NASA - Manned Spacecraft Center
Langley Station
Hampton, Virginia
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MEMORANDUM for those concerned

Subject: MA-7 Remote-Site Flight Operations Debriefing

1. The enclosure to this memorandum is the Remote-Site Flight Operations Debriefing that was conducted on Grand Turk Island the first and second days after the MA-7 mission. The material has been edited by members of the MA-7 engineering debriefing team.

2. The enclosure is intended for use by engineering personnel during their evaluation of the MA-7 flight data. The material is also submitted for review by the Editorial Committee of the MA-7/18 Postlaunch Memorandum Report.

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Enc
Debriefing

CONFIDENTIAL

4.0 FLIGHT OPERATIONS DEBRIEFING

4.1 Prelaunch

4.1.1 Insertion and Countdown.- Starting way back at the hangar, things went right on schedule. We actually picked up time in the hangar. We waited a little while to get the word to go to the van, and waited a little while in the van. The Weather Bureau representative came down and we did the weather briefing at the pad. We had forgotten to synchronize the standby clock and standby wrist watch. We did this at the base of the gantry. When the word came to go up, I went on up and climbed in with very little delay.

4.1.1.1 Comment on insertion procedures: The insertion went without a hitch, except for one item. The helmet visor seal bottle hose was not properly restrained, out of the line of vision, by the new velcro tabs on the survival kit flap. This made it necessary to bring the visor seal hose underneath the shoulder strap and then out to only 2 of the 3 pull-downs provided on the survival kit. It was not well restrained. It needs to be improved. Threading the hose through the shoulder harness allows it to work its way out directly in front of the chest mirror as you move around in the seat, so the hose may have partially obscured the mirror.

4.1.1.2 Comment on countdown procedures: The count went perfectly until the weather hold. We had 45 minutes for that, picked it up at T-10 minutes and the count proceeded perfectly again until lift-off.

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4.1.2 Communications.- I have no comment on the communications other than they were excellent throughout the prelaunch period.

4.1.3 Prelaunch Period.- There weren't any moments of confusion in my mind, at least, during the prelaunch period. During the weather hold, I managed to get a call off to my wife and the kiddies. It just went very smoothly, that is my general comment on prelaunch feelings. No problems other than the visor hose.

4.1.3.1 Comment on the length of the prelaunch period: During the prelaunch period I had no problems. The couch was much more comfortable with the confort liner in it than it had been before. The liner is left off until X-1 day, because it is fragile and it gets torn up with people climbing in and out. I had no pressure points. I didn't even have to stretch my legs up toward the small end. I moved the left leg out and crossed it over the right one, but I was very comfortable and could have stayed there quite a bit longer and not have felt any the worse for wear. I had thought about the heat pulse and that I might forget to drink during the flight, so I wanted to make sure I had a lot of water before lift off. In addition, I was just plain thirsty before I got in the capsule and I drank a lot of water, which I soon regretted because I had to use the urine collection device three separate times before launch. As you know, I'd never tested it in the centrifuge that full. It was full, and I also thought it was leaking. As it turned out, it did not leak, but I thought it was leaking, and this concerned me some.

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The length of the prelaunch period was not bad at all. I think I could have gone at least twice as long. I did exercises. I strained against the couch and against the restraint harness, and worked against the seat. That helped.

4.1.3.2 Did you suffer from physical discomfort during the prelaunch period?: No. I just can't think of anything.

4.1.3.3 Were you adequately trained in prelaunch operations which involved you?: Yes. I got a lot from MA-6 and I received more training during MA-7.

4.2 Launch and Powered Flight

4.2.1 Sensations.-

4.2.1.1 What were your predominant sensations during powered flight?: At firing signal, everything became very quiet and I expected to feel the booster shake, or some machinery start, or the LOX valve make some noise. Incidentally, during the whole prelaunch period the booster was much more dormant than I had expected it to be. I didn't get a lot of the clatter that John Glenn had mentioned. Once I felt the engines gimballing, but I don't recall hearing the boil-off valve. It was just very quiet. I was relieved to get down to 18 seconds but everything was very quiet. I expected to feel the verniers light off, but I didn't. Nothing happened until zero. Then I began to feel the vibration. Then you get some idea of the force you're on top of. There's a little bit of shaking. Lift-off is unmistakable. I called lift-off and time-zero before I heard it on the radio. There's no mistaking lift-off.

I remember starting the clock, and I remember most of the reports. All the instrument indications were just what I had expected them to be. The reports, as I remember, went off pretty much as they had in the trainer. I reported the cabin sealing. I took off with the mirror down so I could watch roll-programing, but I didn't see it. And very shortly after that, I moved the mirror out of the way so I could see the pitch attitude. I did look out the window. I could see one contrail and an airplane making another contrail at about 35,000 feet, just slightly off to the right. At around 1:30, the sky changed in brightness rather suddenly. It didn't get black, but it wasn't a light blue anymore, it was a dark blue and the change was sudden. Max q was not nearly as bad as I thought it would be. There is a lot of noise anyway. I could hardly believe we were through max q. It is something you wouldn't notice unless you were looking for it. That's the way it felt to me. BECO is very gentle and you hear a noise. Three seconds later staging occurs. There's no mistaking staging. There are 2 very definite noises at this point; one is accompanied by the drop in acceleration. The other is associated with staging. I think I called staging since I felt it. The VOX linger was a little too long at this time and it cut out some of Cape Cap Coms transmissions. I heard him say something about "staging". I called back again and said, "Do you confirm staging?" This time I got all the transmission saying that Mercury Control Center confirmed staging. At staging you get a wisp of smoke or a change in the light outside the window. The sky

looks like it did down lower. All of a sudden, there's more atmosphere around you. It becomes hazier outside the window. It's gone in a second, just a passing thing. I just waited for tower jettison. This is unmistakable. When the tower goes, you get a bigger jolt than staging. I looked out and saw the tower rotating about 20 RPM, way off in the distance. I could just barely see it. And I saw just a bit of the horizon at this time and smoke still trailing out of the three nozzles. It was headed straight for the horizon. I went through the BECO check and went back to watching the gages. Just prior to BECO, from about 1:45 on, a cyclic yawing at about one cps. had occurred. It was not sinusoidal. It was jerky. And this picked up again after BECO at maybe three minutes and increased very gradually until SECO. At SECO there was a gentle drop-off in acceleration and you hear two separate bangs; a little one that was the clamp ring and then another bang which was the posigrades. And cap sep was green, of course. And the thing that really is your best cue is the weightlessness. That just sort of surrounds you all at once. And it's silent too. It's the silence you notice. I went to fly-by-wire.

4.2.1.2 Relate the above sensations to your previous piloting experience?: I can't. The only thing to relate it to really is the centrifuge and procedures trainer. I can't think now of anything in an airplane that is similar.

4.2.2 Vibration.-

4.2.2.1 Did you notice vibrations at lift-off?: I did, but I wonder if you don't notice the noise more than the vibration. You notice some vibration too, but the noise is predominant.

4.2.2.2 Did you notice vibrations at max q?: Yes. There was a slight build-up, but I don't remember that it was much greater at max q than it was at lift-off. I didn't look out the window to see if the tower was shaking. Maybe one of the reasons I did not, is that I didn't expect it to be. There just wasn't enough vibration, as far as I could tell, to shake much of anything.

