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PRELIMINARY

GT-4 FLIGHT CREW DEBRIEFING TRANSCRIPT

PART II

Prepared By

Spacecraft Operations Branch

Flight Crew Support Division

June 18, 1965

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PREFACE

This preliminary transcript was made from voice tape recordings of the GT-4 flight crew debriefing conducted aboard the recovery ship, the USS Wasp, on June 9, 1965, and concluded at the Manned Spacecraft Center on June 12, 1965.

Although all the material contained in this transcript has been edited, the urgent need for the preliminary transcript by mission analysis personnel precluded a thorough editorial review prior to its publication. Errors in this transcript will be corrected as soon as possible and an official transcript will be published at a later date.

This document contains a transcript of the second part of the total debriefing. A preliminary transcript of the first part was published on June 16, 1965, and it contains the crew's description of the mission from an operational standpoint.

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8.0 SYSTEMS OPERATION

8.1 Platform

McDivitt Actually, the first portion of any alinement is to cage the thing. The case of caging the thing is much more important than the alinement itself. In the daytime I felt that I could cage the platform to a reference with an error plus or minus about 3 or 4 degrees in all axes. Did you think we could do that well?

White Only in the daytime.

McDivitt The yaw was a little problem. It took longer to get it, but if you kept after it for awhile, I felt that you could get down to just a few degrees.

White Within a couple of degrees.

McDivitt The big thing is that you have to stop your yaw rates, and then sit there and look outside for awhile and see which way you're going, straight ahead or sideways. If you are going sideways you rotate around for awhile and stop the rate and then look out again. Right? I felt you could get the thing caged quite well. We didn't do it BEF at all, did we? We never did cage in BEF.

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White I'm not sure.

McDivitt The caging of the thing with small-end-forward in the daytime was relatively easy. At night I don't think it would be quite that simple. I think what you would have to do at night time is to point the spacecraft down at the ground pretty much so you can see the track across the ground. I could see which way the land was moving under me. I felt--although I never did this--that if I could do that and then roll around to where I had no bank angle, and face in my yaw direction, either small-end or blunt-end-forward, stop the roll there and pitch up to the horizon I could cage there within plus or minus 10 degrees for sure. It was much less accurate at night, I felt, than in the daytime.

White You aren't kidding! We both felt that on those dark nights when you really couldn't see anything on the ground, pure star reference for yaw was pretty rough.

McDivitt Pure star reference for yaw was almost impossible to use. That was the only place where that thing we decided not to take with us--the view of the stars through the window--might have been of some

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use to us. We knew the stars along our track but you couldn't see enough of them. The quickest way to get the yaw reference was to look down at the ground. Once we got the platform caged, alignment was quite simple. All you had to do was just hold the needles at zero and the platform aligned itself. Of course you had to have the scanners on. The modes--the SEF and the BEF were identically the same except the spacecraft is pointing in different directions. You tended to null the needles by using pulses and just hold the needles very close to null and the platform aligned itself through the horizon scanners. Orbit Rate was a satisfactory mode, I thought. As a matter of fact, it was very good.

White I liked that Orbit Rate.

McDivitt Yes, because we finally had a reference where we didn't have to look out and see the ground. It's like having the old altitude indicator back in an airplane. The only thing was, we had the wrong orbit rate in the spacecraft because it was set for an orbit rate that was to take care of, I think, a 60 nautical mile circular orbit. This was to take care of the short period of time between

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going to Orbit Rate at T-5 and firing the retros at TR. We wanted to have exactly the right rate in there so when we did our closed-loop reentry we wouldn't have an error. As I said, I had the most accurate platform in the world with nothing to do with it. I think the displays were adequate and the controls were adequate. After the first couple of revs I really didn't have any confidence at all in the platform. I had done nothing to establish any confidence in it. I really didn't get the chance to get the thing alined, and I really didn't have the view out the window to check it with. We were hurrying and scurrying through there. We finally shut the thing down before I really got a chance to use it very much. When we powered it up there on the third day and we saw that thing coming around there and cage properly, we compared the out-the-window attitudes and that old attitude reference was right there. That's when I got some confidence in the platform.

White

This is where we lost a couple of bets.

McDivitt

That's right. We lost a couple of beers on that platform. At retrofire I had a lot of confidence in the platform, but the first two and a half to

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three days I really didn't have anything with which to establish any confidence. It was just an unknown.

White Jim did the majority of the work in this area and I think his comments reflect my opinion also.

8.2 OAMS

McDivitt On the pad we did the thruster check that we wanted to. We went around one whole cycle and got nothing. We went around another whole cycle and got nothing until we got to the last one. We were going yaw left pitch-down, yaw right pitch-up, yaw left pitch-down, yaw right pitch-up. When we got to that second pitch-up, I heard the thrusters fire for the first time.

White You can hear them. It was very distinct.

McDivitt That's right. And then we went around and yawed left and they fired again. We waited 20 seconds and fired a yaw left again, and they fired again. These were the bottom manifold jets. We said, "Okay, we're ready to go.", and that was the end of it. So, it was a pretty straightforward check. The inflight checks--I got my operational checks on the OAMS systems while chasing the booster around. I had Direct, Pulse, and Rate Command in

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there as I chased it around, and those were the only modes I intended to use right then. Later on, I checked out the Reentry Rate Command and I checked the Rate Command before we thrust. It did seem to be operating fine. Why don't you go through the next part, Ed?

White

All right. We're going to get into the source temperature and pressure, the regulated pressure, and the propellant quantity. Let's take the temperature first. The temperature of our OAMS was 75 degrees all the way down the line. The initial indications on the pressures were approximately 2800 psi for the source and 320 psi for the regulated pressure.

McDivitt

The quantity gage operated all right except that, as I mentioned earlier, the thing seemed to wander up and down somewhere between 2 and 4 percent, depending upon where you were in the mission. You'd read it one time and it would be 60, and you'd read it a little while later and it would be 62, and you'd read it a little while later and it'd be back about 60. The greatest variation in that thing that ever occurred was when I went to sleep one time with it reading 60 and woke up and

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it was reading 56. Another hour or two after that it had climbed slowly back up to 60 again. I had a long time to look at it in the same position. When we ended the chasing-around at the end of the first hour, we were down to 70 percent indicated and we never got below 50 percent in four days.

White

I'll tell you, the position it seemed to stay for days and days was 59 to 60 percent. We fired in Pulse Mode for a long time with the gage at that position, and all of a sudden that one time it dropped down to about 55 percent.

McDivitt

But then it came back up to 60.

White

I guess it did, didn't it? The temperatures all stayed fairly constant. If I recall right, they dropped down to around 70 degrees. It seemed to me they continually decreased throughout the flight. I noticed this particularly in the RCS, but I guess we'll get to that later. The propellant quantity though, I think we mentioned earlier, ended up on our gaging at about 3 percent at the end. We got a little bit of ground information on the OAMS propellant. I felt a little suspicious of the gage when it kept staying there at 59 to 60

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percent for so long.

McDivitt We were pretty miserly with that OAMS fuel. We set out to save the fuel and we sure did it.

White I think that in future missions, if they permit the crew to use the Pulse Mode in a saving-manner they could do a lot more with the mission--if you could use Pulse Mode instead of just free-drifting around. In other words, line yourself up so you can make some decent observations.

McDivitt Shoot! We were in Horizon Scan Mode when we got the last data, and I don't think we used any more fuel than we were when we were in free drift.

White That's right. We certainly got more out of the orbit than we did when we were just drifting free.

McDivitt I'll tell you one record that we ought to hold. We've looked at the earth from more different angles than anybody else in the world. Well, maybe not. I guess the Russians did, but we sure got a lot of different views of that earth as we rotated around.

White I think the ground information that they called up on the status of our OAMS wasn't as much as they could have called up to us, but I'm really satisfied that our OAMS was staying pretty constant.

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McDivitt So did I. The way I felt was that I knew that we had to be as miserly with the fuel as we possibly could, so we got as much out of as little fuel as possible. There wasn't going to be anything to change that velocity. We just went along and I really didn't care how they were plotting that fuel on the ground. I knew that we were starting to get ahead of the schedule, because I was plotting it roughly onboard the spacecraft. I could see we were up above the line that we needed to remain above to handle our OAMS retrofire.

White Actually, we followed the profile rather closely. We leveled off there at first, and then when we started using it, we went right down the profile.

McDivitt We were a little below the line and we just held the same fuel level until we walked out across it and got up on top of it. Then, we went on down above it.

White I think the controls and the switches were all satisfactory.

McDivitt I think so too. The attitude controller worked fine and dandy. We didn't have any trouble with it. The stick forces weren't too high. We didn't get a chance to use it in any other mode besides

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Pulse. It seemed to work all right in Pulse. I don't really have any comments to make on the attitude controller.

White As a matter of fact, I didn't use any Rate Command.

McDivitt Didn't you really?

White We didn't use the Rate Command. I got to use Direct a couple of times. I used Pulse a lot. Everytime you'd go to sleep, I'd really have a ball!

McDivitt I could tell that by the wiggling.

White No. That was really great--flying that spacecraft.

McDivitt That's right, and I think Pulse is the mode. You can do a lot with it. With a little bit of planning you could get to the attitude--if you start out 5 or 6 minutes ahead of time. That's what we were doing. At 10 minutes before I was supposed to be at a certain attitude I'd start, and one or two little pulses and you'd--boop, boop, boop, boop--the bad thing was if you were in an attitude where you couldn't see the horizon and didn't know where you were. You would give it a couple of pulses and nothing would happen, and you'd have to give it a couple of more pulses. It'd take a long time sometimes before you would get to where you could see. As a matter of fact, if at 5 minutes before

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we were supposed to be at a certain attitude we weren't approaching it, I'd start pulsing a little harder.

White You'd hear a series of about five quick pulses.

McDivitt It was a very economical control mode.

The maneuver controller worked the way it was supposed to.

White What about the deadband? Did you think the deadbands and breakouts were all satisfactory?

McDivitt Yes, just like the one we used in the simulator. You've got a lot of slop in it when you're making gross maneuvers because you're not fixing your elbow and manipulating around that point. You're fixing your shoulder and your whole arm, and it's just like shoveling coal--you've got about that much finesse to it. I don't think there's much you can say about it. The controls weren't too gross and they weren't too minor. The whole thing was adequate. We did have an inflight malfunction, or irregularity. We were in Horizon Scanner Mode one time and Ed wanted to yaw around. He started to yaw and the thing rolled. The Horizon Scanner Mode fired the roll thrusters to level it back off--

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White I couldn't get the yaw. We had a circuit breaker off.

McDivitt Finally, after you did that a couple of times I looked up and saw we had knocked a circuit breaker off. That was one thing that we didn't cover in EVA that I should have mentioned. Ed was a real hazard to the switch positions in that he was all over with his feet, arms, and hands --.

White I don't think I threw any though. Did I? Come on now. You're not guilty until you're convicted.

McDivitt I don't know. You kept putting your foot on the HF Reentry Antenna Switch and stepping on it.
Ha. Ha. Ha.

McDivitt As for the attitude control modes--I mentioned the Rate Command in OAMS seemed to be tighter than the Rate Command in RCS, although they use the same electronics, the same gyros, and the whole thing. It might have just been my imagination, but I felt that the Rate Command system in RCS was a lot looser than it was in OAMS. The Reentry Rate Command operated just the way it should. It had a 4 degree deadband, and handled the spacecraft very well during reentry. Direct had a lot more authority than I thought it would, but it was

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pretty straightforward. I think Pulse was the best mode on the spacecraft for the orbit phase. We were able to save all kinds of fuel, it worked fine, and it was just about what the doctor ordered. We didn't use the Horizon Scan Mode during about the first three days of flight, except for the second orbit when I think I was in Horizon Scan so that I could have the freedom to help Ed prepare for his EVA. The last day we used the Horizon Scan Mode, and I found it to be an excellent mode. There was only one case when it broke lock and didn't recover. Wasn't that it, Ed?

White You've got it in the book.

McDivitt We've got in the book and we'll check on that. The Horizon Scan Mode worked essentially for 24 hours without any problem and I think it's an excellent control mode. It seemed to be very economical on fuel. We were doing a lot of yawing around and right at sunrise and sunset it seemed to get a little nervous, especially if we had the horizon scanner pointed within about plus or minus 45 degrees of the sun. The moon didn't seem to affect it at all. I noticed that, occasionally, we would get some thruster blips with the sun

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pointed toward the horizon scanner although we never got an unlock light. We wouldn't get an unlock light, but we'd get a bunch of maybe four or five thruster blips right there.

White Particularly at sunrise.

McDivitt It would hold. I thought the Horizon Scan--

White It was definitely getting some spurious signals through but not enough to break it out all the way.

McDivitt I thought the Horizon Scan Mode was an excellent attitude-hold mode.

White Did you notice the water boiler venting, Jim?

McDivitt Yes, I did. We kept yawing around to the left. I believe it was left. I did notice the fact that we were yawing, but not very much. We were yawing at rates that were extremely low and it just took a pulse every once in a while to handle the thing. As a matter of fact, when we were chasing the booster around a lot at the beginning, I never even noticed. It was when we were in the Pulse Control Mode for a period of time, when we didn't do much thrusting in yaw, that I noticed we did start drifting off in yaw. So I did notice the water boiler venting.

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White I didn't think you noticed it earlier when we were working.

McDivitt Well, I did notice it a little bit in that first orbit, but it wasn't distracting at all. It would just drift off a little bit and I'd whop it and it would be back. At SECO + 30, I used the translation thrusters to damp the booster-spacecraft rates. One of them was a little higher than the other, although they were both down in the order of a half of a degree/second. I did fire one thruster one time or possibly two times to damp the rate. I don't know if it was pitch or yaw. You know, you are working in spacecraft pitch and booster yaw and spacecraft yaw and booster pitch. I was getting my coordinate system transformed around in my mind, going from booster coordinate system to the spacecraft. I don't remember whether it was yaw or pitch, but I did thrust once or twice. By the way, I could hear those thrusters fire. At SECO + 30 I said, "Thrusting," and I started thrusting. "Separate", and Ed punched the SPACECRAFT SEPARATE. We were in Direct and I thrust straight ahead for about 5 seconds. Then I went back into Rate Command. Separation was

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just smooth--we didn't come off with a rotational rate.

White I think one of the things you might comment on, Jim, is that you fired most of those thrusters during that initial time.

McDivitt I'm sure I fired the upward-firing thrusters a number of times. That isn't any more difficult to control than the other one. Actually you can fire these thrusters whether you are in Rate Command, Direct or even in Pulse. When you fire them, you get a rate and you just damp the rate out with the attitude controller. When you are firing the translation thrusters, the things that you really hear are not the translation thrusters, but the attitude thrusters. Those translation thrusters are really tough to hear, but the attitude thrusters are very easy to hear. I don't understand why. They must be mounted differently because their location isn't that much different. I think I fired the aft-firing thrusters a couple of times and they didn't make any more noise than the forward-firing thrusters, that I could tell. The up and down and left and right ones were just as easy to fire as the other ones. Our OAMS retro

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was 127 feet/second which, incidently, happened to come out exactly 2 minutes and 40 seconds. I suspect that we selected OAMS retrofire on the basis of time, rather than on the basis of ΔV .

White Very convenient, wasn't it?

McDivitt Very convenient. It was obvious there is no more difficulty in timing 2 minutes 40 seconds during our OAMS retrofire than it is during any other thing. We had no trouble with it. I was convinced that when we got through with it, that was really the proper conversion factor between ΔV and ΔT . We had exactly 127 feet/second, and we sure had the time nailed down.

8.3 RCS

McDivitt The operational checks that we did on the RCS occurred at about TR minus an hour. When I checked the system out it seemed like I had a lot less authority and a lot sloppier Rate Command than I had in OAMS. The operational check consisted of pitching up and down, yawing left and right, rolling left and right on each ring in Rate Command and Direct. Direct worked as I expected it to. In Rate Command, however, as I pitched up and down I noticed that my top left yaw thruster was doing

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a lot of firing, too. I started out checking the Rate Command, so I thought I might possibly have one bad pitch thruster that was causing a rolling moment that was being counteracted by the yaw-roll jets. When I did it in Direct, however, it wasn't doing that. It wasn't rolling either, so I felt that it must just be a very tight deadband that was trying to hold us in there. So, the operational checks were all right. The only thing we had to monitor on the system was the temperature and the pressure of the propellant. It seemed to hold pretty well.

White

I have some comments on that. I kept a running log of them as we went along. The temperature started out at 75 degrees and 3000 pounds. It held that way pretty well until about the 65th hour, when the temperature gradually went down. The temperature decreased to a point where we started getting the RCS heater lights that we noted earlier. We got about eight series of RCS heater lights. It took about 5 minutes to extinguish the light. It was the A-ring, then the B-ring, and then the A-ring. It seemed to alternate each time back and forth and it came on for about 15 to 20 minute periods of

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time. It started right after a night cycle. It seemed rather natural to me that there wasn't really something wrong, but that we actually had a cold RCS thing out there and it did need some heat. After heat was applied it did appear to go away. I decided to go ahead and set up a slow roll rate in the daytime, and I kept that roll rate in for several orbits. Whether this actually helped to get the light off or not, I don't know. We didn't get anymore lights after this time. I think there ought to be one other comment on the RCS, and that is the temperatures and the pressures stayed up pretty well except when we actuated the system. The pressures then went down further than we had expected them to go. They went down to 2400 to 2500 psi. This was a little lower than I expected to see.

McDivitt I think the pressures in the RCS A and B dropped by about 100 pounds throughout the four-day period. They were slightly over 3000 pounds and they got down to slightly under 3000.

White The lowest temperatures I noted were in the neighborhood of about 63 to 64 degrees. They started out at 75 degrees.

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McDivitt Let me ask you a question?

White Yes.

McDivitt When you turned on the RCS heaters, did you turn on the heaters on both rings, or did you turn on the RCS Heater Switch and then turn off the circuit breaker on the other ring?

White I turned the heaters on and then I checked to see which ring it was that was actually heating up by using the circuit breakers. The first time I went ahead and left them on and then the other ring came on. I felt that one of them was about as cold as the other, so I left the heaters on both rings throughout the heating cycles.

McDivitt Good.

White They were in perfect sequence--A and B, A and B, and about 15 minutes apart. The regularity was surprising. The temperatures at the time when these lights came on were indicating about 63 or 64 degrees and it seemed like it would come up a little bit, and then come right back down and pop back on again. I felt it was not an actual temperature problem.

McDivitt I used Rate Command, Reentry Rate Command and Pulse control modes. I didn't use Direct. They all

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operated as I thought they should. I've already mentioned I thought Rate Command was a little sloppier in RCS than it was in OAMS. It certainly did a fine job of holding the retro attitude during retrofire. Retrofire attitude control was excellent. We didn't deviate more than about a degree from the attitude we were supposed to hold, and I had plenty of authority there. From my standpoint it couldn't have been any better. I was really happy about it. I used the Reentry Rate Command with roll rate gyro off, so that I had essentially Direct in roll and Reentry Rate Command in pitch and yaw axes. It had the typical 4 degree deadband that it was supposed to have. It did do rate damping as it was supposed to. It performed just the way it should. Ed, you want to cover that heater-lights thing again? I think you've already got that thing pretty much in detail.

White

I have the precise times at which the lights came on. It started at about the 64th or 65th elapsed time hour. At 06:47, the first light, in the A-ring, came on. At 08:23 the A-ring light came on again. That was the last time. During that period of time the A and the B-rings cycled on and off inter-

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mittently.

McDivitt During descent, we turned the power off to see if the drogue chute was unstable. It wasn't. We turned the power back on and the propellant valves off and burned up all of the fuel in the manifolds. We had no fumes after impact.

8.4 Environmental Control System

McDivitt I thought the suit mobility was as good in the spacecraft as it is anywhere else. I think these suits are pretty good suits. I didn't find any trouble with them whatsoever in the spacecraft that I wasn't already aware of. The pressure held up good. I did a pressure check on the suit. It bled down about 0.2 or 0.3 psi in about 30 seconds, which really wasn't too bad. The temperature was always good. It ran between about 50 and 55 degrees during the entire flight except when we really worked hard. I don't think it ever got up over 60. Do you, Ed?

White No.

McDivitt We had reasonably good temperature control.

White The cabin temperature got up pretty high one time and then it came back down.

McDivitt Yes, on about the first orbit.

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White That's right. It got up to about 90.

McDivitt 100, it was. We turned the cabin heat exchanger on for just a short time and it went right back on down to 80 degrees.

White It stayed in the area of 82 to 83 degrees the whole flight.

McDivitt The humidity in the suit must have been pretty dry because my foot dried out. I didn't take any wet-bulb readings inside the suit. The CO₂ stayed at zero all the time. It never did go up except when we'd go to O₂ High Rate, when it would bound off the top peg and fall back down again. The comfort and suit controls were pretty reasonable. The O₂ demand regulator seemed to work all right. My umbilicals were short. My fingertip lights were lousy. Before launch I only had one that worked. On my right-hand glove one of the bulbs obviously didn't work. One of them did work. On my left-hand glove the switch on the batteries would only turn the lights on if it was in one exact position, which wasn't full throw in either direction. So I found out I had only one fingertip light that worked. However, during the flight I didn't use my fingertip lights except one time when I used

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them for a flashlight. I had my gloves off and I reached over and got my gloves and turned the fingertip lights on and shined the gloves on something. I didn't use them a lot. I do want to comment on one thing, though, since we're talking about the suits here. I launched without the plug that goes in the blood pressure port in the suit. I don't feel we should launch these things with no plug to plug up the blood pressure port in the suit, especially when we're going EVA. I think that was a mistake. The only pressure points I had in the suit were in the helmet. Those were just above my ears where I tended to move my head back and forth within the helmet. I finally rubbed up all the hair so that it was going in the wrong direction. When you press against hair for a long time in the wrong direction it becomes very uncomfortable. At about the end of 2 3/4 days I took my helmet off for a couple of hours, and it felt a lot better. The only problem is that when you have your helmet off there is no place to stow it. We had the foot wells full of gear, so when I had the helmet off I just let it float around on my lap, and over in Ed's lap. There wasn't any place to

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put it. The micro-meteroid blanket that I had strapped under my right leg wasn't a detriment. As a matter of fact since we had no place to stow it, I just left it strapped to my leg until reentry. Then, I felt that if we had to get out in the water I didn't want to have any straps hanging off me that I didn't need. So, I took it off and threw it on the floor along with Ed's sleeves. I don't have anymore comments on my suit.

White

I wore the EVA suit. I think the mobility of the suit was about what I had expected. Actually, I think the mobility in some respects was a little better, and in some respects it was a little less than I had expected. I wasn't able to get into the right-hand aft food box as well as I had thought I was going to be able to in zero g. In fact, the position that I had figured out to use, which was leaning forward and reaching in backwards with my left arm, didn't work out well at all. I had to actually turn around 90 degrees in the seat and reach in with my right arm. This worked out all right. I was able to get hold of things in the box. The surprise that I got though, was that I could get into the right-hand aft refuse box much

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easier than I had thought I'd ever be able to. It turned out that I was able to get into that box easier while in orbit, by far, than--

McDivitt It's a rubber covered box.

White It's a rubber covered box on the right hand side. I think that box does have the capability of stowing refuse in it and stowing some things prior to launch in it, too.

White Did you try that box during flight, Jim?

McDivitt Yes, I did. I didn't find it easy to get into. I thought the things we had stowed in it were real good things--items that we didn't need at all in flight and possibly might not need--

White I used all four defecation bags that I had on my side. I used them up during flight. In fact, you used one of them.

McDivitt That's right, we did have a bag of those defecation bags out. It just happened to be over on my side where you could get to it.

White You were asleep. I had to get them or wake you up. I pressure-checked my suit. I checked it at 8.5 and it bled down several tenths of a psi. I was satisfied with the pressure-holding of my suit.

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There was one thing though with the suit that I wasn't too happy with. I was hot all the time in the suit. It got so that after a while I got used to the normal temperature as being warm. I could increase the temperature, which seemed rather strange to both Jim and me, by putting out my gloves and closing my faceplate. I could go to sleep. At that time my temperature would go up considerably inside the suit. It seemed like I could stay in there only an hour or an hour and 15 minutes and rest before I had to either open up the faceplate or do something else. So, the temperature got uncomfortably warm in about an hour or an hour and fifteen minutes with the faceplate closed, the sleeves on and the gloves on. The humidity in the suit, I thought, was quite dry. I had quite a tendency for my lips to crack and my nose to get very dry. In fact, I noticed my nose was itching considerably. This was an indicator to me every time I would go to sleep. I would wake up with my nose itching and feeling quite hot and uncomfortable. My lips got to the point where I thought they were going to crack,

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and I was trying to be very careful and keep them from cracking and getting anymore uncomfortable than they were. Jim mentioned the CO₂ sensors stayed on zero, which I was happy to see. I think one thing that I was fairly happy about was that the suit, as bulky as it was, wasn't depressingly uncomfortable. I felt that I did have a pretty heavy suit on most of the time, and I was a little bit constrained in my mobility. The idea to have the detachable sleeves that I could take off after the EVA work was, I felt, a very good decision. I felt much more comfortable, and I had a much higher degree of mobility around with my arms in the spacecraft. It was not as tiring to move around as it had been when I was inside the heavy sleeves. So, I was quite happy to take them off. We took them off, I believe, shortly after my first sleep. I slept with them on the first time, and then we took them off. I think they were quite easy to take off. As a matter of fact, I think if you went EVA at a later time you could take those sleeves onboard, and if they were made just a little easier to slip on and off over the wrist, you could take

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them on and off in flight if you wanted to.

McDivitt

I don't know. I'd hesitate to recommend putting them on in flight. It might get pretty tricky. I think if you put them on in flight, you'd want to put them over all the harness, rather than under the harness.

White

That's exactly what I was going to say. I think if you took the life preservers off, you could actually make the sleeves big enough so that you could slip them on and velcro them across the back over the harness. This might be for the type of operation of throwing equipment in and out. I think in the future, though, a suit as heavy as this might not be required. The controls and the switches in the suit, I felt, were satisfactory. There wasn't anything that I couldn't get at in the spacecraft. It was easier under weightless conditions for me to operate certain controls. In fact, I think I was able to get down and unscrew the bellows in the gun hose as well and maybe a little easier than you could, Jim. At least initially, I was able to get down there. Of course you weren't really particularly trying to do it at that time.

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McDivitt I suspect I probably could have gotten down there as easy or easier than you if I had really gotten around to trying.

White I don't remember, but, anyhow, I was surprised with the ease which I had in getting down.

McDivitt We were trying to dump the pressure in the bellow before we went EVA with it.

White Right. The demand regulator was satisfactory. My umbilical, I thought, was very easy to use and disconnect. I was quite happy to have the micro-dot in there. One comment on the micro-dot--the first time we exercised the micro-dots on our suit, they were pretty hard to operate. Mine got progressively easier to use each time I used it. The fingertip lights that I had were better than Jim's. I had lights with Lexan tops on them. All my lights worked, and I felt that their operation was quite satisfactory. We had decided to put my lights between the first and second joints for several reasons. We thought the EVA gloves would be easier to don and there'd be less tendency to break them. I think, though, the position of the lights was still a little too far forward if it was intended to put them back between

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the first and second joints, because the lights were resting right on top of my first joint. I think if I had worn my gloves anymore, I would have gotten a very sore first knuckle. If you are going to move them back, I think they should definitely be moved back behind the first knuckle.

McDivitt Where were they getting you, Ed?

White Right on the top of the knuckle.

McDivitt You think they ought to be back?

White If they are going to be anywhere, they ought to be back here, and I'm not too sure that is necessary. In fact, I think the best place is behind the fingertip and in front of the first joint.

McDivitt But, with the plastic covers over the gloves.

White With the plastic cover on the glove, and I think we've got the right position for the lights. I don't think they should be back behind the first knuckle. I think they should be in front of that first knuckle and behind the fingertip. That's a good place for them. That's where we've been using them in the past. I think the Lexan cover on the light bulb is a darn good idea.

McDivitt Yes, I think so, too. Shoot! I checked my lights before launch and found out that I already had one

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of them out on my right hand. I wasn't too happy about it.

