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GEMINI V

Technical Debriefing

Part II

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PRELIMINARY

GT-5 FLIGHT CREW DEBRIEFING TRANSCRIPT

PART II

Prepared By

Spacecraft Operations Branch

Flight Crew Support Division

September 2, 1965

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PREFACE

This preliminary transcript was made from voice tape recordings of the GT-5 flight crew debriefing conducted August 30, 1965 thru September 2, 1965 at the Crew Quarters, Cape Kennedy, Florida.

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 September 1, 1965, and it contains the crew's description of the mission from an operational standpoint.

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8.0 SYSTEMS OPERATIONS

8.1 Platform

Cooper By day we used standard procedure of finding a zero yaw, which is a little easier to do down at about retro position. The nose is a little bit in the way for determining zero yaw unless you pitch down just a little past nose low in zero-zero-zero position. When pitched down just a tiny bit, zero yaw was very readily apparent to within a fairly reasonable degree of accuracy, and then ease it right on up. We had lines for the zero-zero position to give us our pitch and roll on the horizon. This was the regular day alinement.

Night was pretty much the same except we'd get zero yaw by a star, get roll and pitch by the zero lines on the window (or knowing where they were approximately) line this with the top of the air-glow or the horizon. At that point you'd go into Cage, hold it there at that position until it caged) then uncage the platform to BEF or SEF whichever the case might be, and then to to Platform and Attitude on the FDM and FDI's. Then aline the platform fine aline SEF or BEF by keeping

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the needles zeroed. It would slowly gyro torque itself and correct out the small errors for fine alinement. Anything to add, Pete?

Conrad

Well, I didn't hear all of that, but I think the alinement is straightforward. One thing I had not read in either the GT-3 or GT-4 debriefings on this subject on out the window alinement was that we have a window gage that you can use that will put you right on in roll and pitch and, of course, for yaw you still have to use the same out the window reference.

Cooper

One thing that I think that should very definitely training wise be readily available and we looked and looked and looked and couldn't find any was an actual scale picture of the left hand window and the right hand window with what the horizon should look like at zero-zero-zero and at retro attitude and at minus 90 degrees left and 90 degrees right and at 60 degrees left and 60 degrees right and this type thing. I've never seen an actual drawing showing the horizon line on a window and what it should look like.

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Conrad Yes

Cooper I think this would be a tremendous benefit and shouldn't be difficult to come up with.

Conrad If you place your eye so that it goes through the lower left corner of the right window or the lower right corner of the left window and run that eye position right through the front RCS yaw thruster, the lower yaw thruster in the front ring, I guess that's ring A, anyway, you take a line between your eye, the corner of the window and the front RCS yaw thruster, right through the middle of it, and put that line on the top of the airglow or the horizon. Then the spacecraft, and this looks like an excessively nose up attitude, but it's not, you're zero degrees in pitch then the window frame is just about vertical to the horizon and it forms a perpendicular angle.

Cooper The inside edge of the frame.

Conrad The inside up and down edge of the window corner makes a perpendicular angle to the horizon and you can use that as a roll gage. If you set it up

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that way that platform isn't off 4 or 5 degrees in roll or pitch.

Cooper So, it really looks like, when you first start lining it up, it appears to you that from the left seat that you're actually rolled left.

Conrad Yes, that's right.

Cooper And from your seat it would look like it was actually rolled right.

Cooper It doesn't look horizontal at all, but that's due to the fact that you're sitting off by this offset.

Conrad One other thing that you might say about platform alinement is that if you're not on in roll and pitch, mainly roll, this really will eat you up in alinement time.

Cooper Roll and yaw are the bad errors creators. Pitch you can be off a lot in and it'll correct right out.

Conrad Not if the other two (roll and yaw) are off.

Cooper But if you're off in roll and/or yaw then it really takes a long time and its real rough.

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Conrad You don't want to be deceived by the fact that the needles are holding in the center pretty well.

Cooper That's right, one thing that we found when we were going through this real, real long platform alinement prior to getting all lined up for retro-fire was that we had the needles all alined, they were sitting all glued out. But you have to sit there with them for a little bit glued out. They sit there all zeroed out, it looks like everything was all alined and all of a sudden yaw begin to ease off quite a bit showing that we weren't alined.

Conrad At one time we went to Orbit Rate when we had not pulled the yaw all the way in and, boy, it showed up in roll as we started moving around.

Cooper Orbit Rate and Horizon Scan.

Conrad I mean it showed up in the roll axis.

Cooper Oh, yes. Right.

Conrad You have to take the time and be careful with the platform alinement, no doubt about it.

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Cooper And it takes time to do it and do a really good job on it.

Modes. The only thing I can say about Cage is that it takes an excessively long time to Cage.

Conrad I'll comment on this even though we didn't get a chance to do the rendezvous, but even in simulation, it was apparent and the little bit that we did in flight caging the platform, getting ready for alinements and things like that, it was very time consuming. I think that you could find use for a fast slave cycle.

Cooper Very much so.

Conrad Fast Cage cycle is what I should say. I'll say it's a luxury item but it sure could be helpful.

Cooper SEF and BEF worked just like advertised. SEF for fine aline and small-end-forward, BEF for reversing your phase angles so that you're still steering to and fine alining blunt end forward.

Conrad Jim and Ed made the comment that they never alined BEF, that they always alined SEF. We alined SEF normally through the flight and when we were ready

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to retro, we wanted to save as much fuel as possible, so we alined BEF and I think alining BEF is easier than in SEF.

Cooper Yes.

Conrad I think you can tell yaw better going backwards than you can going forward.

Cooper Yes.

Conrad I don't know why, maybe it was just psychological.

Cooper I agree with you, I really think you're right. I think you can tell it better. It streams away from you a little more.

Conrad Yes. It was easier to pull in in yaw. I thought it was a little more comfortable feeling. I enjoyed the riding around alining the platform BEF much more than when we alined it SEF, and I felt we were closer to being on most of the time when we pulled it in in yaw.

Cooper Of course, we had a little better control system there, it does help.

Conrad Yes.

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Cooper I think either way (SEF, BEF) is good, both worked very adequately and it just depends on which way you want to align for what you're going to do. BEF is certainly at least as acceptable as SEF.

ORBIT RATE was not bad off at all. We didn't have any large errors in it due to the fact that we had more nearly circularized our orbit from the burns that we did.

Conrad We were about at 171-60 at that time period. I don't know what they had picked as an orbit rate number at the end finally for the REP.

Cooper We were about 107, 166.

Conrad Yes. I was really surprised with how well the platform stayed on after just taking a quick look at zero-zero-zero, not even trying to align these. We just passed freely through this in drifting flight and uncaged the platform right into Orbit Rate, and it didn't get off five or ten degrees in any of the three axis.

Cooper For about 20 hours.

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Conrad Yes, for about 20 hours that we drifted around. It was finally off the most in roll. It got about 15 degrees off in roll.

Cooper Orbit Rate worked very well.

Conrad Other than inertial work, I just didn't see any big advantage in free. You'd still think in terms of the local horizon up there most of the time.

Cooper Yes.

Conrad We just never had much occasion during the flight to use FREE.

Cooper Platform displays.

Conrad Ball operation through the poles was just fantastic! It was so smooth. The only way you could tell that you were going through a pole is you could see the roll index, vehicle is on the roll gimbal, flip.

Cooper Yes. This is something we had trouble finding out, whether this was the case or not and we deliberately ran several specific checks of this.

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Regardless of which way you approached it from, whether you approached it fast or slow or whether you're going through the 90 or 270 point on the ball, you can go right smack through the middle of it, you can sit right in the middle of it, you can move up or down, right or left and the ball doesn't jump, doesn't jitter, doesn't do anything. It's just beautiful.

Conrad Yes.

Cooper We did a burn right through each one of the poles.

I think the controls are pretty similar to what they are in the simulator. There are two exceptions, one of which I think is valid and which I think may be influenced by the fact that we had a lot of slow degradation in our OAMS system. I thought that the FULSE system in the spacecraft had a lot less torque, a reasonable amount less torque and it got a lot less, as we went along it got less and less and less.

Conrad Yes.

Cooper But even initially, it felt like the FULSE system

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had less authority in the spacecraft than it does in the simulator. On the other hand, I felt the RATE COMMAND system had a heck of a lot more authority in the spacecraft than it does in the simulator.

Cooper That RATE COMMAND just flat snaps you in. In the simulator, when you come around in RATE COMMAND and you let off it will go through 5 to 10 degrees. You have to let off on it 5 to 10 degrees early. By golly, in the spacecraft you didn't have to let off even a degree early. When you let go, it stopped right there just like you put on the brakes.

Conrad Yeah. It was good and it was tight.

Cooper It was so tight that you almost had to - -

Conrad That was OAMS Rate Command.

Cooper You almost had the feeling that the OAMS Rate Command was almost bending the Adapter Section. It had such high torquing rate.

Conrad On day 2 and 3, our OAMS system was working completely correct. I was extremely impressed

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with how nice a control system it was. We made several maneuvers using this control system and didn't have any gripes on that system at all. As Gordo said we were really impressed with the Rate Command system.

FCSD REP When you turned around 90 degrees in order to get rid of the REP, did you use the 8-ball?

Cooper Yes.

Conrad FDI's are on this Gimbal flip business too, you see. They do that in the trainer, but they were steady as a rock in the spacecraft.

Cooper Yes, we used the FDI's for the fine aline. Although to get there we used the 8-ball.

Conrad We had trained to use the IVI's.

FCSD REP That's right.

Cooper We used the IVI's, not the FDI's. We used the IVI's as the real fine measure of being lined up. We used the FDI's too.

Conrad You can use anything in the spacecraft.

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Cooper You can't use the FDI's or the 8-ball as a reference in the mission simulation because you have this gimbal flip which just gives you fits.

We didn't use Rate Command very much, mainly just for the burns. In fact, the burns are the only times we used Rate Command. I used the Direct system several times and I thought the Direct was really good. It was good and crisp and you had good authority with it.

Conrad I had the impression that the spacecraft was a lot more stable vehicle in Direct than it was in the simulator.

Cooper That's right.

Conrad In the simulator you tend to sit there and go too much and go too much. When Gordo'd stick a shot of Direct in to go someplace, it never showed up in another axis. An equal shot in the other direction would stop it right now.

Cooper Yes.

Conrad The effects momentum of the spacecraft didn't seem to be as great in flight as they were in the

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simulator. You didn't have to lead as much.

Cooper That's right.

The Direct system was a much more precise system in the spacecraft than it is in the simulator.

Conrad I thought it was quite easy to fly, but there's no doubt about it, boy, that Rate Command eats up the fuel.

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Cooper Direct uses quite a bit of fuel also.

Conrad We did use a little fuel that one day. We were doing so many experiments in a row that we had to very rapidly get the spacecraft back to a zero-zero-zero or a pitch down 30 position. When you track one of these targets and come through the nadir and keep on going, boy, you're really smoking towards a rearward direction.

Cooper You're sitting inverted BEF.

Conrad That's right, you've got rates built up going away from you and you'd have to use Direct to stop those rates, get yourself moved all the way back up here and stop them again. Maybe it'd be so tight that you'd use Direct to get down and start on it, and then switch to Pulse and track in Pulse and then right back up and start doing something else. Well, we did eat up a lot of fuel that day, but we got everything done that day. We hit darned near all targets.

Cooper Direct is a real responsive, real fine way to maneuver.

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Cooper Platform controls were very straight forward. I thought they all functioned as expected.

Conrad The Platform took the full 25 minutes to go through the fast heat, and the first time on it was really cold and took another 3 minutes worth before start of the Cage Cycle. After that, it seemed to stick right around 25 minutes to get the platform up and on the line and start into Cage.

Cooper Right now, I've got extreme confidence in that Platform. I really think it does well.

Conrad The platform did an outstanding job during the entire flight.

Cooper It sure did.

8.2 OAMS

Cooper We fired the OAMS on the pad and it was mushy. You couldn't hear them fire just gas mainly. About the third round of firings however, you could really feel them fire off, they were all good.

Cooper During flight the OAMS started out very good and in about the third day began to degrade. The fifth day

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is when we found the two thrusters that were not operating correctly.

Conrad The number 8 thruster was working real good when we found that the number 7 thruster was out. So we shut the system down again and had a big talk with Houston about this. We went one more revolution and they gave us some tests to perform on 7 and that's when we discovered 8 wasn't working.

Conrad Two of them quit, within an orbit of one another.

Cooper We had already run complete tests on it and number 8 had been working on the previous tests and quit on the next one. The story of the old OAMS inflight system was that gradually as the days went by there was more, and more that went wrong with it until finally at the end we had less than half the thrusters left and they were pretty bad.

Conrad I realized a couple of heater blankets were probably out on the OAMS system, but I'm still convinced until somebody convinces me otherwise, that the thing that shot the OAMS system down, was the decision to turn off the OAMS heater. I had questioned the decision in the air to only point that

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I could. I didn't think we were in that much trouble for electrical power. I still think it was a mistake because I think even with a couple of blankets out, if we'd have kept the system warm with the rest of the heaters, we'd have never froze them up.

Cooper The thrusters themselves were actually working because you could actually get a glow off of them. There was a little bit of fuel or oxidizer coming out of it and burning, but it wasn't getting the proper amount of mixture ratio.

Conrad Now, they could have been dirty. That could be it, but it was purely in the valves in the thrusters themselves because they were putting out thrust even at the end. If you wanted to hold it in full Direct with 7 and 8 circuit breaker engaged, you were getting wet fuel thrust.

Cooper Yes. You were getting a little wet thrust.

Conrad Let's go into how the whole thing occurred. We had shut the heater down a long time ago and we really hadn't agreed with that, but there wasn't much we could do about it. We were in the middle

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of doing experiments on the fifth day, and we had had a little trouble alining the platform. What was happening, apparently was the number 7 thruster was getting cranky, but we also knew we were venting hydrogen and we knew this because we were getting some torqueing out of that. At the time Gordo was having trouble alining the Platform, we thought it was because the hydrogen was venting. Finally Gardo said, "There's something wrong with the control systems." Once we decided there was something wrong with the control system, that's when it went just like back in the simulator. We shut everything down, went to Direct, thought about it for a second and turned off all the circuit breakers, turned them all back on one at a time, tested all of the thrusters and, sure enough, when we got to number 7, it was out, completely out.

Conrad So then I tried secondary ACME bias power. We tried the secondary yaw and the secondary attitude drivers with no effect so we were relatively assured that something had happened in either the hand controller or the fuel was not feeding. We decided to power down right there, which we did, and we advised flight of what the problem was. I

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think that's about the time we really decided the scanner wasn't any good, or had we already told them about that?

Cooper Yes. We'd already told them about that.

Conrad Yes, you're right. I know what it was. That's when we discovered that the voice tape was out. We were right in the middle of several experiments and it occurred approximately like 16:30:54 on the fifth day. We reported to Houston that the voice tape was out, the number 7 yaw left thruster was out and that I had turned the OAMS heater back on. I was suspicious of that all the time. That's when they called up and gave us this minimum power down. Why did we go into that? They had us power down everything.

Cooper At about the same time that we came up with this, they came up with this idea that the hydrogen was boiling off so fast that we were going to be out of hydrogen by about the end of the fifth day at the rate we were going if we didn't power down and stop the usage of it.

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Conrad Yes. That's when we came around on the next revolution. They had us fire up everything again to take a look at it and that's when we found out number 8 had just gone down the tubes too. But number 8 was still giving us something; number 8 was still burning, but it was burning off mixture. You could see a flame.

Cooper You could see a glow out of it.

Conrad You couldn't hear it like you could hear the other thrusters, but you could see lights on the night side so you knew something was coming out. The drivers just weren't opening all the way or something.

FCSD REP The fifth day at 16:30 is the first problem you had with the OAMS, is that right?

Conrad No, earlier. When we first powered the system up, we were having trouble with that very first platform alining and we felt we were having some hydrogen venting problems. That's when we drifted way off, and Gordo said, "The Pulse system isn't going to hack this hydrogen venting." He went to Direct and blipped the yaw left thrusters.

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All kinds of garbage came by the spacecraft. It looked like we blew a whole bunch of junk out of it. I remember distinctly seeing gold balls.

Cooper Great big balls of liquid.

Conrad So it must have been raw fuel. Something at this time wasn't working right, but I guess number 8 was putting out full thrust and number 7 was still working but not all the way. Now maybe right then and there if we'd have really worked that system over; fired all the thrusters in Direct and a couple of good healthy loads through it, and put the heaters back on the line, we might have salvaged the w
vaged the whole system. It must have been right at the point of freezing up.

Cooper This was early in the fifth day.

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Conrad We didn't hit the direct thrusters long enough to heat them I don't think. I do distinctly remember saying to Gordo "We blew all this junk out of there."

Conrad We'd never seen anything like that before and we'd been up there 5 days and seen all sorts of things. We could see liquid oxygen when we vented it, if we vented it under the right light conditions. We could see when we vented hydrogen under the right lighting conditions. It would all float by the spacecraft and at low sun angles, either at sunup or sundown any one of these quantities, ECS O₂, CRYO O₂, or RSF hydrogen, you could see it come whistling by the spacecraft. We were continually floating around in these old silver balls of either hydrogen or oxygen.

Cooper Okay, well that was pretty well the background of what happened. Some thrusters that had checked out good would subsequently check out bad or be completely inoperative as the days went by. So finally we wound up with maybe half of the total OAMS thrusters still operating properly.

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Conrad We had some thrust remaining in every axis but yaw left. We had some in yaw left if you just wanted to dump raw fuel overboard. I don't know whether it was fuel or oxidizer.

Cooper Generally, what we'd do is roll and pitch to get our yaw left.

Conrad If we were tumbling and wanted to damp we just waited until we translated into the right axis in which we had some authority.

Cooper The one axis that always seemed to work pretty good so far as control authority was pitch.

Conrad Yes

Cooper Pitch up and pitch down seemed to work reasonably well all the time.

Conrad Yes. I wonder if that had something to do with the pitch thruster lines on the manifold being close to the source. Pitch was always good. Our trouble was mainly coupling in the yaw thrusters both right and left.

Cooper Source pressure was easy to monitor. Source temperature we could monitor and it was too cold.

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Conrad It ran down in the 48 degree area.

Cooper It showed that it was running too cold. That's why we questioned turning the OAMS heater off.

Cooper Regulated pressure was fine.

Conrad Right on the money.

Cooper Propellant quantity seemed to read reasonably good until it got down towards the end. At that point (from about 10 percent on down) the propellant quantity just went on down to the bottom of the scale. It was reading below zero and yet ground readouts indicated OAMS propellant quantity remaining.

Cooper Monitoring of OAMS propellant remaining onboard information was fairly good.

Conrad Yes. I thought we were fairly close.

Cooper Ground information agreed fairly good with onboard information in general.

Conrad The whole OAMS systems got to be reviewed. I think that they think we wasted a lot of fuel and I think that on day 3 we probably were a little overgenerous with our fuel usage. But I'm still

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convinced that because we went so long with the QAMS heater off that we were not burning a nominal fuel to oxidizer ratio.

Cooper Yes. Even though we were in a rush to get a lot of these things done, I was still extremely conscious of fuel usage. Although I'd used Direct to get it started, I wouldn't just fire all the way around in Direct input, let it coast around, and then stop it right there.

Conrad Yes. I never saw fuel usage in the simulator like we saw in flight.

Cooper It just seemed to go down very rapidly on the gauge during that one period of time.

Conrad And yet we went night after night all night long in Horizon Scan or in Pulse and would hardly use any fuel at all. As a matter of fact, the ground gave me the figures. This was when we were running all night long in Horizon Scan so that we had a nice reference. They said "You're using about 2 pounds a night." Now, that seems like a reasonable amount for what we were doing.

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Cooper We were using it for Attitude Hold and for getting pictures and to get through the day side.

Conrad Oh Yes. We never used Rate Command except for the maneuver burns.

Cooper We were tracking the missile using Direct. Had to get on it in a rush so I went to Direct.

Conrad I questioned propellant quantity prior to lift-off. It was 87 percent at lift-off. I thought we were supposed to be 100 percent on the gage at lift-off. I thought we had propellant quantity loaded to the maximum?

Cooper Well, they said we were about 50 pounds under.

Conrad Yes, they said we had about 50 pounds less fuel than we were supposed to have.

Cooper We asked them about this before we lifted off.

Cooper At about 4 or 5 minutes before lift-off, we asked them about this.

Conrad We got a "We're checking" and that's the last we heard from it. And off we went.

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Cooper So then we asked again when we were in orbit,
 "About this underload on OAMS fuel". I suspect
 that something was fouled up because we didn't get
 a full OAMS load. That was pretty bad.

Cooper I think monitoring onboard of propellant remaining
 to complete the mission was pretty good. The fore-
 cast fuel for mission completion of Gemini V ought
 to be reviewed because somebody didn't quite come up
 with the right fuel figures. Twenty-six percent
 remaining after the REP would not have been nearly
 enough to have done the remainder of the mission.

Conrad Yes. I think that in computing the amount of fuel
 used to perform a maneuver, they figure out how much
 to get the rates going but they must stop there.
 They must not figure how much fuel it takes you to
 get back to, say, zero-zero-zero. Apparently they
 assume that whenever you get done with a tracking
 maneuver, you just drift to get back to zero-zero-
 zero. Over the U.S. we had maybe 6 or 7 minutes be-
 tween a 30 degree pitch-down target to the next
 30 degree pitch-down target. You've got to track
 it all the way through, bring the spacecraft all the
 way back up and then go to and track the next target.

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Cooper And stop your rate at the back.

Conrad As a matter of fact, that's about twice the fuel usage. They may take this into account, I doubt it. They're very conservative on their estimates.

Cooper Selector controls and switches were all right. Attitude controller was fine. Maneuver controllers. We had every intention of checking the right one and we never did check it because of other problems. Inflight malfunction irregularities we've already covered pretty well.

Cooper Attitude Control Modes, Rate Command was excellent. Reentry Rate Command we never checked.

Conrad I don't even think you need it.

Cooper And I think it could be removed from the spacecraft as far as I'm concerned. I never used or need it on the simulator. I never liked it.

Conrad Pilots aren't going to tolerate these higher rates. They will damp before these rates are reached.

Cooper Direct is a good mode. There's nothing at all wrong with Direct. I thought it was much crisper, much crisper in the spacecraft than in the simulator

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shows that it is. The Pulse mode was very economical on fuel and I felt that in the simulator you had a little more authority than you actually did in the spacecraft. The spacecraft had slightly less authority in Pulse than the simulator does. Incidentally, you can use Pulse just for a month of Sundays and never see the fuel go down on the OAMS gage at all. You can use Pulse all day long with using little fuel usage. Horizon scan, the primary Scanner was inoperative as was stated earlier. The Secondary Scanner worked fine. The scanners, I think, operated quite satisfactorily. We had a lot of scanner dropout in the primary and even in the secondary. We had some dropout in the secondary when we first were going in and out of sunlight areas.

Conrad But then it seemed to work allright.

Cooper Horizon Scan Control Mode worked fine. Real good.

Conrad It's a loose mode but it still works fine.

Cooper It's got wide limits on it of course, which is okay. The mode itself works fine. There was something really fouled up in the platform mode. It didn't work at all like it's supposed to. The platform mode is supposed to be plus or minus 5/10th of a degree. If it was plus or minus 10 degrees I'll eat my hat.

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Conrad I thought it held to about a degree and a half.

Cooper Not in yaw, you remember. It allowed yaw to wander off by probably a good 10 degrees there. Remember it allowed right yaw to wander off by about 10 degrees and just sit off there in right yaw several times. It wouldn't even bring it back.

Conrad Yes. That was the trouble.

FCSD Rep Do you think this had anything to do with your control problem?

Cooper Well, it may have been. It may have been that control was somewhat intermittent right there. I don't know, but it might have been. But Rate Command sure worked good using those same controls.

Conrad Yes. I suspect that being the first time that it was cranked up since spacecraft number 2, it may not have been tweaked as well as it could have been.

Conrad It certainly didn't work like it did on the simulator, I'll put it that way.

Cooper It didn't work properly, and it was no good the way it was. We never used it after we originally tried it out and after we'd tried doing this one burn on it to see if it would hold. The one that it did hold on, our first perigee adjust, it held beautifully. During the next one, it got so bad it wasn't any

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good. There again, it might have been a function of the thrusters going out.

In any event, I think that's an error that somebody needs to look into. I'm not sure that platform mode is doing what it should. I know that, theoretically, and by the diagrams on it and the limits that it ought to be a very precise control mode.

Cooper Spacecraft separation at SECO + 20 couldn't have been better, just fine. Translation perigee adjust went like clockwork.

Conrad That was our first real burn and I think we got something like 9.6 ft/sec on the IVI instead of 10.0, but the burn wasn't that critical.

Conrad I checked accelerometer bias and it seemed like the accelerometer bias increased later in the flight. I specifically checked it for the REP and it was okay. I'd just set up zeros in the window and went to Catch-Up and they stayed zero for 3 or 4 minutes or longer. So that satisfied me. I checked it later on in the flight and I don't think we ran more than a minute and we clicked up a foot per second on the fore-aft window. That can be checked on the tape. In the beginning it was entirely acceptable for the REP.

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Cooper I think we had some bias, just how much I don't know. The timing of the translation was fine, updating was fine. Operations and checklist were okay. Computer usage, okay.

Conrad It was easier to make a burn on the simulator that had no up-down or left and right in it than it was in the spacecraft. Gordo did a real good job of tracking on every burn and I didn't see it wander hardly at all.

Cooper And all the IVI's would be zero.

Conrad And all the IVI's would be zero, but we'd have $\frac{4}{10}$ of a foot in one axis and $\frac{6}{10}$ in another.

Conrad Yes. The worst cross-coupling, we had $\frac{8}{10}$ in one axis, and when we burned in the platform mode, but we were checking that. It could have been accelerometer bias again, or, the spacecraft is more sensitive to picking up up-down and left-right velocities than I thought it was.

Conrad Gordo did a real good job of tracking. He tracked as well as he did in the simulator and we never had this show up in another axis in the simulator.

Cooper It would be zero, zero, zero in the simulator.

Conrad It was hardly worth my time checking address 81 and 82 in the simulator because I could just tell he

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wasn't going to have any velocities in there, and very seldom did. But we never failed to have fairly sizeable ones, like $\frac{3}{10}$ and $\frac{4}{10}$ fps, in another axis and I'm not quite sure how it got there. I guess the spacecraft is extremely sensitive. If you're going to make precise burns, you've gotta really burn precisely and if you want to take out the errors, take out the address 81 and 82 errors so that you don't introduce anything else. During the difficult rendezvous maneuvers, you have to plan on more fuel usage because you're going to have to take it out with the up-down thrusters.

Cooper I think what you're going to have to do is stop short of burning off all your forward or aft velocity, particularly the forward velocity, and then use the canted thrusters to burn off the right-left and up-down and that will take out part of the remainder of the forward velocity. If it hasn't taken it all out, then bleep out the rest of the forward. I think that's the only way you can do it if you want to burn them all to zeros. I don't believe you can track any more precisely if you keep all your IVI's zeroed right down the money. If you burn it off and stop just at the right time so that everything should turn

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up zero, then you still wind up with $\frac{4}{10}$, $\frac{5}{10}$, or $\frac{6}{10}$ in all your windows. I just don't know how you're ever going to do any better than that. (Unless you use the above procedure).

Cooper Translation REP deployment was passable.

FCSD Rep This one you didn't. You didn't fire back at the REP after jettison?

Cooper No.

FCSD Rep Let's replace this maneuver with the simulated operation (phantom rendezvous).

Cooper We did deploy the REP and the radar did operate properly.

FCSD Rep Originally when the debriefing guide was made out, this section covered the translation back after REP deployment and the subsequent translations.

Cooper Okay.

FCSD Rep We'll just have to use the translations that they made on the simulated run.

Cooper We kicked the REP out at 90 degrees right yaw.

Conrad We kicked it out at 02 07 + 15, or 15 seconds late.

Cooper The reason we were 15 seconds late, as we stated earlier, was that going into the night side the night before, after all our careful platform alinements, all of a sudden the horizon scanner began to drop

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out on us and we began to drift off in yaw.

Conrad Dropping out wouldn't have been bad, but when it dropped out it also commanded some thrusting.

Cooper We got some real good blips out of it.

Conrad We were alining in the Horizon Scan Mode and I got the impression that it pitched us up.

Cooper We were already alined, and we had gone to Orbital Rate and Horizon Scan, just to come along there in time to go in. As soon as we had the platform all alined, and before we went in on the night side, I decided I would realine the platform just very briefly. So I had gone to SEF and to PULSE and I was checking and pulsing it. But because then in SEF position all your torquing is done from your Horizon Scanner. When the Horizon Scanner began to drop out we began to get real erratic needle display and it looked like our platform alinement was deteriorating. I was trying to correct this, but obviously, it was really kicking us off. That was when we went to CAGE, tried desperately to get it caged and realined in time, and thought we had it realined. We may have had it reasonably well alined by the time we finally yawed right. It looked like it was. The needles were all zeroed out and

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everything was settled down. The Horizon Scanner was working at that point. It quit working properly after we turned to yaw right. We had already gone into Orbital Rate, so we could care less about the scanner at this point. We got it alined, and we're already in Orbital Rate. We yawed right, got squared away and 15 seconds late ejected the REP on the IVI's all zeroed. We then used a couple of DIRECT pulses, zipped back around, picked it up going around to the 270. It was going right straight out to 270 on our ball. We could see the REP light whenever we were passing through the 90 degree point. On my side, I could see it flashing on the nose. By the time we got around it was in quite close, we could see it going out with a very slow tumble rate, flashing.

FCSD Rep What would you estimate the tumble rate to be?

Cooper It was tumbling very slowly, I would say maybe a half to 1 degree per second.

Conrad I'd say a degree per second.

Conrad I couldn't tell what it was in roll. It didn't seem to be tumbling in more than 2 axes.

Cooper That was hard to tell.

Conrad When I saw it, you could see the dipole come around. We couldn't tell anything about roll, but it was not

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tumbling in the other axes. The blanket was sitting right next to it.

Cooper The blanket went out and was sitting right by it. It went right on out with it. That was the funny part of it. The blanket was between the REP and us.

Conrad Yes.

Cooper The blanket goes out first. The REP has a lot more momentum, apparently the REP had gone by the blanket. Apparently it had either hit it or moved it over or something because the blanket was between us and the REP.

Conrad Yes. I don't know exactly what happened there.

Cooper It was just a few feet outside of the REP. The REP went straight on out to 270, radar was working fine, reading out everything just right, locked on, and went out to the point where it should have started slowing down.

Conrad This is where I had a mistake in the flight plan and didn't catch it. The computer was in PRELAUNCH and I was wondering why I couldn't get any digital readout. It took me a few seconds to catch on to that one and I realized that I had to get the computer into CATCH-UP. We had never run into this problem where we'd gone through a complete insertion checklist

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which calls for putting the computer to CATCH-UP.

I had gone through and zeroed 25, 26, and 27, taking the ascent routine numbers out of it. So that I knew that we were getting the right readings. I had put the computer back in PRELAUNCH, also had this discussion at that time and that's when I didn't blow the cold IR doors until the REP was out.

Cooper I've said it before, and I also said it after my Mercury flight; that is, "If you continually shove things in on people very early in the flight, the quality of it is going to be degraded." You need the first two or three orbits to check the systems over, to get oriented, learn how to aline the platform, to learn how to use the systems, to learn where things are, to do these things before you start giving people complicated tasks. You just aren't going to get the quality out of them unless they're flying exactly the same vehicle for the second or third time and they're very experienced in it and they're familiar with everything that's onboard and there's no change in equipment, no change in control system, no change in any of these things. Then, perhaps they could leap right off and go right into the first orbit and do these things. But to put somebody into

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a strange vehicle, with strange control systems that you've only simulated as about best you can, and no visual simulation available for doing anything out-the-window; you just cannot expect people to stay right on top of things when it occurs in the first part of the flight. This is an ideal example; we had worked and worked and worked and worked and worked to have our timing down just right. If nothing had happened, we would have had our timing down just right and everything would have gone just perfect. Pete would have been right on his checklist and blown the cold IR doors right on time.

Cooper

I'd have been right exactly on time on getting the REP out and everything would have gone peach-keen. Just that one thing, the Horizon Scanner failure, really threw the skids to the thing and caused us to be running slightly late. There was added confusion in trying to figure out how to get things going and salvage the whole thing really threw the skids to it.

Cooper

The REP went out and it continued going out instead of slowing down as it should. It continued to move on out at quite a separation rate. The thing that still has us a little puzzled, instead of slowing

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down and coming to a null out there, it appeared to start moving somewhat at the same separation rate to the south of us slightly towards a trail position very slowly. We tracked it for a long time. We were tracking it straight out and then all of a sudden, it began to loop around slightly to the left.

Conrad It did something like I'd never seen before!

Cooper I'd never seen this happen in the simulator, and it still doesn't seem quite feasible to us that this could ever happen.

