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FLIGHT OPERATIONS DEBRIEFING

OF

MA-8 MISSION

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

Cape Canaveral, Florida

October 23, 1962

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INTRODUCTION

The following is the transcript of the flight operations debriefing of the MA-8 mission conducted onboard the U.S.S. Kearsarge after the flight.

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4.0 FLIGHT OPERATIONS DEBRIEFING

4.1 Prelaunch

4.1.1 Procedures.- Comment on prelaunch procedures from the insertion through the countdown.

The insertion and countdown proceeded just by the book; I would suggest no change. I do feel that the astronaut's insertion countdown is too long and should be reviewed.

4.1.2 Spacecraft performance.-

4.1.2.1 Comment on ECS performance during prelaunch.

This time the suit circuit of enviormental control system had been insulated. Therefore we anticipated about a 5° to a 10° lower suit-inlet temperature. I am quite sure this insulation was effective. We did lower the freon flow from the MA-6 and MA-7 settings of about 35 pounds an hour to 30 pounds per hour for the launch simulation. On the simulation I felt a little warm just about the time that we would have had a theoretical lift-off. So, I asked them to increase the flow. I think it was about 32 or 33 pounds per hour for the actual launch, which was perfect as far as I was concerned.

4.1.2.2 Comment briefly on any astronaut or spacecraft difficulties encountered during prelaunch other than those mentioned in communications:

There were no difficulties during prelaunch. I am sure we all are aware of that.

4.1.3 Communications.- Comment on communications during prelaunch.

Ever since I first checked the UHF-hi in capsule 16, I have had trouble with it. We had thought this was due to the GSE cabling. Even on launch simulation, I do not recall having had a good, clean, and crisp UHF-hi circuit. UHF-lo was always cleaner. During the flight, I did not use UHF-lo except during the one required check. As I recall, this was in the first orbit over Kano or Zanzibar. That check was satisfactory but at this time I do not have a feeling for whether it was better or worse than UHF-hi.

[redacted]

4.1.4 Training. - Were you adequately trained during prelaunch precedures?

Yes.

4.2 Launch

4.2.1 Procedures

4.2.1.1 Comment on launch procedures from lift-off through turnaround:

The launch went much like the textbook. I did not note the fact I had an early BECO. I understand that an early BECO does affect the SECO; you should anticipate a late SECO. I think it might have been worthwhile to prepare me for this. I would have been less anxious later on at SECO, even though there was nothing I could do about it. This would have prepared me at least for a no-communication SECO. I did have a feeling that SECO would be late as a result of my receiving the V/V_r much later than I anticipated. I knew then that we were going to have a protracted sustainer flight. As far as I was concerned, the rest of the launch procedures were exactly as advertised.

4.2.1.2 Comment on turnaround maneuver procedures.

The turnaround was accomplished strictly on instruments. As soon as I felt spacecraft separation, I selected aux damp, went down to the fly-by-wire low select switch, then came back up to the fly-by-wire control mode select switch. I did not race through the turnaround maneuver. I dialed in 4 degrees per second yaw just as exactly as if I were sitting in that Procedures Trainer. It was just as simple as that. I had to play with roll and pitch coupling just as I would have done on the trainer. Each axis responded immediately. There was no delay in light off. I would say the thrusters were on the line just as if they were simulated by an electronic computer. There was no difference whatsoever.

4.2.2 Spacecraft performance.-

4.2.2.1 Comment on ECS performance during launch.

[redacted]

I made no observation on this other than my routine check that the altimeter was off the peg and my normal monitoring of the cabin pressure decrease as I came through 10,000 feet. I believe I said that cabin pressure was decreasing on schedule. It capped off at 6 psi, and finally came down to about 4.9 indicated at the lowest reading during the flight. This was well into the sixth orbit, so, the leak rate must have been very low.

4.2.2.2 Comment on electrical system performance during launch.

I feel that the electrical system was perfect throughout the flight. The d-c system was checked very shortly after tower jettison, and all batteries were well above the mark. I checked them frequently during the flight and read them out on the on-board tape. I checked them again subsequent to landing, and at that point none were below 25 volts. Amazing! Before I powered down, I read approximately 20 amps on the ammeter, and the current went down to about 12 amps. When I powered up, the torque that was required to bring the gyros up, increased the ampere load to a maximum of about 25 and then settled down to 20 again. The light off amperage for the big inverters was about 25 amps. This is well within the requirements that we were worried about initially on the ASCS rate gyros running up simultaneously with the ASCS gyros.

4.2.2.3 Comment on roll and pitch programing indications during launch.

Again, they followed exactly what I anticipated seeing. The roll doesn't show very much because you are in a 90° pitched attitude. The observations of roll I merely scanned once or twice. I didn't feel that this was abnormal, so I didn't want to waste time scanning it. I had systems to monitor more than the attitude indications. I naturally monitored pitch, but again, I can't change pitch on the boosters; so I monitored other systems, which were much more important to me. When Cape Cap Com called out nominal pitch angles, they were within what I would accept, at least, and I think possible this is little laxity on my part. I probably would - if I did it over again now, having more faith in the systems - would watch pitch programing more carefully. Just because I'm sure that this wasn't nominal pitch programing. It was very close, I'm sure.

[redacted]

When Cape Cap Com gave me a reading, I was within a degree of it, and that was enough to satisfy me. Unfortunately, the trainer never did really have a good pitch programing schedule, and I think this is something that we should get straightened out once and for all. We should get the trainer to give you the correct pitch programing so you do get used to seeing it, and it's not something you have to study and then analyze and add to another number. We do so darn many lift-off simulations in the trainer, I think, and I'm not criticizing this. I think we should do as many as we did. I also think that we should get some training out of it monitoring pitch programing.

4.2.2.4 Did the abort light illuminate?

Negative.

4.2.2.5 Describe your flight through max q.

I felt it was noisier than I anticipated from very good discussions with the MA-6 and MA-7 pilots, both, on this area, although I think this just depends on what your own decibel tolerance is. I don't think you can really say that it's noisier than something or less noisy than something. It's strictly an experience that is an individual experience well within the tolerance of any hearing level that anybody might be sensitive to. To describe the decibel level would be impossible. I did feel sufficient vibration during max q to make me work a little harder to focus on things, not that I was shaking violently by any means. I'll modify that by saying a slight quivering, where I couldn't just look at a needle and have it sitting straight in front of me and not moving. I think this is about the only way I can describe it. The noise of max q I'm sure is what caused the VOX to close up and keep the transmitter keyed, and this is quite apparent from the onboard tape. You can hear the booster noise steadily through this phase, and this, unfortunately, is not a cue to me; I don't know this. I suggest though, and I would do this in the future, I would launch on push-to-talk. In training I always went to VOX record because it seemed a lot easier to say things, although there is nothing you should have to do with your left hand. If there is, it's an emergency. And the best place for your left hand to be is on the chicken switch (abort handle), and you might just as well push-to-talk. So I definitely feel that this is wrong to launch in VOX record, and I also feel that I would like to put to bed once and for all the controversy about

push-to-talk and VOX. To me VOX is a requirement. You're just too busy to have to push-to-talk every time you say something. There might be an alternate solution, and that is to give you two buttons much as we have in many airplanes, where you could push-to-talk with either hand. Then I might compromise this statement. Where your right hand could push-to-talk while your left hand is busy, and conversely. Most of the time when I had communication troubles, I would whack off VOX and go to push-to-talk. I will admit this as well. I suspect if we had push-to-talk on the stick, as we have in every airplane I have flown, we might very well not need the VOX.

4.2.2.6 Describe BECO.

Very definite deceleration, not that you get any eyeballs out sensation at all, it's just the decrease of the positive acceleration. The BECO itself is accompanied by sound and the booster drop-off is as obvious as can be. I did not use the rear view mirror. I wanted to watch the attitude instruments more than I wanted to look back at the earth or anything else. The staging was as evident as could be, although in training I kept insisting I wanted people to confirm staging as soon as possible only because I didn't want to see the 3 plus 50 abort staring me in the eye. To me there is no doubt about staging. I had the feeling of a sort of a white thin cirrus cloud coming up toward the window. I did not see any color associated with the staging.

4.2.2.7 Describe tower jettison.

The first cue to me was noise. Then the rocket zapping off. I was not pitched over as in the previous flights to where the tower went off in a lighted sky. It went off in the black; so, I merely saw the burning rocket, and when it burned out I didn't see much more of it after that. I saw the burning trail of it as well as smoke and associated debris that comes out from a solid propellant rocket. And also I noticed immediately on the window some after effects. I hope I don't stress this too much. It merely decreased the visibility a small amount, but it was noticeable, particularly later in flight where you had sunlight on a very oblique angle across the window surface. I did detect colored spots - as the MA-6 pilot said, 'like bug juice' - one was a definite reddish orange. The windshield, to make the statement clear in case it isn't hit here, was clean as a whistle prior to tower jettison.

