

PRELIMINARY

*J. James*  
*Accur Section*  
**AP 6**  
*Feb 20,*  
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MEMORANDUM for Those Concerned

Subject: MA-6 Pilot's Debriefing

The enclosure to this memorandum is a edited transcript of the pilot's debriefing aboard the destroyer Noa and at Grand Turk on February 20, 21, and 22. This transcript is released in a PRELIMINARY form in order to aid in the writing of the postlaunch report. A more finished, edited, and index text of the postflight debriefing similar to the documents on the pilot's debriefings for the MR-3 and 4 flights will be issued at a later date. Request for clarification of any of this material should be sent to the Training Office.

The format of the enclosure is as follows:

1. Astronaut's brief narrative account of the flight.
2. Specific questions keyed to a chronological review of the flight.
  - a. Prelaunch
  - b. Launch and powered flight
  - c. Zero G phase
  - d. Reentry
  - e. Landing
  - f. Recovery
3. Miscellaneous questions covering the pilot's evaluation of capsule systems
4. Description by John Glenn of the special astronomical, meteorological and terrestrial observations.
5. Discussion of the predominant sensations during launch and powered flight
6. Miscellaneous discussion of flight activities by the astronaut.  
(This section was taken from recordings of several hours of discussion with personnel at Grand Turk. Time has not permitted organizing this material under appropriate headings.)

*R B Voas*

R. B. Voas

WORD ONE/KEYSEARCH

D:02-22-62 NS N.O.C. d MER

*Mercury Atlas 6 Pilot Glenn R18012*  
*Debriefing Material*

## Brief Summary of MA-6 Orbital Flight\*

by John H. Glenn, Jr.

There are many things that are so impressive, it's almost impossible to try and describe the sensations that I had during the flight. I think the thing that stands out more particularly than anything else right at the moment is the reentry during the fireball. I left the shutters open specifically so I could watch it. It got to a brilliant orange color; it was never too blinding. The retro-pack was still aboard and shortly after reentry began, it started to break up in big chunks. One of the straps came off and came around across the window. There were large flaming pieces of the retro-pack - I assume that's what they were - that broke off and came tumbling around the sides of the capsule. I could see them going on back behind me then and making little smoke trails. I could also see a long trail of what probably was ablation material ending in a small bright spot similar to that in the pictures out of the window taken during the MA-5 flight. I saw the same spot back there and I could see it move back and forth as the capsule oscillated slightly. Yes, I think the reentry was probably the most impressive part of the flight.

Starting back with highlights of the flight: Insertion was normal this morning except for the delays that were occasioned by hatch-bolt trouble and by the microphone fitting breaking off in my helmet. The weather cleared up nicely and after only moderate delays, we got off.

Lift-off was just about as I had expected. There was some vibration. Coming up off the pad, the roll programing was very noticeable as the spacecraft swung around to the proper azimuth. There also was no doubt about when the pitch programing started. There was some vibration at lift-off from the pad. It smoothed out just moderately; never did get to very smooth flight until we were through the high q area. At this time - I would guess a minute and fifteen to twenty seconds - it was very noticeable. After this, it really smoothed out and by a minute and a half, or about the time cabin pressure sealed off, it was smooth as could be.

The staging was normal, though I had expected a more sharp cutoff. It felt as though the g ramped down for maybe half a second. For some reason, it was not as abrupt as I had anticipated it might be. The accelerometers read one and a quarter g's when I received a confirmation on staging from the Capsule Communicator. I had been waiting for this message at that point because I was set to go to tower jettison as we had planned, in case the booster had not staged. At this time, I also saw a wisp of smoke and I thought perhaps the tower had jettisoned early.

\*Based on recorded debriefing onboard the destroyer Noa shortly after the MA-6 mission on February 20, 1962.

The tower really had not jettisoned at that time and did jettison on schedule at 2+34. As the booster and capsule pitched over and the tower jettisoned, I had a first glimpse of the horizon; it was a beautiful sight, looking eastward across the Atlantic.

Toward the last part of the insertion, the vibration began building up again. This I hadn't quite expected; it wasn't too rough but it was noticeable. Cutoff was very good; the capsule acted just as it was suppose to. The ASCS damped and turned the spacecraft around. As we were completing the turnaround, I glanced out of the window and the booster was right there in front of me. It looked as though it wash't more than a hundred yards away. The small end of the booster was pointing toward the northeast and I saw it a number of times from then on for about the next seven or eight minutes as it slowly went below my altitude and moved farther away. That was very impressive.

I think I was really surprised at the ease with which the controls check went. It was almost just like making the controls check on the Procedures Trainer that we've done so many times. The control check went off like clockwork; there was no problem at all. Everything damped when it should damp and control was easy. Zero-g was noticeable at SECO. I had a very slight sensation of tumbling forward head-over-heels. It was very slight; not as pronounced an effect as we experience on the centrifuge. During turnaround, I had no sensation of angular acceleration. I acclimated to weightlessness in just a matter of seconds; it was very surprising. I was reaching for switches and doing things and having no problem. I didn't at any time notice any tendency to overshoot a switch. It seemed it's just natural to acclimate to this new condition. It was very comfortable. Under the weightless condition, the head seemed to be a little farther out of the couch which made it a little easier to see the window, though I could not get up quite as near to the window as I thought I might.

The rest of the first orbit went pretty much as planned, with reports to the stations coming up on schedule. I was a little behind at a couple of points but most of the things were going right according to schedule, including remaining on the automatic control system for optimum radar and communications tracking. Sunset from this altitude is tremendous. I had never seen anything like this and it was a truly beautiful, beautiful sight. The speed at which the sun goes down is very remarkable, of course. The brilliant orange and blue layers spread out probably 45° to 60° each side of the sun tapering very slowly toward the horizon. I could not pick up any appreciable Zodiacal light. I looked for it closely; I think perhaps I was not enough night adapted to see it. Sunrise, I picked up in the periscope. At every sunrise, I saw little specks, brilliant specks, floating around outside the capsule. I have no idea what they were. On the third orbit, I turned around at sunrise so that I could face into the sun and see if they were still heading in the same direction and they were. But I noticed them every sunrise and tried to get pictures of them.

Just as I came over Mexico at the end of the first orbit, I had my first indication of the ASCS problem that was to stick with me for the rest of the flight. It started out with the yaw rate going off at about one and one-half degrees per second to the right. The capsule would not stay in orbit mode, but would go out of limits. When it reached about  $20^{\circ}$  instead of the  $30^{\circ}$  I expected, it would kick back into orientation mode and swing back with the rate going over into the left yaw to correct back to its normal orbit attitude. Sometimes, it would cross-couple into pitch and roll and we'd go through a general disruption of orbit mode until it settled down into orbit attitude. Then yaw would again start a slow drift to the right and the ASCS would kick out again into orientation mode. I took over manually at that point and from then on, through the rest of the flight, this was my main concern. I tried to pick up the flight plan again at a few points and I accomplished a few more things on it, but I'm afraid most of the flight time beyond that point was taken up with checking the various modes of the ASCS. I did have full control in fly-by-wire and later on during the flight, the yaw problem switched from left to right. It acted exactly the same, except it would drift off to the left instead of the right. It appeared also that any time I was on manual control and would be drifting away from regular orbit attitude for any appreciable period of time that the attitude indications would then be off when I came back to orbit attitude. I called out some of these and I remember that at one time, roll was off  $30^{\circ}$ , yaw was off  $35^{\circ}$ , and pitch was off  $76^{\circ}$ . These were considerable errors and I have no explanation for them at this time. I could control on fly-by-wire and manual very adequately. It was not difficult at all. Fly-by-wire was by far the most accurate means of control, even though I didn't have accurate control in yaw at all times.

Retrorockets were fired right on schedule just off California and it was surprising coming out of the Zero-g field that the retrorockets firing felt as though I were accelerating in the other direction back toward Hawaii. However, after retrofire was completed when I could glance out the window again, it was easy to tell, of course, which way I was going, even though my sensations during retrofire had been that I was going in the other direction. I made retrofire on automatic control. Apparently, the solid-on period for slaving just prior to retrofire brought the gyros back up to orbit attitude, because they corrected very nicely during that period. The spacecraft was just about in orbit attitude as I could see it from the window and through the periscope just prior to retrofire. So, I feel that we were right in attitude. I left it on ASCS and backed up manually and worked right along with the ASCS during retrofire. I think the retroattitude held almost exactly on and I would guess that we were never more than  $3^{\circ}$  off in any axis at any time during retrofire.

Following retrofire, a decision was made to have me reenter with the retropackage still on because of the uncertainty as to whether the landing bag had been extended. I don't know all the reasons yet for

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that particular decision, but I assume that it had been pretty well thought out and it obviously was. I punched up .05g manually at a little after the time it was given to me. I was actually in a small g-field at the time I pushed up .05g and it went green and I began to get noise, or what sounded like small things brushing against the capsule. I began to get this very shortly after .05g and this noise kept increasing. Well before we got into the real heavy fireball area, one strap swung around and hung down over the window. There was some smoke. I don't know whether the bolt fired at the center of the pack or what happened. The capsule kept on its course. I didn't get too far off of reentry attitude. I went to manual control for reentry after the retros fired and had no trouble controlling reentry attitude through the high-g area. Communications blackout started a little bit before the fireball. The fireball was very intense. I left the shutters open the whole time and observed it and it got to be a very, very bright orange color. There were large flaming pieces of what I assume was the retropackage breaking off and going back behind the capsule. This was of some concern, because I wasn't sure of what it was. I had visions of them possibly being chunks of heat shield breaking off, but it turned out it was not that.

The oscillations that built up after peak-g were more than I could control with the manual system. I was damping okay and it just plain overpowered me and I could not do anymore about it. I switched to Aux. Damp as soon as I could raise my arm up after the g-pulse to help damp and this did help some. However, even on Aux. Damp, the capsule was swinging back and forth very rapidly and the oscillations were divergent as we descended to about 35,000 feet. At this point, I elected to try to put the drogue out manually, even though it was high, because I was afraid we were going to get over to such an attitude that the capsule might actually be going small end down during part of the flight if the oscillations kept going the way they were. And just as I was reaching up to pull out the drogue on manual, it came out by itself. The drogue did straighten the capsule out in good shape. I believe the altitude was somewhere between 30,000 and 35,000 at that point.

I came on down; the snorkels, I believe, came out at about 16,000 or 17,000. The periscope came out. There was so much smoke and dirt on the windshield that it was somewhat difficult to see. Everytime I came around to the sun - for I had established my roll rate on manual - it was virtually impossible to see anything out through the window.

The capsule was very stable when the antenna section jettisoned. I could see the whole recovery system just lined up in one big line as it came out. It unreeled and blossomed normally; all the panels and visors looked good. I was going through my landing checkoff list when the Capsule Communicator called to remind me to deploy the landing bag. I flipped the switch to auto immediately and the green light came on and I felt the bag release. I was able to watch the water coming towards me in the periscope. I was able to estimate very closely when I would hit the water. The impact bag was a heavier shock than I had expected, but it did not bother me.

Communications with the recovery ship Noa were very good. The Noa had me in sight before impact and estimated 20 minutes to recovery which turned out to be about right. When the destroyer came alongside, they hooked on with the Shepard's hook and cut the HF antenna. During capsule pickup, I received one good solid bump on the side of the ship as it rolled. Once on deck I took the left hand panel loose and started to disconnect the suit hose in order to hook up the hose extension prior to egressing through the upper hatch. By this time I was really hot - pouring sweat. The capsule was very hot after reentry and I really noticed the increase in humidity after the snorkles opened. I decided that the best thing at that point was to come out the side rather than through the top. I am sure I could have come out the top if I had had to, but I did not see any reason to keep working to come out the top. So I called the ship and asked them to clear the area outside the hatch. When I received word that the area was clear, I removed the capsule pin and hit the plunger with the back of my hand. It sprung back and cut my knuckles slightly through the glove. The noise of the hatch report was good and loud but not uncomfortable.

In summary, my condition is excellent. I am in good shape; no problems at all. The ASCS problems were the biggest I encountered on the flight. Weightlessness was no problem. I think the fact that I could take over and show that a pilot can control the capsule manually, using the different control modes, satisfied me most. The greatest dissatisfaction I think I feel was the fact that I did not get to accomplish all the other things that I wanted to do. The ASCS problem overrode everything else.

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MA-6/13 DEBRIEFING

ASTRONAUT COLONEL JOHN H. GLENN

February 20, 1961

A. Prelaunch

1. Were there any problems with the insertion and countdown procedures?

I thought in general, things went pretty smoothly during the pre-launch phase. I got all the information I really needed. The actual insertion itself went very smoothly. We've been through this a number of times and Joe Schmitt knows exactly which strap to pick up and when. He does a wonderful job of getting you plugged into the capsule. So there was no problem from that standpoint at all. The practice that we had had before I think stood us in pretty good stead for a smooth insertion because we find we're working as a team. When Joe reaches for a certain strap I just automatically turn my body to let him pull it out to a certain point and when he's tightening it up, I know just where to squeeze in a little bit to help him. I guess maybe it sounds rather peculiar but even something like that becomes sort of a team maneuver. We have been through this so many times that it was very easy and went very smoothly I thought. We had some problems of course, such as the problem with the mike in the helmet that delayed us a little bit. I guess we have probably pushed those mikes up and down many thousand times with no trouble and it had to pick that particular time to break, right in the middle of a count. It was the little fitting that slides up and down on the left mike that broke. Joe was able to change it rapidly. We had problems with the hatch bolt also, which delayed us for a little while. But this was no problem as far as I was concerned. I was surprised at the leak rate we achieved. All they would read it as was below 500 and this is phenomenal. The best we have ever registered before on capsule 13 as I recall, was 610. So this was excellent. I think that the constant bleed was probably greater than the leak rate. Later on we did build up a pressure slightly above ambient in the capsule. The card storage for the star charts was not ideal at all, even for getting them in and out on the pad. We need some better way of stowing things. The map book storage just doesn't seem to be too good either; you shove that map book in and out of that case trying to review things and leafing through it is very awkward. If the pages are open, this adds to the difficulty. I don't know how we are going to improve it. I felt that it was unnecessary to go back over the switch positions a second and third time during the count. It seemed to me that the last time we go over the switches and set the fuses is completely redundant and unnecessary, a sort of WPA program designed to keep the astronaut

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busy. I was not particularly annoyed, I didn't have anything else better to do at the time; but to have something in there just to keep the astronaut busy isn't necessary.

2. Were your communications and information flow satisfactory at all times during the countdown?

I thought Scott kept me informed very well without a lot of extra chatter. He gave me all the information I needed to know. The MOPIS circuits and our cutting in and out on communications worked very well. We had good volume control up and down; all I had to do was say that something was too loud and the volume was controlled adequately. I thought all the communications went very well. The RF checks all went better than I had ever heard them go before, they were all very clear. I think the only time anybody didn't hear another station on the RF was when Rescue 1 had a little trouble getting the blockhouse. I came up to make sure they could hear me and they reported that could hear the capsule OK, and then they picked up the blockhouse immediately thereafter.