Conrad One possible answer, and it's related to something that we saw later in the flight, Gordo, where we alined the platform and had yaw error couple into roll. Might not this have given us bad steering information as far as our radar needles were concerned if the scanner wasn't working properly? We didn't have the platform alined right. We went along 30 minutes, almost one-third of an orbit. If we didn't have an alined platform, that would start coupling up in some other axis like roll and we would be off in yaw. Then when we thought we were pointing at the pole, we really weren't. Maybe it didn't really drift behind us, maybe it stayed out on our wing. We must have put it out fairly well

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out of plane, in that it hung around us so darned long.

Cooper It stayed with us for 20 orbits!

Conrad We saw it until the light burned out. It was never far away from us. During five night cycles it was close enough that the flashing light illuminated the spacecraft. At the proper times, when we would get nodal crossing, when we turned around and actually saw the REP it was very close.

Cooper We thought we were going to hit it.

Conrad It was bright enough to illuminate the spacecraft and the flashing light really impressed me.

FCSD Rep Did you take pictures?

Conrad Yes, I think we have some 70-mm Hasselblad pictures and I took 16-mm moving pictures.

Cooper That was the last of the REP exercise.

Conrad I understand all the movie film came out, too. So you'll have pictures of it.

Cooper At this point, we were rapidly running out of cryogenic fuel cell oxygen. We decided that the only way we were going to salvage the flight was to stop using it at this rapid a rate. We had to make the choice whether we were going to power down and continue the flight, or whether we were going to end the flight very abruptly if it continued going down

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at this rate.

Cooper We had a short discussion on this and decided that we'd better power down and forget the REP because we were in trouble.

Cooper So we tearfully decided to give up the REP and power down. Houston agreed with us when we got in touch with them that we had done the right thing. That ended the REP. We did see it for quite a few orbits later. Then Houston came up with the simulated Agena rendezvous exercise, which they put on one of their computers. The three burns they gave us to do went off very satisfactorily, the thrusters worked very well. They would not allow us to use anything but the aft firing thrusters because they wanted to keep the cryogenic oxygen in the right position in the cryo tanks. Apparently the burns went to their satisfaction too. They seemed to feel that it put us right where we should be.

Cooper We tried one of these burns with the Platform Mode. It did not work satisfactorily so I used Rate Command which worked very well.

Conrad We tried to take the errors out and that's where we got into trouble. We had about a $\frac{3}{10}$ error left and right and a $\frac{3}{10}$ error up and down, so Gordo fired off the $\frac{3}{10}$

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left and right. We wound up with too much going forward and we started to back up and suddenly we remembered we couldn't back up so then we decided well, we'd just leave the errors on the burn and burn it the best we could because no matter what happened we're going to translate into forward and what we should have done and we didn't think of it at the time--but you learn--we shouldn't have burned all the forward--we should have burned down to about a foot of what we were supposed to have forward and then taken out the left, right, up and down and go ahead and burn the forward again.

FCSD rep

The updates that they sent you on--

Conrad

That worked fine. There was no problem.

We copied the numbers down, entered the computer. We had plenty of time to make the maneuver. We burned right on the clock as advertised and we seemed to have gotten approximately in the position they wanted us to get to.

FCSD rep

What burns did you simulate?

Conrad

Well, we did a--I've got them right here.

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Cooper We did a separation burn and we did a closing burn and a coelliptic burn. Those the ones we did, Pete?

Conrad Well, it was--

Cooper We did not a standard coelliptic--it was a--

Conrad No, we did a maneuver burn, which as--wait a minute--we did an apogee adjust maneuver which was a retrograde of 20.1 feet, then we did a phase adjust maneuver which was a forward burn of 15 feet. No.

Cooper Yeah.

Conrad 15.8 feet, then we did an out-of-plane burn, yawed left 90° of 15 feet and then we did a reverse coelliptic burn--

Conrad We burned--let's see--we burned 16.4 feet forward and we did four burns altogether.

FCSD rep Aft thrusters for all?

Conrad Aft thrusters for all--on out-of-plane-- and that was the only time that we did ever, ever fly the translational left, right, up, down thrusters. We used them to take out some of the IVI readings there

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a couple of times. And they were very straight forward--left, right, up, down.

Cooper We even fired the forward-one quick little blip.

Conrad We fired the forward one then we suddenly remembered we weren't supposed to.

FCSD rep What kind of visual out-the-window did you see on these translations? In other words--

Cooper Left/right lights things up real well-- I could see the glow from the aft--they were--

Conrad J. B. is referring to visual cues on the horizon and we were on the gages--

Cooper They were at night--middle of the night-- everything we did was in the middle of the night--this spacecraft only ran in the middle of the night (laughter).

Conrad I really don't remember making a burn--

Cooper We never did anything in the day--

Conrad Yeah, I think one or two of them were on the day side--but by and large--

Cooper I never did so much night work in my life--

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FCSD rep OK- well, I don't think there is much we can add then--did you get all of these readings out of--

Conrad 80-81-82-58-59-69- Yeah, that stuff works just like the simulator. We got the readings.

Cooper OK - On to 8.3 - RCS.

8.3 RCS

FCSD rep Let's go into the RCS - yeah, I don't think there is anything more--

Cooper This is all--

Conrad Yeah, this is all we can do on the REP.

Cooper OK-RCS Operational Checks - We did just like we had planned in our little book. We activated the RCS and Check Ring A and ACME and direct--all three axis- Ring B - Check Ring B in ACME and direct--all three axis and they worked beautifully.

FCSD rep How about the pad checks--were they--

Cooper Negative

FCSD rep No pad checks?

Conrad Not with the sealed system--

Cooper A sealed system - I'm glad it was--

Cooper Control Modes - We used pulse and we used horizon scan--

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Conrad We didn't even check reentry rate command--

Cooper We used direct, used pulse. We used the rate command. We used horizon scan.

Conrad I know what it was--why don't you tell them about this--and I'm going to see if I can get the fuel figures--

Cooper OK. And they all worked very adequately. I thought the rate command system, I mean the RCS system was an excellent system. It was really crisp and just really, I thought, it was a real good solid system. Rate command was much more--

FCSD rep What about the retrofire - how did it hold retrofire?

Cooper Beautifully, it was just no effort at all-- hold--

FCSD rep + 1 degree or less?

Cooper Oh, yeah, easily. We had a little offset in number 3 and number 4. I could feel them offsetting us. I just cranked in a little bit of RCS. Boy, it just glued it right in there, it just wasn't about-- I felt like we could have had four or five times the offset we had--and never have

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budgeted it off there. RCS, I mean the rate command--One thing on rate command before retrofire and just after retrofire, waiting for retrojet, and then starting the pitch up to go up and roll over inverted and go to zero lift, the dual ring rate command is just more than you can handle. It's just a lot more than control authority than you want--you tend to over-shoot on things because there is just so much control torque in there. As I had stated, after I fired retro and jettisoned the retro pack and pitched up to roll over then from thereon I went to single ring pulse, and used that. Reentry rate command--we didn't use. Direct - used direct to do the reentry on single ring direct and used the pulse mode from retrojet to 400K.

FCSD rep: On the single ring direct reentry did you have--did you feel like you had all the authority you wanted?

Cooper: Yeah--until very late--as I stated some time down, oh, half way thru the reentry

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where you really begin to get the high g, after your high g, in fact, along about coincidental with a real high g, when you begin to get some fairly good oscillations, very rapid rate, I had no problems damping them at all but I didn't have the time to keep switching back and forth from rate to attitude and go back to rate and damp them real quick and then go back to attitude and decide where I was on the guide and then go back to rate and damp them and go back to guidance, so I finally--they got to getting fairly good where I had to devote a little bit of time to damping them, and I finally just went to guidance and stayed on guidance and just flicked over to single ring rate command to damp the oscillations and then used the attitude control in the rate command to steer the computer steers. Which worked out very well and there was--there never was really any oscillating--you never really--I could go to rate on there and you could hardly ever see the rate needles

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jiggle--single ring was holding it just as tight as could be. Retrofire attitude control - I had already mentioned on there--dual ring. Rate Command, reentry attitude control--I had already mentioned how we shot the reentry. No primary heater lights. Heater lights on the RCS - they were on practically--we had the heater on 99 percent of the whole flight. We turned it off, got heater lights on Ring A first, brought the RCS heaters on then rechecked--heater light went off and turned the heater off and about five or ten minutes later--fifteen minutes later, the heater light came on and then it was on Ring B and we turned the heater back on and this went on five or six times and finally we just turned the heater on and left it on the whole flight. I monitored the temperatures frequently throughout the whole flight in the RCS Ring A - temperature ran about 70 degrees or about 65 degrees and the RCS Ring B temperature ran about 70 to 72 degrees the entire flight. At

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one time I noted the RCS Ring B was up to 80 degrees. I watched it quite closely for a while and then it never went beyond that and came on back down to about 70. And they stayed there essentially the whole flight. I think you need those heaters on obviously the whole--all the time--I'd never have any of them off at all now. Thruster firing comments. When the RCS thrusters fire at night they blank out whatever you are looking at in the night side. The only way you are going to use any night attitude reference is to watch what you are doing, get lined up in a reference and then fire a thruster and plan on waiting a few seconds before you can tell where you are at again. They really light up the place. When you are firing them at night.

FCSD rep

How far does the flame stick out?

Cooper

The plume goes out about--appears to go out about 4 feet and the plume is just the width of the outside diameter of that thruster as it comes out--it has a little bit of expansion ratio as it comes out and it goes

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right up just about that size--it grows very slightly but not a heck of a lot and so it's just about something in the order of 4 inches diameter. Something like that--it has little expansion ratio--it expands as it comes out the nozzle slightly, and then it just goes sort of like a column and it fans out very slightly but it goes up something in the order of 4 to 5 feet distance from the thruster.

FCSD rep

Did you ever get any pictures of that?

Cooper

No, we didn't. We had all our cameras stowed at the time we got that cranked up. We intended to. Systems Shutdown - It worked just like advertised and we turned the prop valves off, very shortly then it runs out of fuel and stops firing and you notice that there is a little burning around all the nozzles. There we got a little residual fuel--not much--just a little bit--it dribbles and fumes after impact--probably very negligible. I don;t really think we got them after impact, I think we got them while still airborne. But they were almost

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negligible--you had to really be looking for them to tell they were there. There was just a very slight musty odor in there--fume. Not sure--I'm not sure that part of this odor isn't part of the ablating going on because fiberglass ablates with pretty high fume rates. Some pretty pungent fumes off-ablating fiberglass.

8.4 ECS

The mobility of the suit is no better or no worse than any other suit. It--suit definitely cuts you down and decreases mobility. In anything you do, it just limits you in what you can do, limits the movements you can make and I'm talking about unpressurized mobility at this point even. We didn't do any pressurized work in the cockpit but to unpressurize the suit definitely cuts you down a great deal in your mobility and where you can reach and takes up a great deal of room. Pressure - Are they talking about pressurized suit work here?

FCSD rep

Well, since you didn't do any pressurized, how about the half pound and--

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Cooper

Yeah, when you are sealed up in it it gives you about a half a psi in pressure in there which doesn't decrease your mobility a great deal over what the regular suit does. Temperature in the suit, I certainly can't complain there. I had to sort of eat crow on that. That suit circuit ran consistently. We had to really shut it completely down to get above 55 degrees temperature on the suit heat exchanger outlet and generally it ran around 50 degrees which just froze my rear off and I had my suit flow.. the general configuration we had was both of us had the suit flow rates quite a bit back. I had mine clear back to almost a minimum position and we had the suit coolant loop shut down to where it was just about a half to one notch open from the fully OFF position. I really got quite concerned that they were going to freeze us to death. In fact one whole night side I had my suit inlet exhaust hoses off and laying down alongside the seat because it was just too cold in the suit. Humidity.

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The suit seemed to run pretty dry. I wasn't conscious of any great amount of perspiration in it at all. A couple of times when we had fairly heavy work loads I was aware of the feeling of cool air and felt like it was drying sweat. CO_2 . We got 2 or 3 indications of CO_2 on the PCO_2 gage. One thing, whenever a station sends you a calibrate, well, you get a big jump on that gage but there were other times when we weren't even near a station when that gage came up and began to give an indication and one time it gave such a positive indication for quite a period of time that we got a little concerned about it because it was right when all this other stuff was going, on day 5 and we'd shut down control systems had failed and we were destined for 3 days of drifting and the PCO_2 started up. So we pulled out one of the tapes, one of the CO_2 tapes that we had onboard. It showed it was below 2 mm of mercury, below that anyway. It was this usually erroneous gage. The suit comfort is no damn good. It is worse than any

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other suit but there just isn't any way of having comfort in a pressure suit.

Damn thing gives you pressure points and bulges and gouges and cuts down, scrapes you here and there, prevents you from being able to stretch and scratch and have any comfort. There isn't any comfort in a suit.

I don't give a damn who says so. There just isn't any real comfort in a pressure suit.

In the configuration that we flew in from the time we got 6-4 GO, our helmets and gloves came off--were stowed in the footwell, and they were never put on again until just before retrofire. We ran the whole flight in just the basic pressure suit torso with the neck dam on and the wrist dams on and with the light-weight headset and I guess the comfort was as good as you could possibly have, but it still wasn't any good and we cuffed the pressure suits plenty of times.

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Cooper Humidity. The suit seemed to run pretty dry. I wasn't conscious of any great amount of perspiration in it at all. A couple of times we had fairly heavy work loads, I was aware of any little cool air and felt like it was kind of drying sweat. CO_2 . We got two or three indications of CO_2 on the PCO_2 gage. One thing, when ever a station gives you a calibrate well you get a big jump on that gage but there are other times when we weren't even near a station when that gage came up and began to give an indication and one time it gave such a positive indication for quite a period of time that we got a little concerned about it because it was right when all this other stuff was going on, day 5 and we had shut down, control systems had failed and we were destined for three days of drifting and the PCO_2 started up. So, we pulled out one of the tapes, one of the CO_2 tapes we had on board and gave a check of the suit circuit there and it showed that it was below 2 millimeters of a, two millimeters of mercury was what it was ... below that anyway. We probably assumed it was this usually

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erroneous gage. The suit comfort is no damn good. It's no worse than any other suit but there just isn't any way of having comfort in a pressure suit. The damn thing gives you pressure points and bulges and gouges and cuff dam scrapes you here and there and prevents you from being able to stretch and scratch and have any comfort. There isn't any comfort in the suit, I don't give a damn who says so, there just isn't any real comfort in a pressure suit. In the configuration that we flew in, from time we got our 6-4 Go, our helmets and ... gloves came off, were stowed in the foot well and they were never put on again until just before retrofire. We ran the whole flight in just a basic pressure suit torso with the neck dam on and with wrists dams on and with a light-weight head set. I guess the comfort was as good as you could possibly have, but it still wasn't any good and we cussed the pressure suit plenty of times. The controls were good on it. No problem there. The O₂ Demand Regulator, as far as we could tell, worked fine. We had no real occasion to really stress it much or anything. The suit umbilical was always in the way. Both my inlet and my exhaust

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made my whole chest and rib area sore from the mainfold, the end inside the suit being gouged over, being cantilevered over and digging in side ways on me. So, it's a real pressure point. It was the worst pressure point I had were from the suit hoses, and I had my suit hoses deliberately longer than people said they should be so I could get away from this effect. So, I did have slack to prevent them from getting drug over but even so they bothered me. Finger tip lights were good and I kept one glove out and kept it over on a piece velcro on the side to use in the event we had any kind of cabin light failures. When Pete was asleep I frequently used my finger tip lights on that glove to light up some of the gages to look around with. Cabin pressure sealed off high on our gage. This is under section 2, Cabin. Our cabin pressure at launch sealed off high at about 5.9, which it always did in the attitude chamber in all the runs we made, in fact, in just exactly the same way. Then it bled down slowly to about 4.9 and never budged from there the whole flight. It stayed right there. We never saw one flick out of it at

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all. Cabin temperature ran 70 to 75 degrees and humidity ran about 62 to 67 per cent the whole flight. We have the figures somewhere here. We can get in here and get those out, but we have the figures where we ran daily checks; at least once a day and generally two or three times a day, of the wet and dry bulb readings.

FCSD Rep Okay. We have that back in the original check.

Cooper Okay. CO₂. The cabin, I thought was just really good. It was very seldom that you really got any smell in the cabin at all. We thought the cabin would have a dark green cloud evolve out of it when they finally opened it, but I think the cabin, to the time we landed, was still a pretty fresh cabin. It seemed to scrub the odors, defecation odors would linger on for two or three or four hours perhaps, but it even scrubbed those out. You couldn't smell them at all. CO₂; we had no--any kind of CO₂. Comfort day or night. The cabin ran too cold at night, particularly when we were drifting and had some fairly high drift rates the cabin got quite cold and in fact even froze up the windows. The cabin fan we never used at all until we turned it on just before retrofire;

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about 45 minutes before retrofire we turned the cabin fan on and let it run for about 30 minutes and it decreased the cabin temperature about 20 degrees. Got it down about 50 degrees and then turned it off prior to starting retrofire. Cabin pressure relief valve; never actually did we ... the cabin pressure dual regulator, the release side of the cabin pressure regulator was the only one that ever We never heard the cabin relief valve actuate after launch. During launch we were going up we heard it moan a couple of times. The cabin vent valve. The cabin vent valve, we actuated it on the way down once since we couldn't maintain positive pressure we actuated the vent and the snorkel. Cabin repressurization. We never checked it because we didn't need to. Cabin air inlet valve. We actually never ran any check on it. Cabin air recirc, we had open the whole time. Fully open. Primary O₂. System monitoring, system monitoring was easy. Primary O₂ was very good. The only problem we had with it, it kept yawing us around when it was venting. Whenever it would get up to vent pressure and vent, why, it would give us a bit of a yaw, left

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yaw. Build up to any rate you wanted to. Over a period of time, one time we got up to about 12 degrees per second. You just sit there, and drift it will build you up more, and more and more. You can really hear it pop off back there. You can hear it "shhh". You see this tremendous big field of stars go by. If it's in the early or late night you just, the whole sky is just completely covered with this, just millions of stars...particles, liquid gases ... I guess. Quantity measuring system; worked perfectly satisfactory. Flow rates were good. Pressure was ... pressure was fine. It got up; I don't think you ever need to use, unless you are doing something like EVA, I don't think you ever should consider ever using a heater on that oxygen system because it all by itself fairly rapidly gets on up there to boil off pressures. Boil off temperatures I should say.

FCSD Rep How about HIGH RATE. Did you ever use that?

Cooper Used O₂ High Rate when they were purging the cabin. It worked fine, reset fine. We used it then for landing. Manual heater we never used. The controls; we did very little as far as doing anything with

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the . . . Secondary O₂. Mine was open, Pete's was closed the whole flight. That's the way they stayed, just like for the check list. Never saw one quiver in either one of them the whole mission.

FCSD Rep Pressure stayed right?

Cooper Pressure stayed right where it was on launch. CO₂ partial pressure. The gauge was somewhat erratic and gave us two or three readings that we had CO₂ partial pressure, one of which we finally checked and found we did not have and so then we disbelieved the gauge.... After that, although it generally read down at zero. Coolant: Coolant loops worked real fine. ... we were running two coolant loops ON most of the time since we had fuel cells running. For 2 twenty-hour periods we had fuel cell, section 2 of the fuel cells shut off, and the coolant loops shut off. In one period of time we had circuit breaker pulled on coolant loop number 1 coolant loop. Secondary coolant loop, then we were running on pump B and with bypass ON. Bypassing it around so we were heating before bringing the section 2 back on the line after long shut down period we bypassed the coolant loop, the secondary coolant loop, in order to warm

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up the fuel cell section and then went to normal configuration right on the line. Evaporator operation: for 45 minutes the ... Oh, this is not the suit. Yes, this is the water evaporator. 45 minutes after launch we got yaw deviations from the evaporator and after that they stopped. Somewhere just slightly beyond 45 minutes they were gone. By the time we got around one orbit anyway, I didn't notice any at all. Water management. Well, we ran the water management in the normal mode all the time. In our configuration the normal mode is the drink mode. We ran NORMAL, NORMAL, NORMAL and OFF the whole time. The only time we went to OFF was when we went to over-board and the FLUSH position on the urine heater system and they all worked fine. No problem at all, and the water was excellent water. It was full of air. It had a lot of air in it, a lot of air bubbles, but they didn't seem to effect us adversely. We decided to go ahead and just ignore it and drink it and it seemed to work out fine. The water was really nice and cold the whole time, so it tasted good. No objectionable taste to it at all. I thought the water was excellent. Humidity sensor.

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Yes, we took it. It worked fine. It dries out very rapidly; you have to refill it with water frequently, but that is no problem. The drink gun fills it very readily. It seems to be pretty accurate. Stowage, of course, is always a problem and we obtained readings at least once a day on it.

8.5 Communications

Cooper Communications. Interphone: operation and quality were excellent. UHF performance: countdown was excellent, orbit was excellent, and recovery was excellent, except that nobody was receiving our transmitter in the recovery area. However, they were receiving it back here in Houston. Twice AIR BOSS finally shut up talking long enough, said "some other station calling me say", and then immediately he'd launch off into another long spiel and I don't know whether he was just drowning us out or whether they just never got us. At any rate, nobody was getting us, except Houston, a couple of times. But the UHF performance in general throughout the whole flight was excellent. And even AIR BOSS received when we were on our way down in the parachute. He got two steers to us on the way down. Voice tape recorder worked

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fine for two cartridges worth and then quit.

FCSD Rep Was it two or four?

Cooper I don't know, it was some low number. Maybe it was four. Anyway, it quit fairly early in the flight. The tape recorder was finished. DCS. Okay, until the last 30 minutes of the flight, the DCS couldn't have been better. The updates were good, the ground coordination was fine on it. The things they gave us to put in the MDIU were given in a good manner and were put in. No problem. Pete got them all loaded in fine. No problem at all until that last up-date we got from Carnarvon which they updated us with our computer and reentry configuration, after we were all ready supposed to have our last update from Houston and without telling everybody to look on his board and see what mode our computer was in, he sends this update which is just about ... blew our cork there. And which I think at this point right now, having experienced this one occasion of this happening at the worst possible time it could happen in, my recommendation right now to flight crews is that they fly the DCS circuit breaker in the OFF position.

FCSD Rep I concur.

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Cooper That's a drastic move to make, but just that one experience was just enough to convince me that **if** you can't 100 per cent trust everybody and the system isn't going to work, then you just don't dare trust it at all. I wouldn't even think of not flying again with that DCS circuit breaker ON.

Conrad At least for reentry.

Cooper At lease in crew

Conrad You couldn't have hurt us any better than by sending that load up.

Cooper Real-time transmitter, delayed-time transmitter, fine. Stand-by transmitter

Conrad We were out of fuel on Ring A. And we had 4.9 and 4.6 left in Ring B. Which is good. It says that Ring A ran out sometime after Ring B came on, which says we went around the world 1 1/2 times and re-entered on Ring A by itself. That's pretty impressive. 33 pounds of fuel It also shows you how much fuel we used in Ring B. We tested Ring B and turned it off and didn't turn it on until sometime less than 70,000 feet and turned it back off again at 30,000 feet so we used the majority of the fuel on RATE COMMAND in Ring B from 65 to 30 which says it probably fired continuously all the way down,

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damping those rates. But it sure was steady. We used almost 80 percent of the, yes, 80 percent of the fuel in Ring B from 65 to 30.

Cooper 65 down.

FCSD Rep On this voice tape recorder. Didn't you say it broke after you got 4 tapes.

Conrad Yes, what happened was that the thing worked just like advertised. Two minutes before the tape ran out you get the little flicker on the tape recorder light which is now up on the caution and warning panel, and at the end of the two minutes the TAPE OUT light comes on steady and that operates just as advertised and then one day I put a new tape in it and Gordo and I held a big debriefing on it, About what all our storage was and present configuration that we were in in the spacecraft, and what we thought the six, I mean, that the seven troops would want to know about how we were using our storage and we thought the best place to do it was in flight right there while we were using it and we really put down some good dope and we also had some thoughts on Apollo on the darn thing and I figured we talked at least an hour on the thing, and I couldn't understand why it hadn't run out and

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I looked down in there and I marked the tape, you know with my pencil, and put it back in the tape recorder and turned it on and sure enough it wasn't running. The motor burned out in the tape recorder. Now, when I turned the tape recorder switch ON and OFF I could see a slight rise in the ammeter but I think what was happening was that we were getting the amplification part of it, but that the motor to the tape recorder was not running, it wasn't driving the tape. That seemed to be the failure.

FCSD Rep While we're here why don't you flip back a couple of pages while you were out and see if there is anything that you want to add.

Conrad Okay. Yes, Gordo covered the heater operation on the ECS. Okay, they came on pretty early in the flight and we kept checking to see that it was truly working and it was. System check covered the fumes and we got fumes at 27,000 and we were very light because we did have the

Cooper Under ECS I covered how you loved your pressure suit for mobility and comfort.

Conrad Yes, okay. I won't say anymore on that.

Conrad Finger tip lights. Listen, now there's a very in-

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teresting thing. The finger tip lights were the only darn lights we had in the spacecraft that we could move around, which is ridiculous. We kept holding a glove up once in a while looking at lights all night because we

Cooper They sure were

Conrad We had the gloves stowed and I broke my auxiliary light because it was too hard to hold there. When I pulled it out, the very first time I pulled it out I shattered it and Gordo never used the one on his side because it's just not handy. What you really need in there is, we've got to quality one of those little pen lights.

Cooper One of those little pen flash lights.

Conrad A guy really needs one of those little pen flash lights up there and I really wish that we had taken the ones along but we couldn't get them qualified. They had an open switch in them and we couldn't get them qualified for 100 per cent oxygen.

Cooper You really need a little light that doesn't have an electric cord fastened to it that you can just stick in your suit or on a piece of velcro where you can just get to it and use it, you know.

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Conrad There is plenty of time at night when you are flying. Now the worst thing at all was a guy sleeping. If you turn on your instrument panel lights it only lights your instrument and the thing is you are interested in most is that center panel with the cabin press and the secondary O₂ and all these things in it. So, the big thing is that you need an auxiliary light in there, like a pen light.

Cooper Yes, you did.

Conrad The umbilicals: I had about the right fit on the umbilicals and all that sort of jazz. The cabin press was great. The thing locked up a little high on lift off like it was supposed to but then a 4.9 never moved. We covered the CO₂ bit. Did you cover the comfort day night and how the high rotation rates that effect us? We never used the cabin fan except just prior to lift off where it is called for in sequence and when we put the cabin cooler to the full cold position and brought on the cabin fan and flew it through re-entry that was it. Primary O₂ did vent quite a bit. You covered that.

Cooper Yes.

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Conrad I'm sure that's all for now. It never bothered us, of any odor. The normal type venting system worked fine.

Cooper I covered that on the CO₂ partial press

Conrad Did you cover the coolant splashing all over the nose of the spacecraft just after adapter sep. That must have been coolant, it's the only thing I can think of that wouldn't be frozen up there. But it was liquid and it actually splashed on the nose after adapter sep and retrofire. It came around behind the spacecraft and I saw it splash and the marks are still on the nose of the spacecraft where it hit. Water management I thought was great except it had air in it. It did have air in it but pressures were good, the water was cold, it tasted good, but we did have air in the water and it wasn't the amount that we had at the factory, but there was air in the water. You could see it when you filled your darn rehydratable food bags.

Cooper Yes.

Conrad But, it was good water.

Cooper I covered the humidity sensor, we used it ... communications, I don't think you say anything but

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excellent on that.

Conrad They were great. Even the UHF worked well. I mean HF.

Cooper Voice tape recorder. Then we were on. I just covered that. It didn't work.

Conrad Did you cover the ... the exact details on this DCS? How we didn't get the light. The only time we didn't get the light.

Cooper No, I didn't cover the details on that except just that we had gotten DCS unforecast over Carnarvon after when we already had our load in from Houston, and then it came on unexpectedly, not even checking to see what mode we were in here. We were in re-entry mode and sent us this DCS updating our T_R and updating our load, DCS load there, and just as he said he was sending, why rapidly then we switched out of reentry to prelaunch but never got any DCS light on either the T_R or the load.

Conrad Yes, he sent two separate commands, and theoretically the light should come on each time but I never got the lights, so I'm highly suspicious of what happened and I've got to have an explanation why this load....

Cooper Which he verified to the cores and they checked out

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all right.

Conrad Yes, it was address 03 and address 10 and they verified okay and that seemed to convince everybody except me that the load was correct and my mistake, in retrospect, I should have made them transmit the load and either satisfied myself that the DCS light had burned out, or that the operation did take place truly in the manner in which it was supposed to and it did light the DCS light. He knew the T_R was right because he had his T_R clock synched in with the spacecraft T_R .

Cooper And he assumed the load was right because he got maps back on it, but I'm not too sure I

Conrad Yes, that's pretty dangerous. Pretty dangerous.

Cooper I think this is it as I just pointed out to J. B. and we were discussing in the corridor here, my feelings on it are right now are real strongly, that my recommendation would be to pilots during really critical time periods, "I'd just turn the DCS circuit breaker off." I wouldn't even fiddle with it because that one violation that of everything we had agreed on has just completely destroyed my confidence in the whole set up. That's all it takes is that one time just to completely foul you up.

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Conrad Big Brother.

Cooper Yes sir. I do feel that way, I really do. Okay.
Let's see, all this real time, delayed time,
standby, that all worked fine, I thought.

Cooper Yes, we had real little trouble.

Conrad The coordination with the ground really in general
went excellent.

Conrad Yes, the only guy that had any problem was Guaymas
doesn't have a command system so, poor old Guaymas
was stuck when he was first to pick us up coming
into the states with having to call us and tell us
to turn on real-time and ack and then the Houston
people would have to remind us to turn it off again
but the rest of the flight the command system ran
that telemetry and dumped telemetry and everything
else just fine as far as I was concerned. We
were glad not to be bothered with it.

Cooper Communications control and switches. The VCC. Man
I tell you, that really worked slick, except those
damn rubber guards on there. Those have got to go.

Conrad Yes. The cabin is dry enough. The only reason
I can see they need them on there is in case you had
a catastrophic water spillage which you do very
easily have....

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Cooper Yes, I pulled my ear plug and put the ear plug right in the bottom of my ear where it was barely hanging there and I could hear anybody calling then. Then I put the plug back in. I thought the quality of the communications was really, as far as we were concerned, in the air anyway, was excellent.

Conrad Our beacons worked satisfactorily both adapter and reentry, C band beacons most of the time they were in the command position, the people used them as they wanted them.

Cooper Let's see, the sleep configuration, we covered that, yes, that worked fine.

Conrad Antenna selection. I went to adapter and I really couldn't tell much different and then we decided we would go back to the check off list which called for reentry. Oh, I know how I got in adapter position.

Cooper Somebody asked you Oh, it was that test.

Conrad Yes, it was the UHF test that we pulled and we were switching from reentry to adapter, from reentry to adapter, and I finally left it at adapter one time and the thing was working just great as far as I could tell.

Cooper Yes, it was there for a day or so.

Cooper Yes, it was there for a day or so. I really

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Cooper You could dump OUZD or something.

Conrad Yes, I

Cooper But the neoprene things are hard to see through, you could actually push them up to the control knob to read what you got on there.

Conrad Let's face it Gordo, once we got those controls set, we never moved them.

Cooper Yes, that's right. Once you set them you very seldom ever set them from there on. So, I guess it really isn't too bad. It's kind of a Mickey Mouse thing, and it works, I guess.

Conrad Those light weight head sets. Those Plantronic head sets that we had, I don't think anybody can argue about the voice quality and they are really comfortable up there.

Cooper Yes, and they were really good reception, too.

Conrad Just pull a plug out of my ear and let it hang and turn the sleep switch on when I wanted to sleep. Never took the think off my head in 7 or 8 days I don't believe. I'd sometimes take it off and hook it under here for sleeping, but after a while I just got so used to having it on my head I just unpull the ear plug and let it hang and turn the sleep switch, and the sleep switch worked great....

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couldn't see, we didn't have too much problem with that, but they wanted it back to reentry and I presumed that they will get the right data out of that UHF test to know what's wrong with the adapter antennas, if anything's wrong with it. But we stayed in reentry configuration most of the time.

Conrad ETM controls?

Cooper We didn't have any problems with it.

Conrad We had no problems there at all.

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Cooper Electrical system monitoring.

Conrad Well, I can't say enough for the fuel cells, they really performed they --

Cooper They sure did, boy those little rascals really work.

Conrad The purging, I recommend that we change those purge switches, and I don't think this is dangerous. I recommend that we change those purge switches to three position. Maybe guarded ones. Yes, maybe guarded ones.

Cooper What you might do was put a little three position guard there.

Conrad But that spring loaded business, that spring tension on those, so I tell you my fingers are still sore from doing that. I used my toothbrush that's what I used all the time to purge them with. You had to jack them up with your toothbrush because we've got them guarded and they are spring loaded, and you just don't think about it but you just try and hold that spring in that position for two minutes, it's like a year.

Cooper Particularly under zero g. You don't have anything to push against.

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Conrad So I recommend they make the purging switches.

Well, I recommend that they either come up with a gimmick that you can insert on the switches when it is time to purge so that you can flip them on and time it and then flip them off, or they make the switches three position. Especially in that 14 day flight. You purge every 6 hours you know, and that's minimum. If you are running higher loads you are purging every 4 or every 2. So, that's quite a chore and it's like house keeping. Those fuel cells have to be purged and 5 minutes of switching is what it takes, holding those spring loaded switches.