Subsequent to tower jettison, there was one definite orange-red spot that I can only describe as being either some of the paint from the tower or RTV-90 colors. I know they are different colors. The tower is much more orange. And there were a number of little black, blackish-grey, debris type spots on the window. In other words, a general greyish filmy fogging, and I'm using this description as what I saw later with the sunlight on these oblique angles.

4.2.2.8 Did the jett tower light function properly?

Yes, it did. Although I looked for it after I had seen the tower go, this was not my cue for the tower.

4.2.2.9 Describe SECO.

It is a very clean, positive SECO to me. I felt it was rather crisp. I didn't have the tail-off that I anticipated having. The MA-6 and MA-7 pilots both agreed they had tail off. And I think possibly we didn't have much to tail-off with, because in subsequent observations of the sustainer I did not see the wisps that the MA-7 pilot had described. I think the wisps even showed in some of the pictures he had. I had no evidence of this at all.

4.2.2.10 Describe capsule separation.

Capsule separation was a definite sound. I'm positive I heard the posigrades. I believe it's a 1 or 2 second delay. I'm not sure of the textbook answer on this, but I think it's 2 seconds in my mind. But there's a definite - "Pung!" - of the clamp ring and the - "Khue!" of the posigrades. I heard both and again did not look for the light.

4.2.2.11 Did the sep capsule light function properly?

I knew I had separated and I looked for the light subsequent to separation, just to see that the sequence had been made up. Immediately, as I described earlier, I went into aux damp and then through the routine to turnaround. That I think answered the cap sep light function.

4.2.2.12 Did aux damp function properly?

Yes, there are practically no rates at aux damp that I detected. And I don't think we used any fuel at all in aux damp. I'm sure this can be checked out much more accurately than my opinion by onboard data. So, at any rate, aux damp functioned properly.

4.2.2.13 Did fly-by-wire low function properly?

Fly-by-wire low functioned perfectly.

4.2.2.14 Comment on any difficulties encountered during launch other than those mentioned or communications.

By gosh, that darn key transmitter sure gave me some moments of anguish, I'll admit. And I guess about the third or fourth time I asked for Cape Cap Com was sort of sounding kind of plaintiff. I wanted somebody to talk. When he came on the line I was very much relieved. I was about ready to start switching sets. Yet, it seemed like everything was putting out perfectly. It's kind of hard to judge whether you are or are not putting out. I had all three volumes going up like mad. It took me quite a while to get those back down off the high mark.

4.2.3 Training

4.2.3.1 Were you adequately trained in launch procedures?

Yes.

4.2.3.2 Were you adequately trained in turnaround maneuver?

Turnaround maneuver, yes.

4.3 Orbit

4.3.1 Procedures.-

4.3.1.1 Describe the sustainer tracking procedures you used.

I observed the sustainer subsequent to turnaround, picked it up exactly where it should have been on the upper left hand portion of the window, which confirmed to me immediately that we were right on in attitude, that the scanners and the gyros were matched. I might add that I didn't ask about the scanner match up until the Canaries. And if you recall, I at one time had talked about getting scanner observations made during boosted flight to cross-check them with the known attitudes of the booster. This was one area I thought where we could have determined scanner problems that did develop in the MA-7 flight, and this is why I was asking for it. I didn't ask for it while

in the flight. I asked for it prior to the flight. I was perfectly satisfied that attitudes were right on from the very first part of insertion. Continuing on with the sustainer tracking, I was surprised, as I have mentioned, that the sustainer was black in appearance with a white belly band of frost, which was down where the LOX level was. The sustainer, when I first acquired it, was just about completing its turnaround maneuver much as I had. It had about 10° more yaw to go. It was pitched up about - I think it's an easy way to describe its reference to me rather than trying to give it an inertial or spatial reference. It was yawed right at about 10°. It was pitched up about 10° from my observation point, only meaning that it was almost horizontal. It was pitched up about 10° above the local horizontal. There was no wisping, as I said in the past, from the sustainer engine. The sustainer continued in this same translation of motion, going around, as I was looking at it, counterclockwise. If you were looking at it from the top, it was continuing to yaw to the left - very, very, very slowly. I wouldn't dare use the word tumbling. I was going to say it was in drifting flight, which it was, of course. And its rates were on the order of, from what I now know, of 1 and 2 degrees per second, I would say it was about the same. Very, very slow rates. It tracked down through the window. I was in auto retro mode at about 10 minutes and 20 seconds - I then commenced tracking it with fly-by-wire low. Elapsed time might have been as much as 10 minutes and 30 seconds, in that my cue for picking up the tracking was to be subsequent to the sequence panel lights going out. This is the tower jett and the cap sep lights going out. And this occurs at T_s + 5 and T_s was 5:15; so, this would be at about 10:15. So somewhere very shortly after that I threw the armed squib switch off, threw the retro fuse switches on, and the retrofire switch to arm. Then I went into the tracking. The fly-by-wire low is easier to track with than any airplane I had ever flown for an air-to-air gunnery problem. I think that's the best way to describe it. I got immediate responses and cutoffs, which was the other thing. There was no residual thrust from minute, little, tiny blips, and that's what they were, just "barely think" shots rather than using large stick deflections even though I knew I wouldn't get anything but fly-by-wire low. I'd say these were minute pops on any one thruster or any one axis. And there was no problem at all to hold it there, and while tracking it the rates, that I described for the sustainer, were exactly the same. There weren't any that should have caused it to wind up, I know. I would say, as I did say in the general briefing yesterday, that there is no problem at all in tracking the sustainer. I merely stated that, at my state of training, I felt I could not have affected a rendezvous with it. But I don't feel this is something that is going to be

impossible. As the Operations Director described yesterday, and this is obvious, it was my first time in this new environment, and I had other things to get used to besides backing off and trying to join up again with the sustainer. This is the logical point to say over again. I do feel the capability is there and that we can do it. I think where my concern came from was that you really have to know a precise attitude to get into to apply a thrust to change your flight path to get a rendezvous. You can't just look at it and thrust to it. This I am sure will not work. It's a celestial problem, or it's a space problem.

4.3.1.2 Describe the day terrestrial attitude check procedures using the window and the periscope.

I felt that this problem was put to bed during the period of time that I was cruising across the Atlantic on route to the Canaries. While in ASCS retroattitude I detected the slightest yaw change. Immediately from the window itself I amplified it or polished it, whichever way you want to say it, with the use of the yaw reticle. The most rapid observation of yaw itself was through the periscope high magnification; this is quite obvious, as it would be. A small field of view with high magnification, but obviously not any more magnification than you would have through the window. Still less than the window magnification, but it does give you the verticle reference. There's no doubt in my mind that you do increase your rate of acquisition of yaw attitude through the periscope or through a steeper angle. But in any case, you can acquire yaw much faster than you'll ever need it through the window directly. You don't need to even pitch down to acquire it. I felt once I had established in my mind that I could see yaw through the window; then I didn't even have to go down to -34 degrees to acquire it. I was just looking through the window, the plain, bare window, and without the reticle. I used the reticle and checked it, of course, and then went to the window. I wanted to use the crudest device we had which was the window - which we would all assume would be the crudest - and yaw was just as obvious as the simulation device that we have at the Cape. In the blank sky there's no reference; this was under the day terrestrial area using the earth's horizon. Any objects that you see on the surface of the earth all come right into the center of the window converging, and if you're off in yaw, they don't come into the center of the window. You see the clouds; even on what I would call "sock-in" areas there are always rifts in the clouds, and that's enough. You don't need the spotty cumulus that we thought we would need as we used on the simulator at the Cape. If anyone wants to see what yaw looks like, have them erect this device we have at the Cape, and you've got exactly what I saw - exactly. There's no difference. And I was very pleased that this was prepared and put up in time for me to assess it. I felt I devoted probably 5 minutes of my time using this thing, and that's all you need. Let's not set

up a grand training procedure with this device; just look at it, observe it, and that's it. And if someone wants to log less than 5 minutes, I think it's his perrogative; it's sufficient. Now I would like to say one thing about how you do yaw, and it's exactly the way we ended up doing it with this training device. You track around the horizon maintaining roll and pitch, until you eat out yaw, as you fly the arc of the curvature of the earth. It's not a pure translation. It's a two axis translation that you are flying -- roll and pitch -- because if you take pure roll, you're going to lose it. You take roll and pitch and yaw; it's really a three action maneuver that you're making. As you come around into the yaw attitude that you want to stop yaw or, in other words, make yaw zero. It's so easy to find. With the fly-by-wire low thrusters, you can't miss. Now I think this is probably the key to why it was so easy for me to find yaw. So I could get these very, very slow rates. And this is what both the MA-6 and MA-7 pilots made quite clear to me -- when you do try to determine yaw if you have your other rates as near to zero as possible and attitudes, and roll particularly, at zero, you can see yaw. That's the real key to it. You can't be sloshing around. But I could see yaw while I was moving just by keeping the capsule arcing around the horizon. And there yaw just laid right in. During drifting flight, which was another period, terrestrial observation of yaw was so fantastically graphic to me that I'd just as soon forget about it ever having been a problem. I could tell you I was doing 90° yaw, a 100° yaw, 120° yaw, 80° yaw - almost any angle you wanted, I could give you. And then there was 180° yaw. It was obvious I was whistling right into it, that I was going head first, or small end forward. To me the easiest yaw to acquire is terrestrial yaw.