4.2.2.3 Did vibrations interfere with instrument readability? Which ones? Describe: Not at all.

4.2.3 Telelights.-

4.2.3.1 Did all telelights operate correctly through turnaround?

4.2.3.2 Which ones did not?

4.2.3.3 Describe your corrective action:

Well, of course you normally have two on at that time and they were on. I did not notice when they went off. They should have gone off at 10:05. I didn't notice it and did not report it.

4.2.4 Communications.-

4.2.4.1 Comment on the quality of voice communications from lift-off through turnaround: Excellent. They did drop off from the Cape. I could tell when Cape Cap Com went to Bermuda transmitters. It was much clearer and I commented on this.

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4.2.5 Noise.-

4.2.5.1 Identify major sources of background noise at various times: You hear the engines. You hear staging; this was very audible. You hear the tower. You hear the clamp rings, and you hear the posigrades.

4.2.5.2 Did background noise interfere with communications or your performance? Which noises? When?: Not at all. The only problem was with the VOX linger. I set it the best I could, but I think it was a little bit too long. It cut out some prelaunch communications and some launch communications with the Cape Cap Com.

4.2.6 BECO.-

4.2.6.1 Describe booster engine cutoff and tailoff characteristics: It's not a sharp cut off, it's just about what I had expected. The noise associated with BECO is about the same level as that at staging.

4.2.6.2 How did you discern BECO?: BECO is unmistakable because of the noise, and the reduction in acceleration.

4.2.7 Tower Jett.-

4.2.7.1 Comment on tower separation: It's sudden and certain. You get a slight deceleration. Well, perhaps it is more of a jerk. I always thought of it as deceleration, but it's a jerk -- something you feel and hear.

4.2.7.2 Did you see it separate?: I didn't see it separate. It happened too fast. The tower looked to me like it was a half-a-mile off by the time I looked up to see it.

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4.2.7.3 Did you see the exhaust?: I didn't notice the exhaust at tower jettison. I could see the exhaust, well after burn-out. The smoke was streaming out as the tower rotated.

4.2.7.4 Did the window cloud up?: I did not notice that the window was fogged. I noticed no change in the window before and after tower jettison.

4.2.8 SECO.-

4.2.8.1 Describe sustainer engine cutoff and tailoff characteristics: There is a gentle reduction in acceleration followed quickly by two noises; the firing clamp of the ring and the posigrades.

4.2.8.2 How did you discern SECO?: By the change in acceleration, the silence of the booster engine and the other two events that follow so closely.

4.2.9 Sep Cap.-

4.2.9.1 Did you discern separation of the capsule clamp ring? How?: Yes. By the noise.

4.2.9.2 Did separation occur immediately?

4.2.9.3 How did you know?:

You don't really know, but you do hear the clamp ring fire. Then you hear the posigrade rockets during. The most immediate sensation is the weightlessness.

4.2.9.2 Describe sustainer motion in pitch, yaw, and roll at Sep Cap: The spacecraft was oscillating one of two degrees (4^{o} double amplitude) in yaw at SECO. This stopped and I did not notice any motions in roll.

4.2.9.5 Did you detect posigrade rocket firing? Describe: You do detect it by the noise and that's all. I do not remember feeling any acceleration during the posigrade firing at all.

4.2.9.6 Describe spacecraft motions at separation: There were none as far as I can remember.

4.2.9.7 What were your cues to spacecraft motions?: I had none. I started the turnaround and wondered why I did not feel something, but you just do not feel the rates and you see nothing out the window at this point. So you have to go to the instruments to see how you're doing. It is just like the trainer. You follow the needles around and pretty soon there is the horizon. It stops you, boy, it stops you when you see the horizon! You should have about 30 seconds with nothing to do here so you can drink this in and take account of what has happened.

4.2.10 Turnaround.-

4.2.10.1 Describe the turnaround maneuver: It went just like in the trainer. You are distracted somewhat by this odd sensation of weightlessness. I don't remember rate and attitude during turnaround, but I remember it seemed to go at a pretty good pace. I went to ASCS right after that. I started talking to Cape Cap Com about the 'GO' and the retro times and so forth.

4.3 Orbital Phase

4.3.1 Sensations.-

4.3.1.1 What were your sensations from spacecraft motions?: None. You just don't have any. I got into some pretty high rates. The needles

were on the pegs a number of times. You just can't tell unless you can see something. If you look out the window, you know what you are doing. If you don't look out the window, you don't know what way is up and you care less. You can assign your own up. That's just how simple it is.

4.3.1.2 Could you feel angular accelerations during spacecraft motions?: Compare with ALFA Trainer: No. The ALFA Trainer provides a good simulation of what you see through the window when looking at the stars, but nothing can simulate this lack of sensation that you have in the weightless condition. The ALFA Trainer very closely approximates the spacecraft rates that you get looking up at the stars, for instance. This is very realistic. There's one thing I'd like to mention here before I forget; when I picked up the booster, it moved down the window just exactly the way it was supposed to. I described its tumbling rates. It was very slow, not rolling. It was pointing away from me with the sustainer engine down. I could see what looked like little ice crystals spewing out of the sustainer nozzle. They seemed to be visible for two or three times the length of the booster, in a gradually expanding pattern. It is quite bright, and easy to see. It crossed the horizon very early. I expected it to be against the sky longer than it was. I took the camera out and had the long lens on, and got what I hope are some good pictures of the booster. It was farther away than I had expected it to be at this time. It was so far away, I knew it was going away, but at this distance, our relative motion was hard to determine.

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4.3.1.3 Were you ever disoriented? When? How did you reorient yourself?: You have to define disorientation. I always knew where to go to see the window, so, with respect to the capsule I never lost orientation. I knew where everything I wanted was. There were times when I didn't have any idea where the earth was, but it didn't matter at all. There were times when I could look out and not see anything. Then I couldn't determine which way I was looking, or what my rates were. At these times the rate needles are the only reference that you have. If you want to call this disorientation, then I was disoriented. But it's not important. You can get to everything you need. You know where they are, and pretty soon the earth will show up. All you need to do is start a rate and it will come around. The periscope is very useful in this respect, because you have such a wide field of view. But, if you didn't have that, the window would suffice. You also have a very good idea of rates through the window if you can see anything at all.

4.3.2 Communications.-

4.3.2.1 Comment on the quality of voice communications from turnaround through retrosequence: I think they were very good. I did not get any transmissions through to Indian Ocean Ship on the first orbit. I heard the Cap Com calling and answered a number of times, but he didn't hear me, and then Cape Cap Com said that Indian Ocean Ship's voice communication was out on the second orbit, I believe. The only other problem I had was with Hawaii. I called them and

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heard them calling me a number of times on the first orbit, but they never read me. When I was within range, everybody said they could hear me, and I heard very well. At one point the Muchea Cap Com made the comment that I was still loud and clear and I got the idea that he had expected a loss of signal long before then. So, communications were excellent.

4.3.3 Noise.-

4.3.3.1 Identify major sources of background noise during orbit: The major source of noise during orbit is the noise you get through the headset when the VOX is keyed. Outside of that, noise is conspicuous by its absence. It is very quiet and this is one of the things you notice most at SECO.