3. Did you have any problems with pressure points, stiffness, ventilation, etc., during the countdown?

I had no particular pressure points out of the couch, no stiffness. It seemed that after I had been on my back for several hours I had a spot about across the shoulder blades that, while it's not extremely tender, is an area you realize has more pressure on it than any other part of your back. I remember after the five hour session up there on my back the day we scrubbed, the next day I had a little spot across the same section of my back that felt a little different but that is not a real pressure point. The ventilization was adequate. I was comfortable. The temperature during the launch count was cool and I intentionally wanted to cool on down as much as I could at that time. Along about the last 20 minutes of the count I was beginning to get too cool. By the time I started calling for them to warm things up a little bit they couldn't change the freon flow; I had waited too long on that one. So I just exercised two or three times to pep things up a little bit and then I was very comfortable.

4. Comment on the length of the prelaunch period.

I do not know exactly how long we were up there this time prior to launch. As I recall I got in the capsule about 6:05, was on my back back in the capsule from then until we launched at 9:47, a total of 3 hours and 42 minutes. There wasn't any problem with this time period. The shorter we can keep it the better, of course, but I think I was still in very good condition and was not fatigued to an extent that would affect any of my operations.



5. Do you feel you had sufficient training in prelaunch operations directly involving you?

Yes, after all the counts we have been through, all the practices on the pad, the simulated flights, and the launch simulations, I think I have been adequately trained.

6. Was the ground checkout procedure with the Control Center Capsule Communicator and other MCC operators satisfactory? Were you satisfied that MCC operators were happy with the T/M measurements at lift-off?

Yes, if we were to repeat this flight right now, I can not think of anything I would want to change in the checkout procedure with the Control Center. The fellow in the capsule does not particularly want to get involved in all the workings of the Control Center. He doesn't need to. And I would just as soon keep all extraneous things that you're not particularly interested in off of the circuits to the capsule. Go ahead and check communications and let the fellow in the capsule have as much spare time as you can. Don't give him a make-work program because he has a lot of things he would like to review such as the checklists on the panel and the flight data cards.

B. Launch and Powered Flight

1. What were your predominant sensations during powered flight and relate these sensations to the over-all flight environment and to your previous piloting experience, if possible.

Well, in particular, the vibrations, some of which we have run into before. One that comes to mind is the sensation of shaking due to the limber spring effect of the booster. It is very similar to an F8U in rough weather. The cockpit of an F8U sits out so far ahead of the rest of the airplane that it is a limber affair. In rough weather, you have a feeling that the cockpit is bouncing up and down quite a bit. It was the same type of sensation that you get on the Atlas.

2. Did the ECS perform properly during the powered flight phase?

Yes. I had no problem with ECS at all during the powered flight phase. Temperature was comfortable. No malfunctions at all with ECS during that phase.

3. Did you notice any vibration of the escape tower at lift-off or near maximum q?

You can not really pin down where the vibration is coming from. I don't think you can differentiate between one type of vibration at that time and another. You have the sensation that the spacecraft is vibrating but it's not possible to determine whether it is from the tower.

4. Did vibrations interfere with the readability of any of the instruments?

No. I don't think they ever reached a severity where I had any trouble reading the instruments.

5. Did any capsule components vibrate excessively during powered flight? Describe.

(See section describing sensations during launch and powered flight.)

6. Did all telelights operate correctly through separation? If not, what did you do?

Yes, all telelights did operate correctly through separation.

- 7. Comment on the quality of the voice communications during the powered flight phase.

Voice communications, I thought were very good. There were a couple of times, I believe, when Al and I blocked each other on a transmission. That was probably my fault. I was trying to get as many impressions back to the ground by radio as I could. Perhaps I overdid it, and I tried to get too much back. The quality of voice communications was good and I do not believe there were any communications problems.

- 8. Can you identify the major source of background noises at various times? (Booster, aerodynamic, RF, inverters, fans, etc.)

Well, to a degree, you can. During the high q period, I think you can hear a rushing or aerodynamic sound, like rushing wind. I think you hear that as a separate noise from the thundering noises you hear from the booster. The noise of the inverters and fans and the high-pitched 400 cycle tone, that we're so used to, are there all the time. You can not get away from that.

- 9. Did you think the tower either hung up or struck the antenna fairing during separation?

No. You feel a bump when it leaves but I think it's mainly a change in acceleration. I think it pretty well matches the g profile which shows a little bump when the tower leaves. You can feel that you are unloading about 900 pounds there in a split second. I did not feel that the tower hung up or struck the antenna. However, it happens so rapidly, it is gone by the time you see it start firing, that I can not be really sure whether it struck anything or not.

- 10. Did the escape motor shake the capsule or make the shingles flutter?

No. The only affect on the capsule that I noticed was that it left a coating on the window. This was not serious. Up to that time the window had been nice and clean, but the tower jettisoning left the window coated with a little film. This was very noticeable later in orbit. When the light reflected off the coating at certain angles, it made it difficult to see through the window. Later on in the flight I noticed that there was a long, thin, red streak down about two-thirds of the outside of the window. The red streak ran down the right side of the window as though a bug had been smashed against it. I remember wondering if we ran into some bugs during launch.

11. Did you see the tower during separation and did you see the exhaust?  
For how long could you observe the tower following separation?

I think we already covered that earlier.

12. Are you satisfied with the procedure for reporting cabin and suit pressure during the critical phase from 80,000 feet to 100,000 feet from both a "ground" and your point of view?

Yes, I believe the ground received its information right on time. I was watching the cabin pressure and reported it when it was sealed off. It stopped first at about 6.1 psi and bled on down very slowly. I remember being a little bit surprised that it stopped as high as it did. Later on, during the flight the thing had come down to an indicated 5.5 and held very steady, it was just on solid five five.

13. Did you note the pitch down of the booster at the time of booster cutoff through your window?

I did not notice it as a rate that I would sense. I didn't feel that I was suddenly being pitched down. But I certainly noticed it when the horizon view came up on the window. It came up on the window, right at the same time that I was counting the seconds off to myself and watching for the tower to go.

14. Could you discern booster cutoff and tailoff characteristics? By which of your senses?

You can certainly feel the g changes that accompany the booster tailoff. You feel the g's by your body senses. There is also at booster cutoff a change in vibration because two engines are dropped. I think you also sense a change in sound as a result of jettisoning the booster engines.

C. Zero-g Phase

1. Could you sense separation of the capsule clamp ring? How? Did capsule separation occur immediately? How did you tell?

There is no doubt about separation of the capsule clamp ring. You cannot tell whether it separates except by the sequence light, but you certainly can tell when the clamp ring goes off because you hear it. There is a very definite report when the clamp ring bolts fire. The capsule separation did occur immediately. I was mildly surprised by the force of the posigrade rockets. I had thought that the spacecraft would appear to just drift off the booster and that you might not even be aware that the posigrades had really fired. But there is no doubt about it. They give you a definite little jolt when they go off. You can also hear the posigrades fire just as you hear the retrogrades fire later on.

2. Was the booster pitching, yawing, or rolling at this time?

I was surprised that just before SECO, it felt like I was out on the end of a big, long, rather limber spring. Apparently when all the lox is out of the tanks, the Atlas has a lot more give and swing to it. The motion was random, it was not limited to one plane. The thought that came to my mind was that the ASIS might kick off, but it didn't. The booster was not rolling. The oscillation was in pitch and yaw. As you approach SECO, there seems to be a build-up in the vibration which I experienced earlier in powered flight. I imagine this is probably due to an increase in engine vibration at that time.

3. Could you detect posigrade rocket firing? Describe.

Yes.

4. What motions did the capsule go through at separation? What were your cues?

I think it came straight off the booster. I don't think we had much random motion because there wasn't any damping action. My only sensation coming off the booster was of a very slight pitch down, as though my head had gone over toward my heels. This is a normal sensation from a reduction in linear acceleration. It is possible that we might have pitched down just enough to give me that sensation, but I don't think we did because I was watching the rate indicators and I don't recall any real pitch down motion.

5. Comment on ECS cooling during weightlessness.

The comfort control calibrations from the chamber runs at the Cape are not accurate at all apparently. The setting of the suit circuit comfort control which provided cooling at the Cape during our ECS runs was marked in red, right in the middle of the scales. By the end of the flight, I had increased this water flow on the suit circuit clear past the maximum setting on the scale which was 1.7 pounds per hour. My setting was beyond that and the steam exhaust temperature was still only down to about 47°. I increased it slowly even beyond that point. I did not want to turn it way up for fear I would freeze the outlet up, so I kept edging it up slowly until I finally wound up with it clear above scale. On the other hand, the cabin temperature got up as high as 105° at one time. I increased the flow slowly over a period of a full orbit and the cabin temperature gradually came down to about 95°. When I tried to increase it even more to get the temperature down below 95°, the excess water light came on, so I had to back it off. The water light went off in about 10 minutes, so I turned up the water again. I turned the water off everytime as we were suppose to prevent hysteresis in the valve. When I would bring it back up again it would freeze. The excess water warning light was on and off 5 or 6 times. I never really achieved one setting which was close to the limit and still low enough to keep the excess water light off. I just didn't have a good feel for the cabin water position at all. It froze up rapidly on the position that was satisfactory in the chamber at the Cape. Thus, the planned setting on the suit circuit determined at the Cape is too low, while on the cabin circuit the planned setting was too high.

6. Did the ASCS sequence properly and did it hold the correct attitude (rate damping, turnaround, etc.)?

During rate damping, turnaround worked properly. It worked properly, all during the first orbit. Everything went according to plan during the first orbit. We had that long period on ASCS in order to hold an optimum attitude for radar and communications. Just as I got to the coast of Mexico, the capsule started drifting to the right in yaw and it would drift over to about 20 degrees, instead of the normal 30 degree limit, and then the high thruster would kick on and bat it back over to the left. It would overshoot to the left and then it would hunt and settle down again somewhere around zero. The spacecraft would then drift again to the right and do the same thing repeatedly. Sometimes it would do this just in yaw but at other times when it kicked into orientation mode in yaw, it would drop into orientation mode and all three axes would go through a period of fluctuation and the whole capsule was doing this until it gradually settled down. I let it do this 3 or 4 times and decided it was just too wasteful in fuel to let the thing continue, so everytime the yaw

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would kick in, I would take over manually, recenter it slowly, and reengage ASCS. It had that same characteristic every time I turned the ASCS back on for about some 15 or 20 minutes. On the second orbit, when I was pretty well over toward Africa, it reversed, and then it would drift to the left in yaw instead of the right. During the difficulty with yaw, when I would try to use low thrust to bring it back, there was no left low thrust. That's the reason the spacecraft would drift off course and hit orientation mode, where the high thrust had to take over. It seemed that later on if I held an attitude other than just zero-zero and  $-34^{\circ}$  for any period of time at all, any axis was liable to drift off in any direction and I never could pin this down to a pattern. This is what consumed the bulk of my time for the last two orbits. I was trying to analyze the trouble with the ASCS, so we would know exactly what it was doing but I was unable to pin this down to any exact pattern. The attitude indicators were most in error after I yawed around 180 degrees and held this attitude for several minutes, looking at these little bright spots at sunrise. I had had the capsule lined up in orbit attitude just before I made the  $180^{\circ}$  turn. I had caged and then uncaged the gyros after visually aligning the capsule to orbit attitude by reference to the horizon. Following my return to orbit attitude, the indicators were in error by  $30^{\circ}$  in right roll,  $35^{\circ}$  in right yaw, and  $42^{\circ}$  pitch up, which puts it some degrees higher in pitch than it should have been at that point. I don't know whether this got reported or not. I felt that the gyros should have been aligned properly when I returned to orbit attitude unless there was some malfunction. During the majority of the first orbit, all the control systems functioned perfectly. The ASCS performed the turnaround maneuver properly and dropped into orbit mode. After Bermuda, I started into the controls check that we had practiced so many times. The test went just like clockwork. It was just like running it on the trainer again; the same rates and the same reaction of controls. I was really elated by the precision with which the controls check proceeded. It is quite an intricate little check until you practice it a number of times, and there are quite a number of switch and pull handle activations during this check. We had run through this so many times at the Cape, it was really a pleasure to see this thing work properly. Thus, the ASCS was working properly at that time. Following the controls check, I went back on ASCS and it held fine all through the first orbit. I could not pin down any pattern to the malfunction of the ASCS. I tried caging the gyros and getting everything lined up and then uncaging the gyros. Then I would try flying on the fly-by-wire to see if there was any connection between that system and the ASCS problem. It would still drift off in random fashion. So I would recage again, uncage, and try the same thing again on manual. There was just no pattern that could be established to it. Whatever the problem was, it was random.

The fly-by-wire system is excellent. That's one that really gives you fine control. On fly-by-wire you can control right to zero rates with no problem at all. I liked it very much. The manual system was not quite as good as on the procedures trainer. It felt mushy. I think this had been predicted from the tests that were run on capsule 15. On manual, I didn't feel I had as accurate control as I did with fly-by-wire. The low thrust fly-by-wire is excellent for very accurate control when it works. Yaw was the only dimension that had any problem. There was never any problem on fly-by-wire in roll or pitch.

- 7. Could you hear operation of the control system (i.e., firing of the control rockets, action of solenoids, control linkages, etc.)?

No. More than hear them, I think you sort of feel them as a vibration - not as a movement of the capsule, but as the thruster operates, you feel a very high frequency buzz. I think you feel this more than hear it. You can hear the high thrusters. They are not very loud but you can hear them. But the low thrusters; you feel them more than actually hear their operation. Yes, you can hear the solenoids click, though I don't think you hear all of them. You can hear some of them clicking and I was also picking up some of the solenoids in the headset, too. Evidently, the signals the solenoids were making feed through into the communication system.

Part b on question 7: Could you see the exhaust from the pitch-down thrusters?

A couple of times I saw the low thrust pitchdown thrusters. This occurred when the light was just right. In the case of the high thrusters, any time that the light is coming from behind the capsule, you could see the exhaust if you were looking against a dark background. If you have the nose of the capsule down where you have a bright land or cloud area as a background, then you can not see it at all. This was very noticeable at the sunrise period when you still had a dark sky and a dark background of the earth toward the western horizon that silhouetted the steam coming out from the thruster. The steam from the thruster reflected the brilliant sunlight through the window. You could see a fan-shaped cloud of vapor 20° wide coming out of the thruster. The fan shape of the vapor was very clear cut, very sharp, and even.

- 8. Comment on the quality of the hand controller for each manual control tried (i.e., effectiveness, backlash, slop, binding, lag).



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I didn't feel that there was any particular trouble with the hand controller at all. It was effective. I think that the fly-by-wire switches had been reset to about where they had been before. They felt very similar to the procedures trainer. There was no binding in the system at any time. It did not tend to hang up at all. I think it was correct the way it was finally rigged.

9. How did the performance of the manual control systems compare with what you expected as a result of training on the various Mercury simulators?

The procedures trainer is a very close simulation. I think the manual system on the procedures trainer is a lot more crisp and gives a lot better result, particularly at low thrust, than the capsule did. Fly-by-wire action is very similar, in fact, identical. On the ALFA trainer, I think the characteristics of the control response are probably very close, but I somewhat revised my opinion of the ALFA trainer as a result of this flight. Whether we realize it or not, we sense and react a lot more to our body movements on the ALFA trainer than we realize. This may not be true for other people, but I think that I at least react a lot to my body movements on the ALFA trainer, as well as to the instruments I am looking at. Now in the actual capsule, once you get into orbit, you just don't have these same body sensations at all. They are just not there. You go by what you see. And, in that respect, I think that the procedures trainer actually comes closer to the type of presentation that you have in orbit.