Cooper 2, 2 and almost 1. Yes, 2, 2 and half a minute. 26 seconds. That's really hard on the fingers, hiding behind these guards we have, makes it even more difficult but the guards should be there. Let's see, monitoring electrical power remaining.

Conrad There was no big argument there.

Cooper No problem there at all, just watching the hydrogen fall.

Conrad They were either there or they weren't.

Cooper Ground information required to complete mission.

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Well, that there again. The cryos were really the only problem we had with electrical. The main batteries ... the times that Pete touched them they were just exactly like advertised.

Conrad Yes, they were $22\frac{1}{2}$ volts every time we tested them.

Cooper No problem at all. Squib batteries were fine, no problem.

Conrad Squib batteries came down about, I would say $2\frac{1}{2}$ volts during the whole flight. We started out with a common control bus that had been $27\frac{1}{2}$ volts and at the end of the flight it was 24.7 or something like that, 24.8 or something. It came down about 3 volts. But one thing that nobody ever told me, was man, when you fire thrusters and things like that you can see a lot of transients on that common control bus. That thing really gets to oscillating up and down. I wasn't sure something wasn't wrong at the beginning, and I just pass that on as a tip to people who go later.

8.7 Onboard Computer

Cooper Onboard computer.

Conrad I can't say too much for the computer either.

It worked fantastically.

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Cooper It couldn't have worked better. It really did.

Conrad The IGS Guidance was indicating everything that we did. We knew that we were going to loft a little bit and boy, it showed that we should pitch down at second stage and RGS did pitch us down, and when it pitched us down and put us on the IGS was centered up. I never saw any big needle deviations. I didn't see this big pitch transient at the end of the flight. I think it did wander just a little bit in pitch but none of this off the scale stuff. It looked like it was on the money all the way, and I felt that if we ever switched we would be right down the pipe with it.

Cooper Yes. I did too. Real good.

Conrad In the insertion, boy, that math flow 6 came up with all the right numbers. The numbers were just right. You didn't read the numbers. Where the tape began the numbers were on the money. Address 72 was 25,808. Address 94 R dot was plus 20 feet pga. 97 was plus 2 feet. 52 said we had a perfect insertion that we had no apogee adjust. At perigee there was 00000 and then calculated, even though

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we didn't need one, the directions should be applied at 3,042 seconds and the nominal value is 3,008 seconds and I just don't think you can ask for better computations than that.

Cooper Okay. I think that everything that we did on it worked out quite well.

Conrad Catch-up mode worked well. The the one thing it did though, there was one anomaly that I saw on there and I almost had a heart attack at the beginning of the flight. Remember, we got into orbit and I don't know whether I did it or what, but I got in the mode where I got the darn IVI's running and it wouldn't stop running, and the worked until I switched into pre-launch nav again a couple of times and I finally got the IVI's to quit and then I was very careful about how I did any switching after that and I don't know what that was. I'll have to sit down and talk to the computer people about that. It seemed to me that what I did

Cooper It happened once more.

Conrad Yes, it happened one other time and we got out of it by going to pre-launch and letting it sit for

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awhile and it finally ran itself out and stopped. But it looked like the accelerometer bias took off or did something that just made IVI's run. I don't really understand what happened but I wanted to note that an anomaly. I felt that the thing was running right and that this might have been a little glitch so I didn't report it to ground because, well, later on we didn't really have any need for catch up or anything like that and it seemed to operate okay.

Cooper Okay, let's see. Orbit maneuvers. I don't think there was

FCSD REP How about the powering down and powering up?

Conrad It shut down and started up just as advertised. ON with the on switch and 18 seconds it went through it's self check and the green start comp light came on green and it did it every time.

Cooper Okay, Orbit maneuvers we have already covered that.

Conrad We powered it up for all our updates and it accepted it every time, no strain.

Cooper Retro fire, you got those numbers through. We gave the number to IVI's after retro fire. Read 269 aft and 10 left and 181 down.

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Conrad 10 left and 181 down, 269 010 181.

Cooper Yes.

Conrad And as soon as those retro's fired the light came on green and it went right into reentry guidance ... reentry guidance

Cooper Reentry guidance was right on the money when it came on, it came on exactly on time. Roll needle, roll bug

Conrad Stopped at 400,000 feet, right at the time Houston gave us our computed time to 400 K.

Cooper And the 290 K steering commands came in just right. Came in just where they should, the direction they should come in and everything.

Conrad At about the right magnitude

Cooper And about the right magnitude. Then the problems started.

Conrad And that was the loose nut on the ground and not in the air, fortunately.

Cooper MDU, that worked fine.

Conrad That apparently worked fine.

Cooper Computer modes. Let's see, pre launch worked good. Ascent worked beautifully, catch up we didn't really do any catch up except the one

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Conrad Now, there was one thing there, I don't know if it was the radar or the computer. But, the first time we flew over the Cape and locked up on the back up REP on the ground, it read out the digital millage to a gnat's eyebrow. It locked up at 248.66 miles and I don't believe it will read any higher than that supposed to be 250, but I had the same number at the other end so I suspect that that is as high as it will read out. And it tracked that thing right over the Cape where we got down to, I think we got down to our slant range at the closest approach was 161 miles or something like that, and everytime I punched it up to the range went down and --

Cooper Man that was really beautiful, just beautiful. The radar itself stayed locked on for I felt like you could almost point out the tower it was right on the milage mode.

Conrad But in the catch up mode it read out to 248.66 miles both at the start of lock up and the end of lock up, and I was really impressed with that. Then after that we always locked the Cape. The radar locked on like it should on the REP, but we

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never got it to read through the computer now I

....

Cooper Yes, but my analog read-outs read.

Conrad Yes, but wait a minute, your analog readouts only go to 300,000 feet and that's 50 miles and we were never within 50 miles of it, so

Cooper Yes, but they read correctly and I got steering, radar steering.

Conrad Yes, but the analog couldn't have read correctly. If it read anything on your scale it was wrong because it should have read only digital

Cooper What I saw it was showing that it was getting a reading.

Conrad Oh, yes, well, there was no doubt that we were locked up.

Cooper The R dot was going right on out past there, you know, and then it came on past.

Conrad But I don't know whether if the problem in the

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digital read-out was a computer problem in the catch-up and rendezvous mode of accepting radar data or whether it was radar problem, but I'll mention under the computer because I sort of suspect it was a computer problem.

Cooper But I don't understand why it worked so well the one time and the other time it didn't work.

Conrad Something gave out. Either in the radar or in the computer. Well, then we never did get to check anything in the rendezvous mode.

Cooper No, reentry

Conrad We don't know what the problem was in reentry, but I think the computer did a 40 job it did just what it was suppose to do. It just had bum dope.

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8.8 Crew Station

Cooper Okay, controls and displays, sequence telelights.
 The only comment I have on sequence telelights is
 that the comp light on the computer is too bright.

Conrad That's right.

Cooper We are going to have to have some way of dimming
 that or put some tape over it or something, because --

Conrad That's a comment for GT-6 especially.

Cooper Because when you are running it at night with the
 computer on for rendezvous, that comp light darn
 near blinds you.

Conrad Yeah, it's really bright. That needs a dim feature
 on it.

Cooper The other sequential telelights that are in there
 are all dimable, or turnoffable.

Conrad Say, there is one thing that we didn't try through.
 I wonder if that thing is on the bright-dim sequence
 We never did put the switch to dim. I never
 thought of it in 8 days either. I'll bet you it's
 on the bright-dim circuit, but we never used that
 switch. We've never had occasion to ever use that
 switch. You know we always check sequence lights
 bright.

Cooper So, that is what that check is for. (laughter)

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Conrad Learn something new everyday.

Cooper I didn't think about that.

Conrad I'll bet baby it is.

Cooper Well, that's something somebody ought to check out.

Conrad This is just a comment.

Conrad But we never did have any reason to dim it in the simulator. You never tried to look out the window.

Cooper You don't have anything to look out the window at.

Conrad Yeah.

Cooper Okay, event timer -- We stopped at 48 minutes after insertion and never ran it again until we cranked it up at 27 minutes prior to retrofire.

Conrad Yeah, that's right. That was one of those things they had us power down. We never powered it up in the flight.

Cooper Apparently, it is a fairly good power consumer.

Conrad But it worked all right.

Cooper The IVI's worked fine, other than the one comment Pete made while ago that they were continually running there for a while. The FDI's -- excellent. Range and range rate indicator worked good on the REP, boy, really, really good. It worked very good on the --

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Conrad And the analog range was in close agreement with the digital range when the REP was going away from us.

Cooper Yep. The GLV fuel and oxidizer pressure gauges worked excellent except for the IPS. Stage two IPS fuel gauge failed to the full max deflection position just shortly before POGO started, and stayed in the OFF position until after staging. It came back on and worked for about a minute and then went back off again. The altimeter worked just like it worked in the altitude chamber. Stopped at 96 800 feet.

Conrad It was very jerky on the way up.

Cooper It was erratic going up.

Conrad And I don't guess you can expect a pressure altimeter like that to follow as fast as that booster is moving.

Cooper It's really winding up.

Conrad Coming back on reentry, why, we were apparently a lot slower on the other side of it, because it unwound in an extremely steady manner and it seemed to be right with the barostat.

Cooper It was right on the barostat, actually.

Conrad And this is really the important thing.

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Cooper Rate of descent -- you know, I even forgot to look at the rate of descent.

Conrad Well, we didn't even worry about it. When the chute

Cooper When the main chute opened as good as it did --

Conrad -- out there, that we both watched the main chute and I saw the water coming at the corner of the window --

Cooper I didn't even think to look at the rate of descent.

I knew it was good.

Conrad Yeah, we didn't have any reason to look at it.

Cooper I forgot about that.

Conrad No, we got busy doing a check there, too.

Cooper Well, we were also having a couple of radio calls in there and it was interrupting --

Conrad Yeah, radio calls, and we knew the chute was good, and there wasn't any reason to look at it.

Cooper I'm sure the rate of descent worked all right.

Cooper Accelerometer -- it seemed to work fine.

Conrad We'll look at it the next time.

Cooper Yeah, okay. I'll make a note.

Cooper The accelerometer worked fine. The switches and circuit breaker panels --

Conrad It's still extremely easy to knock off any circuit breakers --

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Cooper Anytime you move around in there.

Conrad You get in the habit of real fast checking that.

Cooper I would strongly recommend to anybody in any crew that anytime they do any moving around or turning around in the cockpit that they run a circuit breaker check.

Conrad We did.

Cooper Because, invariably, we would always find one off. Everytime we would run a check, somewhere or another we would find one knocked off.

Conrad We usually found a reason for it though, the overhead ones we knocked off with the water gun so we stopped putting it up there. And the one I thought I knocked off on the right hand side, I came to the conclusion that was one the O₂ heater blew out. It just blew it off.

Cooper And the mirrors worked excellent. I must say, Deke, you do need that in-flight repair occasionally to tighten those mirror --

Conrad You mean the postlanding kit.

Cooper Whew! Gracious! I lost my head. The postlanding kit to tighten up the adjustments on those mirrors to keep them tight. Repair reticle, you know, things like that.

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Conrad Suits.

Cooper The first thing that happened -- Pete's suit had to be repaired.

Cooper Swizzle stick -- I used the swizzle stick for quite awhile to punch off the DCS light when Pete was asleep, but, finally, it got to where it was just easier to reach over there. I've got pretty long arms. I think most people would probably need the swizzle stick to get over there to punch it off.

Conrad I never had the occasion to use it.

Cooper That's the only time I used it. I used it once for turning on the ACME power over there.

FCSD REP Before we go any further, while I'm thinking about it, on the pad out here, you said you could see that umbilical tower when they started to raise it.

Conrad No, the erector.

FCSD REP The erector. Yes.

Conrad You could take the mirror out of the holder and hold it at the bottom of the window, and you could measure the distance. Now I don't know exactly how high we are above the road, but where the road winds up to the pad and makes a left turn in and drive straight into the pad, you could see the intersection of that road. So, I say that you can see the ground some

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350 feet away from the booster. You can see ground level, and we were going to use that procedure if we aborted. We didn't know if we were going to make a land or a water landing, but we felt that we could use the mirror to see if we were over water or over land, at least within 350 feet of the spacecraft in the direction of the windows. I didn't use the mirror on the water landing out over Bermuda, because I could see the water out of the corner of the window by just putting my head up and peering at it -- in the two-point attitude. I could see the water coming. I knew we were fairly low. As a matter of fact, that altimeter was just about on the money, wasn't it?

Conrad We were at just about zero feet when we hit the water. We had a good altimeter setting.

Cooper Almost exactly zero feet.

Conrad This is what McDivitt said. Don't go on that 29.92. They gave us a 30.10 altimeter setting, and when it read zero we were on the water.

Cooper Yes, that was a real good one.

Conrad So, I recommend they stick with this -- giving the altimeter setting in the recovery area because it can make the difference of a couple of hundred feet.

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Cooper Okay, radar. Warm up time -- we don't have any comment on that?

Conrad No. That was straightforward.

Cooper Acquisition range --

Conrad It acquired in excess of 250 miles and read at 250 miles.

Cooper That's that. Acquisition attitude -- well, at one time I thought we were out of attitude, and it still was reading right on, locked up.

Conrad Yes.

Cooper Ease of lock on -- good. Capability of holding lock -- it seemed to hold lock very well. Flight display --

Conrad It was fine. All you needed.

Cooper Radar tests generally -- from our point of view it went very well. We never had any false lock problems at all. We didn't really give these a fair shake, however.

Conrad Yes.

Cooper But, from the testing that we did, we encountered no false locks.

Conrad We didn't get a false lock when we turned around and looked at the REP.

Cooper No, we didn't.

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Conrad We turned around and we waited until 1 minute was over, and banged on the radar and it didn't take this 23 seconds or anything. It just bammed. It just locked up on us right there.

Cooper Locked up instantaneously.

Conrad There it was. No doubt in your mind.

Cooper Lighting, indicators, and instruments.

Conrad Okay, there's a deficiency here. You need to see that center instrument panel, and --

Cooper You need some kind of glow. You need some kind of a little glow down that center instrument panel to be able to see that thing. That thing is really black. Without bringing that big darn --

Conrad I really don't understand why those guys took that red center light out.

Cooper While we are talking about lights, let's see if we cover that. No, we don't. But there is a real safety-of-flight item in that cockpit -- lighting. That is, if you leave any one of these lights on, and, in particular, the big bright center light which is the landing light -- I think it is on there -- in the light solenoid area, the reostat, you build up a heat thing that is actually to the point of being explosive. It actually gets to

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where it will burn --

Conrad Yes, you could smell paint.

Cooper It burns the paint in the spacecraft.

Conrad You can smell paint cooking. That's the first thing that we noticed, the first day. I'll tell you what heats up. It's the reostat. Well, the thunderstorm light that Gordo's referring to doesn't have a reostat. That just flat puts out heat.

Cooper It just flat puts out heat. You can burn your glove right off your hand on that one.

Conrad Your under-window right and left lights -- if we ran those at great periods of time with the light dimmed down, that reostat gets so bloody hot that you can smell the paint cooking again. I felt that that was a real bad situation and we have comments on that --

Cooper So we kept rotating these lights on and off.

Conrad We never did burn our lights too steadily unless we absolutely had to. The other problem there was that anything that generates that much heat is going to have a tendency to burn out, and I'll tell you, you lose one of those cockpit lights, buddy, and you are screwed.

Cooper You really are.

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Conrad I had already busted my auxiliary light and if I would have burned out the light on the right instrument panel, we would have had to run that center light a lot, and I don't think that center light would have lasted either.

Cooper No. I think that whole center console area is a very weakly lit area. It could certainly stand a very, very faint soft light. When you are running under night light conditions you'd be able to see the radio switches and this type of thing. Let's see, indicators and instruments--well, of course, a pet peeve of mine is that we couldn't get EL in the 8-balls. I still think the 8-balls could certainly be lit a lot better, although they are satisfactory for what we've got. I think the--

Conrad We really didn't use that except during lift-off and reentry, but it does shine. Mine shines in your eyes, doesn't it?

Cooper Yes, there is a real bad feature in the cockpit in that any lighting at all, either one of the right or the left lights--say Pete turns his right light on, particularly--if I'm trying to look through the reticle, it just zaps. It's gone. Can't see a thing in

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there with any light on in the cockpit. In order to use the reticle, you have almost got to dim out all the lights in the cockpit, and this is pretty hard to do because you need to use some around.

Conrad And, you know, they had a light down on the center pedestal shining aft that was supposed to light up the water management panel, and everybody took it out. You have to do most of your work on that water management panel blind. I mean, you sort of put your hand in there backwards and everything, and, as long as everything runs all right, you only need that one switch to go from off to overboard. The other two switches stay in the normal position unless you have some sort of problem. But it would be nice to light up that whole area down there. There is no way, without a flashlight or pulling that auxiliary light way over there, to tell how much water you have in the water tank.

Cooper I don't think you can tell with it. I took that auxiliary light and got back in there and practically crawled down in there. With that darn M-1 experiment thing installed on top of the tank there, you can't see the water level bubble anymore. They installed

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Pete's M-1 experiment right on top of the water tank where the water level bubble and the measuring gauge is. It's built right on over it, so you can't see it.

Conrad We used every combination of lights in there that you could think of, depending on what we were doing. Sometimes we ran with Gordo--if one guy was sleeping, the other guy would run with his red lights on dim. And many nights, we ran with no lights at all. We had that much confidence in things like cabin pressurization and so forth, that we just powered down the lights and we would go through whole night sides without ever turning the lights on and never even looking at the instrument panel when we were in drifting flight. We would both nod or look out the window.

Cooper Or sleep.

Conrad Yes, and one of the reasons we did this was because of this heating problem. I had a decided fear that we would be in real trouble if we burned out any light. We had no way of replacing them. So, any time I could conserve electrical lighting, by saving the bulb, I would turn the thing off. I didn't want to build up big heat loads in them. We ran red lights, we ran white lights, we ran the center lights only,

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we ran the left side only, we ran the right side only; we ran them in any combination you could think of, just dependent on what you wanted to do with them. Sometimes you needed lights in the daytime, sometimes you didn't need lights in the daytime. It depends on what your orientation was and what you were doing. That was very interesting. It's an entirely lighting situation than in an airplane.

Cooper Let's see. We checked out the one light that we hadn't mentioned here. I think we mentioned all of them except the doggone docking light. We did check it out, and it really throws out a nice light out there. We didn't have anything to try it out on out beyond the nose, but it sure lights up the nose. As a matter of fact, on that one night side we kept wondering where in the heck that light was coming from.

Conrad I kept saying, "Hey, the sun is really shining on the nose for a long time." It was the night I blew up the--

Cooper We were pointing straight up.

Conrad Yeah, I'd blown up the shrimp and gotten it all over the right console, and when I was cleaning it off, I had inadvertently turned on the docking light switch. It took me about 10 minutes looking out there trying

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to figure out what the heck it was shining out there on the nose. It finally came to me in a flash that the docking light was on. Now that is another thing-- I don't know how they covered that REP with the reflective tape, but, man, that thing was bright!

Cooper All you could see was the light.

Conrad No, I mean in the daytime.

Cooper Oh yes.

Conrad In the daytime with the sun shining on that thing, it almost burned a hole in your head. Boy it was bright!

Cooper Yes, actually--

Conrad It looked like a little sun out there.

Cooper Pete went into it deciding that he was never going to see it in the daytime, and I think he had a big surprise. I was determined that we were going to see it.

Conrad And we did see it in the daytime, several times after it had gotten a fair distance away from us, I'd say 2 or 3 miles away.

Cooper It was bright. It was almost brighter on the day-side than it was at night. In fact, it was so bright it would blot out those blinking lights.

Conrad Yes, that's right. The REP, itself, was bright enough and reflective enough that it would blot out the

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flashing light, but there were times when we saw it close enough in the dayside that we could see the flashing light. it didn't get that far away from us, and thats why I still challenge this 375 miles--

Cooper You aren't going to see that dipole as long as we did. The last time I saw that thing, I was still seeing the dipole antenna.

Conrad That's right. That's the last thing I saw.

Cooper You aren't going to see that dipole at several hundred miles.

Conrad That's right, and we saw it in the daytime.

Cooper Yes.

Conrad And it was on the 5th or 6th orbit.

Cooper Okay, utility light, interior lights, outside lights--

FCSD REP Talking about outside lighting from external--

Cooper We didn't have any flashlights. All we had was the gloves.

FCSD REP It says glove. It should be glare.

Cooper Glare--well, anytime the sun comes whopping in the window there, you are going to really have a glare. And anytime you are sitting there watching the earth, tracking a target down on the earth, and you suddenly come back into the cockpit, you aren't going to see a

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thing. You are completely blinded because when you have gotten used to the outside--sunlit earth--and you come back in the cockpit, it takes a few seconds to adapt to seeing things inside.

Cooper Intensity controls--I think they were fine. I thought they worked pretty well, and I must say, as Pete mentioned, I did like those red lights very well. Fingertip lights--they worked out all right. A flashlight would have been better, but the fingertip lights are fine. Onboard data--

Conrad Flight plan strip we really didn't use. We used our own checkoff list, because all we had on the flight plan strip was checkoff lists. You couldn't read it at night, and we just put something on there because it was going to be in the spacecraft.

FCSD REP You didn't use it?

Conrad I set it up in the proper places, but anytime I really used a checkoff list, I used this one right here. And I think that one is going to be replaced by a clock.

Cooper Yes. Checklist cards--

Conrad I can't say too much for them.

Cooper They are really good.

Conrad We beat them over the head and we reworked them and

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reworked them. I know we drove those guys nuts down there, but I'll tell you, there are darn few things I'd change on these set of cards right now, after having flown the flight. They really helped us. And the experiments book helped us and the log book worked well, and I think we kept things fairly straight.

Cooper In general, I think the books worked out very, very well.

Conrad Our big flight plan book worked out well, it didn't get in the way. Our reentry book, I think, could be made smaller. I would recommend next time that they put the schematics together like Neil did in the GOH Junior, which turned out that he had the schematics in a book that was 10 inches high and 2 1/2 inches wide and about 1/2 inch thick. Just by folding them a certain way, and this you would put away and never pull out. Now, everytime we hauled out that reentry book to do anything, we had all the schematics and everything. We really didn't need to haul those around all the time. We could have found a proper place for them. So, I'm not complaining against the reentry book and I wouldn't take anything out of it. By golly, we used everything in the books. We looked

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at schematics when we were up there. Don't think we didn't with the troubles we had. We used everything in that reentry book. There is only one book that we didn't take out of its holder and that was the REP and that is because we gave up the REP, or we would have used that one. And this big flight plan like this, I'd recommend that you make it even bigger. You've seen how much writing we did in it. I recommend that you use the same procedure of keeping a log book and a flight plan, because two guys are working all the time. You put it down in the log book and then you write it down in the flight plan, and this helps you organize it. By writing it down in the flight plan is when we really recognized just what we had to unstow and how we had to put it together to make that series pass work right. It took us three days to do that. We still spent a lot of time thinking about this. The maps--boy, that's another thing. If we didn't have that map, we wouldn't have known where in the hell we were.

Cooper Yes, that orbital map--

Conrad Those map updates were the greatest!

Cooper I'll tell you the map that was the useful one was the

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D-6 map that Harry Kozuma had in there.

Conrad Yes, we used this one, too.

Cooper Yes, this big map that he had in here was really a good one.

Conrad Yes, that helped you even better find out where you were.

Cooper Man that's a good map. For instance, over here, we were over here trying to find some details on some islands. Where was it?

Conrad Yes, you could go to this map and get an orbit and come down to--

Cooper Oh, islands or something off here. Let's see, where were they? Some of these little islands right here, off India--

Conrad We could pick up these little tiny chains and these things. The Solomons and these little messy things down in here--boy, and all this stuff out in here. Here is all that junk we kept passing over in there--

Cooper Yes! We were getting the New Hebrides, the Carolines, and the Marshalls. We were going over everyone of those darn islands, just like on our maps, boy. Just beautiful.

Conrad And you could really pinpoint your location. That

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really impressed me.

Cooper Here is where we did all the photographing.

Conrad Yes, that's right. Here is where we photographed
Australia one day.

(Much Laughter)

Cooper We were photographing the hell out of Australia coming
right down across here. Then we thought, well, that's
odd. Never had noticed that. Where is that island
off here? Well, that does look kind of like Sumatra
coming across there. And there is another big island
and I thought, well, darn, I know there isn't another
big island coming off there, and it was Borneo, and
then here comes Australia. Fortunately, we had the
time on it, so somebody can go back through and
reconstruct where we really were.

Conrad I was trying to find where we struck out Australia and
wrote down Palestine.

Cooper Palestine. Dear me. We had two cameras going just
as fast as they would click. You know, clickety
click click. Nobody had gotten aerial photographs of
Australia before during the daylight.

Conrad Listen, I talked to Paul Backer and he told me the
16mm film came out great. So, maybe we got the REP
pictures, too.

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Conrad Okay, maps and overlays--they were really good.
D-6 books and the data books were good and we used
the star charts--

Cooper The only maps I thought weren't worth a darn were
the Apollo landmark maps.

Conrad Yes, well you'll get to debrief on that through
Apollo in here. But our straight data books and
everything--

Cooper Yes, they were good.

Conrad We used all of them.

Cooper No comment on them.

Conrad We took the experiments procedure book and the ex-
periments log book just like this, and whoever had
the watch side put them in the Volkswagen bag. We'd
take the reentry book, which we had the PLA updates
in, and the other book, and we would just throw them
down between our legs. If you wanted to look at the
flight plan you would just flick it up, grab it, and
read the thing, and throw it back down there again.

Cooper There was enough room so that Pete kept them on the
side of his left leg, and I kept them on the side
of my right leg, and we would just pass them back
and forth.

Cooper Okay, start charts--by golly, I thought they were

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really good, and I think anybody that wants to get lined up for a night retro, if they do it once and aren't convinced that star charts were pretty useful they're --

Conrad Well, it gave us a great deal of confidence to go into the star chart the last day and pick out the right yaw stars, and then, as we were alining the platform, to see those yaw stars go right through the middle like they were supposed to.

Cooper I think the star chart was very usable and very neat, much smaller and neater in this fashion than it is in this great big mechanism thing we have. I think they're very usable in that fashion.

Cooper Stowage. Hah! What are we supposed to say about stowage? Boy, it's probably the most critical thing in a long flight. It has to be kept up on an hourly basis. Belts and harness-- I thought they were perfectly satisfactory, except for one set of belts I wanted to get out before the flight and if I were doing it again, I'd take my own scissors down there and cut them out. That is the knee belt which was put in there for pressurized ejection. It is still in there, and it is in the way, and I hated the darn thing. Mine flopped and flapped around in there.

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I finally took them and gouged them down in along side the seat. I took my scissors and crammed them down in there, and that is where they stayed the whole flight.

Conrad Yes, I'm not convinced they are necessary.

Cooper That knee restraint belt was put in there so that if you were ejecting at high altitude and you came out in a pressurized condition --

Conrad I think the arm restraints ought to be looked at the same way.

Cooper My arm restraints stayed in the down position, I launched with them down, I reentered with them down, and they never came out of the down position. They could have saved a good 2 or 3 pounds of weight on my seat by taking my arm restraints out. I told them that before and they said, "Well, they wouldn't ever be able to get them off." You know the seat was out sitting over there and I could have removed them myself in 5 minutes when we were in Weight and Balance. They said the paperwork involved in removing them would probably take a year. So, those two items I flew with I thought were completely worthless. And the lifevest--I don't know what you are going to do better. I really don't

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honestly know what you are going to do better because of the ejection situation, but they are in the way. They are in the way of everything you do, and they are real little bearcats to get on and off---these little lifevests.

Conrad We didn't have a place to stow them.

Cooper Yes, we left them on the whole darn time just because we didn't have anywhere to stow them. But they are really in the way. They are a real pain in the rear.

Conrad Yes, it's all part of the suit combination.

Cooper Well, that's right.

Conrad If you didn't have the suit, they wouldn't be so bad.

Cooper Waste disposal--pack harder.

Conrad Yes.

Cooper Pack tighter. That's a very grave problem, in the fact that as you start getting defecation wastes of this type you want an area where you are not going to mixing that with other items too much, and you want an area that you start packing right the first time so you don't have to keep dragging it all out and repacking. I don't know how you are going to do it any differently than we did in keeping one area completely open for it, and just working and using that for your disposal

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area.

FCSD REP How about urine?

Cooper The urine system worked just great.

Conrad Except for one problem. It leaked on occasion, and I really attribute that to the fact that this rubber device gets covered with tars. I covered this pretty thoroughly with the doctors. I recommend that you take new urine rubber receivers along, one per each day of the flight. We had four along and we changed them every two days. They get gummy and tarry and they don't have their holding power and urine tends to flow back.

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around the side. That is what it amounts to.

Cooper Yes.

Conrad We never had any trouble with them when we put on a new one. The new one would last about a day before it would start getting gummy. We tried everything to keep them clean.

Cooper It would get gummy.

Conrad ...wipe on them and we left them unrolled so that they would dry out.

Cooper The rubber gets so gummy you can put the two together and they just stick together. It gets all gummy and sticky. It may be a better material is available.

Conrad I still think its the urine that does it.

Cooper That's what I'm saying. There may be a better material available that the urine won't effect that way. The urine is eating into that latex--its latex rubber, I suspect. Either carry more good ones along or get a better material to use. That should have been evaluated by CSD. They should have determined that urine does effect them and makes them go to pieces in a hurry.

Conrad Yes, I'm not sure they don't even wash them out occasionally.

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Cooper Two other things we have is that you leave preheat on for 4 minutes prior to flushing. We got one tremendous big glob of urine ice that broke off sometime about the fifth day.

Conrad Oh, yes.

Cooper And, man, that indicated that it really built up. It must have been as big as that box there.

Conrad It looked like one of those sand castles you build. It was a conical buildup of ice. The liquid had flowed out. It kept building up and building up. But it was still flowing out through the center like a volcano. The darn thing broke off one day out there, and, boy, I tell you that thing was about this big around and it was about 3 and 1/2 inches high. It just went floating right by the spacecraft and it was pure yellow. Ha, ha! It was about 3 by 4 by 3 or 3 1/2 or 4. About 3 inches in diameter and about 4 inches high. It was triangular, dribbled up, rough shaped, but you could see where it was smooth on the back side where it had actually started to freeze. Boy, that scared us. We didn't want the urine system to freeze up so we went to 4 minutes. We used the recommended McDonnell procedures and we revised those slightly when we found out the tar was beginning

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to gum up the little valve too.

Cooper The little relief check valve.

Conrad We'd built up a pressure in there when you would start to urinate in that thing. We would open it up and dump for 30 seconds after we went through regular dump cycle and evacuated the bag. We would open it up to the cockpit and let it dump 30 seconds which is what MAC recommended. Then we would sit there and cycle it on and off and have that vacuum suck around down on that valve.

Cooper Open and close that valve dry.

Conrad We cycled it three or four times rapidly with the vacuum opening and closing it and then we shut the system down. I don't know whether that helped or not. We had the impression that it did.

Cooper It made us feel better about the whole situation. At least the thing worked the whole time.

8.9 Biomedical

Cooper Medical Data Passes--They weren't really too big a problem. They're necessary. I guess they are as minimum in interference as you can get these medical data passes. They weren't too bad. I talked to Chuck Berry this morning about it. I think that getting the food down into a better type system where

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you give the pilot more option in what he eats rather than try to give him meal A, B, C, D, E, F, G is going to alleviate their problem as well as the pilots a great deal. It'll make it easier and take a lot less transmitting. They were thoroughly confused by this numbering system. It made it more difficult for them to keep track of what we were eating. The exercisor worked fine. No problem at all. In fact, I used that exercisor a lot of times other than medical passes. My knees got hurting me. About the third day they really started hurting. So I started using the exercisor regular and found that it helped. Pete did the same thing later when his--

Conrad I didn't use it as much as Gordo did, but I did use it for the same reason. Both my knees got sore from being bent all the time. For some reason, I don't know why, it settles in your knees. I just found out that maybe once or twice a day with that thing in addition to the medical data pass eliminated the whole thing.

Cooper Yes, it really helped. Food and water evaluation. We have already evaluated the water. The water was excellent. Having cold water is really a luxury.