4.3.1.3 Describe the night star attitude check procedure, using the window.

Very simple. Use a star, planet, or moon known in reference to the star charts that were carried. Put it where it belongs in relation to the capsule, and that's your attitude. And it's strictly a case of tracking. You put it where you want it, and that's the end of the problem. Pitch and yaw reference, I used the day-glow which was a very thick - I said day glow, I should say air-glow or haze; I'm not sure what term to use for this. I don't think anyone's defined a term. I will say that the belt above the surface of the earth is well enough defined to give you both pitch and roll, and the upper layer of this belt was just about, to me, my zero reference line for pitch. That's how high it was. That seems awfully high I'll admit. This, I surely feel, must be something different than what the MA-6 and MA-7 pilots saw. They never gave me the feeling, either of them, that this extended this high. I'd say, at the most, I was probably 5° to 10° above this for a good 0° pitch. That's about

as close as I can recall it. The night yaw, I feel, we've got to use star or planet fixes, and I don't know what the solution is. The window field of view isn't big enough to use constellation tracking to find a known star. I, frankly, preferred on the flight to get my yaw back through the day side as compared to the night side. I didn't have complete confidence that I had solved yaw on the night side even though the planets and stars had to be where they were supposed to be, when I acquired them over Muchea on that first night period after drifting. This was the short drifting period. I still had a degree of hesitancy, and this is why I was asking Muchea Cap Com to giveme match out readings from his scanner readings which I can't get aboard. And as it was, we matched out very well, and I think we were off 4^{o} in yaw, and I said I concur because that's exactly what I was off. This is by readouts. This is where I had covered up the yaw attitude. I've mixed myself up there. I've talked about two different cases at once. One was qualifying night yaw where I had it covered up. I pulled the cover off and was off 4^{o}. I didn't believe I was doing that well. Too many people made this yaw acquisition a major problem as if man would never find this in space. And I was almost talked out of thinking that you could find it. What I'm really trying to get across here is that I didn't have myself convinced the first time I made a night yaw check that I was doing it as accurately as I thought I was. And this is only because you have a star chart that's good for $\pm$ 15 minutes. You get about a 3^{o} or 4^{o} shift, and this is well within the areas of what we want for yaw. Meaning by this that I launched right about 7:15 (a.m. e.s.t.) and the chart ran out at about 7:16; so, I was pressing it's limits. So, I wasn't about to pull out the second chart and compare the two, which I did do by the way, but I wasn't going to set there and replot all these stars. I suspect that if we wanted to make this easy for a man we could have, as we have done, had these star charts deployed around the range, and they could tell you exactly what the bearings should be. Someone could compute this out and say that Fomalhaut should be 2^{o} right rather than 4^{o} right as seen on your chart. This would be a much better way of doing it. I don't think you can sit up there and compute this out on your own. It's a little too much of a chore. You can sit there (at the ground station) and lay a chart out in front of you on a desk and read this off just like you can read off a countdown procedure and everything else. It's real easy to follow it. This is why I think the range could help you, if you asked for it. And I, in turn, would have asked for it if I hadn't been satisfied I was finding it well within the tolerances of the slop of the star chart. That's really what I'm getting at. That is why I had the 4^{o} error. The planets were really my major fix objects.

The moon and Venus were ideal for the Muchea - actually over Indian Ocean - Muchea approach, and those were ideal. The picture for preretrosequence for the Pacific Command Ship was just as graphic as could be. I had all attitudes nailed from the stars at this point in retroattitude with this device we have, which is a beauty. The planet Jupiter was in the upper right hand corner, and it was in the upper right hand corner for me. The double star constellatiin of Grus came tracking in from the left side of the window, right to the base of the window; and Fomalhaut was right at the top of the window, right at about 2^{o} right yaw. And once I had that picture on the end of the - during the night side of the first orbit, I said that's my check prior to the Pacific Command Ship. That's all there was to it, because the star field is going to be identical every pass you make. You're just flying a great circle route across the celestrial heavens. If you consider the heavens as a sphere, you're flying a great circle within it. I think what we could use for an aid in training would be the Farquhar globe. But the lettering on the globe should be printed so you can read it from the inside, instead of on the outside. You should be able to see through it much like the plastic balloon that we have. This would then give you an opportunity to read it more readily. By the way, I used the plastic globe for prechecking of the star charts. I found that Nunki and Kaus Australis were inversely labeled wrong on the star charts. Other than that I compliment Al Meintel and others who were involved in preparing the star charts. They were very beautifully done. I should add that we - my suggestion now if I were to do it over again - (should) make a circular slide-rule type of computer, to take the computations for night side time for each orbit, and put it right on the glove box door, because you will use it that often. It should be available to you, and you might very well, if you want to get more exotic, put another circle (a log base slide-rule computer), on there for that, and then you would have that computer available to you.

4.3.1.4 Describe the night terrestrial attitude check procedure using the periscope.

I gave it every break I could including cabin lights out, and I couldn't see "schmatz" through it. "Schmatz" translated means I could see nothing. This in itself I think is enough to say that the periscope is redundant. My translation of redundant is excess values. I'll put it this way - the use of the periscope at night proves that the periscope is excess baggage.

4.3.1.5 In view of your flight experience, give the procedures you believe to be best for (1) day and (2) night attitude alinement.

[redacted]

I think I've discussed that. The window is sufficient if we never have to worry about it being occluded. I don't think the window is occluded enough (by the tower) to cause a problem. I think just to improve visibility, we should try to prevent the window from being partially occluded by the tower. A number of stars could have been seen, by this I mean lower magnitude in the sense of pluses, because a fifth or sixth magnitude star could have been seen without this film on there very easily, if we hadn't had this coating on there. The technique is to track around the horizon rather than pitch way down. There's no requirement for it, and if you can stop your roll rate and maintain zero roll attitude, yaw is right there. And obviously if you have these under control, pitch is there. I used -34° because the scribe lines on the window were as accurate as I could ask for. And I think those are what we need. I'm glad I brought that up because I haven't confirmed their value before. They are ideal. The other scribe lines, the -14°, can be used for the night side, although I could still pick up sufficient stars at night with the remaining field of view above the -34° line. To uncage at night let's say I acquired yaw roll at 0° and pitch at -34°. I would then have three zeros, having uncaged at this point. I would be gyros free; maneuver was off all this time. I then would pitch up an indicated ∱ 34°, cage as soon as the needles quivered to a stop and uncage. I then had three zeros, and wherever I wanted to go from there, I went. If I wanted to fly in reentry attitude, I merely hit reentry select; if I wanted to go back to retroattitude, I would merely pitch back down again to -34° indicated and then select attitude Retro and go back on ASCS in that mode. I insist on (being about to uncage at -34° pitch) and having gyros indicate -34° pitch. I wanted it and could not get it for this flight. Too many people thought we had it. I noticed this is in the process of being done and I will encourage it with all efforts I can put in this direction. This is a requirement, not a desire. I don't feel I used much fuel going through this caging and uncaging technique, but it's a waste of time. If you can acquire all three axes in retroattitude, for gosh sakes, why can't we just stay there. This means you can just, from any unpredicted attitude, just go directly. If you needed to get there in a hurry, you could go in there in high thrusters, and then when you get close, you come back into low thrusters just by selecting the other switch position, and you stop it, and there you are. You take your retro. So, this means you can acquire, if you had a fairly good idea where you were, within about 10 or 15 seconds, which is well within the requirements of getting a retro. I think this would be satisfactory for the night acquisition as well, because you can see the known stars that you want for yaw reference. You then have a good look at the horizon as well, and you're on. So there it is. And if there is any terrestrial lighting by a lot of moonlight which I did not have, and

[redacted]

this is why I had to throw the periscope out, you could acquire roll and pitch rapidly from a visible cloud deck instead of looking at the haze or what we will call the night belt - I don't have a definition for it. We need the ability to cage the pitch gyro at -34°. I wanted it and could not get it. And I've played with that plastic box (the 3-axis flight instrument display trainer) at the Cape for hours looking at the caging and uncaging device and was somewhat concerned about the fact that it couldn't be done when it looked very simple. I admit that there are probably amp-cal problems and people can be worry-warts about this, but I think if we say, "Do it", it will be done. I'd like to put a few barbs on it because there were a lot of what I would call psychological resistance to this, that's all. We just cannot out-guess this little chimpanzee configured amp-cal; that's all there is to it. That's what it is, and let's not deny it.