White

I was a little disappointed. I think the only discrepancy I found in my suit was that I had no blood pressure plug either. A point that I was pretty happy with was that I had no pressure points from my suit at all on my body. I had one set of pressure points from my helmet pressing down on the front forward part of my head. I knew why this was. I'd had Joe Schmitt adjust my cables so that I could pull my helmet down to a maximum amount for the EVA work. I felt that I just bought this discomfort by having my cables adjusted in this manner. It was pretty uncomfortable though. I checked out the use of the emergency bottles on the EVA equipment and they worked as they were supposed to. I was able to regulate the flow. Incidentally, before I went out the reading on the EVA bottles was full-scale, 3400 pounds. I was happy to see that. All in all, I was quite happy with the suit. I think it was a very well designed suit and it met the requirements that were levied upon it. It was a heavy suit and a big suit to wear for four days, but I felt the suit wasn't as

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bad as I had expected it was going to be.

I have one more comment. I'd like to comment on the inner liner. We decided to go with the inner liner in and I felt this was a good decision.

The inside of the suit was comfortable, and I didn't get any pressure points. I think one reason why neither Jim nor I got any particular pressure points from the suit was that we had worn these suits a heck of a lot of time. I had over 50 hours on my flight suit. I don't know how many hours Jim had on his.

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McDivitt Actually Ed had just finished talking about his inner liner. I'd like to comment about the inner liner too. I thought about it when he was talking about his. I think that was one of the really wise decisions -- to go with that inner liner. I felt that it offered a lot more comfort than wearing that rubber suit up against my body, or up against my underwear. I sort of felt that I was really quite comfortable in this suit. I didn't find my mobility limited by my inner liner at all, and I had made sure that it fit. I think that has a lot to do with it.

White I worked the suit once for about a four-hour period with just the rubber inside. I did notice it sticking to me, and I didn't feel as comfortable. After I got inside the suit with pressure on my body, the suit felt pretty darn good. I had the knees cut out of my suits. The knees are still too short. Having been in it for four days, I know the dimensions are wrong. The dimension from my knee down to my foot is not long enough. It's not just the inner liner, but the

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link net in itself just isn't long enough.

McDivitt You wouldn't say you had a pressure point though?

White No, it was just a constant pull on there all the time.

McDivitt Did it bother you very much during the flight?

White Yes, it bothered me a little bit.

McDivitt So you really did have sort of a pressure point then?

White Yes, to some extent in that area. I had had that one so much before. It had been so extreme in some cases that it really didn't bother me too much.

White Both of us should mention something about the visors.

McDivitt I thought you ought to mention something about your visor problem, your EVA visor or the other one.

White Well, I have briefed the visor on the EVA pretty well. The one that I will mention now is the visor that I had on my regular helmet. I thought that the vision through it was quite good. I noticed no distortion at all through it, but I did immediately put a couple big scratches on it

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in the beginning when I was unstowing equipment. I continued to scratch it throughout the mission. When I finished, the visor was considerably scratched up as you would probably notice if you looked at my suit. I don't know what there is to do about this other than to accept a scratchy visor.

McDivitt If you've got the visors down in front of your face, you don't tend to scratch it up as much. I think it was really worn out because you started opening up your visor and leaving it up over your head a lot earlier than I did. At about the two and a half or three day mark, I looked at your visor and it was really a mess. I took the helmet off and cleaned the visor because it was dirty on the inside and the outside. I looked at my visor and had very few marks on it. I had a few little scratches, but very minor. Then I started putting my visor up more and more because they wanted us to stay open. Because I'm a lot taller than you are, I really started beating mine up. In the last day, I think I caught up with you and maybe even surpassed you in the

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amount of marks on it. I'll say another thing. I'm sure glad we didn't go in for those Lexan visors that they wanted us to fly with, cause the distortion would have driven me batty in about the first six hours.

White I think you must insist on perfectly optically clear visors.

McDivitt That's right. You've got to have good optics.

White I took my helmet off about three times, and I didn't leave it off very long.

McDivitt I took mine off about two times. I took it off one time for an hour because my hair right above my ears was really bothering me. I didn't bother getting a light-weight headset out, and when anybody called me, I had the thing sitting in my lap and I could hear it. I took one of the ... and pulled it back and I hollered into the mike, Ha, ha!, till I could hear it. I said, "I've got my helmet off. Unless you've got something important to tell me, don't bother me." Ha, ha! And he said, "Okay." It was one of those passes, you know, where you only talk to one guy for about an hour. Then I took it off one other time for about a half hour to rub my ears. I was quite

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comfortable with my helmet on for two days.

White

Do you want to know something that's kind of strange? I was more comfortable with my helmet on than off. In fact, I kind of got used to those pressure points on the top of my head with the helmet on. When I took the helmet off and moved my head around, I felt a little dizzy from not having these restraints. I didn't feel as comfortable as I did with my helmet on. The times I had my helmet off were when I was running D-9. I ran the D-9 Experiment several times with my helmet off so I'd have better use of my sextant. I took it off one other time near the end when they indicated they would like to have everything off. I didn't feel particularly comfortable with my helmet off any more. I got so used to having that thing on that I put it on so I could talk better with the stations. They were calling me from time to time, and I thought it would be a little better. Before I forget, I think the portable headset is really a lousy design.

McDivitt

I concur. I think it ought to be thrown out.

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White

I've seen the ones they've got in the MCC and they're good plain old headsets. I don't see any reason why we can't get one that stays on your head and stays in your ear. You put this thing on and it pops off about two minutes later. It's not built to stay on my size head and I noticed it didn't stay on Jim's very well either. I think the portable headset idea is a good idea, but we ought to have a good headset for it. Okay. As we mentioned earlier the cabin pressure relieved at about 5.5 and held that way during launch. It went back down to 4.9 or 4.8 and this is where it stayed for the remainder of the mission. I think that they probably overshot their zeal to correct the cabin pressure that John and Gus had had on GT-3 and put ours down so that it was actually relieving lower and sealing lower than it would have been desirable. I was expecting it to seal up around 5.5 or 5.7 like it was advertised.

McDivitt

I checked my suit gage against the cabin pressure gage and my suit gage read higher than the cabin pressure gage by about .3 of a pound.

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White Yes, mine was right on it though.

McDivitt I know. You checked your suit gage against the cabin pressure and yours read just about on it, didn't it? Was it a tenth of a pound higher or was it right on it?

White Right on.

McDivitt Okay. So mine was reading a little higher, indicating to me that possibly the cabin pressure was higher. But since Ed's read with it, I don't know where we were.

White Well, the pressure at which it relieved at went right into the problem of the temperature-pressure relief in the cryogenic oxygen system so that those two problems kind of lashed together. The venting in the O₂ system was set at around 970.

McDivitt 967, I think the poop sheet said.

White Well, it was about 967 or 970. We had the possibility of losing oxygen in a steady manner out of the spacecraft if we let the pressure rise up above--well, the ground felt 960, and I concurred with that figure. So throughout the flight we had to keep venting our O₂ system

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down so the pressure would remain down below 960. They initially told us to vent it to keep it at 930 to 960. Then they told us to vent it on down to about 890. From then on, we vented it down in the neighborhood of between 890 and 93, depending upon who was asleep and who wasn't asleep. It sure seemed to be an unsatisfactory solution to two problems--one of the cabin holding at a higher pressure than they wanted it to on GT-3 and also the problem of the O₂ system venting outside of the pressure gage. In the oxygen system I think the solution to putting the venting down at 967 was a poor solution to the problem of having a poorly designed gage. I think the gage was again poorly designed and it should be designed to read about 1200 pounds. Relief should be up in that area.

McDivitt

If they really went ahead and jacked down the relief pressure, to get it on the gage, I think that is one heck of an approach to an engineering problem.

White

I think that's a gross thing to do and if they did that deliberately, I think they deserve a

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very black star for that one.

McDivitt They need their heads examined!

White I guess we beat that one around pretty well,
didn't we?

McDivitt Yes. The way that we were venting the cabin
was by going to O₂ High Rate and venting the
oxygen out through the cabin vent or going to
cabin repress and using up the oxygen through
the cabin and through the cabin vent valve
that way.

White I was quite satisfied with the cabin temperature.
It started out and got pretty hot at one time
early in the flight and went up to 100 as you
noted, and then it went back down into the 80's.
I think it actually dropped into the 70's a time
or two.

McDivitt That's right. It was in the 70's most of the
time.

White Right.

McDivitt Let's get the data book. The dry bulb tempera-
ture was 80; 80, the first time we took it.
Then it was 79, 79, 79. Then it was 75, 75,
75, and then they stayed between 75 and 77, I

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think, the rest of the flight. No, here it is down as low as 72. So it got down to around 72 late in the flight, and here we are with a whole bunch of 70's to 73's and a couple of 76's. So I guess that 75 was the average temperature throughout the whole flight.

White I think our cabin temperature gage was reflecting a little higher temperature than these.

McDivitt No, let's see. It was down around 75.

White It went down to 74 at one time, I remember.

McDivitt Yes, I think 75 was a good average cabin temperature for the whole flight.

White I thought this was a pretty satisfactory cabin temperature. The suit temperatures were also down. They stayed down from about 52 to 54 most of the flight. I thought that was a pretty satisfactory temperature there. I believe that there was a difference in suit temperatures between Jim and me because I was continually hollering about being hot. I think that temperature-wise Jim was relatively comfortable.

McDivitt I was very comfortable, and as a matter of fact, when I went to sleep, I tended to get just a

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little bit cool, especially if I had urinated all over myself.

White

I don't remember one time during the flight during which I was cool in the suit. I think I was hot most of the time in the suit. I got used to it after a while. The only time that it was not satisfactory, as far as I was concerned, was when I was trying to sleep. The humidity data that we got doesn't go along with what everybody was expecting.

McDivitt

No, not by a long shot.

White

No, not at all. Our little gage seemed like it was working properly. We didn't have any visible moisture at any time at any place in the spacecraft. It seemed to be indicating down around 62 to 63 percent relative humidity which was a big surprise to myself. With this type of data, I began going open faceplate and open gloves fairly early in the flight, about a day or a day and a half, and continued in this manner just about throughout the flight. We used the wrist dams quite a bit of the time. But I had my faceplate open with my wrist dams '

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on a great deal of time also. I think you had your faceplate closed a little more than I did. There at the end we were both going to an open-faceplate and open-gloves all the way.

McDivitt Yes, we were especially going open-faceplate at the end just to see if we could jack up the humidity. I actually preferred to have my faceplate closed, as opposed to having it open. I went ahead and left it open trying to get the humidity up. We never really did get it up over 60 percent. That seemed to be where it was going to stay.

White We were happy to see that the CO₂ sensor gage stayed down low the whole flight. It would pop up any time we turned the O₂ High Rate on and go up to a pretty high reading, and then settle back down to zero. I didn't notice any particular discomfort versus day versus night.

McDivitt No, as a matter of fact, I didn't either. We took some temperature readings on the cabin window frame and they varied by about 6 or 8, 10 degrees at the very most.

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White Yes, I don't think there was any discomfort associated with the day-night cycle. We didn't use the cabin fan as we planned during the flight. We did neglect to turn it on initially during the preparation for Retro. We noticed that we weren't cooling off in the cabin as much as we would have liked to. So, we turned the fan on and immediately the temperature dropped down about 10 degrees, if I remember right.

McDivitt Yes, that cabin heat exchanger and that cabin fan really do the job.

White It really cooled it off.

McDivitt Early in the flight when we got the temperature up to 100, we turned the fan on and the temperature went down to below 80 in about 20 minutes, or so. It really did the trick.

White The cabin pressure relief valve was venting just a hair above 5.4. We checked this out very many times. Every time we filled the cabin up with O₂ High Rate, it vented, or if we used the repress lever the cabin would vent.

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McDivitt Here we had an environmental control system that was supposed to protect us. We found out that the darn thing was overpressurizing. The first couple of times, to keep the ECS O₂ bottle from venting, we vented the cabin itself. I found myself sitting in there venting this thing with my gloves off and my faceplate open. It began to dawn on me that the pressure went down inside the cabin at a tremendous rate. If this thing ever stuck open and I had my gloves off and my faceplate open, I would be a dead man. So we made it a procedure to suit up when we were going to dump this thing. This meant that every four hours we had to put our gloves on and put our faceplates down and lock them and get all suited up just in case this vent valve didn't reseal. Frankly, as much of an inconvenience as it turned out to be, I think that was a wise maneuver. I would never suggest that anyone vent that cabin again without being fully suited. I think there is such a risk involved that you would be fool-hearty to do it. For

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that reason I think that we ought to make an effort to get the ECS O₂ tank vent and the ECS O₂ tank pressure gage compatible and at a lot higher pressure than they are. This suiting up and unsuiting every four hours is for the birds.

White

I thoroughly agree with you, Jim. There are two things I want to know. I want to know if they deliberately lowered the venting pressure for the O₂ system down to 967 to solve the problem on GT-3. I would also like to know if they deliberately lowered the cabin venting down to 5.4. I'd like to know the answer to those two questions. I think the combination of those two situations make what I feel is an unsatisfactory situation in our flight. It occupied far more time—

McDivitt

That's right, we were screwing around with that ECS O₂. That's something we never had touched. It was a gage that we should have monitored, instead of a thing that we manipulated all the time.

White

Right. Okay, the cabin pressure regulator.

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I didn't have any comment on that.

McDivitt Neither did I. It seemed to be doing a good job.

White I felt the cabin vent valve was set lower than I had thought it was going to be. I thought it was supposed to be set up around 5.7. I'd like to know if it was changed intentionally.

McDivitt The manual vent valve worked fine. When we wanted to vent the cabin, it vented.

White The cabin repressurization valve worked fine. I was very happy to see how well it worked also with my chest pack. Any comment on that?

McDivitt No, I don't think so. I don't think the cabin repressurized or overpressurized when we were trying to vent it. Since you were repressurizing it and venting it at the same time, I think the vent valve actually overcame the repressurization, which is a good thing if you're trying to vent it, and it is not a good thing if you're trying to keep it from venting. Going back a little farther to my other statement, in case that vent valve sticks open

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and you are not suited, I don't think you're going to have time to get suited. It takes me too long to put those gloves on.

White Okay, the cabin air inlet valve worked fine. We vented the cabin with it when we went EVA. It apparently worked all right when we used it down on the water. I have no further comment on that.

McDivitt Neither do I. It seemed to work fine.

White The cabin air recirculation valve worked as it was supposed to.

McDivitt As advertised.

White Okay, that primary O_2 system gets another black star. I think this is the area that I want to know the answer to, for sure. I want to know whether that was deliberately set down into the range of the gage to solve the complaint on Gemini 3. I think that if this was the case, this is a prime example of poor engineering. As far as monitoring the system though, as long as their reading was down below 960 the system worked pretty well. I felt fairly confident that the pressure was--

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McDivitt That's right. The way that the thing was set up, we could sure monitor it because we knew it was going to vent without being on the gage . I think they compromised the whole system so we could monitor it.

White As a matter of fact, we monitored it very thoroughly and spent about 100 times as much time on this system as we should have. John Young's been complaining about this point, and I think that it's a very poor thing. They ought to dig up the money and put a gage in there that will do the job. Very strong point. The quantity measuring system, I thought, was all right.

McDivitt I thought it was pretty good. I thought it was excellent as a matter of fact. It was a very readable gage . It had tremendous scale on it, but, shoot, you could read the thing to a percent. I don't know why it was any more readable than the other ones, but I thought it was pretty good.

White The flow rates--I don't have any particular comment on that. I thought the flow rate on

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that repress valve into my suit was satisfactory to keep me in a pressurized state and keep me ventilated enough under normal operations. Under tough operations though, the flow rate's too low and you really heat up.

McDivitt Yes, I think since it was an open loop system, you had to keep from dumping all the oxygen overboard, and had to go high enough to keep it from dying from the heat. I think it was a compromise system.

White I thought it was well set up. I have no complaints there. Primary O₂ temperature--I didn't have any comment on that.

McDivitt No, neither did I.

White The manual heater--I think that you used the manual heater twice during EVA.

McDivitt Twice during EVA for about five to six minutes each time. It responded all right, but it didn't go overboard. It got the temperature right back up there, and I shut the thing off again.

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White We were able to turn the automatic part of it off quite early in the flight, particularly since this was the problem we were having. We were getting--

McDivitt That was something I wondered about. You know, the thing is marked, and we were always instructed that when the thing got down below 38 percent we didn't need the heaters any more. We shut the heaters off at 42 percent.

White Right.

McDivitt Obviously, the guy that told us to shut the heaters off at 40 percent knew what he was talking about because we never needed them again.

White I think, again, I am very suspicious of McDonnell on the fix on that gage, and on setting that pressure on 970, and I'm going to get to the bottom of it.

McDivitt Yes, but I think, though, that the pressure would have still built up even if we had the relief set at 1050 or so. It would have still built up.

White It might have built up and stabilized,

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because it's a cryogenic system and it could have stabilized out around 1000 or 1050.

McDivitt But on the other hand it could have continued to build right on up.

White Sure it could.

McDivitt But I sort of suspect that the--well, I don't know. It's different from this other problem where we were told that the thing didn't require heaters below 38 percent, and we found out that it really didn't require them below 42 percent.

White We turned them off at 42 percent.

McDivitt Right.

White The secondary O₂ system--I thought those performed admirably. In fact, they had more oxygen in them than I thought they could hold. Jim's was up to around 5500 pounds shortly after launch. It remained up there and drizzled out about 100 pounds throughout the flight.

McDivitt Actually they increased by 100 psi each right after launch.

White Right at the first mode of flight. Then they drizzled back down and stayed at 5400, I think, right on down through the flight. The lowest

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mine got was about 5250 maybe.

McDivitt Did you notice by chance what they were at landing?

White No, I didn't check them.

McDivitt Neither did I.

White That was the last thing I had on my mind, to tell the truth. I thought the quantity measuring was fine. It was a little questionable, that we might have overpressurized on your system, but I guess they had plenty of margin in that respect. The secondary O₂ flow rates were satisfactory as far as I was concerned.

McDivitt I think so. I was amazed that secondary O₂ flow was such that I really didn't get too hot in it.

White Yes, I was not as uncomfortable as I had been at other times.

McDivitt You know, after awhile you hit yourself in the head so long that it finally stops hurting.

White It's like that big heavy suit, after awhile you begin to feel good. I know the average guy on the street probably wouldn't like the flow rate, but it didn't seem to be too bad. It wasn't too objectionable.

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White I think we jumped into something else. We were in secondary O₂ system and we weren't on flow rate. The only time we had the flow rate on that was during reentry. The flow rate there was satisfactory. The pressure obviously was satisfactory, but we didn't check it at the end. The control-- we put an extra detent on that control. I think the control was a positive one and we were able to keep it in the detents where we wanted it. I had no problem there.

McDivitt Right, I think that the way it's rigged up now is excellent. We designed it. It had better be, ha, ha!

White Right. Okay, the CO₂ partial pressure. The gage has been discussed prior to this time. It stayed down satisfactorily.

McDivitt Yes, it never got off zero.

White Okay, the coolant-- the radiator operation configuration--I don't have the times in front of me right now that we went onto the radiator, but I think it was about 40 minutes.

McDivitt 40 minutes.

White We went on the radiator about 40 minutes and we

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never had to come off it again. We didn't get any abnormal operation of the radiator at any time. One time they called up to me and mentioned something about the radiator and the coolant loop and I didn't get any clarification. I lost contact at that time, and I thought just maybe that I had a failure of some type in my primary cooling system. So just for caution sake I turned on the secondary coolant pump and waited till I got contact with them again. They asked me why I had the secondary pump on, and I said, "I thought maybe I had a problem in the primary system." They asked me why I thought that and I said, "I thought they were telling me something about it when I lost contact with them. I did it just to be sure." But that was the only time that I thought we even might have had a problem in it, and I turned it off. We used double coolant loop early in the mission, and after we turned the secondary system off we did not use it again until the reentry. Prior to the reentry, we turned it on.

McDivitt That's right. That coolant system really worked.

White Okay, here is one at which we'll get at them--

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the water management system. I think you have a few thousand words you'd like to say about launch. I think you actually already hit on most of them, anyhow.

McDivitt Man, I sure do. The Normal mode, Drink Mode, and Flush Mode. We got the water management thing kind of goofed up. Let's just take the drinking thing first. The drinking nozzle was attached to the management panel by a hose and the hose looked like it was made out of rotten rubber. The first time I tried to drink out of it, I stuck the thing into my mouth--

White The first bad moment of the flight.

McDivitt --I pushed the button in and no water came out, and I almost had a heart attack. I said to Ed, "Ed, this is going to be the shortest four day flight in history." Ha, ha!

White Jim said, "Guess what? The water doesn't work."

McDivitt Ha, ha! But you'd already had a drink out of it, though, hadn't you?

White No, I hadn't.

McDivitt Oh, hadn't you?

White You handed it to me.

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McDivitt Oh, so I handed it over to him and then he took a drink out of it and didn't have any problem at all. What happened was the hose was wound in the helix. It came out to the gun in a straight line. When I drank out of it on my side this thing always crimped like it was an old rotten piece of rubber that had been bent over in that position many times before. It looked like something that came out of a 1890 steamboat or something, instead of a--

White It looks like your old oxygen mask hose.

McDivitt That's right. It looks like my old rotten oxygen mask hose. So I think that we ought to get at least a decent piece of hose in there. The next thing is the water gun that you drink from. You push the button in and a little spigot would come out and the water would start running out of it. This worked great. You could always get the water to come out when you didn't have your hose bent. It got worse and worse and worse and worse and worse. As far as returning it towards the end of the flight, I almost drowned a couple of times because I'd get that thing out and I couldn't

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get it back in. I finally ended up actually using two hands to operate the water gun so that I could get the button back out.

White The button definitely did get more friction in it as the flight progressed.

McDivitt It seemed like it was all scored up and it kept getting worse and worse and worse as the flight went on. This could have been a major disaster too. If we had that gun squirting water inside the spacecraft, you'd have had water all over the place. I'll be the first to say that we made a real effort to keep the water out of the spacecraft. We wanted to get four days out of the flight. I felt one of the major problems would be the humidity in the spacecraft. As it turned out, it wasn't a problem. We didn't know it right off the bat and we were really concerned about the water. The last thing I wanted to do was to have an open water nozzle running into the spacecraft. So I think that takes care of that. I think the whole water management panel ought to be clarified before we fly GT-5. We were arguing about what position the Waste Management Switch was going to be in during the countdown to launch. I think this is

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certainly not the time to be deciding what the heck the position these switches were going to be in. We were always briefed that this thing would be in OFF. We were going through the switch positions and they'd ask me to check in the count at about T-45 minutes or so.

White And I couldn't see that one.

McDivitt You couldn't see that one and you asked me to look down at it. I saw the thing was in EVAPORATOR, so I question the STC. He checked around and they had a big flap about what position it was supposed to be in. Pretty soon we got a call back and he said if I could get unstrapped and reach the thing, I ought to turn it over to OVERBOARD. We thought it should have been in OFF. They had it in EVAPORATOR so we finally decided we ought to go to OVERBOARD to keep the thing venting. I was already strapped in the spacecraft. I undid my shoulder harness and reached around in the spacecraft and flipped a little valve over to OVERBOARD where it should be and then got strapped.

White You sure they didn't have you put it OFF?

McDivitt No, we went to OVERBOARD.

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White I remember they argued. I thought they had it on EVAPORATOR first.

McDivitt It went from EVAPORATOR--

White That seems like the least likely of any position to put it in.

McDivitt That's right. We went from EVAPORATOR over to OVERBOARD. So I think a comment that I'd like to make right now about the whole water management panel is that it's a simple thing. It's got three knobs and each knob's only got three or four positions. We had the ECS engineers at McDonnell give us a briefing on this simple water management panel. We had about seven guys there with seven different versions of how it was designed, how it operated, and what the different positions we were supposed to be in. They got us so screwed up that when we left there we didn't have any idea in the world what it was supposed to do.

White I think those designers didn't either.

McDivitt They didn't either and it was pretty obvious that they didn't. We went through a lot of discussion with that water management panel. Finally I think

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that the four of us got it pretty well squared away. Then just before launch we found out down at the Cape that because they had gotten those switches in the wrong position we pumped 32 pounds of water out of the adapter, used up all the pressurant for the water system, and pumped all the water into the lithium hydroxide canister. If it hadn't been for one last minute check in the data, we would have lost the lithium hydroxide canister full of water and nothing to drink with. So we would have had about an hour flight, if we had gone that long. I think that before we fly another flight we ought to have all the people at McDonnell and NASA, who are responsible for this thing get it squared away and figure out just where the heck they want these switch positions, and get them there. If there are a lot of switch positions on that panel that aren't useful anymore, we should just go ahead and block them off. We decided between the four of us that there were--I don't even know what they call those switches--

White

Condensate Valve and Water Valve.

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McDivitt --and the Water Valve should be put in NORMAL NORMAL and left there. That was exactly what we did and we knew how to work the waste management valve. We didn't screw it up, but I'm not sure that if with a little trying, we couldn't have. We never had to use the Evaporator Fill Mode. The Flush Mode, or the waste management portion of the thing, had a couple of different positions. In the normal OVERBOARD position and in using the Preheat and Flush switch over on the side, we managed to dump a large number of urine dumps through this. We dumped both our launch-day urine bags which were full. I probably urinated eight or ten times and you probably about five or six times.

White About five times.

McDivitt About five times. So we had a lot of dumps through this thing. At 92 hours it stopped working. Ed had filled up the bellows pretty well just before this. I was the man in charge of dumping urines, it seemed like.

White The Urine Dumper!!!

McDivitt I was the only one who could reach the knobs and switches. It generally went down in spurts.

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About halfway through the dump, it started slowing down. Then it just went in very slowly the last two or three inches. Then I urinated in the thing and had a bellows full of a mixture of air and urine. It started dumping. It looked like it went down about halfway and then it stopped. I wouldn't be a bit surprised if it wasn't the air going out of it. It went very slowly for just a short time and then it stopped completely. Nothing else would go out of it. So, I turned off the Flush Switch and I went from OVERBOARD to EVAPORATOR, and it flushed through the evaporator. We had one more urine dump through the evaporator and this worked all right. Well, I'm sure glad that we had those two ways of working it. All the way through the flight after I'd dumped the urine through this thing, I kept saying, "Well, McDonnell finally designed this thing so it works after about 30 or 40 attempts and redesigns." But I guess I was over-optimistic because it did drop out just before the flight. It finally got to work for 88 hours. We didn't use the Evaporator Film Mode. Okay, Ed, why don't

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you take over. I extended my wrath.

White I just had a feeling you wanted to say something about that, Jim. Ha, ha!

McDivitt After having messed around with that thing for 96 hours trying to make it work.

White I think you expressed my feeling too.

McDivitt Did I leave anything out?

White No, no. I had the same feelings. I thought you might have had them a little stronger since you were the one who discovered the water gun was not working.

McDivitt I'm really serious about that simple panel being able to screw up the whole flight. If we don't get that thing figured out we ought to stop flying space missions.

White One of the worst moments of the prelaunch down there was when I found out they had that two gallons of water in the system somewhere and didn't know where it was.

McDivitt That's right.

White The humidity sensor--I thought if the readings are right, it worked very well and proved the point that the humidity in the spacecraft is

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relatively low, and that the water problem is not quite the problem we had it cracked up to be.

I'll make a comment on the sponge material on the side of the spacecraft at this point, since we're talking about humidity. I didn't think the sponge material was a very good idea to begin with but once it was in there and we flew with it, I think it was--

McDivitt It was a real bad mistake! Ha, ha!

White No, I thought it was all right in there. The only thing wrong with it was what they had it treated with for fire-proofing. I thought that part of it was unpardonable. There is no excuse whatsoever for having those ammonia vapors and the hydrogen sulfate, or whatever those other things were that we had permeating around the spacecraft.

McDivitt We smelled bad enough, but it was no contest when it came to comparing ourselves with the spacecraft. It smelled worse.

White If there was any moisture it grabbed it all. I don't really think there was any moisture for it to grab.

McDivitt I don't think so either, Ed. I kept feeling that

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thing and it was dry as could be.

White There was no moisture that I could notice.

The sponge stuff on the side wasn't objectionable to me but the odor that obviously came from it was very, very objectionable. The readings we obtained I thought, were easy to take. The stowage of the unit was not a problem. It was easily stowed in the spacecraft while we were using it.

8.5 Communications

White Okay, I have a few comments on the communications which we ought to go on to. We'll take them in sequence.

McDivitt Okay, why don't you go along I'll express my comments.

White I think the interphones worked pretty well. I noticed one thing, though, as we progressed along. The volume requirement on both my side and on Jim's side needed to be increased all the time to get—

McDivitt No, Ed. I launched with all my volumes full up.

White Is that right? Anyhow in my interphone, I progressively raised it as the flight went on.