4.3.3.2 Did background noise interfere with communications or your performance? When?: The noise level changed 2 or 3 times and I thought perhaps something had stopped running. As a matter of fact, I swept through all the inverters once because there was a change in noise level and I thought maybe an inverter had stopped operating. It may have been the programmer, or the camera, but it did not sound like the camera. One time a noise started, that had not been present before. Another time a noise stopped that had been present for a long time.

4.3.3.3 Was the noise level annoying?: The noise level was not annoying at all. In fact the silence was welcomed. The headset was very quiet too, no static. I got emergency voice loud and clear every-time. You can tell when you get R and Z Cal. through the rate needles. I noticed them jump when R and Z Cal. was sent. The rate

needles are the only indication of R and Z Cal. I didn't notice attitude needles jump.

4.3.4 Weightlessness.-

4.3.4.1 Describe weightless flight briefly: It's exactly what I expected it to be from my brief encounters with it before. It's very pleasant. It's a great freedom. It's a situation that you adapt to very quickly. It becomes just as natural to let go of the camera in mid air because you know its going to stay there, as it is to put the camera on the table. It also becomes natural to stick heavy items on the velcro on the hatch. In the trainer, they droop down and fall off, but up there they don't. I did everything with my head that the suit and helmet would allow, and could get no sensation which differed from what I would experience here. I shook my head voilently in every direction I could think of, and there just was no unusual experience.

4.3.4.2 Were the controls easier or harder to reach and operate under zero g: Everything is easier.

4.3.4.3 Were there any floating objects in the cabin during weightless flight: I noticed one washer that appeared and re-appeared a number of times because I didn't have any good place to put it. It kept leaping out of the glove compartment, it bounced around until it could find a hole in the gove compartment and then it would slide out. I think it was the same washer each time. When I started to eat the first meal, I noted that the food had all crumbled. The food in a bag is hard to handle, especially when

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the bag is not transparent. It was only translucent and you couldn't open it up and know whether you'd find things on the bottom where you would have to reach in to get them, or clustered right at the top. Every time I opened the bag some crumbs would come floating out. There were crumbs all over. I ate one of the little bite size pieces. It was hard to get down past the mikes; I should have moved the mikes and put it in. I had to sort of feed it in over the mike. I was aware that it might get away and was very careful to get it into my mouth right. As soon as it's in your mouth it's just like eating anywhere else -- no problem. Like John Glenn said, you've got a positive displacement system working for you and once it's in your mouth your problem is over. I put the food back in the bag and didn't both with it anymore until I ate the xylos pill. At that time I had some difficulty with the crumbs, a lot more got out. The rest of the food had either crumbled or melted.

4.3.5 Cabin Lighting.-

4.3.5.1 Was cabin lighting satisfactory during daylight? During darkness? During daylight, yes. During darkness, no. If you were well night adapted, you could read every instrument by the light from the time correlation clock. So it was difficult to dark adapt. I'm not sure that dark adaptation does any good anyway because even in the dead of night through the window I could not see as many starts as could be seen from the airplane coming back from the carrier last night. And so, I think it is useless to waste time counting starts in a given area to determine if your visibility has

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increased outside the atmosphere. The window is more restricting than the atmosphere. The little fingertip lights are beauties. Very, very helpful. I think we should have red filters over the photo lights, as well as the cabin lights. More red light is needed to see everything well. I had to shine my red fingertip lights on a number of the instruments in order to read them. This was particularly true in the case of the clock, because digital windows are recessed and the numbers are not lighted well with just the red cabin lights. The star charts are not legible under red lighting because of the shiny surface of the plastic. There are so many reflections that you just can't read them without either the cabin lights, the photo lights, or the fingertip lights. But even with the fingertip lights, there is so much glare that it's hard to see the small numbers on the side showing elapsed time. The star charts are hard to use under night lighting.

4.3.5.2 Did sunlight effect the visibility of the instruments or controls? If so, how did you compensate for this?: The sun went right down the window on the first orbit. As long as it was coming straight in the window, there was a bright glare, So bright that I felt like shielding my eyes, and I did. I held my hand up to shade my eyes and then I could see allright. When the sun is shining directly on your face through the window, it's very bright. The light is scattered by the window. The sun is not a little tiny point but produces a great white glare on the window. You tend to shade your eyes or change the spacecraft attitude so you can get the sun out of the window.

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4.3.6 Control System.-

4.3.6.1 Could you hear operation of the control system? (thrusters, solenoids, control linkages, etc.) - Yes. You can hear the solenoids, both low and high, on fly-by-wire. The manual thrusters can be heard but you do not hear the clocks like associated with solenoids. You can hear and feel rate command, you can hear the manual solenoids clock. You do not hear the control linkages but you do hear the solenoids. You can hear the thrusters, and you can feel the rate command system kick in.

4.3.6.2 Could you see the exhaust from the pitch down thrusters? You can see the pitch down thruster. It is just faint and transient little "V's" of steam coming right up by your window. You don't see anything moving, you just see this little "V" appear and disappear. It is white, it looks just like steam and it's very vaporous, but visible even at night.

4.3.6.3 Comment on the quality of the manual control system for each control mode used: For maneuvering in orbit, there is no need for the 24 pounders. I feel that they should be wired out in orbit. All the control systems worked perfectly throughout the flight. The manual proportional was very smooth and I still prefer it. Manual proportional is exactly what you want. If you touch the controller very gently, you get the rate you want and you can vary it gradually. With the fly-by-wire low thrusters you get very imperceptible needle movements and you must wait to pick up the

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the desired rate. Once you know the low thruster is operating, you hold the stick in position until you have gotten the desired rate. If you want as much as three degrees per second, it requires either a long wait on the low thrusters or use of the high thrusters. On manual you can get three degrees per second in just about the time you need it. To my mind, manual proportional was very good. I used rate command, once, possibly two or three times and was not aware of the boot you get in yaw right, pitch down, and roll right. As far as I am concerned, the boot was not present. The boot is supposed to make you over-control, but I think that this little gas pocket disappeared in flight because there was no tendency to over-control. Rate command is a good mode for reentry or for retrofire but is no good in orbit. You just don't need that type of control. I much prefer the manual system. For normal maneuvers fly-by-wire low thrusters are the best system. For a tracking task it would be best to have manual proportional. The fly-by-wire high thrusters, and the rate command and auxilary damping systems are not needed in orbit as far as I'm concerned. I was very pleased by the performance of all the manual control systems. They were effective, just as effective as you needed. There was no backlash, slop was not noticeable. No binding or lag. The rates produced by the low fly-by-wire thrusters are so imperceptable that you can go past low and not know that you have activated them, particularly if you're

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doing something else, such as talking at the same time. I think we need another stick, for fly-by-wire low. Then there would be no danger of over-shooting and using the high torque thrusters. I did this a number of times. I over-shot and activated the high thrusters because it's a natural thing for me to do. If, for instance, you want to roll left, you move the stick to left. If the rates are not exactly what you want, the natural tendency is to increase the displacement of stick, as you do in an airplane, and pretty soon you overshoot and activate a high torque thruster and then you've got too much thrust. I'd like to get rid of the high torque thrusters when maneuvering in orbit. Another problem is that you do not really get a chance to get a good feel of the control system on the ground, because you can't operate the valves dry. It would be good to be able to tell by feel, when the thrusters are just ready to come on. A pencil stick would be very good for this. You get to the stop on each side you've got fly-by-wire low thrusters. I think that would be good.