10. Did you have any unusual physical sensations from capsule motions?

No. That's exactly the point. I don't think you really have much of a sensation of movement at the rates that we are talking about. You go by what you see your attitude is and react to that. In flight, there are no motion sensations to which you can react. I think in the procedures trainer, you just ignore your body sensations and react strictly to what you see. On the ALFA trainer, you tend to combine the two and react not only to what you see but what you feel.

11. Could you feel angular accelerations during capsule motions?

Only at the higher rates. If you get up to a rate of about 5 degrees per second, you are usually accelerating rapidly enough in achieving that rate that you can feel the acceleration. Most of your rates, of course, are much lower than that, down around zero to 2 degrees per second. Thus, during most of your maneuvering you just don't feel much in the way of acceleration and deceleration when you start and stop.

- 12. Did the periscope, window, and instrument attitude references agree during the mission?

Periscope and window did. Instruments varied. (See Question 6)

- 13. Could you determine yaw attitude: (a) By checkpoints through the window? (b) By checkpoints through the periscope? (c) By terrain drift through the window? (d) By terrain drift through the periscope? (e) By star drift through the window?

I believe there was a period of learning to use the periscope and window during the flight. I think I wound up at the end of the flight much better able to discern yaw and set the capsule on the correct heading than I was at the beginning of the flight. Roll and pitch are so definite, that there is no doubt about controlling the attitude in these dimensions. You sit there and just drive the window where you want it. With accurate control on fly-by-wire it is very easy to position the capsule exactly where you want it. But this wasn't quite so true in yaw. Your reference in yaw is not as good. I found that the best way I could set up yaw was looking out the window and alining with some object that was going straight away from me. The procedure that seemed to aid this more than anything was pitching down. If I would pitch down to about 60 degrees or so where you have a pretty fair vertical view, then I could pick up clouds and land moving out from under me at a much more rapid rate than in orbit attitude in which I was looking way off toward the horizon. When you are viewing the horizon the land marks are much farther out and their apparent motion is considerably less if you are pitched down and are looking at them coming right out under your nose. When they are doing that, it's pretty easy to see what your yaw is. It's much more apparent that things are moving at an angle across the window when they are going at a greater speed. I wound up pitching down whenever I wanted to set yaw toward the end of the flight. The periscope I think just required a little more practice. At the beginning of the flight, it was a little bit difficult to pick up yaw rate, but I think by the end of the flight, I could probably set yaw on the periscope down to within a couple of degrees. I would say that this is about the tolerance of accuracy on the periscope, I don't think I could have got any closer on that. I think using the window you can get down to about the same accuracy maybe, possibly a little better. I think the big difference between the window and the periscope is probably the speed with which you can determine yaw. Looking out the window, you just come right around until it looks right, that's it, and it's very apparent to you because you are looking directly at the clouds and they are moving rapidly. On the periscope I seem to have to do a lot more maneuvering and look and watch and track a cloud along the line and then make an adjustment, then track another cloud along

the line and so on. It took longer to do it on the periscope than it did looking out the window. You could determine yaw rate by star drift through the window. This took a little bit longer. If you were alined pretty much on track it seemed a little bit more difficult to track the star and make your final accurate alinements in yaw. In fact, without watching it for a very, very long time it's apparent if you turned a little bit - yawed one way or the other as the drifting of the star field becomes more apparent. If you pick a particular star and track it, and it drifts rapidly while your rate indicator shows that the spacecraft is not yawing it is apparent that you are not quite on track. But, once you get this alined pretty well on track, adjusting within the last 10 degrees of yaw is fairly difficult at night. The periscope gave no help at all in alining with anything at night. You could see different patterns in the scope at night because we had a full moon on these cloud decks but this wasn't much help - it's so dim through the periscope you couldn't really aline with any particular spot and follow it as a yaw reference. So your yaw reference at night if your instruments are not operating properly, is strictly out the window. You use the window in conjunction with the rate indicator when the yaw attitude is widely displaced from track. If you track a particular star since you have no sensation of rate you must cross reference to yaw rate indicator to be sure that the motion you see is not due to a capsule yaw rate. You have no sensation of turning unless you do look at the rate needle. Your rate indicators operate properly at all times. Alining at night in yaw is not very easy. You can see cloud patterns out the window and this helps some. With the bright moonlight we had you could keep alined by reference out the window on some particularly outstanding cloud formations. This was much more rapid than star reference. I think you could probably aline out the window, almost as rapidly as you could in the daytime, when you have a full moon which illuminates the cloud formations.

- 14. Could you determine yaw rate:
  - (a) By movement in the periscope?
  - (b) By movement in the window?

(See Question 13)

- 15. Did sunlight effect the visibility of any of the instruments or controls? Was it necessary to adjust the capsule light to compensate for this effect?

The sunlight coming in the window is very brilliant and intense, extremely bright, very clear brilliant white light. It reminds me of the pad with the arc lights on. One of them shining in the window is a brilliant white light - that's just what it's like. Just

like someone had an arc light right outside with the brilliant white light they put out. I didn't change the capsule lights for this at all. We had thought before the flight that we would probably not be able to look directly at the sun. I sort of peeked around the edges of the window to try looking directly at the sun without my eyes being protected. Previously, I had used the filter that we had for this purpose in the open position. By squinting the eyes it was possible to look directly at the sun with no ill after effects at all. This would be very similar to looking directly at the sun from the earth. You don't accomplish anything by doing it since you can't see anything anyway with your eyes squinted down that far. But it is interesting at least that the sun is not quite as intense in that regard as I thought it would be. It's not completely blinding if you happen to open your eyes to the sun. I know a number of times when I'd be maneuvering the capsule, the sun would come across the window and by squinting my eyes and looking to another part of the capsule, I could still see the instruments and see what I was doing, even though the sun was coming directly in. It's very bright, I don't want to minimize it, but it does not stop all other activity when it happens to shine close to your face like we thought it might. As far as the lighting of the capsule goes, the finger tip lights were very useful. We had thought from some of our practice in the Procedures Trainer the little finger tip lights we had might be very helpful and they were. I used them numerous times to look at the charts. They were also useful before my night adaptation was complete, for making gage readings or trying to read out a report. The instrument panel is not evenly lighted in the capsule. You really need edge lighting on some of the gages to make them readable. We have flat red lighting on gages that are rather far away from the light sources, so that the illumination is dim. Another factor in capsule lighting is that you need to be dark adapted to where you can really make the maximum observation of the sky shortly after sunset, or determine yaw position from a cloud formation out the window immediately after sunset. To do this, you would have to adapt your eyes a lot more in advance of sunset than we had planned to do on this flight. I tried for maybe a minute or so before sunset - we had an eye patch - and I tried it on the first orbit. It was sort of a jury rig item that we put together at the last minute with tape around the edges to hold it in place. The tape just didn't stick the way it should have. It kept coming loose and I kept changing its position. I thought from our previous practice that it would work all right, but it wasn't worth much. I gave up on it and stuck it over on the emergency O<sub>2</sub> rate box. It wasn't much good. So I tried then just to shut my eye and adapt one eye while we were coming up to the dark side so that I'd have pretty good reference after we went through sunset. I just wasn't trying it far enough ahead because to make any real observations or really pick up yaw reference rapidly, you have to be night adapted farther ahead than I was.

- 16. Describe the appearance of the earth relative to colors and light intensities. (Refer to earth-sky camera pictures.)

Looking back at the earth, colors and light intensities were the same as flying at high-altitude in an airplane. You look down at the ground and you see the same colors and the ground looks the same as it does flying at 40,000 to 50,000 feet in an airplane. Now if you look off to the horizon, the view is completely different, of course. It is also different if you look up at the sky. But looking back at the ground it's just like you were in a high altitude airplane of some kind. I could see patterns on the ground and rivers. I particularly recall the area around El Paso, as one of which we had made a photographic study. The green irrigated area that goes up and down the valley each side of El Paso can be easily seen. It contrasted well with the desert area on each side of it. You could see squares of the irrigated land. I don't imagine that I was seeing the individual little irrigated plots that are only a few hundred yards long. I don't know what these were, maybe they were quarter sections. I could see rivers and lakes. You can see several cities, such as Savannah and Charleston, very clearly. Knowing that there is a river winding through an area, you interpret little blobs that you see as being bridges across the river. I think you can probably pick out areas down to maybe 100 yards long. We were figuring before that just using a gunsight on a fighter plane, you could pick out areas down to one mil. I think we figured that 1 mil at this altitude would be on the order of 100 - 150 yards. On the night side the visibility is pretty much dependent on whether the moon is up or not. In one area off the east coast of Africa before the moon was up I could see nothing in the way of cloud formations or anything at all. Reference then was strictly by the stars, but even without the moon being up it didn't appear to be any problem at all seeing the horizon because the stars were so clear. Maybe you do have some very low intensity light that comes back off haze in the atmosphere that aids in seeing the night horizon. When there is no moon out, looking right straight down this is like looking into a black hole. We had wondered about whether you could see lightning flashes at night and they were very visible. There were two big storm areas, one big general storm area that was just north of track off the east coast of Africa and another smaller storm center that was south of track and a little bit east of the first one. The lightning flashes in both of these storm areas were very visible. You could see the lightning going from cloud top to cloud top - sort of sheet lightning effect. You could see lightning in the clouds - lightning of the type you normally associated with clouds of vertical development where there is one single big flash rather than going from cloud to cloud. These were very visible. I tried the air glow filter in looking at that area but it was so soon after sunset that I don't think I was night adapted enough to really pick up air glow. The Indian Ocean ship said they set their flares off, but I did not see them.

17. Were the controls easier or harder to reach under zero g?

No difference. I don't feel there is any difference in reaching for controls or controlling switches or knobs under zero g than there is at any other time. I think that most of us who have flown quite a bit have gotten use to being at odd-ball accelerations. You consciously reach for something and control your hand until you get to it. It's the same thing under zero g. There was no tendency to come out and overshoot a switch and have to put your hand down. I just never had that problem happen right from the start of the weightless period. Just reach for what you want and that's it. I think you just glance at the switch that you want to go to and you control your hand visually all the way out. I don't think you put your hand out by feel like this when you are looking at a knob. You put your hand out to go to a certain knob and whatever force you need on the muscles of your arm to get there, that's what you use. I think perhaps there were some erroneous impressions from some of the studies that Wright Field was running. We were subjects on some of them because we happened to be onboard for training. Changing from a  $2\frac{1}{2}$  g pullup through a period of weightlessness and back into  $2\frac{1}{2}$  g's again, there's bound to be some overreaching and underreaching. But where you're in a constant g state, even though it is zero g, you just compensate for this automatically. If I wanted to reach for something or go back to controlling attitude, just for a moment, rather than put the camera away, I'd just leave it floating where I had used it. It's something to laugh about now, but it just seems natural up there. I think that the human is more adaptive than anybody thought. It wasn't something that I had thought of before and planned to do; it is just that you put it there and you know it will stay. You don't need to think anything about it. I noticed as I moved the capsule that things would drift. Some of the things didn't stick on the velcro and when I would maneuver and stop a rate, something would come drifting across.

18. What items, if any, vibrated during zero g? Did you consider any of the vibrations annoying, excessive, or possibly damaging to any capsule system?

None that I know of.

19. Can you identify the major sources of background noise at various times during the zero g period? (RF, inverters, fans, tape recorders, cameras)

No, this was pretty constant. You have a little different type of background noise on HF and UHF. The inverter, fans, tape recorders, cameras, were operating all the time and this was a pretty constant noise level.

20. Was the noise level annoying?

Well, I think we have probably become pretty well acclimated to this through a great deal of time in the capsule. It's not desirable, that's for sure. But it's certainly no worse than you have flying in a fighter airplane. It certainly is not annoying to the extent that it interferes with your activities. Any noise of this intensity is undesirable but it does not interfere with the operation.

21. Were there any floating objects in the cabin during weightless flight?

Surprisingly few. I really expected to see more things floating around. In particular I expected to see a lot more very small flying particles; a dust and a little fillings and things like that, but there weren't too many of these. The capsule had been pretty well cleaned out. There were a few washers and I picked a few little odds and ends out of the air. We had put up some double sided tape over on the hatch so we would have something to which to anchor floating objects. I took some of the floating objects and stuck them over there. One of the washers came off the tape and I noticed an orbit later this little washer came floating back. I got it again and looked over where I had put it and it wasn't there, so I think it was the same one. The only two items I couldn't control were two 1/8 inch bolts that were loose inside the periscope. They kept floating in and out of the view. Overall the cabin was surprisingly clean, especially after some of the pictures we've seen of previous flights where there was all kinds of litter floating around.

22. What did you see, hear, and feel during retrorocket firing? Describe.

Apparently the alinement of the retrorockets was such that it initially displaced the capsule in yaw, because the first motion I recall was when the yaw rate went full-scale to the right. I brought it back with manual control. I don't know whether ASCS was helping. I suppose it was, although the ASCS yaw operation had not been reliable at all, to say the least. But yaw came right back into the center and held in the center during the rest of the retrorocket firing. You do hear the retrorockets firing very definitely and you certainly do feel them. Al and Gus had both noted previously that there is no doubt when the retros fire. This is a very positive bang on the back at that time. It occurs very rapidly and very sharply. The sensation was interesting during retrorocket firing; you're sitting there weightless and although you know you're going very rapidly towards your back, when the retrorockets fire, I had a sensation as though I was being accelerated back towards Hawaii. The very same acceleration feeling that you feel during launch. It doesn't take much effort to kill this sensation, when you look back out the window at the end of retrorocket firing and see the ground still going in the

same direction. Nevertheless that was the sensation you experience when you're concentrating on the instruments during retrofire.

23. Could firing of individual retrorockets be detected?

Very definitely. Each one hits you with about the same additional force. There is no doubt about there being more deceleration during the period when two of them were firing. The cutoff was not as positive as the initiation of the firing. There is no doubt about when you go on to second one, as when you ramp down to the third.

24. Could you sense separation of the retropackage and did it affect the capsule in any way?

We retained the retropackage so it did not jettison during the weightless condition. (See reentry section)

25. Did retropackage straps spring back and strike the capsule:

(See reentry section)

26. Compare the sensations (sight, sound, feel) during retrofire with those experienced in the ALFA Trainer, the Centrifuge, and the Procedures Trainer.

That's sort of a tough one because I don't think any of the simulations we have had really reproduced retrofire. Now the movements we expect from the rate needles, these have been pretty well duplicated on the Procedures Trainer and the air bearing, but not the sensations. The centrifuge doesn't do it because the centrifuge has to build up to their speed changes much more than the actual retrofire does. I just do not think there has been any trainer that really simulated retrofire. On the ALFA the motions are the same as far as controlling goes, but I think that the most noticeable thing is the changing g field. After you have been there under zero-g for such a long period of time, the changing g field hits. The retrojet actions are all very positive; there is just nothing that we have done that is similar to this.

27. If you controlled retrofire manually, what was the difference in the degree of difficulty in controlling actual retrofire as compared to controlling the retrofire simulations presented to you during your training on the ALFA Trainer, the Centrifuge, and the Procedures Trainers?