4.3.1.6 Describe the procedures used to conduct the ground flare and light experiment.

I had a much more careful briefing from Jerry Jones as more data came in. This was about, finally, 3 or 4 days before launch when I got the final information on this, although these experiments were set up in the original flight plan back in early July. Somewhere along the line somebody was on a real long leave period, I guess, and didn't get this done. As far as I know, tracking data has been available on Mercury trajectories since we first anticipated the original canned man orbit. And I don't think we've varied that much. Yet, 3 or 4 days prior to launch - this would have been subsequent to the original launch schedule due to demating - I got this information. The picture of where the ground flare should have been over Woomera was with a pitch angle of -50° at a precise period of time in which I have on my flight plan, not in my head. It would track up from about the middle of the window on the right side up through the top of the window approaching within about 5° to 6° of zero yaw; in other words, yawed right. And I did not see any flare in that segment of the window. I saw lightning spotty, all over the area, which could be above cloud decks. They couldn't see it, and I could see down from the top. I'm looking at half of the continent of Australia at this time. Again I'm straining my eyeballs trying to find the flare. Instead, I saw the other lights that were just plain old city lights in the general area, which was quite surprising. I'd say I saw lights that covered an area of miles, not just a single sourced light, as I understand it. I agree with everybody's statement in the past that at altitudes in orbital flight, I felt I should have been much higher than I appeared to be. I definitely should get that on record because I haven't said it before. I felt that I was very disappointingly low. And I definitely

could see elevation changes in cloud structure. The terrain structure from the desert floor from Edwards up towards China Lake. I could see the terrain structure coming up on the Sierras, no strain. Looked just like it did to me if I were a little closer, as if I were in an airplane at a high altitude. Same old deal, nothing new. Perigee-apogee altitude change was not obvious to me at all, and I could tell you right now, I probably couldn't tell you much difference between 40,000 feet and 55,000 feet in an airplane, which is about the same magnitude; in fact, it's a greater magnitude change. I know pilots can't tell you even altitudes of 10,000 feet. A lot of people say that from safety-of-flight evaluations in most jet aircraft, if you're not out of an uncontrolled verticle maneuver, you should get out at 10,000 feet, and if you don't have a good altimeter, you don't know where 10,000 feet is.

4.3.1.7 Describe the procedures you used to obtain terrestrial and weather photographs.

When I saw something that was worthwhile, and I had nothing else on my mind and was able to get the camera peeled out of the ditty bag, I took pictures. I found that I had trouble stowing the camera. There was a, I'd say, a 3- by 3- inch patch of female Velcro on the base of the camera, and when I put that in the glove box and then went to close the glove box door, it was about a 5-minute job to get it back out. I had to get both hands in there and really wrestle with it because I didn't have much room there. The clearance was so small that I couldn't get all of the bulk of my strength around the camera to pull it out, and I think we've got to take another look at how much Velcro surface we use on the female part. The male part, that's no problem. We need smaller patches of Velcro.

4.3.1.8 Comment on the power down and power up procedures.

They did just what they were supposed to do. The ASCS inverter went off and came back up on the line on power up with about 5 more amps indicated than what they finally settled down to. What I'm saying here is that when I powered up the ASCS inverter, the amp flow was about 25 amps and then decreased down to about 20 after the gyro torque had slacked off and they had come up to speed. In essence this is one thing you can practice on the ground, and it's the same thing that it is in flight.

4.3.2 Spacecraft performance.-

4.3.2.1 Comment on ECS performance during orbit.

During the flight, we had too many people trying to advise the pilot on how to run the suit circuit. I had the advantage of being [redacted]

able to continuously monitor the suit circuit, rather than having to wait for summary reports from the range station sites. I began the flight with initial settings of 4 on all three coolant valves. I did not change the inverter cooling system at any time during the flight. I did reduce the cabin coolant setting. The change is recorded on the tape. I believe I reduced the setting to about 3. Even at this setting the cabin dome temperature was much lower than we had planned to use. The expected dome temperature was $55^{\circ} \pm 5^{\circ}$. I do not believe I ever read more than 50° on the cabin dome gauge for any length of time. I would say that in general the dome temperature held between 42° to 47°. I think you should leave the launch setting of the cabin coolant control exactly where it was. If I had gone to a setting of 7, I am sure it would have frozen or saturated or both. Cabin temperature always held less than 100°. The lowest reading I recall was about 92°. I did not feel that a change in the setting was required. The prelaunch coolant setting was valid for the inverters. I did not change it from the launch value of 4. The highest inverter temperature I read during the flight was 142° on the 250-volt inverter. We discussed the suit circuit settings around the range for almost two orbits. There is no sense in reviewing them here. If I were to launch with this vehicle again and from the information we had from the MA-7 flight, it is obvious to me that the suit circuit should be set at least at position number 7. It seems definite to my mind that we cannot evaluate the heat exchangers in a 1g environment and come up with accurate control settings for the flight. The settings determined in space are much more applicable. I did shut the three coolant valves off prior to landing at about 5,000 or 6,000 feet. I would say this is a brief summary of the ECS system. In general, it performed exactly as we hoped it would. I would say we have an unqualified "go" for eighteen orbits, pending a check of the coolant quantity remaining.

4.3.2.2 Comment on electrical system performance during orbit.

Perfect, I'd mentioned that the d-c volts never went below 25 on any known circuit. The a-c units were never less than 115. All the controversy about what would be a low inverter voltage that would be acceptable for a go, we finally resolved, would be 105 volts, and this was to be played against what the initial conditions were. For example, if you powered up, 105 volts as an initial voltage would probably be an acceptable inverter. I had no problem with this at all. I saw 115 volts every time I have turned the inverters on in this particular capsule.

4.3.2.3 Comment on the $T_s \neq 5$ check.

I never felt there was any rush on this. I only intended in the flight plan to do it some time subsequent to the $T_s \neq 5$ lock-in

which I used as a jet tower light-cap sep light out, and I performed this about the time I was going over the Canaries. This was not a time critical check, is what I'm trying to make clear, and merely observed the pitch to see that it tracked with the window observation, which it did, and I ran gyros free. This was the check, of course, for a period of about 2 to 3 minutes. I wouldn't want to pin it down accurately. It was long enough to where I would have detected at least 8° pitch change if they had not locked in. That satisfied me that we had it in, and we obviously did because the rest of the sequences fell in, in order, subsequently.

4.3.2.4 Comment on ASCS flight.

At no time did I ever feel that the ASCS was not acting as predicted. I did not detect the low thruster pulses to maintain ASCS attitude, be it reentry or retroattitude. The rates were so minute in correcting that they were barely visible. They were on the order of 1 degree per second, which is about what I would accept as my sloppy controlling on fly-by-wire low. They were much lesser orders of magnitude as far as rates, and I'm convinced on numbers of occasions I saw as much as 10° off nominal attitude, yet there was no case of going out seeking orientation mode. It came back in again. I saw it, and I think the best way to check this, of course, is on the attitude readouts onboard. I did comment on it a couple of times. I think I saw it in left roll once or twice. The others, in pitch and yaw, they were fairly tight far as being within 5° or so. As you do know, this amp-cal was opened up to ± 5.5° on attitudes. I was looking to see how far they would go beyond this; anticipating that if they did go way beyond it, they wouldn't come back in. Now I may be wrong on these readouts, but I definitely have the feeling that they were in excess of 5½°, particularly in roll. The ASCS was tight as a drum on retrofire. I had the manual handle pulled out, and my hand wasn't near the hand controller; so I wouldn't feed anything in. This was to give me double authority if I wanted it, and I looked at both the rate indicators, which is our normal cue for retros and the attitude indicators. In addition, I was observing star patterns to see how they varied in travel just in case the electronic package was not up to snuff. The star field didn't change one iota during the period of retrofire. The attitudes I couldn't even give you as much as a degree off in any axis. The rate indications for corrections went up, I'd say, maybe three to four degrees per second in any one axis. That was about all - very, very tight control.

