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STS-1
Technical Crew Debriefing

Flight Operations Directorate
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1.0 PREMISSION PLANNING

1.1 WAKEUP TIME LINE

ABBEY Well, I think we ought to talk about the wakeup time line first of all and see what we want to do differently there.

YOUNG I think we can cut the wakeup time line down some. After wakeup, we shaved and took a shower in 10 minutes.

ABBEY The weather briefing can be combined with breakfast as we discussed.

1.2 MEDICAL EXAM

YOUNG The medical examination can be done in 5 minutes with two doctors or one doctor.

YOUNG And you know one doctor could do this physical in 5 minutes because you know all they do is look in your ears, take your blood pressure, put a thermometer under your tongue, and weigh you; you can weigh yourself.

ABBEY Right, but we can get that done, we've already done that, we'll have two tables going - probably cut that to 5 minutes.

YOUNG Yes.

CRIPPEN I personally would also say I think that the getup time and how fast you rush and all that kind of stuff that morning, there is probably going to be a lot of personal preferences to what the guys want.

YOUNG Yes, I think so, too, but the problem we get into is that if you don't cut that to a minimum pretty soon, if you have a

YOUNG (CONT'D) 6-hour hold like we did on Friday, your day is going to be very long. And you don't give those guys any flexibility and I also think we're getting up about a half hour too early.

ABBEY Well, I think you're probably right because when we got into the suit O_2 flow problem, that cost about a half an hour yet we still made the launch time.

YOUNG We can take care of that problem by running a test on it properly in the T minus 10-hour count before they tank.

CRIPPEN When they work themselves down to such they can get that 30-minute hold that you have after we ingress, we could get up later.

YOUNG Well, you know they aren't really giving them a lot of flexibility. You get the crew in there early, then if they get into a hold situation, you're pretty well set, you can do stuff. You can fix things and - -

ABBEY We ought to be ready to go early if the weather's clear, rather than get caught with clouds coming in off the coast like it was on Saturday. You could have launched at 6:30 and couldn't have launched at 7. It would be good to go ahead and try to work to open that window up.

2.0 SUITING AND INGRESS

YOUNG — They really had an extra 20 minutes - we started suiting at 3:10 and started for the pad at 3:50. There is no way in the world it can take a half hour to suit up, although that time Crip had the problem, it took longer.

ABBEY — It helped on Friday when we had the helmet leak problem.

CRIPPEN — That's the main thing we have some of that stuff in there for, you probably need to allow some time for contingencies and that's the hard part.

ABBEY — Well, we've already gone ahead taking steps to cut down the physical time and combine the breakfast and the weather briefings. How about the content of the weather briefing?

YOUNG — I thought the weather briefing was good, I think they should emphasize on launch day the weather - where you're going to land there the first rev or so, and if it's marginal on one place, like say, for example, it was marginal at Edwards but Northrup was okay, you also kind of look at it as either/or, I think. Like how the Rota abort weather was and if we get other downrange sites for STS-2, which I think we ought to have, like if you get into one of these cabin leak problems or something. Nobody can say that things aren't ever going to happen again.

YOUNG — On the way to the pad, that trip went okay; went out in the White Room okay, they didn't slow us down out there. And the time line says crew ingress for 4:30 and we invariably were up there to ingress at 4:20 both days.

ABBEY — Friday, I don't think we had any problems after you got in, I think everything went pretty smoothly.

YOUNG No. On Friday, we were actually seated and strapped in almost at 4:30 and got out at 11:00. Both days, I checked the critical switches on the middeck aft bulkhead when I crawled in. It had a plexiglass GSE cover over those switches and we flew that cover.

ABBEY How about the time getting you out.

YOUNG I thought it was a little long but it gives you a good data point. I really think if you're going to lay in there for 6 hours and then launch, that's pushing it a little, and I don't know how on these missions that you'd cut your day down much either.

ABBEY It seems like on Friday, if we'd have launched on that last time around, that would have been about as long as you would want to go.

CRIPPEN Our current ground rules said a 3-hour hold and we were a little over that.

ABBEY I guess you still feel, based on that, you think that was a good ground rule?

YOUNG Well, I would feel that way except that I know on mission day 1, I worked 21 hours that day because I was up the whole time and it did not bother me.

CRIPPEN It's not a matter, I don't think, of how you feel once you lifted off, it's just a matter of laying in that cottonpicking seat and how much it hurts and once you're underway, well, that's a different story. But I personally think somewhere around 3 hours ought to be a good ground rule and if you choose to break that in real time, you may feel like, "Hey, we're close and we might get there." The problem is they get you out there and we'll go into a hold for an hour; we think

CRIPPEN (CONT'D) we're almost there and then, no, we're not quite there, so I believe we ought to stick with the 3 hours myself.

TRULY One of the problems is it's difficult to ask you directly what you think of the situation.

YOUNG Well, I think two 3-hour cycles, like you get in there at 4:30 and you launch at - what were we launching at - 6:50?

ABBEY 6:50 Friday.

YOUNG And then you recycle and do that again and that's about it.

ABBEY I don't think we'd have gone through another hour cycle.

YOUNG An hour wouldn't have been too bad - -

ABBEY I think you get into the game where they say it's going to be an hour, and then by the time they get into it, they hold longer.

CRIPPEN And that's why they need somebody like you, George, back there applying the rules.

ABBEY Well, that's why I think it would incrementally catch you. Then you'd be darned if you do and darned if you don't.

YOUNG Well, the count went pretty smooth, didn't it?

ABBEY Friday, getting you out, getting you back, and unsuited, I think that went okay. Sunday, we had that problem with the O_2 flow.

CRIPPEN The guys did a good job on that.

ABBEY Sunday, I think - except for the changes we talked about, I think it went pretty smooth.

3.0 STATUS CHECKS AND COUNTDOWN

CRIPPEN I got a couple of small things in the configuration there in the cockpit that I think will probably need addressing at some particular point.

ABBEY You guys both mentioned a comm problem to me on Friday, getting unplugged. John's comm lead was too short?

CRIPPEN The comm cord was too short on Friday because they had snapped it in backwards. They didn't discover it on John. Mine was wrong also; Joe discovered it, but he didn't go back and doublecheck John's.

YOUNG When I turned my head a little bit, I lost comm and that was a bad scene. In fact, I lost it twice during the count and was able to feel my way to the comm cord/seat attachment and reconnect it both times.

ABBEY That was on Friday.

CRIPPEN Yes. Both days I ended up doing something we already knew about, and that was accidentally brushing the LANDING GEAR HYDRAULIC ISOLATION VAVLE to GPC which isn't a big deal but we meant it to be in CLOSE and we really ought to fix it in one of several ways. One would be to lever lock it in CLOSE or do something about a guard. I knew about it and was sitting there worrying about it, and I still hit it both days.

ABBEY You hit it Sunday, too?

CRIPPEN Yes.

TRULY Just hit it with your elbow?

CRIPPEN I expect. Somebody ended up calling me. The other was that they had put a cover under the glareshield that covers this wire bundle. That obscures the C&W matrix light in the upper right-hand corner for both guys.

YOUNG Even when your ejection seat is all the way down, you can't see under this cover.

CRIPPEN Covers about one and three-quarter lights.

YOUNG Now I can see Crip's from over there.

CRIPPEN We can see each other's.

YOUNG Can see my side, sort of.

CRIPPEN But that's not a good thing, like FUEL CELL DELTA-P was obscured totally. I think they could just take the shield off or modify it. But that's not a good situation, we ought to get that flagged.

YOUNG You're always getting cabin atmosphere C&W alarms when they raise the cabin pressure and lower the cabin pressure on the leak check. You hear the flash but you don't see any lights and wonder what is going on.

CRIPPEN Another offhanded comment which I know both of you guys have seen, that is the talkbacks all over the vehicle are much more recessed then we have in the SMS, and things like looking up at what your RCS status is, if you get off at an angle, you can not usually see them. Later I had a problem with a LANDING GEAR ISOLATION VALVE in entry. I couldn't get my head swung up far enough to be sure what the talkbacks were. I would have never thought that I couldn't do that. And that's just a function of how recessed they are. I'm not sure we

CRIPPEN (CONT'D) need to change anything but everybody ought to be aware of it. The SMS gives a little false sense of security on that.

ABBEY We can get the cover fixed.

TRULY We should delete that from the checklist, shouldn't we?

CRIPPEN You really can't do it. The only thing I know to do is to back it up. You can see the switches and you can open them up yourself if you wanted to. Could the ground verify it or do something?

ENGLE You got to ground verify?

TRULY Well, I think we ought to erase it out of the Flight Data File so that we put the ground on the hook to do it.

CRIPPEN Actually, the count I thought went beautiful. I really think both days they handled it well.

3.1 QD O_2 CONNECTOR

ABBEY The only problem I can't understand, on Friday, the suit flow was fine; on Sunday, we had the problem. The QD was loose.

CRIPPEN I heard that they took an air sample.

ABBEY That's what Loren said they must have done.

YOUNG They take oxygen samples, too, they test the oxygen to see whether or not it's pure, George, can you believe that? I think they only test it to see if it's oxygen or not.

ABBEY Well, we ought to try and understand what happened, that sure cost us an awful lot of time Sunday.

CRIPPEN I was going to say Loren and Joe Smith deserve several "atta-boys" because they did a super job.

ABBEY He said he finally decided that was the only thing it could be and reached right back in under the panel and sure enough the QD was loose.

YOUNG That connector itself, it's a bad connector.

ABBEY Yes, it's a two-stage, you push it on and then you have to rotate it.

YOUNG You have to rotate it and it's one that we are expected to install if we have a cabin contamination and you want to breathe, if you had smoke in the cabin while you had to make this O_2 QD. Under those kind of circumstances, the O_2 QD's absolutely impossible to do by feel and therefore it's a lousy connector. And it's used in other places. It's used in the MMU, too, for servicing the MMU. The connector is really bad for a human being to operate.

ABBEY Well, okay; other than those items, did you have anything else on Sunday?

YOUNG I think the recycle where we went out, flew the STA, and had the briefings. I think that is the way to do that.

ABBEY I think, obviously, on the recycle, that worked out super.

YOUNG I really felt okay flying the Columbia a few days later; I really felt comfortable.

CRIPPEN Having the STA down there is a really neat thing.

ABBEY I think the other thing, at least in my observation, having helped in the tower, both for that STA work and for launch,

ABBEY (CONT'D) worked out well. I think it helped on weather updates with Joe. The weather checks worked out well.

ENGLE I think they worked better going through the tower than they did going over the loop.

ABBEY Yes, because I think they know the questions and what they want to talk to you about. I think it was a better route as it turned out.

3.2 BEANIE CAP

YOUNG When they got to removing the beanie cap, they said they removed it. I kept looking out there and looking out there and didn't know where the beanie cap was going to go and then finally I found out it comes back across the windows.

CRIPPEN It comes right over the top.

YOUNG I said, "Oh, yes, the beanie cap's gone," and I could still see the smoke coming out where it was in there. Anyway, it comes over your head like this and they tell you the beanie cap is off.

ENGLE Where do they park it?

YOUNG They parked it right back against the tower, just above the White Room access arm.

3.3 WHITE ROOM ACCESS ARM

TRULY Access arm?

CRIPPEN Over the top of you, it rotates back over you like over here.

YOUNG The White Room access arm moved in jerks at first. I watched it. My concern was that it would stop completely.

CRIPPEN The White Room with the Saturn used to shake the vehicle every time, but the White Room just walked away smoothly. I didn't feel anything shaking.

YOUNG Then cameras. The only thing my left camera showed at lift-off was the tower. It showed that we didn't have the camera pointed correctly.

CRIPPEN Yes, it should be angled down toward the horizon.

3.4 RUDDERS AND HAND CONTROLLERS

ABBEY I guess you didn't seem to have any problems with the rudders and hand controllers - they fixed the hand controllers - but you still have the rudder.

CRIPPEN Well, they didn't put it in the count, they just put a check in there to see where it was, so it doesn't cause any automatic hold or anything. I ended up, from what I was told, thinking what they had was probably satisfactory and it probably wasn't necessary to put the check in there, somebody's looking at it.

ABBEY Okay.

YOUNG They ought to get the rudders and the hand controllers and the speed brakes out of the GLS because we are <u>always</u> accidentally bumping them. You can't talk on the attitude controller button without moving the stick.

CRIPPEN But, John, they've gotten out now from the standpoint of having an automatic hold.

CRIPPEN Well, so go down in the countdown now?

YOUNG Yes, we're there. We're on 7 minutes already.

3.5 APU STARTUP

CRIPPEN APU startup? All that went smoothly. You can hear them and feel them in there just like during the hot-fire test.

ABBEY You can tell them both?

CRIPPEN After the one comes up, it's hard to tell what's going on with the others. But there wasn't any big problem with that. I felt comfortable with the timing, I'm not sure how quick I got them started.

TRULY Based on the amount of APU propellant we had at end of mission, it looks like . . . if that was too rushed, there wouldn't be any problem doing it a minute earlier or something like that.

CRIPPEN No.

TRULY Would you still do it in the same place?

CRIPPEN I personally think I had plenty of time, Dick, to start them up. You and I have more APU starts than just about anybody. I felt pretty comfortable with the amount of time I had to look at them. They ended up, to the best of my knowledge, not needing them up until like 3-1/2 (minutes before lift-off).

YOUNG Yes, but right at 3-1/2, man, they go into those engine gimbal checks and - -

CRIPPEN I personally felt comfortable the way they were; we ended up with enough propellant so that if you wanted to start them early, you could do so.

TRULY No, no, I just wondered. I was watching them crank up on the little display in the MOCR.

CRIPPEN The rest of the stuff was incidental within the count, we didn't really have any other biggies in there. The crew really doesn't have that much to do except just lie there and wonder what's getting ready to happen. Well, guess I might as well talk a little bit about lift-off.

4.0 POWERED FLIGHT

4.1 SSME START

CRIPPEN At main engine ignition - there was a little bit of shaking going on when they came up. The meters fluctuate at lift-off.

ABBEY What kind of shaking?

YOUNG It's a medium frequency. I would estimate between 10 and 20 cps.

CRIPPEN But it's enough that - I mean, you can say, "Hey, there's some shaking going on there."

YOUNG The vehicle pitched forward and you can feel that when you come back, then you get "KAWHAM," a sharp sound, and the noise becomes somewhat louder than the main engines.

Ten to twenty cycles or something like that vibration - and the instruments, it was hard to read them just after lift-off, but the amplitude decreased in the first several seconds and, really, there was no problem after that.

CRIPPEN I really didn't find that the vibration, in my opinion, John - maybe I couldn't get all my senses going there to cover the thing, but the shaking was a lot less than I expected; I personally didn't have any problem reading anything.

YOUNG I didn't have any problem after initial lift-off, but we're not anywhere near simulating these vibrations properly.

CRIPPEN Oh, yes, what we have frequency-wise, I almost say take out all of the shaking myself. The noise; when we did that acoustic test, we went over there and had them play the noise, it was way too high. There was some additional vibration

CRIPPEN (CONT'D) right around there, at max q. The only place where I noticed some vibrations was up near max q, we shook a little bit but it wasn't bad and we had the pitch needle standing off. It looked to me like the winds were a little bit different or that the SRB's were hot or something.

ABBEY Well, what do you think we ought to do with the SMS, then?

CRIPPEN Well, I'm not sure but I think, rather than leave what you have in there now, I'd rather take it all out myself.

YOUNG The vibration was more of a metallic-type vibration, not a hydraulic vibration, real sharp. Really sharp vibration, it wasn't bad particularly, but it was a lot different than anything we had in the SMS. I don't believe we can even approach simulating those frequencies and amplitudes in the SMS.

ABBEY A lot sharper?

YOUNG Yes, a lot sharper, you think of the vehicle banging around riding on top of all these fittings that are holding it and mechanically "jiggling."

YOUNG If you look at the data, make sure it's a medium 10- to 20-hertz frequency - -

CRIPPEN Low-amplitude, high-frequency, 5 to 10 hertz probably.

YOUNG I think the noise is a little louder at max q but right after max q, noise from the boosters just went away.

ENGLE John, did the vibrations stay the same pretty much throughout first stage?

YOUNG Well, there were places they would increase and then decrease back down again. I thought they increased at max q, or when we were going supersonic and then decreased again.

CRIPPEN When the solids came on, I guess, listening to John, I was expecting something like a hydraulic cat shot. I would akin it more to something like a steam cat. It didn't really feel like it kicked me in the tail. As far as I'm concerned, it was just a smooth push out of there.

YOUNG You could see the vehicle translate north. I sure would like to know how close we came to that intertank access arm.

CRIPPEN I think we were clear of the tower when John called lift-off.

(Laughter)

YOUNG No, but we were halfway up when I called lift-off.

CRIPPEN Because it didn't waste any time when it took off.

YOUNG I swallowed my Adam's apple there.

4.2 ET DEBRIS

CRIPPEN But the other thing, all through first stage, we had stuff - well, through second stage, too, but really in the first stage - there was stuff sluffing off what I thought was the ET. It was white.

ABBEY You could see that from your windows looking out?

CRIPPEN It was coming down on the windows and spotted the windows considerably. In fact, the film that we have out of the left-hand side shows that. It ended up spotting even that window.

ABBEY What did it look like? Just white?

CRIPPEN It could have been ice but the way it stuck on the windows, I didn't think it was ice.

ABBEY No, it wouldn't be ice. If you look back at the OMS pod, at least in the pictures, it really looks like something hit that.

TRULY Looks like you dropped a ball bearing on it; something hit it.

CRIPPEN And it ended up that John and I on either side of the aft part of the corner window (W2 and W5) had a chunk a little smaller than your fist missing. It looked like somebody took a bite out of it.

ABBEY Where?

YOUNG On the aft window frames, if you look out the side quarter windows. It looked like somebody reached out there and bit a gouge from two tiles. You can only see about 200 tiles over the nose and we saw that we had at least two of them with big bites out of them.

(Laughter)

4.3 SRB SEPARATION

CRIPPEN When the SRB's went off, the light from the little boosters that shove them away, went completely across the front end. We didn't see the SRB's going off, but there was certainly a big flash.

YOUNG There was a tenuous orange flash glow for less than a second in the side window. I was surprised to see it come over the front windows rolling back toward us. The g's were low enough that if we could have turned our heads - but you can't, you need

YOUNG (CONT'D) to get your head over to the side window but you can't do it because you're strapped in. The first-stage g's built up to 3g's, just before staging and then they died off at tail-off.

CRIPPEN I could have ended up doing in first stage a lot more than I thought I'd be able to. I was worried about the shaking and the g's, I felt like I had good dexterity at all times and only got restricted right there toward the last with the g-load.

4.4 TIME LINE

CRIPPEN When tail-off came up, you could still do stuff. Still, I think the practice of not doing too many things during first stage is probably good. When we got staging, you could move around in that cockpit pretty darn good.

YOUNG It really lofted in that first stage because the pitch needle was off-scale high there (5 degrees).

CRIPPEN And, Richard, when we got in second stage, when the g's started building up, I did break out the pocket checklist and see if I could use it. I guess you could do it, but I still think I ended up favoring the cue cards. Incidentally, one of the things I was pleasantly surprised by was reading cue cards. I guess it's old age catching up with us. In the simulator, I ended up having lots of difficulty with some of these that we have up close. It is mainly due to the fact that we don't have much light in the simulator. In the vehicle, you have all the light in the world, there wasn't any problem reading any of it.

YOUNG In the daylight, you didn't even need any glasses at all to read it most of the time.

CRIPPEN And the Sun, which I had anticipated being some problem from visibility, was there for a little while and it was one of those kind of things you can do just like you do on an airplane when you're flying - if the Sun starts to come up wherever it was, you can use your hands up there momentarily to block it out. It ended up not being a significant problem as far as I was concerned.

4.5 SMS VERSUS VEHICLE (BEFORE MECO)

TRULY Do you think - would you leave our reach and visibility limits the way they were?

CRIPPEN I think they are pretty close.

YOUNG I'm not sure that that vehicle does not have some geometry difference because I had trouble reaching over here in my suit to get the FLASH EVAP switch and reaching all the way to the abort panel. I never had any trouble in the simulator, I'm not sure there isn't a difference there.

CRIPPEN I ended up thinking it was fairly close, but there may be some small difference.

YOUNG Certainly there's the difference in what you can see in terms of talkbacks. I couldn't even turn my head enough to see the gray talkbacks on the DFI recorder.

ABBEY Right after max q, do you - -

YOUNG The most shaking we got was there, and even then it - -

CRIPPEN Wasn't enough to scare you.

YOUNG It was a lot less vibration and noise than we had been led to believe, and right after max q, all the noise went away and after staging, we got off the SRB's, low-g forces - every so often on the SSME's only I felt some much higher high-frequency, very low amplitude vibrations - it seemed almost like a grinding, somebody ought to look at that. It was very much like we felt on the Saturn J-2. It could be the turbine pumps running?

4.6 LOFTING

TRULY John, you'll hear the attitude deviation in the first stage got up to about 6 degrees.

CRIPPEN In pitch, I just don't understand that.

TRULY There is a big ditty going on to find out exactly what that was. They think it was a combination of two or three things.

YOUNG If you want performance, you don't have a completely open-loop pitch profile on first stage, you would optimize. As soon as the Shuttle goes through max q, close the loop and let it guide from there. It must have thrown away a heck of a lot of performance lofting so much and then closing the loop on the second stage.

CRIPPEN We were way up at the top on the traj 2 display.

TRULY Were you?

CRIPPEN Well, not way up, but we were well above it. Traj 1, I couldn't notice it all that much.

YOUNG I think once you come down off your q-alpha and your q-beta maximums, you can put in guidance. If you want performance,

YOUNG (CONT'D) you can close that loop earlier. That's what I think. It is something we ought to look at.

CRIPPEN John got the flash evaps going good and those buggers worked like champs all through the flight. Really nice. As I suspected I would, when I got to 5 minutes for my cryo heaters, I forgot it. That is just a poor place to put something like that. You don't have any real event to cue you on something like that.

TRULY Does it have to live there?

CRIPPEN It is arbitrary that it is there. I recommend personally pulling it back if we're going to do it, during main stage. I'm not even sure that the rate of cryo pressure decay requires them on in main stage. If we're going to do it there, I would recommend doing it at SRB staging, myself.

TRULY I agree with you, we either ought to put it at a place that you can remember or let the ground call it or wait until afterwards or something because it didn't surprise a soul when you missed it.

CRIPPEN I had told Dan already to stand by to call me because I'm probably not going to remember.

4.7 S-BAND LOSS AT LAUNCH

ABBEY We didn't mention one thing that came up during that countdown. We lost that S-band tracking right before launch, and Jay went ahead because we had C-band. We found out why that happened. Somebody at KSC had called MILA and asked them to slave the TV cameras to the antenna so they could have TV. They had never tried that before. So you either have S-band or TV.

TRULY When you came that close to holding because of that - the two C-bands were up so Jay pressed.

CRIPPEN How did Jay's tracking turn out, generally, was it good?

ABBEY It was pretty good, he was plenty upset about it and I don't know who did that down here, because they called MILA and they had flipped the switch a couple minutes before lift-off.

4.8 MECO

CRIPPEN Coming up on MECO - -

YOUNG Wow, the g's built up normally, the launch profile was almost normal. There was no noticeable g oscillation associated with engine throttling, it was very smooth.

CRIPPEN The engines throttle down just like they are supposed to - -

YOUNG The performance was just right on, man, I'll tell you.

TRULY Engines were nominal performance and the SRB's were a little bit better than nominal.

ABBEY A little hot.

TRULY And so that, combined with the lofting - John's exactly right - he threw away some performance he could have had on the solids.

4.9 ET SEPARATION

CRIPPEN John had been warning me about unloading at MECO and both he and I wound up bracing ourselves on the windscreen, but it was a soft shutdown.

ABBEY You were talking about stuff in the cockpit.

CRIPPEN Oh, yes, sometime about MECO, I had nuts and bolts in the cockpit. There was a lot of stuff. The fan started sucking it up. It pulled it down pretty quick.

YOUNG And we're sitting here on this tank upside down after MECO stable then suddenly the Orbiter/Tank combination pitched down an additional 8 to 10 degrees, I don't know exactly how much that was - and then it stopped. The implications of this unexpected tank/vehicle motion in pitch on the RTLS sep and fast sep recontact "boxes" will need to be investigated. The engine lights and tracking changed to MM 104, indicating separation.

CRIPPEN We got a transient that was post-OMS-1, but I think it was associated with the MPS repositioning at the dump.

YOUNG You could not feel separation - but you could feel the vehicle translate away from the tank. The acceleration was very evident. Then when we put in the Y-translation, the Y-translation went - oscillating. Apparently, the Y-jets don't fire simultaneously. We felt the vehicle was oscillating in Y during the translation.

CRIPPEN Then, the impression I got was right at the end of a Y, no matter whether we did it then or did it on-orbit, you get kind of a wobble, it sits there and rocks on itself, back and forth, and I'm not very sure what that is. It doesn't like to move in Y as easy as it does in X or Z.

4.10 RCS

CRIPPEN That was the first time we'd seen big jets. You know when the big jets fire. It's like a big cannon just fired.

YOUNG Sounds like muffled howitzers right outside the window. And the entire cabin vibrates and moves away from the firing. It felt like the nose was being bent.

CRIPPEN And they really move the vehicle. You don't like them the first time you hear them.

YOUNG At night, when you fire the upfiring forward jets, you see this orange fire shooting up here, 20 or 40 feet out there.

CRIPPEN But we went into the maneuver to get into the OMS-1 attitude and John did that in PULSE and maneuvered over nice and easy. Everything with regard to the OMS burn was smooth. Every time we used the OMS, it was beautiful.

YOUNG It was 164 ft/sec, a little less than nominal. We had had the MECO at the 25 680 ft/sec, I believe, and up at 220, just like in the simulator, an incredible thing.

ENGLE Did you see the external tank?

YOUNG No, didn't see it at all.

CRIPPEN Only way I knew it was sep was when the lights went off and then we felt the surge - a little push. If we had cancelled the translation by holding the controller, the only way I would have known it was the fact that the lights went out. I did not feel anything. From when John and I were down there and they fired those sep bolts, that is what I expected.

YOUNG We didn't even feel the part - the foot through the floor-board, it sort of felt like somebody tapped you on the bottom of the foot when we fired the nose sep bolt in the test and this one didn't even feel that.

TRULY You didn't hear anything?

CRIPPEN Nothing.

YOUNG Didn't hear anything.

4.11 MPS REPOSITION

CRIPPEN We got through the burn. That was nominal as could be. We were waiting on the MPS dump. Somewhere after finishing the burn (at 3 minutes and you finish the MPS dump and the SSME's were repositioned to the stowed position), somewhere around in there, we got shuddering on the vehicle. I'm assuming that it was the bells moving around back there.

YOUNG Like three separate shuddering events, didn't you think?

CRIPPEN In fact, we almost thought we had one of those - we had been told about jet instability in the trans-DAP and thought maybe we had one of those for a minute and I think John went to MAN for a minute to see if we could stop the jets from firing and by that time it was gone. We went through APU shutdown and that was all clean.

TRULY Incidentally, for the first time, they had a solution on you before BDA LOS.

CRIPPEN Is that right?

TRULY When we came up to Madrid, they already had a burn report, they had seen the whole burn and had gotten enough tracking - -

CRIPPEN Did they see the entire burn?

TRULY They saw the whole burn, they saw the shutdown and had enough data at the shutdown so that Jay had a vector.

4.12 HYDRAULIC C&W

CRIPPEN Someplace, Dick, and I can't remember exactly, during SRB staging or SSME shutdown - we ended up with a couple of those hydraulic alarms that were just momentaries, and I'd have to go back and try to look at the data to even remember where they were. I think there was one somewhere around staging and I think there might have been another one up around MECO. We had a MASTER ALARM, we just had some kind of shake in the vehicle, and there wasn't anything there, and I didn't even check the C&W memory because I basically assumed that it was the hydraulics, but all that APU stuff worked out just like it was supposed to.

4.13 FLASH EVAPORATOR PROPULSIVE PROPERTIES

YOUNG And when you are in PULSE up there, right at first, after you shut down the APU's, I remember I noticed this, the Orbiter kept rolling left and yawing left. The rolling moment appeared to be more pronounced on the rate needles than the yawing moment. It must be the high-load flash evaporator.

ENGLE Which way did you get it?

YOUNG Roll left and yaw left.

CRIPPEN Yes, and we kept getting some torque in there that we assumed was the evaporator.

YOUNG And so I went back automatic because the DAP could fight those small torques a lot better than I could. I wasn't fighting them too well. The DAP knows when to hit a thruster, but usually when I hit one, it would overcorrect.

ENGLE Roll and yaw left, you mean.

YOUNG Yes.

4.14 APU PROPULSIVE EFFECTS DURING ENTRY

CRIPPEN Was that before we shut the APU's down, John?

YOUNG No, it was after. When you put the APU's on during entry, there was a pitch up torque.

CRIPPEN Yes, those put out a pretty good pitch.

YOUNG The APU's are always pitching us up. I don't think the APU thrust is properly simulated in the SMS. Nor is the thrust that you can get out of the high-load flash evap. It should be because, if you are going to be in PULSE, you are going to have a continual attitude management task. Sometimes you have to be in PULSE because you have to do the alpha management or maneuver to a new attitude.

4.15 ET UMBILICAL DOOR CLOSURE

CRIPPEN The shutdown of all the MPS stuff went smooth and the ET door closure was just as nominal as could be - right on time and it sure made Crippen feel good.

ABBEY Went like clockwork?

CRIPPEN Just went like clockwork.

YOUNG Of course, you know we launch with the flash evaporator heaters off but feedline heater B was the only one working and guess who turned both heaters to A, right?

(Laughter)

YOUNG Yes, so I put them both on A there.

4.16 SSME PRESSURE ALARMS

CRIPPEN We, somewhere right in that time, we ended up with a - was it the left SSME? It must have been the left engine, we ended up with the reg pressure falling - downstream of the regs, the pressure dropped. I guess that later turned out to be a leak. We had indications of a pressure drop on another engine, and that gave us an alarm. I think that was maybe just cooling off or a little gradual leak.

TRULY Yes, the left engine had a leak.

CRIPPEN But we ended up with another engine also showing a reg pressure dropoff downstream of the regs. That is probably going to be a natural phenomenon, so you can probably anticipate some alarms.

ABBEY When did that occur, Crip?

CRIPPEN It was somewhere right in the time frame of after we completed the dumps and post-OMS-1. We also had an MPS C&W due to H_2 MANF PRESS being low. We need to figure out a way to inhibit the low end.

4.17 SEAT SAFING

YOUNG And you got in there - to safe your seat after the burn, but I had this pre-flight problem trying to reach the D-ring.

YOUNG It was a lot easier to safe it zero-g's. In fact, the problem was with the scramble handle, in zero-g - as soon as you get it in zero-g, the scramble handle pops up and you can't get

YOUNG (CONT'D) the safety pin under it. The only way you can safe the handle is to push down on the handle, then install the safety pin.