4.3.6.4 How did the performance of the various control systems compare with what you expected as a result of training on the Mercury simulators?: I think that fly-by-wire low rates were a little bit less than I expected. I think the procedures trainer simulates thrust values which are too high. I think the ALFA Trainer does too.

4.3.7 Maneuvers.-

4.3.7.1 Comment on the following maneuvers: Sustainer Tracking, ASCS Zero Pitch, 180° Yaw, 180° Roll, Forward Inverted Flight, Drifting

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Flight, 720° Roll (for radar test) - Sustainer Tracking: With the low relative motion between the sustainer and the capsule, fly-by-wire low torque thrusters worked very well. I did not track very long, but I stayed on the stick and kept the sustainer right in the open center plus mark. It was a very short time but I convinced myself that it is quite an easy task to line up a point on the window with the sustainer and track it. I did not actively track very long because I also wanted to get some pictures of the sustainer at this time, and tracking and picture taking are not compatible. Tracking is only a function of the components of the control system, with one to four pounds of thrust you could get proportional control down to low levels. If you want tracking, I feel this would be ideal. ASCS Zero Pitch: I don't think that I ever held ASCS zero pitch. I doubt that this would be any different than ASCS in any other pitch attitude. You are without any reference to the horizon and this is alright except if you have cause to doubt your attitude indicators. You must crosscheck your rates in the periscope. The zero pitch mark on the periscope horizon line is very valuable for gyro alignment. I used it a great deal. 180° yaw. This is no problem. I used varying rates in performing this maneuver without any difficulty. However, it is easy to confuse yourself as to exactly what you're doing, when you have rates in more than one axes at a time. This produces a coupling effect and you don't really get a lot of good out of what you see out of the window, I did not, at least. 180° Roll. I think the only thing that I

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can say about this maneuver is that you do get pure roll without coupling. Rates in the other axies stay at roughly zero. I cannot remember doing a complete roll. I was supposed to do two over White Sands. I was talking to the Guaymas Cap Com then. I called and said something about "give me a mark on the White Sands radar test" and it seems to me that he said "begin six degree roll rate now". However, at that time I was not in the right attitude and my gyros were caged. So had I performed the radar test it would have yielded meaningless readings since I wasn't rolling around the correct yaw axes. So, I told Guaymas Cap Com to wait until I got in attitude. I then realized that I wouldn't make it in time. I don't feel I can give a good story on 180° roll, except that I do remember one time or another noticing that pure roll stayed pure roll. It did not couple into pitch or yaw. Forward inverted flight. This is beautiful. That's the way to fly. It's nice to have either the horizon ahead of you in view, or it's nice to be looking stright down, and I think you can pick out your Nadir point very easily without reference to the horizon. You can whether you are looking straight down, or off at an angle. I don't know how you do it, but at least I felt that I could tell whether I was looking straight down or ten or twenty degrees off to the side. Drifting flight. This is a thrill, a tremendous thrill. Except it's not much fun when you don't have any rates because then you see the same things all the time. But if you pick up a rate on any axes and watch the world go by, you have a moving picture up there. You see

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something new all the time. Everything, of course, is brand new. You can't beat it, it's wonderful. Drifting flight is really the most fun. 720° roll: I have commented on the 720° roll from radar. I didn't do it. It certainly would be no problem.

4.3.7.2 Comment on the gyro uncaging procedure: Aligning the gyros is a time consuming, or fuel consuming, process if you have to do it in a hurry. Yaw reference is something that has to be studied. I think that we need a visual simulator to give us some practice on this problem. It is of vital importance to have all roll rates, exactly zero before you can use terrain movement to determine yaw attitude. The gyro uncaging procedure is good. It is very handy to have a scope to check on your pitch attitude after you lose the horizon. But it is time consuming and it takes your steady attention for quite a period.

4.3.7.3 Comment on yaw attitude determination under both daylight and night conditions by using: Check points through the window; Check points through the periscope; Terrain draft through the window; Terrain drift through the periscope; Star bearing through the window; Star drift through the window: By pitching down fifty to seventy degrees in pitch you can obtain the best yaw reference through the window. But you have to move a long ways out of orbit attitude to get this reference. Another good yaw reference is available on the scope in nearly any attitude. The high magnification setting on the periscope is the best for this if you have a pattern on the

ground or a cloud pattern which you nearly always have. Yaw Reference by star drift through the window is a very time consuming, even more so than terrain drift. We should not put a lot of stock in it because it takes so much time and it would be better to recognize a star that should be on the horizon, get the horizon in your visual field and then put the star where it should be.

4.3.7.4 Comment on yaw rate determination by using: Movement in the window; Movement in the perioscope: Movement in the window is also good but, again, roll can affect what you see so markedly that you have to be very careful to have your roll rate zero before your indication of yaw rate means a thing. If you're way out, say ninety degrees in yaw, the very best reference is low mag on the periscope, for vernier corrections close to the proper yaw attitude, the high mag is best and the relative motion along the reticle on high mag is quite rapid. I should emphasize again that any roll rate at all is magnified tremendously in what you see as a yaw angle. Yaw attitude is difficult to determine at night. The very best reference is a known star. You can look at the earth and tell when you are looking straight down, but I could not look up and tell whether I was looking straight up or not. Without the horizon in the window you just don't know whether you're pointing up. So, at night, the only really good yaw reference is by knowing the time and the star that should be on your track, you must find it and point the spacecraft at it. I agree with John Glenn that the very best yaw reference on the daylight side is the window, but the window loses its effectiveness as your pitch attitude approaches zero. The scope is useless

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at night. As a matter of fact, I remember saying into the tape the first night side, "something's wrong with my scope, it must have come in". And I was looking at the switch and trying to figure what happened to the scope and then I realized that it was looking at the night side and dark earth below. I was still looking out the window at the sunset and it was just a black hole down there through the scope. So, when the moon is not up, the periscope is useless, and the very best yaw reference is a familiar star pattern. You can also align yourself in yaw if you can see the Dipper, find north. For this you must know what your attitude should be with respect to a compass Rose. I did notice that the terminator is visible on the surface of the earth when the moon finally does rise. The part of the earth that is lighted by the moon and the part that is not are both visible through the window. The lines on the window are very helpful, and boy! did they glow at night! They really were bright at night.

4.3.7.5 What is your opinion of using drifting flight for extended periods of time?: (i.e. several orbits): I think this is wonderful. I think that we could use some study on what rates to start out with. We should set up an attitude and then put in a rate that will, in the period of one orbit, allow you to sweep through at a very slow rate everything you want to see. The spacecraft was very very stable. I think that it is possible to set up a very slow rate and have it stay in there for as long as you care to leave it. One degree per second is enough. John Glenn said in his debriefing

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that he wasn't able to hold zero rates for any length of time, his spacecraft gradually picked up a rate. But I didn't notice this, I felt that once zero rates were obtained the spacecraft would stay oriented for a long period of time. During one period of drifting flight the moon crossed the window and the rates were low enough so I just zeroed them all out and the moon stayed in the center of the window for a long long time and I was occupied with something else for some time and I was surprised to see that the moon had not moved after I was through.