McDivitt Yes, I started off with mine almost all the way up. On the UHF it was absolutely all the way up,

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and I flew with it almost the whole flight.

White I don't think it was all the way up. The one thing though--I think the interphone operation and quality were quite good.

McDivitt Yes, I thought so too.

White We were ready to communicate back and forth. It was just the way I would liked to have done it. I thought it was very good. The UH performance at the countdown was satisfactory and just after we got into orbit we felt that we had a bit of a communication loss. We switched to UHF No. 2. Later during the flight we used both UHF sets and didn't have any difference in performance from either one. During the recovery you were using the UHF primarily. I think you had as much communication as you could expect.

McDivitt That's right. I think so too. I do think, though, that we had a very bad UHF situation in the first eight or nine orbits. It was really lousy. As a matter of fact, I was getting concerned that maybe we were going to have to land because we were going to run out of communications.

White You were actually working more on this problem

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than I was. You were communicating during the EVA work and also after I went to sleep. I heard you working on the Communications Check and that's when you went to the reentry antenna.

McDivitt That's right, when we ran through these checks, it finally became apparent to everyone that the reentry antenna was doing a better job than the adapter antenna. And then later on, I switched back to the adapter antenna for some reason which I can't remember right now. We ran a couple of more checks and it seemed to be--

White I know what we did. We ran an HF check, Jim, and we switched back to the adapter so we could use the HF antenna back there. We got just as good UHF transmissions at this time as we did on the reentry antenna.

McDivitt When they checked them out again, they said they still thought the stub antenna was better. So, we went back to reentry antenna.

White We used reentry just about 95 percent of the flight.

McDivitt That's right. In the last 55 orbits it was great. In the first eight it was lousy. I was really

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concerned about having to come down because we didn't have any radios.

White One thing that I'd like to say is, I would give a good gold star to the controllers down there. I thought their voice procedures were excellent and their methods for giving us information were all good. I had no comment, whatsoever, other than I thought it was all very good.

McDivitt That's right.

White I had no objection. I thought there was no time in the flight in which we got a cluttered voice from anybody. Yes, I think that is pretty good when you have that many people working the loop.

McDivitt I think so too.

White Okay, the voice tape recorder--let me vent my wrath on this one.

McDivitt Get 'em Ed, get 'em!

White Right. This is another thing that should be fixed before the next flight. I think we're going to end up being very, very sorry. We're going to end up losing valuable data from time to time. This will be due to no reason other than a voice tape recorder which is poor on all accounts.

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McDivitt We've already lost some very valuable data from this flight. We could have taped the entire EVA and brought those communications back down. As it was, we couldn't tape them because we had to put the thing in UHF so that we could transmit to the ground. We lost all of the blessed stuff going to the ground anyway.

White There are certain systems in here that I think are very poorly designed. I think this is about the poorest of them all. It's located in such a position that you can not see the operation light when it is on. The light is in an area where you normally would put things. Things get put on top of it so that if you look down there, you can't see the light. The light is such a small insignificant thing when it comes on. Unless you consciously bend your head down and look down below your right elbow, you can not see whether the light is on or not. The switch is set so that you have to go in either RECORD, UHF, HF, or INTERCOM and you can not be in RECORD while you're on UHF or INTERCOM. This is a very unsatisfactory method of having a tape recorder. The tape recorder

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should be set up so that it can record conversations on normal UHF, HF, and INTERCOM type operations. As Jim pointed out, in our flight alone I think we lost sets of valuable information. During launch we weren't able to tape anything onboard. We weren't able to tape the work during EVA. We could have taped some of the work during the rendezvous part of the flight. I don't believe we taped it though. The way it's set up you wouldn't leave it on in that manner. We both had requirements to communicate over UHF. This was our normal mode of operation. If we have a tape recorder, it should have a separate switch. If there is an hour limitation on the tape, there should be a light that comes on and is easily visible on the front somewhere.

McDivitt That's right. It ought to go right on the VCC.

White That's right. That's really where the light belongs. I think that it would be desirable and important to have a voice tape of what's going on throughout the flight. I wouldn't have any objection to having a tape recorder with the capability of recording more than the one hour at a

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time that we have now. I'd like to see us recording a great deal of the flight. It'd be nice to have a switch to turn it off from time to time if you did want to discuss something that you didn't want to go on tape.

McDivitt I don't think we ought to put the whole flight on tape. If we flew a week-long flight, it would take a week to go through the tape. You wouldn't want long periods of nothing on there. I think the way we wanted to operate it this time would have been all right, if we could have just operated it that way. There were certain periods where we put a tape on and ran it all the way through. Well, that was the tape that covered a certain experiment or something.

White On our D-9 Experiment, we used it.

McDivitt Yes, that's where we used a whole tape on it. Then there were periods that were questionable when you were sleeping and I wasn't doing anything, or I was sleeping and you weren't doing anything.

White If you carried adequate tapes, and you had adequate warning when the thing went on and off, you would not have the same situation we had on the D-9

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Experiment. You could have the tape stop in the middle of the experiment and be lying on your back looking out with the sextant. You haven't got any idea in the world the tape's run out on you.

McDivitt Right.

White I think that it's a very, very unsatisfactory system. It ranks right up along with the top ones, and we've already hit on some of them already. The digital command system I thought worked very well. I thought the light in there gave us a good indication of several things. It gave us an indication of when the station was about to come on and communicate with us. We used this as a clue to turn on our UHF to warm our transmitter up so we would be ready when the transmission came up. I think updates from the ground came up in a very orderly fashion. I don't have any objection about that or any further comments. Do you?

McDivitt Ed, I thought it was very good.

White Handled in a very good manner.

McDivitt I think so.

White The only update that I have an objection to is

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that they updated our time reference system and had it inaccurately updated by a second.

McDivitt Yes, I think there is a big flap about that.

White I'd like to find out about that, too. The real time-transmitter, delayed-time transmitter, standby transmitter--they seemed like they all worked pretty well. We had no use for the standby transmitter and we used the real-time and delayed-time transmitter throughout the flight. You don't have any comments on this, do you?

McDivitt I've got one comment. When we came over Guaymas after our computer went out, and we'd already fouled the thing up, I know, they said they wanted us to come right-side-up for a critical tape dump. So I did, and I got a message from the ground saying, "Put your Tape Playback to CONTINUOUS." So I put the Tape Playback Switch to CONTINUOUS. Pretty soon they called up and said, "Do you have your TM switch to REAL-TIME and DELAYED-TIME?" I said, "No, I don't have. You're going to have to put it down there." They didn't bother telling me that they didn't have any command capability whatsoever. I went ahead and put the Tape Playback to CONTINUOUS, which means that you're dumping

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all that tape. If you don't have the real-time-
delayed-time transmitters on, you're just dump-
ing it into nothing. You're erasing. So we got
some pretty inadequate communications there. They
should have said, "We don't have any command
capability. Will you please place your tape
recorder and your TM switches so we can receive
it?" We knew how to work the thing. It's just
that the instructions we got conflicted with the
normal procedures. Consequently we dumped all this
tape that really was critical. I'm not sure how
much of it they got on the ground. I'm not even
sure if they ever got any of it on the ground,
because we got some not only inadequate but really
erroneous instructions.

White

Okay, communications---we covered them in coordin-
ation with the ground a little earlier. I think
that the flight controllers handled our flight in
a very good manner. I think that when they had
something to say, they said it, and when they knew
that we wanted to talk to them, they'd talk to us.
When they didn't have something to say, it was kept
in a good manner. I thought it was a very profes-
sional show.

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McDivitt Yes, I thought that they were to be commended.
As a matter of fact, when we have our world-wide network debriefing or whatever the heck we're going to have I really intend to applaud them loud and long.

White I thought the teamwork between the spacecraft and the communicators on the ground was outstanding.

McDivitt It was really good.

White No adverse comment on anytime during the flight.

McDivitt Shoot, if you wanted to talk to them they were more than happy to talk to you. A lot of times they'd come on and say, "This is Guaymas. We have your TM solid. We don't have anything for you. If you have anything for us, we'll be standing by." And that would be it. They were really good, I thought. We've about covered procedures.

White Right, I think we've hit that too. Okay, the communication controls and switches--voice control center--I've always been pretty happy with that.

McDivitt One other thing I want to comment on is the voice control center. If we had carried that idiotic

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contraption that McDonnell had designed to keep the moisture out of that thing, we would have had one more hunk of junk in the spacecraft with us. It would have been a completely useless thing because of the number of times that we switched switches on that VCC. Heck, we switched switches on the VCC more than all the other switches on the spacecraft put together. I think if we would have had to pull off that big piece of plastic every minute, it would have gone on the floor and stayed there. That's right.

White That was a very poor fix to try to solve a bad design.

McDivitt Okay, why don't you talk about that sleep configuration?

White Okay, with the sleep configuration, we knew right away we had bought a weenie. The first time I tried to go to sleep, we tried to turn everything off. We tried turning all my volumes down to zero. We turned to PUSH-TO-TALK only, and I could still sit there and hear it about a one by one level. It was just enough so I could hear audibly what was going on and understand if I paid attention

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to it.

McDivitt If you really listened, you could hear.

White That's right. If you were very close to going to sleep and something went on that was interesting, you could hear just enough to wake you up and pull your interest to it. It made sleeping rather difficult. We didn't want to disconnect ourselves from the system altogether. We'd like to have a way to actually turn the volume all the way down and provide the astronaut that's awake the capability of controlling the voice control center's volume so that he can turn the sleeping astronaut's volume up and talk to him anytime.

McDivitt That's right. I think what we really need in there is an ON-OFF switch for each half of the VCC.

White So you can effectively cut him off and turn him back on.

McDivitt That's right. You just reach over there and you break the communications with a simple ON-OFF switch. Then if you've got to get to it in a hurry, you just flip the thing back on and then

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talk to him. I don't know where on the VCC you'd mount it.

White I think they can solve that problem pretty well. It might not be in that manner but I think they can solve it so you've got it definitely on or off.

McDivitt That's right. They need a simple way of disconnecting the man from the communications center without disconnecting his--

White I'd say that this was a very unsatisfactory condition. When we finally went to get some rest, we disconnected the communications cord at the helmet. I think this is an extremely unsatisfactory mode. If we should go pressurized at any time and have to pressurize our suits, we'd just lose communications between each other. This would be a very, very unsatisfactory situation. I believe that this should be corrected prior to the next flight. The Beacon Control, Adapter and Reentry-- no comment. Those were all right.

McDivitt Yes, that was excellent.

White The TM control transmitter and antenna--I don't have any comments on them.

McDivitt No, they were pretty well designed, I thought.

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White That's right. Okay, the electrical system--

8.6 Electrical System

White Okay, the systems monitoring. I thought it was satisfactory. We went through and monitored the systems every time for the GO/NO GO checks, and quite a few times along the line in addition to this. So I thought the method of monitoring was satisfactory. I don't believe we really had any way of monitoring the electrical power remaining.

McDivitt Yes, that's a drawback, and we all know it, I guess.

White Right. That's an unsatisfactory condition and I don't know what we're going to do about it. I think it's too much of a job to try to think that you're going to sit in there and calculate all the things you have on, and try to keep an onboard plot of what electrical power you have remaining.

McDivitt Yes, I think this is a ground function. I don't think that we can realistically do it onboard the spacecraft.

White I don't believe we got any indication of how our electrical power was going from the ground, except

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for one time when they called us up and told us we were 190 amp-hours, I think it was 190 amp-hours, over--

McDivitt That was after we turned the computer off. I wanted to find out why we turned the computer off and if we were really short on electrical power. Then they told me we were 160 amp-hours over the 200 amp-hours cushion. I almost went through the overhead.

White I think I'd like to have had a little more information from the ground on the status of our electrical system. The main batteries--I have a comment on them. They started out with a charge of about 24 volts and progressively decreased to the point where I was a hair concerned about them. They progressed down to the 22.5 reading and began to shade lower than that near the end of the mission. I was using the parallax to be sure I had a satisfactory reading on the gages each time. I noticed they decreased down to a minimum of 22.5. Maybe it got to 22 but it was getting near the end of the mission.

McDivitt Ha, ha! Maybe 22.49.

White Just the way I'd lean my head I could get the

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reading the way I wanted it. Ha, ha! The squib batteries--our electrical briefing I thought, ~~was~~ very good. Everything behaved just the way they told me. The squib batteries started out pretty high, around 27 or 28 volts, and they progressively decreased in voltage as we went through the mission. The main batteries--every time I checked them they always checked out at about 9 as far as the amps were concerned. The adapter batteries--I was glad we'd had the briefing on them because I realized that knees on the adapter batteries were in operation during the launch when we got a high reading on the left stack ammeter up around 27 or 28 amps, and we had a reading of around, I believe, 14 amps on the right one. I didn't alarm Jim with this information because it was still below my cut-off point of about 30 amps or so. I felt that it was due to the knees in the adapter batteries causing unequal loadings of the main batteries with respect to the adapter batteries.

McDivitt Hold it. I want to make some comments about the electrical system and the power as we used it.

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When we powered down, we turned off the a. c. power, the OAMS power, the ACME bias power, the rate gyros, the horizon scanner, the IMU, the computer, both FDI's, and the attitude indicator lights. We operated with as little in the way of cockpit lighting as we possibly could. It got less and less and less as the flight progressed. In earlier orbits we had all the lights on in the cockpit—the over, the middle light, and the two side lights. Then for the night time passes, as the flight progressed, we got around to using the red lights. We finally got around to making the night-side passes generally with one red light on or one white light on, as we got more confidence in the spacecraft. I think we save quite a bit of power that way. They were surprised that we were 160 amp-hours ahead, and I don't think that we got that way by accident.

White

I've got a comment to make on that. We were both watching the loadings and I could read them a little better over there. We started out operating around 14, maybe a little better. The reading on the combined amp-hours slowly decreased down

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and near the end of the mission, we were down to 12 or 13 amp-hours on unpowered down configuration. That was as low as I saw it go, down around 12.

McDivitt Another thing that we did was that when we weren't actually planning on transmitting on one of the radios, we were always putting the mode control switch to INTERCOM, which would then cut the transmitter off the line. You could actually see the ammeter go down a little bit. So I think that by really powering down the spacecraft and getting all the non-essential items off the line, we helped ourselves a lot. We got this 160 amp-hour cushion because we really worked at it, not because it just happened like that.

White This takes a little diligence.

McDivitt Yes, not because it was a miscalculation on the guys who were planning the flight, but just the fact that we really worked at keeping the lights off, keeping the radios off, and keeping those little bitty things down. You know, you only have to save two amps per hour. We ran on a single suit fan almost the entire flight, except when Ed was getting warm when he was sleeping we had to

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go to two suit fans.

White Right. When it got so uncomfortable that I couldn't sleep, we would go over. We really didn't do that too much.

McDivitt No, we didn't. We made a real effort to keep the electrical load down. I think that it sort of showed up there towards the end of the mission when we really had enough spare power to run the IGS through the last day--uselessly of course, but at least we ran it.

8.7 Computer

McDivitt In the launch we had the computer in ASCENT. Ed was reading out the errors during launch. I read out the rates which didn't require any information from the computer.

White I was reading out the lack of errors most of the time.

McDivitt Lack of errors, right. Why don't you discuss the error status.

White I think we discussed it earlier and I'll just go briefly through it. We didn't have any errors that I feel would be worth repeating during Stage I. At guidance initiate we got a full-scale-down indication. This indication I had been told

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fairly routine, and it appeared routine' to me too as it began to steer into zero and steered right on into zero. As we approached SECO the error started to increase a little bit and increased out to a little less than a degree in pitch-down on the error needle. Aside from that, we didn't have, as far as I can see, any other error that was worth talking about during launch.

McDivitt Okay, at SECO + 20 the IVI's counted up as we separated, rolled around, and did all the maneuvers we were supposed to. The IVI's acted as they should. When I got turned around and was faced toward the spacecraft, I was in a hurry to get all these things done. I started thrusting and I went from Ascent to Catch-Up, and then hit the Start Comp button. I lost a couple of feet/second here, but this was sort of insignificant at the time. The IVI's counted up in the Catch-Up Mode and they operated properly throughout the rest of the chase-phase of the mission. We were getting the kind of information that we needed right there early in the flight. Ed had 52 punched in and it read out at 30 feet/second, I think he said earlier.

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White Yes, I picked that up later on because I wasn't even concerned with it since we had a good orbit.

McDivitt Once we had a good orbit that kind of information wasn't that important.

White Do you want the IVI readings at this time?

McDivitt Yes, you might just as well read them out.

White The IVI readings at the time we decided to read them--at zero, zero, zero on the attitude indicator--20 forward, right 11, down 5.

McDivitt The attitudes weren't really what they should have been, because we had a good insertion and we had to go right then and we had to get turned around and get at that booster. I didn't fool around with getting the spacecraft at exactly the right attitude to read out the IVI's. I thought that was of academic interest. It would be great for post-flight analysis but it wasn't going to help the flight at all. So I didn't do justice to those things. I'm sure that we can go back and resurrect this thing to find out exactly what it was. It wasn't very meaningful at the time. The orbit maneuvers consisted of really just chasing the booster around and reading up the IVI's as they came out. We received all our updates

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properly. We got the computer on and got it loaded. The DCS updates were going in and they were getting verification on the ground. One time I remember we didn't get the DCS light. As a matter of fact, they sent the load up again and we still didn't get the DCS light. They verified on the ground that it was going in.

White Well, the funny thing ~~was~~ when the computer wasn't on we got a DCS light.

McDivitt The DCS lights come on when they get set up for the TX and send out a realtime command, too.

White Well, maybe the TX when they sent up — They kept telling us that they got a good load in it and I had no light. I really didn't quite believe them.

McDivitt Neither did I. As a matter of fact, we had it verified at the next station.

White Okay.

McDivitt And that's where the onboard computer thing ends. I might go through what happened to the thing. We were over the States and had the onboard computer on for getting a new load in it. I got just about over Florida. He said, okay, I could turn the

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computer off. I turned the switches off and nothing happened. The comp light stayed on and I don't even think the malfunction light came on, did it? No, it didn't. So I said, "Well, that's interesting that the darn thing doesn't go off." So we flicked the IGS power off and back on quickly and told them on the ground that it didn't look like I could get the computer to go off and stay off.

White

I think you told them you thought you had a failure in the switch.

McDivitt

Yes, I told them it looked to me like I probably had a failure in the ON-OFF Switch or the ON-OFF switching function. And they said okay. So I said, "What do you want me to do here?" I knew we could always turn it off by turning the IGS off, but I wasn't too keen on that, So they said, "Stand by. We're going to have the experts check it." So we flew on out of communication with them. I think they talked to me over Bermuda too, but nothing of much importance. They said to stand by they were still checking it. Then we got over Tananarive and I got this message to turn the

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switch to the ON position but to turn the a.c. power to ACME, which was going to power down the computer whether we wanted it to or not. It was a voice relay station but we weren't getting the voice relayed. We were just getting a message sent up from somebody on the ground. I'm quite sure we didn't have any controllers at Tananarive. I don't really know who was talking to me. Probably some COM TECH. So, not being able to discuss the thing with them and not knowing what the status of my total electrical power was at the time, I went ahead and turned them off. The comp light or the malfunction light came on and then it sort got dim and went out. Then I sort of figured that's the end of the ACPU. So we put the thing back on over Carnarvon and back off again and it wouldn't come on. It was dead, of course. So that's the life story of the computer. Then we played a lot of games afterward trying to make a dead man come back to life. I have nothing else on the computer. I sure wished I'd have had it though.

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8.8 Crew Station

McDivitt

Controls and displays—okay, I'll talk about that. The sequential Telelights all operated properly--came on in the proper colors, and punched off and everything. The event timer operated properly. The IVI operated properly. The flight director indicator operated properly. I would like to discuss the GLV fuel and oxidizer pressure gages here for a minute. We got about a \$25 million vehicle, I think, that depends almost entirely on a launch. We've got an onboard manual detection system, or something like that.

White

Malfunction detection system.

McDivitt

Malfunction detection system. An integral part of the malfunction detection system, are the fuel and oxidizer pressure gages for both the first and second stages. This is one of the abort criteria. On the scale of these gages down below the glass is a beautiful, beautiful set of lines and numbers and hash marks that are wrong. They updated the GLV information and found out that these things were in error by quite a bit. Now, to take and fix these gages would have taken a couple thousand bucks. I don't know exactly how much or how

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long, but it would have taken a few dollars. Instead we decided it would be simpler and cheaper and a lot quicker to go ahead and paste some paper decals over the top of the glass. The parallax with these things is horrendous. The decals were pasted on over the top of the glass in such a manner that they completely obscure the inside-the-glass readings. They also obscure the center needles which are not only the clue to what the tank pressures are but a clue to whether you have any APS power, which is also critical. When you cut these things back so that you can see the inside needles, you see the inside gage too. I think this nickel-dime fix to our multi-million dollar vehicle is ridiculous. I think that we ought to get those inside gages painted the way that they're supposed to be painted. I think we ought to end this Mickey Mouse gage routine right now and get going on GT-5's fuel and oxidizer gages for both stages. It's ridiculous the way they are right now. The altimeter worked as advertised. I mentioned that it went down and back up again at around 100,000 feet.

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The rate of descent seemed to be all right. The accelerometer was okay. The switches and circuit breaker panels--I had no comment. We knocked a couple of switches and circuit breakers off during the course of the flight. We always caught them and got them back on quickly, or maybe we didn't get them back on quickly. We got them back on quickly enough because nobody ever said much to us about it. They commented one time. Two times, I think, they asked us if we turned something on or off.

White I remember that. One was over on my side.

McDivitt Was one the A pump on the secondary loop or the B pump on the secondary loop, or did you turn that on?

White No. I think one of them was up there, and I forget how we got it on.

McDivitt Maybe we just bumped it. Yes, there was another one over on your right-hand side and there were a couple of them in the center circuit breaker panel. One time I know I bumped one on the left-hand side circuit breaker panel. I thought it was the electronic timer. It was one right above

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that. I almost had a heart attack when I saw that thing go down because it would have messed up the whole time reference system. I thought the switches and circuit breaker panels were very good. I have no complaint about it. I think that's a well designed cockpit. The mirrors were fine and the swizzle stick was a real life saver. I can't reach the circuit breakers and switches over on the right-hand side unless I use the swizzle stick. I had to do a lot of switching when Ed was sleeping. This swizzle stick was the real answer.

White I've been always telling you to get some long arms. Ha, ha! I didn't use the swizzle stick very much.

McDivitt Yes, but you don't have to reach over and get those switches all on the left-hand side.

White I found the swizzle stick was quite useful for unstowing items out of the center stowage box.

McDivitt That's right.

White It was really good there. I used that every time when I unstowed.

McDivitt It's a good piece of equipment. Okay, lighting—do you want to cover the lighting, Ed?

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White

Okay, I think that the lighting to me was surprisingly good. I think that at one time there was a press to put two white lights on either side on the instrument panel. I think the lights on the instrument panel should remain just as they are. I think we used the red light much more than we used the white light. There was quite a bit of time when you had to do a lot of out-the-window operation at night and you wanted to have some reference inside. The red light doesn't seem to destroy your night reference at all. So I think the instrument lights, the two on either side above the panel, are satisfactory. I also thought the deletion of the red light in the cabin light and the substitution of a bright white light was certainly good. There were several times when I wanted to get a reading on something right away and I didn't want to fool around with dim lighting. I would switch on the big bright light and I was almost always able to get good readings. Now when the sun was really bright in your face, there was a period of time in which your eyes had to adjust to the instrument panel before you

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could make the readings. I think you could put spot lights in there and not get by that problem.

McDivitt That's exactly what I was going to say. Lights aren't going to solve that problem.

White No, it's just plain bright outside. When you look back in, even though you have your lights on, it's fairly dark inside. I personally wasn't troubled by this very many times during the flight. Were you, Jim?

McDivitt No, I wasn't.

White I didn't feel that was too bad. So, actually, I felt that the lighting, although not abundant, was adequate. I think the actual lighting of the instruments would certainly be nicer if we had individual instruments lit up. Oh, one thing-- several times I would like to have had a flashlight in there, something where I could direct a real beam of light. The little side lights, I thought, were close to being useless. I didn't use my little side light, the auxiliary light, very much at all.

McDivitt As a matter of fact, I didn't either.

White Very seldom. I think that if we're going to have

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a little auxiliary light like that, it ought to be a light--

McDivitt It ought to be a big auxiliary light! Ha, ha!

White -- a directed beam. This goes right back to something that we forgot to point out in water management. I think we ought to point it out right now loud and clear. I think that we have to have a system in which we can gage the water outflow. I think the medical people feel fairly strong about this also. I know that I restrained from drinking because I didn't want to drink all the water out of there prior to the end of the four days. I got a feeling Jim was doing the same thing.

McDivitt That's right. I was doing exactly the same thing.

White I didn't drink abundantly at any time during the flight except perhaps right before the reentry. I felt I was taking quite a bit of moisture with my reconstituted food. I felt that if I overdid it the first part of the flight, we wouldn't get through the last part, because water is so critical.

McDivitt That's right. We've got a number of expendables like OAMS, and we've got a couple of gages for

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the propellants. We've got the ECS oxygen. We've got quantity gages for that. We've got electrical power and we've got ways of measuring that from the ammeter. We've got food and we can always count that. But when we get down to water, which is just as critical as all these other things in flying long duration missions, there's not a single way in the world we can measure how much we've gotten or how much we've drunk. I think it's imperative that we get some method of measuring this thing before we try to fly another long duration flight.

White The white light on the little utility light was not satisfactory. We tried to look to see if we could find out what we had in the cabin bottle--

McDivitt Water tank.

White And that wasn't satisfactory. I think we ought to have some type of a metering system which would enable us to actually determine the water that we've utilized and in some way know that we're getting it out of the adapter. I don't know. We need to look into the whole water metering system, which is non-existent, and see if we can't get some kind of system.

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McDivitt You know even if we can't get something that they can pipe into the spacecraft, at the very least we ought to TM the pressurant pressure down to the ground and back up again, or something, and get some sort of calibration curve--

White So that we'd know what we have remaining in the adapter.

McDivitt We could at least call the people down at the ground and say, "How much water do we have left?"

White That's right. And I think we ought to be able to tell what our bottle has inside of it in the spacecraft.

McDivitt Yes, I think they're really two separate things. I think first of all you've got to know the total water that you've got left and the rate that it's going down. I think the second thing that Ed's pointing out is that we don't even have any way of telling what the water supply is in the spacecraft. The first clue that you get that you're out of water is you just run out of water.

White The lighting on the water management panel I think is just about non-existent. You can see it in the daytime. If you know the position of the

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switches and know where they're supposed to be, you can make sure they're located properly and on the proper indication, but I can't read anything down in that area at night. The lighting is very poor in that area.

McDivitt One thing that I'd like to comment on here a little bit is that , amber light that I insisted that they put on the Preheat-Flush switch over back of the water management panel. I felt it came in real handy. Two times during the course of the flight I left the Preheat switch on after I flushed it for short periods of time to make sure we didn't have any ice left in the lines. I did it on every occasion, but two times the thing that called my attention to the fact that I still had the thing on, was the fact I could see that orange light—amber light—shining up between the food box and the front of the spacecraft. I could tell that I had another light on in the back.

White And so I think the left panel, center panel, right panel, pedestal, and console are not lit abundantly, but are lit what I'd call adequately and perhaps

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a little marginal in some cases. I had no difficulty in reading the designations on the switch-breaker panels. I think they were lighted adequately also. I'm not going to say they're lighted well, because I don't think the lighting is real good in the spacecraft. The water management panel isn't lighted properly. I'm not sure we really have to have it lighted too well. The utility lights, I think, as they are now, are very close to being useless. It's like taking a match and trying to use it to find your way around. It doesn't provide enough light. From time to time I would have liked to have had a light which had a little stronger output of light available, so that I could--I several times wanted to look behind my seat for things at night and I'd like to look down into the area in the water management panel light.

McDivitt Yes, I think probably the wattage on those bulbs should go up an order of magnitude to make them effective.

White You use it so seldom that it wouldn't be a big power use. You'd only use it when you needed it,

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It wouldn't be something you'd use very often.

McDivitt I'll tell you what it all is, though. When you want it, you want something that you can see. You just can't see with those things at all.

White I don't particularly understand what the interior and exterior lights mean. Do you?

McDivitt I think the exterior lighting is probably the lighting that could probably be used for docking. We didn't have any exterior lights.