On one period during the flight there may have been some confusion about my remarks, and I think we should straighten that out. It was programed during the fifth orbit, I believe, I'm debriefing without my flight plan in front of me. At any rate, it was the period where I went to gyros free to cut the scanners off. This was when I came down the West Coast; it must have been fifth orbit. This was for a period of a[redacted]s, at any rate, and it's

[redacted]

not significant that I know exactly what it was, but the comments should explain what I'm driving at. At this period, roll and yaw were not being corrected; it was just pitch plane precession. We wanted to run a period where we had no inputs, where the capsule was flying spatially free on ASCS, and this was rejected in that we wanted to maintain the attitude and have other studies completed at the same time. And, of course, we were supposed to be under complete gyro control during this particular phase of the flight; so, we had to give up not programming pitch and not torquing for pitch as far as the thrusters were concerned. At any rate, when I came over Guaymas, I asked the Cap Com for some scanner readings, because I just don't have those, and I wanted to find out how bad my roll was, because it was off - and I forget the numbers - but we discussed this carefully enough in the flight itself that this is recorded, but the capsule did drift off in roll and slightly in yaw. It was off, I'd say, to the left about 15° to 16°, I think 16 was the number Gym Cap Com gave me on the scanners, and this was quite apparent to me when looking at the horizon; and the attitude indication was about 5° or 6° left. This was anticipated; it was not at all unusual; this is gyro drift; but it was, I think, a little bit higher order than we anticipated for that short a period. As I recall the period was only 20 to 22 minutes, that's all. As soon as I said something to Gym Cap Com, which I think was the wrong thing to say, out of confusion I had the Gym Cap Com thinking I was caging and uncaging again. It may have just been poor communications. I didn't explain what we were really doing, but I had the gyros free and I was going to go back to gyros normal. Well, I did go off ASCS, go to fly-by-wire, and fly it back to zero to get the roll using outside reference, and then went to gyros normal and the scanners started coming back on the line again.

This was a good scanner check, I might add, to see it smooth out. From that analysis, alone, I can say those scanners must have been very good, right on the money. When the roll inputs from the scanners finally straightened out, it was right on the horizon, just beautiful. In other words, the zero attitude and the horizon were perfectly matched.

Something bothered me earlier in the flight, and I talked about it, and it straightened itself out. I think I better go over it again here. On the initial yaw checks crossing the Atlantic, I don't think our yaw reference was exactly right. I think it was off about 5°, which I made a remark on. I was checking the drift with high magnification on the periscope - this was my first exposure looking at yaw, crossing to the Canaries. And I said I think we may have something wrong here. As we got on through the flight over Africa, I was looking then at pure terrain, no clouds, it was CAVU, it started to straighten out. I don't think I made a remark

on the tapes to say that the yaw reference had stabilized. Once the capsule has acquired scanner inputs, it takes about another 2 minutes and 10 seconds in capsule 16 before yaw reference is slaved, and it corrects very slowly, particularly on small errors. I suspect I actually saw that error there right from the beginning, and the only thing that brings back to my mind is I had a chance to hear part of that on the (on-board voice) tape, I said something to the effect that we have a little problem here but I'll check this out. Well, I was checking it out crossing Africa, and I'm pretty sure we had it precessed out, or torqued out is the proper term, by the time I got to Zanzibar; so I was satisfied that the ASCS was doing well. I do recall long ago when we first talked about insertion with the g-forces on the gyros that we might anticipate some precession due to the boosted flight. I suspect we did have some yaw reference error there of about 5° or 6°. Now, this should show up in that the scanners were good; we've proven that, I'm convinced. It should show up, and I think we should look for it, during the first 15 to 20 minutes of orbital flight to check the gyro yaw attitude against the scanner readouts. I think we'll find that there was a disparity in the two readings.

(On the basis of this) you might very well anticipate having a yaw error if you had an early retro such as (area) 1-B or something like that. Other than those two, not abnormalities, but predicted disparities, I guess, I saw no criticisms on the ASCS itself. On one occasion when I first selected ASCS reentry attitude and tried to settle into it having been in ASCS retroattitude, I flew up on fly-by-wire, had the attitudes real tight, and I think this came out on the tape also. I noticed a - I'm quite sure it was not a high thruster it was a lot of low thruster - correction, it made about a 1.5 to 2 degrees per second pitch down change as I went in. This is the only time that I went into ASCS that I saw a thruster actuation. Other than that one time, I never saw the (spacecraft) not accept orbit mode, it went right in. Now we were concerned about this. I talked to every engineer that appeared to know what he was talking about on the logic of this amp-cal, and I was left with the confusion that they all seemed to have, that when we go out of any other mode than ASCS into ASCS, you must satisfy orientation logic -- pick up your orientation relay -- and then go back into orbit mode. For this 0.4 second, the time interval required to pick up this relay, you may get some thruster activity. And I can put this to bed. If you satisfy the attitudes and rates are within the energy capability of the low thrusters for the five pulse system on the orbit mode, you will not pick up any extraneous thrusters. It dropped right in beautifully.

All I can say is it dropped in just as the Procedures Trainer did. Now one of the things I should bring up at this point, the

training that the backup pilot and I did on the Procedures Trainer was done with attitude limits for orbit mode of $\pm$ 3° rather than the $\pm$ 5.5° we had in capsule 16. I found it out quite late in the game, and I'm sort of pleased that we had it that way, because it made us fight that much harder to meet the attitude requirements. And it was good positive training in that sense, much like other things that we do where we fire retros on the 90-percent probability of the greatest dispersion or greatest thrust vector misalignment.

In this light if we could satisfy the 3° requirement we could certainly satisfy the 5.5° one in orbit, and this is why I am sure I could drop in and out without any thruster activity. This didn't teach any bad habits; in fact, it taught me good habits. So, I have no objections to this sneaky play, but I didn't know about it as soon as I should have. I had, I feel, two goofs in control mode shifting; one, I was talking my way down to retroattitude from a reentry attitude on the ASCS - of course, at this point I'm on fly-by-wire low coming down in pitch to get to -34 - and I was doing about two or three other things, probably dialing suit circuit or something else. But, at any rate, I neglected to take the reentry attitude select switch and put it in retro, and when I dropped into ASCS, I got a high thruster then and I immediately went right to fly-by-wire low and stopped it with the low thrusters. So, it wasn't a real big "zap" of fuel. In fact, you probably wouldn't even see it on the fuel counter anyway, even if I had accepted all the way back to ASCS reentry attitude. On another occasion - both of these are recorded - I was using manual with the rate command switch in rate command and the manuel lever pulled, and wanted to go to fly-by-wire, and did -- just taking it from normal to fly-by-wire. Having had the rate command switch over, (I was) now in fly-by-wire and had double authority. (I) pushed the manuel lever in - I still hadn't used the stick yet - but had not thrown the rate command switch back to auto. And immediately, having flown fly-by-wire for a long period of time, detected that I had double authority just by the rapid response from the stick. I knew exactly what I had done there. This was no big problem; this is a good cue to you that you do have double authority, particularly when you are so used to fly-by-wire low which is a real slow reaction system as far as lots of rates of change. Those are the only comments I have on what I call control systems and control goofs.

4.3.2.5 Comment on manual control.

The Procedures Trainer at the Cape right now is identical to what I saw in flight. If anybody wants to find out what manual control

is like, at least for what I had, that was it. Every time I used manual and was coming back to ASCS mode, be it reentry or retroattitude, I was not satisfied with my control fineness. I would go off manual into fly-by-wire low to polish it up and then plunk in. That will give you an example of what I thought of it. When I came back up to retroattitude on the first attempt using manual proportional - this is coming off the sustainer, I guess I had a fetish on the fuel which was kind of obvious from how much I had left, I guess - when I came back to retroattitude that first time, I said, 'Baloney', and went to fly-by-wire low and dropped into ASCS. I just didn't want to throw in the high thrusters to get back into orbit mode.

4.3.2.6 Comment on fly-by-wire control.

I think I've talked so glowingly about it there is no reason to talk any more about it.