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It is sure different than Mercury. The food just boils down to the fact that we quit eating the bite size food entirely. We had absolutely no desire for it after the third day. I doubt whether we touched a drop of that bite size food after the third day. We ate strictly the rehydrated food. If I were sitting down right now to redo this flight, I would make up a recommendation for the food. I would have a number of bags made up just the size of these rehydratable bags. Bags that don't have to be folded, crushed, rolled, or steam rollers driven over them. I'd make up these packets of eight, ten, or fifteen or whatever the neatest package with a zipper or a velcro on it is. I'd put those in there and let the pilot pick out what he wanted for a meal. He could pick out one or two or three or whatever he felt like he wanted for a meal. He could do the same with the juices. I'd have other bags in with just juices. We'd have a great many juices all stacked in there, and they don't have to be all folded and crumpled up. I think they will probably package a lot neater this way. You just have two types of bags. You'd have

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food bags and juice bags. And then I'd have another bag just full of these wet wipes. If somebody wanted a wet wipe they could go in and get a wet wipe. They wouldn't have to be handed back and forth, back and forth. They wouldn't be hanging all over the cockpit. And that way you'd have a very neat set up. You wouldn't have a lot of food that is difficult to stow. The big difficulty in stowing this food is the paper. This makes the bulk. All this tinfoil and other things wrapped in individual plastic and then more foil and a great big package holding the whole thing. And When you get all this paper gathered up the best you can possibly packet you have at least equal volume to what you had initially with the food. I think that you can cut down a great deal by clever packaging and allow the pilot to choose his foods per meal. I think he'll be happier. I think the packaging of it will be neater and easier. I think you will get a lot more effective use of space. I think the biggest problem for GT-7 will be that they are going to have a 2-1 factor. Everytime they pull out a package of food, by the time they get that food plus the waste products back in and stowed it's going to be exactly

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twice the size it was when it came out. I don't believe there is anyway to get around it the way the food is packaged.

Conrad What are you going to do? Jim and Ed ate everything in the spacecraft. You and I hardly ate anything. If we had known that we were going to eat what we ate, we could have had twice the room in the spacecraft.

Cooper Yes.

Conrad We left 10 packages of food there. We never ever touched it. Plus we filled up the locker with another third of the food we didn't eat from the packages that we opened. Toast, apricot cubes, brownie squares, fruit cakes, and I don't know what all were stuffed all over that spacecraft. We didn't eat any of that. I couldn't eat it if I had wanted to. I just didn't have any desire for that stuff at all.

Cooper I don't know what it was about, but it just seemed to be so dry, and chew and concentrated.

Conrad The doctors figured we were running on about 1800 calories a day, and I don't feel that we were cheating ourselves. There is a big difference between our flight and Jim and Ed's. They went after this big extravehicular thing, and I think that it probably--

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Cooper Well, I'll tell you, a couple of days we ate a lot more. That third day we had a real full day. We were really busy. Man, we really had the appetite. We really gobbled down the food and we ate good. Those days we were just drifting were--

Conrad That makes sense to me because if I'm working I eat a lot and if I'm not working I don't eat much.

Cooper Maybe our morale was low all over. We didn't consume much food. I got hungry and Pete did, too. I could tell when I was hungry, and we'd say okay let's break out the food and eat. We really boiled down to just about 2 meals a day when we powered down and 3 meals a day when we were working hard. It was only about 2 meals a day powered down that we even wanted. The bite size food tastes awful good when you just sit around and snack on bite size food. It just didn't taste worth anything up there. I may have finished off maybe one or possibly two packages of it up there just by having it sitting around in that little nook or cranny. Maybe once a day, I'd have one of them. Just an in-between meal snack but other than that it was really a waste having them along. I think that if we had all bite size food we would have quit eating

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entirely. I imagine that would be an easy way to package the food. But the rehydratable ones were really good. There is just no getting around it. They are good food. They are nourishing and...

Conrad Boy, I don't know what to say about the sleep periods.

Cooper The juices were good. They were really excellent. We had some leaks. We had four bag failures on those plastic bags. I think it was the function of crumpling this bag all up again and having to wad it around to fit it tightly into a different shape from the fold that it was in. I think that those four bag failures could have been real serious. Pete had one that was worse probably--

Conrad I was eating merrily on the eighth day, shrimp creole, and it blew out the side, and it blew this itty bitty dehydrated, rehydrated shrimp all over the circuit breaker panel. It was red and it looked like somebody had flashed their hash all over--Ha,ha! You can't clean it up in zero g. Everytime you wipe a shrimp off one place it would float over somewhere else. I was snatching shrimp out of the air all over everywhere. I was bloody mad at the bag. I was about to have a fit.

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FCSD Rep Why don't we finish this sleep period? And we will be through with systems and pick up those questions.

Conrad Start the experiments. Okay.

Cooper Okay, sleep period. I think the schedule needs to be set somewhere around the normal sleep cycle that a person has already, in other words, I don't think that the sleep ought to be set for mid-morning or mid-afternoon. And I personally think that the cockpit is small enough that you're almost going to have to sleep both guys at the same time.

Conrad I concur. I don't think you can be doing the experiments with one of them--

Cooper And have the other one asleep.

Conrad Yeah.

Cooper Pete and I both found that the times when we really slept the best and most comfortable and really got some good sound sleep was when we powered that thing completely down and turned all the lights out and were down around the backside area of South America and there wasn't anybody to cut in and be flashing in to tell us all kind of things and they would leave us alone and we just both power down and go to sleep and get a good sleep. And that is the only way you are going to do it, because if one guy is

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doing experiments or working, or if one in the spacecraft, or doing all this other stuff, the other one is just not going to sleep. This is pure and simple as that.

FCSD Rep How about mentioning about how quiet it is.

Cooper The inside of the spacecraft is just as quiet as the inside of a very quiet office room.

Conrad Yeah. Well now, the big thing here is that we had taken our helmets off and put these neck dams on so we had no, none of this suit air flow over the mikes. And when you get in that configuration so you are not picking up any noises, as a matter of fact, we had our intercom volumes turned down. Most of our talking we were doing was to one another.

Cooper We were just talking in our normal tone of voice.

Conrad And our radio volume levels were extremely low. We were carrying about 4 on our radio volumes. And that was more than adequate volume. I mean that guy came in loud and clear in the headset. You could hear a pin drop in that spacecraft. The only sound that you were aware of was a very gentle swishing sound of air which was flow due to the recirc being open.

Cooper Right.

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Cooper And it was so quiet that you could hear a guy when he picked the book up and started turning the page.

Conrad Yeah, I could hear in back in the adapter section after really getting adapted to this thing, we could hear the hydrogen vent, we could hear the fuel cell hydrogen purge. We couldn't hear oxygen purge. We could hear all thruster firing of the attitude thrusters. When we did our burns, we didn't even have our helmets on. Did we? We had our helmets off when we did the maneuver burns, when we did those perigee--and we could hear all thrusters firing. Aft firing thrusters. We blipped the forward firing thrusters and we fired the up-down and left and right thrusters and we heard them all fire -- all the maneuver thrusters and all the attitude thrusters. And I could hear many other noises working back in the--There was a pump package or something squeaking back there that squeaked for all through the test period and I was curious to see if I was going to hear it in flight and sure enough, it was loud and clear. It was back there behind my head in the adapter section. And you could hear just anything that was out of the ordinary noise. And that was what the problem

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was, it was so blasted quiet in there that when something did click or snap or that was not cyclic in nature that you got used to it woke you up just like that. And as Gordo says, turning the pages in a book, or he'd reach over and pull something off the Velcro, just a little food package and just that little zip of the Velcro sounded like it was magnified in there cause it was so blasted quiet in the spacecraft. He couldn't talk in the microphone without me hearing it.

Cooper I tried actually cupping my hands and talking into my mike here so I could make as little noise as possible.

Conrad And I tried it too. We would wake each other up. So our recommendation - I'm sure the spacecraft is safe. You may want to look at something - I really don't think you need this, but I think it should be looked at from an engineering point of view - what would - what are the catastrophic things that could bother you if you were both asleep that would need somewhat of a warning to wake you up and I really don't think you need any myself.

Cooper I don't either.

Conrad But I think that the spacecraft - and we felt that

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way in flight, and we did; we both went to sleep at the same time. And I'm sure if we would start losing pressurization our ears would have told us that we were as sensitive to that as we were to noise.

Cooper This schedule we have covered that, I think it should be in. Because invariably, we could get busy doing other things and have many interferences and it would wind up that we would both wind up sleeping during the normal East Coast nighttime cycle. Invariably, we just weren't sleepy at other times.

Conrad Yeah, I think the other thing is that now in the schedule my naptime always took place when we were cleaning the spacecraft. This was too short after the stateside passes. That compressed the whole rest of the sleeping cycle. Although we tried to stick to it. Gordo would go to sleep for his long period which was usually 5 hours instead of 6 because we'd slid into that time. We always ate our meals together and we were scheduled not to. We always took the vision test together. We weren't, this way we compressed things down. And uh, then I usually wound up having about 5 hours off, but I never slept the full 5 hours. There was just one

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night that I did. There was one night that Gordo slept maybe 6 or 7 hours and I let him sleep that whole time because we were just exhausted. And that was the same reciprocal thing -- he let me sleep for 6 or 7 hours. That was the only time in the flight that we both really slept any long period of time. The rest of the time I don't think we ever slept longer than 2 hours at the most -- And most of the time it was 50 minutes between stations.

Cooper Well, that's the whole thing, that the -- on this schedule thing there are many, many, many interferences to sleeping and these stations just calling in letting you know that they have TM scldid and are standing by, interfere with you--they wake you up.

Conrad They shouldn't even do that--on backside passes unless they got something to give you, they shouldn't even call you.

Cooper And then too, when they start handing you a bunch of flight plan updates and they want you to do this and that and one man is trying to be--they are trying to keep one man real busy while the other sleeps, just doesn't work out. Configuration, well, just close your eyes. The best configuration to sleep is to turn all lights off and sleep. I will say one

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thing right now that we haven't mentioned before,
I believe the Polaroid window filters we
took were the greatest things we had along.

Conrad Especially when we got on that drift in flight.

Cooper I'd really recommend those very strongly. We put
both of those up dim then down to where they com-
pletely block things out, turn the lights out, go
to sleep and really have at it.

Conrad One guy could open his up and really see the ground
well with them in the open condition, but it was a
circular hole that was small and with the filter on
the other window it kept the spacecraft relatively
dark if the other guy was trying to sleep.

Cooper Right. What's this mission briefing?

Conrad I think that was supposed to be the thing that we
changed courses in midstream and we did; we briefed
each other and brought one another up on what was
going on and what we had written down.

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9.0 OPERATIONAL CHECKS

9.1 Apollo Landmark Identification

FCSD Rep On these - let's try to get everything in that log on these --it's going to take a little more time?

I think --

Conrad Well, you want to take each Apollo landmark separately? Is that what you want to do?

FCSD Rep Yes. As your list -- go down and call out the ones you did and whatever you have on your log there and we'll put this in one neat little package.

Conrad Well, the first one they gave us--you want to do this exactly fully like - time, rev?

FCSD Rep I'd like to, yes, because we've had an awful lot of trouble.

Conrad Okay, the first Apollo landmark was 208 and it was on day one at 09:27 and it was covered by clouds. And it was Cape Rhir and we didn't get it.

Cooper In fact, the clouds were right over the edge and we didn't see anything until just about off the land.

Conrad And the next one was -- Gordo, why don't you talk about -- You took all these except--you took them all, as a matter of fact, so why don't you give them the business on that, I didn't even look at

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half of them. Most of them occurred during my sleep time.

Cooper Okay, the next one was Sequence 212. And that is on Lake Winemarka and it was a point out in the lakes in Brazil--down in the Brazilian area, and it's a large lake. There are no other lakes in the immediate area. The lake was very, very distinctive. You could see it from some 6 or 700 miles away very clearly--big, heavy jungle all around the lake and the point that they selected was the finger of a little peninsula out in the lake in a particular point right on the peninsula. I thought the lake was easy to find, the peninsula was relatively easy to find from quite a distance out. There was no problem getting on it. It was a fairly distinctive landmark. The light was fairly low - it was late-in-the-day type pass, and the light was fairly low over in the West, but no particular problem getting on it, holding on the target, and identifying it. Apollo landmark--let's see, I took 1, 2, 3, sequences of pictures over that. And Apollo landmark 213 was the next one, and I wonder if they want the magazine and sequence numbers. Okay, on 212 it was magazine 1 and exposure 62, 63, and 64. On Apollo landmark 213

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it was magazine 4, exposure 10, exposure 11. 213 was Lake DePoopo in South America and here again the lake was fairly distinctive although this was a shallow water lake - the other lake was in the mountains in a fairly deep water - crater-type lake, whereas this Lake DePoopo was a flat land lake fairly shallow, the lake was not the same shape as on the map that we had of it. In fact, the map we have is quite a poor map and the island that the point is on, Isla de Panza, is not the same shape as the island that is shown. It is the only island it can be, it is not exactly, quite different in reality than it is here on the thing. The island is changed in shape, but being a shallow water lake you can see that the lake could very readily change with the water level -- change shape with the water level; and these islands could very readily be modified fairly readily just by dredging or hacking away at them. It was obviously the only lake in that immediate area that it could be and it had the same general shape as this lake. And it had the river leading in. The lake was fairly distinctive, and fairly easy to find, the point was easy enough to get onto, and I got these two pictures of it. Light

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conditions were again fairly late-in-the-afternoon type light conditions, but they were good enough. I don't think this lake was nearly as distinctive however, as the Lago de Winemarga. I don't think you can trust these shallow water lakes as being that definitive in that they may change a little on you and won't show up as good, particularly from higher altitudes I don't believe, as the deeper water lake perhaps. And the next one, let's see, as to time--days and times--first of all, I was skipping that, day 2, 21 hours 45 minutes 39 seconds was Sequence 212 which I covered, Sequence 213 which we just covered was day 3, 21 hours 38 minutes and 2 seconds; these were all made at -- 212 was made at 1/250 at f/8 because of the quite low light value, and Sequence 213 was made at 1/250 at 9.5 and then one at f/8, because here again, it was a fairly low light level. They were all made at fairly near 90° pitch down. Sequence 207 was made by day 5, 7 hours 14 minutes 27 seconds. I made two pictures there. 57 and 58 are magazine 4, 1/250 at 9.5 and approximately 70° pitch down and 30 to 50° yaw. These were yawed off at some slight angle. And 207 was Canary Islands and it was the southern point

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on the La Palma Island, and very distinctive; however, one can get confused if there is any little bit of cloud cover at the islands you're looking at. There are approximately five or six islands out in this group and with some of the scattered cloud conditions, you can get on the wrong island there fairly readily, particularly if part of one island, where partially covered by clouds, maybe just a point--you can very readily get the wrong point. However, I think we got the right point all right without any problem. And I think the lighting conditions were very excellent, really, except for the scattered clouds on the water down there; the lighting conditions themselves were good for these pictures. And on day 5, 10 hours 25 minutes and 2 seconds, we got Sequence 208 which was the one we had tried the first day and had had cloud cover. That was magazine 4, exposure no. 62 taken at 1/250 at f/9.5 90° with about a 20° yaw right, and there again that was the point near Cape Rhir near Agadir and the comments that I had to make on this one are that there are three points going down this same general land mass that are neither one a great deal more distinctive than the

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other. In fact, the one that is the most distinctive from quite a distance out is Cape Sim near Osaweira. It is a lot brighter, lighter colored sand and is more distinctive than Cape Rhir. However, once you learn the place, Cape Rhir becomes a little more distinctive when you learn what to look for, because Cape Rhir is at the edge of the mountains and just to the southeast of Cape Rhir, there is a river and a valley--a big, wide, green valley which travels up to the east along the edge of the mountains. When you once learn to look for it, this river and valley are quite a give-away, because look just to the left of it and that's Cape Rhir. I think, probably it is the most distinctive of these three. The three points that show up immediately from perhaps 800--1000 miles out are Cape Hodad and Cape Sim and Cape Rhir. You can see all three little points sticking out there. Neither one of which are particularly more distinct except this Cape Sim has brighter colored sand and begins to show up a little more distinctive, but once you learn where the landmarks are, these mountains and valleys near Agadir give away Cape Rhir. I believe it is the best landmark--in that immediate area. I'm not sure that

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I agree, incidentally on all the Apollo landmarks landmarks we've got here. I'm not sure I agree, in general, with any of the Apollo landmarks that they have. I think there are lots more distinctive landmark features around the country. I think that their idea of selecting a point of land down in the water is good, but I think that there are numerous places around the world where, say a large river comes out and intersects with the ocean maybe at a point, at a point in a river and things of this type, would be even more distinctive or an intersection of a river and the ocean, or an intersection of something in the type of causeways in Miami or the causeways here at the Cape where they cross the water with a very prominent water landmark. They'll give you a very accurate telescopic point to sight on, whereas the particular points of land that they have selected are not really accurate type sighting points for real accuracy, I don't feel. They're reasonably distinctive, but I don't think any--nearly as distinctive as a lot of other areas around the country that could be selected.

FCSD Rep

Okay, why don't you look through these things here and see if there is anything there that you haven't covered.

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Cooper Okay, let's see, going down on the 9.0 Operational Checks - Acquisition..

FCSD Rep That's Apollo Landmarks.

Cooper All right, the--I think to find these landmarks, things of this type, one thing that I feel pretty strongly that you really need is a platform. You need a platform to operate from. You need pointing, something to give you pointing information. Now, you can find it approximately with the platform off, and by knowing about what BEF or SEF are, and by yawing approximately so many degrees, knowing what time to look for it, approximately what degrees to pitch down. Chances are, if it is fairly distinctive you are going to find it. But for certainly very accurate acquisition, you certainly need a platform up and some accurate pointing information, then you really got it pinned.

Cooper We tried it both ways and there is no comparison. If you really want to make sure you get on a target, if you've got a time and at the time you are at this time, then the pitch angle and the yaw angle to be at, boy, you just can't miss it. If you go to those angles just a few seconds ahead of time and set right there and as you come up on the time,

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there the point is, right there. You just don't miss it. Updating, of course, you've got to keep these times updated as you--depending on your ephemeris, and how you are sliding around on your original time. Ours, fortunately, was just right on the money practically the whole mission, fairly late in the program we began to decay enough that we were changing times fairly significantly, but the weather is the biggest factor of all. Of course, if the weather is bad in the area, you don't get it. You just don't get the target. If it exists, humidity like you find along the West Coast of the United States then you aren't going to get it although some places out there like the point by Santa Barbara and Point Arguella and some of those points, even in spite of fog and haze, almost invariably show up. These are the kind of things that should be taken into consideration. The weather is probably the biggest factor on whether you are going to get a point or not. Sun angle is not so important as weather, although it definitely is a factor in that very early or very late the sun angles really tend to cut down the visibility, particularly if you have the addition of humidity in the air. If you have

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the addition of humidity in the air. If you have high humidity and then low sun angles, you are out of luck. If it is a very dry humidity, the low sun angles don't hurt you nearly so much. The sightings --there again the ease of which you are going to get your sightings done, get on to them and get them spotted and so on, is going to be dependent on the landmark itself. Those of them that we got, I think, are certainly reasonably landmarks, although some of the confusion things can be--

Conrad I just found out why the whip antenna didn't go up. It was my fault.

Cooper Why is that?

Conrad Because I powered down the common control bus. Remember, I turned off all squib batteries to save batteries later.

Cooper You didn't turn those off till later.

Conrad Well, I know I didn't, but I probably turned them off before we ran the antenna up though, or tried to. I'm not really sure.

Cooper I don't think so.

Conrad Well, don't mind that. If it comes out, well, that was the reason.

Cooper I remember when you powered those down. We had

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already gone through all the sequences and everything by then.

Cooper Okay, let's see. Designated targets--

FCSD Rep I think you have covered that pretty much.

Cooper Yes, all the targets.

FCSD Rep The targets that they have designated versus what..

Cooper Yes. Okay, well the designated targets--There are some alternate targets right in the areas here that I've already mentioned. I mentioned a couple of cases there that could possibly be better targets than the ones that they selected, although there is nothing wrong, particularly, with the ones that they selected. I personally liked a little bit better than on target 212, or Sequence 212, this point of land. I thought a little more distinctive was the point of land that came out of a little town called San Pedro, just north of there on the same lake. That's something to consider. It's a point of land that is quite distinct because it is fairly heavy. A big mountain sort of came right down into the lake and dropped off into it, and it was quite a prominent point of land. It is very sheer and precise, whereas, it is a little bigger point. Although, from a great distance farther out,

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the point they had might have proved to be better. Maps--Boy, we ran the gamut on them, but in general, the Apollo maps we got were just stinking. They were lousy and they didn't give you any lead-ins to where you were trying to find these things, and if it hadn't been for Harry Kazuma's map over there and our regular orbital map, we never would have begun to have found these places. We couldn't have possibly told where they were. And the Apollo maps that they have on here, these colored lithograph types gizmoes things, are just worthless. They are not worth the powder to blow them up with. There are several real typical examples of why these maps are so bad. For instance, right here, just on the better map of the group, they have the Canary Islands, but they don't even have all of the islands in the group. The island that you pick is sitting way up here at the corner of the map and you don't know what's leading you into there, or whether there's maybe another island just right by that one. You need a bigger scale map like this one. That was a little too big a scale perhaps, really, but that's the kind of map you need to really point out what you need coming into it, and somewhat of a more reasonable

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picture. I think the prime example we had of any difficulty in map location was not on the Apollo maps themselves, but it is exactly the same kind of thing. What was that one that had the little island?

Conrad Lake Depoopo.

Cooper No, no. It had one tiny little island right off the coast and it wasn't on the Apollo maps. It was the--

Conrad It was a D-6. That was that thing off Brazil. That's all it was. It was a chart of water with an island in the middle of it. It turned out that right at the edge of the chart was another island. We took the wrong island first because, heck, it looked like there wasn't another island--

Conrad I'm just making this comment because it will apply to the Apollo map making, as well, and this was an ideal example of how to really screw somebody up.

Cooper We also got another island right up there. We got it and we were sailing along thinking that was a good shot we made of that island, and we looked down and I said, "Hey, look down there. What's that. That's another one." I swung over on it, and he said, "Let's get it, too." So, we discovered

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that it was the one. It was just by accident that we got the right one.

FCSD Rep Okay. Detail--which of these do you think would be best? I think you covered some of this.

Cooper Well, I think that coastline is the best, distinctive features on a coastline. Next best are rivers and mountains. Probably, if you can have combinations of the rivers, mountains, and coastlines, these are quite good. A river running into a coastline and into the sea, I think, is a real excellent one. Very good. And roads--boy, there is just no getting around it that roads make an excellent landmark area. They really show up. And a road in the right area where it is contrasty will really show up for a long, long way away, like a white concrete road and darker background, a dark green background, really shows. . . And then, I guess cities show up probably the least of anything. They tend to have enough vegetation and foliage and everything and they kind of blend in. They don't really show. Lakes are excellent landmarks. Airports are not as good as lakes and things of this type. Airports tend to blend in a little bit. Let's see, color contrast--I've already covered that. Readability --

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FCSD Rep Anything at night?

Cooper Coastline. On a clear night, boy, the best thing that will show up is coastline. The greatest light contrast is between your water and land.

FCSD Rep Okay, I think that's enough on that.

9.2 Cabin Lighting Survey

Cooper I'll let Pete comment on that one.

Conrad Well, it was very straightforward, and we didn't get very many of them, mainly because we wound up in drifting flight. We took the measurements as advertised, except there is one little glitch in the thing. They wanted you to take a light measurement out, the window, and they wanted you to do it in either the heads-up, or heads-down. In doing this, that said the horizon was in front of you. Now the light meter reading looking at the black sky just above the horizon in the daytime, which was the total sky, was usually a number around 11.5. But looking at the earth, or just below the horizon, the meter reading was about 15.6. So, I always recorded two readings, the reading for the horizon and the black sky, because I didn't really know which one you wanted. With the spot meter the thing just turned out that way. Okay, we made one at 01+23+10. Gordo

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made one at 05+04+30+00. I made another one at 03+01+45+00, and we had another one at 04+22+40+00. Out of those, two of them were in drifting flight, and the other two were heads-up. And I had this recording that 11.6 was equal to black sky and 16.8 was normally representative of earth background. That was it. It was straightforward.

9.3 SPADATS Tracking Check

Conrad We did it. We did it by turning our beacon on so they could just track us, but we, of course, didn't get into it with the REP thing. The SPADATS thing, actually, was supposed to take place during the REP operation, and it didn't. But we did turn on our beacon so SPADATS could track us one time over this Williamtown site, or wherever it was. That's all there was to it, so there was nothing to---

9.4 UHF Antenna Pattern Test

Conrad Now, these UHF antenna pattern tests were done just as written in the book and the data is recorded.

Do you want it?

FCSD Rep Why don't you read it out?

Conrad Okay. We did a UHF sequence 03 at 01+10+44+25, and the angles were 0°, 0°, 0°. We did a sequence 01 at 02+13+47+05, and the angles were 90°, 0°, and

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14° left. We did an 02+15+21+19, sequence 02, and the angles were 0°, roll left 132°, 0°, and they were done as advertized.

FCSD Rep How about any updating on that?

Conrad No, they just sent it up and said to do it, and these were the angles they wanted. They set this up for us to do.

9.5 Thruster Illumination Checks

Conrad Never did it. We were supposed to do it the beginning of the first night or something like that, and it was in a sleep period time and we were tired and we didn't do it. After that, we got into either a power down or drifting situation where we were unable to do it, so it was never done during the flight.

9.6 Dual Command Transmitter Test

Conrad That was never done. That had to do with the REP too, if I remember right. I think it was DCS light resets. I think what they were trying to do was to find out if our radar was on. They sent DCS commands and we were transmitting or something--what could happen--We never got into that test.

9.7 Radar Tests

Conrad Okay, Test 2, short range, boresight spacecraft on REP, no problem. We never got time to get into the

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rest of it. We never got more than a mile from him, so we got that 3000 foot transient but we never got the 30,000. What was the transient at 3000 feet like? Do you remember, Gordo? On radar when the REP went farther than 3000 feet, I don't think there was any transient to speak of.

Cooper I didn't notice any particular transient, or any noticeable one at all. I was looking for it.

Conrad Yeah. We did the--

Cooper I had it damped pretty well.

Conrad We never did get the radar to run for 3 hours, so we didn't get test 5, test 4, no correlation between range and range rate display and visual observations at short range, they all worked very well. Test 6, we observed the normal transients that you'd expect, just as advertised on here, and I also noticed that the lock-on light cycled on and off, on and off, when I was in a standby mode after warmup. Radar test 7, stand by to ON, you have to get Gordo on that.

Conrad Test 8. We dashed over there the first time and as soon as we were within about 260 to 270 miles, the radar locked up on 248.66 miles. I got the first digital readout on address 69 and it read down to

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some 160 miles. I read the numbers out over the air. I'm not sure that they aren't on tape, too. The tape hadn't run out then. Then we tracked back out again and it pointed right to this MILA area here at the Cape when we had the needles centered. Gordo was tracking on the needles, and it seemed to work real well. We are really impressed with it. As you know, we got it to lock on the REP everytime after that over the Cape, but we never got the range to read right. I don't know whether that was a radar problem or a computer problem.

Conrad At that time, the voice recorder was working on the first test, and I think there is some information on the tape.

9.8 HF Evaluation

Conrad HF evaluation test number 1. We transmitted all the way around the world. Then we gave up number 2, because it was keeping the other Astronaut awake. Then we did the other HF transmission test which was listen. We did hear Hawaii for awhile going away from them and coming back in -

Cooper That was a ridiculous test anyway.

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CooperHF when they were playing music. It dropped out when we heard it, and we'd transmit once in a while to them and they heard us. It worked real well.

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10.0 VISUAL SIGHTINGS

10.1 Powered Flight

Conrad Well, everything was straightforward up until Fairing Jet. We told you about the problems we had at Fairing Jet. We want to take a look at that.

Cooper I didn't see anything--

Conrad I did see the horizon come into view at about 60°.

Cooper Yes, I saw it just as we began to stage over. I looked out over your window.

Conrad That's right. Right after staging in guidance initiate it came down to about 80° on the horizon and man, it looked great out there.

Cooper And the only thing that I noticed at SECO was a lot of debris.

Conrad Oh, yes, it was stuff all over everywhere. About the funniest thing of all was --

Cooper Snow all over the whole area.

Conrad Yes, and just all sorts of glittering pieces of this, that and the other thing.

Cooper Pieces and bits.

Conrad Then all these washers and goodies started floating around in the spacecraft, but the was the washer floating along --

Cooper That was three or four orbits later. Here we are

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whipping along at 17,000 miles an hour or so and I looked out and here's that washer floating right in front of my window. It sat out there and floated around a while. I pointed it out to Pete and he got over and looked at it and it floated on around and finally it just was drifting on off. Finally it disappeared. And about an hour later a bolt came off.

10 2 Orbital Flight

Conrad We didn't see our own booster. We were too busy. We started the flight plan right away and we never turned around to look at it.

Cooper We never turned around to look at it.

Conrad We sure as heck saw the REP.

Cooper We saw the REP and saw the REP and saw the REP.

Conrad We saw the REP blanket too.

Cooper The REP blanket, I think we mentioned before, but the REP blanket someway or other got between us and the REP. This means that the REP either went through it or tumbled over it, because the blanket was between us and the REP. Man-made objects in orbit.

Let's see booster, REP--

Conrad Okay, now that satellite--

Cooper Satellites. We never saw any of the scheduled ones.

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Conrad We never saw any of the scheduled ones but you've got to have the platform to see them. They gave us angles like pitch 82° and yaw 45. You're looking at the black sky. You haven't any idea of where you're looking. You have to have the platform. One thing that we did find, if their platform pointing at satellites was actually the pointing information they gave us for the ground objects, why we wouldn't have had any trouble finding them.

Cooper The pointing information that we got from the ground was excellent.

Conrad We hacked that time on the second and we were really pointed with the platform up and we were looking right down the pipe at whatever it was that they were wanting us to look at. The only reason we didn't see it is we couldn't make it out. But we were looking at it.

Cooper Satellites--There was only one time when Pete and I thought we saw something and we didn't have time to identify it. We were in drifting flight and we never could identify it. I don't even know if it was a satellite. So many things are going by when you're drifting that it's difficult to say. Geographical--We saw millions of geographical details:

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rivers, lakes, oceans--

Conrad I think all of that will come out in the experiments too. We saw all kinds -

Cooper Towns, airports, railroads, roads, and all that stuff.

Conrad Airplanes.

Cooper Airplanes.

Conrad Anything you say, we saw at least one each.

Cooper I finally saw one and I nearly busted my rear end doing it.

Conrad I saw the carrier. I saw an airliner. I saw contrails. I saw individual houses up in Tibet. One thing I didn't see for Gordo was a car.

Cooper I couldn't find him a car. He was sitting over there asleep. I turned on the whole control system and turned around to show him one. This was the only one I could find during the whole stinking lousy trip.

Conrad We saw just about anything you would expect us to see.

Cooper But there again I think you've got to have the control system to point where you have your windows right to make sightings. You just can't catch them in drifting flight.

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Conrad One day we went past El Paso and the lighting conditions were just right. You really could see the individual streets in El Paso. You could distinguish the streets but this wasn't always true. The lighting conditions had to be right. One day we made a pass over the United States and I could see the streets, the airports, the lakes and every principle town across the United States all on one orbit. We started at Los Angeles, went to Phoenix to Tucson, Abilene, White Sands, El Paso--

Cooper You could see the details down there in Clear Lake - Taylor Lake area--like you were flying over coming in to land.

Conrad Dallas, Nashville, Memphis--

Cooper It was clear as a bell.

Conrad And when we went right out at Savannah and we were looking right down the pipe at Jacksonville, Florida. You could see the bridges and the St. Johns River and everything.

Cooper When we came over the Cape here you could see every one of the launch pads.

Conrad I should have two 70-mm photographs. I guarantee you that I got a 70-mm photograph of the Cape one day like nobody ever took before. If it came out,

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it was the clearest picture of the Cape.

Cooper Boy, that was beautiful. You could see every detail. You could see every causeway and every street, everything that rode around the Cape, and buildings all over the Cape.

Conrad All that was on the same day but it was another orbit.

Cooper Celestial--

Conrad Gosh, we could see seventh magnitude stars--

Cooper Mercury never had a window. Our windows were filthy. When we lifted off it just absolutely unforgiveable how dirty they were. Yet there were many times the magnitude of visibility the Mercury windows were. We could see easily seventh magnitude stars. Well, in Orion we could see all seven stars in the belt and we could see clusters down the side of the leg. I've never seen those clusters before. I have seen big blowups of them, but you could definitely see two good size clusters. Celestial--We saw a lot of planets and we saw the moon under all kinds of conditions. We saw the sun. We took Polaroid testings on the sun. We ran the Polaroid filters at different angles. It looks to me like the sun has circular

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polarization. I just can't find any linear definition of it. When the sun is setting you can get some linear polarity in a vertical plane, but otherwise I just can't see anything different one way than the other. I took the filter out and rotated it a number of times. I took the whole filter out. We saw a Zodiacal light. We saw--

Conrad Yes, we really did a couple of times--just could see it where night vision was right. We had the lights out in cockpit and everything. Boy, you could really--

Cooper Pete spotted an interesting phenomenon that he pointed out one night that I had never seen before. It looked like an Aurora. It was an Aurora type light and it was a very bright green. It changed in color and was in the airglow layer. It actually changed the height of the airglow below. It brightened it above where it -- but below it, it seemed to cut it down and make it more definitive. Where it wasn't it was kind of fuzzy along there and then where this glow was the airglow kind of jumped up and was sort of chopped off very sharply. This was very bright. I don't know what it was. It was apparently some kind of a Aurora effect. We saw a lot of meteorites

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in Australia was a good example. Two different days it was completely clobbered in where you couldn't see anything on the ground in that immediate area. This point Rhir was clobbered in one day. We were going to get an Apollo landmark on it and it was just back in under the clouds in fact. And Kano we were going to get a shot of the Kano air field, wasn't it?