White I thought the intensity control of the lights was an absolute necessity and I think it was satisfactory. I think the fingertip lights are quite useful, and were commented on already. They should have the Lexan covers, and we've also commented that they should be located between the fingertip and the first joint. The onboard data--now here we come to a very useful piece of equipment. Ha, ha! I believe I made a considerable effort three times to update that thing, and I never got up with it any one of those times.

McDivitt We had three positions on our flight plan strip. We had launch, the first five minutes--the next time I tried to get it was 23 hours. The next

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position was 88. Ha, ha!

White And neither time did I catch up really where we were. I turned and turned and turned and then got distracted into something else.

McDivitt Quite frankly, the only things I ever saw in that flight plan roller were the 23-hour and the 88-hour times and I never even read what it said.

White I didn't quite agree with--

McDivitt 84 it was, I'm sorry. It wasn't 88, it was 84. And Ed wrote something on here. He wrote my parachute-deploy time.

White I wrote your times during reentry on there.

McDivitt It would have been much more useful if there hadn't been anything on it at all.

White Yes, we put a few times up there--

McDivitt I couldn't read those things, which were the only numbers that I really was interested in at all.

White 400K 2+38. Ghute 12+33. The only two that I thought you really needed were those two. I put them on there. I didn't thoroughly believe Gus when he said you ought to take the thing out, throw it away, and leave a hole in the instrument panel. But I'm inclined to agree with him right

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Now. You ought to take it out, throw it away, and leave a hole in the instrument panel. But honestly, what I do think ought to go up there, is a good digital clock readout.

McDivitt I don't think an analog clock in that position would do you any good though.

White They both have a high degree of parallax.

McDivitt Yes, the parallax would make it useless. I think if it goes in there it ought to be digital.

White Yes, a one-second clock.

McDivitt I'm not really sure that we're going to get a digital clock in because of the complexity and the weight and all that jazz.

White Let's talk about the clocks right now, Jim.

McDivitt Okay, let's talk about the clocks.

White I'll hit mine and then you hit yours and then there should be a conclusion that we could come to.

McDivitt Very good.

White I think the clock on my side is unsatisfactory. I wouldn't recommend flying it on another flight. It's difficult to read. There are two hands going around, keeping track of minutes, and sometime you read the wrong minute hand. The one

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that's keeping your hack-it's easy to mistake for your minute hand. The way the face is marked it's difficult to read the minutes out. The hours interfere with each other. The whole readability of the clock is unsatisfactory and the readability of the hands is unsatisfactory. So, I think the clock is out in all counts as far as I'm concerned. I kept watching Jim's clock over there and I think I could get a better Greenwich Mean Time off of his clock than I could on mine on my side of the instrument panel.

McDivitt Hey, let me comment on mine. I thought the readability of that Accutron 24-hour clock was excellent. The accuracy of it was lousy. It lost four or or five seconds every day or more. I reset it about every 24 hours. My Omega wrist watch that I had set on GMT never lost a second, except I forgot to wind it one day, and it ran down. It stopped. Ha, ha!

White I was guilty of the same thing.

McDivitt But the Accutron clock on my side of the instrument panel, that they put on as sort of an afterthought, was indeed a fine clock as far as

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readability. It didn't have any chronometer function to it at all. It had strictly a second, minute, and hour hand on it. It told you GMT and it didn't tell you anything else. It told you GMT in a way you could read it. You could read out the minutes, you could read out the hours, and you could read out the seconds. I really didn't have any trouble with it at all. It had a nice thin second hand which I find to be much more useful than those great big blunt things with huge arrows on the end of them. I hate to lose the chronometer feature on that right-hand side, but I do think that the readability of this thing, as far as the GMT is concerned, is so much superior to that other clock that it isn't even comparable.

White I'm not sure that the chronometer function on that side is really too important.

McDivitt Don't you?

White No, I would be perfectly happy to go ahead and take that out and put a good clock on there in Greenwich Mean Time. Now I've got some further comments on--

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McDivitt I guess what you end up with is two clocks that aren't any good. Either one of them aren't any good. You'd rather end up with one clock that was good.

White Yes, the way it's combined together right now, it's really not too good. I hacked your OAMS burn on my watch. I work with two clocks on my left arm and it worked out real well for me. I had elapsed time on one and I had Greenwich Mean Time on the other. I used the elapsed timer as the one on which I made my hacks. So I feel we got adequate backup. If one poops out, you can use the other one to make your time on. So, I think we should have a good clock to keep track of the time in the spacecraft on the instrument panel. Now, I'd like to get back on the clocks again. I think that elapsed time is the only kind of time that we ought to have in the spacecraft. I think that we ought to have a good method of keeping track of elapsed time. I think probably a ten-hour clock that keeps track of each ten-hour increment that you pass to a high degree of accuracy, is the kind of clock that we need. I don't

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know what we're going to do about wrist watches. Maybe they'll design us a ten-hour wrist watch that we can wear. I don't see any reason why they can't. They can design twelve-hour ones just as easily. We're going to go to this in Apollo. We should face up to it and go ahead and spend the money to get ourselves a proper timing piece of equipment and get our ranges and stuff operating on elapsed time. In long flights this is the kind of thing that's going to be of interest. It was confusing to me, to tell you the truth, to operate on Greenwich Mean Time and elapsed time throughout the flight. I was constantly adding and subtracting. They'd call us up Greenwich Mean Times and I'd want to convert them to what I was using on my flight plan. I found this a great inconvenience.

McDivitt

I concur with what Ed said. I ran the whole flight plan using elapsed time except for the times where they called a specific GMT time to perform a function. I did it off of a twelve-hour face wrist watch. I added up all my twelve-hour increments and came to whatever I wanted. If I

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had something like 83 hours and 15 minutes, I had to figure out that that was six times around the clock and another 11 hours and another 15 minutes. Obviously, not the best way in the world to do it, but the only way that was practical from the standpoint of the flight plan.

White Well, to tell you the truth, Jim, I feel strong enough about that elapsed time that I would be happy to go with that type of a system of timing, and just go ahead on elapsed time all the way and use twelve-hour increments. They would call up your time and elapsed time and use your own clock to keep track of it. I felt it was simple enough also to do it in this manner. But I feel that this is inferior to having a good elapsed timer and ten-hour digital increments.

McDivitt I tell you I hate to see us get involved in something where you've got a clock that's so difficult to read, where you've got to add up twelves and--

White Now you're on the other side of the fence now!

McDivitt No, I think that we ought to do things like retro-fire time and that sort of thing in a standard time that you can use -- something like GMT.

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White Well, you really need— -elapsed time. If we had elapsed time--

McDivitt If we had a good elapsed timer onboard the spacecraft, I would say that there's no doubt about it. Elapsed time.

White I think we ought to start working on it right now.

McDivitt Elapsed time is the way we should go. I don't think that with the timing systems we've got available for the Gemini that we want to go to elapsed time for the whole mission.

White Trying to get our data back from this flight is going to be a horrible mess because of those two timing systems.

McDivitt I know it. I agree. Before we launched, we knew that we wanted to run it in elapsed time, and there wasn't any doubt about it.

White I think maybe if we make the point strong enough maybe they'll get busy on it.

McDivitt You're right. We'll get going on it.

White Okay, why don't you take the checklist cards, Jim?

McDivitt The checklist cards. We had two complete sets of cards that were broken up into two groups. We

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had the launch, insertion, Mode II and Mode III aborts, EVA, the suit check and all the things that we were going to use in the first five orbits of the flight on one set of cards. We had another set of cards from Pre-Retro Checklist down to the post landing and emergency egress. The cards included all the plots that were needed to do all the retrofire and to make corrections to take care of all the non-nominal things that might happen to us during the retrofire. We also had in this group of cards a card that we used to contain the final retro information such as with OAMS or without OAMS burns, time to reverse bank, and all the other things that we had. It was a format, something that could be easily held in our hands and was actually used during the launch, during insertion, and during reentry. We actually had these cards out so we could check them off.

White

I thought the only thing we would have out during these two critical busy periods of time were these two easy-to-hold, easy-to-operate, hand-held card checklists. The rest of the stuff was all stowed away.

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McDivitt We got every checklist that was required to make the spacecraft run on these two sets of cards, which together were about 3/4 of an inch thick.

White I feel that we had a real workable solution to the problem. These things were the same size as those carried on GT-3. They were much more expanded than what GT-3 had. We had the whole how-to-operate the spacecraft routine on these cards.

McDivitt The preparation and availability of them-- is this from a training standpoint. That is later in the brief.

McDivitt Well, anyway, we actually received our cards at about 8:00 the night before the launch.

White That's the thing that I was hollering about the loudest not to have happen and it happened. I understand why it happened, but--

McDivitt We had so many changes in the flight plan and nobody was working on turning this stuff out. Our time was so filled with over-all training and the change in flight plan that we just didn't have time to go--. We did not have time to go through the checklist over and over. When we did

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go through them it took too long to get the thing back to us. Dick Benson came down to the Cape and did an absolute marvelous job, I think, in getting these things turned out.

White I think he did, too. I think we all owe him a real vote of confidence.

McDivitt That's right. He did an outstanding job.

White I think the biggest confidence builder that you had, Jim, was when we started getting these books.

McDivitt That's right. Shoot, I was worried about us getting ready for the flight because I didn't think we would be able to get all this stuff together. Finally he showed up and really went through it, but it doesn't change the fact that these checklist cards and data books didn't arrive until 8:00 the night before the flight. We had a few changes that had to be made. I guess I went to bed about 9:30. Dick Benson and Martin Miller were still in our conference room making changes to our books. So a lot of these things we didn't see until we flipped them out in flight. I think our data books, as we had them laid out, couldn't have been better. Well, I shouldn't say that;

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there is always room for improvement.

White Yes, I think we could organize them a little better for utility and use. We had so many changes in so many things that got put in at the end. It got so that they were put in in a bit of a helter-skelter manner, but certainly they were easy to find.

McDivitt Well, I don't know. I was really quite pleased with the outcome. I think that the general arrangement of one data book and two-- whatever we ought to call those other books--

White What did we call those other books?

McDivitt Two Experiments and Spacecraft Procedures and Flight Plan Books--

White Two procedures and one data.

McDivitt Yes, two procedures books and one data book. One thing I would have changed -- I would have expanded the flight plan and made maybe two or three times as many pages as we did. We could have written all the notes right in it and had enough room to make it intelligible. Because it turns out, that's where we really kept all of our notes.

White Yes.

McDivitt Right on the flight plan.

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White About the way they had it initially was pretty good. Maybe that's a little more than we need, but--

McDivitt No, I don't think it is, Ed. I think that is the way it should be.

White This is a whole hour on one page.

McDivitt Really?

White Yes. So later on, you see, they went from one hour down to six hours on a page. Maybe if they cut that in half and made two or three hours on a page--this is probably about the--

McDivitt Two hours on a page for our flight would have made 50 single sheets or 25 double pages. That would not have been bad.

White That probably would have been just about the right length.

McDivitt We'd have gotten a lot more out of our notes, I think, because we found ourselves scribbling in places where it was pretty hard to determine where you were.

White The requirement to make changes in the book after the flight goes on is absolutely nil. So, I think

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that rings should be replaced with something that doesn't come undone. My rings came undone several times during the flight and luckily only one at a time came undone. It would have been a real mess if any of these books would have come apart, because it would have destroyed numerical sequence. So, I think something other than rings ought to be used..

McDivitt I tell you one thing I found.--that size book and that concept that we had, I think, was really good.

White That was just the right size.

McDivitt It's just the right size. Their sheets are big enough where you can write a lot on them.

White They're easy to handle.

McDivitt They're small enough so they're easy to handle. They're easy to stow. They fit into the flight suit. When we launched, I had both flight sets of data cards in my right lower pocket and the big data book and my procedures book in my left-hand lower pocket. I had all the checklists right on my spacesuit.

White I had one procedure book and both my cards.

McDivitt And both your cards. So that between the two of

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us we had all the data books right on the flight suit, which was just right where we wanted them.

White Another thing we did--we hand carried this equipment down to the spacecraft to be sure it was there on launch.

McDivitt The maps, overlays, and star charts we should lump all together along with all the other junk that we carried in the data case.

White Let's start with the star charts. That's easy. I thought the star chart was satisfactory. I think you used the one with less stars on it than I had.

McDivitt Yes.

White I used my own one that I fly with all the time and I was quite happy with it. I think this is exactly what you need and I don't believe you need to overlap two times around, but that wasn't for the chart.

McDivitt Yes, and really the flight chart, the one that was actually designed for the spacecraft, was designed so that this swiveling out the window display fit on it. It was a certain size to take care of that and had a lot of dead space out on the

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edges. I would have rather seen the stars expanded more so that we could tell it. We used two polar plots of stars that were put out for the Apollo thing that we picked up on our training. We actually flew with one of the training things. I took one out of my brief case.

White Those weren't put out by Apollo. Those were put out at our request. Remember? We asked for a--

McDivitt Yes, but I thought they came from the Apollo office.

White No, they came from our own Flight Crew Support.

McDivitt I know we requested them, but I thought that's where they dug them up.

White No, they got them from--

McDivitt Okay.

White See, what they did is they added on all the Apollo navigation stars. They came from our own boys in FCSD.

McDivitt Those polar charts are really the cat's meow.

White All those charts are pretty good.

McDivitt So I thought the star charts sure gave us all the information we needed. The maps and overlays-- I think we really ought to cover the maps and overlays by the experiments. The map with the sliding

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overlay of the orbits, I thought was a real good tool.

White Very easy, yes.

McDivitt Very easy to use and I am sure glad we came up with that.

White I think also carrying pre-plotted orbits on the maps was also useful and stayed pretty--

McDivitt That's right. Right at the last second we decided to take four maps that were glued back to back so we had two sheets. They were on a sticky-back which made them reasonably thick and durable. One of them had no orbits on it, one had one to 22, another one had 22 to 44, and another one had 44 to 66. You could look through there and you could get a quick reference of where you were going to be at a certain time. The times did get off, but you were only off a little bit.

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White You can keep track of how far you're off.

McDivitt You knew about where you're going to be. As Ed says, as the time went on you could tell about where you're going to be just by knowing the correction. It didn't change much. So, we found these to be pretty useful. We didn't really get to start using them until the second day.

White I didn't know you had them in there.

McDivitt We took them out, I guess, one time when you were sleeping just for the heck of it and, my gosh, they started working pretty well.

White I used them almost exclusively once we got them out.

McDivitt Yes.

White We had a lot of other information onboard and I don't know whether we should go into all that stuff now?

McDivitt Oh, yes, I took schematics of all the systems right out of the GOH. I didn't ever have to use them, but I thought it was worthwhile having them along. Everybody was getting so screwed up on the water management panel and I took my notes on the water management panel with me. I had a

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couple of drawings.

McDivitt I had what happened when I put all those valves in a lot different positions. You know when you compare something like that digital computer with the water management panel you certainly think the computer would be more difficult to operate. But after the million conflicting descriptions we had on the water management panel, I think we all agree that it was the worst in the spacecraft.

8.8 Stowage

White Well, I guess I was the chief stower and unstower.

McDivitt All I did was take the food out.

White I thought the stowage in and out of the center stowage box was probably the easiest place to get in and out of. The boxes were easy to slide in and out and the stuff was easy to put in and out. I felt that the right-hand wing box was tough to get in and out of. Getting in to get the bags full of equipment took a little bit of time. When I got to actually stowing the refuse back in the right hand box, it was easy enough for me just to reach over my left shoulder and put the items in without even turning around. It was

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pretty easy to use as a trash can. The stowage of the items of equipment in the footwell, to me, was not objectionable at all during launch and reentry. The ventilation module which was stowed on the left side of the right footwell was well out of my way during these times and offered no impairment to me whatsoever. Something that was a bit of a surprise to me was all the equipment we had in there, that we were not able to jettison after EVA. I knew we were in for a bit of a problem with so much equipment. I think the stowage of the miscellaneous pieces of equipment underneath your legs back up in the heel in back of the stirrup area is pretty good storage for almost all of the loose items during flight. Jim and I had the area just chucked full.

McDivitt This was not any big surprise. Remember how we were talking about how we were going to put all that stuff up?

White We were going to put a big refuse bag in there.

McDivitt We decided that the most likely place to put these big items would be back underneath the seat because we weren't going to keep our legs back

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there. We never did get them back there.

White There was no possibility to put them back there once we filled it up.

McDivitt Yes, but even if we wanted to, I don't think there was any big desire to put them back there.

White It would have been nice to stretch but that's just about all. That would have been from time to time.

McDivitt That's right.

White I found that actually the thing that I appreciated the most was having a lower seat so I could actually stretch my legs out forward than actually behind and bending my knees.

McDivitt Yes, I was more interested in straightening my legs out than bending them back more.

White I couldn't have done that if they hadn't corrected that seat. I was able to get in and use the stowage in the refuse box on my side fairly easily.

White This is the rubber covered box. Jim said his wasn't quite as easy to get into. I had to get into a certain position to get back there, but it sure surprised me. I thought it would be just about useless.

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McDivitt Well, I got things out of it. I got a defecation bag out one time and I got another little bag out. I don't know what else I had back there.

White The right hand box with the clamp lock was easy to get in and out of. I stored things from time to time in there.

White Yes, I found that the most useful storage area that I had was the right-hand little velcro covered container right down by my right knee. I kept all the slides for the cameras and the miscellaneous little pieces of equipment in it. I felt that was a very useful container.

McDivitt Is that the one with the canvas cover on it?

White Yes, I really used that one.

McDivitt Yes, that was pretty nice.

White The periscope container I didn't use much at all. I really didn't need to use it. I kept the blood pressure adapter in it throughout the whole flight.

McDivitt The left-hand aft food box actually had food in it. It was pretty difficult to get the first piece out. It was a long hard struggle, but I finally got one piece out. Once I got one piece out, the rest of it was a real snap. They had the

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things taped together. I left the door open the whole flight after we once unstowed it. I would leave a meal floating out so that when I wanted to get a meal I would reach up and grab the meal that was floating loose. I would pull the tape out until I got a hold of the tape so I could force another meal out of the box. Then I would cut the first meal off and we'd eat it. I managed to get all the food out of the box without getting out of my seat. The left-hand side box had the film stowed in it and it was easily accessible. I think the most useful stowage place that I had in the spacecraft was the little Volkswagon-type bag that we had made up and bolted on the center pedestal.

White

Oh, that was a jewel.

McDivitt

We kept our checklists, maps, data books, and procedure books in it. When we went to sleep and had a change of command and we wanted to get to one of the pieces of equipment that the other guy had, we almost invariably stuck it in that little pouch. I really think the most useful

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thing that we had put on that spacecraft were those little pouches.

White Yes, I think the pouch could even be made a little bit bigger.

McDivitt I think it could, too.

White Then it could receive a little bigger item and perhaps have a little more volume that it could expand out to. I think that it was a very useful item. We used that as storage area more than any other.

McDivitt That's right.

White I used the long khaki refuse bag on the side for various things, but the main thing I use it for, once we got the flight going, was a refuse can. I would put all my refuse in there until I got a full container of it. Then I would package it up and put it back in the right can box. I thought it was very useful.

McDivitt I used it for all kinds of things. I stored your Mae West in it, and I had some of the camera equipment in it when we were doing EVA.

McDivitt When I got all the good pieces fished out of it, I finally started putting trash in it.

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White We both have an interesting item on this. Well, I emptied mine out all the way, but I think you entered with it full of trash.

McDivitt I reentered with that bag full of trash and it didn't tear off.

White It was in pretty good shape.

McDivitt It was light-weight trash. Papers and things like that.

White I have a comment on the other little trash bag. I never used it.

McDivitt Neither did I. I would get them out and I did not even know where they were. Yes, I think it's just too small.

White Yes, it's just too small and I think that Volkswagon pouch can be improved upon. I think both right and left canvas storage bags were very adequate and should be continued. I think it's satisfactory just the way it is.

McDivitt They could make the Velcro strips on it a little longer and the Velcro strips attached to the spacecraft a little longer so that it didn't have the big curls on the edge. It tended to curl in and make an opening. I never could get the thing

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closed.

8.8 Belts

White The belts worked satisfactorily.

McDivitt Yes, mine worked very good.

8.8 Harness

McDivitt Harness. Okay.

White The harness was satisfactory.

8.8 Life Vests

McDivitt Life vests. Very good.

White Very good.

McDivivitt I might comment on those life vests. I never took my life vest off my restraint harness the whole time. It wasn't in the way at all and I was amazed that I didn't pop them. I always pop them in the simulations.

White I was waiting for you to pop one. But I was surprised with the ease I could take them off and put them on weightless. There's just no comparison at all. That's an easy task.

8.8 Waste Disposal System

White I thought the defecation bags worked as well as anything we had. There isn't anything you're going to do to make it go to the bottom of the

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bag when you use it. I think you should be familiar with how to close the bag. I only used one bag and I think you were a two-bag man.

McDivitt I was a two-bag man.

White The stuff didn't float out of the bag or anything. I would permit the thing to remain open while I used the paper. I actually used the paper as kind of a charging mechanism to push the stuff on down in the bag. You know like loading the cannon. Then I sealed it up on top. There was a tendency for the fecal material to be up on the sticky part, which made the closing not quite as nice as I would like it to be, but I was able to close it up all right. I broke two of the disinfectant bags and I cut the bags. There were two different kinds of disinfectants. One of them came in a bag inside a bag and the other just came in a bag. I was a little suspicious of that one, so I cut it first and I think you did that, too.

McDivitt I did that to a couple of mine. I still think that those bags break too hard. I hate to have to cut those things before I stick them in there. I cut one and the darned thing floated back out again and I didn't notice it. I had the bag just

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about sealed up when I noticed this thing floating around in the spacecraft. I had to push it back down in there.

White When I cut it, I got the stuff on me and a little bit around. The two that I broke, that were contained inside the plastic bag, seemed to work all right. On the whole I was satisfactorily pleased with the defecation bags. I felt also that the liquid was easy to work into it. I think that's a satisfactory system.

McDivitt You really have that knack of kneeling.

White One thing, it is just like oleomargarine was --
Ha, ha!

McDivitt A little different in colon. Ha, ha!

White One thing that I want to comment on was the toilet paper with the darn wax job. I did not think the toilet paper was satisfactory. It had a waxy back so that it was like the back side of a Sears Roebuck Catalog.

McDivitt That was not the side you were supposed to use.

White I know it but the other side had such a small amount of absorbency. This is why you always used so darn much paper Jim McDivitt. Ha, ha!

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I found that the tissues that we carried in the little containers were very satisfactory for the purpose. I think they can leave the paper out of those bags and provide us with adequate tissues. While we're talking about these tissues, let's go into the container.

McDivitt That's right. The container.

White Yes, the container failed. Both of them failed in a similar manner. We had tissues just loose. They were tucked in around the spacecraft.

McDivitt The zippers that went around these tissue bag holders ripped out completely. Actually they just separated— almost immediately, as soon as we took them out of the bag.

White And both in a similar manner right off the bat.

McDivitt So we had a bunch of tissues that were not contained in anything.

White I think the containers were very good containers. The method of dispensing would be fine, but they all fell out the side. That's the way I used mine for the rest of the time. I used those tissues for all kinds of things. I cleaned my window with them. I cleaned the camera lenses with them. I

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sal cleaned my visor with them. I got my visor so full of salt spray. Remember when I got that salt spray all over them during the EVA and my visor was dirty?

I cleaned everything all up. I substituted it for the toilet paper in the defecation bags. I think this is another thing I am certainly glad we requested. We started out by requesting lense tissues, and as it ended up this is what we got.

McDivitt We wanted one little bag and ended up with two big bags, and I think we could have used another one.

White I used every bit of mine. I think I could have used them more properly if I had a good dispenser system. I'd grab too many.

McDivitt Those big towels weren't too bad either. They're great for sopping up the urine and stuff.

White Yes, they were great urine mops. If we had had a big spill of some kind that's what you'd want to use, because you could use it, it would dry out, and you could use it again.

8.9 Bio-Medical

McDivitt We have already discussed this in great detail with the doctors so I think we can go over it briefly. The Medical Data Pass Type 1 was not an inconvenience. It got the data down to the

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doctors quickly. I think it made them happy. It wasn't a big drag on us. Medical Data Pass Type 2 was only about half of the Type 1. It wasn't bad and the doctors got some use out of that.

The food evaluation was discussed with the medics so we can just summarize.

White I think we should put a big gold star on the food. I think it was one of the most important parts of the mission.

McDivitt That's right. It was really good.

White Both morale wise and just keeping your strength up.

McDivitt It was a good picker-upper when you felt lousy. The chow tasted good. The thing I didn't like about it--I think it gave me a touch of the GI's.

White I think it tended to loosen you up a little bit. I think, now as I look back, I would prefer to have maybe two of the items in one of those plastic containers and two hard items.

McDivitt Gee, I thought the way they were mixed up was pretty good.

White Sometimes though you'd have four rehydrated and nothing crunchy. One time I had one that was all

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crunchies just about. It had one drink in it.

Every bag that I had, except one, that had any form of an orange drink in it, leaked.

White Mine started leaking, too, as soon as you mentioned it.

McDivitt I only had one other bag that leaked or maybe two other bags that leaked. I think that the rate of leakage was just unacceptable. I think those bags are going to have to be fixed.

White No toast.

McDivitt We didn't open up the toast.

White Well, I ate that one thing of cinnamon toast.

McDivitt I ate the cinnamon toast because you discovered that it had a coating on it and it didn't crumble so much.

White I guess there was only the one cinnamon toast.

McDivitt Overall, I thought the food was good and there wasn't too much of it.

White That peanut stuff also kind of crumbled.

McDivitt Yes.

White I think we ought to include more meats. I think the bacon was outstanding.

McDivitt Oh, that bacon was absolutely great.

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White I could have had that everyday.

McDivitt Ed doesn't even like bacon.

White I could have had that kind of bacon. That was kind of a smoked bacon.

McDivitt It really was good.

White When I ate it, I got to thinking that I don't understand why we don't have more meats in the smoked capacity.

McDivitt That's what I was thinking--smoked beef and smoked barbecue.

White Yes, that's very good tasting, and it's salty. It makes you drink water, and drink water is what you should do. But I think we ought to look into some of this. Another comment, too, is that Jim had thrown the sausage out prior to this time and the sausage that I got was a completely different breed of eat. It was in one of those water bags.

McDivitt I never did get any shrimp. Boy, I bet it was in that last day's meal.

White The sausage was pretty good. There was one thing that I didn't eat, and that was one chicken bite because it coated my mouth. I actually ate two or three of them.

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McDivitt The only thing I didn't eat was the bacon and egg bites, either.

White I think if I had my druthers, I'd take bacon.

McDivitt One of the biggest problems on the whole flight was the lack of sleep. I don't really feel that I got more than six hours of good sleep or even six hours of medium sleep in the whole 100 hours we were up there.

White I think if I estimated my sleep time I might estimate more. I got that one five hours. That was good.

McDivitt Ed had one real good one, and there were a couple of them where I didn't wiggle around for about five hours, but never did I sleep more than two hours.

White You weren't soundly asleep.

McDivitt I just sat there and I rested. I had one one-hour period right there at the end that was pretty good sleep, and I had another good two-hour period.

White That mike was one of the reasons we were getting poor rest.

McDivitt I think there were two reasons. One was the radio was feeding into our headsets all the time during the first half of the flight. The second half

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of the flight, we had the darned OAMS thrusters going so much--BANG, BANG, BANG, BANG, BANG!

White I was just too hot some of the time.

McDivitt Yes.

White Early in the flight the ammonia fumes kept me awake. The first time I tried to go to sleep they kept me awake.

McDivitt I don't even know if they kept me awake.

White I really noticed it then.

McDivitt I think we really need a sleep period longer than the four-hour sleep period. First of all we always fooled around and never really got the sleep that we wanted. If we had gotten a four-hour sleep period everytime it was scheduled, we would have been in great shape. I think we ought to schedule a longer one on the order of six hours. Ed and I talked about this earlier. What I suggested is that we schedule four six-hour sleep periods, if there aren't a lot of experiments that have to be done together. Where two of these sleep periods come together, you can make that a dual awake time so that the people could be up. As a matter of fact, you could modify it in such a way that if you

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wanted two people to be up at the same time you could really have three periods during the day. You could take two of these six-hour sleep periods and really make them sacred so that nothing could touch them. Then you could just take those other two six hour sleep periods, and maybe chop periods off each end of the thing, in such a manner that you'd be able to get one good sleep period and some rest periods in between. I think during a six-hour sleep period you ought to plan to be in a drifting flight and not do any experiments. I really think there ought to be one long sleep period with no radios and no thrusters firing. Then you've got a real chance.

