brought up were already getting dull. They hadn't been used very much. Even the Phillips-head screwdrivers were hanging in there pretty well, and you know how Phillips-head screwdrivers are. They're awfully easy to mess up. But they were still in reasonably good condition after the use we put them to. I was pleasantly surprised by that. So it was pretty - pretty good grade of steel that was used in that.

QUERY And I think you've mentioned this several times on the tech debriefing, but you talked about the value of a workbench and the use of the screen for a workbench. Do you have any recommendations?

CARR It just looks like the aerodynamics style of workbenches is the best way to go. We used the - the screen up there - I should say Ed used the screen for a workbench, and it worked very nicely. He had to make a little cardboard corral to keep the small things in because you could - you could bump or cause the screen to ripple a little bit and it would make the small - the small-inertia items fly. And so he just made a little cardboard corral and stuck it up there, and then all of his little nuts and bolts and washers, he put in there; and it managed to keep them all together.

CARR (CONT'D) The bigger stuff you can just lay on there, and it's got enough surface area so that the air pressure held it down. It's very handy, and it's - it's - it's - I think it's essential that we have a place to work.

QUERY You deal - You do feel a dedicated place like that is - is a very ...

CARR I think so. It ought to be an electromechanical sort of a workbench; that is, it should have - be somewhat of a cross between a mechanical workbench with a vise and an electronics workbench where you've got some power sources, different voltages, and you've got multimeter capability and things like that in the same bench so that you can bring units and - and test them. And if in the future we get to a type spacecraft design where we're replacing modules and things like that, I imagine the ground is going to - going to have us doing some module testing. And you might as well design your bench to do that. Not only that, I think Bill had a good point too, that you need a portable bench to take around with you when you got a job that can't be brought to the bench. And that can be something that just hooks onto the vacuum cleaner. Now all you got to do is have a flat surface with the airflow work - working through it, and you could use it for a workbench.

QUERY I think you've already commented on the arrangement of the tools and the tool kits. Did you use - Well, you used the digital multimeter some. How did that work out?

CARR Very well. Yes, we were - I was very glad to see that.

QUERY Do you have any comments on access on any maintenance task other than the 217? I think we've covered that one pretty well.

CARR Yes.

QUERY And I think we've covered the last one on maintenance capabilities here, too; so that's all I have. Are there any other questions that anybody has?

CARR There's one in the back there.

QUERY Not a question, but just a comment to Jerry. On the dump tape - -

QUERY Should we come up to a mike?

QUERY - - zero - Okay, this is just a comment to Jerry. Dump tape 030-4, I think it was, you did an M487-3D, and that thing turned out awful - had an awful lot of background noise. Now I think it was Bill's fault because he did something up there. Do you remember? You started it off,

QUERY (CONT'D) and you said, "Hey, what'd you do?" You know. What happened up there? And apparently, they must have done something bad, because you kept turning your head and, you know, looking at him. Anyhow, the people that transcribed the thing couldn't understand you; so a whole bunch of dots came in there. And you're talking about the tools and this and that and the other. So if somebody asks you why you needed oil up there, it was a file that turned out to be oil in the transcript.

CARR Oh.

QUERY Also, I think it was a wire crusher and several other things. So something in the tool area that - that somebody read, you know, you know where it came from.

CARR Okay.

QUERY It was a bad tape. Maybe we ought to get it squared away later on, but -

CARR I imagine Bill was probably working the Mark I exerciser. That was an annoyance some - -

QUERY Oh, he did some black magic there after awhile. They picked that up, but -

CARR Can't think of what it was.

QUERY Well, anyway - -

CARR Okay.

QUERY It's awful garbled and -

POGUE What - what was it you were doing at the time?

CARR I was debriefing on M487, talking about the tools.

POGUE Oh.

QUERY Yes. And we took it over the 440 and tried to get some of the background noise out of there, but not well enough. So when the girls apparently typed it, the file - I could understand you saying file, but the world now sees where you want oil up there.

QUERY That's what the world wants - oil.

QUERY Thank you, gentlemen.

QUERY That's all we have. We thank you very much.

QUERY No. Bruce, do you have any questions?

QUERY No ... you and I ...

QUERY Okay.

QUERY I guess that ends it then for all the systems, and thank you, guys, for hanging in there with us for the last couple of days. You've been tolerant and patient.

POGUE Okay.

CARR Thank you.

QUERY ...

GIBSON Yes?

QUERY Let's have some lunch ... find out what it is ... McDonald ...

GIBSON Okay.

# # #



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