Well, we were set up to do an ASCS retrofire. The ASCS was working okay at retrofire time. I backed it up manually. I don't know whether our problem might have been in horizon scanners during this flight or what; but during the period just prior to retrofire, this ten minute



period when the scanners are cut on and we have slaving so that we are correcting, it appeared that everything corrected right up. The window, periscope, and the instruments all matched perfectly as we came up to retrofire so I left it on ASCS and backed it up manually. I played it as though the ASCS wasn't working at all. So we really had ASCS and manual operating at the same time. This is not a mode that I had practiced particularly in the Procedures Trainer, so it's a little difficult to compare it with the Procedures Trainer runs. It was very effective. I would guess that none of the axes varied more than 3 degrees at maximum from their proper setting.

28. Did the whole-body-motion training you received on the ALFA Trainer help you in flying the capsule at zero g?

(See Question 26)

29. Were you aware of any resemblance between the angular acceleration cues you experienced during weightlessness with those you experienced on the ALFA Trainer?

(See Question 26)

30. Did you see the booster after turnaround? For how long and describe what you saw. Did you see it through the periscope when it passed below you?

Well, that was a real good sight. As it came to almost its proper position, the capsule was pitched up a little bit and here was the booster right in the middle of the window. It wasn't more than 100 to 150 yards away. That was some sight, this great big booster sitting right there, just that far away, and going away, thank goodness. It was sitting at an angle with the capsule into the booster pointed down maybe 30 degrees and the longitudinal axis of the booster angle may be 45 degrees to my position so that it was pointed down and northeast. As the capsule corrected back then settled, pitched down a little bit into orbit attitude, the booster went out of sight at the top of the window. I could duck my head down, though and look up and see the booster. I have to give Carl Huss credit. He drew up the chart on exactly where the booster would be and he couldn't have hit it better if he had been there I don't think. I watched, off and on, for some 6 or 7 minutes. It got farther away and was drifting lower. The last time I saw it, it was probably a mile behind and a half mile below. I looked for it again in the periscope, over Kano, where he had predicted it would be, directly underneath and just a little bit south, but I couldn't see it then. You wonder what your capabilities are gonna be. I had good control of the spacecraft and I reoriented to orbit attitude,

put it back on ASCS and didn't drop into orientation mode or anything. I think you could have come off that booster with maybe running a controls check, that plus maybe another 5 minutes of just maneuvering to get the feel of this thing. I think you could have controlled accurately enough right at that stage to have gone back over and probably made an attempt to join up on something.

D. Reentry

- 1. What control mode was used during reentry? Comment on effectiveness.

I went to manual control after retrofire because I set my roll rate in at about the time we had reached a quarter or a half g. The early part of the damping was okay. I didn't feel that I had all the authority that I wanted when the oscillations started building up and I went to fly-by-wire in addition to the manual. I don't think this was until after .05g. I'd like to reserve comment on that until we look back to the record because I'm not real positive where I went to fly-by-wire in addition to manual.

- 2. Compare your reactions to the reentry acceleration profile to corresponding reactions experienced on the Centrifuge.

The g's were no problem. This is similar to centrifuge runs as far as the g tolerance goes. You could still talk at 8g's and although you apparently didn't hear me, I was communicating through that area of g buildup through the communications blackout period. We had all been able to communicate on the centrifuge up to varying levels up to 14g's, although at 14 they were pretty much grunts and some largely unintelligible things. But there was limited communication up to about 14g's so communicating at 8g's was no particular problem. I think our experience on the centrifuge was very similar to this as far as acceleration goes.

- 3. Comment on ECS cooling during reentry.

I never could get the ECS cooling system pinned down to where I felt I had very accurate control of it. I was comfortable, but I would like to have had it a little cooler all during the flight. There was no doubt when the heat pulse occurred during reentry. I had the window shutters open and could see the glow outside. The ECS cooling was okay during the early parts of reentry and I didn't feel particularly hot during the heat pulse. However, about the time we were getting down to around 75,000 or 80,000 feet it got very noticeably warm. It went from the same comfortable level I had been used to up to where it was uncomfortably warm in about 15 to 20 seconds and I never had been able to cool the capsule down as much as I wanted so I was not precooled when starting into the reentry. The capsule stayed uncomfortably warm all the way down through drogue and main chute. When I was on the water finally I was sweating profusely.

- 4. Were cabin or suit pressure changes excessive during reentry?

(This question was not answered)

- 5. Did you lose communications during reentry? For how long?

Yes, I lost communications during reentry. I kept communicating, however, to get some sort of record of how long we are blacked out and I don't know how long it was.

- 6. Did any capsule components vibrate excessively during reentry? Could you pinpoint time of occurrence?

No, you have sort of a general vibration and an increase in noise during that period. I wouldn't say that anything vibrated excessively.

- 7. What was your first cue of g reoccurring upon reentry?

There is no doubt when you start coming back into the g field. You start settling back into the couch again. During the weightless period the natural position is to be slumped forward with the head about three inches out of the couch instead of being back in the couch as for proper eye position.

- 8. Were there any oscillations of the capsule during reentry? Could you estimate their amplitudes? Were they bothersome to you in a physical sense?

Yes, there were oscillations through the main g pulse and these were easily damped out. Following the main g pulse there were just minor oscillations. When we got down to about 50 or 55 thousand feet the oscillations were divergent and they built up to an estimated plus and minus 70 to 80 degrees. The oscillations were diverging so rapidly that I was afraid I was going to get completely over, so that if we fired the drogue it might get wrapped up in the capsule. I was going for the manual drogue button at about 35 thousand feet, and as I was reaching for the button the drogue came out by itself, at about 30 to 35 thousand feet. The frequency of oscillation prior to drogue was about one cps. As far as their being bothersome in a physical sense, they were just about to get there when the drogue came out.

- 9. Were you aware of lateral accelerations during reentry? If so, do you feel it is important to simulate these on the Centrifuge?

No!

- 10. Was there any noticeable difference between the linear acceleration sensations experienced in the capsule and on the Centrifuge? If so, do you consider them important?

The linear g impulse during drogue and main is not a big acceleration that bothers you. The opening of the chute was a

pretty good jolt but was a little mushier or softer than I thought it would probably be due to the stretchy nylon risers. Landing was a little bit sharper than I had figured it would be. I don't know whether you had this type sensation or not. I had thought that this nice big air ride bag back there as being a reasonably soft landing, but this was a pretty big jolt. It wasn't anything that is debilitating or anything like that, but it was just a little more than I had anticipated; a pretty good kick on the back, but nothing anywhere near severe enough to cause any difficulty. The biggest difference is that you don't have any tumbling on starting or stopping like you do on the Centrifuge where you have been going in rotary motion and when you stop or accelerate rapidly you have the feeling of going head-over-heels or heels-over-head, depending on which way you're going. There's none of this at all during reentry. The only time during the whole mission when I had any feeling of tumbling at all was just at SECO, at cutoff. I felt as though I had gone forward, head-over-heels, but this is different from the Centrifuge because your feelings of starting and stopping on the Centrifuge are very, very pronounced. You feel as though you do several loops before you really get the thing stopped.

E. Landing

- 1. Was the capsule stable before drogue deployment? If not, describe motions.

We covered that in discussing some of our other material in Section D.

- 2. Did you hear the drogue mortar?

Yes, there's no doubt when the mortar fires it's a very audible sound. It's not uncomfortably loud but it's a good solid sound.

- 3. Did the drogue deploy automatically? If not, did you deploy the drogue manually? What failure indications did you have?

We described that adequately in Section D. (The drogue did deploy automatically.)

- 4. Describe the drogue opening shock.

The opening shock was not a straight g pulse into the couch as we had thought it would be. This was due to the angle at which the capsule was yawed when the drogue came out. There was sort of a snapping effect as the drogue popped the capsule back up to an upright position. Did I deploy the drogue manually? I was just reaching for the button when it came out by itself.

- 5. What was the indicated altitude at drogue opening?

We covered that in Section D.

- 6. Did the drogue canopy "pulse"?

I didn't notice any pulsing of the drogue at all but there was a lot of back and forth motion of the drogue. I would estimate maybe 2 or 3 feet, it kept sort of ricocheting back and forth in a small circle.

- 7. Did the capsule stabilize after drogue opening? If so, how soon?

Immediately. It was a matter of just 2 or 3 seconds until the capsule was upright and holding steady.

- 8. Did the snorkel door eject properly (did the cabin inlet and outflow function properly)? At what altitude did each occur?

I don't remember hearing the snorkel door go at all, but I assume that it did. That's one thing we can check on the capsule. I didn't get an exact altitude back on the snorkel operation and this is

another thing I'd like to check. I think if anything the snorkel probably operated a little bit low. I would guess maybe that it was down around 15 or 16 thousand.

9. At landing did the vacuum relief valve function properly and did the snorkel valve prevent seepage?

As far as I know, they both operated properly and I didn't notice any water inside the capsule at all, not a bit. And I did check.

10. Was the capsule stable when the antenna section jettisoned? If not, describe capsule motions prior to jettison of antenna section.

We described that somewhat in Section D. The capsule was very stable when the antenna section jettisoned and I could see the whole recovery system just lined up in one big line as they came out. It was almost just like it's laid out in the pictures and the handbook.

11. Did you hear the antenna mortar?

Yes and it sounded very similar to the drogue mortar we talked about a minute ago. These were not real loud sounds but they are very audible.

12. What was the indicated altitude at antenna jettison?

I think we covered that in Section D. I believe it came out at about 10,800 feet where it's been operating on the pad.

13. Did the antenna jettison automatically? If not, did you deploy the antenna section manually? What failure indications did you have?

Yes it did.

14. Could you hear the opening of the main chute? If so, did the sounds coincide with the acceleration pulses?

No, I was looking right at the main chute when it opened and I don't recall any noise at all.

15. Did any noticeable angular accelerations accompany the main chute opening?

No. I think the capsule was pretty well lined up straight below the chute; it was a straight g pulse into the couch but we had a pretty fair oscillation set up after that. After main chute the oscillation wasn't large but we were swinging back and forth plus

and minus 20 degrees at the maximum and the closer we got to the water the more this damped out. This is similar to some of the pictures we've seen of capsules coming down where they had more oscillation shortly after opening than it did close to the water. The chute was very stable by the time I got down to the water. I think we hit with almost no apparent swinging motion. At impact I could see no drift in looking out the periscope, I was watching through the scope and I could tell almost to the second when I was going to hit, because I could see the waves coming up very close right at the last. I could see every little whitecap and the detail on them, and just before landing I braced myself. So you can get a pretty good indication of height just by looking out the periscope. The action of the capsule at impact; it rolled to my right and down a little bit toward my feet down toward the hand controller or the number one battery. It went to that side momentarily and then collapsed over on its side like and then there was water all over everything. The capsule popped back up and assumed various angles from there on.

- 16. Describe the opening shock to the reef condition.

This is a good solid g pulse, I don't know exactly what it was. I think we were estimating a maximum of 4 g's and it probably was, a momentary 4 g I would estimate.

- 17. Describe your view of main chute deployment through the scope and the window. Did you see any chute or riser damage? Was the capsule turning relative to the chute? Estimate amount. Was the chute canopy stable?

The capsule was still turning after it was on drogue and it was still turning even after main chute came out. We were still rotating very slowly and this gradually stopped as we came down closer to the water and at impact we had no rotary motion at all. Did you see any chute or riser damage; no, I couldn't see any damage to the chute at all. All panels looked good, the risers all looked good, just like a completely normal chute.

- 18. Describe the capsule motion after main chute deployment.

I think I've already done that.

- 19. Did the main chute sequence light work normally?

Yes, it did.

- 20. If it was necessary to use the reserve chute, what were the indications of main chute failure? What was the type of failure? Describe the reserve chute deployment. Could you hear the ejection bag inflate?

It was not necessary to use the reserve chute.



21. Were angular accelerations noticeable at deployment?

I believe we've already covered that one.

22. Was it a clean deployment?

Yes, very much so. It just looked like something out of the handbook all laid out in a big long row, and it blossomed right according to schedule. The chute unreefed according to schedule and filled out completely. I noticed no partial collapsing of any part of the chute, it seemed to come out very evenly and came back in about 2 cycles and settled down.

23. Did the impact skirt deploy normally and did the sequence light work properly?

I was going over my checklist and had not yet checked the landing bag at the time Cape CapCom called. I was getting the straps off as he called and said something about landing bag. I went to the switch as Cape CapCom started saying something about the landing bag; it was a reminder for me, and I went to the switch and by the time Cape CapCom had completed his statement I had flipped the switch and the bag was green. I came back and reported that the bag was green.

a. Did you feel the bag was deployed at that time?

Yes, I could feel it release.

b. Did you hear the squib fire?

I don't recall hearing the squib fire. I can't say that it did or didn't.

c. Could you feel it?

Yes, you can feel it go down; there's no doubt about that.

d. Was there shock when it actually released or when it ended its travel?

I don't think I felt much when it went clear down. The main thing I felt was a bump at the time that you activate the switch. I don't recall feeling any bump as it hit the bottom of its travel at all.

e. This was synchronized then with your movement on the switch?

That's right. What I felt was the initial part of the movement. I assumed at that time that it was the lugs on the heat shield releasing and this is just what it sounded like and felt like.

- 24. At what time did the skirt deploy relative to main chute deployment? Did the heat shield drop have any shock effect?

Only at the start of the drop.

- 25. Describe the voice communication with the ships and aircraft during the parachute descent.

They picked me up right away. I think the first estimate was that I would be in the water about 20 minutes, then they shortened that estimate, but I think it actually turned out to be about 20 minutes. I don't have an exact time on that. Communication was very good with the NOA, the Steelhead as it is called. I questioned whether they had me visually at the start and they said they did so I left the UHF VF in the RT position so I could continue to hear what they said rather than putting it back on normal for their homing. They had a P2V around me within a few minutes. Voice communication back to the Cape at that time was pretty spotty. I don't know whether the Cape CapCom was hearing me all the time but I wasn't reading him.

- 26. What was the approximate capsule attitude at impact? Estimate impact acceleration. What was the approximate attitude and magnitude at second impact?

I think we covered most of that, the approximate attitude and magnitude at second impact. I don't think I can differentiate too much between the time the shield hit the water, when the capsule came fully down on it and submerged and then popped back up again as being a primary and secondary impact. This occurred pretty rapidly and you just feel it as one big g pulse. I don't really feel you can accurately say that you felt one impact here and you felt another impact there.

- 27. On what part of the chute swing did landing impact occur?

I don't think I had much swing at that time. The direction that the capsule appeared to go to after impact may have been due to a real slight horizontal velocity, but if it was, it was not apparent to me in the periscope before impact. I don't know exactly what the winds were in the area; I would guess after I was out on the ship that they were probably 10 or 12 knots. So I probably did have a little horizontal velocity, but I could not pick it up in the periscope before impact.

- 28. Describe briefly the landing impact (motions and accelerations). Compare with any other common experience, if possible.

I think we've already covered that one.

29. How long did it take for the capsule to right itself?

The capsule popped right back out of the water and went over to the other side and pretty well stabilized at maybe 20 to 25 degrees off of vertical and almost directly to my left. It was going back and forth quite a bit in the waves but the general attitude it always came back to was a little bit to the left. Over a period of about some 10 minutes bobbing around, it gradually had straightened up quite a bit and was quite vertical, probably within an average position of maybe 5 degrees or so of vertical, and it was fairly stable around that attitude. -- The question was what angle, how much angular travel did it make while it was bobbing around in the water. I think this probably was an average of plus and minus 20 degrees. Occasionally a big wave would hit it and it would go on over to maybe 50 or 60 degrees and bob back up again.