White You might be able to put it in Horizon Scan.

McDivitt Well, even then it goes, THUMP, THUMP, THUMP, every once in a while, you know.

White I think you could almost do this by ear. If it was bothering the guy, you shouldn't do it. In my opinion I think we're pretty close to the same thing. I had originally told Chuck I thought that the four-hour sleep period wasn't satisfactory. We should have one period of six hours of sleep,

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with another rest period scheduled in there some-time of several hours. This would be satisfactory. I felt we were really productive when we were both up. I would like to see periods of time in the day where each of the guys are up at the same time, and doing actual experiments and work. When you are working together like that, it seems you are complimenting each other, and I think you get more productive observations. Some of the experiments require two guys. D-6 is going to require two guys. D-9 requires two guys, and to adequately do it to get the pictures we want, you just need two guys up.

McDivitt Let me modify that position of mine even further. If you scheduled a six-three and then the other guy with a six-three that would leave you six hours up together everyday. I think that might be adequate.

White You should also always try to schedule your eating periods so you aren't eating during this up time. You should schedule your eating when the other guy is sleeping.

McDivitt Right.

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White Go ahead and eat when you just get up and the other guy is asleep. Eat just before you go to sleep, and don't eat simultaneously. Eat while the other guy is sleeping. I think you should spend all the time, while you are up together, working on productive experimentation.

McDivitt Yes. I think you should keep these two six-hour periods inviolate and then make the other ones really flexible where you could move those sleeping periods around.

White If you got tired you could go on and take four hours for sleeping. If you needed it, you would go on and take longer. If you only needed one or two hours, you could go ahead and take that. I didn't feel as strongly as you about being tired. You said I was tired.

McDivitt You commented on it a number of times during the flight and also you looked like you were tired.

White Several times I missed a rest period. I think we got fouled up a couple of times on it. I did get tired before I took that five hour rest. I knew I was tired.

McDivitt You had that one really good sleep right around

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85 hours or so that really seemed to pick you up.

White

It helped me a lot. When I came out of it, I really felt groggy until I had had a few minutes to wake up. I think this picked me up considerably and probably this gave me a little gain on you as far as the rest of the flight goes.

McDivitt

That's right. During the time you were sleeping, I fell asleep. I saved one night cycle out and went to sleep. Ha, ha!

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9.0 OPERATIONAL CHECKS

9.1 Apollo Landmark Identification (D-6)

McDivitt The equipment we carried onboard the spacecraft really didn't apply exactly to D-6. We didn't have a Questar lens. The 200 mm lens that we carried did not have the periscope mounting for it. It did not have any way you could aim it with a telescope, so the only aiming device that we had onboard the spacecraft was the gunsight mounted in the left hand window.

The cameras that we used for this experiment were the 16 mm movie camera with 5 mm telephoto lens on it and the fixed mounted 35 mm Contarex with the 200 mm lens. The fixed mounted Contarex was in the right-hand window, and the 16 mm camera was in the left-hand window.

White It was kind of interesting since we were in free drift, and they told us to go ahead and run a tracking task. But the first one that I ran was Apollo Run No. 1, which was over the junction of the Blue Nile and the White Nile in the middle of the delta of the Nile River.

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White

This was identification and acquiring it and seeing how well the charts that you had equipped you to identify specifically the landmark in consideration. The first one I had was the junction of the Blue Nile and the White Nile, and more specifically it was a little island in there, and it was the northernmost tip on the island. I realized as we came around that I was going to be in pretty good shape in this free drift to be able to see the targets. As we came around, I looked out in the general direction that I had been instructed from the ground, and the first thing that I noted was the major Nile coming down to the intersection. I was able to follow it pretty clearly down to the intersection as we got roughly 20 or 25 degrees from the vertical. I was able to pick up the little island in the junction of the White and Nile River, and I was able to follow it all the way through as we passed over. As we got to the 90 degree point overhead, it was quite easy to track with my eye. I wasn't actually tracking it. It was northeast

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of my track 92 miles, so it was really quite far away even when I was at the 90 degree point. I reported that I thought this was a very good landmark. It was very easy to see, and I felt if I had a higher power telescope I could have tracked it quite adequately. I classed this landmark as being satisfactory, and I classified the charts that I had used to identify it for me as being quite satisfactory. Incidentally, I believe that this, of all the landmarks we had, was probably the easiest one of them all to locate, being right out in the middle of the desert, pointed out by two rivers converging from a major river. It was a very good landmark.

McDivitt Okay. You ran some more -- just Apollo landmarks. It wasn't really a tracking task problem. Didn't you run one off of Puerto Rico, too, or was this the only landmark that we really ran?

White This was the only real Apollo Landmark I ran. I ran some D-6 Landmarks.

McDivitt Okay. Fine. I think the next one that we ran was a border pass on El Paso. Or did you run on Tel-Aviv before that?

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White I'm not sure exactly the sequence in there.

McDivitt Okay.

White I think before that, though, I did run a series on D-6 Targets 11, 12, 13, and 18.

McDivitt Okay. Why don't you go ahead --

White Shall I discuss those?

McDivitt Yes.

White Okay. 11 was Adagier Morocco, 12 was Wheelis, 13 was Alexandria, and 18 was Dhyran. They gave me all these four targets and I realized right away that I couldn't possibly handle this many of them and do it adequately. This was the first time we'd been given the go-ahead for some tracking on which we could use OAMS. I elected to use pulse as a fuel conservation method. I selected to try Wheelis and Alexandria, since I thought that I could locate them quite easily and that they were sufficiently far apart to track adequately. As we came up on Wheelis (I'd been stationed there prior to this time) I knew pretty well exactly where it was. As it turned out, there were some high clouds over Wheelis, and I wasn't able to observe it. No. 13--I picked up Alexandria and took manual

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pictures with the 200 mm Contarex. Since I was actually taking the pictures, I had to divert my attention a little bit to the camera, so I didn't actually look down and, I didn't actually see the airport. But I had seen it prior to that time, and I did see it many times afterwards as we passed over. The recommendation that I made from this was that the targets should be far enough apart to allow adequate set-up, to go from one target to another. I thought the updates were good and the general location of them with respect to my orbits was good. And the next one is El Paso International, Jim.

McDivitt Okay. This was the first tracking task that we were going to do with the telescope, the 16 mm movie camera, and the fixed 200 mm lens on the Contarex. We started out with a time of closest approach and a time we should have been able to see the target. The only kind of identification assist that we had at this time was a piece cut out of a WAC Chart, that showed El Paso International, and the world chart with a gigantic scale on it. This made it a little bit difficult from an acquisition standpoint.

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But later on we found that these same two types of information--the world map and the small WAC Chart--were adequate for other types of targets. The WAC Chart showed of course the range of mountains just west of El Paso and the White Sands and the Rio Grande River. We came across Southern California, and I could see the Salton Sea. I didn't track them, but I looked out the front and I could see the mountains of New Mexico and Arizona. And I saw a bunch of white places down below us, any one of which could have been the White Sands. If I could have really picked out the White Sands by themselves, and unfortunately they were off the WAC Chart that I had, I think the contact would have been good enough for me to pick up El Paso. As it was, the only features I had that would have been of great importance were the river, which was the Rio Grande River--and at that point was not very noteworthy--and the mountain range, which from the altitude of around 90 miles or more couldn't be picked up. I think that this type of a topographical or geographical feature, like a valley or a mountain, is not adequate

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for this kind of task. You need a contrast in color as you get from the White Sands to the surrounding desert. The best of all is a water-land interface or border. As we came across the United States, I think we picked up El Paso just as we were over it, but we weren't pointed down at the town. We were still pointed well out in advance. The only clue that we were over El Paso was that I could see the Gulf Coast. I knew that when I saw the Gulf Coast we were probably too far along to pick up El Paso. Rather than just scrub the run, we went ahead and made a run on a pair of sand spits with a channel between them in the vicinity of Corpus Christi. We picked up a target well in advance, and as I started trying to line up on the target, I found out that the gunsight had a light intensity and the gunsight was inadequate for a daytime tracking task; because as you pointed the sight down and had a background of clouds, you just absolutely could not see the sight. I didn't have any idea in the world where it was pointing. When you put it on the dark land, it seemed to be adequate, but I think we

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can increase the intensity of the gunsight by quite a bit. During the night time you can turn it down and the brightness is just about what you need. We made this run on this pair of sand spits, and the tracking task was quite easy. Now, I just happened to pick something that was obvious to me and tracked on this and picked it up while we got on at about 30 degrees, until I got to the vertical, and then I tracked it out to about 45 degrees past the vertical. This wasn't a real tracking task, in that I didn't select a target before I got there. But, I just stuck with whatever target I happened to be pointing at and ran the tracking task. I think we learned something from this pass in that we want to be very careful about picking out targets in the middle of an area where there aren't any good water-land borders; there aren't any good contrasting colors. There wasn't a really prominent feature that I could start from, that worked down to the city and eventually to the airport. So, I think that on this particular pass, although we didn't get any pictures of our intended target, we learned quite a bit

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from it. I don't believe I have any other comment on that pass. Do you?

White No. I was quite surprised when we missed El Paso. Remember we thought, "Boy, this is one we're going to nail."

McDivitt And the funny part of all this is that we had both flown in and out of El Paso International Airport no less than a hundred times. We were pretty well assured of where we were going and what it looked like. But we didn't find it early enough. We progressed too far before I really saw the town, and even then I didn't see the airfield, because I wasn't sure I was over the right town until I was over it. And then, it was too late to look at the airfield.

White I think that the point that you're making is going to be well brought up in what I'm going to say next.

McDivitt Okay. Why don't you -- you made the next pass, I think, on Tel-Aviv.

White The next pass was Run No. 6, Target 15. The information I got was adequate to locate it. It turned out that this target had the essentials that Jim was looking for and mentioned on his last

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pass I had a nice body of water. The Dead Sea was a good location, and actually the city itself was located at the end of the Mediterranean, so I felt that landmark-wise I had a pretty good target to track. I came in and the first target I picked up was Jaffa, and I was on it so well that I decided to go ahead and track Jaffa. At first I had thought it was Tel-Aviv, and a few seconds later I realized that it was the city 10 or 20 miles north of Tel-Aviv. The reason I picked it up so easily is because there was a little spit of land that jutted out into the water and it sat right in this little natural basin. I looked down and I saw Jaffa and I actually saw the little round circular airport in Jaffa. I also saw Tel-Aviv, and I saw the airport that I was really looking for, but I decided I'd go ahead and track Jaffa and take a few pictures of Jaffa as we went over. You have to realize that I wasn't using a gunsight on my side, and I was also controlling the spacecraft and firing the camera at the same time. So the tracking is probably a little rougher than it would be from the left-hand side.

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But I did get a good indication of the capability to track a target and to pick a target up, and I think that I was quite surprised at the ease at which you could track. I also concurred with Jim's conclusion that a good prominent landmark primer, preferably a body of water somewhere to nail down your target, is the most desirable feature. I also feel that an important thing that the next crew going up could do would be to spend a lot of time on just plain map study in the 30 degrees north to 30 degrees south, and try to pick up the prominent features to permit them to become quickly adjusted to what they can see and what they can't see down below. I think that a little concentrated map study prior to the flight would help a lot with the D-6. Also a concentrated study on the targets themselves would be quite beneficial. This is something that we really never got to do. The original 243 targets were too voluminous even to consider time to study each one, and when we got the final 19 targets, it was pretty late in the flight to be working on an experiment that wasn't even on our flight. Even

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with the limited knowledge that we had of the targets I felt that acquisition and tracking of the targets was a lot easier than I had thought it was going to be. I guess that's all.

McDivitt The next target that we had was Yuma International Airport. Here again we had a target that was not a very prominent landmark. The time of closest approach and acquisition time and the aiming angles were adequate. It gave me a good idea of what I should be looking for and when I should be looking. I used the same maps again; I used the cutout of a WAC Chart plus a great big world chart. There was quite a discontinuity in the scale of these two maps, but I'm not really sure that we couldn't have done the job with just those two. I think that what we probably needed was a world map that showed a little more detail and a WAC Chart that showed a little bit more area. What we probably could have used most of all was a photograph of the area. As I came in across the California coast, I picked up the Salton Sea and El Centro, just below the Salton Sea, and then I knew that Yuma was on the Colorado

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River, which should be a few miles to the east of the Salton Sea. There was a nice big bend in the Colorado River. Unfortunately, the Colorado, although it is a reasonably good sized body of water--if just plain doesn't show up that well. It was a little difficult to see, but I finally picked it up. I saw the bend in the river. The river doesn't actually go through the town of Yuma, so I started looking for Yuma, and I did wander around a little bit before I finally found the town. Then I was unable to find the airfield within the town. When I was just about directly over the airfield, I picked it up. Here is where I think the photograph would have been a lot of help, because the map that I had just showed a yellow blob indicating the city with a circle to indicate where the airfield was. It showed the airfield to be to the south of the town. What I was looking at was a large group of buildings, the town itself. Then as I went to the south, I saw even more buildings and I wasn't sure whether the airfield was south of that built-up area. As it turned

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out, it was south of the main built-up area that actually had another large group of buildings south of it. I did pick up the airport itself at just about 5 degrees before the nadir, and I tracked over to the target, probably just at the nadir and just shortly past. I had the 16 mm movie camera going with the telescopic lens on it. I had the gunsight on bright. I used Pulse Control Mode. I got right on the target and I managed to fly the spacecraft in such a manner that the gunsight never deviated from the target by more than a half a degree, I feel, if it deviated that much. I think it was considerably less than that. But there wasn't any great difficulty in the tracking task, and I managed to control in all three axes and hold the target just about where I wanted it. Here again we had a problem with the contrasting target; the water-land mass was quite some distance away. In this case, how far is it from El Centro to Yuma?

White I don't know, Jim.

McDivitt 150 miles?

White Yes.

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McDivitt It was a reasonable distance, probably something on the order of 150 miles or maybe only 100 miles, but the problem was that between Yuma and El Centro there weren't any identifying masses that led you toward Yuma. And I had not up till this time looked down to try to find where the Yuma airport was, because we'd been saving fuel. So, this was the first time that I'd seen Yuma airfield from orbit. As I get into the next target, I think you'll see what I'm leading up to. Having a first look at a target like this, being able to identify the city, but then essentially wasting time before I found the airfield within the city, I think, cost some valuable time and consequently cost some good pictures; because the best picture is going to be that picture which is taken exactly over the airfield.

White That wouldn't happen again though, would it?

McDivitt No.

White You'd probably have it pretty well nailed.

McDivitt No, it wouldn't. So, the next target I had was Cairo -- Cairo International Airport. Now, we'd been over Cairo quite a few times before

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this, and I had looked down to find Cairo. I think we had had an Apollo Landmark or D-6 type of thing, where we were supposed to look down and just acquire the target, but not actually track it or take any pictures. When we did come by, we could actually look down and find the city of Cairo the first time we came by. Later I found the Cairo Airfield, and Ed and I were discussing Cairo Airfield and Alexandria Airfield. We both had one in sight. When I picked up the Cairo Airfield (I was told to pick up the Cairo Airfield), it had all the ingredients that I think is necessary. I had seen it before. I knew where it was with respect to the local landmark. The local landmarks were the Mediterranean on one side, the Red Sea on the other side, the Suez Canal connecting these two large bodies of water, and a river leading from near the Suez Canal over toward the city and the airfield. Then, knowing the position of the airfield with respect to these landmarks, since I'd already seen it, I came in over North Africa along the Mediterranean Coast with no platform on, just in Pulse Mode, no

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attitude reference, found the Mediterranean on my left, pointed the spacecraft on ahead, determined the direction I was going, picked up the Red Sea, picked up the Suez Canal between the Red Sea and the Mediterranean, and followed the river in. I started this quite a distance out. I knew just about where the airfield was, but it wasn't coming into view. Finally, at about 20 degrees before the vertical the airfield finally came into view. I tracked on the airfield about 10 degrees before the nadir. I was tracking the area in which I believed the airfield to be, so that I had already had the pitch rate set up that I required of my spacecraft. As I got on the target I still had to track in multiple axes, but I already had the rates built up, and I tracked from about 10 to 20 degrees before the nadir to 45 degrees past. I think this will probably be the best tracking experiment that I did. Later on, I had another one. Later on I had another tracking task against Basra in Iraw on the Persian Gulf. Here again, we had the ingredients that were necessary to pick up the target. We had a large

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body of water, a river leading up to a lake, and then the airfield sticking out in a very prominent way. Now I'd never seen the Basra Airfield before. I tried to take this picture. But the landmarks near it were sufficient so that finding the location of it was not difficult. There weren't any towns around. It was pretty obvious from the bodies of water where I should look for the airfield, and I picked it up also 20 degrees before I got to the nadir and was on it by the time I got to the nadir. I tracked it from there out to about 45 degrees past. Once again I had a reasonably good tracking task. I think that on the tracking tasks on Yuma, Cairo, and Basra, I managed to keep the target within the center half-degree circle of the sight. I used the 16 mm movie camera with the 75 mm telephoto lens on each one of these cases. Did you have any other targets, Ed?

White

No.

McDivitt

I don't believe you did. I think the big thing here is that you've got to be able to have a landmark that stands out long before you get to the target. You have to have a lot of contrast.

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White Or some real technique or type of familiarity with the target. I think if you were really familiar with the area you might pick up things that we don't pick up now, but we could with a little more map study and study over above.

McDivitt That's right. I think that the first thing, though, that you need to help you find the target is a really contrasting thing. Now the next thing is that you've got to be familiar with the target, as Ed said. Now if you have never been there on the ground and don't know what it looks like from there, I think what you need are a few passes over the target to study it from the air, and look for it from the air, and try to pinpoint in your mind the local terrain features and local contrasting features that will help lead you to the airfield. Because, it looks to me like it's easiest to find a target when you're exactly over it.

White Boy, you're right. There's a point when you pass over the top where everything really is clear.

McDivitt The big thing is either a lot of target study on

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the ground or a previous pass across the target so that when you go across it, you not only know the general area that you're supposed to point into, but the exact spot where that target is and some identifying features that will lead you to this target. So with the initial things like a lot of contrast to get you in the area and then a lot of detail gathered either from target study or from a previous pass across the target, I think that you could go ahead and find it. Once on the target the tracking task in the Pulse Mode is not difficult at all. I think you can track within just tenths of degrees of the target without too much difficulty whatsoever, in multiple axes. And I found that without having the platform up every tracking task I did was in multiple axes, and although you're going through some very peculiar maneuvers, it's very instinctive to track up and down, left and right, using the gunsight, without any regard to what your attitude with respect to the local horizontal is. In air-to-ground gunnery you sometimes find that you've got to pick your attitudes up from the

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ground. They sort of tend to be a constraint on what you can do, but that's not the case in this kind of a task.

White

The thing that really amazed me, Jim, is the first time I saw an airfield from up there. First time I saw one, I saw it directly from overhead. I was amazed at the clarity I could see of field. Although, of course, I saw no airplanes sitting on it, I felt that I was seeing down to a resolution of 50 feet or better with my own eye when there was a contrast of some type available to me. In general, I thought the clarity of things that you saw was far better than it is from just flying at 40 000 feet. Things are much smaller but they are much clearer to me. Also, at night things are much clearer. And over one town we passed in Australia the lights were very, very clear down there to me. I think that with some type of an optical aid we can see a great deal. I think that with cameras with higher power and more capability, we can take pictures of a lot more down below. I think that the only picture I've seen so far that I thought would be nice

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from a tourist standpoint is the one I took of the Cape, which everybody seems so excited about right now. That's one that was taken with the sun on the window and at roughly a 30-degree angle down from the horizontal, which indicates you're shooting through a lot more atmosphere than necessary. The clarity was quite surprising, even to me. You can count the launch pads and see sizes of buildings. Because of the oblique angle, you can actually measure the sizes of these buildings. I think we've got a tremendous amount of photographic potential from in space. I think that Jim and I mentioned a little bit earlier that the area capacity inside the spacecraft limits the capability to carry a good size telescope or a very big piece of camera equipment. I think that coupled with the EVA capability that we have, we can carry some equipment back in the adapter--some nice sizable cameras and telescopes--and build mounts on the outside of the spacecraft. We can go EVA, pick these pieces of equipment up, bring them out, and mount them on the sides of the spacecraft so that we can take a series of

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pictures and use really good, big, higher-powered telescopes for observations. If we do mount them out there, of course, we should mount them somewhere so that if we had a failure of some kind and had to come right in, or weren't able to open up the hatch again, we could separate them by some type of pyro. But I think that is the one way we can combine our EVA operations with the desire to bring up big pieces of equipment and operate them with our spacecraft.

McDivitt I agree. I think that the possibilities of viewing things on the ground from space are practically unlimited, and I was quite surprised at the ease with which you can control the spacecraft and take pictures and I was surprised at pictures you get. We've got an awful lot of work that we can do in this area. I think the technique of acquiring these individual targets needs a lot of work. I feel that the best way to do it, if you're going to be limited to one pass over the site, is to use a photograph of it made from some previous time. I feel that the need for a large landmark nearby, especially a water landmark, is pretty great. I thought

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that the information that we got from the ground of what time we would be over the target and what time it would be 30 degrees below the horizontal were excellent pieces of information. It certainly contributed a lot to finding the target. I think there's an awful lot of work that we can do in this particular area. You have anything else, there, Ed?

White

No. Oh, this is one thing that I have been bubbling about the last week or so, wanting to tell somebody, and haven't been able to tell anybody. I couldn't, of course, tell it in the press conference. I really didn't want to talk too much about it at the meeting we had before with everybody, but I think this is one area in which a tremendous amount of capability exists, and I think we'd be very foolish if we don't work further to exploit it.

McDivitt

I concur.

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9.2 Apollo Yaw Orientation

White Okay, I'll probably go into this a little bit, and then we can go over the data on it. This was a fairly simple test. All we did was start at a zero-zero reference and establish rates of 3 degrees/second simultaneously in all axes. We had a secondary objective, to see when we established these rates and put them in three axes simultaneously if we got a scanner ignore light. And I'll clear that one up really quick. We put them in at two different times and neither time did we get a scanner ignore light. We did this at night the first time, didn't we? That was really the only time we did it.

McDivitt Just the night one. That's right.

White That's right. We did it once at night. I established the rates in three axes and allowed them to build up for about 30 seconds. Then, I told Jim to go ahead and take control of the spacecraft, and using visual references to move to a retrofire attitude.

McDivitt I did this in Pulse Mode, I believe, because we were trying to save fuel. I think I did it in Direct, but I did not do it in Rate Command. I did it in Direct. The first thing I did was try to find the horizon so I would have some reference point to

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start from. This was quite easy. I just had to wait for the spacecraft to move so that I could see the horizon in any position, and then I went for it. The yaw reference, though, wasn't present when I got to the horizon, so I ended up level on the horizon upside-down, but without a yaw reference. I pitched on down well below the horizon so that I could look down at the ground. Watching the clouds go by, or whatever was down below me, I could pick up the direction of my motion. So, I rolled around such that I was pointing down at the ground, probably 45 degrees plus or minus 20 degrees. I rolled around until my head came up, and all I had to do then was pitch back to the horizon to get to the 30 degree nose-down attitude for retrofire. This took 2 minutes and 20 seconds. Now I did this trying to save fuel. I could have done it much quicker if fuel wasn't a constraint. Also, I think I learned something from this in that I made a mistake by going first to the horizon. I should have pitched down until I was pointed straight down to the ground, picked up my yaw as quickly as I could in this

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position, rolled around so that I could just pitch straight up, and end up at the horizon blunt-end-forward, heads up, and wings level. I think I could've gotten it down to about a minute and 20 seconds. I felt that I wasted a minute doing this.

White You were taking it slow.

McDivitt Okay, now, I'll go through the Apollo Yaw Orientation debriefing here. The control mode, as we said, was Direct when Ed put me into the condition. I used the Direct Mode, I believe. I damped out the rate without any difficulty at all. The orientation, I've already gone through. What I should have done was to go nose-down. What I did do was that I came to the horizon first, tried to find a yaw reference and couldn't, then went down to the ground. I should have gone straight down to the ground. The time, as I mentioned, took 2 minutes and 20 seconds. I feel that I could have done it in a minute and 20 seconds. We did not get the scanner ignore light due to acceleration, but we did get the scanner ignore light when we finally

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got to a position where we were outside the attitude constraint of the scanners.

White There were a couple of things. As far as the initial rates were concerned, they were $3 \frac{1}{2}$ degrees/second roll-right, 3 degreed pitch-down/second, and 2 degrees yaw-right/second. The final orientation that Jim came to was such that his pitch was on, his roll was on, and his yaw was off by 18 degrees. We found early in the flight that a yaw reference at night on the stars, particularly on a dark night, was very difficult.

McDivitt Yes. I still thought that the quickest yaw reference was to go to the ground.

White As far as the day check, we decided that the night was by far the tougher case, adn it didn't seem to be too difficult. So, we thought that since the day was so easy we wouldn't even go ahead and do it. The orientation by day was a quite easy thing.

9.3 One Attitude Thruster Failure Check

McDivitt Okay. We'll just go right through the debriefing here. It was not difficult to establish the rate as long as we had the roll jets in the other axes. We could damp out the

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rates. We used the Direct Control Mode. It's just pretty straightforward. It's identical to the simulator. We didn't learn anything new from this check except that the simulator was indeed correct. Do you have anything to add?

White No. That it was pretty straightforward.

9.4 Horizon Scanner Track Check

McDivitt Horizon Scanner Track Check is next. The horizon scanner ignore light came on as expected except the attitude band through which the horizon scanner operated was considerably broader than we had expected. The scanner ignore light went off again at the proper attitude, considering the fact that the scanner ignore circuit keeps the scanner ignore light on 7 seconds after the scanner has relocked. So, we always had the scanner ignore light go out at a different attitude than where it came on because of the fixed rates we were using. We went through the zero bank angle, pitch-up and pitch-down. We went through the zero pitch, bank-left and bank-right. We then got to the roll with pitching. Here, I only banked to the right and pitched up and down. I didn't bank to the left and pitch-up

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and down. We did the pitch with rolling, and here I pitched up and rolled left and right, but we did not do the pitch-down, rolling left and right because of a fuel limitation and a time limitation. We had another experiment that had to be done. We had to get the platform off and we had a limited amount of time to accomplish this. I sort of felt that the check was very well accomplished at this time. The data is in the data book. I saw no need to waste time doing the other two maneuvers, especially since we were so limited on time and fuel. Did you have anything to add to that, Ed?

White No. I think that the remark that the data is in the book is adequate.

9.5 Horizon Scanner Check

McDivitt The first one is the sun. I think the best way to do it is to have Ed read out the comments that we wrote in the data book as we did this. We started with the blunt-end into the sun.

White We started blunt-end into the sun and we got the scanner ignore light momentarily as the sun

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hit the scanner head.

McDivitt It went right out again. It went out in 7 seconds like it was supposed to?

White Right. It was just a momentary light and 7 seconds later it was off again. Going back around to the 180-degree position, we didn't get the scanner light again. Again in here, we got a scanner ignore light when we were faced right into the sun with the nose, and it went out again and came on once more, and then stayed out.

McDivitt So, sequentially, we started with the blunt-end in- to the sun and started a yaw to the left. As soon as we came around into the sun we got the scanner ignore light, and it went out a short time later. We came around right into the sun, and at this time the scanner ignore light came on, went out, and came back on again. Is that correct?

White Yes, and then finally stayed out.

McDivitt And stayed out. Then we yawed back around till we were blunt-end to the sun again, and yawed back into the sun, and back around blunt-end to the sun again, and we did not get any more

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scanner ignore lights. The next step is the Moon Scanner Check. We did this with the moonset and, Ed, you might add the time that we did the Sun Scanner Check.

White The Sun Scanner Check was at Greenwich Mean Time of 11:50. We'll have to correlate that later.

McDivitt I think that we were supposed to be in the blunt-end to the sun configuration at 11:54 and start there, but I'm not really sure about that. Okay, the moon check was performed just about like the sun check. We started blunt-end to the moon and made two cycles. Blunt-end to small-end and back to blunt-end, and small-end back to blunt end. Ed, go ahead and read the data.

White Okay. On the moonset, we started with the moon quite high, so we had a good moon. We started at 12:17. We had no scanner ignore lights for the first 180 degrees and, actually, throughout the next cycle we had no unlocks or any lights for two cycles.

McDivitt So this was completely normal.