CRIPPEN You know that little button sticks up a little bit and there was this yellow-handle thing that floats a little bit, so you need to make a conscious effort to push down.

YOUNG You haven't anything to push down on in zero gravity.

CRIPPEN When I put the pins in, John, I think I had already undone my shoulder straps. In entry, I could not get the pin in. John did it easily, but I could not reach down far enough with out undoing my left shoulder strap, but that was not a problem.

YOUNG That was luck there. I think what those pins ought to have on them, to really put them in and take them out in a hurry, is a guide. You know, why couldn't they put a chamfered guide in there so that you could reach down in there and do it in the blind? But you can't do it in this thing in the blind, you have to look over at it.

CRIPPEN My problem is primarily reach, I think. Joe should not have any problem at all.

CRIPPEN I unstowed my little note pad - My scop/Dex were tucked away in there, and I took that.

ABBEY How many did you take?

CRIPPEN I just took one.

ENGLE When did you take it?

CRIPPEN Right after OMS-1 when I opened up the visor.

ABBEY You just took one, then?

CRIPPEN That was the only one I took, per the doctors. I took that one by decree and could take any others as I felt I needed them.

YOUNG Remember when they called us up and said the PC ducers were reading - -

CRIPPEN Reading off-scale high. But they were nominal onboard.

ABBEY Off-scale low.

CRIPPEN Well, they were down at the bottom.

YOUNG We did not have any air, what made them read 15 psi (about 15 percent) before lift-off.

TRULY The indication on the ground worked properly during the burn, but when the burn was over, it was off-scale high.

TRULY It stayed off-scale high and they think it is somewhere in the building there.

4.18 ASCENT OMS BURNS

CRIPPEN Sounds like they have a problem. I mean, they just read the same ducers we do.

YOUNG They are reading like 105, 106 percent when they first started and then they slowly went down to about 102, and they read 102 on every burn, around in there, 102 or 101.

CRIPPEN No, the time line between OMS-1 and -2 that we had was super as far as I was concerned; you weren't rushed, you had time to do everything.

YOUNG Sit there and look out the window - -

CRIPPEN Look out the window - -

YOUNG We maneuvered, and got to the attitude for OMS-2.

ABBEY Could you see out the windows there, you had that stuff already on the windows, it was coated on by that time.

CRIPPEN . . . . Yes, there were streaks and spots and that kind of stuff, and back on both of the left and right windows (1 and 6), right at the forward edge, there was a bunch of fine powdery stuff.

TRULY When had that stuff started coming off, was it immediately after lift-off?

YOUNG I knew we were in orbit because as soon as I looked out the left window, that washer that we bought off on started floating.

CRIPPEN There was lots of junk floating around, but it wasn't the kind of thing you worry about getting in your eye. Second stage.

ABBEY At pitchover, what did you see?

CRIPPEN Just saw the horizon out over the ocean. I didn't see the Azores or anything. Never saw Gibraltar.

YOUNG Didn't see Gibraltar?

TRULY . . . . Bob Stevenson said he was disappointed that you didn't see Gibraltar.

YOUNG We got two pictures of Gibraltar in stereo!

CRIPPEN We did the MPS vacuum inerting - that was nothing.

TRULY I have a question on that OMS-2 burn. Later when they look at the data, it looked like the pitch gimbal got stuck during the OMS-2 burn, somewhere during the burn, towards the end, and the command never drifted far enough away from the position to - -

CRIPPEN Cause an alarm?

TRULY - - declare failed.

CRIPPEN Never noticed any attitude perturbation?

TRULY No, it was perfect timing and then later when . . . you had the fail onboard they looked and during the first gimbal check it never moved. And from then on, it moved slowly.

TRULY You did not notice anything during the burn?

CRIPPEN No. Did we do the gimbal check pre-OMS-2?

TRULY The one that failed was pre-OMS-3.

CRIPPEN Yes, that's right, we didn't do one pre-OMS-2. But we didn't notice that onboard as being slow rate.

YOUNG We did the gimbal check, it didn't work and it got the data here, and I figured it just like the simulator and so we did it again and it worked. Just like a simulator, I said.

TRULY Good thing that they caught - they had high-speed recorders on when you had that failure and they saw right away.

YOUNG And every time we did it again, we did it for all the burns, it never came on again.

TRULY It was moving slow.

YOUNG They don't really need to move fast.

4.19 COMMUNICATIONS

CRIPPEN And the comm was beautiful on all those passes. We could hear UHF all the time and I guess we just didn't have enough power output to pick it up on the ground.

YOUNG . . . We should have a UHF blade antenna between the overhead windows (cabin minus-Z-axis windows) just like the one we had in ALT. Let's just stick it out there in the breeze. We don't always have the PLBD's open.

4.20 EFFECT ON PROPELLANT JET ON OMS BURN

CRIPPEN Should we go over postinsertion? The DPS transition went completely nominal, there weren't any problems at all associated with that. We ended up getting through this just a little bit ahead of the time line and I tried going through very slow and deliberate, not like I usually do.

YOUNG Really? That surprises me that we could jettison all that MPS prop in there like you did and not have it bother anything.

YOUNG I mean, we were briefed that during the OMS burn, we'd see the needles move off in pitch because of the extra thrust from the MPS dump. We saw no pitch or yaw errors.

CRIPPEN Somebody ought to go back and look at the data on that.

ENGLE Did that seem like a fairly good surge on the OMS engine or did you hardly ever feel it?

CRIPPEN It's a nice soft push as far as I was concerned.

YOUNG In fact, you could feel the OMS and every translation we made, RCS or OMS. There is no doubt in your mind when you make them.

ENGLE Vernier, too?

YOUNG No. We could not feel the verniers.

CRIPPEN Well, if you are sitting there very quietly, you can feel the verniers.

YOUNG You go into attitude control and you can tell.

TRULY When did you get out of the seat, I mean unstrap in between OMS-1 and OMS-2?

CRIPPEN I did not unstrap until post-OMS-2.

YOUNG I was in the back doing something there.

5.0 ON-ORBIT OPERATIONS

CRIPPEN That was post-OMS-2 that you got out of the seat, started doing other things. I went ahead and went through all my good stuff and John was in the back working. Then I went ahead and got out of the seat. One of the things that some folks I talked to that have flown before warned me about is that they started to get up and made the mistake of trying to move too fast and got into weird orientations and started feeling woozy. I particularly paid attention to that. When I got out of the seat I maintained myself upright in the vehicle. I kind of moved around with a heads-up attitude. I might have felt a slight fullness sensation in the head a little bit, but that was the only thing that I noticed any different. I continued to maintain a heads-up attitude when I went downstairs for the first time. I took it nice and slow. I did that up until time to get out of the suit (for about 3 or 4 hours) and I never felt woozy or anything at all. I kind of recommend that as a good way to go. Proceed kind of slowly and do not fly around the vehicle fast and furious. At least it worked for me because I never had anything that came close to motion sickness.

5.1 COMMUNICATIONS CARRIERS

YOUNG As soon as I got out of the seat, I was supposed to get down there to get the cabin vent on, and I had the comm carrier on and I couldn't go anywhere with that on. You've got to get those wireless mikes. It is very inconvenient to operate that thing. The whole time I could never keep the earpiece in my ear or the mike on my mouth. We need to get rid of the cabling that hangs up on everything and pulls the earpiece and mike away from you and we need a mike/earpiece system that stays properly positioned on your head <u>all</u> the time.

CRIPPEN The clip we had, he could not get on. That little thing on the ear worked pretty well for me. I knocked it off a couple of times. Basically, it stayed on mine but if you have a pair of glasses on you really need some kind of a clip there.

YOUNG We can't afford to mess with all the cable. The wireless mike system would immeasurably improve your performance.

CRIPPEN . . . . That's the main problem you have right here, trying to keep from getting wrapped up.

YOUNG Every time you go down to the middeck with the comm cable system, you get a loud squeal off the speaker system.

CRIPPEN You wouldn't even need the speaker if you could wear a headset all the time. When you do a lot of work on the middeck you can't keep wearing all that cord. I would turn the speaker up, when it was loud enough to hear, you started getting feedback from anybody broadcasting on the flight deck and then you had the big pain.

YOUNG I'll give you a for-instance. Like every time I went down in there by the WCS to throw those valves to reconfigure the PCS, as soon as I did, the tone would pick up off the speaker.

CRIPPEN Oh, yes, if you tried to talk down there, no matter what level the speaker was on, it was going to squeal on the flight deck. Just like the simulator.

YOUNG Yes, it was very realistic . . . . I mean it was terrible.

CRIPPEN You need those wireless mikes - you really do.

YOUNG Run some good test on them in the vehicle to check for EMI.

CRIPPEN We are going to make a push to do that.

YOUNG That would improve your efficiency 100 percent. You shouldn't have to worry about comm.

5.2 CREW SYSTEMS

CRIPPEN John got all the switches configured for the on-orbit configuration, I got out of the seat, and we got into the payload doors OPS.

YOUNG I'll say this about all those operations, I never did practice them end-to-end in real time. And I think if you are going to do a lot of that, you need to practice it if you want to do it right. As soon as I unstowed and temp stowed two video tape cassettes on the VTR, they floated somewhere and what else happened there? I pulled those card kits out. You need more Velcro back there on those panels.

CRIPPEN We've still got a lot of room for Velcro.

YOUNG There are all kinds of places you can put Velcro. You could just lay everything on the side of your TV monitors, or under your TV monitors, just hook stuff up in there and it will stay in there. Because it is out of the way and you will never bump it and you would know right where it was. But we did not have enough Velcro.

CRIPPEN The several patches that we've got along the aft panels are good but it would be better if you had some up right under the window and more on the aft seats and also on the R panels and on the left panels. Velcro is just nice to have. Always has been in the space program. One of the things that they didn't do, I thought it was going to have been done, is to launch with a VTR cassette installed. Also, on entry they tell you to pull the last one out. We ended up leaving ours in there. It isn't going to hurt anything.

YOUNG Did the VTR work for the first pass? Does anybody know? I don't know if we got - -

CRIPPEN Nobody has played it back - -

YOUNG Well, those photographs did not come out. The ones that I have F/4 at a 60th . . . .

CRIPPEN . . . . You mean the 70-millimeter stuff didn't turn out?

YOUNG It did not turn out - the ones we took of the latches.

CRIPPEN Does it look like they could enhance it someway?

YOUNG Maybe so, all I see is a couple of dark lights in there. The planned pictures have been taken but none of them came out.

CRIPPEN For some reason, the impression I had with the lights in the payload bay was that there wasn't as much light there as I was anticipating.

ENGLE Would a light meter . . . ?

CRIPPEN It wasn't dark but it was just less than I anticipated.

YOUNG They gave me the settings and said, take the pictures. I didn't know the picture wasn't going to work.

CRIPPEN Well, we got into that and I started cycling latches and all the latch times were almost right on the money. They were about 19 seconds for all of the center lines and they were on the order of 26 to 27 seconds for the bulkheads. The door coming open was like 55 on both of them. When I first brought that right door back down, it looked to me like they were all going to hit about position alpha. The second day, back aft (latch 12) and I estimated it . . . they looked to me like

CRIPPEN (CONT'D) they were going to come down somewhere about 1.5 inches below C. Even with the binoculars it is hard to estimate. Also, when that door comes down, it's got at least a plus to minus 8-inch swing on it. So, every time I'd bring it down, when I stopped, it would set there and oscillate three or four times before it settled down.

5.3 PAYLOAD BAY DOOR AND RADIATOR DEPLOYMENT

TRULY It is a suggestion, but if we end up flying the theodolite - -

YOUNG Don't fly that thing. You'll spend a life trying to make it work.

TRULY Yes, that's true. Whether you could use it out of the - -

YOUNG And you don't need it.

TRULY - - the starboard side of the rear window as opposed to the port side.

YOUNG Don't let them put that on there. That is another piece of junk and won't do you any good. I bet you a hundred bucks that they look at these pictures if they get them to come out and nobody is going to notice anything. You're going to train for that for the rest of your life. But up there in zero gravity, try to set it up and align it and operate it and I bet you a hundred bucks it won't work.

CRIPPEN John was running the TV. I don't know if you had any comments on setting up the TV?

YOUNG No, it worked real well. That cue card helped me a lot. I wouldn't have been able to do it without it. You know you can run those things around and put them on the monitor and

YOUNG (CONT'D) put everything you want on them. I was ready when we got the door open.

CRIPPEN The first time I saw the right OMS pod I said, "Uh-oh!"

YOUNG But then he opened the door all the way. I looked out there on the wing which I could see real well before Crip deployed the radiators.

CRIPPEN The wings looked good.

YOUNG The surfaces were untouched. The carbon-carbon on the leading edge and the HRSI, LRSI and FRSI on the top and the back of the wing and elevons had nothing missing. So I said, well, maybe that's an anomaly. And then we opened the left door and it was the the same way. The OMS pod had some damage on it - -

CRIPPEN But you could tell that the vertical stabilizer was okay.

YOUNG . . . . There's more than just those squares that you see. There's a whole bunch of triangular tile missing out there. I tried to point out to those guys . . . I don't know if they could see them.

ENGLE I think they analyzed it very well and they knew right down to the tile numbers. They went back and figured out who put them in there.

YOUNG I'll bet you that the area is an unbelievable vibration area when we go supersonic and at max q. It probably really took a beating.

ENGLE It was interesting to see the overlay of the densified tile vs. undensified tile. I'm sure it's not random but they are

ENGLE (CONT'D) interspersed back there and the only ones that you lost were undensified tile.

CRIPPEN Is that right?

TRULY . . . . Also, the ones you lost were diced after installation and they convinced themselves that they didn't have to go back and reproof them. That was really analyzed very well, I thought.

YOUNG You know, as soon as I saw that RTV down there I said, "Unless it gets up to 2000 degrees, we'll just melt some RTV because that's an ablator." I bet you a hundred bucks, well, I bet you can take all the tile out of the top of that thing and never notice the difference.

ENGLE Your backface sensors never got over 185 on the surface.

YOUNG You know that thing is overdesigned. Well, ...

CRIPPEN The radiators, put those out. They were again right on time. It took 24 seconds for the latches and they were both essentially at the same time (not simultaneous exactly but just a pause between them) and 38 seconds for the rad deployment. Oh! I did want to mention, on the doors, Dick, when I opened the doors, just like they were in the zero-g fixture, they don't just move smoothly. They move with a few jerks before going through the 90-degree position. I hope that we got some of that on the VTR's . . . it will show it, but they're not just smooth all the way over. The rads, when they got deployed, they were visible on each side. One of the neat things I noticed was that if you're sitting either in the right or left seat, you can look out your aft window and there are the rads!

YOUNG I took a picture of it. No matter how close you get to that window, you can't see any wings out there.

CRIPPEN You cannot. You can't see the wings but the radiators are right there.

YOUNG I knew we had too short wings. Okay, as soon as we turned off the HI LOAD EVAPORATORS, as soon as we did that, the HI LOAD DUCT HEATER came on and gave us an alarm, so we turned that off. Then the ground told us to turn it back on because they wanted to get the bake out. They didn't care. I guess we had the limit set wrong on the HI LOAD DUCT HEATER; it went up to 302.

CRIPPEN We ought to get somebody to go back and doublecheck on what that limit should be.

5.4 MOTION SICKNESS

CRIPPEN The only thing I recommended based on talking to people was to move slow and keep yourself in a basically upright position and don't go flipping around the first time.

ABBEY If the doctors had told you to move your head rapidly from side to side - -

YOUNG Yes, I think the doctors' recommended method of curing motion sickness is a very poor one. If you ever get motion sick, the last thing in the world you want to do is move your head around. First place, in zero gravity, you don't need to turn your head. You turn your whole machine.

CRIPPEN That's a good point there. When you get ready, instead of whipping your head around like that, it's much easier just to flip something and rotate your whole body around. I think it's just wise to make sure you haven't anything bad coming on.

YOUNG I thought that we spent so much time in the simulator that the environment was as normal as anything.

5.5 CREW SYSTEMS

CRIPPEN I was back there opening the doors and I got that "Oh, am I really here?" You know, I felt like, except for the fact that I was floating with my feet up in the air, I was doing the same thing we've been doing the past 3 years and it felt just as natural as it could be.

ENGLE You didn't have any trouble keeping in the position you wanted to be in?

CRIPPEN Well, one of the things that I did want to mention that Dick asked us to look at is, that, throwing switches, you don't need any restraint back aft at all. First, you can just take hold of a couple of those switch guards with one hand and hold yourself in position while you throw switches with the other. Also, it is very convenient just to put your knee on the aft panel and your back against the seat. You can sit there and do anything you want to do including controlling the RMS or what have you. As far as restraining yourself with your feet, somebody might like to do that but I think it's a waste of time. You're much more effective if you don't get yourself restrained. That allows you to shift around quickly and easily. But restraint and motion control was no problem.

YOUNG Just no problem at all, doing things like stowing those vent hoses, then getting down there and pulling out the data card kit, and throwing all those circuit breakers in. I mean were so far ahead of what you could do in a 3-day sim, doing that part of it, because we didn't have the restraint of one-g slowing you down in that suit. It's really neat.

CRIPPEN There is a learning curve getting used to moving in zero-g. That is, John was much more proficient at it than I was, I found sometimes, especially if I was doing a long translation. I tend to try to go too fast the first time. It's like watching a young bird learn how to fly or something like that - it takes off flopping. If you learn to move slow, you can control yourself and you go floating into position wherever you want to be. You can touch this and you can turn a corner. That's really something else.

YOUNG You guys have got a thrill coming, I'll tell you that.

CRIPPEN You've just got to take it easy, move easy and deliberately. There are a couple of places where it doesn't seem convenient to grab hold of something or to latch yourself down, but if you play with things, you will find places. If you wanted to brace yourself when you wanted to work with the lockers, you can put your feet against the airlock. Also, you can brace yourself by reaching up on the ceiling by putting your feet on the floor.

YOUNG It's really neat.

CRIPPEN I felt like I was running a little bit slower than I should be but you also gain time going back and forth between the flight and middeck.

YOUNG Oh, yes, you can go down and up, you can work a million times quicker up the exit and down the exit than you can ever do in one-g.

CRIPPEN George, we did mention this before. We ought to do everything possible to sell the program on getting some wireless mikes for these guys.

ABBEY It was obvious on the TV there.

CRIPPEN It just - holds you up and you have to worry about winding the wires around something.

ABBEY Just looking at you guys with those things hanging on your heads was unreal.

5.6 PAYLOAD BAY DOORS

ABBEY You guys already talked the payload bay doors, that was nominal.

CRIPPEN Completely nominal, there were a couple of things - -

ABBEY You mentioned that ratcheting.

CRIPPEN Yes, they don't move nice and smooth, especially coming - up through the 90-degree position.

TRULY Well, we've seen stuff like that and they always say that, due to the strongback - -

ABBEY Yes, he's saying they do the same as they do in strongback.

5.7 IMU ALIGN

YOUNG We're at 2:40, we were 10 minutes ahead of the time line.

CRIPPEN Yes, we ended up ahead on the time line for the IMU align.

YOUNG We did the single IMU alignment attitude and had it all torqued at 2:39:35 - -

CRIPPEN That's one of the things we really liked; those star trackers were beautiful. You get over there and you say, go to track - -

YOUNG Item 3, item 4, zap. In seconds the stars were in the table. Premission we were briefed software could take up to 2 minutes to get the stars in the table!

CRIPPEN You've got it.

YOUNG You've got both stars as soon as you select the star tracker, it picks them up and puts them in the table.

CRIPPEN Now we did have some problems. It ended up with both star trackers that the shutter on it would close and wouldn't open back up. They noticed it on the Y because that's the one we normally keep operative, but it ended up being on their Z also. I'm not sure what that is. It's only when we wanted to have it continually tracking that it caused some problems. Getting stars is a piece of cake compared to what you've been working with in the simulator, and that might be something that we might make more realistic in the SMS such that it doesn't sit there and hunt for so long.

ENGLE On the star trackers, when you maneuvered to attitude, were you in verniers?

YOUNG Yes. As Crip says, we opened the shutters manually many times. Someone should look at the data, but I think the earth's 20-degree occulting disk is unnecessarily conservative.

ENGLE You could tell when it was going but you didn't really feel that much?

CRIPPEN They're about as smooth as you could get out of any kind of an RCS system.

5.8 DIGITAL AUTOPILOT

YOUNG The autopilot operation, let me speak about that in general. You know they told us before we launched that every time you turn on the flight controller, you fire jets, and every time you turn it off, you fire jets, so you should have been in PULSE every time. Well, I think maybe it only happened to us a few times. The most was five times that that happened, because we either weren't in PULSE or we were in some other mode. But that's a heck of a trap because you're always turning flight control power on and off. Every time you go somewhere, you turn it off.

CRIPPEN Somebody ought to do something about that.

YOUNG As soon as you come backwards out of that seat, you've got these big shoes floating up there past it and you're going to bounce your leg off of it or something, unless you have it turned off, and they ought to fix that. They ought to fix it so that it doesn't fire jets. Turning the flight control power off should not fire jets, and turning back on shouldn't fire jets. Procedurally the best thing to do is to go on verniers.

5.9 CREWMEMBER OPTICAL ALIGNMENT SIGHT

YOUNG The COAS cal was a piece of cake. I was using DAP A VERN, which was one-hundredth of a degree per second. With that you make a pulse. You don't even know you've made it. The problem with it, and it is a problem, you can notice it, you're getting some thrust off something because you could sit there and make repeated pulses and not have any perceptual motion. The COAS cal worked out just fine. Once you just get that star in there, you know you've got it right in the middle and you've taken the world's best mark. Stars are 10 times better than they ever were in the simulator and the COAS cal was 0.23.

YOUNG (CONT'D) I took two more and it started right in the middle and it kept saying I had one-tenth of a degree bias.

CRIPPEN About a tenth of a degree to 0.06.

YOUNG Yes, but it wasn't a tenth, it was right in the middle when I marked on it. And then the IMU torquing angles, like these torquing angles off the first one, when we had been out there 2 hours in the flight, the biggest torquing angle was minus 0.1 after being up there for 2 hours.

CRIPPEN Those platforms really looked good.

ENGLE John, you left your COAS up there, didn't you?

YOUNG Yes, the whole time.

ENGLE Did you hit it every time you got out of the seat?

YOUNG I hit it every time I got in there. Then you would redo it and it would come out that the COAS bias would be the same. And you could reach up there and wiggle it, and it would sit there and oscillate until it damped out; then you take another mark and it would be the same. We had the COAS screwed down tight, but it would sit up there and bounce like a bowl of jelly.

CRIPPEN I bad-mouthed how loose that thing was since the first time I saw it until we flew, but it was repeatable as heck.

5.10 DFI PCM RECORDER

YOUNG And right at that period of time, we had the DFI recorder - -

CRIPPEN Yes, that was right after we got that circuit breaker. I guess it popped actually about 10 minutes after we got into flight, or somewhere in there - -

ABBEY Yes, it popped early.

CRIPPEN - - But we had no indication of it onboard and - -

ABBEY They saw it on the ground.

TRULY Well, they thought you had messed up a switch at first, and then that was a tough one because - -

YOUNG They wouldn't ask us if we messed up a switch, would they?

TRULY Well, no, they asked you to check the switch and you said it was okay.

CRIPPEN Well, they asked us to check the circuit breakers.

TRULY Well, yes, and they finally got around to the circuit breaker on the DFI PCM recorder.

There was all the thermal data, and all the strain gages on the tiles. And they would have lost it between EI and after blackout exit; they get real time also. When they realized that about the middle of the second day - all of a sudden, they're convening meetings about changing out recorders.

YOUNG I think that's all wonderful, but if they want us to work on that, they better fix it so we can take it apart and put it back together. If it had wingnuts on there so we could have opened that panel, it would have been all right. It is a fix that we could have made it if the bolts had not been torqued by really strong techs and <u>then</u> painted over.

ENGLE But you need something that you don't have to push while you're torquing.

CRIPPEN Yes.

YOUNG If they want you to take panels off, the panel ought to come off, if it's a wingnut or something with a bolt on the end of it so you can get torque in there. I don't care, but it ought to be something the crew can unscrew in zero-gravity.

5.11 STAR TRACKERS

YOUNG The star trackers self-test and door open? Star tracker passed the first test, I couldn't even believe it, the doors opened in somewhere between 7 or 8 seconds. You know, it is supposed to be 8 to 12. The auto maneuvers worked great.

CRIPPEN John said he could see the cavity. Which one was it?

YOUNG Z-cavity, you can't see the hole, you can see where it goes down into the vehicle.

CRIPPEN You couldn't see the door itself.

YOUNG And, matter of fact, you can look up over the nose and see, you could take some pictures up in there. Right over the nose you can see tiles down the nose and up to the roughness of the insulation right around the upward-firing jets. As you know, I looked out there, and there were no tiles missing.

5.12 IMU ALIGN

YOUNG The dual IMU align is really interesting because the same two platforms (we torqued platform 3 and the same two that we took 10 minutes later), the torquing angle difference with the other

YOUNG (CONT'D) two platforms was within 0.02 of being the same as it was before. So it looks to me like the granularity of how well this thing knows what it is about 0.04 according to the maximum difference in torquing angles.

Okay, we did that, we did the verification on the same star there and I took all the angles down after we torqued them. And there on the first two platforms they were 0.01 to zero, right after we torqued them. I knew that our alignment systems and platforms were really in good shape.

Another thing is that we were right about there, 25 minutes ahead of the time line because we did the dual star and IMU align verification in the dark over here and we maneuvered to the ZLV Y POP. This was supposed to be at 3:25; we did it at 2:57.

CRIPPEN I would recommend not changing the time line. I think that at that pace, had we any problems, this would allow us to get through it pretty smoothly. It was relaxed enough that you didn't feel like you were running out as you went through it.

ABBEY Because everything was happening as it was advertised to be.

CRIPPEN I don't think you would want to make it any tighter.

YOUNG Yes, I wouldn't.

5.13 FUEL CELL PURGE

CRIPPEN Getting down to the fuel cell purge, there Billy Moon warned me that the data we saw at the Cape said the flows were probably such that they would probably flunk the auto purge. First time we tried auto purge, it failed on all three of them. We then did it manually. It's almost easier to do it manually. I'm not sure that auto sequence offers a great deal.

TRULY That was working so well that EGIL thought you could probably do one when you get up in the morning and one at night.

CRIPPEN Also, Dick, the temperatures may depend on what kind of flight attitude you're flying but fuel cell purge temperatures were such that I never even really had to turn on the heaters because they were always up.

YOUNG That's right, you didn't have to turn on the heater.

CRIPPEN They were in limits basically when I turned the thing on. You may have needed it when it started flowing but no initial wait time was required.

TRULY We'll look at the SMS model.

5.14 FLIGHT DATA FILE

CRIPPEN I'll tell you what I'd do, if I was going to fly this thing in a hurry, I'd fly the same checklist because it's a good checklist. If you want to make any changes you can to reread it better, it would work, it is all right. And basically the way we flew this thing, you could do it as fast as you got to it anyhow.

5.15 CRT DISPLAY

CRIPPEN There's one thing we forgot to mention. On CRT-1, there was something inside of the glass, a black blob of some nature, not very big, maybe an eighth of an inch or something like that. It was inside of the tube such that if you wanted to look at something under it, you had to lean around to look around it. I guess it was like that when we got the CRT, but that was a little bit of an inconvenience.

YOUNG Like as not, it's the Sun that would prevent you from reading your tape meters very well sometimes when it was shining in the window. You get around that by putting your hand up and reading it, then letting your hand down. You really don't get above 2g's on second stage until Mach 14 and even that isn't a g force to amount to anything.

ABBEY So you didn't have any trouble with the lighting on the CRT's as far as that goes?

YOUNG The CRT's, I never have any trouble seeing them.

CRIPPEN Well, you can get the Sun such that it's coming in your back window, but you can cover them up by putting your hand in a position to cover them.

5.16 SUIT DOFFING

YOUNG Suit doffing.

CRIPPEN Suit doffing. John doffed his first.

YOUNG I think suit doffing the first time you do it is really interesting. Problem was that in zero gravity, I wasn't getting my zipper all the way up to the top, so I was down there trying to get that thing off, and must have spent about 10 minutes in that suit. Seemed like an eternity, but it was a while.

CRIPPEN I think I had my zipper essentially all the way up. I finally got my head out and said, "Where am I?" I felt like I was upside down.

TRULY Did you not help each other to get out of them?

CRIPPEN No, I mean you could have if you'd wanted to, but you can get out.

YOUNG The problem is you have to talk to the ground and you have to have somebody up there minding the store.

CRIPPEN It was just easier to go down there and shuffle out of it yourself. You could have somebody unzip you if you want to.

YOUNG Crip's idea is the one that works. He takes his shoes off before he comes out of the seat and just leaves them all hooked up with the spurs on. It was impossible for me to get the spurs attached with the boots on in zero-g

CRIPPEN They worked fine for me. I just unzipped them. I didn't want those big boots on when running around the spacecraft anyhow.

YOUNG That's a very good place to store them, right in the footwell in place. That way you don't make a mistake and get the wrong suit.

(Laughter)

YOUNG Of course when they put the new EES cover on they didn't put any Velcro on it. I didn't have a place to slap it on the wall, so what I did was stick it over there between the aft lockers and bulkhead.

CRIPPEN Yes, you know we're supposed to have the Velcro patch on the suit? It wasn't on the flight suit.

YOUNG They had Velcro on the wall, but they didn't have any on the suit, so I stuck mine over behind the lockers. You'd know where it could go, and if it did, you'd be able to find it.

CRIPPEN We got out of our suits and they weren't even wet. Weren't wet at all.

ENGLE Is that right?

YOUNG All the stuff to take them apart and put them inside out wasn't needed.

CRIPPEN We never got hot at all during that part of flight. In fact, I never got hot at all in the suit.

TRULY You'd think that going through those long sims, all that drill for that 4 hours helped.

CRIPPEN Tougher, much tougher than the real world.

YOUNG Twice as bad.

CRIPPEN I tell you what, Dick, you guys have done it enough now. I wouldn't recommend it any more.

YOUNG Yes, I don't think you should ever wear the suits in these exercises.

CRIPPEN I think it's probably worthwhile once to go through and get some idea of what the suit is like.

YOUNG I think to do things like ascent and entry suited would be helpful. Putting it on and putting it off is all unrealistic in one-g. Putting a suit on in one-g and taking it off in one-g, that isn't anything like doing it in zero-g, just not the same at all. It's just wasting your time unless you just don't even know what to zip up and all that, see, and you both already know all that. I mean you don't even need a cue card to put that turkey on and take it off or hook it up.

CRIPPEN But you don't need any kind of restraints to get in and out of the suit. It's best just to sit out there floating around in the cabin and come out.

5.17 CABIN TEMPERATURE

ABBEY Was that when you started getting cool?