30. What was the final trimmed angle of the capsule in the water?

(Answered in 29 above).

31. Did the main chute disconnect normally? Did the reserve chute eject normally? How could you tell?

As soon as I had bobbed back up again, the rescue aid light was red. I operated it manually and I didn't feel the main chute disconnect. I wasn't positive that the chute had disconnected for about 10 or 15 seconds, then I saw it through the scope in the water and I knew that it was disconnected at that time or at least it wasn't pulling the capsule any more. I didn't have any sensation of the reserve chute blowing out at all or of firing, and I assume that it did. This package was lying in the water along side the capsule (I could see that through the periscope also), but I don't recall hearing any big firing of the reserve chute and it's surprising because these other pyros operating earlier were so audible that I would think I would have heard that one in particular. I operated this switch pretty rapidly after impact, though I think I caught it bobbing back up before we'd been on the water very long. There was quite a bit of noise from the water hitting the side and it may have blanketed some of this other sound from the reserve chute being popped out.

32. Did any equipment break loose at impact?

No, there was nothing flying around inside at all during impact. The g loading at impact - that's a difficult one to estimate because it's mainly a shock g and those are extremely hard to estimate. I would guess the initial shock is probably 12 or 14 g but it's very short (probably not over 1/4 or 1/2 second duration).

33. Could you anticipate the landing time and prepare for the landing shock?

Yes, I had gotten into position so that in case I was not estimating altitude properly through the scope and it sneaked up on me, I would be ready for it so I was back and pretty well braced. The closer I got to the water, the more detail I could pick out through the scope. I used the little hand mirror a couple of times but there was so much junk on the window that I couldn't get nearly as good a view of the water with the mirror as I did through the scope.

I finally gave up trying to estimate my height with the mirror. One reason that I wanted the mirror was that I thought it would give us our best estimation of height above the water, but I just couldn't see enough through the window to make a good estimation. The closer I got to the water, though, the better the indications were through the periscope, and, just before impact, you could see the little white-caps and every little wave detail and you can get braced very adequately.

34. Could you estimate your horizontal speed at impact?

I think we've already covered that.

F. Postlanding

1. Comment on the period of time while you were waiting for recovery vessels or aircraft.

The ship kept telling me that he was 1,000 yards away and then closer in and closer in and I couldn't see him for a lot of this time. I tried to use the mirror again out the window and still couldn't see him, couldn't see him in the periscope, apparently he was coming around on the side away from the scope. Finally the capsule did turn enough so that I had the ship in sight through the scope and all the time he was making his final approach. The scope was lined up perfectly. If I had had control of it, I couldn't have lined up better with the ship so I just watched him coming down; it was a real good sight. This bobbing around out there as I mentioned yesterday was the only time I had any stomach awareness at all on the whole trip and this was after 10 to 15 minutes on the water. I wasn't sick or really nauseous but I was aware that I did not feel quite as good as I had felt before. I think the main comment on this period of time while waiting for recovery was heat. I was very warm. The capsule had heated up considerably inside. I was sweating very heavily at this time and was trying to remain just as still as I could so that I didn't add any more heat to this than was necessary.

2. Comment on ECS cooling during the post impact period.

The humidity increase was very noticeable after being in the comparatively dry oxygen atmosphere all this time and then coming down close to the water. I was not cooling down as a result of the flow even though I did remain pretty static in the capsule during that period. There was no extra activity I had to do at that time. I did run through the postlanding checklists on the main chute and after impact. I went through each item first from memory and then by checking the checklist to make sure that I had everything. I had not completed this check when Al called about the landing bag on the main chute. On the water after impact I immediately began getting the straps and helmet off. I kept the neck dam pulled down over that little collar hook so we kept flow going out without blowing the suit up and that worked very well. I thought about leaving the helmet off to aid cooling a little but I didn't want to lose communications with the ship so I left it on.

3. Was there any leakage into the capsule from any source? If so, did you do anything to stop it?

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There was no leakage at all. I looked everywhere I could look to see if there was any leakage, especially after these chunks had been coming off during reentry. I had visions of these being possibly either a broken heat shield or something there that might puncture the capsule or burn through it a little bit. Actually, back in that area the only place you can look is in the area surrounding you in the upper part of the capsule where a leak probably would not occur.

4. (This question has been answered previously.)
5. After landing could you tell the status of the following rescue aid: SOFAR bombs? Chaff? Beacons? Dye marker? Light?

No, I could not tell the status of SOFAR bombs. I knew chaff was out because the airplane said he had picked it up on radar; however, I did not see it. I did not know whether the beacons were operating or not. I could see the dye marker in the water while the ship was making his approach and before I had him in sight. I learned from the ship that the light was working on top of the capsule.

6. How rapidly did the battery voltages deplete after landing? How did the current vary?

The battery voltages came down to about 25 volts shortly after the start of the flight and were still holding steady all the way through to impact. I didn't check the voltages just before leaving the capsule but I did turn the ammeter switch to off.

7. Could you detect the erection of the HF antenna?

No, wasn't sure it was up until the ship said they had it and would cut it during their approach to the capsule.

8. Was steam noticeable at any time?

No, I didn't see any steam at all.

9. Did you think the heat shield was still hanging below the capsule while floating?

I assume that the heat shield was still down there or we would not have been floating in the attitude we were in.

10. Did the explosive hatch eject properly? Also comment on the noise, etc.

I took the cap off and the pin out positioned my hand with my knuckles beside the plunger, turned my head back away and shielded my head with my arm and then bumped the plunger with my

hand. That was a mistake because the plunger kicked back out and cut both of my knuckles through the gloves and threw my arm back over in the capsule. My knuckles were bleeding down both fingers when I finally undressed later on. I was afraid at first I might have broken them. I highly advise if anyone ever has to use that plunger again they do it with the meaty part of their hand or possibly take the swizzle stick and rap it from the side. The hatch made a good loud bang when it left but it wasn't uncomfortably loud. I still had the helmet on at the time so that undoubtedly attenuated a lot of the noise. I noticed after the hatch blew that quite a bit of grey paint from the inside of the hatch area flaked off and settled inside the capsule.

- 11. Describe your egress from the capsule. Any problems or changes recommended?

Well, this is very much like climbing out of the Procedures Trainer or climbing out of the capsule on the pad. There were two men back behind helping lift me out and keeping me up above the edge of the hatch so we didn't rip the suit. Egress was completely normal; I pulled my legs around in the same position we have for getting in and out. I asked one of the men to hold his arm up so I could hang onto it. We've found climbing in and out of the capsule is a lot easier if you have a handle up above the hatch or someone's arm to hold on to so you can hoist yourself and slide right in and out, and he did that.

- 12. During egress did you encounter any hot spots on the capsule?

No, none at all although I still had my gloves and full suit on. Comment on this should probably come from the shipboard people.

- 13. How much of the survival equipment was used? Was everything adequate?

I didn't use any of the survival equipment. I did have the pack unstowed, however, and ready for use. I didn't have any trouble releasing the pack.

- 14. Did you notice any deficiency in the status of training relative to capsule egress? Was the capsule more or less stable hydrodynamically than the Egress Trainer?

My status of training relative to capsule egress is good. I could have egressed from the top had it been necessary. Hydrodynamic stability is very similar for both. They have the same type motions and general banging around.

## G. Recovery

1. Were there any difficulties during the ship or helicopter pickup? Describe.

The ship drifted down on it's first approach in very good shape. My initial physical contact between the capsule and the ship was a very gentle rubbing up against the side of the ship; I could tell when it happened, of course, but it was very gentle and he immediately said they had the shepherd's crook on it. There was very little delay in starting their hoisting operation. They pulled the capsule up part way out of the water and then let water drain out of the bag in that position. They pulled it up rather slowly for a little while, then hoisted it right on up and stopped in a position out of the water. I thought they did a fine, expeditious job of picking it up.

2. Were any recovery ships or search aircraft sighted while the capsule was still descending on the parachute?

No. The only ship I saw was as I came over Area G. Looking down at the water there was a clear area in between some clouds and I saw a little "V" in the water. I couldn't see the ship, but the "V" in the water headed almost straight west. We can check what the ship's heading was at that time to make sure the ship was there. I went immediately back to my map to check and make sure that I was just about at the right time to be over the recovery area. I had just passed it and was looking back this way, down a little bit below orbit attitude in pitch, probably at a 50 or 55 degree angle; when I checked the time it was exactly the time when I should have been looking right back at Area G. By the time I had checked all this and looked back out the window again I couldn't see it again for clouds. So I think probably this answers our question on whether we can see ship wakes up there or not; I think we could. I'd like to check and see what the ship's heading was at that time because if they were heading roughly west I think that was the wake of the ship.

3. Was adequate information obtained from the recovery helicopter or ship to allow you to decide whether to egress or not before capsule pickup? If not, what was lacking?

Yes, information was adequate. I considered getting out but I decided that I would stay in, mainly because of the heat. Perhaps if I had started egress immediately after impact and had gone ahead and taken the increased heat right then by getting out rather than staying in the capsule I might have been better off. That's debatable; I don't know which was better. I elected to stay in and it worked out alright, so I guess in this case, at least, it was OK.



4. If you did egress prior to capsule retrieval, did you receive assistance from recovery forces and was it adequate?

We'd already covered that.

5. If you remained in the capsule until it had been retrieved by recovery forces, did you receive proper and adequate assistance from shipboard personnel during capsule egress? Do you have any recommendations in this area?

I think it went just like we talked about and just like we briefed. I don't know anything that the ship could have done that would have been any better except just getting there in a bigger hurry. Their procedure was good, their approach was good, they hooked onto the capsule the first try and got it out of the water in good shape. I think their recovery procedure was just like we had briefed on and it was very good.

6. If the Stullken collar and the skin divers were used in your recovery, do you have any comments on their performance? Were there any communications problems?

The Stullken collar was not used; skin divers were not used, although the first report was that they were going to put the divers in the water, but they changed their mind.

7. Narrative account of egress:

When the destroyer came along side they hooked on with the shepherd's crook and someone told me he had cut the antenna. He was keeping me very well informed all during his approach. During the capsule pickup I got one real good bump, it was probably the most solid bump of the whole trip. I understand that a line slipped or they didn't have one of their stabilization lines pulled up. The ship rolled and swung the capsule out away from the ship and then rolled back and swung the capsule against the ship. It jammed me over to the side of the couch. But wasn't anything that would hurt me. After we were on deck there was some delay while they were doing something up on top; I never did find out for sure what they were doing. They asked if I could hear the men talking down from up on top. I could not; there was quite a bit of inverter and other noises still going on in the capsule. I still was in good communications with the ship, however, on UHF. I took the panel loose - I kept the suit hose connected and worked over and couldn't quite reach the last restraining strap for that hose extension that was stowed - remember that way down by the end of the wire bundle on the right. I worked a little bit trying to get down to the extension hose and still keep the vent hose connected, didn't want to disconnect the vent hose until I had to. I probably added more heat to the system during that period straining against the vent hose restraining strap than if I had gone ahead and disconnected the hose and reached down and picked up the

extension. But I finally pulled the extension loose without disconnecting the vent. I was working my way up to sitting up on the right side in the capsule, had my head up towards the back of the hatch and then disconnected the suit hose and was in the process of hooking up the hose extension when I decided to egress by the side hatch. I was really hot by this time. I was pouring sweat, and I decided that the best thing at that point to keep me in a little better shape was to come on out rather than come up through the top. If I had had to get out through the top I could have, but I was extremely hot at that time and with the means of getting out I didn't see any point in fighting that one any further. I don't know whether you heard our communications with the ship or not at that time. I think he asked me whether I wanted to blow it or not. I said I did and to let me know when everybody was clear outside. He called me back and told me when everybody was clear.

## Evaluation of Capsule Systems

1. Comment on your suit. Do you suggest any changes?

Well, we'd all like to go in a shirt-sleeve environment, obviously, but the suit worked fine; I had no problems whatsoever. I think the only unusual thing with the suit was probably that I had not thought that the body posture in the suit would be particularly different under zero g, but it is. When you're under zero g there's a tendency to sort of go into a natural stoop. It may be that the helmet tie-down makes a sort of pull in that direction so it naturally bends you over a little bit if you're just relaxed in the capsule. I had to consciously put my head back in the couch when I wanted it to be back in the proper position. I know of no changes I would make in the suit right now.

2. Comment on your couch. Changes?

If we had had more time to look into the changes on the couch before launch I think possibly I would have gone to the change I suggested back at the Cape earlier and that is just do away with the leg troughs. This would make a nice big area in which to put your legs, so you can move them around in any direction you wish or cross your feet, or put your legs over in one corner or the other. It would make more room for equipment. We want to run this through, I think, on the Centrifuge, or on the track at Holloman, or something like that. All we need, possibly, is just a restraining strap around the knee to keep it from going too far over into the hand controller or over into the abort handle. I think this would let you move your legs around a lot more and still give adequate support, with just a net arrangement stretched across on top of the equipment in that area. This would give you not only more body motion area down in there and more area in which to put equipment, but I'm certain that it would make it easier to get the small pressure bulkhead down in there and stowed during egress. That is not the primary thing that holds up the small pressure bulkhead, though. The control handle and the area around the side of the periscope are the primary things that hold it up. I think it would probably still be easier to stow it down in that area. During the zero g state, though, the leg troughs being in there cause no problem. You feel very comfortable. I don't recall ever having to move around in the suit to get rid of a little bunch of material someplace like you do sometimes when you're at one g and you've been in the couch for a while. It's just like you're floating in the middle of the suit. There just are no pressure points, a very comfortable feeling. The couch was adequate during the high g period which, of course, is what it was designed for. I had no pressure points or uncomfortable sensations from the couch at all during any of the accelerated periods. The restraint harness was adequate.

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3. Comment on your restraint harness. Changes?

We had removed the knee restraints because we felt we didn't need them. And I don't feel that I needed them at all on this flight at any time - during landing, or any of the motions or accelerations - none of them gave any vector that I felt would have been better with knee restraints. Shoulder straps were adequate. I could lock them okay. I locked them before coming back in again, before reentry, and I had them loose during the zero g period and intentionally pulled them pretty well back up so that the spring was not pulling down tight on my shoulders. I didn't release the lap strap; that one is too hard to get tightened up again properly. Even when Joe puts me in there, with him leaning and pulling on the straps very hard, we sometimes have a problem getting that tightened up to where I like it, so I didn't release that at all. I did have the shoulder straps good and loose, however, and the chest strap. This does help you move around some. It helps you move up toward the window. I don't think the straps are the limiting factor in moving up to look out the window. I think it's mainly the suit.