McDivitt The Thrusters Check No. 3 --we turned the spacecraft, since the thruster firing wouldn't influence the orbit except to change it

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slightly, and we went ahead and fired the forward-firing thrusters for 1 second. We didn't get any change in our scanner ignore light configuration. It was out and it stayed out during the entire thruster check. So I guess that it operated all right. We'll summarize all of our scanner comments at this time.

White You want me to read some of these?

McDivitt Yes. Why don't you read off some of the comments you have in there.

White They're in your writing. You might read the first page and I'll read the second, since they're in mine.

McDivitt We went to Horizon Scan Mode of control for about the last day of flight, and left it in that mode just about until we retrofired. I'd like to read out some of the comments that I made here as we lost the scanner, when we got the scanner ignore light. At 16:03 Greenwich Time, or about 72 hours elapsed time, I turned on the Horizon Scan Mode in about a 25-degree nose down attitude with a pitch up rate of about 2 degrees/second. The Horizon Scanner Mode added pulses

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to the pitch up rate and increased my rates to something considerably above that, but then as we came up into the Horizon Scanner Mode deadband, it started pulsing rapidly and killed off this rather large pitch rate and held the spacecraft right in this attitude. So we had a very good acquisition of the mode from a somewhat undesirable condition. At the first sunset the scanners were pointed right at the sun but did not break lock. We did not get any scanner ignore lights at this time. Later on, at 17:04, about an hour later at sunrise, the scanner ignore light came on with the spacecraft pointed in such a manner that the small end of the spacecraft was pointed about 45 degrees to the right of a line drawn directly between the spacecraft and the sun. So that, essentially, the sun was shining on the horizon scanners at about a 45-degree angle. The scanner ignore lights stayed on for 10 or 15 seconds, and then went out. There were no false pulses from the jets at all. At 7:55, just at sunset, again in about the same position, I was 45 degrees to the right of a line drawn between the spacecraft and

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the sun. The scanner broke lock. We started pulsing down for two or three pulses, then stopped, but the scanner ignore light stayed on longer than 7 seconds and then it went out. We pulsed up one or two times to start recovering from these initial two or three pulses that started us down, and then the light came on again. It was only off for about 2 or 3 seconds, just a very short time. We were at about 30 degrees pitch down at this time. We then started pulsing pitch-down rapidly with the scanner ignore light on. We pitched down and did a 360-degree maneuver in pitch; we started just about horizontal, pitched down till we were looking at the ground, continued pitching down with respect to the spacecraft until we were horizontal, upside down, now facing the opposite direction than we'd started, and continued pitching down with respect to the spacecraft. The small end ended up straight up and we continued pitching down again until we started coming back back down to the horizon. I did not at any time during this maneuver attempt to control the spacecraft. The pitch-down

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thrusters continued to fire throughout the maneuver at intervals like there was indeed a signal coming from the Horizon Scan Mode. As the spacecraft started back down toward the horizon, I thought sure that the horizon scanner would catch the horizon, because at this time the sun was no longer right on the horizon. However, we developed a slight amount of roll during the last 120 to 150 degrees of pitch, and as we went down through the horizon, we were out of limits in roll and Horizon Scan did not pick up the horizon. I then took over the spacecraft and maneuvered back to a position from which the Horizon Scan Mode could reacquire and put it in this condition. It stayed locked on. Ed has a few notes here. We'll have him read his.

White

About the only notes that I made on the scanner was that at sunset and sunrise it had a tendency to break lock. I have a note here that at 22:22, at sunset with the sun right on the scanner, i.e. 90 degrees to the spacecraft, the scanner broke lock three different times. At 22:58, at sunrise, the scanner put in spurious inputs but was able to control and didn't lose lock.

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Sunrise seemed to be the time at which the scanner had the largest tendency to break lock, and if it didn't break lock, it would at least put in spurious inputs which were obviously not required other than due to the confusion factor that the sunrise was causing on the scanner.

Again, I have one at 11:58, at sunrise, the scanner 60 degrees to the sun, broke lock once and pulsed quite a few times extraneously, but caught itself and continued to track. I think on the whole that the scanner worked real well.

McDivitt

So do I. As a matter of fact, I believe in the last 20 or 24 hours, however long we had the Horizon Scan Mode on, that we only really lost control of the spacecraft that one time, where we did the pitching maneuver I've already discussed. I think in every other instance, although it pulsed needlessly two or three times at sunset if the scanner was pointed toward the sun, it never really lost lock and it certainly never lost control. The light would come on every now and then, but it would --.

McDivitt

But, I don't think that the light came on more than three or four times in those last 24 hours.

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White No. They sure didn't

McDivitt And even though the light wasn't on, it seemed like we would get an extraneous pulse every once in awhile at sunrise or sunset. But I thought that the Horizon Scan Mode worked very well. It certainly proved to me that it was an excellent attitude-hold mode, or pilot-relief mode.

9.6 HF Transmission Reception Check

McDivitt I think that I'd like to start out with No. 3 in this case. We received an update to start and stop our checks and had no difficulty doing this. I think that the transmission and reception, No. 1 and No. 2 under this major heading, are covered in our data book and I'd like to have Ed summarize them at this time.

White We ran a one day and one night-long test on it in which we attempted to have all stations contact us. The data in the book. I think the data will point out that the HF is a rather unsatisfactory mode of reception. It was difficult for us to evaluate our transmission that'll have to be done from the data from the stations. But as far as reception was

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concerned, we got a little bit during the night and just about nothing during the day. We ran also a sunrise and sunset check and we made the long counts as indicated, and listened for any return on all our HF tests from Thule and Elmendorf. We could hear Elmendorf calling us, but they were at one time barely readable, and most of the time you could hear somebody trying to call, but they were very broken and difficult to read. More detailed data is in the Flight Data Book.

9.7 Orbit Navigation Check

McDivitt Following the format in the debriefing guide, I think that the maps and overlays that we had were excellent. I felt that the concept was a very good concept. It gave us a good check on where we were throughout the flight, as far as accurate times went. We used at times the other track charts that were printed before the flight. We found that these were off some fair amount, although they furnished good information also. Once we had the time error that we could apply to times listed on the map, we found that we were able to use these quite well also. I think that the map and the overlays that we used in our

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Orbit Navigation Checks was a very good scheme. The control mode we used was Pulse, and the timing was just the GMT timing we had in the spacecraft. I'd like to have Ed discuss a little of the technique now.

White

Actually we had a form in our book that we had made up to make these tests, but I think it became apparent to both of us as we came along that this is a fairly simple thing to do. If you want to just try to update your map without having an update from the ground, it was quite simple to point the spacecraft straight down to the earth and get a point which you could recognize on the ground, and actually plot this right out on your orbit map. I think we could probably make checks in this manner and update our map almost as well as we could by having a longitude and time called up from the ground. I'd like to make a comment right now that I thought the little map that we had with the orbit plot on it was very useful, but it was weak in one respect; I was always wanting more detail on what I was seeing down there. We, fortunately, carried a map with about two to

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three times the detail of the section cut out of a Mercator Chart, which I found very useful. By properly folding a map, I think I would prefer to have a map of even higher detail with me. It didn't seem to me to be a drawback to have a large map in the cockpit, as long as you kept it golded down in the proper manner. Do you have any comments on that?

McDivitt Well, I agree with Ed. I thought that this was a relatively simple task. I felt it would have been much easier to do if we had the platform up so we could point the spacecraft down using inertial reference and using the platform, but it wasn't difficult to do it just visually. It only took a short time to plot up a couple of points and run back and determine your own ascending node.

White You know, another thing that I found very interesting was when they called up plot points and they'd give you 30 degrees right, down 45 degrees. Even without the platform, those meant a lot to me. I could visualize very easily where I was going, whether I was small-end-forward or blunt end forward. I could visualize quite well, without a platform, 30 degrees down and yaw 30 degrees over, looking for a point. It seemed I could check points nearly as well with

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or without the platform. It wasn't hard to orient.

McDivitt I think that's probably true. I do think that this is a good scheme. I'd like to see us continue it on future spacecraft.

White Yes. I'd take it again if I had my druthers. What do you feel about a bigger map?

McDivitt I think for this kind of thing, this Orbit Navigation Check, the map and the overlay we had were about the right size, but when we got around to looking for things on the ground, I thought the maps and charts we had were pretty inadequate. I'd like to see us get something with more detail on it, just the way Ed says, and I think we will cover this in better detail when we get over to the Apollo landmark thing.

9.8 Relative Humidity Test

McDivitt Another operational check that I'd like to discuss at this time is the Relative Humidity Test that we did during the flight. All data is in the data book, but the thing that I'd like to say most of all is that the relative humidity was considerably less than anyone had ever expected. The cabin temperature was less than anyone had ever expected, and although we were instructed to

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measure the cabin wall temperature with a thermistor that was on the end of our relative humidity gage, I found that this was pretty difficult to do since they'd covered the entire inside of the spacecraft with the sponge rubber. We couldn't find a good place where there was just bare metal. I took some measurements on the inside of the left-hand side food box. I took one or two readings off of the metal frame that went around the window. Those are the only two places I was really able to contact spacecraft metal. Do you have anything else that you want to add to that, Ed?

White

No, the data is pretty well laid out in the data book. I don't think there is anything else. It did surprise me, and it was a very pleasant surprise because I was interested in taking my gloves off and putting my visor up. I sure did as soon as I found out it wasn't going to get wet.

9.9 Zodiacal Light Check

McDivitt

I'd like to have Ed describe this.

White

Okay. We did this one on the fourth day at 22:42 Zebra, and it was one on which procedures were called up. What they wanted to do was find out if the thrusters firing could cause any inter-

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ference on some zodiacal light photography that was planned on later flights. The first test was to pitch straight down toward the earth, open the shutter on the Contarex camera and actuate the pitch-up with the shutter open. Then we'd take another picture and actually open the shutter again and activate the pitch-down thrusters, to see if these two thrusters would cause some type of light interference to the photography. On the pitch-down part of the phase, we waited till the moon had set, and as we were pointed down toward the earth, we came upon an area fairly clear of clouds. But, unfortunately, there were a few scattered lights from homes or cities down below us, which might have caused some interference. I don't think so. They were very, very scattered. The pitch-down test was satisfactory. The next one was the one in which we were actually level with the horizon. Again, Jim opened the shutter, I actuated a pitch-up, and closed the shutter. He opened it again, I actuated a pitch-down thruster, and he closed the shutter. It was a pretty simple test. We took four pictures.

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10.0 VISUAL SIGHTINGS

10.1 Countdown

McDivitt During the countdown the visual sighting I had was a multitude of wasps sitting on the R and R section and crawling all over the windows. Aside from that, the sky was clear and I didn't see anything else except the gantry going up and down.

White That's about it. It appeared to me the wasps were somewhat confused. They felt that the RCS nozzle was a very large beehive for them.

10.2 Powered Flight

McDivitt The first topic is lift-off. At lift-off I was looking at the instruments and didn't see a thing. I think Ed's got something here.

White From the ~~lift-off~~--I could actually feel when we lifted off -- the vibrations decreased a great deal.

McDivitt What about visual sightings?

White I'll get to that. As we started to move, I felt I could see the relative motion. We had a clear blue sky above us; there weren't any clouds, but I could see the motion in the sky. I could also, as soon as the roll program started,

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definitely see the rotation of the booster and spacecraft combination. As we continued on up, I was watching within the spacecraft and outside, also. I could see the pitch program initiated. I could hear Jim call it out, and I could actually see it on my instruments and also see it out the window. BECO's the next topic.

McDivitt Why don't you go through that. I think I just looked out one time to see the horizon for just a second. Why don't you go through the rest of those there and read them off?

White Okay, at BECO I was looking in also. I was waiting for the staging and I had my attention inside, and I didn't see the big sheet of flame that John and Gus described coming from around the separation of the first stage. So, there wasn't anything other than the normal feeling of the separation. As far as visual sightings were concerned, I didn't see anything else at staging. As we started to nose over, I saw the horizon coming up and I called that out to Jim.

McDivitt I think that might have been when I looked out, but I'm not really sure I could see anything at

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the time.

White I had to say something. It is quite an impressive view when you're up there --the very the first time you look out and you see it. I looked out and all I could see was the horizon and the blue down below us. You probably couldn't, because as I think of it now, we were on the side. I could see the horizon and you couldn't. All you could see was the sky.

McDivitt Right.

White So I could see a little of both. I could see the clouds, the water, and the whole smear. The first time I saw that out the window I called that out to Jim, and it was quite an exciting view.

White Engine No. 2 ignition--I didn't see anything that had to do with lighting the second engine off. The horizon view, I just discussed. At SECO, there was a lot of debris going by.

McDivitt That was at spacecraft sep, wasn't it, rather than SECO?

White You're right. You're absolutely right. At SECO, I didn't see anything other than that the acceleration profile went down to zero. At

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spacecraft separation I think Jim and I both noticed a lot of stuff coming by the spacecraft.

McDivitt Right.

White Just plain debris was all it was. Just pieces of white junk came by.

McDivitt Probably little bitty pieces of the adapter there.

White In fact, when I got out and looked later on at the spacecraft separation plane, there were pieces of the same kind of white stuff still back there attached jaggedly to the adapter section. Fairing jettison-- I couldn't see that. Did you see anything on the fairing jettison?

McDivitt When I jettisoned the fairings, I saw the horizon scanner fairing go whipping off, but I couldn't look at it and the nose fairing both. So I only saw the one go, but there were some more pieces flying all over the place, and they went just as soon as I punched the Fairing-Jettison Button.

10.3 Orbital Flight

White Boy! We've been talking about these things for the last ten days.

The first one is geographical.

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McDivitt Yes. Geographical. We could see wakes of ships. We could see roads. We could see towns. Although I never saw any individual houses, I could see an industrial area with what looked like oil tanks and a few other things. We could see canals very well. We could see the Suez canal very well from the air. I don't think I ever saw an individual ship. I never saw any individual cars or airplanes, but you could see runways very well. But the thing that you could see best of all were long lines. I'm sure that if you had a road that was 50 feet wide, or however wide you make roads, and it was long, you could see it. Whereas, if you had the same thing and it was just a square down there, I doubt very seriously that you could see it unless you were looking for it, specifically.

White I think perhaps also there is the contrast between the colors. The things that I saw with very high clarity were runways. As you looked down at the runways you caught a high contrast between the green or the brown, or whatever the color that it was laid out in. You could see it very clearly. I was impressed by how clear you could

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see things. They were small; there's no question that things don't get any bigger when you're looking down at them, but in my opinion things were much clearer. I could see with a higher detail than I could when I fly over in a normal airplane, as far as the object itself being clearly defined. I also noticed this at night when I looked down on it. In the clear stretches the city lights were much finer defined than the lights are in a city when you're flying over at 40 000 feet. Things are small but have a much higher definition. I think it would be interesting to find out in our photographs the degree of resolution that you have. I feel that the resolution, if you have the proper contrast, would go down to 50 feet or below.

McDivitt Yes. I'd agree with you there. Geographically, there were just so many things that we could see. I think that we took pictures of most of the things that we thought would be interesting.

White I'm dying to look at those pictures.

McDivitt Me, too!

White I agree with Jim that if you look at a city, particularly if you look at a city in a desert

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area where the houses are brown and the surrounding terrain is brown, everything's kind of small and it all blends together. Unless there was some type of contrast between them, it's pretty darned hard to pick up a city right out in the middle of the desert. We had trouble when we came to El Paso in finding it, and Cairo blended right in with --

McDivitt -- blended right in with everything. You could see the airport at Cairo--I'm not sure if I ever did really see the city.

White I think I could. When I was looking in that area at Jaffa, as soon as I saw that airfield out there and was concentrating on looking at it, I saw more detail.

McDivitt Yes. The thing of it all is that, geographically, you have to have a real large feature to be able to see it very far out in front of you, like the Red Sea. Now when I was trying to find Cairo one time, I looked out I was having trouble finding the Red Sea. Pretty soon I found the Red Sea about 30 degrees below the horizon or maybe a little more. As I got closer, of course, the Red Sea stood out very well. As we get closer

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and closer and closer, these things really start standing out, but when you're looking from up around 125 or 150 miles, and you're out 60 degrees, you're a long way from your target. It's just that you can't see that far through all that atmosphere, I guess.

White I think one more comment on the geographical is that I think we're really going to see some things down there when we get some type of magnification.

McDivitt Yes, a telescope is what you really need.

White If you can get some kind of telescope to help, I think we can really see something. I wonder if there isn't some way that, while we know we can't carry some things inside the spacecraft, we can work with something outside the spacecraft-- camera equipment or some kind of optical equipment. that we might be able to have mounted on the outside. We can store it somewhere and mount it on the outside after we get up there--mount a telescope right through, with the eyepiece on the inside.

McDivitt Boy that would be great! Wouldn't it?

White And then when it comes time to come in, you just punch the thing off and forget about it. But

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while you're up there you've got this thing with the long eyepiece. I think we can do this with EVA. Stow the thing back in the adapter, go back and get it mounted up, get back in, and you've got yourself just about as long a telescope as you'd want to put up there. Same way with cameras. I think you can take cameras up. We can take some of these big cameras that we've been wanting to use. We can have a sighting device so that we can mount this thing on the outside of the spacecraft after we get up there, and then point it with a pointing device at the ground and get some of these pictures that we've been wanting to take. I think we've got some possibilities there.

McDivitt

Okay. Celestial. I think in the nighttime you can see the stars without any difficulty. In the daytime you just can't see the stars if there's any sunlight whatsoever on the window, or if the nose of the spacecraft is in the sunlight, or if the horizon is in the sunlight, or if some of the earth is in the window. I think all these things tend to limit your night vision. They create

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an optical barrier, practically, between you and the stars. The difference between the day sky up in orbit and the day sky here is, as far as we were concerned, was practically nil, because those just weren't any stars visible. It didn't have anything to do with the atmosphere; it just had to do with the optics of our window and the nose being shiny. We couldn't see any more stars in orbit than we could here in the daylight, but it wasn't because of the atmosphere up there. It was just because we had that coating on the window that reflected the sunlight, and because the nose reflected sunlight into the windows, and the same thing with the horizon or the ground. When it was lit up, it reflected light into the windows. Actually, you had to get that window in total darkness almost before you were able to see anything.

White Pull the shades.

McDivitt Pull the shades. And then when you did that, you were able to see some stars. On a few occasions when I got the spacecraft into this particular attitude, I was able to see some stars in the

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daylight. How about you, Ed? Were you able to see any stars?

White Yes. I called them out a few times. You did have to maneuver just as carefully--

McDivitt That's right. You had to be just exactly in the right spot.

White Let's go into the magnitude of the stars. We had set ourselves with the Corona Australis as a kind of calibrator for us, and this was composed primarily of fifth order stars. That was very clear, and I could see without any difficulty stars of lower magnitude than that. I could see, without question, stars to the seventh magnitude.

McDivitt And that's exactly the same magnitude I would guess. You could probably see them down to a magnitude of seven.

White Now, another thing, though, was that the sky wasn't any more full of stars to me there than it is when I'm flying at about 40 000 feet on a real dark night.

McDivitt No, as a matter of fact, it didn't really seem to be as full of stars.

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White No. On the night when we were flying with that eclipse of the moon, I saw more stars than I've ever seen in the sky.

McDivitt Yes, and as a matter of fact, I wouldn't doubt that we could go out here and fly tonight and see seventh order stars.

White I bet we could see lower than that.

McDivitt That's right. What I'm leading up to say is that I don't think we could see as many stars in orbit as we could flying around in an airplane at 40 or 45 000 feet.

White That's exactly my conclusion also. You could see down to the seventh order stars.

McDivitt Yes, and I think the reason for this is the coating on the windows, don't you?

White I think so. I felt like there was just a little shield of what I was really seeing.

McDivitt If we'd just gotten that coating off, we'd have been in great shape.

White I also noticed a tremendous difference if I turned those lights off in the cockpit. It was just like turning those stars on on the outside, and I don't think we should take those red lights out.

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McDivitt No. I don't think so either. You know, the thing that did look brighter to me was that planet right over by the sun. When the sun set, that planet would really stand out.

White I noticed another thing on the planets. I didn't notice--which one is in Leo now?

McDivitt I don't know.

White It's Mars. Mars is around Leo now, and it didn't look as orange. To me it looked roughly the same color as Venus did, and remember I remarked on that up there, which is a very interesting thing now. I presumed that the color should stay the same.

McDivitt I didn't notice any difference between it up there and here on the ground.

White It didn't have to me the characteristic orange color that it has when I look at it from down here. It looks more like a regular old--

McDivitt A regular old star, huh?

White No, it looked like the planets, and remember I remarked on that.

McDivitt I think you did, now that you mention it.

White And we probably went on doing something else and forgot about it. Let's talk about the air glow.

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McDivitt Why don't I discuss that thing that I saw those
two times at night.

White Yes, I saw it too, so you weren't seeing things.

McDivitt This phenomenon occurred in the dark and I think it
was near Australia, each time, but I'm not really
sure. We've got it recorded on the voice tape, so
we can go back to the voice tape and see where
it was. They were just parallel running lines
of lights radiating from the earth up toward
us but at a distance away, and it sort of
looked like a curtain. All of these lights
rays seemed to be sort of parallel to each
other. They looked a lot like the Aurora
Borealis, except that they were down below us and
they were coming up toward us. The first one
we saw was considerably brighter than the
second one and it was sort of wiggly. It
probably had five or six curves in it, at least,
and I thought it went like this a couple of times,
and was bent up around like this.

White How about in the air glow layer?

McDivitt Was it in the air glow layer? No. I don't
think it was in the air glow layer. It looked
like it was down underneath -- it looked like it

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was right over land and was considerably closer to us than the horizon was. It was, maybe, half-way between us and the horizon. I got the impression that it was a lot closer to us and it was definitely not in the airglow layer.

Both times I had this impression. It looked like it was coming up out of some clouds. I could see the clouds down on the ground, and I had the impression that this was coming out of them, but it only got to an altitude of maybe half of ours. That would be up to 50 or 60 miles. This is the impression I got. I took some pictures of it too, didn't I?

White I had the feeling that the first time you took it you had the wrong setting. You had about 250 at an f11. I don't know what you did the second time.

McDivitt I don't remember, either.

McDivitt This thing was in motion, too. It wasn't a stationary thing. It continued to move the way the lights on neon signs do. It was wiggling back and forth.

White When it came around over toward my side it was to me, closer to the horizon, and it looked more

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like it was below and in the air glow.

McDivitt It looked like it was in the air glow to you? When I saw it, it definitely wasn't in the air glow. It was a lot closer to me.

White Of course, it started on your side and you talked about it for 3 or 4 minutes or so. Then as we drifted around, it went over, I guess, to my side. It was irregular shaped and it was out toward the air glow layer.

McDivitt Well, the second time it was a lot less bright.

White Are we going to talk about the air glow layer now?

McDivitt Okay. We're going to talk about the air glow layer, but it comes under "horizon". Let's talk about that under "horizon".

White Okay.

McDivitt Do we have any other celestial observations? The fire flies that we had around the spacecraft continually—sometimes you'd be able to look out and only see one, and you couldn't see them too well at all at times. You could see them in the daylight occasionally, but I don't think you could ever see them at night. But the place where you could really see them was at sunrise and sundown, because here you had a black background of the sky and you had the

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sun shining on them.

White They picked the sun up.

McDivitt They picked the sun up and reflected the rays. They reflected them just as bright as stars, I thought.

White Didn't they! Well, you know the thing that was most interesting to me was the time I called you and said the sky was full of stars, and you said it wasn't the sky. We were pointing down at the earth. That was my first exposure to having your window in the daylight and mine in the dark. At this time we had all the fuel particles from the fuel from the boosters spewing out all over, and my whole view out the window was just completely full of these reflecting particles. They looked kind of like one of the star fields we had past off on us as star fields. It looked kind of like a star field, but it looked kind of unreal, too. That's exactly what it was.

McDivitt One of the prettiest things was when we had a urine dump at sunset, because we just had millions and millions and millions of these fireflies or particles outside. When you put them all out like that with the sun shining on them, as we'd mentioned earlier with the black background, it just looked marvelous. As a matter of fact, we took some movies of them,

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and I think we might have taken some stills,
but I'm not sure.

White I hope it came out.

McDivitt Yes, it was really spectacular! So we could
just about make our own stars when we wanted to.
Is that all on celestial?

White That's all I can think of, Jim.

McDivitt I couldn't see the zodiacal lights. I couldn't
see the Gegenschein and I could not see the burst
of zodiacal lights that you get just as the sun
sets. Go ahead, Ed.

White Okay. I saw one during the last few sunrises.
I watched the sun very carefully. from the time
it first started to come up till it finally
popped up. I was looking all the time for that
shoot of light that's supposed to come up just
before the sun pops up. Well, I could never
see that. All I could see was the glow as it
came up and a very rapid rise as the sun did come
up. There's something that I did see that was
quite interesting to me. Several minutes before
the sun came up there would be a shaft of light
that would shoot up, and I watched it on two

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different occasions. It was during your last sleep. I was taking a few final movies and I was watching for this very phenomenon. It was the first time I saw it. It would be a little shaft of white illumination and it was a long time before the sun came up. I don't know whether that's what they were seeing before or not. But when the sun itself actually came up, I didn't get much of a big ball of light--just some big, bright lights coming up from behind the earth.

McDivitt That's all I was getting. I didn't see this other thing.

White I saw quite a few shooting stars.

McDivitt Oh, yes.

White They seemed to fall and burn up considerably below our altitude. They looked a half or a third as high as we were when they were actually being consumed and being burned up. I never saw one above us, did you?

McDivitt No.

Okay cloud coverage--

White There was a lot of it.

McDivitt There was lots of it. There were a lot of times when there wasn't any. I don't guess there's much we can say about this.

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White I think we took some good pictures of the clouds.

McDivitt Yes. Well, throughout the four days we had cloud coverage over things we wanted to take pictures of. Other times we didn't have any at all. It was a variable thing, and we just got a lot of good cloud pictures, I hope.

Horizons. Well, at night there was a definite dark horizon, which I assume is the earth's horizon. And then there's a dim band, and then above that there's a bright band that is much narrower than the dim band, and above that it is clear, and then nothing. I guess there are really three horizons. There's the top of what I think is the earth. There's a top of the dim band, and then there's a top of the bright band. In the daylight you don't see these dim and bright bands. It's just a gradual decreasing in intensity of light. It starts out with a very light blue at the horizon and just gradually goes out to the dark blue, and it finally just goes to black. Right at sundown, if you're pointing 90 degrees to where the sun is, you can see the light blue of the day sky coming

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down. It's much, much higher than the air glow that you see at night.

McDivitt If you're looking over at the daylight side, it looks like the light blue, goes up probably three times as high as the air glow does. What do you think about that?

White Let me go into my impressions of the air glow in the evening. I saw the same thing you did, of course, and it looked like to me that the dark part was roughly two or three times as thick as the lighter air glow layer below it. We were both impressed with the phenomenon of the apparent rise in the air glow as you go from the daylight to the dark, and as soon as you get out in full daylight, the earth's layer is all gone. But as you transition between the daylight and the dark, you see the layer start out and narrow down to what you see as you get into the dark side as the air glow layer. And when you initially get into the dark area, the air glow seems to disappear for a moment, and then the air glow layer pops out when you get into full dark, very clearly.

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McDivitt I agree. Okay. Do you have anything else?

White That horizon isn't very good on the daylight side, either.

McDivitt No, the horizon isn't very good on the daylight side.

White The horizon's not very good anywhere, really. We'll go more into that on D-9.

McDivitt You could see the lights of the attitude thrusters, and it didn't seem to make any difference which ones you were firing at night. They weren't blinding by any stretch of the imagination.

White They looked like lightening maybe. Little flashes.

McDivitt The attitude thrusters lit up the sky a little but not a great amount. They weren't blinding either. Not much to say about that. Okay. I want you to discuss adapter separation that you saw.

White Okay. On the adapter separation, Jim and I agreed to separate the electric and the OAMS, and then pause between the adapter separation so that we could dwell a little bit on the separation and absorb as much as we could about it. When it did separate, we got a very clean feeling of separation between the two and a very definite feeling that the adapter and the spacecraft had separated.

There wasn't much question in my mind. Was there much in yours, Jim?

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McDivitt No, not at all.

White There were a few pieces that came around from it, but not as much as there was at spacecraft separation after insertion. Did you see anything?

McDivitt No. I didn't see anything off the adapter.

White All right.

McDivitt The equipment adapter. I just saw it off of the retro adapter.