CRIPPEN At that point in time I didn't think the cabin was cold at all. It just gradually cooled off. It was during the middle of the night that I began to realize how cold it was.

ABBEY So you weren't cool at all at that time.

YOUNG No, it was comfortable at that period.

5.18 SUIT DOFFING

ABBEY There wasn't any moisture in any of the suits, was there?

YOUNG No, nothing in the suit; the humidity was low.

5.19 ZERO-G EFFECTS

CRIPPEN It was a pretty dry cabin. One thing I might mention here. I, from looking at the other people who have flown, expected my head to be stuffy. My head was just as dry as a bone.

YOUNG Until the second day or so, our faces didn't look puffy; yours didn't look puffy.

TRULY I think it's the second day and there was a TV thing, I thought I could imagine that they were a little puffy.

CRIPPEN They were puffy. Well I think mainly it's just that you don't have g's pulling on your facial features more than it is fluid getting in there. That was another thing, I never could find the little clip with the UCD's, which we didn't need on the first time. They were supposed to be stowed with the other UCD's, I thought. I couldn't find them if they were there.

5.20 TRASH

YOUNG We had one box that said return trash.

CRIPPEN And it would be desirable to have at least two or more for 5-day flights.

YOUNG I think you ought to have as many boxes as you think you ought to have because everything you take apart in zero gravity and put back is at least twice as big when you go to stow it. You can't get it back in the box. And these guys in Skylab, I bet they filled up the lox tank.

CRIPPEN For example, Rita was nice; she packed that food pantry full and there wasn't any way that I could get all that back in there when it came to restowing it. After we finished with it, I threw some over with the little neckring thing and figured people were going to be going crazy trying to figure where all the stuff was. I don't think you need your pantry packed that full; if you do you're still going to need at least two or three lockers for stowing trash.

YOUNG They ought to have some empty lockers up there that you could put various things in, like, once you get your blue jacket off, you can't get it back in the box.

CRIPPEN You know, those gals or guys or whoever does all that stowing, they pack it there so nice and neat, but they ought to see the way I pack.

5.21 TELEPRINTER

YOUNG Crip activated teleprinter and I was supposed to.

CRIPPEN I wanted to make a couple of comments on the teleprinter itself. Remember that little bar they had with the cutter on the door itself; well, they ended up putting insulation on the door. It's so close to the bar that you couldn't run the paper under it to do a cut. One neat way I thought was to roll it under there and flip it back and do a cut, but you couldn't do that. We had to lay it on top and hold it down and cut across because they had the insulation so thick. On the collection roller where it had the slit, that was much harder to slide paper through than it was on the prototype. When you did the little fold and made the little triangle to stick it through, you'd get it in the first slot and you couldn't get it out the second slot.

YOUNG That paper was different.

CRIPPEN I don't know if it was the paper or what, but it was hard to wrap the paper.

YOUNG The paper was like an old dishrag. You could not get it through even after you folded it. Crip spent too much time feeding that thing; it's unbelievable.

CRIPPEN Well, if they made those two little slots wider, there's no reason to make them as narrow as they have them, if they just made them a little bit wider so that the things would go right through.

YOUNG Was the paper more pulpy?

CRIPPEN I'm not sure it was different paper.

YOUNG But it was acting different.

CRIPPEN You could not put it through the slot because the slot was too small. It would go through the first slot and it wouldn't come out the bottom.

YOUNG And you'd look down there and it would be all wadded up.

CRIPPEN Anyway, those were a couple of minor problems with the thing. The teleprinter in general worked super.

YOUNG Those kinds of minor problems at $2000 a minute - must have taken 30 minutes in that flight because I spent 10 minutes down there one day just swearing at that thing, and I thought I was never going to get it to set right, and it's just lucky that we did. The test messages were inconvenient. You'd go down to get a big message and it would be a nothing test message.

CRIPPEN I'd run off to do something else and here'd come another message.

TRULY Would it be just as easy, you think, to put a piece of scotch tape there and just tape that thing there onto the roller instead of trying to feed it through it?

CRIPPEN I think if they made the slot a little bit bigger, that would be the quicker way.

YOUNG I never even thought of that.

CRIPPEN But you don't need much of any kind of thing. The slot in my opinion worked well if you could just shove it through. There's something a little bit different between either the zero-g or the slot and that tends to make it a little bit different. A couple of other comments since we're talking about this thing - closing up at night, you could still hear it - I heard it on the first night clattering.

YOUNG I heard it every time it did it.

CRIPPEN If I was awake or barely awake, I knew that there was a message coming, but when I was really sound asleep, I don't think I ever really heard it. But it's still going to make noise, you're going to know it's there. The noise on the comm is there, as John said, and is slightly irritating.

YOUNG You could listen to it in the daytime.

CRIPPEN In the day, but you couldn't at night.

YOUNG You couldn't sleep at night because every time it came on, it woke you right up.

CRIPPEN So we ended up just securing air-to-ground 2. Also, one time we got caught, I thought I'd gone around and got all the air-to-ground 2's off and John ended up, when we were going to do the teleconference, plugged into one of those middeck units. On that one it was still in TR and, sure enough, when he started talking the first time, I thought they were sending us a message because it was transmitting itself into the teleprinter and caused the paper to roll out, and I saw all that trash over there. It was all garbled and I said, "Hey, guys, this last message you sent was all garbled," and they said, "Guess what, we didn't send you any message." But the Shuttle printer in general is a good thing to have. They redid the whole Day 2 flight plan and what have you.

5.22 FLIGHT DATA FILE

YOUNG Vacuum vent, Flight Data File config. It is a lot easier to get those Flight Data File containers out in zero gravity but I hit that thing every once in a while, over on my side, at least. If you had a bungee around it, if it came off it would go back where you wanted it. Every so often, I'd hit it and it would float off somewhere. That little amount of Velcro on the Flight Data File didn't hold it on my side. I don't think

YOUNG (CONT'D) Crip had any trouble with it. Why the boxes are smaller than the data file that goes in them is beyond me. This was a big problem in zero g - just as it was in one g. When you closed the lid you had to bang it shut and sometimes, because the data file books kept hanging out, the lid would not close.

CRIPPEN Those canisters you stick on the side. It just doesn't feel very secure. It either needs more **Velcro** or a bungee to snug it up to make it feel a little bit more solid. But it ended up staying there. One of the things I kept having problems with was the PDP or CAP that I was working with. It floated loose and I kept losing my place. I finally noticed what John was doing; he took one of those little clips we have onboard, then he just clipped the book to where he was so that it just stayed there and would keep the page for him. I could usually go back and find my place, but little things like that made it inconvenient and take up time.

YOUNG Typically inconvenient - like when we're working in the CAP and we're trying to do the RCS burns, which are on different pages in the CAP. Trying to switch them back and forth is inconvenient.

TRULY It looked like that on the TV a lot of times, the books floating around with the pages kind of opening randomly.

CRIPPEN Well, it was only true of the CAP and the PDP, but the clip to me looked like it worked fine. I left the mal book floating near R11. I had it clipped on there. I had my orbit pocket checklist, which I never had to go into, clipped in place as well as the orbit OPS book. They floated around with the pages out. You need to clip them down somewhere because things float off, they really do.

5.23 PENCILS

CRIPPEN Incidentally, we still have a problem for ascent/entry. All we've got out for pencils is the little Cross and it isn't tied down at all. Every time I pulled it out, I was afraid I was going to end up losing it. I would recommend that you go ahead and attach pencils to the ascent/entry checklists. What I did was pull one off of one of the other books and stick it on the entry checklist, but you need something easily accessible.

YOUNG My way of thinking you could use a pencil attached to a retractable string. Like here's your old ascent checklist, if that was hung over there and you could pull it out like that and work on it, then it would go back under there and get out of your way. As soon as you put it on this string, once you get to zero gravity, it's sitting up there floating all over the way in front of the TV, in front of the window when you want to take pictures, in front of the COAS. But if you stick it somewhere where you don't want to have it, why, it's never at the same place where you want it even when you tie something down. Sometimes that thing could float off and go somewhere where you had to look for it.

ABBEY Yes, an inertia reel.

YOUNG Yes, and in zero gravity, it wouldn't have to be strong at all. It could be like waitresses used to use to retrieve pencils. We had one in the Gemini program that worked great.

5.24 WCS OPERATION

CRIPPEN Right after we did the doffing we ended up breaking in the waste management compartment and John used it first. It worked; it didn't work as well as I thought it would, though. First time we used it for urination, it worked some. But you still need to clean up with tissue paper.

YOUNG The noise that the WCS makes is very annoying. If you use it when your partner's asleep, you're going to wake him up because he's saying, I wonder what's broke now.

CRIPPEN He says, "Crip, what are you doing down there?" On the last day, it quit collecting urine completely.

ABBEY Puddy figured out just about when that broke. A little glitch that he said he saw on the data.

CRIPPEN We switched over to the other separator but it didn't do any better.

ABBEY They saw the glitch and they thought that's probably what had happened.

YOUNG I would hate to be on a 7-day mission with seven people in that thing and have it break. I would really not like that. And I don't think women are going to like that potty because you have to take all your clothes off to use it. That's a fact.

CRIPPEN John also, between OMS-3 and OMS-4, blessed it for fecal collection. I couldn't believe it. I said, "This guy is cool."

(LAUGHTER)

YOUNG We were in a hurry.

(LAUGHTER)

CRIPPEN The advice is, when you use it for fecal collection, shed your clothes, at least the bottom part, and take a towel and wet wipes.

5.25 C&W LAMP TEST

YOUNG C&W lamp test worked great. Let's get the cabin temperature control.

CRIPPEN Oh, yes, I did that. It was simple enough - they had that little arm they were worried about leaving down there. They stowed it with the seat pins in one of those little folders. I went down and put it on and it worked fine.

5.26 FIRE/SMOKE DETECT/SUPPRESS TEST

YOUNG Okay, now Sensor A cabin fire test. The ones on sensor B's worked okay but the sensor A's did not, and when I did the test again just before the PDP day, it didn't work again. So I opened the circuit breaker and it did it again; I did it three times, and I finally gave up on it because it wasn't working right. So the FLIGHT DECK LEFT and CABIN SENSOR A didn't work. I never mentioned that to ground, the fire and smoke detection suppression test.

CRIPPEN I knew one of them was giving you problems, but not two of them.

YOUNG That's what I am saying: the Sensor A FLIGHT DECK LEFT, and the CABIN didn't work. And then one time the CABIN did work and the AV BAYS all did work. Again, the CABIN worked sometime and the FLIGHT DECK LEFT never worked. I didn't want to bring that up to the ground because I knew that it would create endless unnecessary troubleshooting. That thing ought to be made to test properly or they ought to get a new fire sensor because that thing that's in there now is not a good thing. Anything that comes on accidentally is no good. Then when they called us over a solar flare and it was going to turn on the fire detector system, I was really undone then. I thought, this must be first-class gear we have in here.

YOUNG No big deal there.

CRIPPEN We got an early go for that. Then we went to the CAP.

Waste water storage system dump, that works like a champ. You can see both the dumps. I know it's supply water, I think the waste dump also. It looks like a snowstorm coming out of the left side of the vehicle.

ENGLE You're kidding.

CRIPPEN It really shoots it out.

ENGLE Where is that? I don't even remember where that dump is.

CRIPPEN Over there on the port side.

ENGLE I mean how far back is it? Can you see it out there with the number 1 window?

CRIPPEN Also, when you turn on those heaters, it really brings the temperature up to do the dump. When you turn on the heater, it comes up within a minute or so. It's real easy to pull off a dump pretty rapidly. The technique I used was - I'm sure you guys did enough in the simulator. When they told me to dump down to a quantity, I'd go into the table maintenance and update the trigger level on that particular tank. Then when it rang a bell I'd go stop it.

5.28 ACOUSTIC BLANKET OPERATIONS

CRIPPEN Acoustic blanket installation. I ended up doing that and it wasn't any big deal.

ABBEY How about the difference in putting them in vs. not putting them in.

CRIPPEN I did take those measurements on that entry day. What I ended up with was 67 decibels on alpha with them in, and it was 70 decibels with them off. From the listening effects, you hardly notice the difference.

ABBEY We tried them out in Palmdale; they made a difference there.

CRIPPEN I think the vehicle is quieter than when we tried them at Palmdale but I'm not sure.

YOUNG Not only is it quieter, but, like when you put them on in zero gravity, you probably don't get the same kind of effect that you do when they're floating.

ABBEY Did the noise level bother you at all?

YOUNG No.

CRIPPEN My recommendation is that I wouldn't mess around installing the blankets.

YOUNG I don't think it will bother you. It is <u>not</u> as loud as the SMS by actual measurement.

ABBEY But you didn't notice any particular difference?

YOUNG What I would personally do is leave them there and when the noise starts to bother you, you can put them on, and otherwise don't mess with it. We also didn't do all of that middeck storage and unstorage.

CRIPPEN I did not go take all of that junk out and stick it in the head.

YOUNG Because we didn't need it all.

CRIPPEN I never deployed the toilet kits. I ended up getting a couple of towel holders out and some towels for the head. I also took out the wet wipes and stuck them in the head.

5.29 STOWAGE LOCKERS

YOUNG Locker MA9L was really a son of a gun to latch. I finally barely got it locked for entry by forcibly moving the entire locker to line it up.

CRIPPEN Some of the lockers seemed to get twisted a little bit or something because the lineup wasn't exactly right.

YOUNG You'd turn the latch and the latch threads that you are trying to mate were not lined up.

CRIPPEN It only happened to a couple of them. You'd have to move them to where you'd get them lined up.

ENGLE You'd have to close the doors and they'd be skewed?

CRIPPEN Right. And that one with the 16-millimeter photo stuff over there was also the same way. In fact, there's one I think I never latched down on one corner because I couldn't get it lined up.

YOUNG For entry, who needs to lock something if you are only going to pull a g and a half.

CRIPPEN But it still needs to be locked.

YOUNG When was it they came up and said the airlock pressure transducer was reading zero?

CRIPPEN Oh, we came down and told them that. It gave us an alarm. It turned out the transducer went out.

YOUNG You had zero psid in between the cabin and the airlock.

CRIPPEN I was afraid that we had done something to that hatch.

TRULY That scared me when nobody answered. I finally asked them to get you to go down and look at the delta-P gage. Then we had a short conversation about which is the wrong one. Why assume it was one of them? Steve McClendon said the little pinholes in that little cover would have indicated a real leak. He would have seen it.

YOUNG My question was, when we got back on the ground, do they have an inflow valve into that airlock - -

CRIPPEN It's on the hatch itself. The equalization valve. It's set in the FLOW position so it should equalize.

YOUNG All the time?

CRIPPEN For launch, I'm pretty sure.

YOUNG I don't want the air leaking out through there.

YOUNG Suppose you had a big airlock leak for some reason. Is it going to leak out through there?

CRIPPEN But it's small enough that it isn't going to . . . . It's restricted on how much flow it has. We can go get an expert on it, but I'm pretty sure that's the case.

YOUNG I mean, you put it in the closed position. You understand what I'm saying. When you come down from orbit, if you don't have

YOUNG (CONT'D) something where a lot of air could leak in there fast, you are going to squash it from the outside.

5.30 MEAL PREPARATION

YOUNG Crip was a really super meal person.

CRIPPEN The meal prep worked out fine. I could hook my toes under the lockers. There is a little gap there. There was like one space that a locker didn't fit in, so there was a square where I could kind of wedge my feet in between the tank and the lockers and pull out the trays and set them on the front and they just worked fine. The little clips where we put them over the front part of the locker doors or over the tops of the doors, worked great except there is some kind of little metal clip in the top of the locker door that can interfere with the tray clips. I meant to go over and take a look at those in the one-g mock-up and see if they're different. They really fit snug on there, snugger than you'd like. But they work okay.

YOUNG Food prep works well, the water gun works well.

CRIPPEN If there was any air in that water, it was a minor amount. I noticed that when you'd make something like a drink, you could notice some fine bubbles in there.

ABBEY Water taste all right?

CRIPPEN Water tasted super. I don't think we ever drank pure water, except when John did after the mission when he was waiting to get out. He was squirting water all over himself. So meal prep went okay and the only thing that I had to mention was that they were really packed in there snug. Not the meals so much as the pantry.

ABBEY It shouldn't be packed as tightly as it was?

CRIPPEN Well, either that or you need some extra space. What I ended up doing was taking out the container with the condiments. Once I took it out, there wasn't any way I was about to put it back in there. I ended up shoving it into the tray that holds the food warmer and the trays.

5.31 WHOLE GAS SAMPLE

YOUNG The whole gas sample was no problem and the solid sorbent sampler thing worked okay except there was a vacuum on the vacuum vent side of the device in there because shifting it from day 1 to day 2, I had to use a pair of pliers just to get the top open and also going back to OFF from day 2

CRIPPEN It was that tight?

YOUNG Well, something was sucking that whole gas sample top down.

CRIPPEN There was a vacuum on the other side of it.

YOUNG It must have been.

5.32 CO_2 ABSORBER INSTALLATION

CRIPPEN The CO_2 absorber changeout was a kind of a non-thing. The only thing I would comment on was the little covers - they have the yellow tape on top of them and the cellophane cover that fits over the cannister. They want you to cover them when you pull them out. One of them you put in initially they only use a little while. Putting the cover back on is just not a very neat thing to do. I basically got them on two of them; on one of them, I finally said, the heck with it. It's just too snug a fit to try to get it to slip down in there just right. The yellow tape also gets all balled up. My recommendation is that if they want to be able to cover them after you take them back out, there ought to be a

CRIPPEN (CONT'D) better way to do it. Either make the container larger so that there's plenty of room and it slips down in there easier, or something.

YOUNG Even if you're going to use them again, you shouldn't have to do that packaging job in zero gravity. It just wastes a lot of time. Okay, it's already up to OMS-3 here.

5.33 OMS-3 BURN

CRIPPEN OMS-3 burn. The OMS-3 burn worked perfectly.

ABBEY How much time did you have between 3 and 4?

YOUNG According to this, there's 30 minutes there.

CRIPPEN From 6:20 to 7:15. Let's see, we boosted up to about 146 miles somewhere along in there. The crossfeeds, they were no big deal.

ENGLE OMS PC's look about the same as they did in the SMS when you were crossfeeding?

CRIPPEN No, they didn't drop down that far.

YOUNG No, they didn't drop down that far.

CRIPPEN I don't think they even dropped below 100.

ENGLE Is that right?

YOUNG Somebody can look at the data but I think that's correct.

CRIPPEN Yes, I'm sure they've got the data on it. You can ask about it, but it was way up.

5.34 OMS-4 BURN

CRIPPEN We did OMS-4 and I got so excited about being through with it that somehow I forgot to come out of the crossfeed until somebody hollered at me about it. No big deal.

5.35 NOISE LEVEL SURVEY

CRIPPEN Did the noise survey - I think I was a little bit later than this picking it up. I guess we exceeded the 65-decibel criteria every place except up there in the seats.

ABBEY What was it up there?

CRIPPEN It was - I forget, let's see if I've got my checklist here. Yes, I think it was like 60 decibels up forward. It was 60 decibels overall up forward, 66 in the aft flight deck, 67 on both the middeck readings.

ABBEY Those with or without the acoustic blankets?

CRIPPEN That's with the acoustic blankets. I think it's nice having a sound meter onboard, just in case something gets noisy, you go can check it.

5.36 DPS CONFIGURATION

CRIPPEN DPS transition associated with the OMS burns.

YOUNG All of the DPS worked except for the problem we had on Friday trying to get off.

5.37 OMS-4/OMS TVC

YOUNG Oh, yes, on the OMS-4. The fact is that I went fast both directions and then went back to the needles, and the residuals

YOUNG (CONT'D) looked better than if we had done it in automatic, which is luck. I'm convinced of that but TVC is very easy to fly. So you know manual TVC will be a piece of cake if we ever get to the BFS and have to use it.

ENGLE All the auto maneuvers . . . just like the simulator?

5.38 DIGITAL AUTOPILOT/FLIGHT CONTROL SYSTEM

YOUNG Like I say, the only times we ever had trouble with DAP configuration was turning the flight control power on and off. Now there were a couple of times going in and out of modes where we were in the wrong DAP mode for a while, because as soon as you go from one OPS transition to another, it goes back to A/MAN/NORM. You immediately know when you get in this new mode because if you've been in verniers, the big jets go WUMP!

CRIPPEN It's not like in the simulator - you'd never end up on normal jets accidently and not know about it.

ENGLE Yes, that's a good indicator.

YOUNG It not only fires the big jets, but as we said, the whole spacecraft vibrates. Crip would sit there in the middle, free-floating, and not move, and the spacecraft would move and Crip would just be floating in the middle and not move at all. You could really see it. There's quite a bounce.

CRIPPEN You can feel it shaking the vehicle.

YOUNG It would shake the whole machine.

ENGLE Is that right?

YOUNG Yes - bypass, as soon as you got the down arrows, WHUMP - I didn't know what was happening.

5.39 APU-1 STARTUP AND SECONDARY ACTUATOR CHECK

CRIPPEN In OPS-8 we noticed when we were going through a TACAN check that the TACAN numbers were reading funny.

ABBEY They were reading what?

CRIPPEN They were reading funny numbers. They were locking up on something.

ABBEY Is that right?

TRULY I think later they locked up on Little Rock, St. Petersburg, and Edwards.

CRIPPEN I'm convinced that if you wanted to and you set the right frequencies and everything, you could do all our navigation updates with TACAN.

YOUNG Probably could do a good one in OPS-8 with a read-write and not ever have to talk to the ground about it.

ENGLE I think they're beginning to look into this.

CRIPPEN But there weren't any big deals. We went through the display checkout and this is where we discovered the HSI problem.

YOUNG Yes, the HSI locked up.

CRIPPEN First, on the high test it worked okay. It went to 300 degrees and then we went to the low test that is supposed to be 30 degrees and it looked like it went to 025. We were 5 degrees off.

YOUNG We've got to get the PDP for that.

CRIPPEN Yes, and then we retried the high test but it would not come out of the 025. And we subsequently did some things with the instrument power and cb's on the left DDU to get a null power position, but it didn't move either. And then later, second day, when we did the thing again, it worked right.

YOUNG It sure did.

CRIPPEN And then later in entry, John said it screwed up again.

YOUNG Half way through entry, I looked down and the HSI card moved. We'd do a bank reversal and that thing would jump. It would jump about 10 degrees and finally just give up and wouldn't do anything.

ENGLE But it didn't ever affect the primary pointer?

YOUNG No, at least down to about Mach 6 the primary pointer was giving good delta azimuth. One time in OPS-8, when we checked the Roll Control Mode Switch I only moved one of the switches - I forget which one it was - not far enough or I didn't have it clicked right.

CRIPPEN And you didn't get one contact.

YOUNG I didn't get one contact. I went to yaw jets rudder and only got three contacts and I jiggled the switch and got four. And all the rest of the time, it worked right. I just didn't have the switch in position.

CRIPPEN Isn't that a four-contact switch?

YOUNG Yes, so I got all contacts after jiggling the switch.

CRIPPEN Both radar altimeters had Bites.

YOUNG I don't know why.

CRIPPEN I think that's nominal, but they don't say so in the little book here.

YOUNG It doesn't? As a matter of fact, my radar altimeter broke after you lowered the gear, I think.

CRIPPEN Mine worked all the way down.

YOUNG I had an off flag in mine. I always look at my radar altimeter because I want to get the vehicle down to about 50 feet doing about 260 or 270 before concentrating on the float.

ABBEY It was just like the STA.

YOUNG I'll bet that chase guy was over there.

TRULY Make sure someone knows about that.

YOUNG When it first started working, it worked okay but I had an off flag in the window when I got down below preflare where I looked at it again.

CRIPPEN I swore mine worked all the way through, but I might have had an off flag momentarily. Maybe it was like when the gear would come down, but I think it came right back and locked. I don't remember it being off. It seems like it was looking right to me all the way down. Let me back up and say something. I can't remember, John, whether it was on one of the OMS BURNS or one of the RCS burns. We had a condition which I'm sure you guys have

CRIPPEN (CONT'D) seen, but the only thing I saw different about it, was it happened on two CRT's. It went through and computed the target information, but it did not put up all of the data on the CRT. Two CRT's did it simultaneously.

YOUNG Same part of the data?

CRIPPEN Same part of the data. I went back and selected a gimbal again that was already selected to cause it to refresh, and it came up proper. That was a real timing funny that can occur. It's a GPC thing. But I was always under the impression it would not occur on CRT's driven by different GPC's - but it did.

YOUNG Well, now when was it that we got the right OMS gimbal not reading right?

ABBEY It was the pitch gimbal; the position was wrong.

YOUNG We did it the first time but it didn't work, and we did it again and it worked, so I gave up on it.

ABBEY Never had any problem after that.

YOUNG And every time we did a check on it, it worked like a champ. We did the check at OMS-4 and did a check again. Both checkouts were complete.

5.41 FREEZE-DRIED MEMORY DUMP

CRIPPEN Freeze-dried memory - I guess I messed up and didn't do my Item 2 before I was through. They said, "You have the wrong format". I could have sworn that I had the right one but I must not have. Also, Dick, one thing you ought to check on the checklist - I think what we have in there now is a little bit wrong. You know how when you put GPC-3 back to sleep, you

CRIPPEN (CONT'D) should make sure you put it to sleep with memory configuration 3 selected such that it has everything assigned to GPC 3? Meanwhile, if you've loaded the active set that you've got going - in this case, GPC's 1 and 2 with configuration 3 because you've been doing OMS-3 and -4 - I think that when you bring 3 back up active it gets messed up. If it goes back to bed, it will go back to bed the wrong selection, and our checklist does not make you update that. All of a sudden, when I was doing that procedure, it didn't look right to me, so I made sure before I turned it back to STBY that I did that. When you're reconfiguring, you go through and make sure that it's got the GPC LDB option selected. Then you just put it back to sleep. I think, from the way I remember that thing working, that you really should go through and assign the strings to GPC 3. The fact is that while GPC-3 was in freeze-dried state, we went and updated memory configuration 3 to be driven by GPC's 1 & 2 so you could do the OMS-3 and -4 maneuvers.

TRULY Yes.

CRIPPEN When it comes back in the set, it gets all the data that the others have and gets all the tables refreshed.

TRULY Well, I'll be.

CRIPPEN Small point. Item 2, before you're through - we're supposed to get that thing fixed up right - did we get it fixed in version 18 so that you didn't have to select fixed?

TRULY No, I don't know.

5.42 TELEVISION

CRIPPEN TV status reports this was our first Cecil B. DeMille thing - -

YOUNG Crip really knows how to set up those TV's.

CRIPPEN I ended up leaving the TV's out once I got them out, and just had them around the cabin so that I could go whip them out pretty easily to set up. Those suction cups will not latch on to all the things. You need a smooth surface to get them to latch on. They will not latch on to all parts of the DFI container and I think we have a couple of scenes with you latching on-to surfaces that they just wouldn't grab hold of. Even when they'd grab hold of a good surface - if you left them on there half an hour they quite often would come loose because of slow leakage into them. They will usually hold well enough for the picture.

5.43 PHOTOGRAPHY

CRIPPEN We kept a Hasselblad and a 35-millimeter out and the TV cameras out and I personally felt reasonably comfortable about that. I figured if we had to make a rapid entry, that we could toss them into someplace. I'd be ready to open up the airlock, but I think you can make an entry and have it sitting there on the deck and it wouldn't hurt.

YOUNG About 8:30 MET, I'd used up my first 70-millimeter thing shooting at everything that looked interesting.

CRIPPEN John, how many cassettes of 70-millimeter did you end up shooting?

YOUNG All but one. One of them wouldn't work. And it was a shame to pass over some pretty property - and we should have taken pictures.

ABBEY It wasn't a camera failure, it was - -

YOUNG No, it was a magazine failure. I don't know - I kept turning the magazine crank but the red dot never turned white and the camera never would fire with that magazine.

CRIPPEN I might mention also on the TV stuff that I never used the little monitor. I found that the onboard monitors were much better for setting up and I just used them. I would go ahead and get it plugged in and I'd select that particular camera to drive the onboard monitor to make sure the picture was right, and then leave it alone rather than have to mess around with the little attach monitor. To me, that was a much easier way to operate than having to drag out that other thing and hook it on.

YOUNG Let me say something about that 70-millimeter. At least three out of the seven cassettes, maybe four - before you can get them to fire, you have to get those red dots out of there. The cassettes weren't set up right somehow. You're supposed to have a white dot in there and you have to pull this thing out and turn it, so the normal thing to do is - when you change the cassettes because you're ready to go in a hurry and you've seen this thing going by and you just know you can make it and you get up there - nothing happens. I don't know why they shouldn't all have white dots before they're ready. I don't know what it is about being in zero gravity that makes them do stuff like that.

5.44 DFI CALIBRATION

CRIPPEN Let's see this DFI WB cal - I think this is the one we missed. We were supposed to do a cal before we - we volunteered to do it after the fact.

YOUNG They're talking about the RCS DAP's here. Okay, I made a mistake on that.

5.45 RCS JET TEST

ABBEY On the RCS jet check?

YOUNG Yes, I updated the DAP all right, but then, instead of switching it back and forth, I just started into it the way it was and that kept me from firing the right jets.

CRIPPEN In fact, Mark asked me if I wanted to make a checklist change to go from A to B. I talked to John, but that ended up catching us here on that particular one.

YOUNG Did it work all right or didn't it work all right?

ABBEY What?

YOUNG The jets.

CRIPPEN John, what you're thinking about changing on the DAP doesn't make any sense. We're talking about having four jets that didn't get checked out.

YOUNG Yes, I don't understand that.

CRIPPEN I mean that seems to be something different to me.

YOUNG Well, it does to me, too.

CRIPPEN Could you have possibly just skipped a step in there or something like that?

YOUNG I don't see how.

YOUNG Why they didn't see it on the data - or somebody said they lost the data.

TRULY Well, what I was told was that they thought that you'd skipped a step, but I was not there when you did the jet test. And then they said they thought you'd skipped a step and missed four jets, but two of the jets had been fired during sep so

TRULY (CONT'D) they only wanted to refire the two that had never been fired. So then they came up and it was L2 and R2 then - -

YOUNG Yes, they were yaw jets and I wanted to fire them. And with those two jets - it was two R jets.

TRULY Let's go back. There were four jets involved but two of them had been fired. Okay, now one of my questions is, when you're doing these yaw things, does it - is it supposed to fire just the jets back aft?

YOUNG Okay. Well, RHC plus-Y, and I'd say plus-Y, and that's for right. Okay, so much for that, anyway. I sure wanted to fire those jets and sooner or later I guess we did.

ABBEY And the IMU alignment?

YOUNG If you've seen one of them, you've seen them all.

ABBEY Right.

5.46 FOOD WARMER

CRIPPEN I just want to point out here that just before we did the IMU alignment was the first time we broke out the food warmer. That thing worked like a champ.

ABBEY Did that make a difference, food wise?