Conrad Yes, that was clobbered.

Cooper Yes, it was clobbered. We got right up close to it and there were these low clouds hanging in there just scattered to broken clouds and we couldn't see.

Conrad Actually on the D-6 stuff most of the time the experimenters were up on what was clobbered and they didn't even bother to give it to us, or if they gave it to us it became clobbered before we got there. They usually were able to tell us that it was going to be clobbered and then many times they gave us that the weather was pretty good, but there's three tenths cloud coverage so you may or may not. It didn't bother us too much around the coastal regions.

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Cooper Cloud Coverage. We had varied cloud coverage throughout the flight.

Conrad Boy, I think we saw every phenomenon you could think of with the clouds.

Cooper Just about everything you could think of. We saw typhoons, and hurricanes, and--

Conrad We saw well defined eyes in these tropical storms and others without--with such cirrus cover that you couldn't define an eye. We saw some of the most fantastic thunder storms we have ever seen.

Cooper We saw hundreds and hundreds and hundreds of miles of tremendous big thunder storm lines with squall lines going across it.

Conrad Near South America.

Cooper Had at times as many as 15 to 20 thunderstorms that were lighting up all at the same time.

Conrad I think I have some good 16 mm camera coverage of the thunderstorm lightning at night.

Cooper And these are--then we saw--then we had great expanses over the same areas of excellent weather, clear weather. We saw a lot of dust storms

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in Arabia and Africa.

Conrad Yes. You could see those desert storms real clearly.

Cooper The wind picking up and moving the sand along. Other days we saw the same areas just as clear with no wind. Beautiful weather.

Conrad It was interesting in those deserts to notice that you could really pick up the prevailing wind trails.

Cooper Yes.

Conrad You know from the sand flow.

Cooper The way the sand dunes were--

Conrad And which as I sort of remember back somewhere there was a lot of explanation about how the whole desert moves, you know, and you could really see these great--I mean for a hundred miles-- hundreds of miles you could pick out these great obvious prevailing wind tracks in the sand that just stretched for hundreds of miles.

Cooper Yes.

Conrad And again this was in Egypt and south of Egypt-- down in that area.

Cooper Well, you could actually see by the cloud formation--was odd, too. The thing I noticed was,

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you really could see the lower altitude prevailing winds in the cirrus clouds or the lower altitude stratus type cloud you all around and you really could see the wind pattern and one thing that really impressed me, was the--on cloud formations low altitude cloud formations--up in the Himalayan areas, how that stratus-type cloud would hang-- would just completely define the land shape. You'd see it hang in the valleys and swirl right down in the valleys and you'd see where the peaks were, it would puff and was quite definitive of the land mass. And then coming in off the-- you could see the prevailing wind direction in the lower altitude clouds. You could see the way the wind would come in and you'd get the wind shear where it would hit the mountain peaks coming in off the desert areas there and it would kick it up over the peak areas.

Cooper Okay.

FCSD Rep Let me ask one question.

Cooper Okay.

FCSD Rep Was there--as far as good pictures are concerned-- how many pictures did cloud coverage prevent you

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from getting?

Cooper

Oh, well, a great many. Some areas--well, just in general let's just say that some areas of the country would be completely clobbered in and we'd be traveling over an undercast for great long expanses of hundreds and hundreds of miles, and anything that was in there would be--anything to do with any areas we desired to photograph in there whether they were specified immediate areas or whether they were just general pupose or S-5, S-6, were not available for photography, and yet the next day it might be wide open. The Himalayas was an ideal example of that too. For two different days we traveled over that, you couldn't see any of the craters or any of the ice flows or anything due to the clouds. You could see just occasional areas and some of the lakes would be open, so it was just heavy cloud cover through there for about a 2 day period and then it just broke up wide open one day. But there were a great many areas that there were cloud covered to the point that you could not find it. For instance, the Carnarvon or I should say the woodly side

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Cooper The carrier was the one thing that it really bothered us on. Two different days on the carrier shots doggone it you could see one day--for instance we saw the carrier wake and--

Conrad But the sunlighting was such--

Cooper The sunlighting and the--

Conrad You lose the wake and everything--

Cooper And then the scattered clouds, too were such that you were kind of hunting for him in and around the scattered clouds and sunlight angle was low on it and we lost him.

Conrad The day we got him there were clouds back there but gee we could see him for 500 miles out and we never lost them.

Cooper Just the lighting conditions were ideal that day and he was also out in kind of an open area in the clouds.

Okay, horizons. The horizons were of course, as usual, I think day and night were fairly well defined except as you come into the--as you go in out and out of the terminator. Just at that period of time where you're going into the light or out of the light through the terminator it's a very fuzzy

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ill-defined, odd area--

Conrad Yeah, looking down the sun.

Cooper Where you have no defined horizon at all. It's very--a real messy situation. The only thing I noted different about the horizons this time was at one morning, at one sunrise, when we saw those tremendous thunder heads out clear on the horizon--you remember that?

Conrad Yes.

Cooper Where we saw the horizon well-defined and these great big thunder heads with the handles on them sitting up above the horizon. They were those ; big thunder storms. I would guess that those things must have gone well in excess of 50,000 feet probably to be that well defined--clear out on the horizon some 12 to 15 hundred miles away you could see that profile of them. Do you have anything more on horizons?

Conrad No.

FCSD Rep One thing we might mention here while we're talking about these thunderstorms, you mentioned before the lighting in the spacecraft from this lightning.

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Conrad Yes, the lightning was bright enough to light the shingles on the spacecraft.

Cooper You--the whole spacecraft could be lit. You would, even through the polaroid windows--with the polaroid windows down full dark, some of these big thunderstorms were lighting the whole thing.

Conrad Well, I tell you we saw some lightning like I just never dreamed existed. I mean the lightning bolts must have covered a hundred miles.

Cooper In general in this lightning--

Conrad Cloud to cloud

Cooper In the clouds, in this lightning, in general, these clouds light up like they were a big puff of cotton with a light bulb inside, and the whole thing just lights up. But Pete and I both saw several cases where we would see a thunderstorm a little ways out in the distance, and I actually saw air to ground lightning bolts come right out of the clouds and right down just "choom".

Conrad There was one storm we looked at for them in the daytime where we saw air to ground lightning in the daytime--

Cooper We saw lightning go all the way from the edge of

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this big black cloud right down to the ground.

Very clear.

Another thing that was different that I noted that was a little different than the usual type of the whole big mass of clouds lighting up-- one long series of thunderstorms, I noticed where there was horizontal kind of a chain--horizontal lightning going over and you'd see it sort of travel along horizontally through the clouds like it was moving from cloud to cloud rather than from cloud to ground.

Okay, thruster firing. You could see every thruster on the spacecraft fire in the middle of the night-- you could see the glow from it.

FCSD Rep These aft firing thrusters too?

Conrad I don't know. I was just trying to think about the aft firing ones and we were so busy everytime we fired them that I wasn't aware of them.

Cooper I don't know. We had the lights up in the cockpit when we were firing the aft-firing because we were busy--

Conrad It's unfair to say without pulling the test, you see, because when we were firing the aft firing

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thrusters, we were also firing attitude thrusters and the attitude thrusters you could see all of them.

Cooper I don't know whether you see the glow off the aft firing thruster or not.

Cooper You certainly can feel them firing. You can hear them fire.

Conrad It's not annoying or anything.

FCSD Rep Somewhere we ought to say here--you said you could hear all the thrusters firing.

Cooper Every one of them.

FCSD Rep Now, this is with the helmet on or off?

Conrad Off.

Cooper Off.

FCSD Rep How about with it on at separation?

Conrad I had the impression that at separation that I could hear them firing. The aft thrusters with the helmet on and that is--

Cooper Yes, I did, too.

Conrad Simply because everybody said they couldn't hear them.

Cooper I thought I could hear the--

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Conrad There's no doubt in your mind that they are firing.

Cooper Yes. I think it's almost more a matter of--

FCSD Rep Did you fire them before you separated?

Cooper We fired them just as we separated. We hit SEP--
the spacecraft just as we--

Conrad Gordo counted them down 1, 2 SEP and I hit the
SEP button and I don't know when he started firing.

Cooper I fired just as you hit SEP.

Conrad Yes. We came out clean as a whistle, I'll tell
you that boy.

Cooper We fired at the same second that we hit SEP.

Conrad There wasn't any pitch or yaw of anything--we
just separated as smooth as a bell.

Cooper And what I did, I--we held that on in there
in direct and then switched over to rate command
then a couple to 3 seconds later.

FCSD Rep Okay, how about the--why don't you describe the
plumes a little bit here on the different thrusters
and what you saw.

Cooper Okay. Well, the only really--

Conrad You don't see any plumes.

Cooper You don't see any plumes off the OAMS and all you
do is get the glow from them back there--you see

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the glow as they fire.

Conrad And it is pure white.

Cooper And--

Conrad My recollection of it--like white light glowing.

Cooper Of the RCS Plumes?

Conrad No, of the OAMS.

Cooper Oh yes. The OAMS. The RCS had a little bit of a golden color to them.

Conrad Yes.

Cooper And--

Conrad Plus you see on the RCS thrusters you see little bits of pieces of ablative material coming out like carbon.

Cooper Yes. Right.

The RCS plumes tend to come out of the nozzle with a little bit of an expansion ratio and then just to come out in almost a column that doesn't change much. It just increases in size.

Conrad Yes. I was surprised that it didn't expand out this way.

Cooper Yes, I thought it would expand out.

Conrad But it just went straight up.

Cooper I very much thought it would fan completely out.

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Conrad Like a nice candle flame.

Cooper It just goes up in just a contained column almost--
in fact the column appeared to me to be no bigger
around than that saucer.

Conrad That's right, if it was that round.

Cooper Some 4 to 5 inches maybe, in diameter at the most
and just went right straight up for a period,
distance of about 4 to 5 feet I guess where it
faded, something like that.

Conrad Oh, I didn't really think it went that high. I
really didn't think the thing stuck up more than
about a foot. That it was visible light that would
bother you.

Cooper Well, it would bother you, but I could actually
detect when they would fire, I could actually see
from the pitch down--I could see that going almost
to the top of the window on something on the order
of about a 4 foot dent where you could see any
line at all. I'm talking about where it fades
you know completely. And it's actually only a
couple of feet out from where the light is really
bright.

Conrad The thing that I thought of when first I ever

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saw one fire was one of these 4th of July fire-cracker stand-up type bombs that you light the fuse, you know, and the thing sort of like the Roman candle--it sort of spits out flame and a few sparks you know and then--

Cooper Yes, that's right.

Conrad That really did it. And the other thing is that everybody's been talking about how bright they were at night and maybe again I was geared to see in the really, really brilliant light --I didn't really think they were that bright--now they do disrupt night vision and they did disrupt the horizon, but they're not that bright.

Cooper Well, of course you've got to recognize, too, that we saw them under different conditions and the fact that we were expecting them to be very bright and we had cabin lighting up full bright.

Conrad Yes.

Cooper And they were by comparison with the full bright cabin lighting--they were not as bright as we expected.

Conrad We also went around though with the lights on red there when we were alone and you were firing only

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in PULSE.

Cooper That's right. We actually only had it in PULSE.

Conrad And really what it is--as a matter of fact, firing in PULSE and everything--you could always keep the horizon in sight.

Cooper You could keep the horizon in sight and we had the red lights on, and only we didn't have them down dim and firing just in pulse you could hold the attitude visually very well, but when you go into any amount of RCS thruster firing you've lost the horizon.

Conrad Yes.

Cooper Okay. One thing we have here on thruster firing both attitude and translation. I think we covered attitude pretty well. I think our OAMS was a very good attitude system to begin with. I think it was gradually degrading as the flight went on. Getting worse and worse and worse and mushier and sloppier so it was not fair to evaluate it later on in the flight because it was pretty miserable. But the RCS attitude was beautiful. It was really good. It was crisp and real precise and just a real pleasure to fly. Translation, we

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used all the translation thrusters only one little splurt of it on the forward, in other words the forward firing thruster-the small forward firing thruster, but they were all very, very positive and you got very definite distinct action out of them. And you really got a feeling of real acceleration out of those aft firing ones, I thought. I felt like you really were-really had a big afterburner lit off when you lit those things.

Conrad Yeah, man, I would have liked to have some more kinds to mess around-like turn off thruster 10 or something like that, and burn a couple of feet on one thruster because in the simulator you can't hold it in Rate Command.

Cooper I think you probably can in the actual spacecraft.

Conrad Well, I don't know whether you can or can't but I think that the difference between 2 thruster operation and 1 thruster operation is going to be apparent to you just like that and these guys in FOD are making this big deal about having to burn after separation from the booster and maybe only have one thruster or anything and I think anybody who has flown that thing once is going

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to have a good feel for whether he has two aft fire thrusters or one because boy, with those aft firing thruster are firing you're just like you're flying an airplane and you put the throttle to it. You really feel it.

Cooper You really feel it. Yes, it's really got acceleration.

Conrad And you can hear it--it was that high speed water jet type sound, it wasn't an explosive sound or a roar or anything like that. It was more of a swishing sound.

Cooper More like a big hose.

Conrad Like a couple of big hoses firing back there.

FCSD REP Okay, you say you did fire the forward firing-- you checked out the forward firing?

Conrad Just a bleep.

Cooper Right.

FCSD REP What did you see here?

Cooper Oh, man. You really see the flames off that.

Conrad Yes, well, you don't, I don't really think you really see the flames, but it throws a great deal more light.

Cooper It's a light rather than flames--a light more than flames.

FCSD REP Could you see a distinct plume?

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Conrad No.

Cooper No, not a plume as such, but just it really lit up. You got a lot of lighting from it. Much more so than you did the--It was distinctive enough that it really made an impression on us.

Cooper Let's see, the side firing was really--the thing that's surprising about the side firing was just as I--you might anticipate, if you really stop and thought about it but you don't get this in the trainer or anything when you fire a side thrust--

Conrad A side thrust--Yes, that was really weird.

Cooper You really could feel that.

Conrad It fired down, then up, then left and right then you raise up in the seat or you slide down in the seat or you go left in the cockpit or right in the cockpit. You know that you really going to do this and you--

Cooper And you can see all the debris and everything coming through--swish!

Conrad Yes, everything starts going sideways. And it's pretty funny.

Cooper Okay, we're at paragraph 10.3 reentry. Number 1 adapter separation. No doubt.

10.3 Reentry

Conrad Yes, there was no doubt but there again one of those

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things where both Gus and John and Jim and Ed said, "Man, that thing really went out there with this horrendous bang," and I was really spring loaded. I was waiting for a 16 inch gun to go off in my ear, and, therefore, there was no doubt that it fired, and there was no doubt that it left, but I didn't think it was that loud--but then again, I think, it's what you're anticipating, and they had both said that they got quite a--

Cooper I think there again, you and I were keyed up to it being a tremendous explosion--when it went off--

Conrad But there's no doubt about it that it is loud --

Cooper There is no doubt about it--it's loud and it really gives you an acceleration--a delta acceleration.

Conrad I actually heard SEP ELEC and SEP OAMS lines squibs and I don't know whether you want to say whether we felt them or heard them fire, but we could hear a definite "kerplunk, kerplunk" back there when you push both of them--not loud--

Cooper Just like the trainer. I think the trainer is very realistic of those sounds.

Conrad Yes, the trainer is very realistic.

Cooper And the trainer sound is really pretty realistic

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of the adapter sep now. I think they're all three fairly realistic of the trainer.

Conrad And now in adapter sep you get a little acceleration force with it, and you feel that. You really feel that--

Cooper Well, it shudders the whole thing as you come off-- as you separate. And retrofire to me was a big surprise.

Conrad It was a big surprise to me, too.

Cooper I remember in Mercury that everybody had different feelings on what retrofire felt like, and I didn't feel that they were that distinctive or that great at all in my previous flight, but in this one I felt like we were on the front of Stapp's rocket sled.

Conrad Yes.

Cooper Everyone that fire.

Conrad We were pretty G sensitive by this point, 8 days of weightlessness.

Cooper It felt to me like we were just hanging on the--

Conrad Yes. Gordo said he thought we wound up going in the other direction and I had the decided feeling that we pitched up and did a loop everytime one of them

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fired, I had the feeling that we pitched up another 30 degrees and went streaming up that way you know, and then another one would fire, and I really thought we were going around a big circle. That was my physical sensations although the gages said we were right on the money. But, all through retrofire those darn retros did not overlap.

Cooper That's right. They didn't. Number 1.

Conrad Especially 3 and 4. As a matter a fact, there was enough of a delay--

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Cooper Let's go through these now. Number 1 fired exactly on time. Boy, right on the money with TR. We were right on the money. Every clock we had in the spacecraft was just reading right 0 when it fired. No delay or anything anywhere. Just beautiful. Number 1 was still firing when number 2 started to fire.

Conrad That's correct.

Cooper And there was no off-set whatsoever from number 1 and number 2.

Conrad That's right.

Cooper Then number 2 had finished firing for a definite delta time period before number 3 fired.

Conrad That's right.

Cooper Then number 3 fired and had an offset to the left--to the left--yes to our left which was not bad and I think they had r times that amount of off-set it had and still hold it with the RCS, no with the rate command. No problem at all. No doubt in your mind. You were way more than overpowering. You must keep it glued right there. But then number 3 finished firing and then there was an even greater delta time--

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Conrad That was a period of time that I--

Cooper Before number 4--

Conrad I thought we weren't going to get number 4.

FCSD Rep What would you estimate the time?

Conrad Well, I'd say it would have been a full second.

Cooper Boy, I think it was at least a full second.

Conrad Time up there is going to seem like--

Cooper Time--yes.

Conrad It may have been shorter than that--but there was a definite delay.

Cooper I'm sure that our time sensing mechanism was overly tweaked at that period of time and we probably were overly sensitive to it, but there was no doubt I don't believe there was any doubt, and we both arrived at this conclusion independently too-- that number 2 came in at the right sequence on number 1 and then there was a short delta time and then number 3 fired and then a longer delta time and number 4 fired.

FCSD Rep Okay, how about the visual sightings during this.

Cooper Man--

Conrad We were IFR completely the cockpit lights up full white, pitch black and--

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Cooper And the whole window area was completely obliterated by flames. When the retros go off you're just in a big barrel of flames--because the whole thing is just covered by flames.

Conrad I wasn't even aware of that. I didn't even-- I'd have said that we didn't see any flame at all.

Cooper Well, we had everything at full bright--

Conrad I guess I had my eyes locked on the instruments--

Cooper Well, I did, too, but I also was going to look and see what it looked like out the window there and I noted that everytime one of them went off you got tremendous flame coverage which surprised me because I didn't think you would. I thought maybe you'd see the glow from it but I had a distinct feeling that the whole--that the whole flame expanded to the point where you felt like it--maybe you just felt like it was so bright it just lit up the outside that much, but I had a distinct feeling that you really had flames all over when they went off.

Conrad Really that's the high light of the flight in my mind is going down through that--watching that T_R clock count down and going through $T_R - 1$

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minute to T_R+45 seconds through retro-jet. You know seeing that sequential system go and everything work just like it was supposed to, and the checkoff list go and everything Boy, we were really spring loaded on that.

Cooper I know Pete had made some comment, "Well, things have continued to fail and I just hope that is one that doesn't."

Conrad I had lost faith in sequential systems somewhere along the way. We had all the emergency systems out though, and we were ready to fire it any way we had to.

Cooper Yes, we had gone through our little emergency retrofire and our emergency SEP ADAPT and all this. We were all set to go on those, and I think we'd have been in real good shape even if they hadn't occurred. Retro-pack jettison --

Conrad Straightforward.

Cooper We held retro-attitude, waited on the light, armed the retro-jet and when the light came on Pete toggled them and off they went "Kaplunk". They sounded just like in the simulator.

Conrad Again we didn't see anything. It was pitch black. Had cockpit lights up full white.

FCSD REP Now, you turned around, and you saw it burning up.

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Cooper No.

Conrad No.

Cooper After we started reentering we--

Conrad During the reentry and it was way, way behind us, but I did see it--now, I say the retro pack-- it could have been the adapter burning up. I don't know which one it was, because it was so far behind.

Cooper There was some object way behind.

Conrad It was some object, a large object, reentering behind but it must have been--what would you say? 5, 6, or 10 miles maybe?

Cooper Oh, yes!

Conrad It was way up the path.

Cooper I'd guess a good 5 or 10 miles.

Conrad And it was up in the--let's see, I was upside down, and it would have been--coming heads up--it would have been in the upper left-hand side. In other words, it was reentering to our south and above us. It was entering on the south side of the orbit, and it was slightly above our entry and you could see our trail clear back to it. You could see our plasma jet went way, way back there. I

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don't know what it was, whether it was smoke or what it wasn't flame--you could definitely see it trailing right along side our trail just like we were leaving a con.

Cooper Yes, you could see our con--it was kind of a light color. I wouldn't say it was a flame color--it was kind of a light color compared to everything else.

Conrad We were looking at this in relation to what nobody else had seen it to. We were still looking at this down sun relatively nebulous horizon that you have. We were looking at it ourselves, a trail back there in the terminator.

Cooper Into the dark.

Conrad Yes. And that's another thing. A very important point here--no kidding, saying this spacecraft's in sunlight doesn't mean anything? That's a night retrofire. And we didn't have a definable horizon to fly on until we crossed the Mississippi River. That's way in the heck down the pipe on retrofire, because that terminator is nothing.

Cooper One thing I'd like to add here--I really think all of us always sweated night retrofire and it was a piece of cake.

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Conrad It really was.

Cooper However, if you don't have full instrument panel, I'd recommend you forget it. Because if you don't have an 8 ball and rate gyros and a darn good rate damping--well, that's not true. If you've got an 8-ball and rate gyros, then you could fire them just as well in Direct system as well as Rate Command; although, I think, you could handle them in direct with no problem.

FCSD REP Do you think you need both the rate gyros and the platform?

Cooper I do. Yes. I would strongly recommend that for a night retro you not try them on purely rate gyros because you just--even the little--

Conrad And the reason--

Cooper The RCS attitude system disrupts your night vision so much out there that getting all squared away for it--just about the time you're getting right in to retro attitude there if you have to fire a thruster or two you'd completely lose your attitude--

Conrad I think the other big thing is that that is absolutely the world's biggest "vertigo giver", because you are really sensitive and when those retros go off if you don't have the whole smear of

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instruments--like I said I was watching the instruments and they were sitting right dead center. Gordo had that thing pitched down 30 degrees and we didn't hardly over 2 degrees off that darn retro attitude, and I was convinced we were doing a loop--even watching the gages. That is the worst set of vertigo that I ever had in my life.

Cooper And I had the distinct feeling that I had just lit off the biggest after-burner I'd ever had a hold of and was going back straight west just as hard as I could hold on.

Conrad That's exactly the feeling.

Cooper And everyone of them had fired.

Conrad Yes,--

Cooper Yes.

Conrad All over again and I really--if you were doing it on just rate needles--well, doing it on rate needles wouldn't be as bad as doing it just on the ball without rate needles. Listen, boy doing it just on the ball--that's just bad news.

Conrad I always felt even in the trainer that bad news.

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Cooper Well, I don't know. You could do it on the ball.
I think if I had my choice between ball and rate needles I'd rather have the ball.

Conrad Would you really? I'd rather have the rate needles, I think, because I could understand them even with this crazy sensation; where I might try to interpret the
But, you see,

Cooper But, you see, our rate needles never ventured off the middle. We never got a rate on the rate needles.

Conrad Yes, well that's fine. Then you know you're staying right where you want to be.

Cooper And the ball--to me the ball is the real good indicator. If you keep your rates down to zero you still could actually get off slightly in attitude and still have almost, you know, essentially negligible rates.

Conrad I think the point is it, it's pretty comforting to have a whole bag of instruments.

Cooper Yes, it sure is.

Conrad I'm not saying it can't be done, but really there was no sweat on night retrofire. Gordo's right about that. I mean, we went through that, turned the lights up bright--matter of fact, it's just like you're back in the simulator.

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Cooper Like doing it in the simulator.

Conrad Until retros fired.

Cooper When they fire, it's quite a sensation.

Conrad But, we went clear to 400K--we went almost the 14 minutes before we had a horizon. We had the ground in sight previous to this

Cooper Well, not much previous to this.

Conrad But we were looking at that screwy gray--

Well, I'll tell you, we fired them at Hawaii, and White Sands was the first thing I saw coming out of the terminator and that's looking straight down. It was still black right behind White Sands and no horizon looking at the nose. But looking straight down, White Sands was the first

thing I saw. We still had a rather nebulous horizon about 45 degrees out the window when we crossed the Mississippi River, I had the decided feeling that we were right on the east coast, but by this time the plasma was so bad that I couldn't really tell. I had the decided feeling that we were crossing into the Atlantic Ocean by the time that we had a full horizon out there.

Cooper Well, now I think our windows on this flight--I was

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really pleased. I think our windows were really stayed relatively clean. We built up a slight coating on them, or something.

Conrad I think everything we built up on them was on there at the beginning.

Cooper But most of it was there to begin with. Our windows were so much better than Mercury. There wasn't even any comparison. The things you could see out of them were just fantastic. We're going to have to crank up the planetarium stars much higher, in fact, because we saw so many more stars than we saw at the decreased Mercury values in the planetarium. It was very confusing, which was very pleasing. I think it's really great. But, even with this better window definition, when you crossed the terminator from day to dark or dark to day there's a very decided confusing area in there where you have absolutely no attitude reference at all out the window. In fact, I tried a couple of times when we were going through the terminator, to be completely blackened down, to have no lights on in the cockpit, and nothing to reflect outside; yet when you crossed the terminator

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you can see both stars passing under you and the earth passing under you. I can't figure how you get all these odd reflections in there. There's a period of time when everything just gets completely jumbled and it's a real dim gray area there you're going through just for a few seconds where you have absolutely no visual reference at all. You're doing beautifully on a night horizon on the airglow and all of a sudden "zunk" you're into this cottony ill-defined mess, and you're getting all kinds of odd reflections and all kinds of odd light patterns, and then "zoom" here you suddenly have day reference on the ground. That period of time is a very poor time to have to do any kind of out-the-window attitude control. And it obviously is a very confusing light period because this is what confuses the horizon scanners, too. The times when you do get the-- when we had that one horizon scanner that was really screwing up. It was overly sensitive, of course, and it would just drop out. Every terminator we went through it would drop off the line. And even our no. 2 dropped off, initially there, a few times going through the terminator. You get a few ignores

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going through the terminator. Okay, retro-pack jettison, we covered. Reentry--our reentry was exactly like we had planned it. We flew single-ring pulse down to 400K. At 400K--

Conrad 400K came on the time that Houston gave us, the computer 400K guidance came in within a second or two--

Cooper The roll bug came in right on the second.

Conrad Right on the money.

Cooper At 400K, then, I switched the attitude control selector to Rate Command. The RCS Ring B came already off and Ring A I took to Direct--so it gave me single-ring Direct. I flew single-ring Direct then on down through the--

Conrad I think we covered the horizon adequately.

Cooper Let's see--

Conrad Spacecraft was--boy, I never even saw--

FCSD Rep What do you recall on visual sight rings?

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Conrad the updated blackout at 16 + 14 and end of blackout at 21 +20. He updated reverse bank as 19 + 25 for a bank left 54, a bank right 68, which was a change of 1 degree from 53 and 67. He gave us drogue at 22 + 05 and main at 23 +48. That was the latest updated quantity after retrofire.

Cooper Okay, spacecraft oscillations--

FCSD Rep Could you tell anything visually?

Conrad Man, that thing was like a rock coming in! I'd been hearing about 40 degree yaw oscillations and the drogue and everything else. If we had anything over 5 degrees--maybe it is just me, but I don't think we had anything over 5 degrees.

Cooper Let's start farther up in the reentry. After we got to 280 K, I was switching back and forth at this point from rate to attitude. I would switch back to rate, and when I'd see we had a little rate build up, I'd tweak it, and then back to attitude and hold my attitude on the attitude needles. Then I'd wait just a few seconds and switch back to rate and tweak out the little rates set in, and go back to attitude-- back and forth in this fashion. On single-ring direct, I had more control authority, initially,

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than I needed. I had to be very careful to just put a little teensy tweak in to damp the rates. Later on, as we got on down, maybe half way through the g pulse area, the rates began to increase in amplitude and in frequency. I still was able to handle them very adequately. No problem at all on tweaking the rates out on pitch and yaw. However, at about this period of time, it began to take so much time to switch back and forth from rate to attitude and get the rates damp that I was getting concerned about the math flow guidance in here and making sure I stayed on it. At this point then, probably half way through or somewhere on down through the latter part of the reentry, I just switched over to the ACME position and allowed the RCS rate command to damp the rates. Then, I would reach over and check the rates once in a while to see how it was damping. But, then, I could concentrate on purely attitude and just fly this same single-ring attitude control. It left me plenty of attitude control. Never once when I checked the rates were the rate needles ever off zero. It

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was just keeping it damped to zero. We weren't firing thrusters too overly often. You could see them fire now and then, but it wasn't a great task for them to fire at all. I really thought the whole reentry was quite stable and at no time did we have any real oscillations.

Conrad Somewhere in there Ring A ran out of fuel. But I am almost convinced that--

Cooper Well, let me say right here now Pete. I way flying the thing. Ring A didn't run out of fuel as long as I was flying. We still had control. Now you are talking about down after drogue deploy. I'm talking about during reentry. Until the time that we went to dual-ring RCS, we still had fuel left in Ring A.

Conrad Yes, I know we did.

Cooper Okay, I just wanted to make that clear on the record.

Conrad It ran out somewhere below 65,000 feet.

Cooper Yes, by those figures you got yesterday, it looked like we still had fuel in Ring A sometime after we brought Ring B on, which was at 60,000. Right?

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Conrad That's right. You get an idea of how much fuel you use because Ring B was tested but never used until below 65,000 feet; we shot 80 percent of the fuel out of it on the drogue. So, it is no surprise to me that Ring A ran out of fuel. There is no doubt about it that Ring A was still running, unless somebody shows me otherwise on a traces, at least past drogue deploy. It was running until at least we got Ring B running.

Cooper I really firmly believe, based on what we tried on here and my feeling on the thing, you could shoot two or three orbits of attitude control and alignment and the whole smear of retrofire and the whole reentry and everything on one ring with no problem at all.

Conrad Now, let's look at another thing. When you are at drogue deploy, we were on rate command and there was a high frequency, low amplitude oscillation, but it was well outside the rate band. So, those thrusters went to steady-state firing.

Cooper Yes, they did.

Conrad They were firing full blower all the way, trying to damp. And they did. They did an excellent

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job of keeping it damped. We were steady as rock coming in there.

Cooper Of course, this is the way to do it.

Conrad They were firing all the way, and it doesn't surprise me at all that we used all that fuel out of Ring B. But Ring B, I know, wasn't put on until the drogue was out. And I know that Ring B had no fuel taken out of it except to test it two orbits back. There are some 33 pounds in Ring B, and there was 4.9 oxidizer and 4.6 fuel left in Ring B. So, we shot almost 25 pounds of fuel on the drogue.

Cooper Which is fine. You might as well use the fuel up at that point. There's no sense in saving it.

Conrad Again, this tells me that up to drogue deployment you might as well take that reentry rate command and throw it away because the pilot isn't going to accept four degrees per second anyhow. He is going to damp before that. So, you might as well use the wire for something else. Use rate command, and if you fly the reentries just like that, you've got more than adequate fuel in Ring B to poop it away on the drogue and insure

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yourself a nice steady ride. We never saw anything that approached over 5 degrees oscillation.

Cooper The nice thing about the control system is that it is a simple matter to switch back and forth between direct and rate command in the system that we had set up. If you are damping and the damping gets to be too much of a task, or it gets more than you can damp, all you do is switch over to the ACME position on this one switch and it will damp in the rate command. In that rate command, you have really good damping. You might as well have a system that will damp it right down to a gnat's eyebrow, and then you can switch back into direct, concentrate to what you are doing, and switch back and forth if you want to. Let's see, drogue--

FCSD Rep Did you get enough of an oscillation during reentry? If you looked out the window was there enough trailing you that you could probably damp by looking at this? Was there any possibility to do this?

Conrad I don't think the spacecraft is that unstable.

Cooper We didn't have that much oscillation.

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Conrad I don't think you have to worry about it, to tell you the truth. I really wasn't aware of any oscillations at all. Gordo says he was damping. For all I know we rode in there free.

Cooper He speaks highly of my damping.

Conrad The first time I really noticed anything was when we got on the drogue, and I didn't have a whole lot to do but to look out the window.

Cooper There would have been some oscillation, but it would be kind of interesting to ride one down and not damp it, to see how it would do. I really doubt if you'd get very large amplitudes or very much--

Conrad Not until you get down there below a 100,000.

Cooper I don't think this is true of a rolling reentry. That's why we never were in favor of a rolling reentry. On the simulator the thing goes wild on a rolling reentry. But, I think, as long as you hold a steady bank angle, whether it is full left or 90 or whatever you hold, I think the thing is really stable. It sure felt that way to me. It felt to me that it is a good stable vehicle. Now at drogue deploy--I very deliberately deployed the drogue at 70,000 feet.