White Why don't you go to retrofire then?

McDivitt Okay.

White Do you have anything else on the adapter separation?

McDivitt No, I don't think so.

White I was impressed with the cleanness in the feel, and I didn't even want to look around. I just happened to be looking over at Jim's window at that time, and, as I said, I could see pieces go around, and I could especially see pieces to this side. What I saw looked like a mount with two round things on it. I had been briefed on this thing by John Young and he said it looked like two pump packages. So, I said it looked like two pump packages, too. Looked like just what I expected it to. And there was lots of debris around it as it whistled.

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off to the side, and then it went out of my view.

McDivitt Okay. On retrofire there weren't any sightings to observe. Did you see anything outside, Ed? Did you see any flames or anything like that?

White No, I didn't.

McDivitt I don't think there was much there. The retro pack jettison--we didn't see it jettison, but shortly after that we had rolled upside down and we were flying in, and I saw the retro adapter floating around on the left side. It had turned around so that it was small-end-forward rather than blunt-end-forward. You could see the whip antenna sticking out the side, the four retrorockets, cross-beams, and the plumbing around the edges. It was quite a sight. It drifted out behind us until it got out a couple or 300 feet. It started glowing a little on the leading edge. It started fading farther and farther behind us as we reentered. It finally went from a dull glow to a bright one, and finally you could see the leading edge of it eroding away. Finally, it was just a ball of flame back there.

White I thought that was quite a sight, too. It kind of set the modus for our reentry, of observing

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very interesting things all the way down,
including ourselves.

McDivitt We didn't observe anything in particular that
happened at 400 000 feet. The ionization was
where we really started picking up the fire.

White I think we kind of timed that with what you
were talking about the retro adapter up there.
You said, "Hey, look at it starting to burn",
and about that time we were starting to throw
a sheath around us to.

McDivitt That's right. It looked like to me that it
went from pink to orange and then went out to
a reddish-orange, and then in the midst of the
reddish-orange you could see little tongues of
green occasionally. It was quite pretty.

White I think another thing about it too is that there
wasn't as much of it as I thought there would
be. I can't say that I was disappointed in not
seeing more fire, but when I first heard about
John Glenn's reentry, I envisioned
more fire coming out. In this case you might
call it just a sheath.

McDivitt That's right. There wasn't a big blaze, by a

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long shot.

White It was almost like a veil of silk. There was
no flame.

10.4 Reentry

McDivitt Well, in reentry we rolled. We didn't have any
trouble in seeing the horizon as we went around,
but we were rolling all the way down.
We did see ourselves crossing the ground, since
we were heads-up a fair amount. We could look
out and could see anything we wanted to see. I
saw the Gulf Coast, and then out across Florida.

White A little bit of dizziness was associated with
the rolling reentry as far as the visual--

McDivitt Yes. It wasn't really dizziness. It was just
the fact that you could tell that you were going
around in a circle at a relatively high rate.
It didn't bother us. It's just that you could
feel it. The spacecraft didn't oscillate very
much during reentry. Anything else there, Ed?

White No.

McDivitt When we deployed the drogue, it really made the
ride interesting. I couldn't see the drogue
very well. Ed could see it probably better than

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I could. At this time I didn't know where the sun was. We oscillated back and forth on the drogue probably as much as plus or minus 40 degrees. I never did see the drogue dereef. I couldn't see up to the top to see if it was reefed or not.

McDivitt I don't think there's much else about what we could see on the drogue. Can you think of anything?

White I could see it up there whipping back and forth, and I was sure hoping that it was going to hold on and not pull the front end of the spacecraft off, the way we were oscillating.

McDivitt At R and R-Separate I saw parts of stuff out in front. My window was pretty well clouded over, and I couldn't see that well. I did see something separate, and I did see the chute start off. It went all the way up. At main chute deploy I saw it come out in a reefed condition, I checked the chute and I didn't see any panels missing. I checked the little circle in the middle in the parachute, and it seemed to be in fine shape. I was expecting that we had a good chute. It

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finally just dereefed and we had an excellent chute. It popped out and came back in. About a quarter of it along the edge folded back in and then popped back out again and we had a beautiful chute. Do you have anything else on the main chute?

White No. I couldn't see it until it started to dereef. From the dereef on, I could see the chute and was very happy to see it.

McDivitt During our descent to landing I could see the R and R can with both the drogue and the pilot chutes attached to it, floating off to one side. After we landed, I noticed that there was steam coming out of the RCS thrusters. This steam didn't last very long. I could see the sea dye marker in the water. I could see the parachute in the water.

White I think you also ought to indicate that the windows steamed up quite a bit. I could see out a little better than you. You couldn't even see 50 feet out in front of you on your side.

McDivitt No, I sure couldn't. There was a hole down

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at the bottom of the window that I could see through. Ed wasn't having too much trouble seeing through his. It was real nice to see the helicopter and the swimmer.

White

Both the windows were pretty foggy, though.

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11.0 EXPERIMENTS

11.1 Two-Color Earth-Limb Photography (MSC-10)

White This is one in which we had our first example of poor flight planning. They scheduled our MSC-10 experiment so that it actually conflicted with some Horizon Scan Tests that we had to make. And since our Horizon Scan tests were being made in conjunction with the platform, which was only going to be up for a limited period of time, we had to interfere on the tail end of MSC-10 to go ahead and start working on the Horizon Scanner Check. Anyhow, we went ahead on the MSC-10, starting at 11:04, and went through eight series of pictures. This was the time that we had trouble with the event indicator.

McDivitt Didn't we have ten series? I thought we had ten.

White I've only got eight indicated here. Oh, yes, wait a minute; it says 10 1/2 runs. I only have eight recorded here, and a final one being run at 11:57. We should have 9 1/2 runs.

McDivitt Yes.

White We should have 9 1/2 runs, and only nine were

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required. We should have it all. On the first three runs the event indicator wasn't used, because I was having trouble with the Hasselblad shutter working properly in conjunction with the event indicator. About 11:19, I got the event indicator working all right, and the rest of them were run pretty well. The early runs were taken pretty much in night conditions. I doubt if much will come out on that one. The next one, at 11:09, was taken with the sun right on the horizon, right into the camera, so I doubt if that one will be too much more than a big washed-out mess. The rest of them were all taken with the horizon in the proper position and utilizing the ring sight. The last part of the experiment was interrupted by the Horizon Scanner Tests. In other words, we didn't get to the sunset. I think actually the sunset would have been one more series of pictures.

McDivitt I would think so.

White Okay. I guess that's all for MSC-10.

McDivitt Okay.

White Do you have any comments on that?

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McDivitt No, I don't have any comments. I think we
logged the time and the weather along the route,
such as it was, and we got all that into the book.

11.2 Synoptic Terrain and Weather Photography (S-5 and S-6)

McDivitt I think we had a lot of unusual and significant
subject matter, and it's all in the pictures. We
had one camera that wouldn't wind the film too
easily, but other equipment operated fine. We
didn't get the data reviewed properly--too late.

White And we used the voice recorder as often as we
could record. I don't believe we have all of
this S-5 and S-6 photography recorded. I
think as we go over them, though, the ones we
didn't record will be pretty obvious.

McDivitt Yes, I think that those two experiments are
really in the photographs. The Hasselblad
camera operated fine except we had one magazine
that didn't wind up too well, but it never did
jam up completely. I guess that sort of covers
it. Wouldn't you say, Ed?

White I would too. All the data that we got for it
is recorded in our data book. Let's see
Simple Navigation with the Sextant. Ha! D-9.

11.3 Simple Navigation with the Sextant

McDivitt I guess we might as well cover it.

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White Well, in the Air Force portion of it, we can start right off by saying that the stars they wanted us to run the operation on--I think, Series No. 4--

McDivitt No, that was the last one. They gave us Series 1 to start with.

White --which was the daylight. The daylight operations didn't prove feasible at all. We couldn't see the stars and if we could have, we didn't have a good horizon to run them on. So it became apparent to us that that run was lost right in the beginning, when we first came out of the darkness and lost all the stars. We also got the big picture that the sextant was not going to be too easy to use. It was going to be impossible to use without using some fuel, and it was going to be dam hard to use when we used just pulses of fuel. We needed some kind of stabilization. At least I thought so.

McDivitt We might say that the lightbulb in the counter readout for the angle was burned out.

White That burned out within two seconds after we got up there, I think.

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McDivitt Did it ever light?

White First time I turned it on it lit and it went "flit", and then the light just went bzzz-bzzz.

McDivitt I didn't know it ever lit.

White It lit and then the light went out.

McDivitt Okay. So we lost the lightbulb in the angle readout, which made all the rest of the measurements very difficult. And the Air Force portion in daylight was completely unusable. You couldn't see the stars and the horizon at any time. In the night portion, we initially had great large angles between the stars and the horizon, and we found that about 25 degrees was the maximum star-horizon angle that we could handle. Would you concur with that, Ed?

White Sure do.

McDivitt As we mentioned when we were talking about the horizon and the air glow. We really had three horizons. We had the true earth horizon. We had the top of the dim air glow layer, and we had the top of the bright air glow layer. I think that I always used the top of the bright air glow layer, except where I specifically called out in our

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notes. Ed tended to use different types of horizons, dependent upon the type of filter he had on. Why don't you discuss that a little bit?

White

I tended to feel that the bottom of the bright air glow layer gave me a little finer defined horizon for a no-filter operation. When I put the blue filter on, though, I didn't have much horizon at all. When I put the green filter on, it gave me, as far as the top of the air glow is concerned, a better horizon to measure to. I thought that the horizon was certainly not a very defined point to measure to, and I think accuracy would be lost in trying to measure to a horizon like this. It's just plain hard to take a fuzzy old horizon and try to make an accurate measure to it. That's exactly the kind of horizon that you've got at night.

McDivitt

I concur. There must have been at least a couple of minutes of fuzziness in that horizon, and I don't think that you would ever expect to measure to the horizon within a couple of minutes. Do you?

White

No. You'd have to calibrate yourself down pretty

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close to measure. You know it would be just pure luck if you kept measuring properly to it.

McDivitt

Yes, the thing of it all is that even if Ed got himself calibrated so that he would always measure the same angle between the star and the horizon--it wouldn't be consistent between one person and another. I'm not really sure how you would ever go about measuring to this horizon with any accuracy at all unless you had some way that you could--instead of attenuating the light--build it up in some way and then filter out one particular line that happened to be an extremely sharp line. The horizon I like to measure to best was the top of the dense air glow layer with no filter. The next horizon I liked was the top of the dense air glow layer with the green filter. I liked least of all the blue filter, because it just completely eliminated the horizon.

White

Yes, I don't think the difference between the clear and the green was enough to argue over a preference between. I thought maybe I had a clearer one in the green, but I tended to take far more measurements with the clear one, so

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perhaps they are so closely matched that it really didn't make too much difference.

McDivitt

Yes, I did most of mine with the clear one.

White

For the runs in the Air Force portion, I found out that the stars had too big of an angle between the star and the horizon. To actually follow the format, for the runs as given, turned out to be too difficult. We did make runs on stars and horizons if we took the time on it and took the measurements. It seemed like the angle was fairly well limited between 20 and 25 degrees. This was due to the limited maneuver capability imposed upon us and the lack of having enough window space. If you get behind the sextant, behind the window, and try to make a measurement, you might be able to theoretically measure something out to 50 to 60 degrees. Theoretically, this may be possible, but you must can't get yourself up above the console circuit breaker panel or down into the foot well area, which would be required to make measurements of this magnitude. There were definite

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limitations on hitting the side of the spacecraft and trying to make a sighting and losing the object out of the upper window as you cranked the periscope down to bring the star down to the horizon.

McDivitt In trying to accomplish the Air Force portion of the experiment, we found ourselves completely unable to do the daylight star-horizon measurement. So, to get some insight into the operational use of the sextant, we took a great number of star to horizon measurements at night. They are in the book in quite a bit of detail. As we mentioned earlier, the helmet was an impediment to use with the sextant, so on occasion we had to take the helmet off. The greatest angle that we could normally get was about 25 degrees between the horizon and the stars, but on occasion we got up to 30 degrees. This meant a certain alinement of the spacecraft was necessary so that you could get the largest piece of glass between the star and the horizon and still get the

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sextant in there. We found out that to do the star to horizon measurement, you had to be right-side-up. If you tried to do it upside down, the filter blanked out the star and not the horizon. I think that there are a great number of measurements in here, but I do feel that the Air Force portion of the D-9 Experiment was more qualitative than quantitative. Maybe I ought to talk about the Apollo portion. We made one Apollo run where we used two stars. I held the spacecraft fixed to within about plus or minus 2 degrees, and Ed took a great number of measurements. Ed made a great number of measurements between two stars. And we got our 30 runs on one pair of stars that were quite close together. Then we started out with about another 20 sightings on another pair of stars that were further apart.

White

They were all in Scorpi. I think they were about 12 degrees on the first one and about 22 degrees on the second one. There were Antares and S_corpi in the second series, and it was

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Scorpi and the third star up in Scorpio in the first series.

McDivitt Again, we found that the angle that we had selected to operate between was too large, and we ran our first group of stars in about 12 1/2 degrees, and for the second pair we tried to pick stars that were farther apart so that we could get a better feel for larger angles. This pair of stars was a little over 21 degrees apart. We were too optimistic about the angle between stars that we could see by looking through the spacecraft window. What do you think about the voice recorder usage during this experiment, Ed?

White I don't know why we had to do it.

McDivitt No, we actually hand-recorde most of the information here. The one thing that certainly delayed the experiment was the loss of the lightbulb within the readout. We changed the batteries and bulbs from the cross-hairs and never could get

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this particular light to come back on.

White Did you ever figure out why we needed to hand-record all these things--why we had to record them on the recorder--the times and all that jazz?

McDivitt No, we had to record the angles some place and we had to correlate it to a time.

White Well, it says to prepare sextant and photo-event indicator for measurements. What do they mean by photo-event indicator?

McDivitt The photo-event indicator was to get the exact time. Remember, when you were doing star to horizon measurements you had to have--

White No, but this is just for the star. I don't understand the photo-event indicator. I think that just clobbers up our data.

McDivitt That's right. Yes, that wasn't applicable at all. It didn't make any difference what time it was at all.

White In fact, when I made a second run on this while you were asleep one time, I didn't put the photo-event indicator on.

McDivitt No, there wasn't any need to put the photo-event indicator on this.

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11.4 Electrostatic Charge (MSC-1)

McDivitt I think what we could say here is that we turned MSC-1 on and off when it said in the flight plan and when directed by the people on the ground.

11.5 Proton-Electron Spectrometer and Tri-Axis Flus-Gate Magnetometer (MSC-2 and MSC-3)

McDivitt We turned off MSC-2 and -3 according to real-time flight planning from the ground and whenever the flight plan in the air called for it.

White We had one time when I ran a double small-end-forward set of runs through the Anomaly. The first time, I felt that the heading had not been accurate enough for the small-end-forward requirement. We were doing it without the platform on the stars, and the first time through I wasn't satisfied with it. So, I called down to the ground and told them that I wasn't satisfied with the run and that I'd make a repeat run the next time. This I did, and I left the equipment on throughout both runs and for an hour after that. So, we effectively have two small-end runs through the South Atlantic Anomaly.

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McDivitt Okay. We didn't have any operational problems with it. Did we use the voice recorder with it?

White Yes, I guess we did. It should all be recorded on the voice recorder. If not, we've got backup times in the book. Our voice recorder was our prime means, and our book was just a backup.

McDivitt Right.

11.6 Radiation (D-8)

McDivitt I think one time you were sleeping, and you didn't get it that pass, but you got it the second pass, didn't you?

White Well, we got them logged when we did it. They can go back and get it.

McDivitt Right. There were no operational problems. We did use the voice recorder to record the information.

11.7 Inflight Exerciser (M-3)

McDivitt We didn't have any stowage problems with it besides those is associated with all the other equipment. The outside thin rubber layer broke on the exerciser about the end of the first day.

White Yes. I've got a comment or two.

McDivitt Go ahead, Ed.

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White I had the feeling that my capacity and my desire to do strenuous physical exercise decreased during the flight. Actually, it kind of decreased to a point and stayed at that point for the whole flight. Shortly after I got up there, I really didn't have any big desire to do a great deal of physical exercise. I did do the exercises as indicated, and I did about eight extra series of exercises with the exerciser, but I noticed a definite lack of interest in doing heavy physical exercise.

McDivitt I concur with what Ed said, although I'm not really sure this came about because of the small amount of sleep that we had or just as an effect of the zero-g thing. I did use the M-3 exerciser to do other exercises. I used it to exercise my arms, not only in the manner that was demonstrated but by holding on to one end and pulling the other end with the other hand. I used it to exercise my legs also.

White I did a few other exercises, just with the exerciser. I yanked around a little bit on it, as Jim indicated. But, I also did some exercises in which I pressed pretty hard up against the

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front end of the spacecraft; I tried to tense my legs and tense my stomach and arms, and I tried to exercise in this condition. I probably did that a lot more than I did anything with the exerciser.

11.8 Inflight Phonocardiogram (M-4)

McDivitt To the best of my knowledge we didn't have any equipment problems. About the end of the second day my sensors started itching a little. I don't know if it was my phonocardiogram or my other sensors.

11.9 Extravehicular Activity

McDivitt Extravehicular activities have been covered in great detail earlier in the debriefing, I don't think we have to go over that again.

11.10 Miscellaneous

McDivitt In the external observations I did observe three satellites, but I think that these were covered in detail earlier, and I don't believe we need to go over that again here.

White I think that we'll comment again (we've commented on this point before) that the tape recorder is the most important piece of equipment that we have onboard the spacecraft to record our ob-

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servations, times, and other information concerning the experiments. I think the one we have onboard with the light located down underneath the pilot's right elbow is entirely unsatisfactory. I feel that we lost some information on our flight due to the light coming on and not being observed. We were going ahead with information for the tape, but were losing it in this manner. I think we ought to correct this deficiency prior to the next flight.

McDivitt

I concur heartily.

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12.0 PRE-MISSION PLANNING

12.1 Mission Plan (Trajectory)

McDivitt It is pretty difficult to debrief this pre-mission planning because we had so many pre-mission plans that we couldn't keep track of them all. I think that we started too late on the mission planning for GT-4, because everyone was concentrating on GT-3. Then in the two and a half months that we had to do the mission plans, we changed it about three or four times, drastically. We not only changed the trajectory, but we changed the altitudes of insertion; at one time we were shooting for a 87-145 orbit and then a 87-161, and then we changed it from 90 degree launch azimuth to a 72 degree launch azimuth. We changed how we were going to handle the decay of the orbit. All in all, I think our mission plan changed just too often.

12.2 Flight Plan

McDivitt Same with the flight plan. We kept changing it around and changing it around and changing it around. It was really unfortunate. Up until about ten days before the flight we were really prepared for about two different flights, and finally we got

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the flight plan nailed down. I think our flight, though, was somewhat different than other flights in that we did have some real major changes about two and a half months prior to the flight. Consequently, we had to expect these things. So, I think I'd be the first to admit that I lived with these changes, because I had a great desire to do the mission that we set out to do.

White

We both kind of got to the point where we knew that we had a mission to do, and we knew it was going to be tough as far as getting a good flight plan was concerned, and we were just trying to get the the best we could and go.

McDivitt

That's right. I think that the situation that we finally ended up in was that we tried to have a very good launch and first couple of orbits and a good last orbit or two. All the stuff in the middle, we knew we were going to have to handle ~~real~~-time. I finally found myself forced into the situation where I couldn't even worry about the middle flight plan. We had to lay it out in general and expect a great number of changes. This is exactly what we did. We handled it in ~~real~~-time. I'm not suggesting that we do this for future flights, for

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I really hate to see us go right on down until the last minute before we get this information prepared. I think it's too bad, but I think on our flight a lot of this just couldn't be helped because of the drastic changes in the flight plan in the last two and a half months.

White

I don't feel we've got a big beef coming to anybody. I know a lot of people were working pretty hard.

McDivitt

That's right. There were a few things on our checklist that could have been done earlier, but I think the total mission plan, as such, was modified at a late date to change the objectives by a great amount. We in the crew agreed with the change. It almost doubled the amount of work that we had to do in those last couple of months, but I think that by accepting it and trying to make the thing work, we were able to overcome the problem, and it was indeed a major problem. A situation that I hoped wouldn't occur and did occur on our flight concerned the checklist, the data books, the procedure books, the map for the orbit navigation and our charts and graphs. We didn't receive the checklist and the procedure and data books for our flight

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to look at until 8:00 o'clock the night before the flight. Consequently, we didn't have a lot of time to go through them the way we should have. We should have had these books and charts in our hands no later than two weeks before the flight. Here again there were some extenuating circumstance, but I'm not sure that the circumstances were really that great. I still think that we should have gotten these out earlier. The people down at the Cape doing these things worked themselves to the bone night and day, practically, to get these things done. I have nothing but the highest praise for the people from FCSD that came down to do this job. I just sort of suspect that we should have gotten started on it earlier and that maybe we should have had a few more people down there doing it. Any comment on this, Ed?

White

No. This is the thing that I think I was harping about a long time before the flight, because I saw the same thing happen on GT-3, when the checklist came in at the last minute. In fact, the last night before the flight, I remember John walking down the hall looking at his flight plan and his checklist and commenting on this surprise and that

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surprise, and there were a few surprises in ours. I wouldn't say there was much we didn't know about, because we had gone over it pretty thoroughly. But all our experimental procedures and our books--we're partially to blame in some respects also, because we were running the show and knew exactly what we wanted. But I concur very heartily with Jim's recommendation that we get these things made up at least two weeks ahead of time so that we can use them in the simulator, and that we use the little hand-held checklist exclusively in the simulator that we are going to fly with if you could get them nailed down that well ahead of time. That's what I would have liked to have done. That's what we didn't do, though.

McDivitt Yes, I don't really see any excuse for dragging it out to the last day. If these things would have been eight hours later than they were, they wouldn't even have made the flight.

White I think another thing, too, is that right now we've got a good set of books and checklist. I recommend heartily, unless the crew that comes behind us has some very strong diverse opinions, that they use something similar so that they can get somebody started making them early enough to be useful.

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McDivitt I concur wholeheartedly.

White They may not like everything about them, but I think that they proved their value with us in our flight. I sure would rather use something, and use it well, than use something that may be a little bit better and use it poorly.

McDivitt Okay. I think that covers the flight plan topic, don't you?

White Yes sir.

12.3 Spacecraft Changes

McDivitt Here again we had some changes that were brought about by the change in flight plan, but I think we handled all of these adequately. I just don't think that we ought to use GT-4 as an example as to what should be done on a flight, as far as no change and things like that. I feel that if we don't have the equipment onboard the spacecraft checked out and ready for service by the time the spacecraft leaves St. Louis, they shouldn't fly on the flight. I've felt like that since the time I got assigned to this flight, and I still feel that that's the way to do it, unless you have a major change for a worthwhile reason.

White I was sure wondering right to the very end if they

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were going to get these final changes in that were required for our flight. They sure waited a long time to put them in.

McDivitt Yes, two or three days before the flight we still had a lot of things missing. In fact, when I got into the spacecraft, about the first thing I noticed was that the velcro wasn't around the 8-ball. About 30 minutes later, while we were lying there waiting for the launch, Ed looked up and pointed at the 8-ball at the place where the velcro was not.

White Yes, there wasn't velcro in several places where I had wanted it, and in several places where I had actually drawn in the lines where I wanted them to put the strips. Instead, they put them 90 degrees to where I had the lines. I can't believe they would do something like that. I'm not really complaining. I think they did a pretty good job.

McDivitt Do you have anything else on spacecraft changes?

White No.

12.4 Mission Rules

White I thought this was one of the smoother points.

McDivitt What? Mission rules?

White Mission rules.

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McDivitt So do I. I don't really have any comment. I think we had a very good set of mission rules, and I don't have much else to say about it.

White I concur. I think we set a record on running through the mission rules review, and I have one recommendation to make. I recommend highly that the crew review their rules thoroughly prior to the meeting and send their disagreements to Flight Operations Division, so that they can either concur with them and incorporate them, or disagree and then iron the differences out on the major things before you come to the mission rules meeting. Then, you'll find that you sail right through in just the first meeting, and this is exactly what we did.

12.5 Experiments

McDivitt I think we had some pretty good pre-mission planning on our experiments, except D-6, and I think the people in FCSD, specifically, fell down on the job. They did not prepare the Target Acquisition Folders that we needed. They arrived down at the Cape about two weeks before the launch with a foot-thick pile of maps for us to memorize.

White They had a WAC Chart of every place that we were going to fly over, the whole 30 degrees north to

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30 degrees south, and that sure isn't what we needed.

McDivitt I think that there wasn't any imagination used here. I just feel that the people who were responsible for performing this duty fell down on the job completely, and did nothing whatsoever but talk about it. When we really got around to flying this thing they didn't have a thing for us. It turned out that the people who finally ginned up the maps for us were the people from the Department of Defense Office here who were monitoring the thing from the technical standpoint. I sort of felt that this target acquisition stuff was a function of FCSD, and as a matter of fact the people who were concerned with it led me to believe this. When we got around to flying the flight, we found that there wasn't any way to acquire these targets. They hadn't done any work with it at all, so I think that this is a real low point in the FCSD.

White They didn't even have what I would consider a satisfactory method of calling the information up to us.

McDivitt No, to put it bluntly, it was screwed up and unworked upon. I think the planning for all the other experiments was adequate.

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White We had one area where we were a bit too ambitious, and this was in the stars for the Air Force D-9. We reviewed this, also, so there was no lack of planning. It just turned out that using these stars in the sequence that we had for them, with the type of fuel constraints that we had imposed upon us, we just couldn't effectively run the experiment without using a great deal of fuel.

McDivitt Yes. And I think that this came about just because of a lack of knowledge on everyone's part, on just what we could handle in the spacecraft and the rates that the stars move through the skies.

White That was something that we learned on this flight.

McDivitt I think so. I think that's part of the qualitative data that we brought back for D-9, but I do feel that the pre-flight planning for D-6 was completely inadequate. Anything else on any of the other experiments?

White No, I think the other experiments were well briefed to us. We understood them quite well and I think the procedures were well taken care of.

McDivitt That's right. Let me clarify one thing. I think that the technical aspect of D-6 was one of the best briefed of all the experiments. The DOD people

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who were responsible for it had some of the most detailed and thorough briefing guides and forms for us on the equipment, and we were more briefed on the equipment. It was just the procedures that were lacking.

White

Yes, I felt that I knew the equipment and its assembly and usage on the D-6 backwards and forwards. Procedures for conducting the experiment were quite clear to me, but the only thing that we didn't have was a good method of passing up the targets and target acquisition once we got up there. Also, just handing me 243 targets was a pretty simple-minded approach in trying to solve this problem, I thought.

McDivitt

I don't think I have anything else on experiments.

White

Nope.

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12.6 Training Activities

McDivitt Well, I wouldn't do anything differently.

White Jim, I wouldn't either. That's one of the highlights, I think, of our mission that we were well trained for it; and I felt in all respects we were well trained. I don't believe I'd add anything extra, and there's nothing I think I'd take out, either.

McDivitt Well, I think that the training went along just about as we'd planned it and hoped it would work. I do feel that the simulators didn't provide us quite the training that we needed early enough in the program. I think the simulator here in Houston was too busy interfacing with MCC and switching from one building to another and updating to "5" configuration and a whole bunch of other things. We never really got it the "4" configuration. The one down at the Cape took too long to convert from the GT-3 to the GT-4 configuration. As a matter of fact, as early as about two weeks before launch I had done four reentires on the simulator down there.

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White I did four for the whole time.

McDivitt Is that right?

White My total reentries were four. I remember I got three that day before the launch. I have one thing, though, Jim, that I think that I would do differently.

McDivitt Okay, what's that?

White Now that I know what kind of checklist I need and what kind of procedures books and data books that I need, I'd have those things ready a month ahead of time. I'd use them and get so familiar with them and iron any little bugs out. We still had some bugs in our books.

McDivitt That's right.

White It was a little hard to use. It was a little hard to locate things in there. And if I did anything differently, I'd put my emphasis real early on getting my checklist and data books up even though I know fully well that they'll change in some little respects right up to the flight, but I'd get them out so I'd have them. We didn't have anything up to a week or eight days before the flight.

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McDivitt That's right. The things like how to do the experiments shouldn't change. They should stay exactly the same. The operational checks should remain the same, and maybe the flight plan will change a little, but you really could have most of those books done long in advance.