TRULY Did you just leave it on all the time?

CRIPPEN We broke out the food warmer, utilized the little strap that comes with it to attach it to one of the locker doors, and left it out thereafter for the entire mission until we got ready to come home. The food warmer worked superbly. It would heat up things like coffee in 15 to 20 minutes. It

CRIPPEN (CONT'D) heated everything fine. I think it really made the meals as far as eating onboard. It was kind of nice to have hot eggs and sausage and so forth.

YOUNG Well, if nothing else, it helped your morale some, I think.

CRIPPEN We even heated up the corned beef - hot corned beef. So that's a big plus.

YOUNG The chow has really improved since Gemini III, I'll say that.

5.47 TV ACTIVATION

ABBEY You have the TV activation.

CRIPPEN We mentioned a little bit about that previously. We did it for the status report here, and we hooked up the two cameras and kept them hooked up basically throughout the flight, such that they were readily accessible in case we wanted to put some more stuff on them. We could have probably ended up recording some of the onboard activities on the VTR's easier than we could have shot 16-millimeter film. I'm a little bit sorry now that I didn't do some of that because the VTR looks like some of the results of that stuff were just as good as shooting on 16-millimeter. It's a lot easier to do.

ABBEY That might be something you guys ought to think about.

5.48 VTR VERSUS 16-MM

YOUNG Let me tell you something that I found out, while we are talking about the VTR. The VTR runs for half an hour. An off-the-shelf VTR that my neighbor has in his house will record for 6 hours straight with the same magazine. Why are we carrying this kind of off-the-shelf piece of gear when we could have 6 hours straight and never have to mess with that?

ABBEY — Those things that are around now will record for 6 hours?

YOUNG — Yes, sir. We've got a 30-minute one. If you really want to do something in space flight that requires a long time - monitoring activity of guys doing something - and you have to change the video tape recorder every 30 minutes, you're going to miss it. Plus, storage-wise, you end up having to carry all these cassettes around.

TRULY — Well, the 16-millimeters that we're using are back in the payload bay. They are mounted in the payload bay.

CRIPPEN — Is that right? They have 400 feet per second of film, or something like that. I think you get a little better resolution out of the 16-millimeter stuff, but the VTR looked pretty good to me for what it was putting out.

YOUNG — For on-orbit ops inside a cabin with a 16-millimeter, they ought to look at carrying a 400-foot magazine. A comparison of 16-millimeter with the inside TV shows the 16-millimeter provides considerably more detail if the lighting and settings are properly done.

5.49 IMU ALIGN

YOUNG — The IMU to IMU alignment worked great. I didn't record exactly how long it took, but it didn't take as long as it takes in the simulator, which seemed like it was about 5 or 6 minutes. It didn't take 12 minutes in any matter of means, and then we did it again. You have to do it twice if you don't have an immediate following star alignment. At 8:35:39, we did the first IMU-to-IMU, and at 8:42:28, we did the second one. But the torquing angles were small - the biggest were minus 02 and plus 02. My question is, is this second torquing really necessary?

CRIPPEN It isn't always.

YOUNG With those very small torquing angles - why would you want to torque again? Why don't you just look at the torquing angles - - That's noise level. We already said that the granularity has to be like plus or minus 0.04 on the torquing angles.

CRIPPEN The thing about it, John, is if you remember, those numbers you're reading there at the end are lying to you. There's a program note out on it for version 16. They may have fixed that for you - I'm not sure.

5.50 MPS VACUUM INERTING TERMINATE

CRIPPEN The next thing here is vacuum inerting terminate. I guess I didn't mention that earlier on the vacuum inerting for the MPS. We always said that if the pressure was zero in the manifolds we weren't going to do it. They came up and told me to do it anyway.

TRULY In every sim, they said that at zero we don't need to do it. All of a sudden, we're in flight and . . . .

CRIPPEN And we do it. It wasn't any big deal.

YOUNG Those engine and MPS feed system valves back there are very important. I'm not sure that's something you want to do just for drill.

TRULY There was a leak back there somewhere in one of those helium systems.

ABBEY Yes, that's right.

5.51 DFI WB AUTO CAL

YOUNG — You know, I've never understood these procedures in the DFI wideband auto cal. Okay, it's continuous control, forward control, power on, forward control or auto, and then verify control to data after 10 seconds. It can't be anywhere else but data, because it's - -

CRIPPEN — It's a momentary switch. That's a useless statement in there. The APU fuel pump thing was nothing when we turned cooling off of it. We just waited until ground told us. We picked it up a little bit early.

5.52 FLASH EVAP MODEL

YOUNG — I'd like to talk about the IMU accelerator cal - the way it related to flash evaporator startup. Your temperature is 39 or 40 degrees on the flash evaporator, so you have to go to Hi temperature on the radiator and let it run up to 50 degrees. Then when you turn it back on, it doesn't work like the simulator. It goes up to 54 or 55 and reaches a plateau and then turns around and comes back down. These characteristics of a flash evaporator are a little different than those we model in the simulator. In terms of the dynamic response of the thing, we model this startup a lot faster in the simulator. I noted it took about 3 minutes in the vehicle, but I am <u>not</u> sure of the time.

5.53 SMS MODEL

YOUNG — I think that we can improve the level of training by providing more realistic models without making any big impacts on the system. We ought to do that.

ABBEY — I think, as you were saying yesterday, right now in the SMS the vibration is probably worse than we really want for ascent.

YOUNG Yes it is - no question about it.

ABBEY We ought to really make it more realistic, based on NASA flight experience - and the same with flight control.

YOUNG I think the Orbiter is as solid as a rock. It really is.

CRIPPEN Things like the RCS system - we're now overpressurizing it, and so the pressures we've been seeing in the simulator bear no relation to what you see when you go fly the vehicle.

TRULY Like fuel cell purge.

ABBEY I think we ought to try to come out with a list of those kinds of changes.

YOUNG We need to update our power usage, like 19 KW on entry - instead of 22 or 23 or 24, which is what we were briefed to have.

We could lose a fuel cell on entry and not have to do as much powerdown. That will be better for the program.

CRIPPEN ZLV Y-POP - flew nice.

YOUNG All the deadband FTO's appeared to be okay. You just have no way to assess what you're doing there, flying on the verniers. You couldn't tell how much gas you were using, and the crew has no way of accessing it.

CRIPPEN I'm assuming that was primarily for recording the data though, John . . . .

YOUNG It sure was, and I bet they didn't get any because the DFI didn't work.

CRIPPEN I'm not sure how much they did get. Supply water storage system tank dump we talked a little bit about yesterday - that it does warm up very quickly when you turn on the heater. It pumps up over 100 degrees in less than a minute, I would say. You could always get those off very rapidly.

YOUNG We dumped it down to 25 percent.

CRIPPEN I think I also mentioned to you that it puts out a beautiful snow shower on the left side.

YOUNG I tried to take a picture of it, and it didn't come out.

CRIPPEN Out the left side - that's where at least one of them comes out. John Glenn's fireflies all over again. Terrific.

ENGLE Does it dump about the same rate as the SMS?

CRIPPEN Seems like the waste comes down quicker than the supply, but for supply, you're dumping down lower. We never did dump tank alpha. We only dumped bravo.

YOUNG 10:26 water dump at sunrise; frame 26 and 28 on CX 22.

5.54 RCS CROSSFEEDS

CRIPPEN This crossfeed right RCS to left RCS we did. It was because they were worried about the crossfeed lines getting too cold while we were sleeping overnight. I'm hoping that is something that will go away pretty soon. I think they have enough data on the thing. One other thing about crossfeeds, Dick - there was one time I almost messed it up. It was one of the things that's really been worrying me about the way we're doing crossfeeds on-orbit where you end up isolating the manifolds completely. When I hit pulse, I guess I didn't verify it and the Y-axis had not gotten in pulse. It stayed in

CRIPPEN (CONT'D) discrete rate. I ended up with the system isolated for a while with the ground hollering at me. It would have been very easy to fire a thruster in that configuration and suck down the manifolds for no reason at all. And I still feel that's a bad way to do business. Manifolds should never be isolated. We need to talk to some of the systems folks again. I think the issue ought to be brought back up. I think that it does not hurt to interconnect those tanks very briefly.

TRULY It took a while for that call - you know how the MOCR is. There was a certain delay there when you could have easily fired a jet.

CRIPPEN You just leave yourself open for an easy procedural error to end up putting the vehicle in a undesirable condition.

TRULY Just a few seconds - but to me it seemed like 5 minutes from the time they finally decided to call up.

ABBEY So we ought to make that point in the systems briefing.

5.55 IMU MANEUVER

CRIPPEN Auto maneuver to IMU - all the auto maneuvers just went clean as a whistle.

YOUNG Even the manual ones did.

5.56 CABIN DEBRIS

CRIPPEN Clean up stowage. We did some of that. I think in general we kept the vehicle shipshape.

ABBEY When you vacuumed up all that loose stuff?

YOUNG The fan was going. There was one time in there where it got a high-pitched squeal in it. I said, "That's shades of Apollo 16," because it did that for a little while and then it just quit cold on Apollo 16. Then Crip said, "I'm going down to clean that up."

CRIPPEN I could hear sounds like it was laboring - like maybe the filters were clogging up or something. And I could also hear this tinkle, tinkle, tinkle - little junk hitting the filter. Then I broke out the vacuum cleaner, and that's another thing - here's this cover that you have to lift up, and it ought to have just a little thing that you twist to lift it. No, you have to break out your toolkit and get a little allen head wrench to go open it. That didn't take long, but I was in a bit of hurry. I rigged up the vacuum cleaner pretty quickly and went in to vacuum. I haven't looked in the bag to see what I have up there. I still heard some stuff clinking for a while after I finished vacuuming. I heard it a little bit later, but not very much.

TRULY Could you see down in there?

CRIPPEN I didn't break out a light. I was in a big hurry, and all I did was put the vacuum cleaner down in and try to run it over the filter. It stopped most of the noise, and it never labored after that.

YOUNG They said, "Don't leave the cabin fan off longer than 5 minutes," and Crip was down there fast. He cleaned the whole thing in 2-1/2 minutes.

CRIPPEN Then, I guess you ended up turning on the other cabin fan, which somebody caught.

YOUNG Yes, somebody caught us.

CRIPPEN But it didn't make any difference.

YOUNG The guys wanted to check out both cabin fans. We never ran, in all the spacecraft testing, on the other cabin fan.

CRIPPEN No, I thought we did once - in one test someplace.

YOUNG Yes, one test. How many hundreds of hours do we actually have of that one cabin fan and we have none on the other one. There was an accident. I don't know why I turned on the wrong fan after turning off the right one.

ABBEY I think after the work they will be doing, we're liable to be right back in the same situation.

TRULY What do you mean, on stuff in the cockpit?

CRIPPEN He'll find some stuff; hopefully, it'll decrease eventually. The system cleaned it out fairly quickly. It really flushed it down.

YOUNG We had washers and bolts, and we had rivets and screws, and we had lots of gear there.

TRULY Do you think it would be a good idea just to build that into the time line?

YOUNG I would think you ought to put it in there and just before you get out of the PDP while you are doing all of these C&W checks. You know, you've been up there for 4 hours or so, just plan on searching through your PDP. Put in there "Clean the cabin fan filter."

CRIPPEN It would be interesting to see whether I've got any trash in the bag of the vacuum cleaner.

YOUNG I think so, too. If you allow time enough to do it, then you can go down there and - instead of running the fire warning test, you can go down there and clean the cabin fan. That fire warning test is not a nice test when that siren comes on.

CRIPPEN It sure does get to you! I thought keeping the vehicle reasonably shipshape was fairly easy to do. There were a couple times I had some stuff spread around. I did leave out big units like the vacuum cleaner once I got it out, the TV cameras and the little heating unit for the food, but generally, we kept most of the stuff tucked away. We really didn't have to wash anything down except clean up the heads once.

5.57 WINDOW OBSERVATIONS

CRIPPEN Window obs. I went around and took photographs of several windows that - -

ABBEY Is this where you photographed the streaking?

CRIPPEN Yes, but I'm not sure how that turned out. It's kind of hard to photograph streaks.

YOUNG It turned out good. They're on there. You bet. They're all over the place. You got streaks and streaks and streaks.

CRIPPEN Well, I think I took a picture of W7. But I think W8 and maybe even 10 in the aft bay looked like it had some junk on there, and I can't figure where that came from. And most of the forward windows had some stuff on them. I believe we got each one of those. The hatch window was as clean as could be.

ENGLE With the stuff on the front windows, was it thick enough that on-orbit it would have made pictures bad, or did you try taking pictures through the front window?

YOUNG There were times when the sunglint was such that when you took a picture through there, I'm sure that it washed the whole

YOUNG (CONT'D) thing out, and that's probably what's wrong with some pictures that we took. Primarily, the right Sun angle just wiped those out, bouncing off that window with the stuff on there. They probably would have been wiped out whether they had the stuff on there on not, in my opinion.

ENGLE And most of it blew off during entry, then?

CRIPPEN All of a sudden, I was sitting on the runway and I realized the windows were clean. Unless somebody climbed up there and cleaned them. I think entry cleans the windows.

YOUNG Of course, I don't know that. My guess is that the temperature on the windows was probably 120 degrees on entry, but I can't prove it.

5.58 IMU ALIGNMENT AND STAR TRACKERS

YOUNG Yes, that was a good IMU alignment - real small torquing angles - the biggest was minus 0.27 and then it did calibrate all right. Then we did a COAS verification and the data takes where you see if you can align the platform with the COAS and those torquing angles for that one just after we finished aligning the platform. Okay, the angular error on the COAS star alignment was zero and the torquing angles were small, the biggest one was minus 0.05 - so that tells me that you can use the COAS once you get it calibrated, to backup your star trackers and, as a matter of fact, if you lost both star trackers, you could still, if you calibrated the COAS, would be all right and, if you can tolerate the initial bias error out there, which was 0.23, you'd still be all right. So I really think the mission rule that says if you lose one star tracker you'd come home is not a good rule. Isn't that what it is?

TRULY Is that the 0.23 bias? Will they crank that in now, too? In other words, would we launch with the assumed direction to include that 0.23 bias that you saw?

CRIPPEN It's an I-load. I would assume that the program can take that into account.

YOUNG I would think that if you had that in there already and you put that machine up - I bet it's repeatable - you could get yourself a good alignment whether you had it calibrated or not.

I don't think either one of the star trackers will ever fail, the way they worked. If we ever got up there on a long mission, maybe something would damage them - maybe the Sun would zap one of them or something like that - then you have to turn around and abort the mission.

ENGLE Like I thought that SMS star tracker model is probably one thing that should be fixed.

YOUNG We should put down all the things that we were told before the flight that didn't turn out to be that way, they told us that it could take up to 2 to 3 minutes, the way the star trackers were, to get stars in the table. That's what we're told by our own folks; there was never a case where that happened, star aquisition and tracking was almost instantaneous.

ENGLE Did you ever get any stars of opportunity while you were there?

YOUNG Yes, lots of them.

ENGLE Did you really?

CRIPPEN Yes, but we were having problems with that shutter closing and not opening back up so we probably didn't pick up as many as

CRIPPEN (CONT'D) we could have. I imagine some of the GNC guys could tell you much more about what they got, but we picked up several of them. In fact, we had one time where John didn't clear the star table. There was already a star in there and when the system went through, it got both the stars we were trying for, but it picked one of those stars and the old star because, if you go through and look at the angles like the one closest to 90 degrees and the time and so forth - and for some reason, it thought that the other star was more optimum. We ended up deselecting it and reselecting the one we wanted so we could go ahead with the star pair that was originally desired. I think on your flight, you could probably end up picking up enough stars that you could do an alignment.

YOUNG You may never have to do an alignment, maybe.

ENGLE Just keep the thing running - -

YOUNG Just call SPEC 22 and look at the star angle difference if you like, and then call SPEC 21 and torque them.

CRIPPEN The thing about it, it does not take but a little while to go get an alignment, but it might be nice to get rid of some of that time for your flight.

YOUNG If MCC could be looking at that all the time and call you guys and say, "Hey, torque," or something like that - or maybe they could do it with a DEU equivalent and not have to worry about IMU alignment attitude maneuvers again.

5.59 16-MILLIMETER CAMERA

CRIPPEN Okay, 16-millimeter camera setup - this is the one, for some reason - I was a little bit rushed on time and I said the heck with it and I probably upset the photo guys. I had the film

CRIPPEN (CONT'D) that was in my camera at lift-off, which is exterior film, and just went ahead and used that camera to shoot the CO_2 changeout.

ENGLE You're still thinking, though, that the TV camera - you already got it out, might as well use the VTR -

YOUNG But the best shot of the whole thing is when Crippen finished - he kicks off the CO_2 canister and goes up the stairs like this and you got a picture of him going up - looks like a seal floating around. Really, that's the best part.

5.60 COAS CALIBRATION

YOUNG I want to say something about this morning/daylight/midnight cal that I didn't say - the COAS cal was 0.12 and we took that bias and updated it, and then we did a 0.07 and at midnight it was 0.06 and at daylight it was 0.06. It says it doesn't vary thermally, which we knew all along, but that's why we did the tests and at least we cleared up that. The prediction was that it wouldn't vary a lot.

5.61 FUEL CELL PURGE

CRIPPEN Fuel cell purge. I'd get one going and then I'd get another one for 2 minutes, and another one for 3-1/2 and another one for 6 sometimes, but we had enough cryo that it really didn't make that much difference. That's the only thing about doing a manual purge - because you usually get busy. I could've kept an alarm going or something like that - only I wasn't very faithful with that one.

TRULY You know there's always time for one more 482. There was a lot of discussion just before the deorbit burn. They decided that if you wanted the fuel cell, you didn't need to turn the master DFI off, looking at the margin.

YOUNG Puddy, he's a good man. That's what the Flight Director is for.

CRIPPEN I told Pud the other day that I really appreciated the way he handled entry day there because they kept quiet. You know, when you are rushing around trying to get in your suits and all that kind of stuff, you don'thave time to talk.

YOUNG There is no place in the time line for pulling out a teleprinter message and reading it.

5.62 CO_2 ABSORBER CHANGEOUT

CRIPPEN CO_2 absorber - a piece of cake. That's about a 30-second job.

ENGLE You looked like, when you were doing that, you just snuggled right down in the hole.

CRIPPEN Yes, that was the easiest place to restrain yourself. You know how you have those little troughs, now when you have a lot of CO_2 canisters in there, they may restrict you from doing that.

TRULY I thought you were going to go in there and close the door.

5.63 WCS DOOR

CRIPPEN The first time John finished using the head, he shut the door. And then I went over to undo it again, or open it back up, and the latch was jammed. There was something that shifted in there and that latch was tight. There wasn't any way you could open it. Every time we latched it, we had to go get a pair of vice grips to open it back up again.

YOUNG The head door shouldn't be opened with vice grips. And the thing about it was, while I made all those mistakes on the PCS

YOUNG (CONT'D) entry day configuration, every time I'd have the door closed so I'd have to go down and get the tools. We just left the door open. On-orbit, it was convenient to just leave it open because you have your wet trash bag hanging there.

5.64 WHOLE GAS SAMPLES

CRIPPEN Whole gas samples - there was one of John's favorite activities. The gas samples worked fine. We sucked all the air out of there.

5.65 PRESLEEP

CRIPPEN Presleep - I guess I want to make one comment about the pre-sleep thing, which I still think is a terrible configuration, where you have to put one guy off comm plugged into that lower station down there.

YOUNG Is that what you did?

CRIPPEN We've got it configured now so that one guy is plugged into the redundant alarm system off the middeck and the other guy is on comm, it's awkward.

5.66 C&W SYSTEM (SLEEP)

CRIPPEN The way the system is rigged up now - you can lose the ACCU and you don't have an alarm system and you don't have comm. If both of you are asleep, there's no way to tell you about it. What we've done to bypass that is a straight shot into the alarm system, which bypasses the comm. You have to plug in downstairs.

ABBEY You are talking about a double failure.

CRIPPEN Well, once you have the first failure, you don't have any capability to monitor your second failure - nothing to tell you about it while you are asleep. That is the system that we have now. I just think that there ought to be some way so that both guys could stay plugged into the comm. The only other way I know about that you could do maybe is to plug one ear into the alarm system and plug the other ear into the comm system - or maybe leave the speaker going in the back of the cockpit or something like that.

ABBEY Well, we ought to look into some way of improving that.

5.67 CRT (SLEEP)

CRIPPEN CRT things. Basically, I guess we never had the situation where one of us awoke and the other one didn't - when we wanted to turn the CRT's on, I was basically setting it up like the guys had suggested. When I got ready to turn the CRT off, I'd give it to the backup GPC using the switch. I'd turn it off, and since the backup doesn't have any MDM's at this point, it can't ring an alarm. When you got ready to turn it back on, you could turn it on and take it away from the backup and look at your CRT. That's a way you can get around the problem of getting an alert. It seemed to work okay. But, with the power we have, there's nothing wrong with sleeping with one CRT on. I think you can just leave it on.

YOUNG Yes, I think that's a good point. Leave a tube on. If a guy wants to look at it, or call up systems, or happens to wake up at a certain time at night and wants to take a look around his vehicle like we used to do in Apollo, you'd have more intelligence than what you've got in that machine and you know that's what they pay us for. When a guy's up, why doesn't he see what his machinery is doing?

5.68 WINDOW SHADES AND FILTERS

CRIPPEN — One thing with respect to window shades and filters, John and I broke out the covers for W3 and W4. We didn't really fit them in there tightly - it was mainly those windows that the Sun was coming through on the orbit. We slept in that configuration.

YOUNG — The only time that I was ever awakened was when the sunrise coming in through the back window hit me on the back of the neck.

5.69 CABIN TEMPERATURE

CRIPPEN — The first night was a little bit fitful. It was kind of cold and I woke up cold a couple times.

ABBEY — When did you notice it getting cool?

YOUNG — It was starting to get a little cool right as we started the presleep. I didn't think anything about it.

CRIPPEN — We kept the things up to full cold up until that point.

YOUNG — I had the temp control knob on full warm during the presleep period.

CRIPPEN — Somewhere around presleep, we decided to turn it up because we were starting to get cool. After I'd been asleep about an hour, I woke up again. I went down and put on another pair of socks. I never wore shoes while we were flying at all, but John ended up putting his shoes on because his feet were cold.

ABBEY — What time did you guys finally start going to sleep?

CRIPPEN I think we probably went to bed somewhere about an hour after the CAP said to.

YOUNG Well, that's what we did, but I had already made up my mind that I was going to sit up and watch the store. I was sitting there and I really didn't object to being cold at first because it helped me stay awake. I was watching new things and, every so often, I'd keep my eyes closed and then I'd look up to see what the cabin pressure was and what the partial pressure of oxygen was and what the cryos were doing and how the fuel cells were working - on the gages. And then I'd drift off again but pretty soon I got so cold I could hardly sleep at all. But the last 3 or 4 hours I was just asleep. There was no way out of it. And that's probably all the sleep you need on the first night in a space flight, I think. I really do.

ABBEY You could always do an EVA again.

YOUNG No, I thought we couldn't do an EVA because I thought all the air had leaked out of the airlock. I hadn't been following that conversation too well.

CRIPPEN There was some place there earlier that we had checked that delta pressure on the airlock and had concluded that there wasn't any problem. All I did was take my lap belt and put it across my lap. I found my arms floated around and bothered me, so I ended up folding my arms and going to sleep.

TRULY You know this cabin temperature thing. One of the things that was kind of strange is the temperature on the downlink was real high.

YOUNG It was a false temperature.

TRULY Yes, I guess we don't have a thermometer. We need one of those big thermometers.

YOUNG You guys ought to take one on STS-2 and measure around the cabin what the temperature is.

TRULY The cabin temp - when you started saying it was cold - the downlink said it was 81 degrees or so.

ABBEY Maybe we ought to get those little temperature tapes - -

CRIPPEN We used those back in Skylab, you know. They just stick on various places in the spacecraft.

TRULY I think that would be very helpful because then, when you said it was really, really cold, they read 76 degrees, or something like that.

YOUNG I think it was around 50 - my guess is.

ABBEY 50?

YOUNG I was cold.

CRIPPEN I'm not sure it was all the way down to 50, but it was chilly. It was in the 60's, at least, and there's also a tendency, you know - when you're sleeping, your body slows down and there's a tendency to get cooler. It was much more noticeable when you were trying to sleep.

YOUNG Well, it was too cold for me to sleep during the first part of the whole thing. I just couldn't. Since we had already said we were going to sleep, by golly, I was too proud to say anything about it.

5.70 DUTY DAY

ABBEY — You figured our duty day was about the right length?

CRIPPEN — Yes, I don't think we wanted the thing any longer than that.

YOUNG — I think that's too long a day as it is, but you know that's what we got. But when we got ready to go to sleep, I wasn't ready to go to sleep - I just wasn't ready.

CRIPPEN — Well, and there's always a few things around the spacecraft, you know, that you have to get tied up that are not in the time line. There's always a few more things to do before you're ready to tuck things away.

5.71 CABIN SHOES

ENGLE — John, do you see any reason for taking those brogan boots along other than to keep your feet warm? If you had had an extra pair of socks, would you rather have had them on?

YOUNG — I would like something to keep my feet warm. Maybe something like a pair of bedroom slippers. Didn't they used to have some soft shoes that we used to wear in some program or another, Skylab or something?

CRIPPEN — Well, Skylab boots were kind of soft things.

YOUNG — Why do you need these big heavy boots anyway? You know what we've got in that spacecraft? These big heavy boots.

CRIPPEN — I know.

YOUNG — I'm serious.

ENGLE — I'm too embarassed to wear them anyway.

YOUNG Yes, looks like somebody's army boots.

ENGLE They are Polish gym shoes. But you run the risk of kicking things with these on.

CRIPPEN Oh, yes, I think so. You wouldn't want those on.

ENGLE If your feet get cold, just throw them out and get them out of storage space and get some soft - you know those things you wear after you ski or hike and so forth.

YOUNG Yes.

5.72 EXERCISER

CRIPPEN The boots and the elevator attach things might be good for somebody but I really think they're useless myself. If you can get them off your storage list, more power to you. Also the exerciser, I don't know; you might want that thing. Joe Henry really likes it.

I don't know - for a 5-day mission or something like that, you might. On some point the second day, my legs felt like they needed to be doing something. I started doing some muscle flexing and that kind of stuff.

YOUNG I think you're right. I sure think you ought to pull out some time in there on a 5-day mission to do something to keep the legs in the kind of condition they are going to have to be in to pull a g and a half. Whatever that is, I don't have any idea. Because I am sure inflating that g-suit isn't going to be worth anything.

5.73 WATER ALERT

CRIPPEN There was one point in there I need to go back and cover, too. When you are using the head, periodically you get an alarm.

YOUNG A water alert.

CRIPPEN It was when the waste water pressure would pop up high.

ENGLE Oh, is that right?

CRIPPEN Just periodically. It probably would be worthwhile to see if we could set that limit up a little bit higher. Somebody ought to go back and look at the data on it.

YOUNG Was it high or was it low?

CRIPPEN It was high.

YOUNG We laid for it because we kept getting this alert and every time we called it up, there wouldn't be any indication.

CRIPPEN It was gone. In fact, that first night, we did not get any other alarms. We got up the next morning and it was only when one of us was down there to use the facilities that the thing went off. The only other alarm we ever got at night was the one that was a real one on the second night on that APU thermal thing. So you guys did an excellent job on maintaining the TMBU's and setting everything up right to allow us to sleep.

5.74 WORLD MAP

TRULY Did you keep the world map out to keep up with where you were looking out the window?

YOUNG I looked at it a bunch of times but I did not make a regular-type thing of it. Every so often, you'd fly over something and you'd say, "Gee, I wonder where that is," and the map would be over here. You'd go get it and find it.

ENGLE About that time, you'd be over the ocean.

YOUNG By that time, you'd be gone.

ENGLE If you were to stick it somewhere or have a map somewhere, where would you put it? Would it be over the overhead windows or up front?

YOUNG I never even thought about that. That's not a bad idea, Joe. You know you have all these switches and circuit breakers that you're not using (013, 14, 15). You could probably take some Velcro and strap it to the roof, and then anytime you were looking at something, you would have a map of where you were and look out the window and see where you were. You need something to stick that rascal, like if you're going to take pictures out the back window, maybe over your RMS panel or something like that. Just put it up there.

CRIPPEN You might approach it just a little bit different, since we were flying around backwards, it was very easy to look out our rear window and see things coming and as it came in under the overhead, you could take the picture. I think you did more picture taking out the rear than you did up forward.

YOUNG I was aiming forward.

CRIPPEN Yes. But flying around forwards may be a little different than that.

YOUNG Those back flat windows, those two flat windows are real good for taking pictures. I got a picture of Crip up there in the

YOUNG (CONT'D) 35 mm that really came out good. In fact, they released it. It was a picture of Crip - floating up there against the RHC and the picture goes through the window and it shows the clouds in the background on the Earth. It is fantastic.

5.75 SLEEP

ABBEY Anything else on sleep before you'd turn in.

YOUNG No, I would have slept well if I hadn't been so cold. I stayed up on purpose for about 4 hours or so just to make sure that everything was working. Then I catnapped the rest of the night, and every time I woke up, I checked everything. That's what they paid us for.

CRIPPEN On the first night, I was freezing. I normally can sleep just about any place. I was waking up a little bit every now and then but not very often. I guess I felt fairly confident with the system by that time that if there was going to be a problem, it was going to give me an alarm and that would wake me up. Although that one we had on the second night, while I was sleeping so darn good, when I woke up I didn't know where I was or what I was doing. That told me that some of the reaction times we've talked about - like jets failed on and so forth may not be conservative. I'm not really sure how quick you can come out of it and react to it in the middle of the night.

YOUNG I was having a lot of fun there. I would get out of the seat and go back in the back and float around there.

CRIPPEN I looked over at John, and he wasn't in his seat once, and I looked back and he was laying horizontal floating back of the seats. I said, well, he's sleeping back there.

YOUNG I was just laying around.

TRULY That would be a great place to sleep, you know.

YOUNG Actually, if you had a Velcro strap or something, tie it to a vent, it would probably be like sleeping on a bed.

CRIPPEN The thing about it is you'll end up eventually up against the ceiling.

YOUNG Every so often I was kicking the R15 C/B panel which I should not have done.

TRULY I don't understand that either. Why would he float to the top? What is it, the airflow?

CRIPPEN May be the airflow. I don't know. But the airflow, I was taught, should be pushing down. It flows out back there high on the aft windows and down into the DEU stuff. I would have thought it would have pulled you down. One time, this little handheld radio we have for postflight over there in the R5, that little bugger kept trying to sneak out every time I turned around and one time I turned and it was gone.

YOUNG It was right on my ejection seat. It was between the two rails just sitting there. And we had looked all over that spacecraft for that. We must have spent 5 minutes looking everywhere.