4.3.2.7 Comment on attitude indicator performance.

Perfect, I never had any problem of having them cage off zero. I saw a roll at one time that sort of gave me some concern at least, it went off to about as far as 80° and then came right back again, just a large oscillation, but it never sought anything but zero.

4.3.2.8 Comment on rate indicator performance.

They were just great. No problem with that. I would say that the roll rate indicator, when I got (the spacecraft) to an actual zero rate, indicated to me about I'd say, less than a quarter of a degree per second to the right. Just a hair off the zero. This is just an instrument face settings I'm sure, and there is practically no parallax on this instrument; this is boresighted to your eyes almost perfectly as far as plane of reference goes, and I think this is a very important thing for any instrument layout for fine control is to have the rate indications - at least the rates - if we have this type of presentation, or attitude, so portrayed that there is no source of parallax. This is prime gear in space flight to me. I probably logged more under-the-hood time than VFR, in that sense. I was, basically, on the instruments most of the time. This doesn't mean that I wasn't looking outside and tracking also, but once I was satisfied that I had very good gyro readouts, this was really good response and took care of all my requirements.

4.3.2.9 Comment on satellite clock performance.

The satellite clock itself performed very well. The time piece mechanism, the so-called 8-day clock, was a mess. It was not

[redacted]

even satisfactory for a six orbit mission. The actual escapement kept the counters within 4 seconds of real time. I think that is the biggest error we had in c.e.t. C.e.t. was I'd say acceptable and you can eat up little errors like this just by advancing or retarding the clock, and this is easy to do. It was consistent. The G.m.t. clock lost over 2 minutes, and was erratic. I might add that the backup clock was within 3 seconds throughout the whole flight of the preset G.m.t., and it was out 1 second when it was set anyway.

4.3.2.10 Did any instruments malfunction during orbit?

No.

4.3.2.11 Did you receive any warning tones or lights?

No.

4.3.2.12 If so, what action did you take?

No action.

4.3.2.13 Comment on any difficulties encountered during orbit other than those mentioned or communications.

None, they have been mentioned.

4.3.2.14 Comment on limited drifting flight.

In fact, I think it's pretty boring trying to keep track of pitch all the time, and I satisfied myself that I could do it, got bored with it, went back to auto retro or auto reentry mode.

4.3.3 Communications.-

4.3.3.1 Comment on HF performance during orbit.

I feel it was not properly evaluated, and it was due to the coaxial switch and its location. I wanted the antennas switch in dipole position for all orbital flight other than when I was preping up for a retrosequence, and each time I came to a potential retrosequence area, particularly approaching Guaymas on the end of the first because I knew people were sweating me as I was beginning to perspire, I did have it in bicone then. But frequently, I should even say more than frequently, I'd say very often I would go for the switch to see where it was, and it was always some place else. That may be because my stowage area was the hatch with the Velcro on it. Every time I'd go over to get something and come back, I'm sure I bumped it -- I even had it in Whip one time and I heard a

squeal and I knew exactly what the trouble was, and I saved my HF transmitter.

I think you'll find that I had sufficient time on dipole that you can see tremendous gains in communications, particularly during the HF checks where all the ground stations came on at 3 hours and 20 minutes. When I made HF checks, I'm sure that I was in dipole. I heard all sorts of stuff on the HF checks. I heard people talking all over the world. Frankly, I wasted too much time on other occasions trying to call people back saying I heard you.

A technique we could use on the range would be, for example, "Sigma Seven, this is Watertown, Com check, out". That's all, which means I don't need to call him back. If he wants me, he can say, "Sigma Seven, this is Watertown", meaning, "Please answer". If I read them this is going to be onboard as well, and we should be in good shape. I wasted a lot of time trying to acknowledge calls, and this is premium time that we can practice on the ground, if we want to play radio.

4.3.3.2 Comment on UHF-hi performance (UHF-lo comments included here).

Obviously, and we all must agree, we weren't getting optimum UHF-hi. Don't ask me why. On other stations than the Cape I had real good UHF-hi.

I kept trying to say what transmitter I was using whenever I called a station up. I don't know whether you noticed that or not. I said, "Sigma Seven on HF", or "Sigma Seven on UHF". I would suggest to the Operations Director that it would have been a real help to me if I had been informed on the results of my communications checks. I made a UHF-lo check on schedule. I made HF checks, and I made UHF transmissions. The rest of the range could have helped in this area. For example, the UHF-lo check was a sweety; it was crisp, clean, and held through the period of time we had it. If this had come back to me that UHF-lo was better than UHF-hi, I would have selected UHF-lo and stayed on it.

This would have helped me assess communications, because when I talk I hear these beautiful side tones, and you (debriefing team) heard how it comes in there (on the onboard tape). That's the only assessment I've got.

4.3.3.3 Comment on the emergency voice checks.

Emergency voice checks were beautiful. I think you heard those on the onboard tape as well. They came in clear. Of course I

don't transmit, I just receive, and every emergency voice check was made at prime time anyway, [redacted] real crisp.

4.3.3.4 Comment on the planned communications procedure for station passes.

I think we've beat that one to death. This has been discussed previously.

The MA-8 backup pilot asked me the question about the position of the receiver volume control. I left HF on 5 almost all the time and that was ample. On the UHF receiver over IOS, I had to use about the position of 7 or 8 to read them. They were crystal clear, but down in the mud as far as volume was concerned. I believe I even said down in the mud to them about transmissions. You know, there's a flaw in the communications systems here to when you run the volume up, your side tone goes up, and you just about beat yourself to death when you transmit to a weaker station. I think we should watch this in future vehicles. I don't intend to ask for a change in Mercury on this.

4.3.3.5 If used, comment on TM CW code communications.

TM CW code was never used except on the command checks on the pad, and that was all, and that did work satisfactorily there. I wanted to do a TM CW code answer to the emergency voice checks over the appropriate stations where I was called, and I plain out and out forgot to do it. It just wasn't a habit that I acquired during flight practice in the trainer. And I think this might be a real good way of qualifying the TM code technique.

4.3.4 Training

4.3.4.1 Were you adequately trained in control mode switching?

Yes, I think with the complexity of switches, I should be forgiven for the two goofs I made.

4.3.4.2 Were you adequately trained in spacecraft maneuvering?

Once in orbit there is very little training required, for orbit mode motions, this is meaning low thruster action. The system is that easy; I think anyone in this room could handle the fly-by-wire low, no problem. And that's the way a control system should be designed.

4.3.4.3 Were you adequately trained for making terrestrial and weather observations?

You look out the window, if you see something you can take a picture of that meets the general requirements for terrestrial photos, meaning that you see the terra, (you photograph it). The basic thing to do is to just say over a certain area which I had marked on a chart, we wanted some pictures. By (clock) time I could say I was there. The picture would include half a continent. I would not encourage

a special course in weather observation or terrestrial observation. I'd say merely brief him on areas of the surface that you want photographs of, or documentation of, meaning verbal documentation, and that should be sufficient.

4.3.4.4 Were you adequately trained for making celestial observations for orientation purposes?

I believe that the work we did at the planetarium and the use of the star charts together would provide adequate training, and I am a complete fan of the technique that's used at the Moorehead Planetarium at Chapel Hill, North Carolina, and feel that there is no other training device required. This will suffice for any celestial navigation or celestial observation training. They are completely aware of our problems. Tony Ginzano came down to the Cape at the last minute and plunked in all the planet positions and they were right on. This is a professional organization. There is no reason to go into any other means for training.

3.3.4.5 Were you adequately trained for uncaging the gyros?

The plastic box we have up in the crew quarters is perfect for this. Maybe we should pursue this further because I learned a lot from that plastic box having gone through the anguish of trying to tell people that I could see yaw. Finally with all the gadgets we had, I couldn't prove it. I had to go into a flight to prove it, and I think that was one of the major requirements that was put on me. A device that uses flight hardware, as this plastic box does, is the only way I know of to understand how these bits of hardware work. It could be made a little better than it is, but it sure is terrific. I think the only thing you could add to it, and I don't see how you could afford to do it, would be to give you some kind of scanner input just to show you the axes drives when you get off scanner limits.