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Conrad You might put down that I was reading the check-list off, and I called standby for 70,000, which is our point to put the second ring on RCS rate command, and we were going to put Ring B on. I said stand by for 70,000, and away went the drogue.

Cooper I reached down, uncovered the cover on it, and punched it out right at 70 K. I might say here that the drogue went out beautifully, it squidded a couple of times--a typical supersonic drogue fashion. No hard squidding.

Conrad I'm not sure that it stayed reefed. Did it?

Cooper Yes, it did.

Conrad It did a couple of gyrations up there. I wasn't really sure what it was. I don't think it stayed reefed for 16 seconds.

Cooper Yes, it did. It stayed reefed for 16 seconds.

Conrad It looked to me like it flew out and opened.

Cooper It came out and opened in the reef condition. That was that squidding you saw. It opened in the reef condition and then it squidded about three times in the reef condition and then dereefed fully opened. It was as stable as a rock. And I fully anticipated some of the lines were

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probably booken, and I began to look at them. They looked good. I decided, well, it wasn't really any problem, even if I had broken the lines. All I had to do was reach up and deploy the emergency main deploy if it departed, and we were still in good shape, so--no problem on it. As a matter of fact, the combination of when the drogue went out and the RCS left us as stable as a rock. We just came right straight down the glide slope and I don't think we had any oscillations of any kind all the way down, other than these very very minor little higher frequency ones that felt like vibrations off the drogue lines.

Conrad: There seemed to be more interaction between the spacecraft and the drogue lines than anything else.

Cooper: Right. At the time that we came to the main chute, when I pickled off the main chute, it came out completely straight; we didn't oscillate or swing on it at all.

Conrad: Let's backup one second. The best calculations of mice and men were completely wrong though. At 50 K we went on with full repress and O₂ high

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rate. And past 27,000 feet that cabin indicator hit zero faster than you could say Jack Robinson. That thing came off the peg and I had to go back to the old procedure of--

Cooper Snorkel open up.

Conrad Snorkel vent open, and recirc at 45 degrees.

We didn't seal it up again until 2,000, so that didn't work.

Cooper Then, at 10.6 the altimeter and the barostat light were exactly right together. I punched the main and it came out reefed. It held reefed for approximately 12 seconds. We were exactly straight, no oscillations or swings or gyrations on the chute at all. In fact, we were so stable on the chute that in the reefed condition the skirt was exactly symmetrical around the bottom. There was no breathing to one side or anything.

Conrad I think that is another thing that speaks highly of this rate command business, even through we shut it off at 30,000 feet. By that time, we were well slowed down, and there was no big oscillation left on the drogue. So the rest of the ride with no system was free. Now, when that

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chute deployed we weren't even swinging or anything. Like Gordo said, boy, when that thing came out of the reefed condition, it was perfectly circular around the bottom. We looked at movies of these things and we've seen them collapsed on one side, billow out, and collapse, and everything. It didn't do that. That chute came out, stayed perfectly circular. Whenever the number of seconds went by, and the thing dereefed, it dereefed perfectly circular. It never breathed, never oscillated, never swung or anything.

Cooper And we never turned on it either.

Conrad We never turned or anything. The only oscillation we got the whole time was when we went to two-point. We got the see-sawing action. That was it. We went straight into the water. The chute almost landed on top of us.

Cooper Okay, on R and R separation--we might cover that after drogue deploy--it is just exactly like it looks in the sequences. You see all the whole smear trunnelling out there, the great long R and R section going out, and all the lines feeding out, and then the main opens, and the R and R

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can goes on off. It looks just like it does in those sequential drawings. Main chute deploy-- we've already covered. We anticipated the landing attitude as being kind of a jar. It is kind of a whip action there, more than anything. As long as you are braced for it, it is no problem. And then on landing--to me that was a surprise, because on landing I could hardly believe we had hit. It was so easy. We didn't go under water, didn't splash water, or anything. The windows were clear when we hit. I could see the water as we hit. I could see the chute. When I punched the chute jettison, the chute just floated out in front of us and slightly off to one side. The windows were clear. They had some condensation on them but not bad. We could see out of them very clearly. We condensed them over a little more just breathing on the inside, I guess. But when the frogmen got there the windows were still clear enough that they came up and got up close to the window and we gave them the thumbs up. They visually got our thumbs up signal with no problem. The only abnormality was that after we got on the water AIR BOSS apparently was not

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receiving us. We were transmitting coming down on the chute, on the main chute. We made two steering transmissions and counts, and AIR BOSS received these and acknowledged them and got the clears on them. After we were on the water, he apparently was not receiving us.

Conrad Okay, now, I found a mistake, and that is my fault on the HF antenna. I went down through the checklist but I read this one item wrong. I had all three squib batteries off. I should have left the No. 3 squib battery on. The antenna goes up on the common control bus, so that is my fault that the antenna didn't go up.

Cooper But, I thought I remembered when you put those off was after we had already gone through all this.

Conrad Well, I'm not sure that you are not right there, but I still made the mistake of turning all three squib batteries off. I'm sure that if it doesn't go up with the squib batteries on, then there is something wrong with the antenna, but if it goes with the squib battery on, why it was my fault.

Cooper But, in defense of Pete on this, I'm almost sure that we had already gone through all the sequence

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and said, okay, let's go through and really see what we can power down here now. We had gone through to really see what we could power down here now. We had gone through a sort of second power-down checklist when he turned the squib batteries off--

Conrad Yes, you are right.

Cooper And we had tried several transmissions prior to this and had gone through and rechecked this antenna switch location. So, I'm kind of inclined to think that was not the fault of the squib battery being off.

Conrad I really don't know. Then, we powered the whole spacecraft down when we left it, so there was no telling what was going on. I can't speak too highly of this checkoff list. As many times as we went over things in the simulator, boy, if you don't check these items off item by item, in the height of the excitement and the way it goes you are going to miss something. That is the way we went through these checkoff lists. We checked them off by the numbers. Anytime back here where I didn't do an item--where I left it open for some

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reason like right here, suit fans 1 and 2--I made a mark out to the side, "faceplate closed", so we would go back and pick them up later. You've got to do it that way. That's all there is to it. It sure did make it easy.

Cooper Very briefly we would like to cover post-landing. First of all, we had ideal conditions. It was early morning, the air was cool out on the water. The wave condition was, at the worst, 2 to 3 feet easy swells. Almost calm conditions, low wind.

Conrad Let me add one thing on that. We sat there for 4 or 5 minutes in these 2 or 3 foot waves, and every once in a while a wave would wash over the top of the spacecraft. I think you want to be real careful, and I still say--

Cooper Not over the top, but they could wash into your window.

Conrad Right over the window.

Cooper Your window was the down window.

Conrad But it looked like it would roll up on your window.

Cooper That's right. That is a good point.

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Conrad Even on as calm a day as that, boy, don't ever open those hatches unless it is a dire emergency until they've got that collar on there.

Cooper I agree.

Conrad I could see that thing going right straight to the bottom.

Cooper I agree. Pete and I both were in complete agreement on this.

Conrad It was as calm as you could get out there.

Cooper It was a beautiful, calm day. And even so, his point is exactly valid. I think that if you open up even the left hatch, which is the higher hatch, there would be an occasional wave which would throw water into it. I think opening those hatches out there, even with the splash curtain, is a real bad situation, unless you just absolutely have to. You are risking really filling it. Of course, I think you can get them closed and shut down if you start taking water on board, but there is no sense in getting the whole inside all smeared with salt water. However, we were perfectly cool inside with both suit fans operating when we got the repress off, the O₂ high

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rate off, and both suit fans back on the line.

We sat there and we were perspiring very lightly, but the spacecraft was cool; we had cooled it down prior to reentry as cold as it can go. It was 50 degrees cabin prior to retrofire and 50 degrees suit loop--

Conrad We had thought when we hit the water if we were going to have any wait--and it was apparent when we got down there we were going to have a wait--the smartest thing to do is to get out of the suit. It became real apparent that the smartest thing to do was to stay in the suit and get the snorkel open, get the both fans running, and the cabin fan running.

Cooper And this was the answer, because we were really cool in there. There was no problem. We got our helmets off, our gloves off, and our neck dams on so we could recirc through the suits good. It was nice and cool in there. No problem at all. We could have sat there for hours on end if we really had to. No problem. Of course, there again, we want to emphasize that we were there under ideal sea conditions, and I am sure that

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- that little spacecraft could get mighty nauseous if you really had rough seas.
- Conrad We did have just a twinge of RCS fumes in there. We had sealed it off at 2,000 feet and it had only built up to a pound by the time we got on the water, so that secondary O₂ flow rate and O₂ high rate is just not putting out a heck of a lot of flow.
- Cooper But it helps. I think you really had to really sniff to--you had to be hunting for it to smell the fumes.
- Conrad Once we got the snorkel open again on the water and had the cabin fan and the two suit fans running, the smell disappeared shortly thereafter.
- Cooper Yes, it was nice and fresh.
- Conrad It got to be nice and fresh in there. As Gordo says, we were perspiring lightly but our best bet there was we were getting good flow in the suits from the two fans with the snorkel open.
- Cooper I might recommend at this point for later crews that this is a good point to take that doggone blood pressure bulb and pump up the water system and drink all the water you can drink right there.

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Because once you hit the carrier, the medics aren't going to let you drink for about a 3-hour period while they run all their little diddies on you. They don't care how thirsty you are or how bad a situation it is. So, I would recommend that you just fill up with water right there.

Conrad The most uncomfortable and the hottest we got was in the helicopter ride back, which was 35 minutes. It was hotter than blazes in that helicopter.

We still had the suits on. We could have gotten out of them, but we had gotten out fairly dry to begin with, and we just decided to--

Cooper We decided, as a matter of principle, we were going to arrive on the carrier with our suits on.

Conrad We arrived in uniform on the carrier rather than in a bathrobe.

Cooper Besides that, we didn't have patches on our bathrobe.

Conrad Right.

Cooper Okay, that's all I think of. One thing, after we got out--just to cover briefly--when the swimmers got the flotation around the spacecraft we decided we would open my hatch. We opened the hatch and

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I climbed on out over onto the nose section. I felt no ill effects at all. I was kind of watching for it, being careful about it so I didn't fall in the water right off. We wanted to keep our suits dry. I climbed out on the nose section, and they wheeled one of the bigger rafts over around the flotation collar and I stepped on off over into the raft. Pete stepped on out. The only dampness we got on us was when the chopper came down pretty low. He was sitting there blowing spray all over us. He had a heck of a time getting the horsecollar over to us for some reason or other. He finally got over. Pete took it and went up in it and dropped it back to me. I took it and went up in it. We had no ill effects in the horsecollar and no ill effects from there on.

FCSC Rep Did you crawl out of the left hatch too, Pete?

Conrad Yes, Gordo got out and I powered the spacecraft down and turned off all the batteries and the rest of the switches and got out on the left side, and then with the flotation collar on, I climbed back over the right hatch and stood on the right side because it was plenty stable over there

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once they got the collar on. A frogman and I closed the left hatch. I hooked up the little gizzy on the way out so that we could close the hatch and get it started--the lock release.

Cooper Incidentally, was that hard to close? The little lock release?

Conrad No, once the hatch was open and started open, then it was free.

Cooper For some reason or another--that is the first time I've seen it like that when you couldn't get it open.

Conrad I checked mine and it worked okay.

Cooper But mine was hung up for some reason where it wouldn't open.

But mine was hung

Conrad Once we opened the hatch it went free.

Cooper Okay, so much for that.

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11.0 EXPERIMENTS

11.1 Visual definition of celestial objects (D-1), nearby object photography (D-2), and terrestrial features(D-6)

Conrad Okay. D-1, mode 01. These are going to be real straightforward. D-1 mode 01 was done in conjunction with D-4 and it was done photographing the moon. It was done as advertised at 01 days 16 hours 30 minutes, and we took the moon with magazine 11. We took 4 pictures at 1/30 of a second. We took the moon on magazine 9 at 1/60 of a second, 4 pictures. We took 4 pictures of the moon on magazine 10 at 1/125 of a second, and all at that time period or shortly thereafter 16:30. In the meantime, we were making the recording IR measurements of the moon, so we have 12 pictures of the moon on the three camera backs, 3 400 film, 3401 film, and 8443 film. That was sequence 3 with the Questar lens, visual acquisition mode. Now, we did not track with the periscope. We found that the boresight was good enough, and we didn't want to screw anything up. So Gordo did all the tracking with the reticle.

Cooper I think we have mentioned it before, but we might

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mention right here again that when the reticle was exactly boresighted on some object, like the moon or a star, so was the Questar lens. It was right on the moon.

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Cooper Reentry--Number 1--Adapter Separation. No doubt.
We set the Magazine at 1/60th of a second--4 pictures
We took 4 pictures of the moon on Magazine 10 at
1/120th.

Conrad At that time period shortly, thereafter 16:30. In
the meantime we were making and recording IR
measurements of the moon so we have 12 pictures of
the moon on the three camera backs using 3400 film,
3401 film, and 8443 film. And that was sequence 3
with the Questar lens, visual acquisition mode.
Now, we did not track with the periscope. We found
that the boresight was good enough and we didn't
want to mess anything up so Gordo did all the
tracking with the reticle.

Cooper We mentioned before, but we might mention again that
when the reticle was exactly boresighted on some
object like the moon or a star so was the Questar
lens. It was right on the money.

Conrad Yes, really good boresight.

Cooper And the radar was also right on.

Conrad D-4/D-7, 422 was done at the same time. Do you want
to cover that now seeing they were done together, or
do you want to wait until we get over into D-4?

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FCSD REP Why don't we wait?

Conrad We did that portion of D-1 that was.... Then the next D-1 we did was Mode 2. This was done on Venus at 02 days 13 hours 00 minutes. We took 4 pictures of Venus at 1/30th of a second on magazine 11 which was the 8443 IR Film. It was taken through the Questar lens visually with reticle tracking. Let me check the book to see if that is all. D-1, Mode 2 we did at 02 days 13 hours 20 minutes, on Alpha Centauri using magazine 9 which was 3401 Film. We used the Questar lens, took 4 pictures and that completed the D-1 Experiments. Let's run through the updating techniques and communications procedures that are used with the other experiments and I'll only cover them once and that's this time. We send up the title of the experiment, the GMT of the experiment, the sequence number if required, a Mode number if required and then any other requirements went in the remarks section. Things such as pitch, yaw, up, down, filmspeeds, and delta times or anything else went in remarks. I think that this procedure worked extremely well. There was never any confusion on our part as to what

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experiment or how it was to be done.

Cooper The only caution that we might throw in is right here--

Conrad Stick to sequential times.

Cooper Right, stick to sequential time exactly so that you have running sequential time. You can keep track of all the great number of things that they are sending up. They might also consider what--equipment set up and stowage problems you have when they're sending these things up. We had a great deal of equipment shuffling to do there. In general, it worked out fairly well. All the equipment worked extremely well except 35mm camera which jammed several times on....

Conrad Okay, now the reason it jammed was that photo event indicator, which straps on the film transport adapter cable, was too long when the trigger was squeezed. That had a tendency to jam the camera mechanism, and I had to back it off out of the thread zone so that it wasn't tightly in there. In zero g it would continue to back itself out. I would get a couple of pictures and then it wouldn't take a picture and I would have to reach down and screw it in. I

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would screw it in too tight so I would get one more picture off and then it would jam, and I would back it out a little bit. We finally got to where it worked pretty good.

Cooper But this still is an equipment discrepancy that should be--

Conrad Yes, and equipment discrepancy and it almost cost us a couple of good pictures. Especially, when we hadn't found the ship about four times and all of a sudden the camera was jammed. ...wall light fit in there. I might say here that this is D-1, D-2, and D-6. D-1 we got, D-6 we got quite a bit of, and D-2 we did nothing. What we are talking about is the camera equipment associated with D-1 and D-6.

Cooper Acquisition Techniques--They varied. Acquisition techniques varied depending on whether it was a celestial or ground target. Again we can't emphasize enough to do experiments where you have to point to certain places to find things the only way to do it in a professional manner is to have a platform up and use the pointing angles. It makes the task a thousand times easier and it eliminates all

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this sloppiness. If these experiments are worth taking platform time and power to do.

Conrad We've got to say here that there was so much difficulty in finding these things and getting organized that we made onboard decisions to drop this tracking technique and we used only one method. We both looked for the target and when we found it, if we found it, I got Gordo pointed in the right direction and he put the reticle on it. From then on, he did the tracking and I took the pictures. I'd coach him if he was off at all by looking in the lens. We never tried the technique of me flying and taking the pictures at the same time. We didn't because the majority of pictures that they asked for in D-6 were Questar pictures. I would never have been able to find it if we were off the least little bit because the pictures that they wanted filled the whole Questar lens. We found that the boresight was perfect so rather than mess things up and we -- Things were getting worst. To make sure that we got the pictures, we dropped these different tracking modes and we used the same technique everytime. Gordo tracked it in the reticle and I coached him if he wasn't right on for the picture. I told him

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where to go and I took the pictures; and we used that consistently. Now that's a switch from what they wanted but I think it bought them some. It still proves that you can do the job. The telescope has too small a field of view. I recommend if you want the man in the right seat to track and fly them he should have a reticle on his side. Then he can track with the reticle and not the telescope. He tracks with the reticle and he looks in his viewfinder just to make sure that he's got the picture where he wants it in the view-finder.

Cooper Comparison of operational modes.

Conrad We covered that.

Cooper Voice recorder usage.

Cooper We used it while we had it.

FCSD REP What about your D-6 logs?

Conrad This D-6 log is pretty long. Do you want it all?
I can give you the time --

FCSD REP Why don't you just go through it?

Cooper I think it might be better to reproduce.

Conrad It's not that long. It's S-5 and S-6.

Conrad At 01 days, 15 hours, 33 minutes, we had a Sequence 053 which we didn't get. Target obscured by clouds. 02 days, 13 hours, 41 minutes, we had 012 which was

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Monterrey, Mexico. It was covered by clouds, so we took Tampico instead. We took two pictures. 02 days, 15 hours, 16 minutes, 59 seconds, they asked for 020 which was James Connally AFB at Waco, Texas. It was obscured by clouds so I think we got the Dallas Air Naval Station and it was sort of hurried but I think we got five pictures. The next thing they asked for was on 03 days, 16 hours, 37 minutes, 28 seconds, we got our first missile. I got five pictures. I won't guarantee whether the missile was in it or not. Shortly after that time, we got seven of Holloman. I was so tickled to see the sled down there that I shot 6 pictures instead of four. At 03 days, 16 hours, 44 minutes, we took five pictures of Bergstrom. On that same pass, we took four pictures of the Cape and that's when we were tracking with radar.

Cooper Yes.

Conrad Then they gave us a target on 04 days, 12 hours, 08 minutes, 13 seconds of Los Palmos and we got four pictures in the mode that they wanted. On 04 days, 12 hours, 24 minutes, 02 seconds, we got Mozambique. I'm not sure how well we got it, but I took six pictures down here so I guess we got it

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pretty well. At 04 days, 13 hours, 29 minutes I got Savannah Municipal even though they were asking for something else and that was covered and then I tried to get them a picture of this Blantyre Airdrome at 04 days, 13 hours, 58 minutes, 50 seconds and all I got was the terrain around it, because it was covered by clouds. I took a couple of pictures down there anyhow, because this was IR film, and I thought they might want to look at Africa. At 04 days, 15 hours, 56 minutes, 53 seconds we got White Sands again on a 424a. I got 5 pictures. Then we got the best one of all 04 days, 15 hours, 04 minutes, 40 seconds. We got 6 pictures of the USS Lake Champlain.

Cooper Let me interrupt one thing here. I think you said 15 hours on White Sands.

Conrad Did I? White Sands was 14 hours, 56 minutes, 53 seconds. Then we picked up the California missile on the next one. I don't think I got any pictures of that. We saw the missile real clearly but Gordo didn't get on track so I don't think we got the missile in the picture--Every one of these pictures that I mentioned are Questar except the Savannah Municipal which was on a 200 mm. Then we came up

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with object 65 which was this small island off Brazil and that was 04 days, 16 hours, 51 minutes, 25 seconds and we have four lovely pictures of the first island which is 120 miles above the correct island. We have four more pictures of the correct island. We finally found it.

Cooper Here is the map problem that we remarked about earlier.

Conrad Here then is the only one that I really messed up. 05 days, 11 hours, 43 minutes, 41 seconds was the Cape radar test, and I had the darn lens on 1/250th and I should have had on 1/30th. I don't think those 4 pictures will come out. And that's it for D-6.

FCSD REP You might mention here the tracking of these missiles?

Conrad No strain. You've got to get on them right away. When Gordo finally saw it the second time it was just too far away to get him in PULSE. When they come right off the pad you can see them all right. It gets harder the higher they get. Especially the second stage. I got the first missile all the way to first stage burnout. Then I was behind him. I kept seeing a piece of the contrail here and there but I really didn't catch up with him until he passed our altitude. Just about that time he

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burned out again and then he was gone. We could have tracked him through second stage. If you are going to get him on IR you better get him coming off the pad because after that you can't follow them very well with the naked eye. We had two entirely different lighting conditions.

The first day we had them against the clouds and the second day we had them against the land and water.

Cooper We had him against that one string of clouds.

We lost him going against those clouds. If you had a solid land water background I think you could follow him the whole way without any problem.

Conrad The first day he didn't come up out of the clouds but he did to us. You know it was clear at Vandenburg but the clouds were close enough to cut off our angular view. First, we saw him when he--

Cooper But we had good lighting conditions in spite of his being above the clouds. The lighting was such that we could follow him real easy.

Conrad But the second day I was looking right at the pad, and I saw the engine light. There's no two ways about it, I saw the engine light or whatever the fire was coming out of the hole. I don't know how they fired them, but from the time that flame was

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above ground or wherever it was, I saw them come off the ground just as plain as day. You really could see them. He really stood out the second time against the sand background.

Cooper You extended your eyes on that. You didn't save them for the visibility targets.

Conrad We'll talk about those visibility targets. I told you, before I went, I didn't think that was the way to measure eyesight up there.

Cooper I don't either. I think, that the problem--

11.2 Celestial, Space, and terrestrial Radiometry (D-4/7).

Conrad Celestial space and terrestrial radiometry, D-4/D-7. I think, what I'd better do is just go right through the log.

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Conrad All right we started out on D-4 on 01 day, 11 hours, 40 minutes, 15 seconds with Mode 410. Let me just read them and look them up for you. 410 was a star measurement. No camera was required.

I have down here 410 and it was done so it must have been Deneb. Anyhow it's annotated on the voice tape and it was a 410. Pitch angle was 70 degrees. The yaw was 0 degrees and the location was Carnarvon, Australia. We put 4 minutes of D-4/D-7 data on the onboard tape. Okay at 01 days, 11 hours, 48 minutes, 00 seconds we did 411 which was a night land measurement, 90 degree pitch down. The experiment was made while over an experiment station. No camera was required.

And it was done past Sydney. It was done for 3 minutes. Okay, at 01 days, 14 hours, 14 minutes, 00 seconds we did measurement No. 420. We started to do measurement No. 420 which was an IR cloud blanket sweep, and the place they gave us had no clouds. We didn't do it. So at 01 days, 14 hours, 42 minutes, 00 seconds we did 410A. That was Vega and I have it marked as Vega. We got some recorder time on it. It should be correlated. I know what it was. It wasn't 410. This was

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done in conjunction with D-1. The first measurement on there was a REP, don't forget that. The first twenty minutes of tape is the REP. Now at 01 days, 14 hours, 53 minutes, 10 seconds we did a 405 and I have the notation "boresight okay." And that was where we calibrated our RAD gages. They were all right. At 16 hours, 03 minutes, we did 422 which was the moon measurements. We got 2 minutes and tape recorder on that. Then we go to the next day. On the second day, 14 hours, 06 minutes, 00 seconds 420 which was a horizon to nadir measurement and back again, and I believe IR cloud findings sweep. You'll have to correlate what part of the world that was in. I'm not sure that it wasn't over Ascension. 03 days, 12 hours, 50 minutes, 00 seconds we did a 408 which was a black sky measurement and void black space. It was done over an experiments station. It was done over Carnarvon. Then on 03 days, 16 hours, 02 minutes, 00 seconds we did a 409 for 4 minutes over Carnarvon. This was Zodiacal light measurement. At 03 days, 16 hours, 07 minutes, 50 seconds we did a 410B' which was Alpha Signus or Deneb. We got

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two minutes of record time. On 03 days, 16 hours, 37 minutes, 28 seconds we got our first missile, 423 Alpha. We have about a minute and 30 seconds of record time on that. 03 days, 22 hours, 48 minutes, 17 seconds we did 425A which was a Hawaii volcano measurement. I did Monique. It is the only one I could find sticking up out of the cloud. That's not active, but it's a volcano. Maybe they will find something. On the fourth day, 14 hours, 57 minutes, 33 seconds we did a 424A which was a White Sands engine measurement. I got one minute of record time. It should have been a good run. 04 days, 16 hours, 28 minutes, 07 seconds we got the second missile, 423B. I don't think it's on the track. I don't think Gordo was looking at it. We may have been pointed at it right at the beginning, but I doubt it. On the fifth day, at 10 hours, 27 minutes, 00 seconds we did a 414 in East Africa, correlated with some 16mm magazine film. 414 was a desert land. It was done in the area of the Sahara Desert. On the sixth day, 08 hours, 43 minutes, 00 seconds I did a 417 in the East African/Mediterranean. 417 was a water land measurement.

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It's on the recorder. At 06 days, 08 hours, 44 minutes, 40 seconds I did a 418 which was mountains. Those were desert mountains in East Africa. Again I got some record time. On the seventh day, 09 hundred hours, 00 minutes, 00 seconds 419 I got the Ascension calibration except it was done in drifting flight over Carnarvon if I'm not mistaken. And that is the end of D-4/D-7. Updating techniques and communications procedures were exactly the same as covered. Equipment set up and usage was very straightforward. The checkoff list was good. The cooled spectrometer checks worked out fine over Carnarvon. We had a go the first time. We never did make the alinements. The only thing we looked at with the cooled spectrometer was the REP. The REP measurements were made 1 hour and 50 minutes after liftoff. We had a go at Carnarvon. I went to PROP GAGE-EXPERIMENTS, RAD-1, Cold IR-ON, IR-ON, power-ON, transmitter-ON, recorder-OFF. Shortly thereafter we had trouble with the scanner. At 2:05 we were still having trouble with the scanner. We were having trouble with the platform aline. We were in the process

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of turning and I missed Agena BUS ARM EXPERIMENTS
and I missed jettisoning the door on the cold IR.
That's my fault and I jettisoned the door on the
cold IR at 02 hours, 16 minutes, 15 seconds after
liftoff. I started taking the first REP measure-
ments and unfortunately it was at 2500 feet. I
felt that it was still readable so that is where
the data starts. We got some black sky along side
the REP with the cold IR. The radiometric and
IR spectrometer alinements were right on the
button. So was the cold IR. We had no trouble
with the power down procedures. It was very
straightforward. We never did get to do the
cryogenic gas lifetime updates. We never got
the Milky Way with that cooled sensor. We did
get the void black space with the cooled sensor.
We got the Zodiacal light. We got most of the
star measurements. We got the moon. We got the
night land measurements. No, well, we got the
numbers that I mentioned. I just don't remember
all of them. I did not get any cloud illumination
with lightning. I did get day land measurements.
I got the Ascension calibration. I got an IR cloud
blanket sweep, but I did not get the cumulus clouds.

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I did get the moon measurements. I did get one missile measurement. I did get one volcano measurement. I did not get the sun measurements. We were in drifting flight then and we never drifted into the sun. The equipment tape recorder should have had by my calculations, which were generous and I think there was probably more left on it than I had calculated, 12 minutes and 40 seconds worth of record time left on it. This says we recorded some 41 minutes worth of data. The voice recorder was used until it broke down. The flight control procedures were straightforward and we did most of our tracking with the reticle. I ran the equipment.

FCSD REP Did missile coordination turn out okay?

Conrad It couldn't have been better.

11.3 Synoptic Terrain and Weather Photography

Conrad I could sum up this synoptic terrain photography. We have over three hundred photographs. I'm just saying that I think we got some tremendous geological shots. I think we got some great weather shots. I can't say anything about it until I see the pictures. We've got them all

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logged. We should be able to dig our way through them. Some of them were done on 35 mm film which was not requested by the man. It was done on the extra 35mm film that we carried with the 200mm lens so we may have some great shots. The relay of data was good. The voice recorder was used until it broke. All the equipment operated. The Hasselblad camera operated fine. It never jammed. It took every picture and I think they were all good pictures. The tape recorder quit somewhere in the third day. I've got a log over here that says voice recorder tapes. We had a tape that ran from launch to 01 days, 09 hours, 25 minutes, 00 seconds and we picked up the next tape at that time. It ran till 02 day, 13 hours, 10 minutes and we had another tape that we picked up at that time. It ran till the third day, 13 hours, 47 minutes. Tape 29 ran until the third day 17 hours, 15 minutes. There was another tape in there and that was the one that quit. We don't know how much we got on that one. That was the fifth tape. We ran 4 tapes and it quit on the fifth one. That fourth tape takes us through third day, 17 hours, 15 minutes. We took

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pictures of Betsy and Doreen and we got a couple of typhoons, also. We got them all marked down.

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Conrad Let me just maybe give you a synopsis here of some idea of what we probably have down here on the log, and, just looking at the pages here -- started out pretty generally, lot of Baha California, few in Mexico, Island chains, sunrise, couple of shots down of Saigon, Tibet, Tibet, China, Japan, Arabian desert, Tibet, Tibet, China, Arabia, Hanoy, Phillipine Islands, desert dunes, Oasis, African continent, hurricane, coast line, Cairo, Gibraltar, Tripoli, Apollo landmark, Mexico, U.S. California coast, Cape, large storm on an S-6 at 01 day 17 hours 12 minutes, Florida, large thunderstorms over Antigua, Baha, California, Islands and coast, large circular swirls and clouds, river mouth in Shanghai, Japan, typhoon by Japan, Tibet, Tibet, Formosa, Cairo, an S-6 mode 07, Florida, Cuba (if I can mention the word), Guaymas clouds, Houston coastal weather, tropical storm - Central America, Lake Titticaca, Arabia, China, Carache, North Australian Islands, Africa, Cairo, Tibet, Pete (laughter), Apollo landmarks, Cyclonic clouds, Hawaiian Islands, Hawaiian Islands, Iran, Turkey, Tibet, Glazier, Tibet, Hong Kong, Nile, Florida, Cuba, West Coast, South America -- gee, he's got a lot of pictures of me in here -- Pete -- tropical

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storm Doreen, West Coast, South America, Andes, Formosa, big Islands of Japan, Tibet mountains and clouds, Tibeten geology, Tibet village, China coast, North Coast of Australia, Australia, China, New Guinea, North Coast of Australia, Cairo, (got a lot of Cairo -- we really liked Cairo), Central Australia, clouds at Cape Rhir (oh, I got a really spectacular cloud shot at Cape Rhir of a cyclonic cloud formation -- a minature one), East Africa, Canaries, Dallas, Fort Worth, Jacksonville, Houston, U.S., Carribbean, Getmo, Baha, California, Mexico, storm Doreen, urine ice, Amazon, Hawaii storm, coral reefs, Midpac, tropical storm, coral reef, urine dump, Tibet, Formosa, Africa, Arabia, weather, Crete, a string across the Meds, large something, India, Islands, Arabia, Palestine, Rev 87 - Australia, East African geology, African lakes south of Nirobi, east African coast north of Tananarive, Madagascar, clouds in the Inter-Tropical Convergence Zone, Jacksonville, Florida, aircraft carrier West Coast by Windowhec, Africa, night photos, clouds, Baha, California, South Mexico, South America, Zodiactal light, moon, cloud formations in the Pacific, cloud formation Hawaii, South American geology, West-South American weather phenomena of sunrise in

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Japan, Japan weather, night pics, stars, Milky Way, thunderstorm and lightning, something village, China, something Shanghai, Marshall Islands, tropical storms, oil well fires in Africa, geology in India, Tibet, Solomon Islands, sequences across Arabia, New Guinea, China coast, Islands due west of someplace -- can't read it -- West Coast Africa, I can't read any of Gordo's writing, some other islands, 102 Rev Australia, Canaries, S-5 no. 48 -- wonder what that was -- East Africa, very hazy, African geology, Cape Kennedy, ice particles, and that's it. Pretty varied (laughter). That's a lot of film there, I'll tell you.

FCSD Rep Greed on Tibet?

Cpnrad No, that was Gordo -- he really goes for that Tibetan country up there -- that's where he sees all his goodies. It's pretty clear and pretty up there.

11.4 Visual Acuity and Astronaut Visibility (S-8/D-13) and Vision Test (M-9)

Cooper Okay.