ENGLE Isn't there a flap over it, a Velcro flap or anything to keep it from sliding out of there?

CRIPPEN Well, the little radio doesn't have a container, it's just floating. It's just like all the stuff in the little lockers, just shoved in there along with the books and, for some reason, it seemed like it had a mind of its own. It was trying to sneak out. But I'll tell you what, that R5 has a lot more

CRIPPEN (CONT'D) room in it in zero-g than it does in one-g, it's easy to get stuff in and out. You just need to make sure you close the door, which I didn't do that time.

TRULY I can't understand why you float up.

YOUNG I can't either but we sure did it. Maybe it is because we are always in contact with the seat or the floor. And any contact makes you move in the other direction.

5.76 DATA PROCESSING SYSTEM

CRIPPEN Okay, so we ended up dumping the freeze dried and I guess I did talk to Russell this morning about what I mentioned to you, Dick; we probably ought to go ahead and say it on the tape here. Our current procedures did not - when we did the freeze dried - recognize that we had changed the memory configuration for memory configuration 3 to be run with GPC's 1 and 2. That should normally be corrected before you put the freeze dried back to sleep, which Ken pointed out that was primarily because we've added in the OMS-3 and -4 burns, but even then - even if you hadn't added it, there might have been something else that had caused you not to change that table so you should go back and check.

TRULY Another thing I asked him about again just a while ago, maybe you talked to him about this, too, was that - remember the business about the CRT-3 and the GPC assignment?

CRIPPEN Yes.

TRULY Well, when they called up and asked you about it, they saw a change; and so they assumed that you had keyed it and I told them that you had not.

CRIPPEN All I did was deassign the backup from driving it via the switch.

TRULY Is that all?

CRIPPEN So I could look at it.

TRULY I wonder if the fact that the backup had control of it faked out their ground processing.

CRIPPEN That ought to be worth exploring.

TRULY They're looking into it but it seems strange.

ABBEY What did you think of the wakeup call?

CRIPPEN Great wakeup call, great wakeup call. I heard that the music was supplied directly from Florida and I think I might even have a copy of it somewhere. I gave Mom a copy to go put on her jukebox.

YOUNG That's not a bad country and western song.

5.77 HEATER RECONFIGURATION

CRIPPEN Heater reconfiguration was no big deal. I'm assuming that they'll probably want to continue that just because that's the only way that they have of assuring that the other heaters are working. Oh, but there was one. When I put the circuit breakers on the middeck in initially, I used our little decals and went through and put in all the little yellow circuit breakers. There is a yellow decal on one of them that ought not be there, apparently. On ML86 Bravo on Alfa, initially, they only want the MAIN A WATER LINE HEATER Alfa closed with Bravo open so you're running on heater Alfa and then when you switch heaters to open Alfa and close Bravo. Well, I had had

CRIPPEN (CONT'D) both Alfa and Bravo closed up until this period of time because of the decals.

TRULY What was the circuit breaker, the name of it again?

CRIPPEN Well, MAIN B WATER LINE HEATER Bravo apparently should not have a yellow decal on it. At this particular point in time, Bravo was already closed and I went ahead and opened Alfa. I'm not sure whether data ended up telling them which one was failed. I asked if they wanted to switch later and nobody ever came back to me so we left it in that configuration.

TRULY Did you ever use those little yellow things to identify switches that were in a nonnominal configuration?

CRIPPEN It was recommended for a couple of places and I guess we ended up not digging them out and sticking them on. We didn't have that many off-nominal configurations.

YOUNG Oh, this is RCS burn day.

CRIPPEN Oh, yes, RCS burn day. Oh, right here was where we did the PCS on-orbit activation for reconfiguration.

5.78 O_2 PRESSURE ANOMALY

CRIPPEN And that was where, shortly after we did it, the O_2 reg pressure on system 1 started going up. I never did physically understand what the nature of that failure was. The first thing I did was, I figured that if it was really high in there, I might as well go back and open up that 14-1/2 reg and let it flow out. And I did that and that didn't do it and then I finally closed the system 1 reg inlet and figured that would stop it. It still kept going up and then the ground finally assured us that it didn't make any difference. If it was going to go up, it was going to level off some place, which it did.

YOUNG It would level off when it was equal to the nitrogen pressure, which is 211 or 213. And, sure enough, it did.

CRIPPEN I never did physically understand where the leak was in the system.

TRULY I thought they concluded that it actually ended up being two leaks.

ENGLE Well, yes, they were thinking in order for it to act like it did, it had to be a leak in the PPO_2 controller and then the O_2 reg controller.

YOUNG A dual leak?

ENGLE But that's why they were confused. It seemed like such a remote possibility.

YOUNG We didn't need that thing anyway because you had the whole cabin full of air anyway.

CRIPPEN The only thing was, we had the first RCS burn coming up and we wanted to go through that without getting worried about it.

YOUNG That's right.

CRIPPEN We were diddling back there for a while. I finally concluded it wasn't going to hurt anything. It wasn't going up fast. That was one of the small anomalies we had.

5.79 RCS-1 BURN

CRIPPEN And what of the RCS burns? They gave us the countdown time for the first three initially, and that worked out well because we knew where we stood. We also at this point knew they had the new flight plan for us and had added a fourth burn.

YOUNG MCC had really redone the whole flight plan. I knew we wouldn't have any trouble doing it because we've done it so many times. We never have run that flight plan on day 2 the same way twice anyhow, so I knew it wouldn't be any trouble.

CRIPPEN Well, also, I thought they did a good job of sending teleprinter messages. I don't know if either of you guys participated in it, but it was something that when I read it over, I knew exactly what it was that they wanted to do and there wasn't any question.

YOUNG But I really question - unless you're trying to do something like what we were doing in real time - I really question that you ought to change your flight plan so much.

ABBEY Like we did?

YOUNG Maybe they had to do it, I don't know.

CRIPPEN I was pleasantly surprised. We had done that flight plan in just about every conceivable fashion anyhow, and we were used to changes. It worked out okay. You need to be somewhat flexible, I guess.

The RCS burn itself, we did configure for it, we even got the RJD's on, we didn't forget an RJD.

YOUNG Until burn 4.

CRIPPEN Until burn 4.

TRULY Is that where you made that comment about - something about the jets failed but don't worry about it, you'd fix it up.

CRIPPEN No, I think that one was the RCS tests, wasn't it?

TRULY Somewhere in there.

YOUNG Burn 4. I know they came up and said we weren't going to have to do it, and 10 minutes later, just before we were about to not do it, they said, oh, yes, you're going to do it.

CRIPPEN If you translate with those RJD's off in OPS-2, it tries to fire some of the jets on manifolds 2 and 4 and they won't fire. In which case nothing happens. There was another time though, John, we ended up on one of the tests where you turned every RJD on but one.

YOUNG Oh, yes, that was the RCS jet 2.

CRIPPEN Yes, I guess that was later.

YOUNG The jets failed off because it was commanded to fire and we turned the RJD on and it went away. The remarkable thing, though, is that we only did that once. That's the remarkable thing.

TRULY We're going back on STS-2 to all arm on.

CRIPPEN They got the change in there now.

TRULY We're going to split power to vernier jets and they're either going to be all on or all off.

CRIPPEN And that's the right way to do it.

YOUNG I think, boy, that sure prevents you from having to test out the RCS RM.

CRIPPEN The RCS RM works great. That was one of the pleasant surprises I had out of the flight because I anticipated that we were going to get some false jet failures which we didn't.

CRIPPEN (CONT'D) Okay, where are we at? RJD config, interconnect OMS to RCS, I went through all that. Again, OMS to RCS, same thing I said awhile ago about RCS to RCS applies. I don't think you should isolate your manifolds but we got through the procedures. Auto maneuver RCS-1 burn attitude was fine -

YOUNG Hey, you know all those RCS valves that weren't supposed to have any cycles on them, the ones you kept cycling? How many remaining lifetime cycles did we end up with - minus 10 or minus 20?

CRIPPEN I don't know. I bet we probably ended up using all the cycles.

YOUNG That's right. I bet we used all the allowable cycles and then some. I know we had six left when we were in the OPF and they said we're going to use up four before launch.

CRIPPEN Somebody ought to look at that, though.

TRULY Yes, you're right.

CRIPPEN Somebody ought to tell us how many cycles we have left on them.

YOUNG I think they've got about minus 15 cycles on each one lifetime limited value.

CRIPPEN Or maybe they're going to go through and replace them all. On the RCS burns, if we had an X and Z component, like plus-Z, we'd thrust the plus-X out and it generally took care of most of the Z's.

YOUNG I forget what it is you get, for 2 foot of plus-X, you get 1 foot of plus-Z.

CRIPPEN It's more like 3 to 1.

YOUNG Well, okay, 3 foot of plus-X gives us 1 foot plus-Z. Somewhere between 3 and 2. And so you do your plus-X first and then if you had your plus-Z, it would take care of it for you. There was no way out of the Y.

ENGLE It would walk on you?

CRIPPEN It would, it really would. It would sit there and chatter.

YOUNG I think the way it does, it fires two yaw jets up front and then it fires three jets in the aft and then it quits on one of the front jets because it has too much moment. It seems to sort of yaw oscillate across the sky.

CRIPPEN Well, I think the moment somehow isn't equally distributed between the forward and aft jets. When you start to translate, then your attitude hold comes in and starts kicking out on you. You end up with some kind of walking effect. It isn't any big thing, it just didn't feel clean to me, that's all.

YOUNG It didn't feel clean on the Y translation off the tank and it didn't feel clean on any of these RCS burns. But it worked. And you can really notice it. You know we can make a motion that you could feel it in the simulator because it's sure there. We have to look at those signatures.

CRIPPEN DPS config back. There was some place in there I ended up with a screwed-up CRT assignment because I was cheating and not doing the deassignment kind of thing which I never do but it isn't a big deal.

YOUNG We've got to get an aval cue for the forward thrusters, too. Boy, I'll tell you. And we've got to get the whole vehicle to shake. The motion base will do that, the whole cabin shakes when you fire the forward RCS.

CRIPPEN Okay, we did that. We got back in OPS-2 and the next thing we did was the GG so shall we talk about that, John?

YOUNG Yes, the GG setup was straightforward. I don't think I messed it up but it will be a miracle if I didn't.

5.80 GRAVITY GRADIENT

YOUNG Okay, back to gravity gradient predrift setup. We set it up like it's in the book here and went to option B and the thing deviated in roll. It got a pretty big error in roll which I forget how much it was - maybe 60 degrees of roll error - and then it started out and then it came back. And it was just as steady as a rock.

CRIPPEN It's also a good picture-taking mode . . . .

ENGLE What's this gravity-bearing nose down?

CRIPPEN Yes, nose down.

ENGLE Were you taking them out the front window?

CRIPPEN Yes. Right.

YOUNG You could have used the top one - the top windows for oblique.

5.81 REMOTE CAMERA OPERATIONS

CRIPPEN Okay, it was also here that we did this remote camera operation and it ended up being after sunset.

TRULY Let me ask John one question about that. Did you ever get the feeling it was getting to be a hassle, that you were tracking something in one window and you wanted to go to another one. Would that have been a hassle to do it?

YOUNG Only if Crip was standing in the way it would. Only if he was in the way. No, heck, it would be easy. We did that a couple of times. Yes. We did some pictures out of the forward Orbiter -that's going around to the front and looking over there. That's the only time I ever spent any time on Crip's side of the spacecraft - shooting pictures that I'd seen from the back and floating right up to the front and being able to get up in there and see it. Really is neat. I mean nice.

CRIPPEN This remote TV camera thing was for the TV folks just to check out their TV system, and I think we did everything that they asked for, to my knowledge. There's one point where they have you focus in on roller number 2 up forward and try to come in focus very close, and it wouldn't focus very well at all. Other than that, I didn't really have any comments on that. I think we did everything they wanted. We never did get the daylight portion of it, and I was hoping to go back and pick it up later, but it ended up getting scrubbed for one of these other burns, I didn't have time to pick it up.

YOUNG Now, well, like the RCS burn times and everything, were all changed. The first one was pretty much on time, wasn't it?

CRIPPEN I think they were all about 20 minutes or so later.

YOUNG Yes. The RCS-2 test was at 2:40.

CRIPPEN That worked out well, I mean we flipped back into this other CAP section back there, and I didn't think that was any problem at all.

5.82 VENT DOOR OPERATIONS

CRIPPEN The vent door ops - we closed the vent doors and they worked and we opened them back up. Thank God we didn't screw up the vent doors.

ABBEY The vent doors - all the way through - you didn't have any concern about anything?

YOUNG Well, here's what I think. I think they ought to look at the heating data, and if you can leave those vent doors open on entry, you ought to leave them open all the way down. You shouldn't ever close the vent doors. There should never be any reason to have 18 doors in the vehicle so that if some of them don't work mechanically, it'll squash the vehicle. That's really bad. To rely on some kind of mechanical system to be 100-percent reliable. If the vent doors don't need to be closed, leave them open. Well, that's what they ought to look at. Yes. Vent doors open all the time.

If you have any kind of a leak in any of the RCS or any of the aft thrust structure equipment such as helium, or APU hydrating or whatever, you don't want the vent doors closed. When you're going to have leaks, you're going to have them on the dynamic flight phases when you're firing thrusters or when the APU's are running. If you ever have one and if the vent doors are closed, you can do damage to the vehicle.

5.83 MEALS

CRIPPEN We usually ended up eating chow on the flight deck. John normally in his seat and I normally, back aft. All we did was use those little trays; it would have been neater if I could just Velcro the tray flat against some of the panels where we had Velcro. It didn't have any Velcro that allowed me to do that. I basically ended up having to take the tray strap and find a part of it that I could stick on something. The tray was just out floating free. What I finally ended up doing most of the time with mine was I would take it and strap it around my left leg.

TRULY Wouldn't it be better to take off those little metal hooks - hickies - and forget hooking them on a door and just have Velcro patches?

CRIPPEN If you have some good Velcro on the back, you could just stick them up on the locker doors.

YOUNG You got it, you got it. Velcro patches on the back would allow you to do that, too. You just Velcro them to something. I would just Velcro my tray - to the Velcro for the OMS cue cards, and the tray would be floating up right in front of you. You have to hold the tray steady when you put your chow on it because it will pull free from the Velcro off the cue cards. That position was really convenient. You didn't get out of your seat, or stop what you're doing to eat.

CRIPPEN All the food containers worked well. We didn't have any failures.

YOUNG Yes. I don't think we had a valve failure on any of the bottles - that I'm totally amazed about. You know, over here in the simulator when we ran these long sims, we had three or four valve failures. You'd take the valve and push it in there so you could drink out of it, and it just kept right on going to the bottom of the tank there. It never happened to us in flight.

ENGLE You know, I thought of going, taking a piece of tape - a piece of masking tape or gray tape or something - and just going over to the SMS and while it's fresh in your mind - and putting pieces in places where you figure Velcro would have been handy to have . . .

YOUNG Yes. We'll do that.

CRIPPEN Maybe over in building 9, ... With respect to food preparation while I'm thinking about it I had a couple of the food bags that I ended up not putting enough water in mainly because I was afraid of getting it too mushy. It ended up being a little bit dry. That's what you don't want because the flakes could float out when you first open it. My advice is you want it gummy. Most of it worked out pretty well. If you have a tendency to do anything, make it a little bit damper so it all sticks together well and you don't get any dry crumbs off of it.

ENGLE What food is that?

CRIPPEN All of the stuff that's rehydratable. You can kind of play with it. Normally, it seemed to work out I was getting about an ounce per second out of the gun. The gun - you've really got to hold in on it harder it seemed than the one we were using over there in the SMS to try to get it to flow. But once it starts flowing, you can get it flowing good . . . if you've got a snug grip on it. I count about 'one potato' for every ounce you want to put in there - seemed about right. Maybe add just a tad more.

YOUNG Really, eating was - that cold water works good, too. That cold water was really outstanding. You could really chill with that.

ABBEY Really chill down?

YOUNG Yes. You could really chill down your cool drinks - your grapefruit, orange drinks, all that.

CRIPPEN I didn't really have that much time. I ended up probably doing less snacking than in the simulator during long sims, but we ate all the meals . . . .

TRULY You had time - during the meal times to . . . fix them and eat them?

CRIPPEN Well, it never did match up exactly with what the schedule here said. Meal time - we had to play that a little bit flexible.

YOUNG Yes, we played it flexible.

CRIPPEN But once you get the meal prepared, you can eat with no problem.

YOUNG You know, the good old ground, they don't pay any attention to this meal stuff. They say, "I wonder what those old boys are doing up there. We're going to give them this PAD." Or something like that.

ENGLE What he meant was that you get the . . . bags open and they tell you to do something. It's kind of hard to zip them back up.

CRIPPEN It was not that difficult. We had one dish that was a little bit messy to eat, but it was good stuff. I wish they could do it a little bit different. It's one of these foil package containers of sliced beef with barbeque. I heated it up. It got so hot that it's one of those kind of things that you take in small bites while it's hot but it comes out in big hunks. It's got barbequed gravy all over it, and there's no way you can cut it up. You know, it would have been nice if it had been in bite-size chunks.

TRULY One of the problems on that in the execution of that thing was that the flight plan that they sent up to you, of course, was also the only flight plan. That piece of paper was all the controllers had to use. It was difficult to refer to the CAP and to refer to this piece of paper and keep up with what the heck was going on.

YOUNG You ought to have seen it in zero gravity.

TRULY Yes, I know.

CRIPPEN They only sent one copy of that flight plan initially, and I asked for a second one so that John and I both could have one - which made it a heck of a lot easier.

TRULY Getting back to Velcro. Did the front side of that right locker - that Flight Data File locker - you know where we generally stick that ref book up there, did that work out okay?

CRIPPEN It worked out okay.

TRULY Would that have been a good place to put more Velcro?

CRIPPEN No, I would recommend - I would put more Velcro back in the aft. I actually ended up using the ref book - well, I used it from the aft more so than the one forward. I guess that one I mainly looked at in dynamic phases.

TRULY What I was thinking for was to stick other things - like calculators.

YOUNG Speaking of that thing, that infernal big guard that goes around the fire extinguisher is useless.

CRIPPEN It just blocks the window.

YOUNG I cannot believe why it's there. They say it's there because they don't want the fire extinguisher to overheat or something. Well, you know the fire extinguisher never got hot. It didn't get any hotter than anybody else.

ENGLE What better thing to overheat than a fire extinguisher?

CRIPPEN I really wish they would get that out of the window there. That is criminal to begin with.

YOUNG Well, I think they ought to do away with that. That's just . . . . All that does is keep you from seeing something out the window you might want to take a picture of . . . .

ABBEY You got a window there, you've got to use the window instead of obstructing it.

YOUNG If it is contributing to anything. Just to get rid of it as a weight saver. It just doesn't serve any useful purpose. It certainly doesn't keep the fire extinguisher cool or hot or anything.

CRIPPEN Dick, you asked me to look at one thing that I want to talk to you a little bit about - looking out the back and imagining trying to work RMS . . . or something like that with respect to how the Sun was? It turned out that it probably wasn't a problem, depending also on the time of the year. The Sun was never rising or setting directly in line with the X-axis of the vehicle. It was always off to one side, at least on our flight. There was never a place where you couldn't move over to this side or that side and get a clear view totally of what was going on in the payload bay without having to worry about the sunshine.

YOUNG There are some things about those pictures over there, though, that I don't really understand. It has to be like the way the Sun was hitting the windows that I couldn't even tell. I'd take a picture through there and the picture would be washed out. It wasn't clear to me that it was going to be washed out before I took the picture. Because the settings were - we used a standard f/11 at 250 and some of those pictures, 90 percent of them are okay, but 10 percent are just crummy. Because they have something wrong with the way the Sun was with

YOUNG (CONT'D) respect to the window, I guess. Or else the camera was malfunctioning. I'm not sure the camera did that.

CRIPPEN Okay. But with respect to the Sun's position, Dick, I'd get some of the guys down on the second floor to run that because they've got that in their program for whatever your launch time turns out to be.

TRULY Where it is?

CRIPPEN Yes. Where it's going to be with respect to the X-axis. Unless it's pretty close to the tail, I don't think you have any problems.

TRULY Generally, the computer said that it was going - it said you look toward the tail generally should be - in your case should have been rising and in our case should have been setting - over that right OMS pod.

CRIPPEN Yes. Mine might have been a little bit farther off than the OMS pod. If yours is directly on the pod, that may be a problem.

TRULY Well, another thing is, though, most of the RMS stuff here is to the right of the tail.

CRIPPEN Okay. I didn't have problems seeing any place on the vehicle.

TRULY So when we get a flight plan, we ought to just ignore the Sun and just deal with it.

5.84 CAMERA OPERATIONS

YOUNG These guys over at the Photo Lab didn't develop that photography that we shot at f/4 at 1/60th. Really too bad about that.

ABBEY Is that right?

YOUNG Yes.

ABBEY Okay, you could see all the PLBD markings that we were worried about being too small?

CRIPPEN We did not actually look at them through the TV . . . I would still like to recommend that we try to make those things larger.

ABBEY Yes. No reason not to have those things bigger.

CRIPPEN I don't think so, there are tolerances, you know they worry about whether they are open or closed, but I think that we ought to see about making them a little more visible because they were marginal from what I saw. Since I didn't really need them to verify that one way or another, I never explored them in flight.

YOUNG There was a place in here when they called us and told us to document the payload bay, vertical stabilizer, and OMS pods . . . 80 millimeter and then switch to 250 millimeter and get the vertical tail, the OMS pods focused at 70 feet or some thing, f/8 at 500. I did f/8 at 500 and those pictures did not come out. They are really lousy-looking pictures. I'm not sure that camera is right. The pictures came out, but not very well. In fact, it looks like there's some window Sun streaks which I didn't see just coming down from up top-side, that really looks very strange.

CRIPPEN It's pretty bright back there actually . . . .

YOUNG Yes, I thought it was plenty bright. It's sure bright enough to take good pictures.

CRIPPEN Well, the next thing we got through is on-orbit dedicated display checkout, and this is the one I referred to a little bit yesterday and got it mixed up with the first APU thing we did.

YOUNG And the TACAN lockon.

CRIPPEN Yes. . . . we saw TACAN lockon and it wasn't in the test so . . . .

TRULY They were really getting the attention . . . .

CRIPPEN . . . pretty strange . . . and there's other parts, I think we ought to mention, we need to verify we had BITE indications on . . . both radar altimeters on when we did the test and I think that's per design but . . . we need to doublecheck that.

YOUNG You know, I tried to get them to run a TACAN test in OPS 304 to see if we could get a good state vector out of that before we committed the vehicle to entry. They said it won't lock on up there, it's going too fast. But once you're straight over something, you're not going very fast, your relative motion is zero . . . .

CRIPPEN It's pretty quick, actually we did it in much quicker time than the time line called for . . . .

YOUNG Absolutely, but leave that time in there . . . There's no time in here, in this whole flight plan, to go to the bathroom. Not one place in there where it says "Go to the bathroom." And you need some time, some free time to clean up.

CRIPPEN Right. Okay, what's the next thing we got? We went back to OPS-2 in remote camera ops - we already talked about that. Okay, this is where we are going to do burn 2 and this was the place we went in first, we took down the EVAP and closed the door, closed the rads up again, that all worked just smooth as glass. Closed the door, this was the second time I did the check of bringing it down closed, and sitting there. It looked to me like aft latches, like around latch 12 was

CRIPPEN (CONT'D) shifted over a little bit closer toward the port door, I was estimating it was going to be about an inch and a half below Charlie. That was an estimate because it was pretty hard to see with the binocs. It was obvious to me they weren't going to overlap.

YOUNG Again, that clip system worked pretty good. You put one clip on there to operate this part of the book and you got to go back to RCS test and you put another clip on there and you can do it right in both pages of the book. Where you can get in it without . . . You remember those RCS tests when you have your overall scheme of the flight plan up in front and the details are in the back of the same book.

CRIPPEN On the first burn, . . . that was one we screwed up on and we ended up instead of selecting plus-X RCS it was selected for right OMS. And we came down, the burn said execute . . . I never saw the thing say execute before . . . . If we had, we'd gotten an OMS failure message. But we never did execute and we went ahead, fired it, and I guess we were a little bit off with the attitude because it was expecting an OMS burn.

YOUNG Yes, one engine burn . . . .

CRIPPEN But they were okay, the next burn came up and they said, "Hey, you got the OMS selected instead of the RCS" because we were over a site that time. Our screwup probably didn't hurt anything.

YOUNG FES restart, I've got in here it took 3 to 4 minutes . . . to get it restarted. The profile we use in the SMS for this restart is too fast.

ABBEY Why did it take so long?

YOUNG I don't know.

CRIPPEN On the second burn, this again we screwed up, and I was supposed to know this, but I forgot and didn't read my little parenthetical statement.

YOUNG For a multi-axis burn, perform burn in postburn attitude.

CRIPPEN Yes, but up here on this one, right here, they told us it was multi-axis, they said do it in the postburn attitude and we ended up doing it, in the attitude that was the one they had called out for us, I couldn't see that it would make any difference one way or the other because the only reason for doing it in the postburn attitude is that they were concerned about how quickly it was going to take to do the maneuvers, there's always plenty of time. But whatever.

I think we made some of that a little too complicated.

Yes, as far as I was concerned . . . we tried to make it much more complicated than it really is. It was very easy to go through it and do it all . . .

I really don't have much more to say about that second burn. John did them nice and clean and they came out very small.

YOUNG Let's see what all we had to do for the test 2. Vehicle recovery and FES restart.

CRIPPEN For block data, MCC told us to . . . move TIG's up 4 minutes and perigee adjust 5 minutes. That was much better than getting new pads.

TRULY 6.

CRIPPEN No, the first time it came it was 4 minutes, they ended up saying 6 minutes later and we changed it. That was just due to the lower orbit. . . . . They also said that for the perigee

CRIPPEN (CONT'D) adjust burn, change them about 5 minutes and they wanted that to be 90 feet per second.

YOUNG Well, I have that on this restart, it took 3 to 4 minutes to restart the flash evaporators. In other words, it went up, came down . . . that's a lot longer than it ever takes in the simulator. Maybe we ought to look at the data, just go back and get some data of those FES restarts if there is such a thing.

TRULY Good example of how we ought to update the model.

CRIPPEN I don't see anything else on burn 2 there where it's worth mentioning.

YOUNG I don't either.

CRIPPEN Then we picked up on burn 3 and this we did in the attitude of the postburn attitude from burn 2. Worked out slick, no problem.

ENGLE John, did the temps when you did all the radiator bypass functions and stuff - did that work pretty much like back in the simulator?

CRIPPEN . . . there was someplace in there we got an EVAP OUT just like in the simulator . . . .

YOUNG Yes, like in the simulator, I don't remember where it was and I don't remember . . . if we run across it, I'll mention it. I just don't remember where it was.

CRIPPEN . . . could have been when we were going back to . . . to flow on the radiators. Okay, we did burn 3 and got the maneuver going, went back and got the doors back open. Door opening was nominal, wasn't anything exciting here.

YOUNG Okay. Well, of course that's where, when we activated the radiators on that one, we went to AUTO and AUTO A, and the loop 2 radiator performance was unusual. First it went to RAD like it normally does. Then I looked down and it was in BYP. The right loop which is loop 2. It went to RAD and all of a sudden I looked down and it was back in BYPASS. It had jumped back to BYPASS and then the temperature started going - the left loop was controlling okay and the right loop wasn't.

TRULY So it really was in BYPASS?

YOUNG Yes, it was in BYPASS and then the temperature started up. We went back to MANUAL and made it go to FLOW and were Mickey-Mousing around with it.

CRIPPEN I think you went back to MANUAL - went back to RAD FLOW, left it there for a minute, and then went back to AUTO again and it worked okay.

YOUNG It worked okay. Yes, I really don't understand that, but I don't think it's any big thing.

CRIPPEN In general, after all the fiascoes we've been through with that system in the simulator, it really worked nice.

YOUNG And then we got a C&W when the temperatures started up and they said cycle a RAD - RADIATOR ON - PRIMARY A ON. Remember that? And I think that was, you know, I think there - I don't think the ground can tell if the thing is not on. They just see the temperature going up. I don't think they have the discretes - remember, we tried to get that put in the system to - -

CRIPPEN To tell whether it's actually on or not?

YOUNG Yes. To tell whether it's really turned itself on electronically.

CRIPPEN I thought they could, but I'm not sure.

YOUNG Maybe they can. But I think we just didn't wait long enough to give that thing a chance to respond because the thermal inertia of that thing as profiled is a lot slower than what we've been using in the simulator. But we did it and, sure enough, it turned around and came back down when it felt like it. But it sure worked well. And I'm just sorry we didn't test the two others. We don't know right now whether the PRIMARY B FLASH EVAP or the SECONDARY EVAP is working end-to-end, and we should have run some tests on it to make sure we had a working system. I mean, how else are you going to know? You have to check your LRU's out, they say. Unless you run the things every so often, you're not going to know whether they are working or not. I'm not sure you need it working, but I think it would be nice to have if it was, because sooner or later the probability is that the electronics on PRIMARY A will crump.

CRIPPEN We got the doors back open - went back to Y-POP.

5.86 RCS-4

CRIPPEN They they added on burn RCS-4 . . . and we went through that. There weren't any special concerns except that translation in OPS-2 - with the deltas that we got on there - is not a good thing to do. We didn't have an opportunity to transition to OPS-3. At that particular point in time, when you have everything configured - like your RGA's on - all you have to do is go OPS 01 PRO and you know the darn thing is back in - or OPS 201 PRO you were back in the other and it takes - if the MMU's in the right position - it's less than about 30 seconds until

CRIPPEN (CONT'D) the transition. Of course, it's no big deal to go back and pull her - once you're in a configuration like we were there.

ENGLE That really could have been your option, too. That was talked about in the MOCR and they figured it would save you hassle not to make the OPS transition.

CRIPPEN That would have been the easiest thing from my standpoint, but we didn't have - that's also another one of those times when I was off running and doing something. John was the one that was plugged in and I couldn't hear the conversation.

YOUNG That's right. Crip really didn't want me to do that burn. But I figured they knew something that I didn't know. They were really insistent. We've had to do that burn - - We really had to do that burn, so I said, "well, I'll do it." But the moment I fired off the handle, the burn - the delta-V we were putting in and the delta-V we were reading out - there was no resemblance between the two of them. I know I put in a foot per second and the delta-V monitor was reading zero. And I thought, "Oh, we've really messed up now." And then we got all the down errors on RCS fail offs, which were due to the fact we had the RJD's off in OPS-2.

CRIPPEN It was fun.

YOUNG Fun? It never should have been done. Well, if it's going to be done, they should have done it in OPS-3 like we did the three other ones.

CRIPPEN Yes. The thing about it is, I guess people just don't have a good feel on the ground for how - there are times, you know, you have to flip the RGA's on and make sure about your configuration of all your switches. Going between OPS-2 and OPS-3 does take a little time, but once you get configured, you really can go back and forth very easily.