4.3.8 Planning and Training.-

4.3.8.1 Were the in-flight activities adequately planned?: I think they were adequately planned and I was well aware of everything that we wanted to do and how to do it. It just took too long to do it and report on it too. I was unable to get any of the Weather Bureau photography. Changing film is just like John Glenn said. It bothers you to have to waste time on little things like changing film in a camera. Everything should be made very simply and very easy. Finger dexterity is something that is pretty hard in the suit but even this is improved at zero g's. There was a lot of activity planned during the flight, there was too much. The training involving inflight activities was hampered by a number of things. One of them was the lack of a visual simulator. Another was the lack of the inflight equipment. Finally there was a lack of adequate flight configuration stowage. Training was also hampered to

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a great degree by the fact that a finished flight plan, one that had approval throughout, was not available much earlier in the preparation program. A flight plan was drawn up and practiced but down deep you knew it was just tentative. You had to wait until the very last minute to get it approved. This is not good. Every little correction has a great effect on what you do -- adding and subtracting things and prohibiting certain items or including other items in the flight plan hampers training and inflight performance.

4.3.8.2 How long before the flight do you think flight plans should be frozen?: I think two months, or sooner. It should be finalized as soon as possible, because it affects the quipment you are going to use on the flight. There are a lot of other things to do besides sitting in the trainer working out the flight plan and working with the eq' equipment. I think that the most vital part of the whole preparation phase is getting a flight plan that has everybodies sanction at the very earliest moment. Then you can work on this and have a guarantee that there will be no additions or deletions.

4.3.8.3 Did you practice stowing equipment in the Procedure Trainer?: I did; however, we did not have the flight configuration equipment. We did not have a glove compartment. There were also a lot of last minute changes. Stowage was not a problem in the flight. We worked that out very well. The ditty bag is almost unreachable in the Trainer, you just can't work with it but at zero g it's just as handy as it can be. The ditty bag was not a problem in flight but in the trainer you know what a problem it is with the suit on.

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You hate to sit in that suit in the trainer because you're so restricted in mobility, but you have the mobility in that suit at zero g that you have in your shirt sleeves in the trainer at one g. It's just fabulous the mobility you have! I would recommend that the flight plan should not be quite so busy. I was unable to do everything that I wanted to do. I think one of the reasons was enough time was not allowed for looking at new things and evaluating and recording them. Now, for example, five minutes was allowed for evaluating the haze layer. It takes you five minutes to look at it and another five minutes to report on it. The flight plan was too busy. I think that a good way to make up a flight plan would be to list the experiments and observations in order of their priority and then provide a certain part of the flight plan for their execution. The investigation of these items should be ad-lib, because so much is tied to launch time which determines sunrise and sunset times. I think we could do some more work on the way the flight plan is arranged. In airplanes you go up and fly and do things in order, and it really doesn't depend much on the time of day. But, when you have other things to do that depend on the time of day, I think we need a new approach.

4.3.8.4 Was there adequate time allowed for a smooth transition from one activity to another?: This varies. There was one very good period on the third orbit after the Cape where there was time available to sort of sit back and thing about what you want to do.

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There was a little time that was not filled with demands and you could experiment a little bit. You could use your own ingenuity to evaluate the situation. The answer really is, no.

4.3.8.5 Was your training adequate for the activities involving control of the spacecraft? (maneuvering, switching control modes, gyro uncaging, etc.) - I understand fully the functioning of all the systems, I believe. However, we don't have a good way to simulate the gyro uncaging procedure because we don't have any visual presentation through the window or the periscope. The first time this was ever really done was in flight and I'm sure that had I had more training it would have been done more easily and quickly. Maneuvering in orbit is no problem. You can maneuver with respect to rates and attitudes that you see out the window when you have a good visual presentation just as easily as you can when you have rates and attitudes on the indicators. I'm very familiar with what is required in switching control modes, but there were two or three times when I had double authority and did not want it. One of these times was during retrofire and, of course, you don't notice it at that time because the spacecraft to the retrorockets is so high. However, in orbit-maneuvering it is apparent when you have double authority because the spacecraft rates are so high. You catch the error immediately but you expend fuel in the process. On two or three occasions the gyros did not cage. One time I caged and one of the needles did not go to zero. Another time pitch and roll attitude went to zero

but yaw stayed at thirty degrees. I went to "free" and "caged" again and this time it did not cage. I caged once when I had a roll attitude that was creating some coupling in pitch and yaw. This occurred when I was low on fuel. I didn't want to use a lot of fuel to being the roll attitude to zero. I caged with roll attitude very close to the indicator stop. Pitch attitude was also very close to the negative indicator stop, but gyro caging worked fine that time. Prior to retrofire, I caged with yaw on the positive stop and this was when I had the ASCS problem. I did not really know what was wrong. The roll and pitch caged correctly but yaw did not. I set up a right yaw rate, I believe this was when the gyros were caged, and when I got past about forty degrees right yaw the yaw needle, flipped around and stopped at zero. This is bad practice. I realized that at the time but I felt there was no other choice. We don't have an adequate trainer for gyro procedures. Switching control modes training is also inadequate.

4.4 Retrosequence

4.4.1 Sensations.-

4.4.1.1 Describe what you saw, heard and felt during retrofire: I was very hurried during the pre-retrosequence period. This is, I believe, when I started knowcking the particles off the side of the capsule. That fascinated me enough and I wanted to get some pictures at that time, that I pushed myself too close to the limit with the equipment stowage and the pre-retrosequence checklist.

The Hawaii Cap Com was a big help in insisting that I get busy with the checklist. I kept watching the clock. I thought I would have time and I would have had it not been for the ASCS problem. Anyway, I was hurried during that period. Retrosequence came right on the California Cap Com's mark, the retrosequence light went green. I had the "switch warning lights to bright" item on the checklist and the lights were not as readily visible as they should have been. I don't really know why the warning lights were on dim. Earlier in the flight I had taped over the cabin water and fuel quantity lights. I may have gone to dim rather than tape a third light. Well, I don't really know why I did. It must have been an effort to reduce the lighting in the cabin at night. At any rate, they were on dim and that was not good, they're not really noticeable when dim. The California Cap Com's count was very helpful on retrosequence. I think it was sometime after retrosequence, that I told the Cap Com that I didn't trust the ASCS retroattitude and was going to have to go fly-by-wire. The Cap Com said, okay, and stated that it would be necessary to bypass retroattitude. I would have forgotten that. I would probably have been five hundred miles long if it had not been for the Cap Com's reminder. I followed the Cap Coms countdown to retrofire. I looked at the clock and it was reading twenty-nine seconds. I did not get retrofire. I pushed the fire retro button and still did not get retrofire for about a second or a second and a half. It was a very short