FCSD Rep Why don't we go --

Conrad Okay -- updating techniques and communications procedures. Again remain the same as before. Equipment set up -- the thing we had there, of course, was a

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vision tester and photometer and the first thing there on the photometer -- I got the first day measurement with the photometer which required a 30 degree sun angle and this was really -- had been given a location to put the sun on the -- Gordo's side of the instrument panel to assure that we had the right sun angle -- okay, we made that measurement. We had the photometer in the window whenever we went by the S-8/D-13 target -- we got those measurements, but we didn't get the last day photometer measurement because we were in drifting flight and didn't have the fuel to set it up. But I don't think the window changed.

Cooper I don't either.

Conrad Yeah, okay.

Cooper Let's see, the vision tester, I thought worked very well. No problem on it -- everything worked just as advertised and we did run it just as we had agreed to run it and was scheduled to run it. In fact, increased our numbers of runs on it later on. Everything went fine on it. I sure noticed a variance from day to day in our performance -- back and forth, back and forth -- it would seem to me like we -- and I think this is probably a function of how much we

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have been looking out the window --

Conrad Yeah, I think you hit the nail right on the head with that one --

Cooper Because once you have been looking out the window for a while, if you come back in and do anything for a while until your eyes kind of got settled down was very difficult. The M-9 -- it's not the M-9 vision test -- it was the M-9 vestibular functions tests of Dr. Miller's -- we ran that just as we had said we would run it -- we held our heads alined with the headrest, as straight as possible, and turned the thing on -- I took mine in my right eye, Pete took his in his left eye, so that I could read along the side of his and he could read along the side of mine. I alined with the top of my instrument panel which is offset by some 30 degrees, or so, and I assume that Pete alined with the top of his also. And we would spin the dial and then while looking in there, aline with what we thought was the parallel alinement with the top of the panel and then say read, and the other man would read their reading or would record the reading down then, and we did this five times to get the readings -- enough said for that. I just will say that I -- my personal opinion on this thing

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is that it was put in here politically, that it was ill planned, ill defined, and is a worthless experiment. I hope someday somebody will have the courtesy to check some of these things out more thoroughly. Ground observations -- we can't even say about the Australian site -- the Woodleigh site because the weather was such that we never got a look at it -- two times we could have gotten a look at it, the weather was very bad over the area and one --

Conrad We saw the smoke so clearly though, and the weather was so clear that I could sort of put that in a category with Yuma, you know, I just wished we had seen it --

Cooper Yeah, I do too.

Conrad That darned Laredo site -- even when we saw the smoke -- the contrast ratio was down so much on the target outlines --

Cooper Yeah --

Conrad That we had a great deal of difficulty finding the target. Now Gordo found them a couple of times when I didn't even find them even looking right at the right spot and I -- when I'd find them, why I'd be too late -- I mean we'd be already at the Nadir and going away from it and by that time, we'd usually be

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in rolling flight because of the tracking involved and the couple of times we saw the marks, you'd be messed up trying to decide whether it was the 1, 2, 3, or 4, just from orientation.

Cooper Well, here again, we were trying to salvage a little bit out of drifting flight and I realize why we continued that experiment where we could and doing what we could, but it's almost worthless to try and do anything of this type if you don't have attitude control systems --

Conrad And a platform --

Cooper And a platform -- because you have got to be able to get powered up, you have got to be able to have pointing information, be able to get on the thing at an early enough date to get your angles right and to get all set up and to be able to control the spacecraft so that you can take the right look angle. When you are trying to climb all over one side of the spacecraft, peer out the back corner of the other window and one in one another's lap, one peering out of one window and one out the other and there's just a mess and it doesn't do the experiment justice and it doesn't do us justice. If the experiments going to be done at all, it ought to be done right and

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here again, I say I realize why we were trying to salvage what we could out of a bad situation but it didn't really do justice to the experiment. We never really once really gave the experiment as far as the ground observation, a really fair chance. And the one time when we really did give it the most fair chance, when we did have attitude control, was extremely bad weather -- the haze was bad -- it was just about like the day when we went over it in the airplane trying to do those observations, it was a low sun angle and haze and the visibility in the area was not real overly good. Pete's already covered the window measurements checklist. I think that this whole experiment was very well laid down and very well prepared for and that the people concerned with this experiment did a real fine job of it --

Conrad I have to make one comment though, I think that the target size was small enough such that the target itself, although it had the high contrast ratio with the surrounding background, that they were looking for, you know so it would stand out, was lost in the acquiring -- in other words, that thing was designed for our close overhead work to see it, and therefore,

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besides the smoke there was nothing else to -- in a contrast nature -- to attract us to the target area --

Cooper That's right.

Conrad And that -- the problem was acquiring it -- we were always in the process of acquiring but by the time we acquired it, we were already overhead where we should have been making readings.

Cooper Yeah, I think that they might do well to put some big colored panels out or some type of something that would be more distinctive --

Conrad Let's say this -- the times that we saw the ships, the time we found the carrier, we had the carrier wake in sight for 500 miles even though we didn't have the ship in sight and we were boresighted, tracking spacecraft pitching down keeping track of that thing when we got close enough to actually see the carrier with our naked eyes, why it's because we had been tracking and looking and focusing right in the right spot all this time. You can't do that with that type target, and this was the thing that I was afraid that was going -- they've tried to control everything in this S-8/D-13 experiment -- measure the atmosphere, they have measured our eyes, they have made the targets the right size, but they

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left out the one thing that really made -- just like being in the desert -- you are flying along out there over the desert and a very, very small thin road stands out and the reason it does, is because it's got the right contrast ratio. You can put a 6 foot road in brown in a brown field and you're not going to see it from 100 feet in the air. And this was the whole trouble. The targets were too small that their contrast ratio didn't help us acquire. I feel the experiment was really a good one. I really feel badly about not getting the data, but my opinion hasn't changed from before flight -- I was worried before flight that the contrast was going to be such that we would never locate it and that was exactly what our problem was. Now the Woodleigh site, I feel might have been a little bit different. We had such a good sighting cue in that Sharksmouth Bay, and there was no doubt in our mind where the target was the one time we saw it with the smoke and in relation to Sharksmouth Bay, and everything that if we had had some fuel up there, we very well may have seen those targets far enough out to acquire the site and start tracking and then we might have gotten them some useful data. No doubt in our mind that we'd

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have had a heck of a lot easier problem if the visual acuity targets had been located up in Yuma and not Laredo. Everytime we came over the West Coast, if I didn't see Yuma, why I was surprised because I think I acquired Yuma every time -- it's real easy to pick it out of the desert and there was many clues to lead you right where those vis targets might have situated if they had been in the Yuma areas, and I felt that you would probably see them. And I still think this is a real worthwhile experiment. I think it's good for 7, but it's got to be revised considerably. They have got to move that Laredo location.

Cooper Okay.

FCS Rep Have you got anything in the book there that you want to put in?

Conrad Well, yeah. Let's just run by it real quick. What happened on each one of the -- I have several passes listed and I have on the first day 00 hours 00 minutes that we took a vision test, well, those are all in the flight plan and they are all marked on the cards so that's not necessary to record. It was on the first day, 18 hours 26 minutes, when I did the window scan. The Laredo siting we did at 1 day, 18 hours, 34 minutes, 38 seconds and we didn't even see it. Then

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at 18:25:05 on the second day, Gordo saw the targets and I didn't. On the third day, 13:32:40 we saw the smoke -- no targets -- bad sun angle -- then the third day, 18 hours, 16 minutes, 14 seconds, we saw a 1 in the first row, and a 4 in the second -- 1 in on the second row -- then on the seventh day, 16 hours, 40 seconds, we saw the smoke, saw the targets on Gordo's side and he scored a 4 and a 1 in the first two boxes and the window measurement was made at that time also. We had to, you know, had the photometer and that's the only S-8/D-13 data I have down.

11.5 Electrostatic Charge (MSC -1)

Cooper

. We did

that just according to the flight plan.

Conrad

Yeah, well, let's see -- I've got -- I'll give the readings here, if I can find them. MSC-1 -- We had an MSC-1 at 01+21+52+00 which ended at 01+22+44+00 and another one at 03+07+40+00 that ended at 03+08+40+00. And another one at 04+05+50+00 that ended at 04+07+00+00 and another one at 06+05+24+00 that ended at 06+06+24+00. Another one at 07+05+24+00 that ended at 07+06+25+00 and another one at 07+20+50+00 and that got cut short by a thruster

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check and I didn't record the time that it was turned off, but I turned on again -- but I'm sure it's on the tape somewhere. So much for the MSC-1.

11.6 Zodiacal Light Photography (S-1)

Conrad Why don't you give them the word on that.

Cooper Equipment set up and usage -- we didn't have any problems in setting up the camera -- all set to go by the procedure that we developed for using the Southern Cross and pointing up towards Alpha and Beta Centaurus with the top part of the reticle worked out all right. We don't know yet what kind of data we got, but we followed the pre-agreed method for where we put the reticle and for turning the camera on and how long it was held on there and then proceeded on around to Gruis, pointing up towards Fomalhaut and held on there and we didn't thrust any during the film. I think there was one film sequence we had to -- we still were doing a little thrusting to get into attitude on one of the longer observations and we recorded this on the recorder and should be on there as to the times and everything.

11.7 Inflight Exerciser (M-3)

We used it extensively for both medical passes and

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for regular exercise through the day--both of us used it. There was no noticeable changes in physiological condition. I think if anything, it is easier to use inflight than it is on the ground, under lg I mean. One thing I might recommend is that it have some little better method of rolling up in maybe some kind of velcro strap fastened onto it to be able to roll the thing up into a stowage type configuration. This is one thing when you start to stow it anywhere, it tends to keep unrolling and getting all over the place. But it worked very well--no problem.

11.8 Inflight Phonocardiogram (M-4)

Cooper As far as I know, it functioned all right. It was just like any other sensor, it itched and was troublesome as far as another sensor. It was not comfortable, but it was not overly painful, but it certainly was very noticeable just like other sensors.

11.9 Cardiovascular Reflex Conditioning (M-1)

Cooper This worked for some 4 days on Pete. He was the one that had this on. There were no procedures or operational problems--it was turned on and left on for all this period of time in which time it ran out of air and quit and the cuffs were itching him very much under his suit, and we proceeded to get his suit

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off -- enough off that we could cut the cuffs off and throw them back in the trash box. The cardiovascular conditioning bottle valve was very objectionable. It was extremely noisy. It woke both of us up everytime it actuated -- with a loud thud and hisses of air-- and I don't care what anybody says in a very quiet room, it was very definitely objectionable and I won't change my opinion of it one bit! It was too loud and my recommendation would be if they can't decrease the noise of this valve, that it be eliminated from any flights. Your M-1.

Conrad My M-1, huh? Yeah, that was a crazy one.

FCSD Rep Let me ask one question on this. You didn't say here. Did you feel anything?

Conrad Yeah, let's go into that. I very definitely felt that after we finally spent many hours down here with Gene Tuggs and rebuilt the cuffs -- yeah, they were doing the job that they were designed to do. They were cutting off the venous flow and I could feel that in flight. Very easily in my feet. So I think it was working correctly. It was a shame it ran out of poop -- gas, air.

Cooper I'm glad it did!

Conrad Yes.

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11.10 Cloud Top Spectrometer (S-7)

Cooper Here again, there weren't any problems in the hardware in the flight that we didn't know about before flight. There were two occasions where the spectrograph's shutter was released inadvertently either in stowage or unstowing and the main shutter had not been -- just as we knew-- this is a very weak point of the mechanism because all you have to do is bump it against something and the spectrographic shutter was released -- which ruined the whole -- that particular exposure -- you had to recock the whole thing. As far as the procedures of using it, it was easy enough to use, it was a little bit cumbersome in shape but we used it holding it-- the lenses upright up high so that they got out the window. I think we got them some good data if Pete will get the log out here he can read over that. We recorded on the voice recorder as long as we had any tape. We recorded comments on the clouds, their appearance, and all that while making the photographs.

Conrad Now, all the photographs taken were specific photographs requested at a specific time. There were some that were requested at a specific time that we didn't get. I think the experiments people have those

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down or they can correlate it real easy if I give you the ones that we got. So we had a -- and we always took two sets, one at an eighth and one at quarter, so we had a set at 1 day 20 hours 2 minutes and 30 seconds, and we actually would up with four pictures. Apparently they requested four. Then we had another one and that was cumulus clouds wherever the location was -- Gordo took the pictures -- and another one on the second day 21 hours 33 minutes and 02 seconds, four pictures of a tropical storm. On the third day, 6 hours 32 minutes and 46 seconds we had four pictures taken over the Philippines of clouds in the Philippines. Then the next frame, number 13, was exposed accidentally. And then on the third day at 21 hours 20 minutes and 8 seconds, it doesn't say what the picture was made of -- but a set were made -- of an 03, mode 03 -- that was, let me look and see here.

Cooper Right, I think that was --

Conrad S-7, 03 Eastern Pacific and then we had on the fourth day at 3 hours 20 minutes and 25 seconds, we had a Philippines/Guam area set again, then on the third day, 20 minutes 35 seconds, you had one taken there -- Gordo, what's that white something -- oh, that white

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calibration card--that was frame number 18.

Conrad Then on the fourth day 16 hours 37 minutes 00 seconds, you had thunderstorms over someplace--is that right--thunderstorms?

Cooper Yes, the tip of Florida, up right off--

Conrad Yes, thunderstorms off the tip of Florida--that's right, they ask for that. And then on the fourth day, 19 hours 44 minutes 02 seconds, we had another Eastern Pacific for two pictures. Then on the fourth day, 21 hours 09 minutes 25 seconds, tropical storm Doreen--two pictures. Twenty-seven was tripped in the spectrometer again--the twenty-seventh--

Cooper That's right.

Conrad Then on the seventh we had seventh day, 4 hours, 18 minutes 21 seconds, we had another Philippine/Guam area.

Cooper Right

Conrad Two pictures.

Cooper Yes, and that was it for the cloud top spectrometer.

11.11 Miscellaneous

Cooper Celestial and External Observations. We saw the Zodiacal light.

Conrad Quite clearly--twice.

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Cooper Clearly. We saw the air glow as usual, always around everywhere -- around the night.

Conrad We did see streaks in the air glow that they talked to us about -- the dark streaks in it which Jim and Ed mentioned. They are really definitely there.

Cooper Right -- banded areas. And we saw this one in the southern Aurora down on the southern celestial pole which was quite -- pretty unusual. Really hard to define at first too -- just what it was.

Conrad Yeah, it looked like a part of the air glow, but it was actually an Aurora -- it changed the --

Cooper It changed the air glow thickness too --

Conrad Changed the air glow thickness and it changed the smooth curvature of the earth -- it put a halt in the black outline of the earth --

Cooper Right.

Conrad And it was a very green band of what you'd -- what kind of Aurora do you call that where it is sort of like a sheet --

Cooper Yeah -- the ~~stria~~ or striden -- something like that.

Conrad Yeah.

Cooper Then one other -- the only other observation other than we did see a lot of micrometeorites and I saw

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one large meteorite enter underneath us --

Conrad Observed quite a few underneath us--

Cooper There was very seldom a night went by that you couldn't watch just for a few minutes to see a micrometeorite or two of them enter. One meteorite came from a long way out burning and went in underneath. There were two other significant things. One was the observation of the moon. The moon was rising out of the airglow. We had about a quarter moon and you could see the entire moon lit partially and then the one part of it lit brighter. It really appeared in three dimensional with the sun back over back off the horizon lighting it. This was quite spectacular, I thought. I thought it looked very unusual. The other observations in the vicinity of the Magellanic Clouds, and actually in the vicinity where this Gegenschein Light is-- it appeared to me to be two to three areas that looked like Magellanic Clouds, only much smaller. There were two or three other little Magellanic Cloud-appearing things. They weren't clusters or anything. I think you noticed them several times too over there when we were fiddling around the Magellanic Clouds, I never could decide what they

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were.

Conrad Yes, we kept looking over the area of Gegenschein to see if we could see and I don't really think it was the Gegenschein, but--

Cooper There was one area right almost in the immediate area of the Gegenschein, but not quite. It was very near that area by maybe five degrees or so though. There was this one area which appeared like the Magellanic Clouds.

Conrad Like a real small one.

Cooper Yes, it looked like a small Magellanic Cloud. That's really what it looked like. It was quite near the area where we had been told the Gegenschein should appear; but, then there were a couple of others of these that similar types back over closer toward the other of the regular Magellanic Clouds. So, I don't know what they were, and I didn't notice these before on my previous flight. These were something that were new to me. We saw a lot of planets. We did try taking the polaroid, the two sheet polaroid filters, and rotating them to all different positions to see if we had circular or linear polarity coming out of the sun. I tried the sun both while well up and while setting.

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Everytime while setting, it seemed to have linear polarity, somewhat vertical, but I never could pin this down to anything well-defined. While the sun was up, well into the sky, I could rotate the filters and rotate them within themselves to any degree and couldn't discern anything but equal polarity coming out of them in all directions. It didn't seem to have any linearity to it at all or any well-defined specific axis of linearity. I never could see anything from the sun other than with the polaroid filter in. After the sun had set, you could see quite a glow with the polaroid filter in, but at the same time you could see it without the polaroid, too. A couple of times when we got the Zodiacal light quite strongly--

FCSD Rep

Can you see the stars down through this airglow?

Cooper

Oh yes. You can see the stars right on down through the airglow. The Gemini window is much cleaner in general, apparently, or much better visibility out of it and night visibility than the Mercury window, because we were seeing down to about seventh magnitude of stars. We saw the clusters in Orion and we could see seven stars in the belt of Orion. We saw a great many stars which we couldn't

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begin to see in the Mercury flights. In fact, on the basis of the number of stars we've seen, our recommendations are that you crank up the planetarium at Moorehead and increase the brightness of it over the level at which we were studying it because it was, to me, rather confusing when we got up there due to the number of stars we actually were seeing. Didn't you think we needed to up the number of that you actually see?

Conrad Yes, very definitely. You see quite a bit of the sky.

FCSD Rep Did you get any pictures of opportunity of something --something that you really remember--that wasn't scheduled?

Conrad Pictures. You mean photographs?

FCSD Rep Yes.

Conrad Oh, I think we have some outstanding photographs in there if they came out.

FCSD Rep I mean something that maybe you wanted to take a picture of that wasn't on the--

Cooper Oh, yes. We took a number of pictures because--

Conrad We got some real good pictures coming across the states, with the clear day we never expected to see, where we got two or three of the big major cities

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in the middle of the States, like Dallas, Fort Worth, and Jacksonville.

Cooper I tried some nighttime photographs with the 200 mm lens on high speed film with several different speed settings just to see if they would come out and what they would come out like--

FCSD Rep Of what?

Cooper Oh, of Orion and several of the constellations-- several celestial fixes--once of some airglow. I took a picture of that aurora that we saw over there and, of course, all kinds of sunsets, sunrises, and the moon coming up through the airglow, and things of this type. A lot of dim light stuff we took with high speed film. It may or may not come out, I don't know. We were guessing at some of the exposures. A great many things on the ground, of course, we took pictures of that were unexpected things that we just thought were real targets of opportunity.

FCSD Rep Okay, that's the end of the experiments.

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12.0 PREMISSION PLANNING

12.1 Mission Plan (trajectory)

Cooper On these longer flights you have to be prepared for more real-time mission planning, which we were. And we had planned on this perhaps being the case and we held all the flexibility that we could in our planning. You need to get all of the key things that you're going to do planned and trained for as well as possible, but the way you fit them together has to be flexible. This applies more to the flight plan than it does to the over-all mission plan.

12.2 Flight Plan

Cooper Flight plan almost invariably winds up being largely real-time planning.

12.3 Spacecraft Changes

Cooper Spacecraft changes has always been a sore point with me and still is. I can't emphasize enough to give the crew and everybody else a fair shake by holding spacecraft changes to a real firm, hard freeze date. No more changes should be made after a certain date because it adds hardship to everybody involved, and does not allow the crew time to train. Some changes are going to be necessary because of what you find out on the preceding flight, but I think they should

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be held to an absolute minimum.

12.4 Mission Rules

Cooper I think that the mission rules were in general very healthy. I think the attitude of the FOD toward mission rules was very good. It was obvious that just as we have seen many times before, that FOD uses the mission rules as guidelines and certainly will deviate from them to keep the flight going, but keep everything as safe and as smooth as possible. I really can't quibble with the mission rules we wound up with at all. I think they were very good.

Conrad The mission rules on the fuel cells were the best things we ever had, they were written real operationally. I would like to compliment the people who wrote those rules.

12.5 Experiments

Cooper Experiments is a sore point with me because I again feel like the flight crew get tromped on all the way down the line. There is no policy that has ever been held to or ever backed up on adhering to an experiments cut-off date. Very obviously, there were a couple of experiments thrown in on a political basis and nothing else. I feel that this is not fair to the experimenters and to the flight crew,

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nor is it fair to the operations people when experiments get cranked in past the experiments freeze dates. I feel that these freeze dates should be established early, agreed to by everybody concerned, and should be held very rigidly to. Unless a safety of flight or a significant development occurs warranting a spacecraft change, the freeze date should be adhered to. If you don't, you affect hardware, you affect all the previous and subsequent training and planning involved, and you compromise everything as well as the experiments which did meet the agreed-to schedule.

12.6 Training Activities

Cooper We were extremely short on time to do adequate flight plan training. Although we had it pretty well in hand, but it was still very marginal. I guess it was just as well since circumstances required considerable real-time planning. It wouldn't do much good to get timing patterns down real pat on these things anyway. Usually it boils down to doing them real time. There were several experiments that I would have liked to have had a little more time to run practice on the simulator, or, at least sit down and lay out exactly how we were going to

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do it. Although experiments worked out relatively well, we could have used a little more time on them.

Conrad Concerning mission planning. I would avoid wiring experiments such as MSC-1. They clobber up very critical time phasing in the mission. For instance, arming the Bus Arm Switch at SECO added an unnecessary step at an extremely time-critical time, which is just pure lousy engineering planning. That door could have been blown by any number of circuits. It didn't have to put it on that one.

Conrad The next thing is the laying out of the flight plan. It became obvious that we were crowded. So, I think they should take a more objective look at the sequential aspects of flight planning, particularly in terms of how long it takes to complete one experiment. This business of being pitched all the way to the nadir, going backward, then having to pitch forward again to pick up the next target, is time consuming. Neither the flight plan people, the crew, nor anybody else for that matter picked this up until we were flying.

Conrad Sleep cycles. On the long flights you have to plan for dual sleep cycles. Stations should monitor and not transmit. The crew should sleep at the same

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time for a period of 6 hours, at least.

Conrad

I am firmly convinced the first three orbits should be devoted only to wringing the spacecraft out.

There was a tremendous mistake made in the planning on our flight. We assumed that everything was going to run correctly in the very beginning. We didn't even test anything but the thrusters and that was a mistake. We had the time to make several systems checks. You have to do a good platform check. You need to check the scanners. You ought to have a detailed procedure laid out in advance. If we'd have done that, we'd have known that the primary scanner was no good. You should have a computer check, which consists of going into Catch-Up mode, hitting Start COMP, maybe inserting a few numbers and see what they read out. We ran into one computer anomaly where the computer kept running and running and I still don't know what that was.

Cooper

Had that occurred during the REP exercise we would have really been up the creek.

Conrad

That's right. In pre-mission planning we should know what the most critical systems are to be checked. For us there was the Platform, Computer and Scanners. One of them bit us and that was the Primary Scanner. We

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were forced into being put all the way back into the first orbit, and it was a mistake. ~~The mission~~ rules were good and I agree with the comments Gordo had on the experiments and the training activities.

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13.0 MISSION CONTROL

13.1 GO/NO GO

Cooper GO/NO GO's--I think we're fine. I don't see anything wrong with the GO/NO GO's.

13.2 PLA and CLA Updates

Cooper I thought those went all right. Do you?

Conrad Yes, we had a hip pocket place to go on every orbit.

13.3 Consumables

Cooper Consumables--In general we had a pretty good handle on those. The oxygen, the OAMS--

Conrad We had one anomaly on the OAMS. I still don't think we lifted off with the right OAMS propellant.

Cooper No, I don't think so either. We had 87 percent--

Conrad 87 percent on liftoff and they never answered that question for us.

Cooper We did ask why we had this reading rather than 100 percent and we never got that answer. We asked this shortly before liftoff.

Conrad This may have had to do with the fact that we had full fuel but not a full load of oxydizer based on that 1.25 mixture ratio. My understanding was that we were supposed to liftoff with 100 percent on the gage. I'm not saying that was correct but it took us by surprise when they blew the Squibs a couple of minutes before liftoff and had 87 percent

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on the gage.

Cooper Electrical--I don't think there was any problem on the electrical system. The problem was in the cryogenics rather than the electrical. I should say in the cryogenics and in the water product of the fuel cells. These were the limiting things rather than the electrical power we were using. As long as you could run the fuel cells there was no limit to the power you could pull off of them.

Conrad Let's put that to bed right now. The GPO fluffed powering up those fuel cells after they'd been powered down. If our electrical problems didn't do anything else, we got to cycle electrical loads all the way through the flight on those fuel cells. As far as I'm concerned, those fuel cells are flight proven. Every fuel cell in every spacecraft that goes off should carry the maximum load of RSS supply so that he has all the electrical power that he wants to use. He can run that platform, computer, or any combination of electrical gear that he wants anytime during the flight. The same thing with the experiments. You've got to have that platform. We kept pinching electrical power and pinching electrical power. I think we proved that the fuel cells can take

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the load. It shouldn't be any problem to fix a couple of things like that. There's no doubt about it, those fuel cells can go up and down, and up and down under load and they will hack the course. We sure gave them a beating. Especially that Number 2 fuel cell.

Cooper Can't say enough about the fuel cells. I just think they did real well. I was extremely impressed at the end when we kept loading them down. We loaded them down even more and the doggone thing began to come up rather than fail, go down or poop completely out.

Conrad That thing stayed on sixty or seventy hours of the whole flight. That's a lot. It must have been sixty hours at least.

Cooper I think that the fuel cell really goes into a hibernation period when you cool it down. I think it almost hibernates like a storage battery.

Conrad The way to bring it back to life is to load it down to get it warmed up, and then to purge it. And I would have liked to super purge that Number 2 cell a couple of times to see if I couldn't have brought it up higher.

Cooper Yes, I think it probably would have worked. The batteries--

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Conrad We didn't always agree with Mission Control. One example--I would have loved to argue with them about the heater circuit on the OAMS. I was against turning it off.

Cooper On fuel cell--do you want to go back to OAMS. We've already gone by it.

Conrad Yes, I'm a curious person by nature and so is everybody else that flies one of these spacecraft. When you send up something you ought to tell them why you're doing it. Especially when we get into these screwy conditions. We didn't have any choice when they said shut down the fuel cell but to shut down the fuel cell. It wouldn't have cost them another two words to say what they were trying to do. I think it was obvious to us what they were trying to do. I tell you, they made some decisions down there on the ground that I'll still sit back here and argue with them about.

Cooper Yes, you are right on that OAMS heater.

Conrad OAMS heater was one of them and another one is the manner in which they conducted that solenoid warmup idea on the OAMS system to unfreeze it. That was a poor way of doing it.

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Cooper That was a very poor plan.

Conrad That wasn't thought out very well. I think, in that particular case, we had all the time in the world to discuss that with the ground. We could have gone a couple of revs talking that one over and it wouldn't have made a hill of beans.

Cooper I think the time that they chose to do it was ill planned. Every test that they laid on us wound up to being a test in the middle of the night. I don't know why. I'm sure this wasn't planned that way, but that is the way it turned out. Anything else on the fuel cells, batteries, or mission control?

Conrad No.

13.4 Flight Plan Changes

Cooper Flight plan changes--I think here is one thing that we want to say about mission control. I'm well aware that the flight plan people were kept extremely busy having to do this tremendous amount of real time flight planning. I think in general Flight Planning back there did a fine job. I'm sure there were a lot of the people coming in and adding this and that and changing this and changing that. There wasn't enough thought given to the crew. The crew was extremely compromised throughout the whole

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flight in the way the flight plan changes were made.

This was unintentional, I'm sure.

Conrad We had to blow the whistle on it.

Cooper They did things like trying to keep one man busy all the time, just to keep him busy. It was obvious that was exactly what was being planned. Certain experiments were put on one man when the other man was asleep then the other man when he was asleep without any thought being given to who had what or which side of the cockpit.

Conrad I think, that we documented this well enough, and I don't think the 4 crew emphasized it enough; but, the people on the ground don't realize how long it takes to perform these other mundane tasks that aren't scheduled such as: hygiene, food, etc. They did allow long time periods for food, but there were other things that they didn't allow the time for such as: garbage, cleaning, etc.

Cooper That's right. General housekeeping and cleaning up the spacecraft.

Conrad I think we can straighten this out with them.

Cooper I do to, but we are talking here about flight plan changes in mission controlling. I don't mean this as critical as it sounds. I want to say I think

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they did a fine job. I think they made a good effort to salvage all we could out of a poor situation. I think they really did a fine job. As a result of what we found, and we didn't know before we got into the real time situation; we discovered that the people compromised are the flight crew. They wound up cutting into sleep periods and certain functions were performed at the wrong time for each one of us. It could have been better planned as for as who did what when.

13.5 Systems

Cooper Mission Control for systems. I think the biggest handle you have on systems is right on board, and I still think so. I think we had a good handle on what was going on. The things that presented a real question were the rate of decay, the rate of dwindling, some of these cyros, etc. The ground got a good handle on them and began to give us some good information on what we could expect. Although, I think some of them were new enough that the ground wasn't aware of what was going to happen. For example, they didn't know when they would vent and when they wouldn't, what the rate would be when they vented, etc.

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13.6 Experiment Real Time Updates

Cooper I think these worked out pretty well. We mentioned about needing a platform before and about needing attitude control. And our OAMS system got worse and worse where we had no attitude control to speak and weren't allowed to use any, I think, a great many of these things that were put in just hoping we might drift through. They were sort of wasted. It was a waste of time. They could have saved our time, theirs, the writing time, and everything involved, because trying to get some of these experiments while in drifting flight is completely impossible.

Conrad It was really funny. It couldn't have been better planned to work out opposite. They'd say get a D-4/D-7, like the Milky Way--You'd expect to drift through the Milky Way long enough to get it. Anytime we had the gear fired up we never got anywhere near the Milky Way.

Cooper No, we would always be pointing at the ground.

Conrad There was one time when I tried to do it. We were pointed at the Milky Way. By the time I found out that we were going to drift through it and the ten minute warm up time for the gear passed, we were

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out of it again. I'd leave the darn IR gear running for a while and we would never get near anything we could look at.

Cooper We never did get that end of the sun picture and yet the sun was in our eyes every time you would turn around. When they would give us some of these locations to photograph and gave us pointing information, it was good. When we had a platform to use, I think, their pointing information was extremely accurate. I was well pleased with it. I thought it was right on the money. We never had a platform to work from so we couldn't evaluate the air-to-air. The air-to-ground was quite good. And you need this.

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14.0 TRAINING

14.1 Gemini Simulator Procedures

Cooper The procedures that we went through in it and our training was pretty accurate. I think that we used the right procedures in the development of our checklist. In going through the procedures we should have had our flight type checklist at an earlier date in order to get a little bit more familiar with them and to iron them out a little more in the GMS. We should have had them 3 or 4 weeks earlier. System knowledge--I didn't feel we were too bad off system knowledge wise, did you?

Conrad No.

Cooper We were pretty well on top of everything. We had a great deal of confidence in knowing the systems. The systems training that we got in the GMS on the failure analysis along with the lectures we got by the systems people, both the GMS people and the McDonnell people, put us in pretty good shape system wise. We were in excellent shape concerning launch training. I might say that if there is any changing to be done we should emphasize the nominal launch more. We ran through all types of emergencies. We had some good sessions on the DCPS. We had some

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wasted time down here trying to crank up some of these launch failures that take quite a while to reset on the GMS. We should have gone through them on the DCPS and let them go at that. It was a waste of valuable time during the last few days.

Many precious hours were wasted cranking the program into the GMS to go through some of the failure modes that we could have done in a tenth of the time on the DCPS. Due to the shortage of time we cut way back on nominal training. We could have had more nominal launches, nominal insertions, nominal insertion checklist, nominal preretro, and nominal retro, etc.

Conrad The best day we had was the day before the actual flight. The day after we had scrubbed. We ran about 8 nominal launches. About 4 reentries all the way through to the end and that really put the frosting on the cake.

Cooper Yes, we should have had another day of that before the first attempted launch. As it turned out we got into reasonable shape because of that one scrub date. We really put it to good use.

Conrad We got a chance to go over the books some more and

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learn things that really helped.

Cooper We were short on nominal time.

Conrad I can't say enough for the way Deke scheduled the things when he asked for two weeks. He was right on the button. We could have used a couple more days.

Cooper Yes.

Conrad A little more nominal training like that to polish it off. If we had, I don't think Gordo would have put the drogue out at 70. And I don't think I would have left all the Squibb batteries off. We shouldn't make those kind of mistakes.

Cooper We would have had more time to run through the nominal procedures and get them down.

Conrad We're the first ones to admit that we made them, because we just didn't have the flight checklist finished all the time. We didn't run that thing that many times.

Cooper We ran very little orbital training other than the REP. I think we spent a great deal of time on the rendezvous and the REP, because it was the first priority.