YOUNG I bet we put in at least twice as much delta-V. We finally had a delta-V total monitor of 10.8, I think it was. Delta-V total, you know - they finally counted up to that.

CRIPPEN But remember that count was both directions.

YOUNG I don't have any idea how much it was, but on entry day we were in a 145 by 141 so I assume we had gotten a lot of inadvertent thrust into the vehicle.

5.87 COMMUNICATIONS

CRIPPEN Shortly after that burn was where we were doing the TV with the Vice President. Meanwhile, we hadn't had chow yet. I had the meal prepared. I'd managed to sneak down and get it prepared somewhere between Hawaii and stateside. Within about 10 minutes there, we managed to gulp down our meal and go get the TV set up.

ABBEY Then I guess that worked out okay.

CRIPPEN Oh, that was - at that point was where John was plugged into that middeck thing and we found out that if you broadcast on Air-to-Ground 2 - you send yourself a message.

YOUNG The message is really neat but unfortunately you can't read it.

CRIPPEN You can't read it. You can't figure out what you said at all.

5.88 B WATER QUANTITY TRANSDUCER

YOUNG Yes, it was right in there, too, remember - it was the first time that we had - yes, it was right in there where we had the B transducer - the B water quantity transducer went off-scale low and then it came back up - -

CRIPPEN It was blipping on at several different times where it would - all of a sudden, it would go to zero, come back up, and go back down again, and it did that a couple of times during the flight. In general, it was very good.

YOUNG We never had a failure like that before, a real intermittent.

CRIPPEN I think they ended up changing out on the TMBU for the second night. They went ahead and dropped it down to zero - something like that for a while. Well, after chow and the TV show, I think we got another alignment. We didn't do the second window observation and we didn't do the other remote camera in the light because of the poor Sun.

5.89 TELEPRINTER

YOUNG Yes, and that alignment - the angles that we're supposed to go to are supposed to be on the teleprinter, but I had to call down and ask them because it didn't print out. It dropped the tail off the nine so it looked like it might have been a zero or something. So I had to call down and ask about that.

CRIPPEN There are a couple of times on the teleprinter, even though I think it's generally been excellent, that little numbers sometimes get messed up just a tad and that's part of the reason that, preflight, I was so concerned about sending up read/writes on the teleprinter. That just made me nervous as a kitten to think that we might end up doing that.

5.90 CAP FORMAT

ENGLE Were you ever bugged by the little print in the CAP's or was that just a Xerox problem in the simulator?

CRIPPEN It worked pretty well.

YOUNG It worked okay. There are places where they underline things like - well, like right there. See, there's a 297 but it's underlined and almost looks like a 2. And that would be a bad mistake to make, you know. They shouldn't underline the things for numbers if they're going to - you know, why underline them? I mean, if they want a pad out to the side for alignments that get changed, yes, put the marks in there and the guy can fill them in. Now why, like in this IMU alignment pad, do we have one, two, three, four, five blocks to fill in, when the most angles you ever see are the first two? Why do they do that?

ENGLE I tell you - if you have one that's really gone bad on you and you're torquing the angle - -

YOUNG You aren't going to torque really big angles, you would coarse align it.

ENGLE That's true, John.

YOUNG I mean, if you do torque big angles, you're going to wait forever. Unless your coarse alignment circuits are broken, you won't do that.

CRIPPEN Basically, I think the way they've got these little lines and the dots on the pads bears no relationship to where I write the number in.

YOUNG Well, I always copy down the delta-Y, -Z star tracker because the delta-align star tracker angles as soon as you get alignment after your first alignment - that tells you how big you can expect your torque angles to be. There's a correlation between the size of your torquing angles and the delta-Y and delta-Z numbers.

CRIPPEN We got another fuel cell purge in here and, again, that was no problem whatsoever. We got into the suit donning and we did this sequentially - do you want to talk a little bit about this?

YOUNG Yes. I'd like to say that I think I've learned a lot in doing that suit donning in zero gravity and I think we both did. The thing that I learned was that the suit donning time line allows zero time for preparation and stowage. Therefore, you should get everything out and have it all standing by and then you just go and do it and it doesn't take any time at all. If you operate in the time line allowed for getting stuff out of boxes, and folding up your gear, and putting it in the drawer, in zero-g, it took twice as long as the suit donning practice. Getting the UCD and underwear out of its box, and breaking loose the UCD and unwrapping it, and stowing that on the bulkheads, and getting the g-suit out, and stowing that on the wall, and then trying to put your clothes back in that same box that you just got all that stuff out of is no easy job. You can't wrap up that pair of pants and that coat (if you're wearing that coat), and then put it in that same box you unstowed them from. So, the first time I did the suit donning, I just left my pants floating. And if you were in a hurry, you could leave them there. They'll end up on the floor - who cares? But as long as you prepare for it, I think you can cut the real donning time so that it fits on the time line. On the first suit donning, I think Crippen and I both overran that considerably. We were still donning the suits while we were supposed to be doing other things.

CRIPPEN I thought we came out pretty close to about a half hour to put the suits on. That's what we allocated there.

ENGLE You didn't do a KC exercise with this suit, did you? You did it with the hard suit?

YOUNG Right. There's no problem getting into it, it's the preparation for getting into it that eats the time.

ABBEY How about getting out of it?

YOUNG That was harder than getting in.

CRIPPEN Seat ingress is easy.

YOUNG Because its a totally different thing than on the ground. I think that practicing suit donning and doffing on the ground is a waste of time unless you want to do ascent and entry simulations with the suits on, which I think are valuable.

ENGLE You don't think the KC would give you - -

CRIPPEN The bad thing about the KC is that 30 seconds is too short. I really don't think we ought to give you the impression that donning the suit was difficult.

ABBEY You didn't help each other? You did it all by yourselves?

CRIPPEN We did it by ourselves.

YOUNG Crip zipped mine the first time, the second time I did it. Remember, we took the grease up there to put on the zipper and that worked great. Once you put the grease on the zipper, it didn't take any effort.

CRIPPEN It would be worthwhile for you to grease the zippers on your flight.

YOUNG That's worthwhile.

CRIPPEN It was just a little bit different trying to don and doff the suit. I felt much better for having done it once for practice when it came up for entry day.

YOUNG If you can't get your zipper all the way up to the top, and I missed it by about that far a couple of times, it makes it very hard to get out of. I got out of it anyway.

CRIPPEN You just shrug it a little - then you can walk out of the suit. The other thing about that was that we warmed the spacecraft up. We had it a running full hot and I spent quite a time in the suit off cooling and it was really warm. So, the next day when we did it, we cooled the spacecraft down real well and then got into the suits - that was a lot better. I got onto cooling pretty quickly, but you can run around without cooling the suit. You're better off if you keep that suit as dry as you can - have the cooling on there. It doesn't really restrict you all that much if you have to run downstairs you can disconnect for a little while.

YOUNG I think Crip is right and before you put the suit on, make sure the spacecraft is cooled, because you aren't going to be cold. It won't be cold once you get the suit on.

CRIPPEN That fan - you're just not getting as much cooling with the suit fans as in the simulator. It's just not that cool. It's certainly acceptable, but it's not that much.

YOUNG So, you don't want to plug into that fan with a big heat load because it would be a long time before you get cooled down.

CRIPPEN The camera stuff again - I never got it set up like I wanted to, but I ended up handing it to John because he was already strapped in and he did some handheld. I thought it might be

CRIPPEN (CONT'D) of some interest to show you about seat ingress but after having looked at it, it doesn't look to me like there's anything there, and seat ingress is a such a piece of cake that there's nothing to show. Getting your straps and so forth is a lot easier because they're floating out there. There's enough rigidity, in all those things, like the seat belt and so forth, that you just go grab them and pull them around you. I didn't have any problem at all. In fact, I mentioned on entry that I couldn't get my arm down far enough to get the pin. I just wasn't concerned at all about disconnecting my shoulder because I knew I could hook it right up.

ENGLE John, with that inertia reel unlocked, could you lean farther forward than in the simulator?

YOUNG Yes, you could do all kinds of things.

5.92 PTC TESTS

CRIPPEN Then we did the PTC. Is this where we ran it up to 0.4 degree per second?

YOUNG No, that was earlier.

CRIPPEN This is a 15-degree deadband - -

YOUNG Yes, you did that. We did it right here, right after we finished that IMU alignment.

CRIPPEN 0.4-degree-per-second rotation on this thing is pretty impressive. During the rotation, I was not tending to float up to the top. I could tell it was rotating around me when I was floating free.

YOUNG I'll tell you, no matter what deadband you're in, with those big jets up there in the nose firing, it's not nice. Right

YOUNG (CONT'D) here at nighttime, we had to put in this PTC with a 15-degree deadband - -

ABBEY Why didn't you guys take a picture, then?

YOUNG It wouldn't have come out. They don't put out enough light, except it scares you pretty badly. You fire the howitzer and this big flame goes up there. Every time it did that, the next morning I would look up there and see if the nose tiles were still attached. I really did. I wouldn't say anything to Crip, but you know, I didn't want anything missing. I tell you - that was really a revealing thing. So as far as I'm concerned, the next bunch of tests anybody runs on jets, they ought to run them on verniers.

TRULY Well, we've got more RCS tests on STS-2 than you can shake a stick at.

YOUNG You do? Well, why do it in the big jets? Somebody ought to look at how much real oscillation and how much instant jolt it puts on that vehicle. You're going to hurt something sooner or later.

CRIPPEN Hopefully, I've got a VTR tape that's going to demonstrate that. We did the thing for the RMS thing here where the VTR is running, showing the forward camera showing the aft camera, and the aft camera showing the forward camera, while you were doing the test. I don't know exactly how they are going to correlate all that, but with the verniers, I don't think you'll see any motion whatsoever . . . but every time there's a normal jet firing you see those things shake all over the place.

ENGLE The cameras shake?

CRIPPEN Well, they shake just like the rest of the vehicle does. But you know how loose those things were anyhow. I believe they're on a VTR tape. I never played it back.

You will not want to operate the RMS with nominal jets. I know that.

YOUNG Well, I don't want to belabor the point, but I don't think anybody is going to like to operate the front of that vehicle with a big nose jet firing. That is just too much shaking. It may be a great thing and all that and it may be great for humanity, but it sure is nasty. You don't want to deploy the RMS with those primary jets on.

5.93 RCS FTO

YOUNG - - FTO's which was manual rotation discrete rate test. I could not make the Z manual verniers with the acceleration, and the verniers - all those worked. The discrete rate test - no problem. The vernier test and accel, accel, accel, itself was no problem. You got about 0.1 degree per second - I don't know. But the manual rotation acceleration test, which I don't even know why you ever run such a test or ever use such a control mode unless you are trying to evade a satellite or something, there is no way you can crank up that RHC for 1 second and then null the roll rate after you've done it. So, that test was a loser, in my opinion. I don't see any point in us having done that test. But now that we've done it, I hope they get some good dope out of it. Because, I mean, that airplane takes off, as quick as you can grab hold of that stick and let go of it, you nearly have a degree per second. Fortunately, you can always go back to rate command, get it to damp and then the manual rotation discrete rate, that's no problem. And the post-testing cleanup was no problem, except we didn't have the DFI recorders which - I kind of wonder why we ran the whole test in the first place. Of course, this was

YOUNG (CONT'D) done during the night, too, and, man, when those big jets in the nose fire and I was - firing was kind of like holding a gun to your head, in my opinion - but I just didn't care for that . . . I mean it worked okay. Maybe it doesn't shake anything, but it sure seems like it does. And we finished that test up early . . . .

CRIPPEN John finished up early - I mean while I'm trying to get a 16-mm camera set up to go, by the time I got it all set up to take pictures of him, he's done.

ABBEY What does that feel like when it shook from the RCS?

YOUNG Accelerometers would show it because the whole thing was shaking, and that's something we can simulate. I'm pretty sure. Shook a hundred times worse that it ever shook the lunar module and . . . .

ABBEY Is that right?

YOUNG Yes, I mean, it was just like you had an active nose cone up there. I didn't think we'd hear it. We heard the sound, we saw the light. It shook the whole vehicle. And you could - of course, you've got the acceleration when you did these things. The acceleration, the cues of motion/accel were always there.

5.94 PHOTO OPS

CRIPPEN This particular part of the time, from our view that we already overscheduled the amount of photos 70 mm, John had been taking pictures out, and you got plenty of Earth limbs outside. I didn't even attempt to do that. And the 35-mm stuff -we'd been picking that up along anyhow so I really didn't even try to do that. I still couldn't get all the stuff in. We did water dumps again, and that was all okay.

TRULY Where in here did we start you into the inflight maintenance drill?

CRIPPEN Well, it was somewhere right in this particular area.

5.95 DFI PCM CONTINGENCY PROCEDURE

CRIPPEN Somewhere along in here was where first I tried to do - when I was suited, I tried taking the swizzle stick and going around and pressing the DFI RCDR cb. I could get my head turned back around where I could see the thing, but I really had a hard time getting any downward pressure applied on that circuit breaker. I was really afraid to commit to it. I was convinced that if that was required, I'd have been better off not strapping in the seat and just flopping back there and getting it at some point in time. Then the suggestion came up about swapping it out. That to me sounded like a reasonable thing to do.

YOUNG It didn't to me, I was against that from day one. I just don't think you ought to be changing big components in that vehicle unless they are flight critical.

5.96 DFI RECORDER CHANGEOUT

YOUNG Okay, they want that stuff, that kind of stuff, changed then they have to build a vehicle so a human being can change it, not so some big guy who's torqued the bolt down and painted it and weighs 300 pounds can never get it off and expect two kids that only weigh nothing in zero gravity to get the thing off.

CRIPPEN I tell you, I really don't think I could have broke those same screws if I had been down here in one-g . . . .

YOUNG All I have to say is if they expect you guys to do inflight maintenance on a mission-success basis instead of on a mission-critical basis, then it has to be designed to work easily.

ABBEY They have to design it so you can do it.

YOUNG It ought to be designed so a human being can get his hand around the nut and untorque it.

ABBEY Well, you have to have the kind of fastener you can get onto.

CRIPPEN One you can get on and off easily.

YOUNG We have said that inflight maintenance was all along a valuable thing, and I think Frank Janes is doing a heck of a job on the things that the crew can fix in case they break up here. But they are all predicated on getting the panel off. You know you may not be able to change out a computer right now because you can't back the panel off while some big 300-pound guy has torqued that bolt down, and in zero gravity no one could untorque it.

CRIPPEN Those have got torque limits on them.

ABBEY We should bring that up as a point.

YOUNG Well, I really think it's also a place where we didn't have to get into it but there's some places where we have to take panels off the floor. The program ought to ask itself if it wants to make those sacrifices for mission success, and if it does they ought to do it. Now, mission-critical stuff, we just - if they'd have said, "Change out the computer," we'd have worked all night to change out the computer. And if the panel had to come off, we'd have sawed it off with a bone saw.

CRIPPEN Yes. I could have gotten in there. If it was really critical to have gotten in there, I could have gotten in there somehow.

YOUNG We could have sawed those nuts off if we could have figured out how to get the saw in there.

CRIPPEN Well, I could saw the panel off. Because I had enough room in there I could get to it.

ABBEY If you want to do that, you ought to have the capability to do it.

YOUNG The kinds of things that we used it for in all the simulations to date - you were going to turn around and go home if you could not change this part out.

CRIPPEN Getting data is also the name of the game on test flights.

YOUNG I absolutely agree, we should have thought of that ahead of time.

CRIPPEN Because I'm convinced that if they could have ever gotten the panel off, we could have changed the recorder . . . .

ENGLE The scare approach was if you . . . don't get data on this, that adds one more flight to the OFT program, and that's why they were anxious to get a recorder that would work.

5.97 LANDING

YOUNG I'll tell you what I'd like to do, I'd like to land the airplane in pretty moderate turbulence before they ever go to runway, George, I think it ought to be done on a lakebed. They are going to figure out how to do that.

ABBEY Absolutely.

YOUNG I think you'd hate to end up on a runway in turbulence and have yourself a line-up problem as well as the turbulence problem on the same landing for the first time. It just might be a champ, but it sure would be dumb to do it if you did not have to. Maybe not, because it was so calm I didn't have to touch the control stick. Now we don't know - my way of thinking - we really don't know that a guy may not have an interaction with the control stick during turbulence.

ABBEY Well, I think we ought to make that point with program debriefing.

YOUNG Most guys probably don't. I mean, a guy like Joe doesn't. I mean, but a guy that hasn't had the training may interact with it. Maybe we ought to go back and look at all the STA stuff and see how the guys operate . . . I don't know.

5.98 DFI RECORDER CHANGEOUT

CRIPPEN Well, after we told them about the recorder thing, we finally knocked it off this day we hadn't had chow, we were already into the bed time because of that. We ate dinner late.

5.99 SLEEP

CRIPPEN We ended up staying up maybe another hour here getting chow, and the temperature was okay that night.

5.100 CABIN TEMPERATURE

CRIPPEN There was one point in here prior to going to bed. The first day before we turned on the second water pump, I had gone down and checked the controller and it was over in the full heat position. Then we turned on the second water loop and there came another point where we were still cold. They asked us to go back and check it, and I expected to find it still in full

CRIPPEN (CONT'D) hot position. It was in full cold, even though we had the controller turned up all the way hot. I still don't understand what happened there.

YOUNG So, I took the little valve and pinned it full hot. It reminds me a lot of the T38. Controls whatever temperature it wants no matter where you move the valve. We're all used to that.

TRULY Once you pinned it - -

YOUNG It warmed up. It did. We didn't have to turn on the other valves loop.

CRIPPEN Somewhere along here - this bedtime - is where they told me that block data was now 6 minutes early and that worked okay. Someplace back here on day 1, they did send up a test message on the CRT just to find out whether that system worked all right, and it worked okay. I never did get a picture of that. We never did end up using the CRT camera although I think it was a nice thing to have onboard in case we needed it.

ABBEY You guys slept pretty well that second night.

5.101 APU-2 ALARM

CRIPPEN Slept like a log, and this was the night that the . . . temp on the APU-2 went out. That was where I woke up and couldn't figure out where I was and didn't know what was going on. Finally I got alert enough to break out the mal book (it was the only time I looked at the mal book) and it told me to go back there and switch heaters. I did, only I switched them on system 1 instead of system 2, which I haven't figured out why I did that yet.

CRIPPEN And then when we talked to ground. We were almost AOS. I did utilize that little AOS/LOS program, that worked super.

ABBEY How long after you went to sleep did that happen?

CRIPPEN It was several hours. It was like 3 or 4 hours - something like that.

YOUNG Yes. We were - I think it was about one-third of the way through the night. Because I was asleep, too, and I was sleeping like a baby then, I made up my mind I was going to stay up for a rev or two and take pictures and I did.

CRIPPEN I think it was also worthwhile having set that tone - I was setting the alert tone to go off for 99 seconds because I'm not sure the 1 second we were normally running at would have ever got me up, as sound asleep as I was, and I wouldn't have believed that I would have thought I would wake up with a drop of a pin. I guess I was a little bit tired. We switched heaters and it seemed like it was doing good. I went right back to sleep.

YOUNG And it came on about 300 degrees and then the tone sounded 297 or somewhere, and said look at the injector temperature - -

CRIPPEN And it took me awhile to figure out where the injector temp was.

YOUNG Yes. We looked at the CRT's and it was on the BFS system summary 2 injector temps but it is not on the OPS-2 APU hydraulic display, SPEC 86, which is strange.

TRULY You mentioned a calculator. You used the CG calculator, too, didn't you? Or did you?

CRIPPEN I did use the CG calculator on entry. I had it all set up with everything loaded in. I had a bad comp on the OMS fuel, especially for the right side, so I never did get those numbers updated. Which I probably should have.

ABBEY The AOS?

CRIPPEN The AOS/LOS program, which is the one I used the most, worked out pretty good. The system we have set up worked super, didn't have any problems with it. Since we did mention on the CG program, there was somewhere in here that they sent me a note that consumables were such that the dry CG - best way to handle it was to bias it about 1 day early. When I typed in the MET. That's what I ended up doing. They talked about it yesterday - about giving me an update to that - and I figured that was still close. The easiest thing was for me to continue using the one day.

TRULY There was a message floating around on entry day, and I don't remember if it got uplinked or not . . . that gave you - -

CRIPPEN They asked me if I wanted it, and I said, "Hey, is this one day bias close?" And they said it was. So I elected not to go ahead and take it.

6.0 DEORBIT PREPARATION

6.1 ENTRY DAY

YOUNG — We got around to all that stuff. The COAS bias that I updated the night before was 0.12 degree and I took two extra marks. Both came out 0.10 both times and the star was right in the middle. The COAS could have been good enough to align those platforms for entry. As I said, I must have hit COAS at least 50 times and it didn't have anything to do with the alignment.

Entry day I got up at 19:30 MET and made breakfast and I used the head and about that time the head started acting badly.

ABBEY — Worse than it had been?

YOUNG — There was more and more urine hanging around that nozzle. Every time I'd go over to it, there would be urine hanging around the urine cup nozzle.

CRIPPEN — We got up a little bit early. John beat me up. By the time I woke up, he already had chow going downstairs - almost had it done and we had an opportunity to spend a nice relaxed morning there looking out the window a little bit before we started talking to Houston. The postsleep day was pretty standard, then another IMU/IMU align - nothing different on that one. Star trackers and all that works okay.

6.2 HSI FAILURE

TRULY — Ken talked to me earlier this morning about HSI and all I could tell him was that during entry, it broke again and what you took - a bunch of large hits and then stuck somewhere.

CRIPPEN — I don't know if it actually stuck or was it just jumping, John?

YOUNG It was stuck there when we turned finally. It was completely broken.

6.3 TIG TIME

CRIPPEN I think the TIG time from that first time they gave it on that morning never changed.

YOUNG 5:12:30, I think.

CRIPPEN They had it pegged all the way.

TRULY Ted Walker told me he got the time from Willis about 4 hours before deorbit. Chase time and you were less than 2 seconds off at 50 000 feet.

6.4 ACOUSTIC BLANKETS

CRIPPEN The only thing I was going to comment about the acoustic blankets we said yesterday and we'll say it again. I went ahead and made another noise measurement here before I took the blankets out. It was still 67 dB. I took the blankets up and it was 70 dB for a 3-dB gain. I'm not sure if it's worth the trouble of installing them and if the system will allow it, I recommend making that strictly a crew option; if you guys want to stick them in, fine. I'd go ahead and fly them.

YOUNG I think we ought to leave it in there and just not do it and that would give you some time to do something else. What do you think of that?

CRIPPEN . . . 67 with, 70 without.

ABBEY If you've got them available and you feel you need them, you can put them down. If you don't, you don't.

6.5 IMU ALIGN - STAR TRACKER TEST

YOUNG — IMU aligns - star tracker align - self-test. The first morning the star tracker torquing angles were pretty big, like the IMU-1. The delta-Y angle was plus 24 but the other IMU's were minus 07 on 2 and minus 08 on 3 and the rest of them were smaller than that.

CRIPPEN — Super platforms.

YOUNG — Yes.

TRULY — One of the somewhat vague things - the uplink of incorrect gyro bias late one evening - it was caught just in time and they uplinked the old one. We were afraid it was going to . . . . I wasn't there. Somebody told me about it.

6.6 RCS JET TEST

YOUNG — The RCS jet tests the next day - I think I did it all right but I might have done some RHC when I should have been THC and vice versa. I can't remember.

YOUNG — Did anybody say whether the second RCS jet test came out all right?

TRULY — I don't think I ever asked GNC about it.

YOUNG — I don't think they cared by that time. I really think it's important to know when your jets are working if you're going to have to use them for entry.

TRULY — I'm sure it came out okay, John, or there would have been some talk about it.

YOUNG At least we should have fired yaw jets. You know, the lower priority yaw jets. We still haven't looked at any offset c.g.'s where yaw jets might be necessary.

6.7 ENTRY STOWAGE

CRIPPEN Entry stowage. Most of this stuff about personal hygiene was unstowed. There was a little bit of it there and we went ahead and started tucking things away in the cabin.

YOUNG Unlike in the time line, we're just picking stuff out and doing it - -

CRIPPEN Entry stowage. I went around and cleaned up everything like my vacuum cleaner . . . .

ABBEY Did you lock it - when we talked the other day, you said you didn't lock everything up. You just stuck it in there and just closed it up.

CRIPPEN I went around to all the lockers and fastened them.

ABBEY Have any trouble with any of them?

CRIPPEN There were a couple of them that were a little bit misaligned. You had to work on them a little bit. And like John says, when the g-loads were pulling, it probably didn't make that much difference. The deceleration on this thing to me was just most noticeable somewhere around Mach 3 to Mach 1. Maybe it was because of the visual thing, because I could look out there and I could see Edwards. It was kind of like you and I talked earlier, Joe. I felt like I was really slowing down.

6.8 WHOLE GAS SAMPLES

YOUNG — Okay, the one thing I'd like to say about this air bottle is that when you plug it into that vent valve, the only way you can take it apart is to use a pair of pliers because you unscrew that wingnut and it doesn't move. You've got to break that seal.

ENGLE — Over in the one-g trainer, we're just not pulling a vacuum.

CRIPPEN — We did a wide-band cal here which again was nothing. This is basically a duplicate of what we saw on day 2 and ops 8 except the HSI worked this time.

YOUNG — Yes, it worked that time.

6.9 HSI FAILURE

YOUNG — . . . It didn't work in ops 8 the first time; it worked in ops 8 the second time. And it didn't work in entry the third time. It worked part of the time and then it quit.

CRIPPEN — Oh, way back in the APU stuff, when you pop the ports, you could feel it in the vehicle.

YOUNG — I still don't understand why the radar altimeter set bites. Auto maneuver tail Sun att, that was nothing.

ENGLE — Those are good-looking films from the landing, too.

CRIPPEN — They're a little bit washed out. I'm not sure that the color - the light setting was correct because we were coming into the Sun and before we turned to the base, it looked to me like they were washed out. Of course, the desert looks like that on a hot day.

6.10 FLIGHT DATA FILE

YOUNG Flight Data File. Just let me say a word about that infernal mapcase. First off, my box wouldn't close. They had managed to make the Flight Data File bigger than the box. That thing sticks out and you can't close it in zero-gravity. The same thing is true of one-g in the simulator, as I recall. Well, let me tell you how to get out of that. First off, you don't need a mapcase. Just shove that stuff in there and leave the mapcase on the ground. And then carry your maps with something on to hold them together and look at them when you want to. But it's locked in the locker when you're not using it. We didn't put it in the mapcase. We had it up all the time. Why should you spend 10 minutes stowing the Flight Data File when it's three boxes that should slip in there? Crip put up the radiation meters and I stowed them. And the only way I could get them to stay in that box with all that junk in there was to take the stowage plug in there out and put all that stuff in there and you stuff the foam plug back. Keep it in there. Joe Henry's got the idea for the rotating map. He's got the right idea. He's going to carry an overlay and lay the map out on the CRT. There were a lot of cases in this postperiod stowage where we didn't have enough room to put stuff, so we just crammed it in there. And I think for a 5-day mission -I think you ought to have maybe one or two lockers for every 2 days. Like we could have used another locker for stowage and waste stowage was real easy for a 2-1/2-day mission. So you ought to make them give you four or five lockers for a 5-day mission. Like there's no way in the world that you're going to get 5 days' worth of chow back into a 5-day thing. Even after you eat all the stuff and you fold it up, it's at least three times as big as it was - the package you took it out of. I'll tell you the real answer is a trash masher. But they won't give you one.

ENGLE A what?

YOUNG A trash masher. Remember we talked about a trash masher on the vehicle? And put the junk in there and mash it.

CRIPPEN Like we did on - we did that on Skylab.

ENGLE Sounds like you need a couple of spare lockers.

CRIPPEN I think that's the right answer. . . .

YOUNG I think you ought to have three or four. Well, we had one.

CRIPPEN And could have used two.

YOUNG The question you have to ask yourself is do you want to waste your life stowing gear and unstowing it. You are going to do it and you are going to spend a lot of time when the ground wants to talk to you that you ought to be listening to them and you will be down there stowing trash.

CRIPPEN But you know the trashbags that we got work very well for that kind of stuff. I mean you just shove it down there.

YOUNG They were going to have a big wet trash storage area in the vehicle but they never got around to it.

CRIPPEN Speaking of trashbags, while I am thinking of it. One of the things that you end up with out of the teleprinter is lots of excess trash. There are no snaps set up in that area, and there are trashbags onboard. I would recommmend that you get snap configurations set up over there where the teleprinter is so you can just use it to place spare paper. I ended up having to collect it all and then go put it in the bag. It would have been nice to have one handy.

6.11 FDF STOWAGE

CRIPPEN — Most of the stuff on the Crew Systems Deact was again just getting the vehicle shipshape. The only thing that I wanted to do was to make sure that I had the stuff stowed on the flight deck that I needed on the flight deck and the rest of it is extraneous. I wasn't going to go to all the problems of making sure that I had the books in the right locker and what have you.

YOUNG — Why did they give us all this? I stowed the EVA - the one on the lower deck - just put that in the box and never looked at any of that stuff.

6.12 SEAT CONFIGURATION

CRIPPEN — The seat really is almost configured itself. The only thing you need to do there is to turn on the O_2 valve.

YOUNG — And turn on your fan when you get up there and it's all ready.

CRIPPEN — The fan isn't nearly as noisy.

YOUNG — Pressure control system entry configuration. Well, my problem was that I never checked all those other valves we had reset when the leak happened.

CRIPPEN — Yes, there was one thing that I wanted to note here. If you go under the Crew System Deact which is at 4:23, you start through here and close the WCS door.

YOUNG — Hey, I'll tell you another bad thing about closing the door and doing Crew Systems Deact at that point in time. You are 4 hours away from the burn, you haven't taken your clothes off yet. When you take those clothes off, you might want to make a last-minute head call.

CRIPPEN In reality, you would prefer to have that WCS closed out after you suit.

YOUNG Or you might want to use UCD's from then on. That's what we did, we had to use the UCD's.

6.13 SNACK

CRIPPEN The next thing that I have - we go down and build a snack. At this time I thought I was getting a little behind and I didn't have time to do all that. There were cookies and cashews and cheese and a slab of ham and some bread. What I did was pull out the things for the ham so that you could nibble on just the meat if you wanted to and put the other snacks up so that we could stick them in our flight suit - and have them available. I think I ended up consuming the cashews and I drank one tea while we were waiting for the Orbiter and I drank another one after we got down on the ground.

YOUNG I ate my cashews while we were sitting there waiting to get out of the door of the vehicle.

CRIPPEN Hey, listen, that's one thing I did want to mention, John, about day 2. I think John and I may also have ended up getting ourselves a little bit dehydrated on day 2. And, you know, I normally drink a lot of fluids. In the atmosphere up there, I'm not sure what the humidity was, it is relatively dry. And all of a sudden I began to feel tuckered. I realized that I was really thirsty. I finally went down and mixed up a couple of drinks, but I had already gotten myself more thirsty than I prefer to get. It is just a point you might think about.