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delay. Another item that concerned me was the fact that just prior to retrofire the balloon was right out in front of the window. This was a result of not being able to jettison it. During the drifting flight that had preceded retrosequence the balloon had become wrapped around the spacecraft. There were a couple of times when the line was coming down from the heat shield right across the window. However, I am convinced that the line was not wrapped around at the time I tried to jettison the balloon. I have never jettisoned the balloon before but I imagine you should hear some sort of report from the squib. I heard a report when deploying the balloon. But when I tried to jettison it the switch was dead. I worked it from deploy to jettison, back and forth. I shook it and wiggled it and did a lot of other things but nothing happened. And so I watched this balloon but it was not in sight at retrofire. I was afraid for a while that it was going to be. I would like to have seen what it did, but I did not. It was out of view. For fiteen minutes prior to retrofire I imagine that I was on fly-by-wire. However, the pre-retrosequence check list called for ASCS with a manual backup which I selected. Then I suspected ASCS so I went to fly-by-wire and did not push the manual handle in, as I should have. This gave me double authority and that's where I lost the rest of the manual fuel. I got the count, at retrofire. I looked at the clock and at twenty-nine the retro-rockets had not fired. I punched the button and I had time think

[redacted]

oh something has gone wrong. Then they fired . I think now as I look back on it again that it was at that time that I saw the smoke, either right then or after all three rockets fired. It did not smell like insulation burning. It smelled like hot metal to me, like oxide burning off when it gets hot. I saw nothing at retrofire. I heard the retros fire, of course, but it was a very mild decelleration. I had the idea at that time of just a little push on back. Just a little jet out there pushing. Not a great big one like the retropack appears to be. I was not really paying much attention to my sensations at retrofire until it was all over. I called out once, two and three. After it was all over I felt, not that I had been pushed back to Hawaii as John Glenn did, but rather, that I had just stopped. I was convinced that if I looked down at the earth I would see that all the relative motion had disappeared, and that I was going straight down. But then, of course, as soon as you look out the window this is all washed away because the relative motion of the spacecraft has not changed much.

4.4.1.2 Did you detect and mark individual retrorocket firings?: Very easily.

4.4.1.3 Compare the sight, sound, and feel sensations of retrofire with those experienced on the Centrifuge, ALFA Trainer, and Procedures Trainer: The sight is similar to what you see on all of these, but I think the alignment was very good this time because I just don't remember any rates at all. I don't remember controlling a great deal. Of course, I had double authority on which we have

not practiced a great deal. But I think the alignment was very good. The "feel" sensations of the retrofire and those produced by the Centrifuge simulations of retrofire are not similar at all.

4.4.1.4 Did you detect separation of the retropackage? How?: I did and that's all. You hear a noise, and maybe you sense a little jerk.

4.4.1.5 Did separation of the retropackage effect the spacecraft in any way?: No, not that I could see.

4.4.2 Control System.-

4.4.2.1 What control mode (s) was used for retrofire? Comment?: I was on manual and fly-by-wire and I think that I had expended my remaining manual fuel during retrofire. After retrofire I realized that I was on double authority. I went off of fly-by-wire and tried to control using the manual system because I wanted automatic control for reentry. I had no control of rates with manual at all. I went to rate command and still had no control. The reading on the manual needle fuel gage was five or six percent, but there just was not any fuel left. So I went to fly-by-wire. At that time the auto fuel gage read fifteen percent. I was concerned, because I thought maybe this would indicate only ten percent fuel actually remaining because the manual tank was empty when indicating five per cent. So I went to drifting flight again for ten minutes. I wanted to keep the attitude such that I could see the horizon. I had ten minutes to get a yaw reference at a pretty flat attitude, which is adequate. I did not want to use

a lot of fuel getting into reentry attitude at that time because there would have been a long period where I could have drifted and not known it. So I stayed down where I could see the horizon and planned to stay that way until I got either .05 g or reentry oscillations. I don't remember .05 g. If it came on, I recorded it. I think I did note it and then I pitched up to an attitude that I felt was about right for reentry. I don't think it was just chance that I was in the right attitude at reentry. I think that prior to .05 g or prior to the time that the oscillations built up, there was enough aerodynamic damping to orient the spacecraft properly. I believe that the spacecraft could reenter and get down to a hundred thousand without any fuel. I think it could do it on its own. The rates were very, very low. The oscillations when they first started were maybe a quarter of a degree on either side of zero and they remained like that. It was as stable as it could be until down around a hundred thousand feet and then I began to observe large oscillations. I noticed three or four degrees in pitch and yaw. I took the reentry roll rate out somewhere about that time. I noticed the rate needles were on the stops and I began to feel a knocking back and forth. You could hear a noise and feel a sharp stop on each side.

4.4.3 Planning and Training.-

4.4.3.1 Was preparation and execution of retrosequence conducted as in flight simulations?: No, it was hurried. The equipment

was all stowed okay. I put the binoculars in the map case and this was not their planned position. Everything else was in the ditty bag and the ditty bag was closed except for the items that I launched with in the glove compartment. I did not go through the complete pre-retro check list. I did get the important items. The retrosequence check list is not in order of priority. It runs from left to right across the instrument panel. Perhaps we should have a short retro check list to use in an emergency. The one I used was very complete, perhaps too complete. It was long, but it was easy to do. I did it in the trainer in two or three minutes on a number of occasions.

4.4.3.2 If you controlled retrofire, what was the difference in controlling actual retrofire as compared to retrofire simulations on the ALFA and Procedures Trainers? I think the attitude alignment was very good. In training I have never divided attention during a retrofire between window, periscope and the instruments. I know that this dividing your attention between the three reference systems is a bad way to control retrofire. However, I did this during retrofire and this was a difference between the trainer and the flight. Another difference was double control mode authority. Another difference was that the pitch needles was not indicating 340. It was around 150. The control task is a very simple one. Since I had double authority and did not realize it, the control task may have been more difficult than necessary. A final difference

between the flight and the trainers was the linear accelerations to which I was not accustomed, which may have resulted in over-controlling.

4.5 Reentry

4.5.1 Sensations.-

4.5.1.1 Describe your sensations during reentry, noting both high heating and high g periods: I did not notice a heat pulse in the cabin at all nor did I notice heat on the suit from direct sunshine. The only g pulse I really noticed was the reentry decelleration. This was because I talked throughout the whole thing and I remember noting that I could not say as many words with one breath, as I expected to be able to. I had to breathe in mid-sentence to get another bunch of words out. But the heat pulse was not noticeable. Incidentally, I noticed rate-of-descent of about six or seven feet per second on the rate-of-descent meter prior to retrofire. I hadn't noticed it before because the flight plan covered this indicator in orbit.

4.5.1.2 What was your first cue to g reoccurring upon reentry?: I noticed a hissing sound. This was my first cue that reentry was starting. I also remember that the hissing sound began long before the Cape Cap Com said "we're expecting the blackout to occur in forty seconds'. I am not sure that I commented on the hissing. You are not really sure you hear it until after it's all gone. Then you realize it has been present. I put in a roll rate. I thought maybe, because an improper reentry attitude, that I might get a coning movement but the spacecraft was rotating right

around its axis. I looked down around the center of the window and it was turning in a perfect roll. I sighted through the lower part of the window right along the center line. I could see a given spot in the sky all the way around, so the roll rate was pure roll. This was after the oscillations had started, so I feel I was aligned properly. The roll rate was reading ten degrees per second. The g period was long, but it may just have been because you do not really notice the length of the g period when all you have to look at is the g needle in the trainer. It's such a subtle thing that I cannot be sure. I remember looking down and reading something under one g. That was my first cue.