Conrad One thing that slipped by us, too, was that it took

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us a whole day and a half in flight to realized that these experiments were going to run so successively close to one another. The one thing that we were not prepared for on the ground and had to learn in the air was how to organize a series of different experiments to run them in a row. I'm not sure we could have figured this out on the ground.

Cooper One thing we could have done if we had had the time, we could have taken one of these Stateside passes that we knew would really be cluttered and run through it in real time.

Conrad I think the recommendation here is what should be done in the future for a flight that had experiments like this one. I'd run a sim-net-sim with Houston. We had individually erected and taken down and put up every experiment enough times that we had no problem in assembling anything. We had no problem in knowing where everything was, we knew where everything was in the spacecraft and we got it in the shortest amount of time as possible even in the flight. We didn't have any trouble in that way. The one thing that we did miss was, and they have a sim net sim of

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revs 15 and 16. It might have been a good idea if we had listened to it in that we might have picked up the fact that the sequential running required just a little bit different operation. Again, I'm not sure that you can practice this on the ground, because at the times we had the gear out we wouldn't have been able to load any spacecraft on the ground the way we wound up using it in zero g. I had lenses floating on the floor and film magazines hanging by just a couple of little velcro threads on the overhead which you couldn't have done in a 1 g horizontal environment. You couldn't stow your gear around the cockpit like you can during zero g. Maybe you might compromise here. You might consider a sim net sim to get some idea of how things are going to run into one another, and then if you're up for 4 days or something like that, you might take an orbit to lay out a series so you can learn how to stick stuff around the spacecraft. It's not apparent to you on the ground exactly how you wind up storing that stuff. We really came up with some new places to stash gear as the result of being in zero g.

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Cooper Yes, that's right. Okay, rendezvous is not applicable. If there was one area that we were pretty well trained on, that was retrofire.

Conrad Yes.

Cooper I think we were in good shape for retrofire. We had our checklist for a long time for pre-retrofire and retrofire. We were in good shape, well-trained, and we went right through it like clockwork. I think this area we were sitting right on top of. No problem at all.

Conrad We were in good shape in SECO, too. We went through those SECO procedures in dandy shape. Got the numbers out of the computer and had all of the sequences and so forth and got that well down in the GMS.

FCSD REP On rendezvous, how do you feel about the GMS training?

Cooper The procedures that we learned in the simulator were fine, but you just can't take away that out-the-window simulation. When you add the out-the-window element to it, it's different. It's easier when you kick the REP out and there it is out there visually you can do it fine. The training that we had up at McDonnell on that simulator was just identical to flight. Didn't you feel like we were

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almost in the McDonnell simulator when we got the REP out? Just exactly. That training that we did up there with the visual presentation was invaluable.

Conrad A lot of people don't realize how time critical that whole REP maneuver was. We didn't realize it even when we ran it at McDonnell. When we ran at McDonnell, we had a visual display and no outside encumbrances and no other systems. We had a computer. Gordo had a ball and an out-the-window display, a reticle and a hand controller. I had a computer and an MDIU over there and that was it. And we would sit there, shoot the breeze, talk to the guys out the window and run that thing. I don't think we became aware of how critical it was until we came down to the Cape and got in that first sim-net-sim. Then we had the ground honking on the horn. They wanted information. We had a spacecraft around us in the GMS, and they could throw in little cliches every once in a while, which they did. It turned out that we got little cliches in flight starting out. The one thing that we spent an awful lot of hours on was the REP.

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I'll tell you I wouldn't have given you a nickels chance if we didn't have up systems. We would have had to fallen back on one of those backup jobber doos. That would have been pure luck. But I wouldn't have made a mistake reading it. You are just reading the checklist. They were extremely complicated and long-winded. Now I guess they simplified this a lot in Spacecraft 6; we were up against the wall. We had to stop somewhere; take it and work with it or we weren't going to get it done. They were still in the process or ironing out the procedures. We did more of an evaluation, although it was a learning process, but we were involved in the evaluation stage, which was not the time for us to be doing this.

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Conrad Let me just add one thing. My recommendation is that you are going to have to be extremely careful with the mission planning people because I saw what happened to us. Every flight is going to have a different rendezvous. Somebody is going to want to start changing something, or mickey-mousing around. I think it is going to wind up to be a crew responsibility and that a couple of months before the flight they really put the axe to them to stop. Whether it is the best way to do it or not, the more you do in rendezvous, the more complicated it is and the more time critical it is doing the maneuvers. The computer is a complex little gadget and can really foul you up if you make one mistake. So, training-wise I can't emphasize running the mission the way it is really going to run in real time. We haven't enough time to really get it down.

Cooper Cut it off at an early date, so you can adequately train on it. I can't conceive that you could ever get the off-sets that we were using in some of our retrofire training. Plus, I don't think we are using the right torquing moments on our Rate Command system. The trainer doesn't have anywhere near the brute power that the actual RCS Rate Command has.

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It is a great deal of difference.

Conrad Yes, it was a pretty tight system. This is probably a function of each individual system because I remember Jim mentioning the fact that it was so much sloppier in Rate Command RCS and there is a difference in the tolerance. But it sure wasn't apparent to us. Both the OAMS and RCS Rate Command systems were just as tight as they could be.

Cooper Well, the OAMS Rate Command system definitely was tighter because you could come zapping around with it and the second you let go of the handle it stopped right there. Bam, it never even quivered, just held right there.

Conrad Yes, we must have had an outstanding set of rate gyros. The RCS Rate Command there had a wider band. There was so much power and authority in the RCS Rate Command that it actually gave me a little bit of problem just hitting the point, getting lined up on it for retrofire. There was just so much authority you had trouble getting just small amounts of control force until you got used to it. There was so much power there, almost more power than you needed for fine control. It would be interesting to simulate

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similar control torques on the GMS to see what kind of off-sets it would take before control problems are encountered. I don't believe that you would actually set one of the rockets off enough to bother you. Possibly, you could since it is not a straightline function.

Cooper We had had adequate amount of reentry training. If we'd had a thousand hours more we would not have done anything differently than we did.

Conrad The reentry in the simulator and the reentry in flight up to a point went right down the line, I would say to slightly after guidance initiate. Then, the ball angles were extremely steep in flight in comparison to the trainer. I would very much like to go back and take a look at this on the trainer while it is fresh in my mind. I always use the horizon for roll reference in addition to the roll bug. The horizon disappeared too soon on our reentry. We were looking at all white on the ball there for a long time.

Cooper We pitched on up pretty good.

Conrad Yes, we trimmed out at an awful high angle. The stagnation point on the spacecraft indicated we were

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in the ball park with the previous spacecraft.

Cooper It had to be traveling right because as long as you keep your rates zeroed it is going to trim to its proper trim point. I agree with you completely. It seemed to me as though we trimmed a lot nose higher much earlier in the reentry than we did in the simulator. You have less nose up above the horizon for a longer period of time in the simulator than you do in the actual case.

Conrad That was the only thing that seemed different about the reentry.

Cooper It didn't concern me because I knew we were damped and trimmed out okay.

Conrad Yes, I knew we were in good shape, but it was a significant enough difference so as to be a glaring difference with the simulator.

Cooper I don't know whether it actually was the case or not, but the reentry seemed to go much faster than it did on the simulator.

Conrad From Guidance Initiate to 100 000 feet, it seemed to pass at considerable less amount of time than it does in the simulator.

Cooper Yes, it sure seemed to me like it did. That is something I think we ought to have people check into to

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see what the actual time difference was. Maybe it was just us.

Conrad They can ring that out real easy. We can improve the reentry on the simulator a little bit, it's different in this respect.

Cooper Okay, Crew Station. I have the same comment that I made after Mercury on that. I think that it is just too bad that we can't have horizontal simulators because that is exactly the way you are in orbit. You are not laying on your back, you are in a horizontal configuration. If your simulator ran horizontal you would be standing just like you would be in orbit. Orientation is entirely different.

Conrad I compliment the Gemini crew station on the layout of the parameters that are displayed to you. I feel that there are some other parameters that I would like to have seen displayed in the spacecraft throughout the flight. As an example, I hate to rely on the ground for radiator temperatures or have them call me to heat up a cooling loop. That type of thing is an onboard function. It is very nice that the ground monitors and takes care of you. The spacecraft was extremely well layed out, and as we thought in the simulator it turned out to be true in flight.

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Cooper I think the simulator people down here did a great job getting the simulator up to our spacecraft configuration.

Conrad Yes.

Cooper When we came down here it was pretty close to our flight configuration.

Conrad Yes.

Cooper Stowage wise, they had it in pretty good shape.

Conrad With particular reference with Apollo, having worked for 2 years in the Apollo cockpits, and having now flown a Gemini, and knowing that these two cockpits have been layed out as far as I'm concerned, with two different philosophies, and I think this is the right one.

~~CONFIDENTIAL~~14.2 LTV and DCPS

Cooper I can't really say how accurate they were because we had a nominal mission. I think that they were good training. I think a certain amount of that is very good, very essential. I think there again we have to be very careful not to over emphasize it. I don't believe we did in our case. I think we had just about the right amount, although I think there was a number of people who were concerned that we could have used maybe more DCPS.

Conrad I'll say one thing about the DCPS horizon. I thought that that worked out just almost the way it actually happened.

Cooper Yes sir, I do to. I would like to--

Conrad Boy, that horizon came in the window just about the same time you saw --

Cooper I think that DCPS should really be utilized to advantage as far as this out-the-window reference. Just crank it just a little beyond and do a little bit of work as far as out-the-window referencing and I think it will be an extreme help.

Conrad I wonder if we might not be able to do some help on platform aligning and this sort of stuff. I would like to go back again and look at the DCPS

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from now - having seen an alined platform. I really was quite surprised at what O-O-O looked like. It wasn't anything like what I imagined it was going to look like. I think we were both surprised when we got up there and got the platform alined and really looked at O-O-O, that it looked the way it did.

Cooper And you are also banked.

Conrad Yes.

Cooper You are banked right and I'm banked left.

Conrad Yes.

14.3 MAC Engineering Simulator

Cooper Okay. The MAC Engineering Simulator.

Conrad I can't say enough for that half a day we spent on launches reading out Math Flow 6, on the computer.

Cooper That's right. And the reentries....

Conrad That's the most worthwhile half a day I spent as far as my side of the spacecraft went.

Cooper The reentries I thought we did at MAC Engineering Simulator were just exactly like the reentry we did. I think it was real good. I think, of course, the rendezvous we did up there we have already mentioned, I thought were probably one of the best things we did.

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14.4 Centrifuge

Conrad We didn't miss the centrifuge at all. The fact that we didn't go, I didn't feel that I was left out of anything.

Cooper No, I don't think we missed a thing with the centrifuge.

Conrad I think you should ride it, you know, a time or two or something like that.

Cooper I think if nobody has ever ridden centrifuge--

Conradboost profile or reentry profile is worth running a couple of nominals in your shirt sleeves. I don't think you need instruments or anything, but--

Cooper I think if no one has ever ridden one before I think it is worthwhile they ride the centrifuge just to get the feel of what it is like. But, so far as--you never even feel those g's. You don't even know you've got g's. You are so busy doing things and you're just "clickty-clickty-click." You don't notice them at all. And that level of g is not enough to even worry about.

14.5 Translation and Docking Trainer

Conrad The tracking tests that we did on the Agena, you know, for the camera, was real good. I didn't do the one up in Denver but the one in the Agena was real good, up to, and of course we would only get up as far as

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the nadir, but I think it was helpful and I think flight proved the same thing that we concluded in this, that it was a very simple task, once you had acquired something.the track.

Cooper: Once you had acquired something, yes.

Conrad: The one thing that I, to this day gave me the funniest sensations though, is when you track through the nadir and the things started to speed up and reverse I get the weirdest sensation that we passed the nadir and got about 30° going behind us. I almost had myself reversed in flight, like I was coming up on it again. Now, I can't explain the feeling but it was weird.

Cooper: It's a real odd optical illusion where you are like you are in an inverted spin-type situation. You are looking--going back over here and the angle out is changing such that you almost do have the feeling that it's - that you have suddenly started changing your whole angle....

Conrad: And if you're looking at the nadir, and you're tracking through in just one axis, pitch or something like that, invariably you're off a little bit in yaw, you see, and you'll get going, all of a sudden it will start speeding up, and if there is any roll in there at all; all of a sudden the roll will pick up,

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so all of a sudden this target which has been going this way and getting a little bit smaller all of a sudden the whole world will start to roll on you too as you are going away. I had the feeling that I was falling over a cliff every time we got back to the end of that thing.

Cooper It was pretty weird.

14.6 Planetarium

Cooper Well, here again, I just can't emphasize enough I think that a lot of people under play the value of the planetarium. I think Pete even agrees with me now that boy, that doggone planetarium is pretty essential training.

Conrad Yes, it felt pretty good.

Cooper The planetarium, unfortunately, is an item in your training program that is very easy to cut out. You say well I don't really know that, I can take along a star chart and I can recognize these, and we all tend to do that. We all tend to try and fall into that.

Conrad I tell you, we would never have gotten Nye's Zodiacal light done without having gone up there at the ... and taken his display on it.

Cooper Oh, yes. If we hadn't gone up there and actually gone through it we would never had done it.

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Conrad And with the gun site superimposed, excuse me, reticle superimposed on it. Put it right there to orient it with the Southern Cross and Grus and Fomalhaut we would have never gotten that experiment done, without having gone through that really that half a day did it for that experiment.

Cooper Yes. That salvaged the experiment. Of course he will probably ruin the film anyway. The celestial identification up there, I think one thing that I recommend that we are going to have to crank up the brightness of the stars because we have had them cranked down to the Mercury level here all this time and it's just too confusing when you get up there you see so many more stars than you did in Mercury so we are going to have to raise the level, brightness level of it back up. Up for the training that we do because there were multitudes more stars than we had been training on.

Conrad The stars move around in orbit too fast to use them for spacecraft orientation, as far as I was concerned. In other words I might recognize a constellation out there. The Southern Cross or Orion or something like that, but unless you know your exact point of time and have a star chart sitting in front of you

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and even with a star chart sitting in front of you it wouldn't help you with spacecraft orientation. I take it that what you are saying. Do I know what I am in roll, pitch and yaw to the horizon, or something like that. I don't think so, because most of that stuff is moving too fast up there.

Cooper Well, so far as it's yaw orientation it gives you relatively good angle. For instance you always know if you swing around just one little You remember when we would swing around and there was Cassiopeia, you knew that you were headed generally north.

Conrad Well, yes that's true. You knew that you were on one side of the track or the other.

Cooper Pleides and the ... whenever you would see the Pleides, it always points east, so that gives you a clue and there are several pretty good clues and I always know when I see Delphinus that the Summer Triangle is near by.

Conrad You're right, it would tell me where it was pointed but it wouldn't have told me anything in roll. In other words I wouldn't say that I would use it completely for a three axis spacecraft orientation. It might give me an idea of which way the sky was

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pointing but that wouldn't tell me whether I was upside down or right side up or anything, but I don't know the stars that well.

Cooper: With the accurate star chart updated and then finding the stars on there, then you could use them for spacecraft orientation.

Conrad: I'm taking this to mean you are talking about a quick orientation, you know, I aborted in the middle of the night on launch if I went on a night launch, would I know which way I was going? I don't think so. I don't know.

Cooper: You would be very lucky, you would just have to see one you could recognize.

Conrad: You can take your time when you are planning in advance. Okay. Now you want to use Orion to line up in a certain way with my reticle. Now that's a different story, but that would have to be done at a specific time because Orion moves all the way through the sky and it turns over on a 72 degree launch azimuth.

Cooper: Well, tracking task. We didn't cover that but I think it is pretty obvious that you can use it for tracking task we found.

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Conrad Oh yes.

Cooper Spacecraft orientation. I agree, you need a little help on that. It would be a help to find a horizon, but you could get pitch and yaw on it and then maybe use the stars as a yaw orientation.

14.7 Systems Briefing

Conrad Well, boy I can't say enough for the type we got at McDonnell - were relatively different in nature and the type we got down here but I can't say enough for both of them because they are both essential. I'll tell you old Bob Snyder's one remark about that cryo stuff being able to go through that heat exchanger as a liquid and not bother anything would ... I just can't say enough for how that took the load off of our minds when we were up there.

Cooper Yes, I think the --

Conrad A lot of little tidbits that we had out of these, specifically the guys here at the Cape.

Cooper I would say that the content that we had at the systems briefing was excellent. I would say the number we had scheduled, I would consider the absolute minimum. I think that you should have at an early date some very thorough, extensive systems briefings and then at a later date, closer to the flight some

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additional, maybe shorter, brush-ups on it. I think the people who have done, the McDonnell people and some of our own people and some of the McDonnell people and up at McDonnell is the way to do it. I think, I want the people to really know the systems, to use the systems briefing. I don't think they can be over emphasized, they're really necessary. Simulations.

14.8 Flight Experiments

Conrad Well, we can rule out Denver because we didn't go there, and MAC, I'll never consider ever flying a flight without a horizontal seater on all the gear.

Cooper Wait a minute now, we are in flight experiments.

Conrad This is training. We got simulation, GMS, Translation and Docking and at Denver. This is all backwards because we didn't go to Denver. Oh, okay, simulation. Well, okay GMS, on flight experiments we really didn't do an awful lot of flight experiments in the GMS.

Cooper No, the only thing we used the GMS for down here was a final stowage revue when we got all changed around. We used it for the REP of course. A brush through on the REP.

Conrad We never rigged. I take it back we did rig. We

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went so far as working out the REP that the D-2 camera wanted to pull it out at real time but we never put it in the window. We rigged a 16 mm. Yes, we did use the GMS for all the things that were concerned with the REP which had to do with many stowed items, experiment items.

Cooper Okay. Translation and docking trainers. Let me just say this as far as the simulations on flight experiments. I really think you can use a mock-up to greater advantage and most experiments than you can the GMS.

Conrad Yes. I think you are right.

Cooper I think you are tying up the GMS in many cases over things that you don't need to tie it up for. Translation and docking trainer. I would like to have had maybe a little more time in it although I think we got 99 per cent of what we needed to get.

Conrad Yes, the afternoon I spent in it was worthwhile, running the D-6 camera equipment, taking some pictures and tracking them. All put together the GMS and the tracking thing and the horizontal SEDR up at MAC ended up to good familiarity with the experiments equipment.

14.9 Spacecraft System Tests

Cooper Okay, and at MAC we didn't really run, as you say,

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the horizontal SEDR was - around the spacecraft -
was really the only
flight experiments thing that we did on it up there.
Let's see, flight experiments. Briefings. Well,
I think some of the experiments, some were better
than others. Some were lousy and generally the ones
that got there in politically where the lousiest,
or they didn't bother to show up. I think this is
something that should be very carefully controlled by
the experiments board. If the experiment is going
to be chosen the people who are the experimenters
should be forced to come in and give you a good
briefing on these, everything about them, or other-
wise they ought to be thrown off. Equipment --
now this is along the same line -- I think that you
need desperately to observe freeze dates for the
operation and availability of the experiments.
Equipment for the experiments, if it isn't available
it ought to be thrown off the flight. I think that
somebody somewhere along the line ought to back this.
Maybe it has to go to the LBJ level or something, I
don't know. Spacecraft systems test I
personally am not very impressed with the multiple

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parallel testing. I don't feel that the crew really gets an awful lot out of, out of the spacecraft systems tests anymore because there are so many tests going on at the same time that you can't really keep a handle on what's going on and really get much of a feel for what's going on. You evolve to an automated-type thing of calling three scripts at the same time and throwing switches and listening to quite a complex thing going on. I think that a few of the systems tests that still go on such as the ECS test and the altitude chamber type thing are still well worthwhile, but I think that the parallel method of testing has decreased the value of the spacecraft systems test to the crew by great extent.

Conrad There's no doubt about it, though, in being present you keep them honest on many occasions.

Cooper Well, that's right. On the--it is good in that respect, but as far as the training point of view it does give you some certain familiarity with the systems too, but I was just pointing out that it was decreased over what it used to be.

14.10 Egress
Training

I really thought our egress training was well worthwhile--

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Conrad Boy, I do too.

Cooper I think that was a good exercise--

Conrad It was well organized--

Cooper I thought it was well organized and well run and just very well done and I felt like it gave us a great confidence in the water situation.

Conrad I felt real good when we hit the water.

Cooper Yes, I don't think there was a qualm in our mind at all when we hit the water that we were right on top of the situation--just no problem. In fact, I didn't even bother listening for leaks.

Conrad Yes.

14.11 Parachute Training

Cooper Parachute training. As far as I'm concerned I think if you've had any--I don't feel that I missed parachute training at all. I personally think that's one you could just delete. I think sometime, somewhere along when people come in to the program, they need parachute familiarity and parachute training. Of course, I'm of the banned school and I believe very strongly that we should have actual parachute jump training.

Conrad I do, too.

Cooper If people think this is too dangerous for this

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unhazardous occupation...

14.12 Launch Simulation

Cooper Launch simulation. I thought they were very worthwhile and I think launch sims that we have with the whole, with MCC tied in, are extremely worthwhile.

14.13 Network Simulation

Cooper I think net sims are worthwhile.

14.14 Reentry Simulations

Cooper I think the reentry sims we had were invaluable. In fact, I would sort of liked to have had a few more reentry sims.

Conrad Yes.

14.15 Simulated Network Simulations

Cooper Sims, net sims. I thought were--

Conrad They were invaluable on the REP.

Cooper They were good for the REP.

Conrad I think we got something out of the launch sims, too, although that exercise is more for on the ground.

Cooper Yes, the launch sims had diminishing returns--it took us a long time to cover the ground that we should have covered.

Conrad I think it stayed with the crew and was worthwhile just to get you plugged in to the neg again and get to hear some of the things you're going to actually

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hear over the net...the reentry sims are more important...because it's a more coordinated effort between you and the ground, and I'm convinced that for any rendezvous situations that some net sims have to be--be run...

14.16 Zero "G" Flights

Cooper Yes, well, okay, zero g flights,...I'm not really sure just what value you get out of zero g flights.

Conrad Well, I learned one thing, it was the only opportunity that I had before the flight to get--even though it was a bunny suit at the time, a pressure suit up there in zero g and get some idea--opening and closing it which we did many times in the flight and so forth...And I think we both learned a little something there. I would say now I've done zero g in the airplanes and I've done it in the spacecraft, and if I fly again I certainly don't need to go back and do any zero g work again.

Cooper I really--

Conrad As far as Gemini is concerned.

Cooper I really didn't--

FCSD Rep

Conrad Oh, Oh, well that's a different story, yes. Well, we did do EVA's...but if I was going to do something

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EVA again, yes,--

Cooper Yes, I think this zero g airplane plane is well worthwhile for a specific mission, especially mission training. But so far, as just in general... I don't believe it's particularly worthwhile. Well, it is worthwhile like Pete said, that if a man hasn't ever made a flight before and never experienced zero g, certainly good to familiarize him.

Conrad Yes, I agree with you on EVA.

14.17 Flight Plan Training

Cooper Okay, flight plan training. Well, we never did really have much time to do any real flight plan training, other than--

Conrad Yes, the only thing that we were involved in really was the REP and how it was going to go. We let Jerry Jones lay out the rest of it without us really putting much effort into it. There really wasn't a heck of a lot we could do along that line...

Cooper And I think for long missions this real-time thing is going to go, is going to have to go on, many changes to be made so I'm not sure that the over-all mission needs training...I think maybe you might just run spot portions of it on the time-critical of course--

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Conrad What do you mean by operational check, you were talking about system checks; in flight?

FCSD Rep Yes, flight plan training...
Operation checks.

Conrad Thruster illumination. Well, I don't have much feel for that one way or another other than what I said earlier this morning--yes, I think I don't know why it's as plain as the nose on my face but I think we leaped off the wrong assumption--that everything was going to run right without checking and I think that we should flight plan up the first orbit now with more checks in it. That was a very poor assumption on this part, the more I even think about it, because it was a perfectly likely situation to have some part of those three systems to be not working right, and it would have been a simple matter to have gone to the secondary scanners and eliminating the problem at the very beginning that we had, but we weren't smart enough to know that. We are now.

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15.0 CONCLUDING REMARKS

15.1 Crew Quarters

Cooper One comment on the crew area here. I think that the crew area here is a real good place to stay and that the kitchen facility we have set up is very worthwhile, when a real tight schedule is almost a necessity. However, the bedrooms are not soundproof at all. You can hear anything throughout the whole thing. Any noise at all that goes on, or a television or radio playing anywhere throughout the whole thing is very easily heard throughout the entire building. I say this only because this was one of the suggestions that we had before the place was ever build, that the bedrooms be soundproofed. This was based on our old Hangar S experiences. Due to the fact that heavy construction is going on all the time, this place is completely useless so far as daytime sleeping. There is no possibility of sleep around here during the day due to the jackhammers and construction work going on. So, if any shift work is going on, I recommend that someone keep them a motel room, and sleep during the day at the motel room if you are working night shifts around here and

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trying to sleep during the day and run any kind of night tests.

So far as the people that we had with us that run the place -- I think the place is very adequately run.

I think one person here who certainly deserves bouquets is the maid, Joyce, who just can't do enough for keeping all the laundry done. She keeps the place, I think, very, very satisfactorily clean and squared away. Pete, do you have anything to add?

Conrad Well, I didn't hear all of what you said, but I really thought the crew quarters were a great save for us. I agree with all the things about the noises and everything, with all the construction going on now. It's kind of hard. I do think that there is one thing that I'm going to have to go on record as saying we missed in our training, and there's no doubt about about it. We were so pressed that we didn't have enough time for adequate physical training.

15.2 Physical Training and Aircraft Flying

Cooper There were two things; we had inadequate physical training, and I think we were somewhat short on airplane flight time. I would have liked to have had a few more days to be able -- when we were down here on our last period of time -- to get out and just fly

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local.

Conrad I flew local once the whole time I was down here.

Cooper Yes, I don't think I flew local at all.

Conrad No, that's right.

Cooper And I think, here again, we were caught in the middle of a bad scheduling situation, which higher level would not allow us to do anything about. But, I think we did the best we could with the short amount of time we had. I personally feel that we were extremely short on recreational time and on flying time. We were pretty hard pushed there and on physical conditioning time.

15.3 Sea Lab

FCSD Rep Did you all ever get to talk to Scott Carpenter?

Conrad Yes.

Cooper Yes.

Conrad The last day, the second orbit before we were at retro.

Cooper Yes, just before retro.

15.4 Watches and Clocks

FCSD Red Do you want to say anything about watches and clocks?

Conrad I think Gordo mentioned his Acutron stayed within 4 seconds during the whole flight and we only set it twice.

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Cooper My clock you talking about?

FCSD Rep It was the one--

Cooper My own personal Acutron I never reset and it was some 15 seconds off at the end of the flight for the whole 8-day period. The Acutron on the panel, the panel mounted Acutron, was--I changed it about 4 seconds. It ran 4 seconds fast the entire flight. The Omega that I wore was some 2 minutes off the first day and the second day was another 1 minute and some odd off, at which time I just quit winding it. I quit winding it about the third day and never even bothered using it again. The stop watch that I was--that I took along--at the end of the third day was still only about 2 to 3 seconds off. It actually was quite good and I just didn't have occasion to use one and let it run on down. And then I cranked it up for reentry and started two minutes after retrofire. Your clock over there ran reasonably accurately -- your little 8 day clock over there, didn't it?

Conrad Eight day clock ran real well. I kept it on GMT-- the two big wrist watches I carried, I carried mainly for the REP maneuver and didn't use them too much. I did use them to count down to retrofire and my Glycene

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watch here I kept on G.m.t.

15.5 Miscellaneous Discrepancies

Cooper

OK, I have a little list of discrepancies ~~list~~ that I might just include here. These are discrepancies that I noted during the flight and some of them have been noted before, but I might just hit them real briefly. Just to make sure we have all of them. 1. We lost the stage 2 IPS fuel gage shortly after launch. 2. We encountered this POGO effect at 2 minutes and 6 seconds. 3. We lost communications near SECO on UHF No. 1. many of these have already been explained why, but I just--I'll get these down. 4. We lost fuel cell O₂ tank heaters. 5. The M-1 experiment pooped out and also I thought it was objectionably noisy. 6. The gray interior paint flecks off of the guard bars and off several areas of the cockpit areas and floats and flecks around on the inside. 7. The platform mode was no good for the burns and was not holding the spacecraft as it should.

FCSD Rep

Let me ask one question. Did you ever try that platform control mode on the RCS system?

Cooper

No, I didn't. Sure didn't. I wish I had, I just-- I guess I had just given it up at that point and just didn't get around to it. I should have. The

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platform mode should work very well. There's no reason why it shouldn't work very well and I just can't help but believe it was probably in the OAMS system. 8. I would strongly recommend unsnapable legs on a harness like a regular aircraft parachute harness with adjustable buckle-snap combination things rather than the custom made harness that we have. I think they would be much more usable for flight. 9. The cabin temperature gage failed-- came back in the fifth day for one day and then went back out again. 10. We did not use the polaroid window covers for launch so we don't know how they will evaluate holding on for launch. However, they worked out extremely well for flight. 11. Rest cycles are not observed. Too many little things keep getting thrown in that require two people. 12. The PCO_2 gage was very erratic. It kept coming up and indicating PCO_2 up around 1 mm and it did that for a while and then back down. And, 13. Tape recorder quit some time during the fifth day. That's about it.

Conrad We had a couple here--let's see, did we get the thing about cabin lights getting hot? And melting paint?

Cooper The cabin lights get hot enough they will burn your

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hands and in particular the bright overhead one is very hot.

Conrad One other--let's see, we talked about the purge switches being 3-positioned rather than spring loaded. And one other thing we noticed, one systems glitch which seemed to affect either scanner--out over the Pacific a couple of times we passed some really, really, really big areas of cloud cover, I mean we were almost--the whole visible sky or ground was covered with clouds or a good portion of it and this seemed to give the scanners fits.

Cooper These same clouds were that big cloud that had all the lightning in it too--later on we--

Conrad Well, it may have been. I didn't make any correlation that way, but I, in the daytime, I noticed that the scanners had quite a hard time doing their job when they were looking at much horizon covered by clouds. Got very erratic. I think that's a known phenomena--with scanners, anyhow, but I just wanted to mention that they did kind of kick up when there were a lot of clouds around. We talked about the right auxiliary light bulb bug thing breaking off. And I have one question. There was one place in the world where we passed at night a great deal of

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gigantic fires on the ground and just out of curiosity

I want to know where we were--and it happened on the sixth day at 01 hours 02 minutes and 15 seconds so maybe we'll be able to find out where we were.

That's all I got, Gordo, how about you, anything more?

Cooper No.

FCSD Rep Oh, I got--Pete, you mentioned you blew that oxygen--

Conrad Blew the OAMS squib--could not hear it blow. Had no way of telling that it really worked. You can't pulse a regulator up and I did and it works just like it does in the trainer. It gives it a blip, you know, and you got to keep blipping it up. And I built it up to about 325 from about 300 just to see if it would do it and it did. So the system worked OK. But I still don't know that the squib was blown--you know you pulse, anyhow.

FCSD Rep Well, other than looking.

Conrad Yeah. Well, I thought the squib was in the adapter.

No way of telling, I don't think.

Cooper If they are lucky they might have--(laughter)

Conrad Well, they found a booster--they might find the adapter.

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Cooper I agree completely that the crew area here should be isolated from the medics. I don't feel that the medical department should have anything whatsoever to do with crew quarters; otherwise, I think the crew should just go right ahead and live up to flight day in a motel or somewhere else, because I have a very strong feeling that the medical department is trying to make a clinic out of this place up here.

I think the crew area should be held completely devoid of medics. I don't think they should have anything to do with the running of the crew quarters. I think the crew should establish its own procedures of whether they're going to have low residue diets, or whether they're not going to have low residue diets, based upon recommendations from previous crews, from previous flight experiences along the way, and what everyone who has worked with it has passed on. We hope we can get all this information gathered up in a form that each crew coming along can be given a condensation perhaps of all the previous crew's comments on things of this type, such as diets, methods of defecation and urination,

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urination systems, drinking water systems, and pre-flight set-up type things. As far as the medical-- I'd like to hit that specifically.

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We landed on the carrier at mid-morning, carrier time, and we accomplished not one bit of debriefing or operational work throughout that day at all. We went to bed that night without ever having done one bit of our own debriefing of any kind, whatsoever. The entire day was spent with the medical community. I don't know that we lost anything there, particularly, but I still think there are a lot of things you could sit down and start taping that would be a lot fresher in your mind. Although, I think with two people on the flight, you tend to jog one another enough that you don't forget about things you might when one person has been on a flight. Now, so far as the preflight medical aspects, I still have some very strenuous objections to it and comments to make. I think that T-2 days physical -- giving that extensive a physical at that period of time is kind of ridiculous. I think you really drag a guy through the hoops there just 2 days before his flight and completely grind him down on a very, very extensive physical that I don't agree with the medics as being necessary. And I don't agree with all the blood-letting that was involved in this. I think that all the number of injections and sticks and reinsertions of isotopic blood and everything was completely

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unnecessary, and, again, was just a matter of re-
search rather than anything else.

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