YOUNG Day 2, we were really adapted to the whole business and we weren't paying much attention but we think we should have.

YOUNG (CONT'D) Well, we moved the meal around where we didn't have anything to eat or drink for quite a while.

CRIPPEN Yes, there were four burners. We ended up going a long time between meals and that contributed a little bit, but it wasn't that bad. It was just enough that I knew it.

YOUNG I backed both flows to about 980. It says 950 plus or minus 25. They were both running real high so I said, "Maybe I'll put them to 980 because when we first got in there, they were 1040."

6.14 SUIT DONNING

CRIPPEN The next thing was suit donning. We were just about on the time line right here, maybe a little bit behind. John and I like to get dressed sequentially so we can keep somebody on the flight deck.

YOUNG But right here you are over MILA, Bermuda, and Dakar and you know that place in the flight plan. There is no way in the world that the crew isn't going to be required to copy something down. It is just unrealistic to ask a guy to - What do you do? I think you probably ought to make your flight plan up so that it is clear that one guy is going to be suiting up.

CRIPPEN Well, Pud and the guys did a good job. It still works out okay.

YOUNG I tell you what, Crip. We ought to look at those messages and we ought to discuss which ones we did need so that they won't do it again because I think there are a bunch that are just of academic interest to read. We sure don't have time for academic interest in that flight plan. We need some uplink discipline on holding back messages of no value. We had many of those in that time frame.

CRIPPEN One of the things with a teleprinter that really kind of bugs me is that initialization messsage. There are a whole bunch of words there that you have to look at every time and try to find out if that is of something of value. But when I finished up my suit donning and I thought I was getting behind, I rushed up on the flight deck. I asked, "What time is it?" I looked at the clock and it's 3:10 right on time and it was time for the DPS config.

TRULY Let me ask you something. Something that has always bugged me in the simulators is not having a clock downstairs reading the same, as you could not see the CRT. Did you all set your watch to MET?

CRIPPEN I set my watch MET and that worked out reasonably well.

YOUNG I always thought that some kind of clock down there that told me what time it was - if you had to work down there for a long period of time, it would be good - like when you get in the middle of the suiting exercise, you are pressed for time, you would like to know what time it is. Well, the only way I see out of this is to get one of these new digital watches that you can start in MET or something like that. Some of them have the features where you can start a countdown on them. And you can put a countdown countup on them.

CRIPPEN We got the suits on and went through the middeck switch verification. Actually, John came whipping through the middeck and he did that while I was suiting.

TRULY Did you find any of the switches out of place?

YOUNG Yes, we did but the - it was the PCS that I screwed up. Actually, I don't think it made a difference because the cabin was so tight and didn't need air or anything.

6.15 PLBD CLOSING

CRIPPEN Configured the manifolds, closed off manifold 5. We did that with no big deal. I still think that it is a waste of time but we did it. Configure for PLB door closing. The door closing this day looked almost exactly like it did on day 2. I could not notice any significant difference. Then we got the rad heat sink ETR, which they had been wanting to do. Apparently, there was still some data they were after. I was a little bit worried due to the fact that didn't have the PCM recorder.

6.16 FLASH EVAPORATOR PROPULSION

YOUNG At this time when we maneuvered to these attitudes and we had these doors closed and the radiators going - if you stayed in PULSE, you'd quickly get off attitude because that old flash evaporator was throwing that vehicle around. So I finally got to the top Sun attitude and put the DAP in AUTO plus or minus 2, and that's what we ended up with - going to AUTO held it in there. And it would still hit the dead band, which was 3 degrees and it hung in there. It's fun maneuvering that vehicle around. And once again, when we got the attitude - as soon as you turn those star trackers on, they would track the stars and load them in the star table. And the torquing angles for the verification were all less than 0.03 degree.

CRIPPEN I never did see the fuel cells ever get below 30 V, never.

YOUNG The star tracker doors closed in about 7 seconds each.

CRIPPEN Yes, they're pretty fast.

YOUNG They don't make this 12 seconds. They make it 7 to 8 seconds.

6.17 SEAT INGRESS CONFIGURATION

YOUNG Pre-ingress configuration. Crip checked all that stuff.

CRIPPEN Several times.

YOUNG Since we'd already checked it, I knew there couldn't have been anything out of configuration. Then we went back down there and fixed that thing in the head. I went in there three times to fix those valves and finally got them right so the ground wouldn't holler at me.

CRIPPEN We also knew that we had the modification because of the leaking helium system on the left engine, which was the very straightforward change that they had set up on the teleprinter. I basically figured out what they wanted us to do anyhow. When we get to the MPS 3 positioning, we'll bring it back up because we're still not sure we did everything exactly right there, but we did it by the Flight Data File that they gave us.

6.18 WCS OPERATION

YOUNG You're sure right. I don't think the WCS door holds any structure and I tell you if we're going to have women fly on this thing, they can't be modest because I don't see how you can use that thing and stay healthy on a reasonably long mission without taking every stitch you got off and cleaning yourself.

CRIPPEN It would also be desirable to have some deodorizer or something to spray around the head every once in a while. It's rather odoriferous.

6.19 SEAT INGRESS

CRIPPEN — We went through that ingress configuration and we were very comfortable as far as the time line was concerned. I felt like we had plenty of time. We were taking it nice and easy and I was holding up for the 1-hour point before I turned on the recorder, at which time I did so. I did that shortly after an hour and we sat down in the seats. We actually started to strap into the seats when we came over the state-side and got a "seat ingress go" because we knew we were pretty much in good shape. I could have hopped out pretty easy from where I was and we started to strap in and, again, I knew it's easier strapping in there than it is in one-g.

ENGLE — Have any trouble mushing yourself down into a seat?

CRIPPEN — Even when you're in there, you're floating up off your seat a little bit, but once you get your little seatkit fasteners snugged down, you're in. I mean you're not going to float away.

YOUNG — And I'd like to emphasize that Crip's trick of leaving the boots in the boot spurs was the only way to do it because I sure spent a whole lot of time trying to get my boots in the boot spurs - zero-gravity, couldn't do it. And I think it's because you know how the boot spur is. To get your foot down in there, you have to back that thing back with your foot and I just forgot how to do it. I just wasn't making it.

CRIPPEN — I tell you after flying the 104 all that time, I never could put those spurs on.

YOUNG — That spring that keeps them in there is really a toughie.

CRIPPEN — In addition to that, I just didn't like the idea of having those big boots on my feet while I was floating around the

CRIPPEN (CONT'D) cabin. I figured I was going to bump something and actually, with the boots off, I was certainly surprised. I don't think we ended up bumping any switches.

YOUNG The other thing you were worried about with the boots off is that you might hang up your bladder on something and tear the bladder, but you know I don't think you're going to do that.

ENGLE How about bumping the hand controller getting in and out of the seat?

CRIPPEN Oh, you're going to do that a little bit.

YOUNG Every time - that's why you leave the FLIGHT CONTROLLER POWER OFF and that's why they ought to fix it so it doesn't fire jets when you move the flight control power switch.

TRULY So on the way from an hour or so before seat ingress for the entry, you were really comfortable on the time line?

CRIPPEN Oh, yes, once I got to the point where I had my suit on and we were up doing the DPS config, Dick, from then on it felt very comfortable.

YOUNG It ought to be relaxed because it may not be in the real world, after you've been up there for some time, equipment's going to break and you're going to have to make some substitution, etc. It's in this area here where the ground, I think, has got to exercise reasonable caution about how much of that stuff will come up on the teleprinter, and I don't think they did that this time, but it didn't hurt us because we didn't have anything to do.

6.20 RCS ISOLATION VALVE MALFUNCTION

YOUNG When I got ready to configure back to RCS, that was when the right RCS tank isolation 1/2 talkback stayed barberpole. I knew that Larry had data coming down that could tell him whether it really looked like it was open or not. I talked to MCC about it before I put it back in the situation where we were feeding. It turned out that the valve was in good shape and we went ahead and went back to GPC to stop the drive on it.

TRULY Yes, that's right. I tell you what that was almost like - a sim, those guys really did well. You reported the thing, Larry looked at the valve and EGIL was looking at the MCA currents, and you know it was one of those deals if everybody hadn't been right on top of it there, they could have gone on for a day chasing back through.

YOUNG They were getting signatures of these great pieces of gear we turn on.

TRULY I tell you those guys were right on top of it. Every time they'd see an ac current or something they didn't understand, they'd bug Flight and go back and they would generally find it and every now and then they'd - you may remember - when they asked you.

YOUNG Yes, that's good.

CRIPPEN They could identify when the food warmer was on and they called that one right on.

6.21 OMS GIMBAL CALL

CRIPPEN So that valve thing - I thought they did an outstanding job of pulling that one together and coming back at me, since I was

CRIPPEN (CONT'D) ready to come around the back way through the RCS crossovers, but it wasn't necessary. They gave us a couple of nav updates and a preliminary "go" and John and I were both very careful about making sure we had item 40 in, although the TIG time was exactly the same. So it didn't make any difference. Since we'd had that gimbal problem, they said to burn secondary on the right; I think there must have been a little misunderstanding originally, but we ended up burning secondary on both engines. We had it selected and that was just as easy to work it that way.

YOUNG That's what I thought they meant to do.

TRULY What Puddy wanted to do was end up doing the gimbal check on the gimbal you were going to use, and what he intended to do was use the primary on the left and the secondary on the right.

YOUNG So then you would go on and you do the secondary on the left engine and the primary on the right engine.

TRULY When you did what you did, he was perfectly happy.

6.22 APU PRESTART

CRIPPEN Well, we did APU prestart coming up on Madrid and threw the tank valves, and all that came out exactly as we expected. 1 and 3 had gray talkbacks. Number 2 didn't due to the cold GG temp. That reinforced the fact that we were going to have to use START OVERRIDE to get the thing going.

YOUNG When you got the "go," it was 86 percent.

CRIPPEN Oh, yes, we had a lot of propellant.

YOUNG How much did we have when we hit the ground?

TRULY 69 percent in number 1.

CRIPPEN 60 some-odd percent . . . . I think it was. I was sitting there trying to monitor the usage rate, It was so low I couldn't see it.

6.23 APU START

TRULY Crip, was there anything at all different about APU start on-orbit?

CRIPPEN It's just like an APU start any place.

YOUNG Sounded like it, too. We could hear or feel it or something.

CRIPPEN They gave us a "go" to start the maneuver out of the top Sun attitude just when we were going over LOS at Madrid. We almost - in fact, we were in attitude it seems like before we went LOS. It was about 25 minutes early.

YOUNG It was almost TIG minus 20, I think when they said maneuver to attitude right at Ascension.

6.24 DEORBIT BURN

CRIPPEN I didn't have anything down at TIG minus 6:30. I went ahead to START OVERRIDE and we had the recorder in continuous record so that didn't make any difference. At 3 minutes, the APU started right up and I went ahead at that point and started 3. If it had not started, I was not going to start anything else and hold the other two until TIG minus 5. Burn came off just as planned.

YOUNG Nominal, man. The residuals were one-tenth and there's just no doubt in your mind that those OMS engines are going to work good. They came and updated our prebank table and we're sitting

YOUNG (CONT'D) there watching the stuff count down as you go through the 80-mile no-go and then Crip says to me it was 85. We were already past that. So then you count down to where you can make it with a prebank.

6.25 APU PROPULSION

CRIPPEN You noticed that the APU's were torquing you. In fact, it did prior to the burn, too. We were a little bit out of attitude preburn.

YOUNG It started to pitch around at 0.2 degree-per-second rate toward the attitude. I think you're going to have to do nothing. All you have to do is just sit there and wait and put it in PULSE and the APU's will drive you right around to attitude. We were at 0.5 degree per second when we got to attitude courtesy of the APU.

CRIPPEN We ought to try it, if we have enough data to model the thrust a little bit better out of the APU's from the flight.

TRULY Did you get any roll?

YOUNG . . . I didn't notice, but there must have been some.

CRIPPEN I think it was mostly pure pitch.

6.26 FLASH EVAPORATOR PROPULSION

YOUNG Yes, you were getting yaw and roll out of that flash evap in high load and you might have gotten some roll out of there because we weren't in the right roll attitude . . . by a long shot.

CRIPPEN Okay, so we went to 303 and then John is maneuvering to attitude, and this is the question I had for the system folks that

CRIPPEN (CONT'D) listen to this. We'd had something come up from Marshall just prior to the flight where they had concern about the MPS He isolation valve for each of the engines. I don't remember everything that was associated with that. We wrote in the procedures to take the MPS He ISOLATION VALVE Bravo center and right to OPEN to do the MPS repositioning. The only point was when we did this, the left one would nominally be open. Since we had the leak on the system, the left one was not open in this particular case and I did not open it.

CRIPPEN Maybe because they had the leak, they didn't want to go ahead and apply it to that left engine. I'll go to our MPS folks to make sure that they understood what it was that I did. I just thought that maybe they all wanted to go ahead and hit it with a little helium there but we didn't do it because I didn't have a procedure change to tell me to do it. We didn't do any kind of forward dump. We checked our entry switches. When I got to the seat pin I mentioned to you earlier, then I went ahead and had to undo my left shoulder strap to get the pin.

YOUNG And I didn't and I have much shorter arms than Crip does and I don't understand that at all.

CRIPPEN I think we're also different in torso height.

TRULY Your shoulders are closer to your feet than Crip's.

6.27 g-SUITS

CRIPPEN We did not inflate our g-suits . . . .

YOUNG And went through the Entry Switch Checklist twice and I forgot to check that mine would even inflate, which I really felt bad about because I thought about it once, but something came up and I just forgot.

6.28 FLIGHT DATA FILE

CRIPPEN — I ended up starting APU 1 as soon as I got AOS at Guam, which is about EI minus 7. I went ahead and I closed the vent doors, told Joe about it, and got ready to start the APU, so . . . we were pretty close to EI minus 5 going into 304; it was about 4:30 or something like that . . .I was just waiting for John to tweak attitude.

YOUNG — And I was torquing, Crip.

CRIPPEN — Yes, and, in fact, at this particular point in time, I swear I didn't seem to feel as much jolt out of the vehicle.

YOUNG — No, it did not jolt.

6.29 ENTRY HEATING

ENGLE — When was the first time you felt some kind of aerodynamic pressure?

CRIPPEN — Well, I didn't get anything that was obvious in effect. One thing I did also notice was that I could see flashes out my right window, which had to be jet firing, but the only way to see them out that window was that there had to be enough molecules to get some reflection off them.

ENGLE — Yes, when was that?

CRIPPEN — That was right after 304. There were enough molecules at that point that I was getting reflection.

YOUNG — I remarked on the flashes, but there wasn't very much firing. No, I mean, the jet firing was minimal, but you could tell it was there.

CRIPPEN I guess the next exciting thing that happened was pretty soon we started picking up a little glow. I noticed it out the left and right sides before I noticed it off the nose.

YOUNG Absolutely, a little pink glow, light pink. And it was like you were looking at a bunch of happy ions. You didn't see which way they were going, but it was just a little glow, just a glow. This started at about 330K feet, as I recall.

CRIPPEN Wasn't like streaks of firing or anything like that.

YOUNG No, not that. It was just a glow like the data Tom Henderson got me after we talked about putting it in the SMS, it was going to happen at EI plus 4 and this was before that. It was like 3 minutes 30 seconds that we started seeing that thing. So I turned the camera on to get some pictures of it. The glow became more pink on the side, and around the nose it started looking like it was light orange.

TRULY You said it looked like it was standing off.

YOUNG You couldn't tell.

CRIPPEN It was like it was the air outside that turned pink; that's what it looked like.

YOUNG That's all it was. It was sort of orange in the front and pink on the side.

CRIPPEN And then shortly thereafter, I started noticing that we were coming up on the terminator and the Sun was coming out.

YOUNG This was like at Mach 22 or 23 or something like that.

CRIPPEN But the terminator light itself started wiping it out.

YOUNG That's how tenuous it was.

CRIPPEN We were getting all this heating coming off this machine, and we didn't even see it because sunlight was just wiping it right out.

ENGLE Is that right?

ABBEY How long was it, how long did it take you to get into the sunlight?

YOUNG Somebody ought to look at it.

ABBEY As you soon as you get into the Sun, it disappeared?

YOUNG Yes, and, in fact, Crip couldn't see it on his side; the Sun was coming up on his side. Before we started our roll reversal, the Sun was coming up on his side, and he said, "I don't see it any more." I could still see it out of my side.

CRIPPEN Mine was wiped out before we rolled in. I don't know, it was 5 minutes or so.

YOUNG I had a band of horizon over there where the glow was wiped out but above it was pink, and it was beautiful. You look at those 16-mm films over there and there is no pink. Really pretty, and the camera could have gotten it.

ABBEY We ought to try to get the right kind of film.

YOUNG They need a camera pointing out that nose to take those pictures, maybe your camera out the nose would have taken some pictures of it. I think you need a camera over on the side away from the Sun to take some pictures of it.

CRIPPEN What John did was turn his on 2 frames per second for a while and the shooting . . . all the way to Mach 4.

YOUNG I shot at 2 fps to 80K and then went to 12.

CRIPPEN All he did was put this little "speed jobby" up, which is a little bit easier to get to on the CDR's side.

ENGLE That would be spectacular if you ever made a night entry.

CRIPPEN I don't think that kind of . . . film that we have will record that personally.

YOUNG But I tell you, there are commercial cameras that you can get in there that have light meters on them that would do it, that would take good pictures of that kind of thing. It would be more than academic engineering to see what those colors really are because that tells you exactly what your outside temperature is.

CRIPPEN We came up through all the $\bar{q}$'s.

YOUNG And I just never thought it would wash out as soon as - you know we were still doing Mach 24 and we didn't see anything out there but the horizon.

YOUNG It sure is a tenuous layer. We probably were looking through a thermal shock wave that supposed to be 4 inches thick, like it says in the hypersonic book. You don't see it; it's just not there.

CRIPPEN Surfaces were solid. Somebody later told me that they could see a little 5-hertz wiggle in the thing.

YOUNG The initial body flap trim was about 80 percent. Let me talk about the first roll reversal. The first roll reversal, the Beta needle went all the way over to the side, and I've never seen it do that before. And that was 2-1/2 degrees or something.

ENGLE What scale were you on, low scale?

YOUNG No, I was on medium, and then we started the first roll. The vehicle was rolling at 6 degrees per second, and we got turned over there and it stopped and overshot once and came back, and then it settled down. I've never seen anything like that in simulations. I'm not sure that it's either good or necessary to roll that fast into the first roll.

TRULY This was the first bank coming in?

YOUNG Yes, first roll, the one that happens at 255K feet. Just like the guidance was absolutely nominal in terms of the comparison. And the roll angle that it picks was a little steeper than the nominal roll ref, comparing it, and I don't remember what the differences were. Later on, in the early part of entry, the roll ref computed angles were consistently 2 to 3 degrees higher than what's on that cue card. And then they got to be right on, and they got to be about 1 degree less as we came on down. My guess is the L/D is better up higher and maybe a tad low, not hardly worth worrying about or maybe that is just the granularity of reading the roll angles.

TRULY On that strip chart - they had a strip chart that started at track 11, when you came out of blackout and at that time L/D was nominal.

ENGLE They seemed to think that the whole system was overgained. You could very easily tone the gains down.

YOUNG I don't see anything the matter with it.

ENGLE Well, one thing, that probably uses more RCS propellant.

YOUNG Didn't use any.

ABBEY Best thing you can do is quit messing with it. No sense in messing with success.

YOUNG I don't see any overgain to me and every roll reversal was right on time, no overshoot, and it went right where it was going to and didn't seem to fire very much RCS.

CRIPPEN From an onboard standpoint, there was no apparent overgain.

YOUNG Wasn't as much as there normally is in the simulator. That's a very subjective statement. It just didn't feel like it was as much. And when we were down to those low Mach numbers, it felt solid as a rock. You know we were pulling g's and it's the first time we were ever able to look out the window. When you're rolling in a certain direction, the vehicle got up to about 1-1/2 g's, that's about all. And you felt like you were flying along a turning path. In the simulator, you never feel that way. You never feel like you're really flying. You never really felt like you are banking back and forth. In Columbia, you did, you knew you were going back and forth on the ground-track. You could look out the window and see the clouds going by and say, "By golly, we really are turning."

CRIPPEN John, correct me if I'm wrong, but the subsequent roll reversal we got out of the AUTO. Looked to me like we were right on the money.

YOUNG Absolutely nominal all the way.

CRIPPEN Right on, the first one. Looked like it overshot on the rate just a tad.

ABBEY That was the only trouble with it.

YOUNG I don't know if we really had trouble with it. I just never saw that inertia needle go all the way up to the wall like that . . . . No air up there when you're doing that turn and that's an inertial measurement, so why shouldn't it go out there? Doesn't amount to anything. $\bar{q}$ was 11 or something, 10 or 11 first roll.

ABBEY Then on down it was just average.

YOUNG Yes, and I think the maximum EAS we got up to was between 230 and 240 between Mach 2.0 and Mach 1.0.

CRIPPEN When I saw the drag altitude come in, we had a 2500-foot error.

6.31 END OF BLACKOUT

CRIPPEN We - somewhere around Mach 12, I believe Rick was giving the call to the CHASE, telling him the Mach where we were, and we heard him so we called back. Joe Allen said that was the first AOS call where we called him.

ABBEY You think you could have heard earlier than that?

YOUNG We just happened to hear him talking on the radio.

TRULY He made a couple of calls pretty close to each other, so that was probably as early as you could hear him.

ABBEY When did we have LOS with you? What Mach number?

YOUNG Out of Guam, as we went over the hill at Guam, we started to get static in there. I don't know whether that was bad comm or what in the earphones. I think it was the beginning of blackout.

ABBEY Was LOS just about on that call?

CRIPPEN EI minus 2 or 5. I understand we made most of the entry on UHF as far as comm was concerned.

The TACAN data - I'm trying to remember exactly where we locked on. I thought we locked on reasonably early. It was somewhere around Mach 7.

6.32 ATMOSPHERIC FLIGHT

CRIPPEN I talked to Mike Collins this morning and he said it looked like about a degree of bearing bias. It was probably coming off the station. When we came in overhead, it looked like it cleared itself up. It was somewhere around just a little bit more than Mach 2, I started feeling a little buffet.

YOUNG Now actually the buffet was worse in my opinion from about Mach 1 to about 0.85. Really, just slowly increased, and it was really very soft down there. We were just flying straight and level and, all of a sudden, this buffet starts picking up and picks up and about Mach 1, it wasn't at its worst. I thought the worst buffet was at 0.95, but I was on nav. I wasn't on air data, so maybe there was something wrong there. Then it came on down to 0.85 and started decreasing a lot, and then about 0.6, it was all gone. There was just no buffet involved in the rest of the flight. Yes, you know Crip and I thought maybe it was because we had the speed brake out or something. You know that I took over at 4.8, or whatever it

YOUNG (CONT'D) was, and then it did that roll reversal, interrupted the roll reversal, interrupted again at 2.

CRIPPEN I didn't know he gave it back to it. All of a sudden, I came through Mach 1 and we were about to . . . the hatch.

YOUNG Yes, I mean it was flying so smooth. We did have sunlight in the window all the way down, you know when you're pulling one-g, it starts feeling like it's a lot more than one-g to me. Crip says he didn't notice it. It was no trouble at all to keep your hand up to keep that Sun out of your face. If you didn't, you couldn't read the tape meters or your instruments but the cathode ray tube over there didn't have Sun on it so that you could read that the whole time.

ENGLE Was it reflection of the suit off the instrument, or was your visor giving you some problem, too?

CRIPPEN There was a little bit of reflection in the visor and the Sun was sliding in.

ABBEY You saw the coastline?

CRIPPEN Yes, at Mach 7, you came across the coastline and I could look down to just south of Vandenberg. There the clouds below that down to L.A. Through the San Joaquin Valley, it was clear as a bell.

YOUNG At Mach 4.8, we do the roll reversal. I looked out and sure enough, there was Bakersfield. Past Mach 3, there is good old Lake Isabella. You know darn well you couldn't have been anywhere but right on.

ABBEY You took over about Mach 5?

YOUNG About 4.8, 4.8 is what it should have been. We flew out there about 3.8, right on time. I went on air data shortly after I put the probe out. I put the probes out at about Mach 3.8 as usual.

CRIPPEN And I was really surprised because I thought these probes on that big blunt-nose supersonic - would jump pretty good. I did the MPS hydrogen purge, and we only opened up the pneumatic helium isolation. We didn't open up the left side. It came to 2.9. We went on to check the HYDRAULIC LANDING GEAR ISOLATION VALVES. They were recessed and I couldn't lean forward far enough. I just couldn't get up far enough to see them. I forgot to give John his call for his FLASH EVAPORATOR OFF.

YOUNG Somebody called us because - -

CRIPPEN Joe called him about 65K and told us to get it off.

ENGLE How did it look coming in over the field? Did it look like you were high?

YOUNG I looked out there and I said we must be about right. You could see everything, and you knew that we were at that altitude where we were supposed to be and there was no doubt in your mind you were doing the right thing.

CRIPPEN I really had the impression of really slowing down through that point, I really felt like, man, we're slowing fast.

YOUNG Now we'd like to - When the rudders came on, I'm going to really hawk it for aileron rudder force fight. I looked over there and I looked back and it was Mach 3 and there was this two-tenths aileron trim. No aileron rudder force fighting - probably has never been one.

TRULY It looked like that tail started getting effective about Mach 10.

YOUNG Yes, I think it did. I think it is effective way out there.

CRIPPEN We heard CHASE call "tally-ho."

ABBEY Good comm with Jon.

YOUNG I always - have a lot of trouble flying HAC in the simulator, this is really easy to fly, this was just like the STA. Put it in bank and you can fly it right around the HAC. You fly it like a regular airplane, but the simulator doesn't do it as well.

CRIPPEN Just prior to about the last 15 or 20 degrees in the turn coming on the HAC, I went ahead and switched over to approach and MLS. We were just about half-a-needle's width above the glide slope on MLS and by the time we got down to final, we were on it, the PAPI lights were in the middle.

YOUNG It was so calm there, speed control was real easy, and I kind of got behind it.

CRIPPEN It jumped around a little bit.

YOUNG But not as much as it does in the STA, for example.

ENGLE You see the jump in the error needles when guidance switched to MLS?

YOUNG Yes, I did . . . it was a big jump on for a long time. The glide slope goes off somewhere. Why does it do that?

ENGLE Well, it's just a scale difference.

YOUNG Well, if you were in the weather coming through there and all of a sudden your needles went away, you wouldn't want to move the Orbiter until they did come back. We were a little slow at 3000 feet. We were about 282 - somewhere along in there, shooting for 285. I know that L/D is better than we simulated. I know it is.

CRIPPEN . . . I deployed the gear about 275 and, boy, they really snapped down - at least it seemed to me, they were down in a lot less time than they had in the simulator. Airspeeds didn't bleed as smooth to me as I see in the simulator. There were a couple of jumps.

7.0 TOUCHDOWN AND EGRESS

ENGLE What was your airspeed at preflare?

YOUNG That was what I was saying it was. Coming through 3, it was about 282, we tucked the boards in at that point, and I don't know what it was when we started back on the stick. The max was somewhere up around 305 or something like that. Like by putting the speed brakes in and taking what you got, now they ought to be able to tell us when it really is or something and find out and get the model right and it sure is super.

7.1 LANDING

ENGLE Before I mention that, I have to ask you, did you think that it was an awful long ways before the nose came down?

YOUNG Yes, as soon as we got to where they said, they kept saying 5, 4, 3, 2, and then the thing kept going faster and faster. And then when we got down there in rollout, oh, man.

CRIPPEN . . . he held the nose up to 165, and started it over, and it did seem like it accelerated.

YOUNG Oh, it gets fast, when you get down to here, it doesn't make any difference, you know those elevons are driving themselves up and then just bump.

CRIPPEN And I reached over and got the WONG switches.

YOUNG I'm sure we landed long because we were so fast when we came around the corner.

CRIPPEN . . . about 2000 feet past. John hardly hit the brakes at all.

YOUNG It felt good, I don't think I hit them very hard and we stopped out there by Roland.

CRIPPEN We got stopped and I was trying to get John to calm down.

YOUNG Man, I tell you, I'm not calmed down yet . . . .

CRIPPEN Got the APU's shut down.

YOUNG I sure liked the idea of doing that - shut the APU's down.

CRIPPEN We got the APU shut down, we got the ET door open and started doing the RCS safing . . . .

YOUNG I sure like the idea of doing that right away and not doing that loads test.

CRIPPEN . . . all that worked out, reasonably well . . . . We did the DPS transition and, sure enough the BFS did not go to OPS 0. It would give me an illegal entry.

TRULY Well, that's when I was going to ask you about the WONG switches.

CRIPPEN You don't even need to do this OPS 0. It's not even a required . . . but it did not follow; why it did not follow, I don't know. But you would rather not be able to go OPS 0 than to have to go to OPS 0 when you don't want to. We did that, and purged and it worked okay, and all the rest of the stuff went clean, and we ended up having to wait a long time and that was what I had anticipated we would have to do.

YOUNG Well, and I got messed up on this postorbit checklist thing here. I forgot the APU heaters back there in the back of the

bus, but I was running around back there. Couldn't get the convoy on the 282.8, they said they could hear us but we couldn't hear them. Why don't they give the convoy 298.6 (or whatever it is). If I've hurt anybody's feelings about anything I said during the time that I was getting ready to egress, I don't remember it. They said there was tile damaged on the nose wheel door. I looked at the bottom of that thing and I didn't see anything.

ABBEY I didn't see anything.

YOUNG I didn't look at the nose wheel door per se. I looked at all the bottom stuff, it's really in good shape. Deke said it was about an 8-inch-long gouge.

7.3 EJECTION SEATS

YOUNG Comm with the convoy didn't work on 282.8. On this thing, I could not put my pin in while I was sitting in the seat. So I got out of my seat and pinned it.

CRIPPEN Did you activate the comm on middeck down there?

YOUNG Yes, I crawled down there. I had my lightweight headset.

CRIPPEN Oh, you just plugged it in down there.

YOUNG Yes, plugged it into the payload specialist station down below. When I accidentally went to move ammonia controls off, I accidentally went back on to secondary A and they called it.

CRIPPEN I just remember one other thing I want to back up on. Some place during the flight, they had me on the ET door come out of the GPC manual and go back to GPC which safed the other

CRIPPEN (CONT'D) switches, which protects against some kind of a fail-on condition - which is a good thing to do.

YOUNG There's a big delay between the time that we got all our switches thrown and hatch opening. Is it going to take them that long to do a rescue or something? Those guys ought to practice getting up there and getting those things done a little faster.

CRIPPEN I did want to mention on hatch opening . . . might have said it already, we were overpressure there in the cabin by several tenths of a psi when they cracked the hatch, it really came down, your ears really popped.