4.5.1.3 Was there a noticeable difference between the linear acceleration experienced in the spacecraft and the centrifuge? Describe: No. As far as the simulation of reentry is concerned.

4.5.1.4 If the window shutters were open, describe how the "fire ball" restricted vision from onset to termination. When did it start? Waht was the duration?: The first thing I noticed was a higher light level outside the window. There was a haze outside but it was not a bright glow. It was a haze with a faint orange tinge, and it was similar to the temporary haze that occurred at staging, had a slight orange glow. This persisted for some time and disappeared. I was surprised that it was quite some time after that I was able to see the little orange glow with a black hole in the center which is, I assume, the track you've been through leaving little glowing particles behind. Flaming particles continued to fall off. I think that

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the orange haze appeared prior to .05g but I am not sure. The orange glow was just sort of a faintly luminous haze. In addition there was a green flame coming from around the cylindrical section. It was very noticeable. I thought for a while that the trim angle might be wrong and that I was taking off part of the cylindrical section. I can remember seeing three separate streams. One right in the center that looked to me to be V-shaped and appeared to come out eighteen inches from the cylindrical section, and then two smaller streams on either side. These fluctuated and glowed and were a bright, light green. Later on about the time we were probably transonic, I saw three or four puffs of white smoke that looked like the smoke you get from a grass fire that's just beginning to burn. They were white and thin. As I looked out the window they would be back behind the spacecraft. A white glob of smoke would shoot back and then another, and another. Three or four at a time. This was just a little above a hundred feet. Just before the altimeter was off the peg. It was also around this time that the retro strap came off and around the same time also that I think the balloon line floated back. The retro strap was eighteen inches long and about an inch wide. Long after the g pulse I saw a little part of that nylon balloon line coming floating back past the window. And there were times after landing when the window was completely submerged, so if it was coated it could have washed off.

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4.5.2 Control System.-

4.5.2.1 What control mode (s) was used for reentry? Comment: I used fly-by-wire until .05 g or until I picked up oscellations, then I went to Auxiliary damping. I put in a roll rate with fly-by-wire before I went to AUX-damp. I was not aware that AUX-damp provided roll rate on reentry, but it did. When I went to AUX-damp the roll rate increased.

4.5.3 Communications.-

Comment on the communications blackout during reentry. Duration?: I heard the Cape Cap Com estimate blackout at, in 40 seconds, and I said to him; "I will standby for your transmission on emergency voice." I heard nothing. Absolutly nothing. I called him a number of times during this period. I did not hear anyone. From then on down, I just talked about what was going on. The duration was from blackout until main chute. Then I heard the Cape Cap Com transmitting blind something about "landing long, estimate an hour." I believe this was after the deployment of the main chute, but I am not sure. It is possible that I missed some transmission because my ears did not clear until I got the visor open and squeezed my nose. When you clear your ears your hearing gets much more acute.

4.5.4 Cooling.-

4.5.4.1 Comment on ECS cooling during reentry: Immediately after SECO I remember reporting steam vent temperatures of 70° for both the suit and cabin. I was confortable for quite some time but I knew

that more cooling was available and so I increased the water flow from the launch marks of 4, up to 5. I may have been impatient. I knew that ten minutes was required. I didn't realize that I might still feel the effect of a change in water valve setting after 30 minutes. I did not get any change and I increased it again. The maximum setting I used on either the cabin or the suit was about 8. I didn't get a substantial change in cabin air temperature through the flight. I did get substantial changes in cabin steam exhaust temperature, and substantial changes in suit inlet temperature, but no real changes in suit temperature. The cabin steam exhaust dropped. Then the cabin excess water light came on and I looked at the gauge and it was down at about ten degrees. Apparently it swept down through 40°, and as soon as it froze, it dropped right down to ten degrees. I think at that time both the cabin and suit controls were set together. I realized that I had frozen the cabin and it was about time that I backed both of them off to zero, and set them at a lower setting. Cabin slowly came up. Suit temperature never changed, and the suit temperature was hot. Anyway, through various manipulations of the suit needle, I finally got a drop in suit temperature. I never saw a substantial change in suit steam exhaust. I was quite confortable throughout reentry. I was never warm on the water, I was busy getting out and I may not have been sensative to temperature. I remember being surprised that the cabin temperature was only 101°. I think that's what it was. In the trainer, cabin

temperature is 130° and John reported 130°. But I was much more confortable during the reentry and the time on the water, even climbing out, than I was for that period on the second orbit. So cooling during reentry, once the suit valve got in the right position, was adequate. In orbit the temperature settings are a very, very critical adjustment, and the lags are much longer than I had expected. I was impatient with the response that I got from new settings. I remember, when I was very hot, I could open the visor and it was just like a fresh breeze on my face. The temperature of the cabin is higher by 30 degrees, than that of the suit, but when you open the visor it is a wonderful feeling. I have an idea that it may be the humidity that makes the suit so oppressive. I think that we do not get rid of enough water out of the suit. I think we need a better way to keep the humidity down. That's the only explanation I can think of that would make a 101 degree temperature feel cool by comparison to 70 degrees.

4.5.5 Oscillations and Vibrations.-

4.5.5.1 Were there any oscillations of the spacecraft during reentry?: Oscillations during the g vise down to maybe 2 g's were minimal and I was really proud of AUX-damp. Another thing that I noticed was that we got through the whole g-pluse with an unnoticeable fuel consumption. I was surprised to see that I still read about 15 percent after we were through the g-pluse. I noticed then that the rate needles began to swing out and then I think I took

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the roll rate out. I noticed rates of 3 to 4 degrees per second. I looked back out, and during this time, things were falling away, I think. The rate needles were soon on the peg and the sun came across the window. The attitudes really diverged then and the thing I noticed was the change--it sort of knocked back and forth--and then the knock on each end became less, but the rotation in that direction continued. I got the sensation that we were building up amplitudes steadily. At about 70 or 80,000 feet the rates really started going up, and at about 45 the oscillations really started diverging. I turned the fuse switch on at 45 and went over for the drogue. I watched the altimeter, and remember saying that the rates were going too far, "I'm going to have to try the drogue now", and I punched it off, I think, at around 26 or 27 thousand feet. It snapped out and it was really straining and shaking and pulsing and all of this, but this stabilized the capsule very well. Then at 15,000 feet, I got the fuse switch for the main parachute and at about 9500 I looked for the main light and it was not on so I pulled the main ring. The main parachute came out and I was surprised at how it strained! I've never seen fabric vibrate like metal. It was stretched so tight--not like a sail luffing or anything--it was stretched tight and just vibrating like a piece of metal! It's taking a tremendous strain. I watched it ruffle around while it was reefed and then it unreefed right on time and came out and it's a beautiful sight! It really is! I remember noting

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the reefing lines. You see these things hanging and you think something has failed and you think, "here's something that's broken". But you realize immediately what it is. The chute rotated so that I could see the whole thing and it was perfect. There was no damage whatsoever; rate of decent was pegged right on 30. I went to auto on the landing bag and it came out right away so apparently there had been twelve seconds of time elapsed.