White Then you know exactly what information you're going to take up on the flight with you and can get this laid out long in advance. I think this is one bit of experience that we could pass on to the guys coming behind, particularly the ones that haven't flown before, at least in Gemini—just what information we took along and the reasons why we took it and what our recommendations would be and what we would want to take now. Because remember you and I sat up there the night before the launch and sifted through a pile of stuff and decided just exactly what we really wanted to take.

McDivitt Of course, on the other hand we knew what we wanted. I think we were just looking for it in that pile of junk that we had on the table.

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White Yes.

McDivitt We had that list of things that we'd made up.

White Decided we were going to take. If I had it to do over again, I think I'd have this all in mind earlier.

McDivitt Yes.

White You and I, two weeks before the flight, I don't think, fully knew exactly what we wanted, and it wasn't ready for us then, anyhow.

McDivitt Yes. You're right. Matter of fact, some of the stuff we took was our own personal stuff, like those star charts.

White Yes.

McDivitt And that polar star chart was mine and that Mercator was yours.

White Right.

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13.0 MISSION CONTROL

13.1 GO/NO GO's

McDivitt Okay. Mission Control. Mission Control is the next major topic. It says describe and discuss updating on the status of the spacecraft on the mission. GO and NO/GO's, I thought, went pretty well. You have any comment on that?

White No. Sure didn't.

13.2 PLA and CLA Updates

McDivitt PLA's and CLA updates, I thought, went extremely well. You have any other comments on that?

White No. We used the form and they're easy to copy down. There's sure a lot of information they can get up in a short period of time.

13.3 Consumables

McDivitt The consumables, we had--

White I got some comments on that.

McDivitt Okay. Go ahead.

White Okay, I thought that their monitoring of our electrical system was deficient. I don't believe they gave any indication of what our electrical consumption had been, up till very near the end of the flight, and they informed

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us that we were 130 or 150--

McDivitt 160, Ed.

White --amp-hours over, and I would've liked to know this at discrete times throughout the flight.

McDivitt I think, really, this was our fault. I think we should've called down and asked them. When they did give it to us, they gave it to us because we did call down and ask them.

White Yes, okay. Maybe that was, but I was looking for it more often than that. Maybe we could have this part of the GO/NO GO, and they could say you're on your electrical profile and your OAMS profile. This might be a part of it to be sure.

McDivitt Yes. That would be a good idea.

13.4 Flight Plan Changes

White Flight plan changes.

McDivitt Flight plan changes. Well, we had a few. I think that in general they all came off where they should. I don't really have any comment.

White We had one area in which they were deficient with the MSC-10.

McDivitt I've already talked to Jerry about that. He

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says that there was a misunderstanding between us. They sent up to do the MSC-10, and then they said not to do the MSC-10. Do it later. We didn't get the message.

White I didn't hear that.

McDivitt Yes. I thought all the flight planning was good except in this one instance that we're talking about. We were directed to do MSC-10 in one pass, and then before it was done, we were directed to start another check. We got this information pretty late before we started the experiment and hence didn't get it. We didn't check over the times ourselves and I guess we should have. So that when we got around to doing it, we found ourselves running into the situation where we were supposed to be doing two experiments at the same time. Fortunately, I think we were able to accomplish all the objectives of both experiments, but there was no need to hurry when we were up there for four days.

White Jim, I've got another one too. I've thought a lot about it. I thought about this one before

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the flight, and I think about it right now. And I thought about it during the flight. I think it's time to start a crusade. I think it's time to start a crusade on the elapsed time. Get us a clock. It's going to cost money, but I think we ought to get ourselves a good elapsed time clock inside the spacecraft. Get FOD to start going on elapsed time. And here's another funny sounding one, but I don't see why we couldn't do it--why we couldn't have a flight watch in ten-hour increments. Let somebody build a ten-hour watch with a counter on ten hour increments. And then we'd have the timing system that we need on the spacecraft. What do you think of that? I know you and I have talked about this before but I think it's time--

McDivitt

Yes. We were forced to run our mission using both elapsed time and Greenwich Mean Time and it's almost an insurmountable problem.

White

I think it's really got our data all fouled up right now, too. I think we'll unsnarl it all right, but, boy, if we could've been putting all our times into those tapes and on our data books in straight elapsed-time increments, and even

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when it gets into long time, you know, fourteen day flights, you can still put in 430 and 20 seconds as well as you can the regular Greenwich Mean Time.

McDivitt Yes.

White I think that it wouldn't cost us any more to have Omega make us a ten-hour watch and fix these dials up on it so that we could keep track of good elapsed time.

McDivitt You've got to leave the minutes and seconds alone there. Well, let's not argue that here or even discuss it. I think what Ed says is right. We were forced to run the mission in both elapsed and Greenwich Time, and I don't think that was the way to do it. I think we ought to really start after this elapsed time thing quickly and get on with it.

White Right. It's time to get on with this. I think it's time to make a crusade on it. I think everybody's ready for it.

McDivitt Yes.

White Except the few people that are fighting it, and I think we can overcome them.

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McDivitt Okay. Mission Control System. I think the Mission Control on this flight was nothing short of excellent. We got all the information from the ground that we needed. We didn't get bothered by them unnecessarily, I don't believe.

White They were there when you needed them.

McDivitt They were there when we needed them. That's right. I have nothing but praise for the ground control on this flight. How about you, Ed?

White I did too, and I had the feeling up there that I had confidence in what they were doing down there and in the decisions that were being made. I felt that when I needed information that the source was available down there and I could always get it. That's a very good feeling.

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14.0 TRAINING

14.1 Gemini Mission Simulator

McDivitt Okay. Over on Training now. The first topic is Gemini Mission Simulator and I think we touched lightly on this subject already. I think that it's an excellent trainer for procedures, system knowledge, launch, orbit, retrofire, reentry, and crew stations. I think the big problem with it is that it takes too long to turn it around. I think that we're fooling around with it too much, committing it to supporting other functions besides flight crew training. The simulator at the Cape was supposed to have been turned around at roughly two weeks after GT-3's launch, and about six weeks after the launch it still wasn't doing its job. When we went down there to start flying this completely checked-out simulator, we found that the launch phase worked, the orbit phase did not work, and the reentry phase did not work. After we got the orbit phase squared away, we found out that we kept losing reentry command system. We couldn't use Direct Control Mode in anything. We never did fly reentries

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until shortly before the actual flight, at which time I think I had four total reentries about a week before the flight. Ed said he only flew four reentries on the simulator at the Cape in total. I probably flew fifteen, I would guess. That's total, so I think that the Gemini Mission Simulator fell down completely in preparing us for this flight.

White Well, not quite that bad, Jim.

McDivitt Well. Okay. We did get a lot of training from it, but I think that the turn-around time is completely inadequate. It made the job for the flight crews a lot tougher than it should have been.

White I don't know really what the problem is, but I think the people down there are working hard, and when things were working right, the training was outstanding. But, gee, there's just too much time when things weren't working right.

McDivitt That's right. I think that's a good point to make. People down at the Cape try very hard, and I don't think it's their problem. The program for the Cape Simulator was done here.

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When it arrived down at the Cape, it was completely inadequate for the job, and I can't understand why that program wasn't checked out in better shape when it went down there.

White

I think, also, they're caught as second-rate citizens as far as keeping their simulators up to date and getting the latest spacecraft changes in them. They seem to be way behind the spacecraft and indicated to me that the system did not permit them to update the simulator with the speed with which it ought to be updated to train the crews properly. The things that were characteristic of Gemini 4 were being incorporated in the simulator down there in the last two or three weeks when they should have been incorporated in the first two or three weeks after the changeover from GT-3 to GT-4. I think we just have to work on a faster processing of the changes in getting the pieces of equipment and the changes out to the simulator so that they can be incorporated in it. Once they got the changes down there, they got them incorporated into the simulator, seemed like, pretty

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fast. As long as they weren't there, they couldn't update that simulator. Another thing that I'll, for the life of me, never understand is where in the world the food boxes were for that simulator down there. I think somebody should explain just why it took about one month to locate a pair of food boxes and put them on the simulator down there. It was the only way that we could actually work on the storage of the pieces of equipment for our flight, and we didn't get a chance to look at that until what I consider too short a period of time prior to launch.

McDivitt Yes. It seemed like these food boxes were ordered a year in advance, and they never showed up. It looked like there was a complete lack of follow-up on somebody's part here. Then it turned out that they did find the food boxes but didn't release them to the Cape simulator quick enough. I came home here to Houston and found that we had a complete set of good food boxes in the Houston simulator; whereas, the one down at the Cape did not have any at all. This sort

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of goes along with putting the following missions in front of the mission that's about ready to go. One last comment that I would like to make on the simulator is that we made a mistake in building it so that it would only tilt up 30 degrees. This lying on your back in a simulator is for the birds. You can sit up in it a lot longer than you can lie on your back. Also, everything that you have to do when you're lying on your back is about five times harder than it is when you're sitting up-- nothing at all like zero g. I feel strongly that we should look into some method of making this simulator go all the way up to a 90-degree point.

White

Here, here! One other thing on this simulator, too, while we're thinking about it. I think, there's no question in my mind, the most effective trainer we have is our mission simulator. I think it could be made about a third more effective if we had a decent out-the-window horizon provided. We didn't have anything that I'd call satisfactory available to us prior to

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flight.

McDivitt I agree.

14.2 LTV Simulation

McDivitt LTV Simulation. I think that on the two trips that we made to LTV to do the abort simulations we got as much for an hour of time spent as we did in any other part of our training. We were able to do a great number of runs in a very short period of time, and we got all our abort procedures down pat in just a very short period of time. I think that I can't say enough for this. I certainly will be glad when we get this type of a simulation at MSC so that we don't have to travel out of town to get this kind of training.

White I hope they can get it so it works as well as it does up there, down here, because one thing that impressed me was that you could go up there and be able to run 70 runs.

McDivitt That's right. In a day.

White And not sit around waiting for things to get fixed all the time.

McDivitt I think on the one day we went up there, Ed

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and I together, in one day, had about 160 runs.

White

Yes. Pretty close to that.

14.3 Centrifuge

McDivitt

Centrifuge. I think that the centrifuge contributed very little to our mission. I sort of feel that once you've been on the centrifuge and you've learned what the effect of g's are and how to counteract their effects, that there's not a great deal more to be gained. I didn't really feel that I got that much out of the centrifuge time. How about you, Ed?

White

I think that your orientation in the centrifuge is very important. In other words, I think that it does give you a feeling for what the g's are going to be like and what the g's on the lift-off and reentry are. I don't believe there's any necessity for beating your head on a centrifuge over and over, running it up there. I certainly wouldn't want to go run a series of runs just before the mission so I'd know how it's going to feel on launch, because I already know how it's going to feel on launch. The first time you run a few runs on a centrifuge, you

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know pretty well what it feels like. I think that it's good in moderation, but I certainly don't think that you should over-train on it. It's not something that you need to train on every time for every flight.

14.4 Translation and Docking Trainer

McDivitt Translation and Docking Trainer. I thought that the Translation and Docking Trainer was an excellent trainer for the D-6 pass that we did, the Apollo Tracking Pass. I think that the simulation that we set up at Martin Denver was also an excellent tracking task for this, and I sort of felt that we got the techniques from these two trainers that we needed to successfully perform this experiment.

White I have a couple of comments on that. I felt the same way. Of course, we didn't have this trainer used too much for the docking phase, but I thought it was quite good for the tracking aspects and also for thruster failure.

McDivitt That's right. It gave you a dynamic simulation of a thruster failure and what you could do and what you could notice when you actually have a

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thruster that failed. I used it quite a bit shortly before the flight to practice the docking and the station-keeping that we never really got a chance to perform in flight. I felt that it was quite valuable for this.

White Yes. I think that it's a very good simulation, too, of the actual way the spacecraft really moved.

McDivitt Yes. I think it is too. I think it is too. Anything else on Translation and Docking Trainer?

White No.

14.5 Planetarium

McDivitt Planetarium.

White I think it's very valuable training. We used this one down here in Houston, and we used the Morehead Planetarium. There's not a bit of question in my mind which one you ought to use, and it's Morehead, because the display of the stars is about as close as you can get to the real stars out in the sky; whereas, in the one down in Houston the projection of the stars just doesn't have the quality to provide the

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information that you want to get. I have one other comment, though, as far as the stars are concerned. I think that probably we got as good training with our stars during our night flights as we got during the planetarium work.

McDivitt I feel that's true too. You've got to go to those planetariums to see all the stars in the sky, but the night flying we did with our star chart was probably the thing that really imbedded the location of these stars in my mind. I kept looking at them night after night after night after night, and when we flew I was convinced that I could go up there and find all those stars that I needed to find. I think I had no trouble at all finding them.

White Yes. We saw every one that was out at night. I think we saw them all. I think we can come back with good identification on them, and whatever information they want us to tell about them, we can tell them.

McDivitt That's right. And where we didn't know the exact name of a particular star in a constellation, we could always tell which star it was in

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the constellation and be able to find the name of the star after we got back here to the ground. But I do think that the star training we had was worth every minute of it.

White Yes, I'd go back some more, too. I'd go back to the planetarium some more.

McDivitt That's right. It's one of the things that you really have to keep at all the time, because you can never go out at night and look at all the stars in the sky. You can only see a certain restricted area, and it takes a lot of looking to see the whole sky. By the time you look long enough to see the whole sky, it's six months since you've seen certain stars, unless you want to stay up all night.

White Spacecraft orientation. I think the little devices they ginned up at the Morehead Planetarium are real good in this respect. You can sit there and they can simulate your orbit. They can put you up in the barber chair and you look out and see approximately the number of stars you can see out the spacecraft, and I thought that's about what I could see out of the spacecraft. When I

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actually got up close to the window, when we were up flying, I could see more stars, as I thought I could. I thought that the training we received was good.

McDivitt Yes. No doubt about it, that was all time well spent.

14.6 Systems Briefings

McDivitt Systems Briefings. We actually had briefings on every system in the spacecraft, and there are quite a number of them. The schedule was such that we had a general briefing here at Manned Spacecraft Center on each and every one of these systems. I think we had a second briefing here at the Manned Spacecraft Center on certain systems like the ECS before we went to the altitude chamber. We had a number of briefings on the systems again up at McDonnell by McDonnell engineers in St. Louis. We went down to the Cape, we had another general briefing by the McDonnell engineers at the Cape probably six weeks before the flight, and then about ten days before the flight we had a final systems briefing where they just discussed any changes

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that had been made since the previous briefing and brought us up to date on some of the things that had occurred during this spacecraft systems testing. I thought every one of these systems briefings was worthwhile, and I think without each and every one of them we would have been much worse off than we were. I think that if I had it to do all over again, I'd schedule them just exactly the same manner we did this time. One or two here at the Manned Spacecraft Center, then again up at the contractor, then a couple of them down at the Cape. Any comment on that?

White

No. I liked the manner in which they were presented, as a buildup of details as we went along. The final ones down at the Cape were just certainly not systems briefing. They were details of the system briefings.

14.7 Flight Experiments

McDivitt

Right. Flight Experiments. Simulations. We didn't have to do any simulations on MSC-1, -2, and -3. They were just throwing switches. The medical experiments, the Calcium Deposit Experiment and the Bone Demineralization Experiment, required that we have a number of x-rays taken

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and we did indeed go make a couple of dry runs and a couple of wet runs on the x-ray table to make sure that we could get it done quickly. I think this paid off. We never had any delay due to these x-rays. We certainly all knew how to use the exerciser. And the phonocardiogram needed no practice. S-5 and S-6 did not require any training here on the ground, because these were supposed to be photographs from orbit. That thing was impossible to simulate on the ground. The D-8 required no simulation, so it boiled down to D-6, D-1, and D-9 as the experiments that required simulation prior to flight. As we said earlier, we felt that the Translation and Docking Trainer and the Martin Denver simulation for the D-6 experiment were very valuable. They gave us the techniques that we needed to perform this thing in space. Gemini Mission Simulator was invaluable, too, for everything-- for experiments, operational checks and for the whole mission.

White

As far as any really D-9 work, though, with the simulator, all we could go through were kind of

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cursory procedures. There was no star field or anything to utilize, which I think would be useful. If we had a decent star field, we could use it out of the GMS. Also, on D-6 the GMS did not provide us anything we could use. There were procedures, right. And like you said, the Translation and Docking was all right for D-6, but, practically, we had no simulator anywhere that gave us anything that I could get out for D-9.

McDivitt Okay. Are we through with the briefings? We had a real major briefing that lasted three or four days here at the Manned Spacecraft Center about four months prior to the flight. Wasn't it, Ed?

White Yes. Well, was it that long? It was in March or April--March wasn't it? Somewhere around there.

McDivitt I thought it was later than that. We had our first real major briefing three months before the flight, on the 8th of March, and we had the experimenters come to Houston and go over their experiments in great detail to explain what they wanted and how they wanted us to go about get-

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ting it. I thought this was very good. We had another briefing on experiments in the flight plan review about six weeks before the flight, and we had another experiments review about ten days to two weeks before the flight. Again, I felt that each and every one of these was certainly time well spent. I think that, probably, the first experiments briefing might have taken place a little sooner.

White

I've got a comment on D-6 here. Ten days before the flight, they came in with the information for D-6 and said, "How do you want to run the tracking on D-6 and send the information up?" This was not the time to bring up this type of information or try to make this type of decisions. These decisions should have all been firmed up at the six-weeks briefing, and this is what the six-weeks briefing was for. It was to tell us how we were going to run our experiments. After that time there weren't supposed to be any changes to the procedures, and 10 days before the flight was just to incorporate any last-minute changes and solidify

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any things that might not be understood too well in the procedures. So this is where, I think, that the people giving this information in D-6 never were with it--as far as getting the information ready for us for it.

McDivitt Very good. I concur completely.

White In the future I think the experiments should be firmed up by six weeks prior to flight and the procedures should be well in hand at that time. They shouldn't drag on and be dragging on right on down to a few days before the launch, which is exactly what happened on D-6.

McDivitt Okay. Equipment. We had some of the equipment available to us as early as six or eight months before the flight. Other equipment kept dragging in until the very last day, just about. I don't believe that you can get the training equipment available to the crews too early. We found ourselves, in many cases, with the training equipment locked up out at the Cape for safe keeping--so safe that we couldn't even get to it, and we didn't get a chance to use it the way we should have. I think only by a lot of noise making, I

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guess, were we able to ever break this stuff loose. Training equipment is just what it says-- it should be used for training and it shouldn't be kept under lock and key away from the crews.

White

I had that same feeling down there, Jim. I think we both kind of got on this one. It seemed like they'd want to get all the training equipment all together and say, "Ha, ha. We've got it all together. We're all up to snuff. There's all of our training equipment. It's all in that locker over there." That's not the way it ought to be. The training equipment shouldn't be in that locker at all. It should all be out to the crew.

McDivitt

In the hands of the crew.

White

And I think up in the crew quarters is where the training equipment belongs and down in the simulator. It should be out and being used. I think that one of the keynotes to our success in having a decent amount of photography taken on the flight was that we took the cameras that were available, whether they were flight type or the commercial types of cameras that we car-

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ried, and became very very familiar with them in the months before the flight. I recommend very highly that crews that follow in the future get the equipment and utilize it so that it becomes second nature to them prior to the flight.

McDivitt Okay. I don't think we need any more on that, do you?

14.8 Spacecraft Systems Test

McDivitt I think that we learned quite a bit from our Spacecraft Systems Tests. We had a great number of them in St. Louis and then down at the Cape. I think that the amount that we learned and the time we spent was a little low. I think the ratio of what you got for your hours spent was low, but I do feel that it's a necessary thing and that you really should participate in this spacecraft testing. There were long periods of time when we learned nothing, absolutely nothing, but on the other hand we got a feel for our spacecraft and saw how a lot of the systems were working and the only way you can do this is to actually participate in

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the testing.

White You know, it doesn't seem to fit in here anywhere else, but I think maybe at this point we ought to indicate we attended every one of the management meetings up there at McDonnell while our spacecraft was up there progressing along through the assembly line. I recommend that all crews in the future have representation at all those meetings.

McDivitt That's right. The most important meetings I've ever gone to in my life, at least since I've come here to the Manned Spacecraft Center, were those Gemini management meetings up at McDonnell. I can't express enough the need for a representative of the flight crews to be there at the meetings.

14.9 Egress Training

McDivitt Egress Training. I thought the briefings were excellent, the flotation tank work was excellent, the Gulf exercise was excellent, and the survival gear briefing was excellent. I can't say how glad I am that we've had this training when we plopped down out in the Atlantic Ocean and we were sitting there. Even though we were about to be rescued, I knew that even if they didn't rescue

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us right then, I felt fully confident about being able to take care of myself out there in that water.

White We were well prepared in this area.

14.10 Parachute Training

McDivitt Parachute training. I thought that the parachute training that we had was good. I thought that the parachute training into the water with pressure suits on was by far the best that we had. It was the most realistic and it was the kind of training that we would need during actual flight.

White And I recommend highly that all crews do this and they go in suits as close to the same kind of condition that you're going to plop down in that water with, and go through the full inflation and not skimp on a thing.

McDivitt You get all tangled up in a parachute just the way you're going to get all tangled up in the parachute when--

White That's right. Inflate the life rafts and inflate the Mae Wests and inflate the whole works every time. And if we don't have enough life rafts

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to do it every time, see to it that we get it.

14.11 Launch Simulation

McDivitt Okay. Launch Simulation. I think that the launch simulations were excellent. I think that was the first place that we really had a chance to work with the people who were going to be controlling us during the flight. I think we got a lot out of it, and I think they got a lot out of it. What we really had to do was learn, I guess, respect for each other, and I guess the only way we could do this was to see how each of us was going to handle a situation that arose. I don't have any other comment on it except that I think that it was certainly worthwhile.

White I've got a comment. Not on that, but a thing that fits right in.

McDivitt Shoot.

White I think that the reentry simulations that we did should be made a regular part of the preparations for flight. It's just as important to me as the launch simulation. I think there should be regular reentry simulation for the preparations prior to the flight in the same manner as the

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launch simulations.

McDivitt I think so too. I think those reentry simulations we did that day were certainly worthwhile. We only had to do a few of them to learn the procedures for getting the information back and forth. We tried one one day, and it was so horrible that I'm certainly glad that something like that didn't happen during flight. But after we had done a couple of more it smoothed out, I had no doubt in my mind whatsoever that we were going to be able to pass the information back and forth.

White That's right. I felt that they were equally as important as the launch simulation.

14.12 Network Simulation

McDivitt The Network Simulation. We didn't actually participate in the Network Simulations, and I don't think we missed a thing. I think, though, that something that was required was a discussion with the Network Controllers. We came back to Houston to tell them our points of view and explain to them the kind of information we wanted passed back and forth and the format of how we wanted this information given to us. I

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think that during the flight it certainly proved that it was worthwhile, because that was the way we got it, and we were able to get this information in a usable manner in a short time. We didn't have to go over and over and over. I don't have any other comment on that. Ed?

White

No.

14.13 Zero-G Flight

McDivitt The zero-g flights are the next topic. I sort of feel that the zero-g flights were one of our most valuable training tools, especially since we were going to do the extravehicular activity portion of the flight. Without this we wouldn't have had the confidence in ourselves in getting in and out of the spacecraft and opening and closing the hatch that was required, so that we probably wouldn't have even done it. Ed, do you have any other comments on that?

White

Concerning the little bit of a hatch problem that we did have, I think that the work that I had done on the zero-g airplane sure prepared me well to meet the problem that we had. I recommend very highly that for any egress work, in which we're going in and out of the space-

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craft zero-g, that you get up there and work the procedures out thoroughly between not only the guy getting in and out but between the two guys that are sitting in the seats. This is the way we flew it. We didn't go up there and fly just one guy jumping in and out the hatch. We went up there and flew with the guy in both seats, whether the man in the left seat actually worked all the time or not. There were times when he had to help, and in our flight it paid off, because there was a time when Jim had to help, and he knew exactly what the problems were and was able to give the help necessary.

McDivitt Another thing that might have helped here was that I've been in and out of that right-hand hatch almost as many times as Ed had.

White So we knew just what the problems were.

McDivitt So we knew exactly what the problems were.

14.14 Flight Plan Training

McDivitt Next topic is Flight Plan Training. I think we had such a great number of changes in our flight plan that it's really not fair to discuss this in any great detail. The approach that we did take, as I mentioned earlier, was that we would

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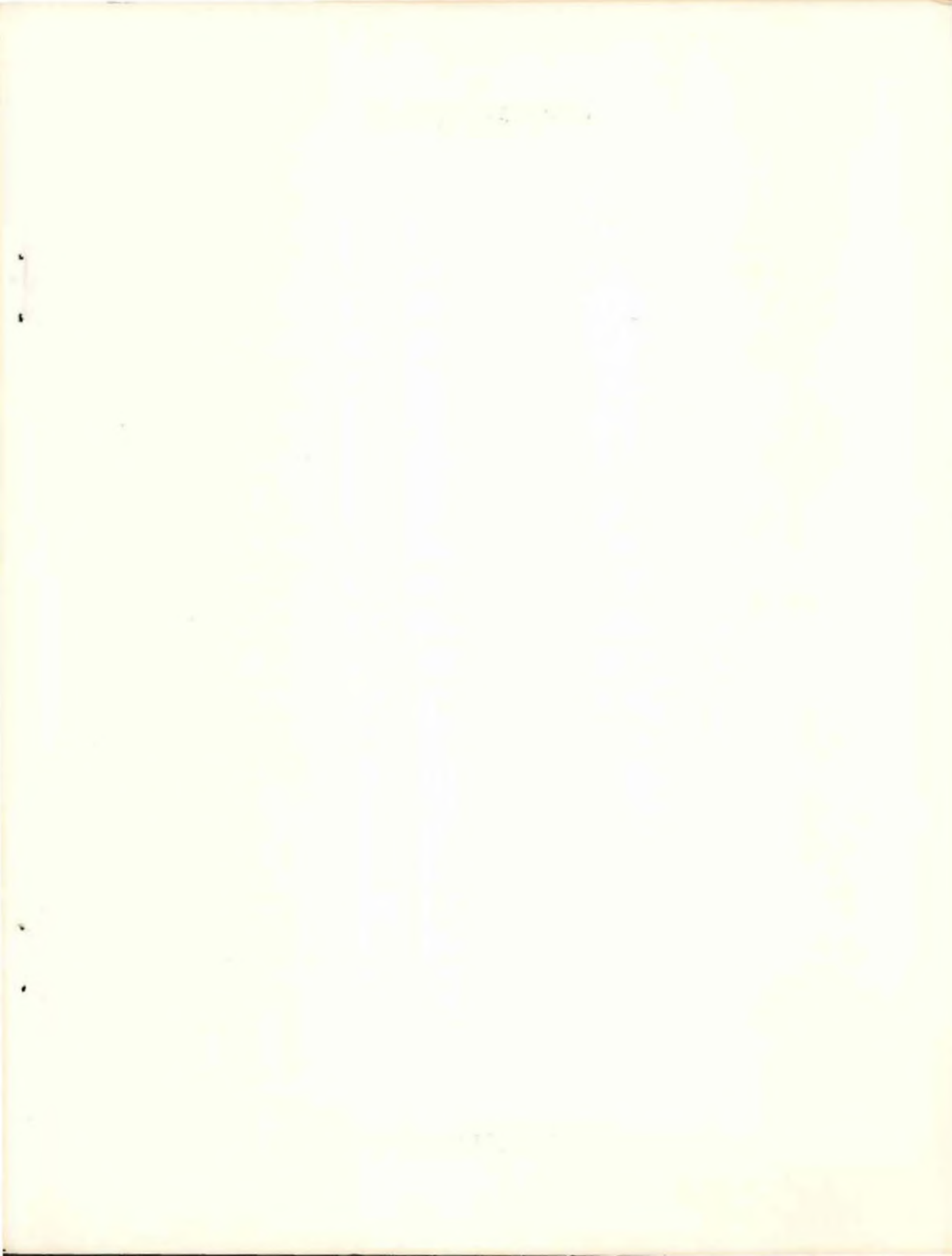
have a good launch and first few orbits, a good retro-preparation, and a good retro and reentry, with the center of the mission being taken care of by doing the experiment or doing the operational check by itself without regard to what went before or what went after. I think this is the kind of training you really need on these long duration flights. Anything else there, Ed?

White No. I concur heartily. I think that practicing it piecemeal is the only way you can do it.

McDivitt You have any concluding comments?

White I think we've been making conclusions all day long. I think to try to conclude them all, we'd never get them.

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