21. Comment on any difference in quality between HF, UHF, and command system outputs.

Well, there's no more difference in orbit communications between HF and UHF than you would anticipate between HF and UHF on the ground. HF is not as reliable, but it is longer range. It's spotty and more subject to interference. You hear some static on it occasionally that you don't hear on UHF. UHF is shorter range, but once you have UHF communication it seems you have it very solid with no problems. I either had it or didn't have it. It was usually pretty clear. I don't know how the HF checks were on the ground, of course, but when we made this world-wide HF check on the first orbit at Australia, I came up and made my call and I heard Cape Cap Com right back. Cape Cap Com was loud and clear and I heard all of the transmission, I think. It was real spotty elsewhere. I'd just hear a word maybe, once in a while from somebody else, but I never received any other solid transmission on HF during that whole pass until the Australian stations came up and I heard them. But for some reason, Cape Cap Com was the only one I heard coming up on the net reliably. We switched back and forth, I don't know how many times - I wouldn't even estimate how many times we switched back and forth between HF and UHF during the flight. After checking UHF lo, we did just like we planned and left it off and flipped back and forth between UHF hi and HF and turned the VOX switch off each time as we had planned, to make sure we didn't wreck the transmitter. That seemed to work very well. You get into a habit pattern on that, where you automatically go down to the transmit switch and automatically reach up and cut the VOX off before you do anything with the transmit switch. You almost tie the two together as far as operation goes.

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Description by John Glenn of the MA-6 astronomical  
meteorological and terrestrial observations

I THE GLENN EFFECT

Coming out of the night on the first orbit, at the first glint of sunlight on the capsule, I was looking inside the capsule to check some instruments for probably 15 or 20 seconds. When I glanced back out the window, my initial reaction was that the capsule had tumbled and that I was looking off into a star field and was not able to see the horizon. I could see nothing but luminous specks about the size of the stars outside. I realized, however, they were not stars. I was still in the attitude that I had before. The specks were luminous particles that were all around the capsule. There was a large field of spots that were about the color of a very bright firefly, a light yellowish green color. They appeared to vary in size from maybe just pinhead size up to possibly 3/8's of an inch. I would say that most of the particles were similar to first magnitude stars; they were pretty bright, very luminous. However, they varied in size so there would be varying magnitudes represented. They were floating in space at approximately my speed. I appeared to be moving through them very slowly, at a speed of maybe 3 to 5 miles an hour. They did not center on the capsule as though the capsule was their origin. I thought first of the lost Air Force needles that are some place in space but they were not anything that looked like that at all.

The other possibility that came to my mind immediately was that snow or little frozen water particles were being created from the peroxide water decomposition. I don't believe that's what it was, however, because the particles through which I was moving were evenly distributed and not more dense closer to the capsule.

As I looked out to the side of the capsule, the density of the field to the side of the capsule appeared to be about the same as directly behind the capsule. The distance between these particles would average, I would estimate, some 8 or 10 feet apart. Occasionally, one or two of them would come swirling up around the capsule and across the window, drifting very, very slowly, and then would gradually move off back in the direction I was looking. This was surprising, too, because it showed we probably did have a very small flow field set up around the capsule or they would not have changed their direction of motion as they did. No, I do not recall observing any vertical or lateral motion other than that of the particles that swirled around close to the spacecraft. It appeared to me that I was moving straight through a cloud of them at a very slow speed. I observed these luminous objects for approximately 4 minutes before the sun came up to a position where it was sufficiently above the horizon that all the background area then was lighted and I no longer could see them.

After passing out of them, I described them as best I could on the tape recorder and reported them to the Cape. I had two more chances to observe them at each sunrise; it was exactly the same each time. At the first rays of the sun above the horizon, the particles would appear. To get better observation of these particles and to make sure they were not emanating from the capsule, I turned the capsule around during the second sunrise. When I turned around towards the sunrise, I could see only 10 percent as many particles as I could see when facing back toward the west. Still, I could see a few of them coming toward me. This proved rather conclusively, to me at least, that I was moving through a field of something and that these things were not emanating, at least not at that moment, from the capsule. To check whether this might be snowflakes from the condensation from the thrusters, I intentionally blipped the thrusters to see if I was making a pattern of these particles. I could observe steam coming out of the pitchdown thruster in good shape and this didn't result in any observation of anything that looked like the particles. I had three good looks at them and they appeared identical each time. I think the density of the particles was identical on all three passes.

I would estimate that there were thousands of them. It was similar to looking out across a field on a very dark night and seeing thousands of fireflies. Unlike fireflies, however, they had a steady glow. Once in a while, one or two of them would come drifting up around the corner of the capsule and change course right in front of me. I think it was from flow of some kind or perhaps the particles were ionized and were being attracted or repelled. It was not due to collisions because I saw some of them change course right in front of me without colliding with any other particles on the spacecraft. If any particles got in near enough to the capsule and got into the shade, they seemed to lose their luminous quality. And when occasionally, I would see one up very close, it looked white, like a little cottony piece of something, or like a snowflake. That's about the only description of them I have. There was no doubt about their being there because I observed them three different times for an extended period of time. I tried to get pictures of them, but it looks like there wasn't sufficient light emanating from them to register on the color film.

## II THE GLENN LAYER

I had no trouble seeing the horizon on the night side. Above the horizon some 6 to 8 degrees, there was a layer that I would estimate to be roughly 1 1/2 to 2 degrees wide. I first noticed it as I was watching stars going down. I noticed that as they came down close to the horizon, they became relatively dim for a few seconds, then brightened up again and then went out of sight

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below the horizon. As I looked more carefully, I could see a band, parallel to the horizon, that was a different color than the clouds below. It was not the same white color as moonlight on clouds at night. It was a tannish color or buff white in comparison to the clouds and not very bright. This band went clear across the horizon. I observed this layer on all three passes through the night side. The intensity was reasonably constant through the night. It was more visible when the moon was up but during that short period when the moon was not up, I could still see this layer very dimly. I wouldn't say for sure that you could actually observe the specific layer during that time, but you could see the dimming of the stars. But, when the moon was up, you very definitely could see the layer, though it did not have sharp edges. It looked like a dim haze layer such as I have seen occasionally while flying. As stars would move into this layer, they would gradually dim; dim to a maximum near the center and gradually brighten up as they came out of it. So, there was a gradient as they moved through it; it was not a sharp discontinuity.

### III NIGHT SIDE OBSERVATIONS OF THE EARTH

Over Australia, they had the lights of Perth on and I could see them well. It was like flying at high altitude at night over a small town. The Perth area was spread out and was very visible and then there was a smaller area south of Perth that had a smaller group of lights but they were much brighter in intensity; very luminous. Inland, there were a series of about 4 or 5 towns that you could see in a row lined up pretty much east and west that were very visible it was very clear; there was no cloud cover in that area at that time.

Knowing where Perth was, I traced a very slight demarcation between the land and the sea, but that's the only time I observed a coast line on the night side. Over the area around Woomera, there was nothing but clouds. I saw nothing but clouds at night from there clear up across the Pacific until we got up east of Hawaii. There was solid cloud cover all the way.

In the bright moonlight, you could see vertical development at night. Most of the areas looked like big sheets of stratus clouds, but you could tell where there were areas of vertical development by the shadows or lighter and darker areas on the clouds.

Out in that area at night, fronts could not be defined. You can see frontal patterns on the day side. In the North Atlantic, you could see streams of clouds, pick out frontal areas pretty much like the pictures from earlier Mercury flights.



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With the moonlight, you are able to pick up a good drift indication using the clouds. However, I don't think it's as accurate as the drift indications during the day. The drift indication is sufficient that you can at least tell what direction you're going at night within about 10 or 15 degrees. In the daylight over the same type clouds, you probably could pick up your drift down to maybe a couple of degrees.

The horizon was dark before the moon would come up which wasn't very long. However, you can see the horizon silhouetted against the stars. It can be seen very clearly. After the moon comes up, there is enough light shining on the clouds that the earth is whiter than the dark background of space. Well, before the moon comes up, looking down is just like looking into the black hole at Calcutta.

There were a couple of large storms in the Indian Ocean. The Weather Bureau scientists were interested in whether lightning could be seen or not. This is no problem; you can see lightning zipping around in these storms all over the place. There was a great big storm north of track over the Indian Ocean; there was a smaller one just south of track and you could see lightning flashing in both of them; especially in the one in the north, it was very active. It was flashing around and you could see a cell going and another cell going and then horizontal lightning back and forth.

On that area, I got out the air glow filter and tried it. I could not see anything through it. This, however, may have been because I was not well enough dark adapted. This is a problem. If we're going to make observations like this, we're going to have to figure out some way to get better night adapted in advance of the time when we want to make observations. There just was not sufficient time. By the time I got well night adapted, we were coming back to daylight again.

#### IV DAYSIDE OBSERVATIONS

Clouds can be seen very clearly on the daylight side. You can see the different types, vertical developments, stratos clouds, little puffy cumulus clouds, and alto-cumulus clouds. There is no problem identifying cloud types. You're quite a distance away from them, so you're probably not doing it as accurately as you could looking up from the ground, but you can certainly identify the different types and see the weather patterns.

The cloud area covered most of the area up across Mexico with high Cirrus almost to New Orleans. I could see New Orleans; Charleston and

Savannah were also visible.

You can see cities the size of Savannah and Charleston very clearly. I think the best view I had of any area during the flight was the clear desert region around El Paso on the second pass. There were clouds north of Charleston and Savannah, so I could not see the Norfolk area and on farther north. I did not see the Dallas area that we had planned to observe because it was covered by clouds but at El Paso, I could see the colors of the desert and the irrigated areas north of El Paso. You can see the pattern of the irrigated areas much better than I had thought we would be able to. I don't think that I could see the smallest irrigated areas; its probably the ones that are blocked in by the larger sized irrigation districts which I saw. You can see the very definite square pattern in those irrigated areas, both around El Paso and at El Centro which I observed after retrofire.

The western part of Africa was clear. That is, a desert region where I mainly saw dust storms. By the time we got to the region where I might have been able to see cities in Africa, the land was covered by clouds. I was surprised at what a large percentage of the track was covered by clouds on this particular day. There was very little land area which could be observed on the daylight side. The eastern part of the United States and occasional glimpse of land up across Mexico and the desert area in Western Africa was all that could be seen.

I saw what I assume was the Gulf Stream. The water can be seen to have different colors. Another thing that I observed was the wake of a ship as I came over Recovery Area G at the beginning of the third orbit. I had pitched down to below retroattitude. I was not really thinking about looking for a ship. I was looking down at the water and I saw a little V. I quickly broke out the chart and checked my position. I was right at Area G, the time checkout perfectly for that area. So, I think I probably saw the wake from a recovery ship when I looked back out and tried to locate it again and the little V had gone under a cloud and I didn't see it again. The little V was heading west at that time. It would be interesting to see if the carrier in Area G was fired up and heading west at that time.

I would have liked to put the glasses on and see what I could have picked out on the ground. Without the glasses, I think you identify the smaller objects by their surroundings. For instance, you see the outline of a valley where there are farms and the pattern of the valley and its rivers and perhaps a town. You can see something that crosses a river and you just assume that it's a bridge. As far as being able to look down and see it and say that is a bridge, I think you are only assuming that it's a bridge more than really, observing it. Ground colors show up just like they do from a high-altitude

airplane; there's no difference. A lot of the things you can identify just as from a high flying airplane. You see by color variations the deep green woods and the lighter green fields and the cloud areas.

I could see Cape Canaveral clearly and I took a picture which shows the whole Florida Peninsula; you see across the interior of the Gulf.

#### V SUNSET AND SUNRISE HORIZON OBSERVATIONS

At sunset, the flattening of the sun was not as pronounced as I thought it might be. The sun was perfectly round as it approached the horizon. It retained its symmetry all the way down until just the last sliver of sun was visible. The horizon on each side of the sun is extremely bright and when the sun got down to where it was just the same level as the bright horizon, it apparently spread out perhaps as much as 10 degrees each side of the area you were looking. Perhaps it was just that there was already a bright area there and the roundness that had been sticking up above it came down to where finally that last little sliver just matched the bright horizon area and probably added some to it.

I did not see the sunrise direct; only through the periscope. You cannot see that much through the scope. The sun comes up so small in the scope that all you see is the first shaft of light. The band of light at the horizon looks the same at sunrise as at sunset.

The white line of the horizon is extremely bright as the sun sets, of course. The color is very much like the arc lights they use around the pad.

As the sun goes on down a little bit more, the bottom layer becomes a bright orange and it fades into red; then on into the darker colors and finally off into blues and black as you get further up towards space. One thing that was very surprising to me, though, was how far out on the horizon each side of that area the light extends. The lighted area must go out some 60 degrees. I think this is confirmed by the pictures I took.

I think you can probably see a little more of this sunset band with the eye than with a camera. I was surprised when I looked at the pictures to see how narrow looking it is. I think you probably can pick up a little broader band of light with the eye than you do with the camera. Maybe we need more sensitive color film.

## Discussion of Predominant Sensations During Launch and Powered Flight

1. What were your predominant sensations during powered flight? Relate these sensations to the over-all flight environment and to your previous piloting experience if possible.

I think lift-off was just about as I had expected. The vibration information that Sig Sjoberg had obtained for us was very accurate. I could feel the engines fire up and when they fired, the whole bird shook, not violently but very solidly. There is no doubt about when lift-off occurs. I had thought the booster might lift-off so gently that there might be some doubt as to when you were actually moving; but there's no doubt about it, you know when you come off the pad. When the Atlas releases, there's an immediate surge--a gentle surge--that lets you know you're underway. Some vibration occurred immediately after lift-off for some 10 to 15 seconds. The roll to the correct azimuth was noticeable right after we lifted off. I had the little mirror pre-set to watch the ground. I glanced up right after lift-off and I could see the horizon going around. After about 10 or 15 seconds of flight, the vibration seemed to smooth out some, but not really as much as I had anticipated. I thought we would go through a smooth flight period before we got to the high-q area, but it never did smooth out completely. The vibration reduced somewhat but there was still quite a bit of vibration and shuddering that you could feel very distinctly. This continued up until we got into the high-q area. There is no doubt about when you are coming into the high-q area. You feel a lot more solid shudders and a lot more intense vibration. I think this started a little earlier and lasted a little longer than I thought it would from our pre-flight briefings. It is difficult to be sure whether you are feeling gimbal or whether it is only the general shaking which you sense. You can hear a roar all during this time, it's a dull muffled sound about the same intensity and type of sound as the roar we used on the centrifuge at Johnsville. That was a pretty good simulation of it. The vibration continued through the high-q area for a minute and 15 or 20 seconds. Beyond that point it smoothed out very noticeably and I think I commented on this over the radio. However, the spacecraft never became completely vibration free, there were always some small vibrations that were noticeable. The acceleration buildup was noticeable but it was not particularly bothersome. I believe I was still making voice reports or talking at maximum g, just before RECO. The capsule came around and I believe overshot a little in its orbit attitude position in yaw. I lost sight of the booster but when the capsule corrected itself to the proper position, I could see the booster by leaning down a little and to the left and looking up a little. When we settled down into proper attitude the booster was right in the position that Carl Huss had been predicting it would be, above the top of the window