4.3.4.6 What additional training would you now consider advisable?

I would say the last piece of training I had, which was the yaw simulation, was ideal. I would like to say this, and put it on record, "Thank God, I practiced reentry training at Langley." The schedule for the Procedures Trainer at the Cape was set up so that I would have had the reentry capability at the Cape at least by the first of August. It was not completed prior to lift-off. It was not available to me at the Cape. So I had to rely on my knowledge of that since about the middle of July. I probably could've benefitted more from having had the flight pl[redacted] settled on it,

available in the trainer earlier. This was a requirement that I asked for that was not met. The checklists, in addition, were on those cards, on the back of them, but this really got to me, and I really needed it. When I went in the trainer for the protracted periods where I went through every maneuver, I didn't have it, and, as a result, I delayed considerable time waiting for it, but I didn't want to train out of the green book. I wanted to train on what I was going to use in the flight. Hardwarewise, I think we had the hardware we needed frozen early enough, meaning that extra equipment, such as ditty bag equipment, experiments, and devices for other than spacecraft control were frozen, and this is the only way to do business. I think we took enough time to discuss what we felt we could make a change in, and we compromised, for example, on limited drifting within scanner limits. And, even then, I told (people), I may get very tired of limited drifting within scanner limits, and I'll go back on ASCS, which is exactly where you wanted me to be, anyway. And I think you'll see from the flight itself that's just exactly what I did. I wanted a block of time available, not knowing how much I needed, to perform these certain tasks. And, once I completed the task to my satisfaction, I saw no reason not to go back to ASCS. It was there to use, and I wanted to use it. If it was working, I'd use it. If it wasn't working, then I'd have to have experience in no ASCS control, and I needed to get some of that, too.

4.4 Retrosequence

4.4.1 Procedures

4.4.1.1 Describe the procedures you used to prepare for retro.

The same that I said I would use. I was prepared for retro on first, third, fifth, and sixth orbits with only one thing to go, and that was the arm squib switch. If this is supposed to go into further checks, such as - I guess it is what I used to determine that I was in proper retroattitude. Naturally for the first and third pass I had plenty of time for daylight checks on attitudes for the Pacific Command Ship. This was the star pattern that I identified during the first night pass. And that, of course, was the same every time I came over here. That was no problem.

4.4.1.2 Describe the procedures you used through the retrograde maneuver.

I had the manual lever pulled; my hand was off the stick; that was the way I decided to avoid stroking manual to buck the ASCS. I had satisfied myself the ASCS was good; I had

[redacted]

checked the high thrusters only that one time, prior to the real retrosequence; and I should add, this is a real easy check to make. The MA-6 and MA-7 pilots convinced me it wouldn't take much fuel. It didn't. I stroked each high thruster for about 3 to 4 degrees per second in each axis. That's very little fuel used. They lit off briskly and shut off briskly, and I went right back into ASCS mode again, and let it sit there. (I monitored) the star pattern that I had determined would be what I would look at, as I came over the Pacific Command Ship.

4.4.2 Spacecraft performance. -

4.4.2.1 What control mode was selected for retrofire?

The control mode for retrofire was ASCS with the capability of backing up in manual proportional as dual authority.

4.4.2.2 Comment on the performance of the selected control mode.

Perfect.

4.4.2.3 Describe any spacecraft disturbances during retrofire.

None, the maximum excursion in rate during retrofire that I detected was about 4 degrees per second. I believe it was in left yaw. There was no difficulty encountered during retro.

4.4.2.4 Comment on your use of instruments, window, and/or periscope during retrofire.

I cross-checked the window with the instruments.

4.4.2.5 Comment on the performance of the automatic sequencing through retrojettison.

As advertised, I switched to fly-by-wire prior to retrojettison, and this of course, is fly-by-wire, not fly-by-wire low.

4.4.2.6 Comment on any difficulties encountered during retro other than those mentioned or communications.

None. Just perfect other than this. There was a delay from the instant that I thought they should fire until when they did fire. I described it as a very short delay because again I didn't want to exaggerate. Time, at this point, seems infinite, and I have heard at least, I guess from Cape Cap

[redacted]

Com, that it was a 2-second delay. This was a clock firing, and I don't get a fire retro light right now. My indication of the first retro firing is as precise as my going -- snap -- like that. I felt it just as graphically. There's no doubt in my mind that they fired and when each fired.

4.4.3 Communications. -

4.4.3.1 Comment on communications from preretrograde until ionization blackout.

I don't think I had much from the ground at that time. I talked to PCS Cap Com as long as I needed to. The Kearsarge did acquire the capsule on their onboard radar. By the way, the worst communications I did see on the whole flight was with the Flag Plot here (on the Kearsarge), which was within yards of me. They were really down in the mud. I talked to "Swiss" airplane, and it was just as crisp as the conversation we're carrying on here. We again had communications problems with the paramedics and the ship, and one of the paramedics left the Stulken collar and went back aboard the helicopter, got the dope from them, and then came back aboard the Stulken collar. The paramedics didn't have communications at the capsule. My communications were good, but the paramedics didn't have communications, the people around the outside of the capsule. I was sweating them, though, when they put the raft by the hatch. I thought, oh, there goes my hatch, and I started screaming about that. I also feel we've got to get the recovery forces checked out on the whip antenna. They broke it off, and then kept it there on the collar. I think they should break it off and heave it over the side, so it doesn't endanger the collar by puncturing it, because it has sharp jagged edges on the end of it. This should best just be heaved away and forgotten. I saw that laying out there, and I wanted to tell him to get rid of it. I couldn't get to them on that.

4.4.4 Training. -

4.4.4.1 Were you adequately trained in retrograde procedure?

Yes.

4.4.4.2 If you controlled the spacecraft during retrofire, were you adequately trained in the control task?

Did not control.

[redacted]

[redacted]

4.5 Reentry

4.5.1 Procedures. - Describe the procedures you used for reentry.

I just said that I selected fly-by-wire prior to retrojettison. Subsequent to retrojettison, I pitched up to reentry attitude, established reentry attitude, and did make one departure from my original concept. I was going to stay in fly-by-wire just to check both the lows and the highs to see if I could fly lows, which I was satisfied with. And I decided I'd like to check and see if ASCS logic had been picked up, because I had not followed the pattern as far as the sequence goes. And I decided I'd like to go back to ASCS to see if it would stay in reentry attitude, which I did. It did, and then, about 2 minutes prior to the predicted time for 0.05g - it turned out somewhere around there when I did it - I went to RSCS and put the ASCS mode select switch in aux damp. This then, left me with one switch position to make if the RSCS had failed.

4.5.2 Spacecraft performance. -

4.5.2.1 What control mode was selected for reentry?

The control mode that was selected was RSCS with aux damp as a backup, not on the line. By selecting rate command you cut it out.

4.5.2.2 Comment on the performance of the selected control mode.

I would say that I started out with a little less than 78 percent (fuel), because that's what I started retro with, and I didn't use the manual tank at all until I selected RSCS. I'd say I probably had (an estimated) 76 percent to 77 percent indicated, I might add. That's something to remember. I only say this because I started out with 93 percent indicated on manual. The fuel usage at first was very low. The amplitudes of the oscillations were very low, and there were very minor strokes from the RSCS. And I was very impressed with the beautiful stability that this had on reentry, knowing full well there was no attitude control. It was strictly a rate function, and the roll rate was what I would call a casual series of slow rolls.

[redacted]

And by looking out the window, which is very easy to do, of course, you can integrate your roll, and see that it was rolling around a straight line, rather than wobbling about a bit. And it was very, very stable, meaning probably just what the MA-6 and MA-7 pilots said, that you probably don't need a thing at this point. The roll, I'm sure, didn't contribute to the stability of the vehicle. It was aerodynamically stable is the point I'm trying to make. The reentry, of course, progressed, and as the g's started building up around 3 g's, just like we were practicing on the trainer, the amplitudes started picking up a little bit, and with my experience on the trainer I did very little control work until about 3 g's. Then you had to start eating up these little oscillations that start coming in from pitch and yaw, and that's just about the way the rate command system was working. It would start stroking a little bit faster, and then I was monitoring both rates and fuel. This is what I felt was the true test of the RSCS system, the fuel usage, and its capability of performing a task. The rates were not violent at first, and then as we got to high g, I'd already had one thought go through my mind, "My gosh, the fuel flow rate is just like the afterburner in an airplane." You could see the fuel gage going down, actually see it going down, just like a simulated leak rate. It was more than I expected, too. On the simulations we did at Langley, prior to my coming down to the Cape for the training I did all of this, and RSCS took about - as I recall the highest was about 6 percent to 7 percent fuel through where the (trainer's computer stops) at about 80,000 feet, as I remember, maybe it was about 60,000 feet, I guess, at Langley. And they (the trainer simulation) got away from the area where you're just approaching the drogue point, and that's where you really are getting the work out. So, at that point, I almost selected aux damp, because of the fuel rates. And you could see those old thrusters in pitches and yaws just, "Pffffft, Pffffft, Pffffft", just like an old steam calliope. I pickled off the drogue about 22,000 to 23,000 feet, again this is documented, I read this off. At another time, I had the feeling that I was going to go striking out for aux damp, and I had my hand up there ready to grab it, throwing rate command to auto. I saw a yaw

[redacted]

rate that went off scale, to the left, then immediately corrected back to about 4 degrees per second, then came back in strokes between ± 3 degrees per second in yaw. I think this is probably during the point where the pitch had translated over into yaw as far as the oscillation goes. I think this one high oscillation rate is one we want to look at very carefully. And then I had no strain at all monitoring altitude. The altimeter actually came on the line just as advertised; I checked it against the cabin pressure, and they both seemed to be tracking very well. And at 40,000 feet indicated, I punched the drogue off, and of course, the RSCS then was just pumping away like mad. And it was zero (fuel) long before main chute time. Then I immediately scanned the pattern trying to say to myself, can I get rid of automatic fuel, because I still saw it, and it was up around 53 percent, which is what was left after my last fly-by-wire work.