8.0 SYSTEMS

8.1 THERMAL CONTROL

ABBEY — Too cold the first night . . . .

YOUNG — Somebody needs to understand that valve . . . the thermal control valve.

ABBEY — So I guess with the exception of having a "stuck on" temperature indicator, there were no other comments.

CRIPPEN — That would help people to understand what the actual temperature is around the cabin.

ABBEY — . . . . But the tile; we talked about the OMS pods.

CRIPPEN — The aft portion of the windows had a chip out that we could see.

ABBEY — And tile off the OMS pods, we knew about. The radiators, we talked about the radiators.

CRIPPEN — Flash evap worked well, ammonia boiler worked great.

YOUNG — I think we got the model problems, the way it worked in the simulator.

ENGLE — Crip, I forgot. Did you notice those tiles on the windows? Was that during ascent that that happened?

CRIPPEN — It probably happened during ascent.

ABBEY — The thing they did find and that those guys commented on was that Friday through Sunday the windows started to get that salt spray on them.

CRIPPEN I thought Sunday they were reasonably clear. I mean, you have to have a little bit of that, or a little more junk than they had on Friday. Still, when we lifted off, the windows were in excellent shape, I thought.

8.2 PURGE, VENT, AND DRAIN

CRIPPEN John commented about the vent doors. They ought to go through and take a look at the data. If we could fly entry with the doors open, we should do so. As far as cycling the doors - works okay.

8.3 LANDING AND DECELERATION

YOUNG I think what I was impressed by was the deceleration that occurred right after we got the nose wheel on the ground, that vehicle really slowed down there. And I hadn't done anything with the brake; it's just . . . .

CRIPPEN It has lots of drag.

YOUNG Yes, really. I had never thought about that before.

CRIPPEN I think we were just talking about . . . the fact that the nose was leaning forward. And they make you think that you were decelerating.

YOUNG Is that what it is, you think?

ENGLE We talked about that a bit.

YOUNG The thing about our landing is that there was a braking in the FTO right there.

ABBEY That's right. You guys never really kind of coasted.

YOUNG I'll tell you what. I thought that nose wasn't ever going to stop dropping. We were looking right at the sand.

I'll tell you what. I'll be glad when they go through with the extended nose gears. I'll be glad about that.

ENGLE Are they going to do that . . .?

YOUNG Well, if you're going to fly heavy payloads and not break the main gear, you're going to have to do something like that, when the elevons are trying to keep everything up.

8.4 ORBITER/ET/SRB SEPARATION

CRIPPEN I guess the SRB's were quite a bit more dramatic as far as the amount of flame that was warped around the windscreen.

YOUNG There are no vibrations or noise.

TRULY On ET sep, did you hear anything?

CRIPPEN Only way I knew ET sep occurred was when my main engine lights went out.

YOUNG I really feel like that. Based on the test that we ran at the Cape, we wouldn't feel anything, because there you are, down in zero gravity and your feet aren't on the floor, so you don't have feedback.

CRIPPEN It was about like I expected, really; both John and I were sitting in there when they tested it.

YOUNG It felt like somebody was hitting you on the bottom of your foot.

CRIPPEN — ET doors work super . . . . They closed up just like they were supposed to. We talked a little about wanting to change the procedures to go back to GPC so the manual portion is deactivated . . . make sure that we got those procedural changes . . . . We never did activate the ones that were associated with the airlock and we really didn't even bother the one that was associated with the side hatch.

YOUNG — The first check I made was when I went down there in the thing before I went into middeck to look and see if that side hatch was in fact latched and locked. I think they still have a safety system on there with the measuring device that tells that it is locked. That tells us the latches are latched. What do you call that? Some kind of microswitches in there. Because they have to deactivate it. Before they pull the . . . and I would be curious about whether they do it or not. I'm going to ask them about that and the plan to take it off on one of the subsequent missions. And I'm categorically and unequivocally against that; because if anything happens to that door, it's really bad and you always make sure that door is locked before you do anything.

ENGLE — Why would you want to take it off?

YOUNG — Because once you've done it once or twice, then the doors are always going to be locked. They always do the procedure right every time. They don't ever have a new man come along that has never done the procedure before, that messes up like we did in Apollo on two different occasions where we got the altitude chambers depressurized and the hatch came open. So . . . and I mean they had to go some pressure to get it, more than any 2 psi, as I recall.

CRIPPEN I want to go back to the payload bay doors. I think they are pretty much covered but I just want to say one more time . . . the payload bay doors worked just about as nominal as anything could work.

8.6 HYDRAULICS

CRIPPEN APU's - we've been through that and only had that malf associated with the cooling on APU 2 and the . . . . I didn't know we had a secondary control on that.

YOUNG I didn't either. And I don't think that's in the simulator, is it? The secondary control?

CRIPPEN No, when the heater fails, apparently there is another control level. And it controls like around 100 degrees. At least that's what they were telling us and that's what it appeared to be.

YOUNG They said don't worry about it because it is going to be controlled by the secondary system at 100 degrees.

8.7 CREW ESCAPE

YOUNG Everything works okay.

CRIPPEN Yes, strapping in all of that works fine. And we talked a little bit about that earlier, about trying to get those seat pins down between the knees and the one on the side.

8.8 ATMOSPHERIC FLIGHT SURFACES

YOUNG You notice no oscillation. Didn't notice it in the simulators, no force fight.

CRIPPEN Everything works just like you want it.

YOUNG — No oscillation. You know, I knew there was going to be some wiggle there because we had never seen anything that didn't wiggle. There was no wiggle.

8.9 PROPULSION

CRIPPEN — We talked about the prop system. I guess there were a couple of points I made with respect to not isolating manifolds. I think we need to get the simulator to reflect the high pressures we're flying with today. I really would like us to go back and evaluate completely isolating the manifold when we are doing crossfeeds and interconnects. One time procedurally I messed up . . . and I think that it is an unnecessary risk as opposed to the risk of having the tanks momentarily interconnected.

YOUNG — I'll tell you. I hope we don't ever have to run where you are shutting off this RJD and that RJD because all it's ever done was get you with jet-failed-on indications.

TRULY — This business with isolating the manifolds is nothing new.

CRIPPEN — I just quit arguing with the folks. Figured I'd just try to do it very carefully - and even so, I still messed it up once. It was lucky I didn't get a jet firing.

How about the main engine. We talked a little bit about the manifold tank isolation valve, and the big RCS thrusters are really big. . . . run verniers as much as you can. I highly recommend that we add the secondary vernier system on this bird, they really ought to be working to have that.

YOUNG — Yes, another set of verniers would be ideal. You never have any occasion to maneuver or translate fast up there on-orbit unless you are rendezvousing or escaping from a loose tumbling payload.

YOUNG My question is, why does the first stage lob so much and why isn't it optimized for performance?

CRIPPEN I heard that we flew a nominal NZ profile. They think they have the wrong pitching moment on the bird. It tries to fly a specific g-profile. It maneuvers to get that g-profile. In this case, it was trying to pull the nose high to get the moment. I heard the SRB's were 1-percent hot.

YOUNG What is the NZ profile?

CRIPPEN It's the load relief profile that was put in there for NZ and NY. It's designed to always fly a certain g-profile. If you deviate from that g-profile, it maneuvers to get the g-profile, and if you have an absence of the thing giving it to you, it will do whatever is necessary to get it. It will create the load . . . .

YOUNG Okay.

CRIPPEN And if pitching moment were evaluated wrong on the things, it was trying to pull the nose higher in the air there to get the moment, apparently - at least that's one explanation of it.

ENGLE Is that what caused the pitch error needles to be off scale?

YOUNG Well, it's okay to loft, but I mean that pitch needle was saturated long after max q and that vehicle didn't ever come back down off there, and I know we're high at SRB sep. In fact, I heard we were 5 miles high at SRB sep, and if you're going to move something as big as that on first stage, 5 extra miles up in the air, you have just dumped considerable performance.

CRIPPEN Although we got the PRESS early.

YOUNG Yes, but . . . .

ENGLE It really converged in a hurry in second stage.

YOUNG I'm not sure you shouldn't close the loop a little earlier, somewhere or another to get performance. On the first entry bank initiation, I'd be curious as to how much control margin the Columbia had. How stable the Orbiter appears to be hypersonically. I'm wondering if maybe we shouldn't investigate using no yaw jets on some of the rest of the flight and entry, and maybe bring them back on-line during that place where we have low maneuver margins, like at Mach 5 on down. You could at least put a roll maneuver in there and no yaw to make sure that it worked up there in the low q region . . . .

CRIPPEN But it's also true, John, it isn't like a control system, at least like before . . . it worked like a champ.

YOUNG It sure did, Bob, and I'm saying it worked so well maybe we can get away with no yaw jets.

CRIPPEN I don't know. What would you want to do it for unless you lost them?

YOUNG Because you don't need to keep your RCS margin. You know I'm talking about downstream missions.

CRIPPEN You can reduce your RCS margin. . . . although 900 pounds - that isn't much.

YOUNG We were setting aside a budget of something like 2200 pounds, so already, if we want to we can bring that down lower. I wouldn't run off and do any of these things right now. I'd have some more flights, because something could be different later that we hadn't thought about, such as an offset c.g.

ABBEY I think that is true, I think you have to keep things biased in a conservative fashion . . . . Some of those PTI's and ASI's that have been planned have got to use more fuel.

8.11 CAUTION AND WARNING

ABBEY Caution and warning?

CRIPPEN We had a little late-flight situation with respect to limit changes on OMS pressures, and so forth, but all that worked fine, assuming they will probably clean it up a little bit for our second flight. I guess there was one there I still don't understand, the MPS manifold pressure C&W. For the MPS, when we did the inerting, I got the manifold pressure which is set at zero. Matter of fact, I'm not sure why we even have a low side C&W for that . . . . Somehow I was thinking that would be corrected so that we wouldn't get a hardware caution and warning, but we did. And it looks to me like you will. Other than that Friday incident with the DPS, that did work well; there were a couple of minor things, I guess, which we've talked about. One of them is the freeze-dried procedure associated with after you've done the dump, making sure all the strings assigned to the GPC 3 are the freeze-dried GPC. The most we had in the case of CRT assignment was apparently a little bit of confusion between ground and us as to what GPC was driving CRT 3. The other BFS after landing didn't take its transitions to OPS 0 clean. We'd seen that preflight, and to the best of my knowledge, I gave it both WONG signals so that - well, I never thought that was the problem.

8.12 ORBITER INSTRUMENTATION

CRIPPEN Orbiter instrumentation. We had the one signal conditioner circuit breaker pop. A transducer quantity on water supply tank, Bravo, that we had dropping in and out. Breaker for the power fuel cell, that worked like a champ. There was one

CRIPPEN (CONT'D) measurement on the main Charlie back aft that I think the amps were reading too high. They told us about that.

YOUNG What was the electrical load on ascent?

CRIPPEN 25 kilowatts.

YOUNG They told us it was going to be about 27. And on entry it was 19?

CRIPPEN That was about the max I ever saw.

YOUNG We'd been running 22 or 23 in the simulator.

CRIPPEN . . . . Well, it means we could probably reduce so much of that powerdown stuff. How much you want to go through that prior to your flight, I'm not sure . . . .

TRULY I know somebody that would go through it, but I don't want to . . . .

YOUNG We could simplify those procedures considerably by not having to turn on and off, and then having to turn everything back on again . . . .

8.13 ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM

CRIPPEN . . . ECLSS . . . . We did have a lot of trash in the cabin shortly after we got in zero-g, that was evident. It was collected by the fans. I think you need to nominally schedule a fan cleaning, and we talked about that on the filter.

YOUNG Be interesting to see how much the filters in the avionics bay are clogged, too . . . .

TRULY Somebody is going to make sure they review the contents of the vacuum cleaner?

CRIPPEN I don't know. I'm hoping . . . .

TRULY We ought to mention it to them . . . .

YOUNG The head failed.

CRIPPEN Yes, I guess basically it looked to me like the blower was degraded even more than I expected it to be when we initially started out. Probably should have a little more suction on it and it seemed to degrade finally to the point where it was not collecting at all.

ABBEY Should you look at improving the whole system or just fixing what you've got? You obviously are going to fix that door.

CRIPPEN Yes, the door, the latch was hanging up on it a little bit. I don't know of anything that we could do that would improve a system like that. Now I'm not saying you would be smarter to get some experience with this system and try to make it work right, rather than going out and trying to add some specifics to it right now, as far as the design we've got . . . . I don't know what you could do.

YOUNG I'll tell you one thing. If you have seven people on the Orbiter and the thing quits the second day, you're going to have a real mess.

CRIPPEN You're going to be coming home.

ABBEY Well, I think we ought to point that out.

8.14 SMOKE DETECTOR AND FIRE SUPPRESSION

ABBEY — How about smoke detector and fire suppression?

CRIPPEN — That's one of your favorite subjects now.

YOUNG — Sensor A flight deck left light never did come on. Sensor A cabin light was intermittent. I pulled all the circuit breakers and ran all the tests. Reason why I didn't tell the ground is because I didn't want to go through all the stuff they'd have gone through if I'd told them. Sorry I didn't.

8.15 COMMUNICATIONS

CRIPPEN — . . . . In your communications, UHF for reception, our reception was excellent all the time.

YOUNG — . . . . I never heard anybody, I didn't have any extraneous talk.

ABBEY — . . . . You claimed you heard somebody once on UHF?

YOUNG — One night I heard somebody talking that might have been on UHF, but I don't know.

CRIPPEN — I really think the program ought to consider trying to get a UHF antenna on the top of the vehicle . . . .

YOUNG — Just like in ALT and it won't burn off. It could be made out of the same stuff . . . and put right between the overhead windows - a UHF blade antenna.

ABBEY — How was the simul UHF S-band?

CRIPPEN There was a small barrel effect, there was one station it was worse on. I don't know right now which one it was, but even that they got cleared up. Teleprinter was good, there were a couple of minor things associated with it, that padding they put on the door for sound insulation. They . . . fixed it so you couldn't shove the paper under, the front door mounted cutting bar. Most of the print was good. There were a couple of instances that some of the numbers were hard to read . . . . It was mildly noisy. Even with the thing shut up, you could tell you had the teleprinter on.

YOUNG And it is unacceptable for loading and unloading.

CRIPPEN The little slot is not wide enough to insert the paper.

YOUNG Widen it or make new paper or do something.

ABBEY Speaker, microphones versus headsets.

CRIPPEN I like the speakers in certain conditions because you are running around, but they squeal if you use the microphone some place else . . . when you turn it up to a reasonable level. I think the real answer to all that is a cordless headset.

YOUNG We went over there and tried that thing out and it really works well. You can carry your other comms as a backup thing in case it breaks. The wireless mike will do away with the cords. We need to make sure the earpiece and microphone are firmly located on the head. I wasted more time reaching for the microphone to position it than was reasonable.

CRIPPEN Because I'm not only talking about the interference of the headset and the mikesets. It's the keeping up with the wires . . . .

YOUNG Well, the thing I'd worry about that ought to be looked into is that you ought to run a preflight test in the vehicle with all the equipment powered up to make sure the wireless mikes doesn't have EMI interference with the vehicle.

9.0 VISUAL SIGHTINGS

ABBEY — We've talked about visual sightings, shedding from the ET in ascent.

YOUNG — Fire coming around the vehicle at SRB sep. Material coming down the sides of the vehicle as you come on to orbit.

CRIPPEN — Talked about entry, water dump coming out - very visible.

ABBEY — Talked about the glow on entry . . . .

YOUNG — I wonder what that range safety system hold we had was about. Remember that, we had a range safety system hold for 55 seconds during count.

ENGLE — Two airplanes out there.

10.0 PRELAUNCH PLANNING: HEALTH STABILIZATION

YOUNG — We don't need any health-stabilization program, these guys are healthy . . . make it an operation-stabilization program, give the crew an office in building 5 and keep people from bothering them the week before launch and they'll be just as happy. They don't have to sleep in those trailers. That just takes a lot of time and money and doesn't keep them any healthier. They've been training on this thing for 3-1/2 years and to put them in quarantine a week before flight is an unnatural act, if you ask me - and I've been in a whole bunch of flights - and in the last two of them, I've been put in quarantine. It's an unnatural act. That's my opinion of it. I mean, we didn't do that before, we had an operational thing where we gave the guys an office over in another building and we set a limited-access contact. We had a list of people who could go and talk to them. We did this in Gemini and Apollo and it worked just fine.

ABBEY — And that's a good idea. There were some benefits that came out of the health stabilization in that sense. The fact that you were more inaccessible made it harder for those guys to keep from running in the hall.

YOUNG — They won't be able to run up to you in the hall under operational off limits - that's how we did in the Gemini program, Apollo program - all the way from Apollo 13.

ABBEY — Those memos and notes and everything that came out right close to the last week or two went up astronomically. There are a number you probably haven't even read yet - -

YOUNG — But that's right - but unless somebody really gets nervous, there probably won't be that many for STS-2 on the way I see things.

ABBEY Well, the food - did you get enough to eat? On that circadian rhythm, do you think doing it the way you did it, you peaked out too early?

YOUNG I kind of thought you had to do it - it hurt more at first.

TRULY I think we drove ourselves too early in the morning. What we should have done was drive ourselves to the on-orbit wakeup time and wake up there several days in a row. Actually, we drove ourselves to your Cape getup time, which is a couple hours earlier than that.

ABBEY You mean you should have tried to make it to the on-orbit time - -

TRULY What I'm saying is that 3 or 4 days ahead of time, wake up normally at your on-orbit getup time - and then on launch morning, just get up an hour earlier.

YOUNG I am thinking you are right. What we did really didn't mesh with what we were doing in the flight.

ABBEY You're right. We were gearing everything to the Cape getup time.

YOUNG And everyday at flight, I woke up at 2 o'clock e.s.t. in the morning whether I needed to or not.

TRULY But in general, I hate to admit it, I thought it worked for me. Well, shifting the times helped because the first couple of days I wasn't worth having, and then, during the mission, 3 o'clock comes and I get up - it's time to get up.

CRIPPEN The bad part was going to bed at 6:00 in the afternoon.

YOUNG O&C Activities - they were organized pretty well. We bad-mouthed Nygren, but they were good.

CRIPPEN STA flights - I recommend that we do those.

ABBEY Vehicle status updates.

CRIPPEN Good job on those briefings.

YOUNG Yes - kept us up.

ABBEY System briefing. Flight Data File. How about Flight Data File reviews?

CRIPPEN Well, we do them, but basically what you need is what we ended up with - Flight Data File available to you in there while you're down there - -

ABBEY Weather briefing. We talked about combining that with breakfast. More doctors, more examining rooms.

11.0 MISSION CONTROL

CRIPPEN I thought Mission Control did a good job.

YOUNG I really liked them, their positive attitude about 2 hours into the mission - go for 2 days on-orbit - I thought that was super.

CRIPPEN We completed an OMS dump.

YOUNG Well, maybe about 2-1/2 but it was pretty early - -

TRULY The only comment I'd make about that was they changed the mission rule.

YOUNG That loss of flash evaporators system deorbit burn is not nearly as straightforward as they led us to believe in the flight rules. They said, you'll run with all your DPS up, the procedures say the DPS configuration for GPC is 1, 3, and 5, and that is not all the DPS running.

TRULY I'm not sure when they decided to change - that's my point. I don't think they had somebody really give them an assessment of systems things and I think they made the right decision, but . . . it's just awful late to do.

CRIPPEN In general, I thought we had worked the mission rules well and I thought we interfaced well. I recommend that we try to keep that up pretty heavy . . . . There shouldn't be that many changes except the things we got a lot smarter about.

ABBEY . . . . How about updates?

CRIPPEN The Silver Team did a good job on the nights, they usually put us up a summary message of vehicle status and consumables.

CRIPPEN (CONT'D) Some of the teleprinters' messages we might have been able to hold down a little bit.

YOUNG I would like to see somebody look at all the teleprinter messages we got on the entry day, and somebody decide if we needed those teleprinter messages, because Crippen spent a long time down there running around that teleprinter.

TRULY There was one thing that I thought was missing in the MOCR, and that was that the Capcom's messages would come up and you'd be forced to sit there and evaluate these messages. You really didn't know if there were 6 other messages, 8 other messages, or 21 other messages down there in the bowels of the ship somewhere. And then the team will shift and the Capcom would just flip through and read the messages from the last shift and all of a sudden find another one. There wasn't any king that sat there and said, "Okay, here's the total picture that we're swamping you with." I don't know how to do it. I could hardly keep up with it.

ABBEY The Flight Director would look at the teleprinter messages.

TRULY Each teleprinter message was reviewed. I'm not sure anybody was sitting and looking at them from the point of view of these guys here. One guy had to sit there and look at the whole stack.

CRIPPEN But what the tendency was, I thought, at least with a few messages, is that when they generate the messages, I'd just as soon they'd send them to me in words - it's a lot quicker. We have air-to-ground time available and if more time is involved both from the MOCR standpoint and our standpoint for them to send a message, go down there, get the message off the teleprinter, and read the message - and if it's not something you necessarily need to write down - for instance, they sent us lakebed status - which is nice

CRIPPEN (CONT'D) information to know, and about the fact that they marked the runways out there. I could just as soon have had that over air-to-ground.

YOUNG The teleprinter sure isn't as convenient as air-to-ground.

CRIPPEN And there was another time that there was some kind of procedure they were wanting me to work, maybe associated with DFI, I think it was. They worked out this message and procedures and it wasn't but about two or three steps.

TRULY Yes, there is a trade-off.

YOUNG There ought to be somebody that's a czar on that stuff, and says, "Yes, this has got to go, and it's going up there at such time, and it isn't going to be in the middle of a crew activity." There were times when it looked to me like nobody was looking at the flight plan. When the crew is doing something, they can't go down there and pull stuff out of the teleprinter. Another time, the second evening, we had a communication problem. Henry said, "You have to get this IMU alignment out of the way - get that IMU alignment done, we need those torquing angles right away." Why? What was the big deal, we were not behind the time line in any respect.

CRIPPEN It must have been something we were out of sync with them on.

YOUNG Well, I'll tell you. Repeatedly, Henry would call up and tell us to do something in the middle of when we were doing something else. If you recall that night when you started talking about taking the cover off the DFI and they explained to us carefully how they were going to redo the flight plan so we didn't have to do anything but fix the DFI. And then they carefully did <u>not</u> redo the flight plan. They still

YOUNG (CONT'D) wanted us to do it all and then jumped on us for not getting the TV ready when you first started down there trying to get those bolts off. I couldn't believe it. You remember that.

CRIPPEN I don't believe they really jumped on us, John.

YOUNG They did so!

TRULY One example of - because there was a comm session about that TV - the highest priority in that whole thing was to have a crack at change of the recorder. So then they said, what would you do without this TV? I said . . . number 1, cancel it, because if you're going to do anything . . . forget all those settings and everything and just get the camera turned on and we'll take what we get. But they just couldn't stand it, they set up a whole bunch of numbers . . . .

CRIPPEN Private medical comm, we haven't even talked about that. We had one time that they came on, they talked to us, and I told them that, "Yes, I took my pill, and no, I wasn't motion sick."

YOUNG . . . I told the guys, that we were healthy, we didn't need any private medical comm if they wanted to use the pass for something else. Did you all hear that? And that didn't even slow them down.

CRIPPEN It's tradition . . . .

YOUNG . . . . It's not tradition, we do not take enough time.

ABBEY Unnecessary time is one thing and we don't need to do it.

YOUNG We didn't have a private medical communication all the way through the Apollo program and we went to the Moon . . . . It isn't tradition. You only need it for long-term space travel in excess of 30 days. How can NASA have a private medical comm? When we got back, I read in the newspapers what our heart rates were! What could be more private about a crewman's health than that? And I read a summary of the so-called private medical comm that was exactly what Crip told the doctors on the first night. "Private medical comm" is a joke!

ABBEY You only had one and you didn't need that.

YOUNG They talked to us in the blind but we couldn't talk back to them.

CRIPPEN Right.

YOUNG Because of a comm problem at Santiago or somewhere.

12.0 TRAINING

ABBEY — Training facilities.

YOUNG — Classroom. We need better desks. We only had 300 hours of classroom training and that probably wasn't enough. We should get a lot more than that.

ABBEY — Anything in the mockup that you want to comment on - a one-g trainer?

CRIPPEN — One-g for EVA prep and post - good for that and - -

YOUNG — WETF - found a hatch problem there. I think it's a point for them to be congratulated on - for fixing that thing so fast, so late - probably the optimum time to find out the problem - -

ABBEY — The planetarium.

CRIPPEN — No. John knew the stars already. I learned more about the stars from the SMS than I did at the planetarium.

YOUNG — The SMS stars are good enough, if anybody wants to wait around, don't you think?

CRIPPEN — The SMS stars, I think, can still use some work because I think we can do better than that.

ENGLE — The SMS has such a limited field of view. Did you get the feeling you could really look out and see the whole sky?

YOUNG — Oh, yes. You could see it. You never had any doubt where you were because you had the whole sky to view just like being outside.

ENGLE If you can work the SMS, you can sure work the vehicle.

ABBEY SMS fidelity. I think what you guys need to do is come up with some specific sessions, critique, how to improve it.

YOUNG You know like q's, like RCS firing, ascent shaking.

CRIPPEN Yes, I think that is an important one.

ABBEY I think we have to specifically identify a list of those things we need to work fidelity-wise.

YOUNG No SRB sep, no ET sep, no bump, no nothing in the ET sep - -

ABBEY I think we need to get together with the training guys and get them working on a specific set of improvements.

CRIPPEN I really think that's associated with some of the stuff with the models - now that we have some real data on what the vehicle is - and some of our guys downstairs can work it.

TRULY I think every systems model ought to be updated.

ABBEY Compared to the flight data, certainly, and then also on those things where you don't have data but at least have identified your experience.

CRIPPEN Like these star trackers. We're just wasting time fooling around with those things. They just lock on. And we ought to try talking out of an update time to get that into, but we'll get something going on with that . . . . I'll tell you what, I really think - even though the vehicle behaved well - I think that the mission went as smoothly as it did mainly because we had to spend so much time on sims.

ABBEY I think that's true because we had to exercise the whole thing in an integrated fashion.

YOUNG You know, the confidence and rapport that you get working with those guys - that's really an important part of the business. But if I were you, I surely wouldn't do them suited - because it is really painful and there's no reason.

CRIPPEN One thing with respect to that - I noticed when we first started out doing sims, it was just like we were working with three teams - like the teams weren't passing information to one another. And I didn't see that during the flight. As far as I could tell, we were all talking about the same thing at the same time.

YOUNG Team transitions was a lot smoother in the mission than it was in the integrated sims where it came up to a place. It looked like you were running a whole new ball game.

ABBEY Okay. But the thing that made that easy - we had hardware that was working. We didn't have a lot of problems.

CRIPPEN To pass on to one another - -

ABBEY When you had hardware working as well as this hardware did they take care of one another?

CRIPPEN Good point, on that second day with all those RCS burn changes and that teleprinter - if we had had a big failure, then it would have been a big square wave. I thought those guys were really working hard and did a really good job.

ABBEY How about the Shuttle training aircraft?

CRIPPEN I think they are good trainers, but John was the driver so he's much better at commenting.

ABBEY How does it compare?

YOUNG When you place Orbiter nose or wings somewhere, they do not move. I mean they do not go drifting around at all. When you put the STA somewhere, it drifts off somewhere else. I have argued with the STA people on that and they have showed me the math on why the nose moves. It doesn't!

ABBEY I think if we are training, the transition is easier to the Orbiter.

YOUNG But what I'm saying is, why doesn't the STA fly exactly like the Orbiter? That's what we've been trying to get it to do.

ABBEY I think we ought to take a look. We made some runs out there on 23 and I think they got a direct comparison.

TRULY I think it is about an hour before you landed. When you put the nose of that thing somewhere in the Orbiter, it is just POW and you don't move it and it isn't going to move. That nose is going to stay there.

ABBEY We didn't talk about our Ames. There's a lot of discussion on the part of some people that we needed to do some stress training and go out there and put those cuffs in and do all that kind of stuff. How do you feel about that?

YOUNG I don't think Shuttle trainer aircraft will handle turbulence like the Orbiter. We are probably going to have to do it if they're really serious about flying moderate turbulence. You're going to have to do it somewhere. But how come we can't put a turbulence model - that is agreed to by guys like Hewitt Phillip - that flies like the Orbiter flies, into the STA and do it in the STA?

CRIPPEN You have to have a calm day. Then you might be able to do it.

YOUNG Well, we have calm days. Because you know the Orbiter's low aspect ratio wing has to handle in turbulence like the T-38 does. Sort of. A big airplane with a low aspect ratio wing should do it the same way, it will handle like a big airplane but with the low aspect ratio wing, it ought to be solid as a rock.

ABBEY What do you think of L/D work in the T-38? Did that work the best?

YOUNG Yes, sir. Because we run into all these various conditions of visibility and weather.

ABBEY Then you would recommend doing that kind of thing.

YOUNG Yes, I really would.

ABBEY Combination of STA and T-38 L/D work.

YOUNG I think the more a guy does it, the more he's not going to do it wrong when he gets the chance to do it.

YOUNG On various conditions, you go out there and fly the T-38 where you couldn't even take the STA.

TRULY The thing about the T-38 is that you can see so many multiple situations, and you can sit yourself in so many views. If you can get yourself to the point where one glance tells you whether you're hot, low, and where you're going - -

CRIPPEN I'm not sure how much you need to continue to do it. I know toward the end there I backed off on the amount of T-38 stuff . . . .

ABBEY Toward the end we emphasized more the STA.

YOUNG Well, it worked well as our L/D basic trainer, and during the time the STA is broken, you can go fly the T-38.

ENGLE Can I ask a couple of questions on STA. Were the instruments easier to see in the Orbiter than they are in the STA, outside to inside, sometimes in the Sun?

CRIPPEN About the same to me.

YOUNG Going through Mach 1, I had put my hand up, again, to see the angle of attack indicator.

CRIPPEN John and I both opened our visors sometime after . . . .

YOUNG Just have to get your visor open. There are just too many panes of glass between you and what you should be looking at. One thing I forgot to mention is that - maybe I said it already, my radar altimeter broke.

ABBEY You said something about that.

YOUNG I had an off flag in the radar altimeter after preflare. It may have been working but the off flag was on there.

ENGLE John, were the suited runs in the STA of any benefit at all?

CRIPPEN I found that I thought the first one was desirable and the next one was maybe a little less desirable - but it had been long enough to make it worthwhile. But after you have done it once, you've probably gotten most of the benefits you are going to get out of it, in my opinion.

ABBEY Well, don't you think you need to do a lot of it?

YOUNG The last 30 minutes of your deorbit is probably a lot of time in terms of machine and everything. You can probably use that for your approach and landing practice for your entry, where you're doing all that stuff unless you just want to fly it. But it's not quite the same flying suited in the STA as it is in the Orbiter because the geometry is different. You can hardly make it the same.