and a little to the left. Anytime I wanted to see it, I could lower my head and see it up in that position. Then it slowly drifted down to the window where I had a constant view of it for I guess probably some 6 to 8 minutes. The last time I saw it, it was probably a mile or so away from me and about a half a mile below my level in a slightly lower orbit. I looked for it later over Kano where it was supposed to be directly below me but I couldn't see it in the periscope at all. There was no sensation of tumbling head over heels like those you experience on the centrifuge with its rotary motion. Before the flight, Scott said he thought it would feel good to go in straight line acceleration rather than just around in a circle. It did feel good; I knew I was accelerating with a purpose this time rather than just making circles on a wheel. I think I was rather surprised at BECO. The BECO cutoff was not as sharp a line as I had anticipated it might be. It felt as though it ramped down a little over approximately 1/2 second. BECO was very comfortable. I checked the accelerometer and it was indicating about one and one fourth to one and one half g, right where it should be. At that time you could feel the booster engines leaving. This creates some vibration as those come off. I think you could also hear them. I think you could feel the whole booster shake at that time a little. I don't recall any sensation of head over heels tumbling at this time. I did get just a little bit of this sensation at SECO later on but that, once again, was not as pronounced as I expected. I can remember having just a little feeling at SECO as though I had tilted forward, as though my head was going over a little toward my heels but it was very slight. It may be that the capsule actually did pitch down enough at SECO so that I felt the angular acceleration from this motion rather than just an illusion of movement. At BECO I felt the g reduction and then the slow buildup in acceleration again. At BECO I saw out the window what looked like some smoke coming back by the capsule. I caught just a flash of this out the window. Before the flight, we had noted that at booster staging some smoke and fire did appear up in the area of the capsule. Though we had discussed this a number of times, the first thing that entered my mind was that the tower had fired early. And I think I made a comment on this over the radio. Of course, it had not fired. It did jettison on schedule at 2:34. I remember being puzzled about what this earlier smoke could have been. I imagine it probably was just deflected smoke or flame coming up from the booster as those engines separated. Tower jettison occurred right on schedule at 2:34 and I was all set to back it up at that time. I looked out the window fire. I had my hand up on the pull ring waiting for it. I had checked the clock and got in sync with it. I was counting the seconds to 2:34 because I wanted to look out the window and watch it fire. I was looking right at the nozzles when they fired, just a big belch of smoke coming out. It wasn't a very bright light at all. The tower really accelerated from the capsule; it moves fast when you fire it. I watched it to a distance of

approximately one half mile. It appeared to go straight. It didn't appear to be tumbling at all. I was just looking at the back end of it as it was going away in a straight line with the center of the window. This was a little surprising because the alinement of the tower is such that it should take off back over your right shoulder on a 120 degree course, relative to the spacecraft heading, so it shouldn't have stayed in the middle of the window. At tower jettison, the spacecraft pitched down and provided my first real view of the horizon and clouds. I could see the horizon behind the tower as it jettisoned. It came down below the horizon maybe 3 or 4 degrees. I could see clouds out across the Atlantic. The horizon was just visible. After the tower fired, the spacecraft immediately started pitching up again, and I lost sight of the horizon. There was no marked roughness during this transition period to guidance. I don't recall any bumps or shudders of the capsule as a result of guidance starting. It was a smooth flight from there on. The pitch was about on nominal. I think I called out a couple of variations from the values the Capsule Communicator was reading. I don't recall the exact numbers of them now but there was only a slight variation. I remember making comment about the sky getting very black. When I looked out once before that, it had some color to it and it was very noticeable at this time that it was just black. As we came up toward SECO, the acceleration built up. There was more vibration and, just before SECO, it was very noticeable. There was one sensation I was not expecting. At this time the tanks are getting empty, and apparently the booster becomes considerably more limber than it normally is. You have the sensation of being out on the end of a spring board. You feel a lot of oscillating motions, as if the nose of the booster were waving back and forth a little bit. The oscillations were not high in frequency. It is like being on the end of a big, long, loose spring, which is what you are, I guess. I remember wondering at the time how close these oscillations would get to our abort limits; obviously, they did not trigger the ASIS. I recall I heard a little more noise coming up to SECO, too. I don't know whether this noise echoes up through the hollow tank. Right at SECO I had the very slight sensation of tumbling forward just a little bit. I don't know whether it was just a sensation due to cutoff or whether it was due to a natural pitch down that the capsule made at that point. There's no doubt at all when the clamp ring fires. Boy, you can hear those rings fire! And I was surprised at the force that posigrade rockets had, too. I've always thought of the posigrades as being pretty insignificant little rockets. I thought that if you were not paying much attention you might miss the whole program on posigrade. But there is no doubt on posigrade

fire. They boot you right on off the booster. The capsule damped turnaround in good shape. As I recall the spacecraft pitch came up a little bit as we turned around. I think maybe it pitched a little high coming around and then corrected back down again. And as we came around, I could see the booster. I bet it wasn't 100 yards away. The nose of the booster was pointing off to north or northeast.

Miscellaneous Discussion Abstracted from Grand Turk Debriefing for MA-6

I could still see the booster very clearly as it was drifting down below. If it had been further away and against a perfectly white cloud background, it might have been a little more difficult to see, but I doubt it. It was very visible; the sun was glinting off it. That thing is a pretty good reflector; you can see it all right. I'd hate to estimate how far away I could see it. That would probably be the same as it would be on the ground. If you just came on the Cape and looked at an Atlas booster across there, it's pretty small at about 5 miles away. If sunlight was glinting off of it, you might be able to see it out to 15 or 20 miles. But that's just a glint of sunlight. I think for really knowing that there is something there and seeing the rough shape of it and being able to make an approach on it would require, as a rough estimate, 7 or 8 miles. However, don't set up the Apollo program on that estimate.

The sun shining in the window was very bright. However, this problem is not serious enough to require a servo control shutter mechanism to adjust the light. The sun was not the problem that I thought it might be. It is just like one of those great big arc lights at the Cape. The light coming through the window is the same color and about the same intensity. It's the same very clear, brilliant bluish-white light. It was noticeable for a while, too. The sun was trying to come in the window and was falling down on my arm, which got considerably warm. As far as seeing instruments in concerned, your eyes adapt to the lower light level of the cockpit all right.

I think we probably should reserve opinion on the periscope. I think you can anticipate hitting the water; I wouldn't keep it in just for something like that. You can tell close enough on your altimeter to prepare for impact. When you come down to a thousand feet, just brace yourself. I have felt all along though that the periscope would be of the most value in drifting flight where you're assuming very different attitudes. This is the only wide field reference that you have. Out the window, you have tunnel vision, and if you are pitched up where you can see only stars, you don't know where in the whole 180 degree hemisphere you are. There's no doubt that you can start a rate and roll over until you do see the earth, and then reorient yourself from there by using the window. But this is where I think the periscope might prove of value. I could have done well without the periscope on this trip. But I think that it might be of more value if you are allowing your attitudes to drift. For just holding position, the periscope was not as valuable as I thought it would be. I tended to rely more on the window than I did on the periscope; it's a more natural view. It's just like flying along in an airplane and looking at the clouds.



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You could see stars on the day side out the window. You can't really see them as long as the window is down far enough to view the horizon with its reflected light. I couldn't pick up stars until I'd pitch the nose up above the horizon and waited a short time to dark adapt. Also, I pulled the red filters up once so it cut the lights down, quite a bit, and this helped. I didn't try and adapt far enough to pick up any real constellations or to identify any of them particularly, but I stayed up long enough that I could see several stars.

The briefings that Ed Nieman and the rest of the engineers at the Cape gave were probably of more benefit in getting familiar with the systems on 13 than anything else we did. I used those notes from those systems briefings to review before the flight and it was very valuable. I think that's probably the best training we did as far as systems familiarization goes, outside of the procedures trainer and actual work in the capsule. Those systems briefings they gave us were excellent and in particular, a real special tribute to Ed Nieman. I just don't know of anybody that I would trust further on giving information on these systems. He has really worked on that, and he didn't let it end with the systems debriefing; he continued to give us information right down to the last few days on his own free will, even though we weren't pushing him for it at all.

I don't mean to say that we should do away with other training. We already had a good basic knowledge of the systems, but as far as getting ready for flight the last couple of months there at the Cape, where you really want to get down to the fine points of each system, something like those briefings were invaluable. I thought it was almost prophetic. I stayed up late the night before the flight doing some last minute reading. I was going over our systems briefings and notes that Ed had given us on the stabilization and control system.

I also feel very strongly that you must get intimately involved in the SEDR's and check out activities. You just don't get a feel for an individual capsule unless you're there working with it. There are enough idiosyncrasies from capsule to capsule that you just have to be there to pick them up or you don't get them. Also, when you're working with the gantry crew and the blockhouse people, they know you personally. The side benefits from just being around all the people there at the Cape during checkout and getting to know all of them personally is very worthwhile. It's worth it from that standpoint alone I think.

No, I don't think so. I think the checkout procedure has shown a tremendous improvement, looking back to all the troubles we had the time of capsule 7 and 11. You can certainly see the improvement in check-out systems and the knowledge of the people working on them. Too bad we can't just line up about 50 capsules now and fire them as fast as we could go. That's the stage they've reached now. It's the stage where

all the ground checkout equipment and the ground systems equipment are all working along fine. On 13, in the final stages of testing, it got to the point where, if you had a problem, it was just automatic that the problem was somewhere else besides the capsule. It wasn't that way when we were working on 7. They dug into things and cut bundles and wire changes and made all kinds of changes. I think checkout procedures we have now are good; I wouldn't suggest any changes. We are super-cautious. We repeat things and repeat things, just to make real sure. Probably some of this testing is not necessary but I don't think I'd want to eliminate any checks at this time. If we had it to do over again, knowing what we know right now, I don't think I'd do anything different in the checkout procedures.

As far as seeing the instruments is concerned, your eyes adapt to the lower light level of cockpit lighting all right.

I never saw a single island in the area across the Pacific where I thought I might. The lights of Perth on the western edge of Australia were very clear. I called Gordo and told him but I don't know whether he heard this or not, but evidently everyone in the area had their lights on. I could see a large area of Perth, and also another town just south of Perth that was a very concentrated little bunch of lights. This town was even brighter than Perth. Further south and inland, there were several little towns sort of in a line, that I could see very clearly.

They asked me in Woomera if I could see the airport lights. I couldn't since there was a cloud cover in the area. It was just white down below and I wasn't able to see anything there. The area of South Africa (Johannasburg) was all covered by clouds. I never saw South Africa at all.

The area out over the Indian Ocean on the first orbit was covered by clouds. I described the storm areas in the Indian Ocean last night.

I was really impressed with the amount of time you are over water, away from continents on a flight like this. The large amount of cloud coverage was also very surprising. I thought we would be out over the blue water a lot of the time and could see a lot but there sure were some huge areas with cloud cover. I tried out the binoculars a couple of times and I couldn't see better with them. I would take them again, though, in hopes that there would be more land area to use them on.

I never did operate with the gyros in the free position. I caged them, then placed the switch back on the normal position and I didn't place them on free. I was thinking last night that this was something I probably should have done to see if it would go on precessing in pitch at the programed rate.

During the powered flight phase, as far as I know, I received all the transmissions from the Cape. The only place I felt that I really miscued during the launch period was right after BECO, when I transmitted that I thought the tower had gone. Apparently, some smoke was tossed back up around the capsule at booster staging and my initial reaction was that the tower had jettisoned. You can see the two nozzles of the tower by scooting your head way up in the helmet and looking up. I had just done this when I caught this smoke and my initial reaction was that the tower had gone. I told the Cape this at this time but I corrected it later when the tower did jettison. The only other time we had problems in powered flight communications was just before SECO. I may have been trying to relay a little too much information at that time because I blocked the Cape out a couple of times or the Cape blocked me out. Anyway, we transmitted simultaneously a couple of times just before SECO.

When the retros fired, the yaw rate went full scale to the right. I brought the rate back to zero manually or I helped the ASCS recenter the needle. It was very positive when the retros fired. This was very solid and there was no doubt when it occurred. The attitudes before retrofire were right on. I checked them just seconds before retrofire started and they matched the window and the periscope presentation. So during retrofire I was controlling the yaw rate needle. The oscillations during reentry were certainly not as violent as the ones we experienced as hard cases in the last Johnsville training session. It was not as touchy. The oscillations were pretty similar to a normal case on the Procedures Trainer at Langley which is fairly easy damping.

After reentry I held the hand mirror up to look out the window and held it at all different angles but I couldn't see enough to pay to use it. The whole window was fogged over evenly. The uneven coating that was on the window after we got aboard the ship was due to the washing action of the sea water.

I don't believe that I made a complete station pass on HF. We switched back and forth many times from HF to UHF to extend the communications range. I do think though that HF is a good backup in case the UHF radio fails.

It was not difficult to retract the scope manually at all. When I retracted it the door went shut and I couldn't see any light through it. It was shut tight. It pumped in just like it did in tests at the Cape with the same amount of force needed to actuate the manual handle. I tried using the high magnification in the periscope for yaw determination but this didn't work out. I think one thing that bothered me a little bit was the discontinuity between the outer and inner ring in the scope possibly, although I don't see why it should. If you've flown photo airplanes you know

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that if you look in the scope and ignore all other inputs it's difficult to fly the machine. I seemed to get my best sensing of yaw by just looking out the window and watching things go by and lining the capsule up with their motion. First you had to be sure that the capsule stabilization was holding since capsule motion will make objects drift by fast also. I think when you are controlling out of the window you are receiving three dimensions and you are lining up in three dimensions all at once rather than each axis separately.

When I first saw the booster after separation, it was pretty close and knowing the size of an Atlas booster I could estimate its range fairly well and there was no doubt in my mind that it was the booster.

We've known all the way through the program I think that as far as human engineering goes we had a lot to be desired on the panel layout. Within the weight limitation in which we have had to work we have been forced to take largely off-the-shelf-type gages. You would have to look at each specific gage and read it as an individual gage to get the information off of it. It would be better, of course, if we had some of the new tape-lined type presentations where you can look at a line of tapes with their normal reading areas alined. You can get much more information into a human being with a glance at some of those presentations than you can with these gages. As for specific changes we could make in the capsule for 18 orbits, I'll have to think about that one a little bit more.

There is nothing outstanding that you would want to change immediately. One that we haven't covered yet is the question on the ditty bag, the equipment container; that needs some changing. It's pretty difficult to get to, the way we had a line hooked to each piece of equipment. It was just about the only way we could figure out to really restrain them so that we made sure that none of this equipment drifted away from us. But it really presents a problem when these lines start getting mixed up. After I used the equipment several times and put it back those lines were a real mess. In future flights, I think that the string could be left off the bigger items of equipment like the camera. I think the only things that you need a string on are some of the smaller items. The velcro hatch worked fairly well in restraining all the equipment while in orbit. The motion of the capsule, even though the weights are very slight, seemed to work this stuff loose occasionally. This was probably due to not getting it solidly based on the velcro to begin with. I don't think we did enough work on choosing the spot on the camera for the velcro. We picked a convenient spot; I think we should have been a little more careful and determined what position and angle you would

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stow it and put the velcro on the specific spot which would come in contact with the hatch. We had put the velcro across the back of the camera. The whole back of the camera had to be placed flat up against the hatch in order for the velcro to really hold it. This was not the natural way to place the camera on the hatch. There wasn't very much room for all of this equipment. We had looked before for other areas for velcro. Possibly the area on the window shutters would have been alright except I wanted the windows shutters open all the time. And this would have meant the only place you could have put velcro then would have been on the red filter. We ought to do some more work on the method of storing the gear, and on the procedures for getting it out, placing it in a usable position, the means of restraining it while in orbit, and stowing it before reentry. Perhaps finding a spot for each item of equipment would be better than trying to concentrate them all in one spot the way we did. I think you could probably have your lanyard hook into a little eye-bolt on that spot. Then when you get ready to end the flight, unhook it and stow it. I had wanted them all at one spot so that if I were required to make a rapid reentry, everything could be stowed in a big hurry. Now I don't think there would be that much time lag in going around and picking these hooks off and putting each item back. It might make a minute's difference in being prepared, but wouldn't be any more than that. I think in general the whole area needs looked into before 18 orbits.