4.5.2.3 Comment on ECS performance during reentry.

I did advance the suit circuit coolant valve as I was on ASCS during the reentry attitude subsequent to retrofire and went up about a half, little over a half a mark, to about 8, and I didn't detect any change, and didn't expect one. I just wanted to have it on the high side. I was plenty cool, and the highest temperature I ever saw on suit inlet, up until the time I actually got out of the capsule on the number 3 elevator, was 78°F. That was the highest suit inlet temperature. I think I probably hit snorkels early, I just - for some reason or other, at 20,000 feet, from my procedure trainer work (I) had always wanted snorkels at about 20,000, and I know that they normally would go at 17,000, but I did manually pull the snorkels. Don't ask me why I did it; I think it was just a habit. I was trained to do it. I should add that I threw the H_2O_2 jettison (fuse switch) somewhere between drogue and snorkels. I wanted to do it earlier, but I think I got interested in other things.

[redacted]

4.5.3 Communications. -

4.5.3.1 Comment on communications during reentry.

I think I might've goofed on this, although I don't know what HAW Cap Com could've told me that would've helped me, other than the recovery forces. I feel I was too excited about getting everything I saw on tape, and didn't give HAW Cap Com a chance to come in. I should've taken a breather. Although I hadn't had any communications from anybody, I think you ought to know how long it's going to be before the recovery forces come. I should've left time for somebody to cut in; I kept the thing blocked.

4.5.4 Training. -

4.5.4.1 Were you adequately trained in reentry procedure?

As far as I'm concerned, yes.

4.5.4.2 If you controlled the spacecraft during reentry, were you adequately trained in the control task?

No, I was adequately trained in the control task, but not refreshed in it as late as I wanted to be. The (reentry simulation on the Cape) trainer was not available, but it was scheduled to be available the first week in August, and hasn't been completed yet. And this I had asked for when I left Langley, I said I wanted the trainer as soon as we can get it. I understand, also, there were some contract negotiation problems on this that were not straightened out. I think this bears looking at. Why was there a delay in getting this in? I might say that as a general statement, liaison between the trainer at the Cape and Langley was never good, and, as an example of this, the manual proportional data that we had in Capsule Fifteen, Deke Slayton took to the trainer at the Cape right after we ran Capsule Fifteen. And when I was up at Langley doing reentry work and trainer work prior to coming down here to the Cape, this was to train for my flight, that was in June, they didn't know about the runs that were made on Capsule Fifteen, besides (not) having the data. We finally got that in, by the way, and I want to make congratulations on that, we

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finally got the Capsule Fifteen data in the Procedures Trainer here at the Cape. Now, a lot of modifications were made in this trainer down here at the Cape. There's a lot of down time. There was a lot of activity on the trainer that we had to share with other people. And this is possibly a defense note for not using the trainer as much as many people thought we should have. We had to share the trainer a lot, because it's the only one we had, the one in Houston, as far as I know, still isn't in commission.

[redacted]

4.6 Descent

4.6.1 Procedures. - Describe the procedures you used during descent and landing.

(Not answered)

4.6.2 Spacecraft performance. -

4.6.2.1 Comment on ECS performance during descent.

I said I ran it up a little bit, and I gave you temperatures on it. (See 4.5.2.3)

4.6.2.2 Comment on spacecraft motions before, during, and after drogue deployment.

I gave you that. (See 4.5.2.2)

4.6.2.3 Comment on drogue deployment.

Drogue deployment (was) manual at 40,000 (feet).

4.6.2.4 Comment on snorkel operation.

Snorkel (was) manual at 20,000 (feet).

4.6.2.5 Comment on main chute deployment.

Main chute (was) automatic at about 10,600 (feet), I would say.

4.6.2.6 Comment on landing bag deployment.

Landing bag deploy, and I, if you did recall, I did mention it earlier in the general debriefing. I had a lot of trouble seeing the left side of the cockpit. And I looked for that landing bag (switch) and finally had to twist around to see it, because it's way down in the bottom and really dim in relation to what I could see. It's kind of dark in there.

[redacted]

4.6.2.7 Comment on landing.

I said that I predicted my impact and I'd swear it was within a split second. That mirror does help you there, as (the other pilots who have) used it (have said). I knew exactly when I was going to hit, and I could just see that water --- "splat".

I spent a lot of time cleaning up the cockpit, and disconnecting the visor seal hose, and the other equipment that was required to be disconnected. I did not connect the survival kit ever, and I don't think I like that. The reason I didn't is I couldn't find the darn tab. I had a lot of trouble with the water tube, and we have a Velcro fitting that holds the water tube along the side if you need it. I had to put this on because I couldn't - this correlation clock thing, and a wire bundle that wasn't there before in the other capsules, blocked out the view of where the little coiled tube would stow away at the end of the survival kit. So, I took it out prior to flight, before I had lift-off, as a matter of fact, when we were inserted (into the capsule). I then routed it down the side with this Velcro loop, and held it with this Velcro loop which worked very well for flight. As a result it blocked out my view of the straps that I wanted to get to, particularly, the yellow strap and I, frankly, don't like my technique on that. I still think you should connect it. I was asked prior to lift-off if I was going to connect it to the suit then, and I don't think I ever would want to do that. That's a strap in your way, and you've got too much loose junk to move around in there anyway without having a strap binding you up. Particularly, this would have been a complete problem, if I had that connected when I was reaching over to the ditty bag and the antenna switch. I would have pulled the darn thing right out of the stowage point, I'm sure, because I was doing a complete half roll, over like this, to get to the ditty bag, and I never could get to those food cubes. Then I looked down and said, "You look just as good as those cigarettes, and I'm not going to get to those either."

[redacted]

Oh, on the landing itself, I did not notice a recontact case. I ended up with what I would call a 90° left roll and about a 10° to 20°, even as much as 20°, pitch down. I'm laying on my left side, in any case, with my knees lower than my head by 20°. And this is the time when I said, "Where is my little, black handle?" Gee, I wanted that thing badly then, the pressure regulator lock. I'm sure we've beaten this hard enough to say that it should be in subsequent capsules, Mercury, at least. And the only thing that was satisfying is that I could see the undersurface of the water through the window, which meant I wasn't going any deeper anyway. I could see the dye marker and a lot of green.

The dark filter was on the scope. That is why I never saw anything through the scope on descent or subsequently and the reason I didn't detect this, of course, is right after retro I was concentrating on fly-by-wire and then the scope retracted after retro jett. So the next time I had the chance to evaluate the scope was on main chute and then I was interested in main chute more than the periscope.

4.6.2.8 Did rescue telelight illuminate upon landing?

Yes, red.

4.6.2.9 Comment on rescue sequencing.

I manually enacted that by punching first the main chute and then throwing the recovery aids -- manual. Had the red light through it. (When I went) over to manual, saw the whip antenna deploy under water - wondering what kind of lure I should have on the end of it.

4.6.2.10 Comment on ECS performance after landing.

ECS performance after landing never got higher than 78. I had killed the ASCS bus on descent.

4.6.2.11 If the spacecraft shipped water, or leaked, describe.

I did not ship water.

[redacted]

4.6.2.12 Describe spacecraft motions after landing.

Motions after landing - I'd like to comment on under landing as a whole. And it's darn hairy, at least as impressions go attitudewise. You expect to sink any moment.

4.6.2.13 Comment on any difficulties encountered during descent and landing other than those mentioned or communications.

No difficulties encountered during descent or landing.

[redacted]