I'm sorry that I didn't get to try more of the equipment. I think that we had some tests that might have given us some good information. But when we ran into trouble that just precluded a lot of the things we wanted to do. I'm sorry we didn't get to try them.

As far as freedom of movement goes I think our restriction in the suit is the limiting element in restricting freedom of movement. We are not going to beat that one right away until we get a completely different design for a suit, or larger capsules where you can float out of the couch and move around. Obviously we'd like to have more freedom of movement but I don't know how we can get it. Moving the "E" package in capsule 13 helped a lot. On the pad I could put my legs up, stretch, and move around quite a bit. I did this a number of times during prelaunch period.

In orbit my drift rates varied from just barely perceptible movement to about  $5^{\circ}$  per second. The most rapid rate occurred in yaw. I probably had around  $5^{\circ}$  in each axis at some time. Most of the rates, however, were kept down to  $\frac{1}{2}^{\circ}$  per second to  $1^{\circ}$  per second. To get low rates on manual proportional, you just bang it. For low rates it essentially winds up as an on-off fly-by-wire system. The most accurate control was on the low thrust fly-by-wire. It really puts the capsule where you want it. I don't know whether I was getting some motion from thrusters

occasionally, without intentionally making stick inputs or not. I know I was for a little while in pitch, because I would bring the pitch up on manual proportional and I would have it all set on zero and then the pitch would drift out a little very slowly. This continued through the whole flight. Now, in the other axes I may have been getting the same thing because I would have it pretty well zeroed up and then for some reason it would have a slow rate. Whether this would have built up over a period of time, or whether we could have drifted for an indefinite period of time, I don't know. One thing I might have tried, but did not, was to have switched over to RSCS to see if that would have stopped this drift. That would have kept the fuel out of the manual proportional system and then we could have cut off fuel to the auto system. I did not do many things that I would have liked to have done. I spent 90% of the time during the last few moments trying to determine if I could set up any pattern at all.

As the little yellow spots I saw at sunrise would go around the capsule they would tend to follow the contour of the capsule come up behind and float up by the window and then depart, which indicated to me that we did have a very slight flow around the capsule. Otherwise they wouldn't have changed course. They would come floating right around and maybe come on across, you could see them actually curve back away from the capsule, so we still did have a little flow, slight as it was. Of course they could have been ionized too.

Controlling to a certain attitude was no problem at all, I had active control. I could stop it where I wanted, could control it more than one axis at a time. I could run the gyros right up to the stops where you reach the limit of that particular attitude indication and play with it right on the edge of the stop, without losing accurate control. The attitude indicator limits were no problem. It turned around on manual twice facing forward. Once right where we had planned to do a 180° turn around and an other time when I stayed around in that same attitude for some time while I was still trying to figure how to isolate the ASCS problem. When I turned back around from that manuever I had the maximum errors on the gyros. I had not been beyond the stops. I had made a flat turn around and stopped there for some five minutes or so. That is where I had the maximum errors in gyro indication.

Facing the direction of travel is, by the way, the best way to travel. You can see where you're going. You see everything coming toward you, it's just like sitting up in front of a Greyhound bus, watching the world come at you. Boy, that's beautiful! I like that attitude better than flying backwards. I think I was probably turned around about five minutes during that period and then I slowly yawed back again. When I came back and put the capsule in orbit attitude again, using the window and the scope, the indicated attitude was, as I recall 30° right roll, 35° right

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yaw and  $42^{\circ}$  pitch up, which put pitch attitude some  $75^{\circ}$  off where it should be. I spent the whole time trying to figure what was wrong with the attitude indications. I never could figure out a pattern at all. It was random, you never knew which axis was going off when. The rates at which the attitude indications would drift appeared to vary. They would stabilize occasionally after I'd held orbit attitude for a while, the attitudes would come back and indicate pretty close to orbit attitude. I let the attitude drift occasionally, but I did not let it drift beyond the gyro stops.

We have always tried to minimize the time spent in the capsule before launch. Now in considering this problem I feel we have been thinking about being four hours in orbit. Under the conditions which you experience at Og you do not have any pressure points, you are not cramped physically. It is a lot more comfortable in orbit than it is on back on the pad. I could have waited on the pad longer. How much longer? I don't think I can definitely answer that. The best I could say is based on the day we scrubbed after five hours and 13 minutes when I still felt I was still ready to launch, that I could have gone a similar period of time yesterday and still have been in real good shape. Now I don't think we want to go much beyond that. I think my statement when I got out the day we scrubbed was accurate. I said I felt like I could have gone another hour or so, and still been in good shape for launch. Many of us thought that it would be quite a strain in orbit. It's quite the opposite, it's the most comfortable feeling. It is a very pleasant physical sensation. If you had some means of just sitting here weightless, it would be a wonderful feeling. You are completely relaxed, so that the physical strain part when you're in orbit is much less than being on the pad. I suppose some people will feel that we are trying to ham it up on how easy it is, but that's actually the way it feels. You just feel very relaxed, you're just floating. You have no physical discomfort at all.

I feel that a man can be depended on as much for manual operation of the capsule as he is in an airplane. From my own flight experience I think a man can be depended on. I have no experience in flying aircraft with a pressure suit. But, from our simulations I don't think our control capability, with the pressure suit on, departs too much from our capability in shirt sleeves. We certainly are able to operate the capsule in the pressure suit. I think that man can be depended on to control manually not only attitude but the sequential system. I think that on the next flight we should run an essentially manual mission. I think this would be the next logical step. The pilot could beat the tower jettison by a couple of seconds, with the automatic to back him up this time, instead of the other way around. That would put the pilot completely in the driver's seat. The pilot can not really control BECO or SECO but as far as the rest of the sequence system goes; 5g, drogue, retrofire, I don't think this would be any trouble at all.

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I think I was just as alert, just as capable of taking care of anything that happened in this capsule as I ever am in an airplane. Every bit as much, probably more so in this case because I was more keyed up and more alert. I was certainly scanning, checking systems, much more rapidly and continually than I ever do in an airplane. You don't just go driving along and assume that everything is alright, you're checking the gauges continually. You may look out the window and check something but you immediately come back and set up the scan again to see if anything has changed. This is just automatic, I did this much more thoroughly than I do driving an airplane.

The best time to hold the countdown, if we knew we had to hold, like for weather, is before insertion. If you possibly can, when once the count is started and you're inserted and the hatch is on, you should count as far as you can, considering the fact that the further down the count you get, the more you have done, the less likely you will have trouble later. It doesn't make any difference whether the hatch is on or off if you're strapped in the capsule; you can't get out, anyway. I prefer to have the gantry out during the hold since you have a much better view. It's very nice when the gantry goes away. The only thing to consider, though, is that during extended hold periods, you're burning up your oxygen at that time. If we had the hatch on and we knew the weather was going to hold us up for two hours, I would prefer to sit it out with the gantry away for two hours, rather than bring the gantry back and open the hatch up. I see no advantage in taking the hatch off at that time if you have it on and your checks are done. Leave it on and keep the gantry out.

I am not positive that the snorkel door blew. I don't recall hearing it go. I did not feel a sudden rise in temperature that might indicate that we were bringing heat up from the beryllium shingles. A long time after the heat pulse, the capsule heated up rapidly. We speculated that we were heating the inflow air because it was passing over the beryllium shingles. Now we thought we were going to improve this situation by bringing the inflow through this door and I don't know if we did. It was plenty warm.

I didn't really control on RSCS. I had planned to control some, using it later in the flight, but I didn't because I was busy with the ASCS or the manual all the time. During the controls check, I checked the RSCS by letting it damp, but I didn't actually go ahead and control on RSCS. This is just a check to see if the dampening functioner is working all right. I couldn't hear the RSCS solenoids operate all the



time. The solenoids were feeding through, though, into the comm system and I could hear them click when I operated them in the headset. But this wouldn't give you a true indication of whether they were moved or not.

When the fly-by-wire one-pound thruster was not actuating in yaw, I was using a real fast flip of the high thruster in the mode that the one-pound thruster was not operating to control. I couldn't control this as accurately as you can with the one-pound thruster, not nearly as well, so what I did several times was when I would overshoot in rate with the 24-pounder, I would use my one-pounder on the other side to bring it back into zero and stop right on zero. I think you can control within a half degree per second with the 24-pound thrusters and this is probably pretty close control. I wouldn't call this desirable. Those one-pound thrusters are the best ones for control in orbit. You can control right on the money with those.

The orbit mode limits are pretty low right now. It's a lot tighter than it needs to be. It would be nice to have a system where you could bring the capsule around manually to a certain spot for a particular observation and have the ASCS hold it in this position while you go ahead and make an observation. If you just let the capsule drift, all you need to do is monitor your rates and if you saw a rate building up over a period of time which could indicate a little thruster problem or something that is accelerating you, all you have to do is zero your rates and reorient and you're in good shape. Rather than broadening the limits of the ASCS hold way out, I would favor letting the capsule drift. In other words, have the capability of holding the limits but just don't use them.

Q: As you know, the capsule reads out many functions through telemetry that you have displayed on the instrument panel, which you in turn relay to each station. I think on this flight it was all right, but from now on do you think that this duplication is desirable, or do you want other instrumentation, or do you like this readout process?

A: No, I didn't go over very many stations before I thought we were just unnecessarily repeating a lot of these switch positions that didn't need repeating. I think it's good to give the consumables over each station so there's a good running record of this information back at the Cape to check against what the telemetry is showing. I do think that reading off all these switch fuse positions, for instance, which you haven't changed and you know you haven't reached over near them or you haven't bumped them accidentally, is just unnecessary. The important readouts, I think, are the consumables and cabin

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pressure and outside of that we don't need to give all these readouts every time.

Q: Would you rather have more telemetry? Or less? In other words, depend more on the pilot for information? Or less on him?

A: Well, I think for some of these real early flights that complete telemetry is very fine and needed, until we get a good feel for how reliable some of the systems are. I don't think that on continuing programs in the future we're going to need such elaborate telemetry to send back all of this information all of the time. I really feel that a man is capable enough of operating in this environment to go ahead and operate much as we do in airplanes. We're not going to be able to get completely to that concept, I realize, but I think we can depend on a man with good communications to give us a lot of the information that we are now receiving by telemetry. I spent quite a bit of time just communicating unnecessary information that really wasn't important to the conduct of the flight so that time could better have been spent making other observations. There are so many significant and new things to look for that to me it seemed a little silly to be sitting there parroting off things that they already knew on the ground, anyway. Perhaps this was good for this first orbital flight when we weren't sure what we were going to run into, but I think in the future, on Deke's flight for instance, we could cut way down on this reporting and keep it pretty much to consumables.

Q: Did you use any manual overrides?

A: Yes, 05g. That's the only one. Almost did drogue-- it beat me to it.

Q: Have you any specific test that you want us to make in the postflight? Of course, we are going to make checks of the gyros, control system and whole ASCS and I hope we can get enough scrapings off that window to find out what constitutes that covering on the window.

A: About half of that film on the window washed off during the time that I was in the water, but there was still quite a bit of it on after the capsule was out of the water. The first coating, and the coating that was on all during orbit, was pretty much from the escape rocket firing except this one little red mark that was a bug or something. The rest of the coating on the window was obtained during reentry and this might show up as molten metal, ablation material, and many other things. It might be good to check the 21K barostat and see if we had any shifts in it. We haven't had any trouble with barostats before, but just in case this thing did change its setting and triggered off high, I think we should know about it. I imagine the reason that

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it actuated above the normal altitude was because dynamic pressure was introduced to where it kicked off.

Q: How do you feel about a bag-up landing?

A: This would be tolerable. It's going to be a pretty good jolt, but it would be tolerable.

Q: How about a bag-down landing on land?

A: This is difficult to answer. I can't really say, having hit the water once with a bag. What conditions are going to be like on land impact with the bag-up and bag-down, I don't have the slightest idea. As a real wild guess, before I would have been hurt, I think we could have at least doubled the forces I had. It was a good solid impact, but before you started really being knocked out or stunned or injured, it would have to hit an awful lot harder than it did. I think you could make a bag-down landing on land and be all right. If you've got to make a bag-up landing, I think this might be a little bumpy.

Q: Did you see any of the booster flames envelop the capsule, as predicted?

A: I just saw smoke out the window. I looked real quick and couldn't see it directly but there was smoke outside the window. My initial thought, even though we had talked about this previously, was that the tower had fired and I reported it but then corrected myself later.

Q: You didn't see any flames?

A: I didn't see any flames but I think probably the smoke I saw was deflected from off the booster.

Q: Did you get any of these crystals in your periscope like we have had on previous flights?

A: No, the periscope was good and clear, outside of the two bolts.

Q: Did you notice any sound during launching?

A: Yes, it was the same as it was during the abortive launch attempt before. When they start to supercool the lox tank before they really start filling it, quite a vibration is set up in the whole tank. This was surprising the first time I ran into it but I was expecting this last time. This evidently sets up a real resonance, a real vibration, and you can feel this very definitely in the capsule. It shakes the whole thing. You're sitting there shuddering. This

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vibration starts out and builds up in intensity for maybe thirty or forty-five seconds during that cooling period, then holds pretty steady at a pretty good shake for maybe a minute, and then tapers off again. The whole vibration period probably lasts for three minutes. It's a two and a half to three minute period. The frequency would be at least a hundred cps or so. It's a real good shake with a fairly small amplitude, just sort of a resonance.

Q: At about T-3 minutes we were putting some super-cool lox in. Was there any vibration at this time?

A: No, I didn't notice any there. Everything is all cooled down at that time.

Q: Evaluation of systems operations - item no. 4, part d. Could you hear the demand regulator?

A: It kicked on a couple of times on the pad, when I took a real deep breath. I wasn't scooting down and holding the suit up to make it kick off as we had done before. It kicked on, in a normal big, deep breath, when I expanded my lungs to clear things out a little bit. I never heard the demand regulator kick on in flight.

Q: Could you hear oxygen flow through the helmet exhaust hose? Was it annoying?

A: Yes, you can always hear this noise. No, it isn't annoying to the point where it bothers you. Any noise that is steady over a long period of time, you get used to. It's undesirable, but it's there, and you get used to it, and don't pay any attention to it. So it doesn't particularly annoy you.

Q: Did it interfere with communications or your ability to concentrate?

A: Well, not by itself. But that, along with inverter noise, gyro run-up, and everything else, makes a noise level that occasionally causes you to miss communications. There were a number of times when I had to ask for repeats on transmissions which, I imagine, was largely due to the fact that we have some noise in the capsule. The noise level in the capsule sounded just like it did during SEDR 83 in the chamber. When we switched the fans back and forth on the pad, I could hear the check valve in the ECS system pop and it really pops. The noise makes a real good check on the closing of that valve. You have no doubt about when it closes.

Q: Part e. Did you use emergency oxygen?

A: No, not at all. There was some indication that the emergency oxygen decreased. The indicator in the capsule went down to, I believe, about 90 percent on the secondary system even though the temperature in the capsule had not decreased enough to produce such an indication. So it would be good to check to see if there are any leaks in the system. It may be around that shutoff valve, where we had troubles before.