4.5.5.2 Could you estimate their amplitudes?: Greater than 180 degrees double amplitude. It seemed to me like they might have been approaching 270 degrees at the time I pulled the drogue. This is only my subjective feeling.

4.5.5.2 Were they bothersome to you in a physical sense?: No, except I thought maybe I was going to start going round and round. You know, all the way. But it didn't bother me.

4.5.5.4 Did any spacecraft components vibrate excessively during reentry? Note exact time of occurrence: No, everything was very solid inside, except there was this audible noise when we stopped. It seemed audible to me--maybe it was just a jerky--not a nice gentle vibration.

4.6 Landing

4.6.1 Drogue.-

4.6.1.1 Describe spacecraft motions before and at drogue deployment: They are definitely divergent at this point. At drogue deployment I think we had maybe 270 degrees of oscillation. This is something that I just felt from having seen the sun go through past the window, and noting the rate, the rate at which the amplitudes built

up. The oscillations diverged very rapidly. They went from a double amplitude of say 30 or 40 degrees to these violent 270 degrees oscillations in about three or four cycles. The period of these violent oscillations was something like two to three seconds. It really snape around. The thing that I noticed prior to drogue, was the oscillations building up. They stop abruptly on either side and there's some noise there too. You hear it snap, and then the snap on either end gets easier, and you feel yourself going past the other side and very definitely increasing. I called out the drogue fuse switch at 45 and waited and watched the altimeter and got very good correlation between cabin pressure and altimeter reading. I think I punched the drogue off at around 26,000 feet. I had wanted to wait and let it come out but the oscillations were increasing so much that I said, "I'm going to have to chance the drogue now". It stabilized the capsule immediately. I think we were in a pretty good attitude when it did go out because there wasn't a violent snap into the proper attitude at drogue deployment. I watched it out the window. It vibrated very fast back and forth--very quickly. It had maybe three or four CPS everyway it went. It was pulsing and breathing and going back and forth at a very rapid rate.

4.6.1.2 Did you hear the drogue mortar?: I did.

4.6.1.3 Describe drogue deployment. Automatic? Manual? Failure indications?: The drogue deployment I can't describe very well--it's just there. You hear it and it's there. It's that fast.

It just manually deployed. As far as I'm concerned, it was a perfect drogue. I couldn't see any damage at all.

4.6.1.4 What was the indicated attitude of drogue opening?: Again I think 26,000 feet.

4.6.1.5 Describe spacecraft motions after drogue deployment: There was none. It was very stable.

4.6.2 Snorkel.-

4.6.2.1 Did the snorkel door eject properly?: As far as I know, yes.

4.6.2.2 Did the cabin inlet and outflow function properly?: O_2 handle came up automatically and I reached over and pushed it up at the tone. The light came on and I turned the tone off. There was no noticeable cooling effect at this point. I couldn't tell that anything had happened through noting suit temperature at this time. I couldn't tell that the fan had not shut down. I couldn't tell that it had continued to run. I probably would have noticed had the fan shut down. Very little happens in the suit when the snorkels open.

4.6.2 3 At what altitude did each of the above occur?: I think the snorkel came out at about the right altitude but I didn't notice the altitude. I think it will be on the tape.

4.6.3 Antenna Jettison.-

4.6.3.1 Describe spacecraft motions prior to jettison of the antenna section: The spacecraft was very stable.

4.6.3.2 Did you hear the antenna mortar?: I did hear the antenna mortar.

[redacted]

4.6.3.3 What was the indicated altitude of antenna jettison?: The indicated altitude was around 9,500 feet. A lot of things are visible through the window at main chute opening. At main chute deploy, you see a lot of things falling away.

4.6.4 Main Chute.-

4.6.4.1 Did you hear the chute open?: I don't think anything is audible after antenna fairing release. The g peaks at reefing and unreefing are noticeable.

4.6.4.2 Describe the opening shock: There isn't really a shock. It's just sort of a gentle pressure.

4.6.4.3 Describe the view of the main chute deployment through the scope and window: I didn't notice the chute through the periscope. The view through the window was good.

4.6.4.4 Was any chute or riser damage visible?: I could see that it was a sound chute while it was reefed and after it opened fully.

4.6.4.5 Was the spacecraft rotating relative to the chute? Rate?: There was a relative rotation between the capsule and the chute so that I could see the entire chute. In a period of just two or three seconds I was able to see the entire chute through its rotation and there was no damage whatsoever. Rate of descent was locked right on 30 feet per second.

4.6.4.6 Was the canopy stable: I was unable to sense oscillation on the main chute. It seemed very stable and I felt that I was descending straight down without any oscillations. There was rotation but it disappeared after a short time. The canopy was very stable.

[redacted]

[redacted]

4.6.4.7 Describe the spacecraft motion after chute deployment: It was straight down as far as I could tell.

4.6.5 Landing Bag.-

4.6.5.1 Did the landing bag deploy normally?: Yes.

4.6.5.2 Did the sequence light work properly?: When I went to automatic on the landing bag, the light turned green immediately. I don't remember any physical sensation of the bag or heat shield going down.

4.6.5.3 When did the landing bag deploy relative to main chute deployment?: I don't remember exactly. It was after I had looked at the chute and made sure it was okay.

4.6.5.4 Did the dropping of the heat shield have any shock effect?: I didn't notice any shock.

[redacted]

4.6.6 Impact.-

4.6.6.1 On what part of the chute swing did landing impact occur?: I couldn't tell. Through the periscope the horizon was very stable and it seems to me that I was going straight down.

4.6.6.2 How long did it take for the spacecraft to right itself?: It never did right itself. The window was completely submerged for three or four seconds and then the capsule came up. I think the very first attitude it went to was the attitude it stayed at. The attitude was half pitchdown and half left yaw and it stayed in that attitude after I got out. It may have been a little more nearly pure pitch after I got out. But anyway, the spacecraft did not right itself. It's possible that when I went to manual landing aids the small end could have been in the water. I'm not sure, it was down close, and it never got very far up. Oh, that's right, I looked out and saw the main chute still in water. I went to landing aids and I heard something then. I then went to reserve chute override as a backup and this fired. I heard that. For a long time on the water, the reserve chute floated its package. I was tempted to go over and get it, but I'd have to disconnect from the capsule to do that and swim so I didn't. But it wasn't very far away and it stayed close all the time.

4.6.6.3 What was the final trimmed angle of the spacecraft in the water?: I think the capsule was at about 60 degrees from the vertical all the time. Before I got out and after I got out too.

4.6.6.4 Did the main chute disconnect normally? How could you tell?: I think the main chute disconnected normally. I heard the landing aids operate.

[redacted]

[redacted]

4.6.6.5 Did the reserve chute eject normally? How could you tell?: The reserve chute, I heard and felt too.

4.6.6.6 Did any equipment break loose at impact?: Nothing broke loose at impact.

4.6.6.7 Could you estimate the landing time and prepare for the landing shock?: The altimeter is really your best indication. I didn't evaluate the appearence of the water through the periscope. I was busy with the landing checklist. I knew everything was okay, and I did keep track of my height by the altimeter, but I didn't look out the periscope to try and tell exactly when impact would occur. I looked at the altimeter and saw that it was close and did a couple of other things. Then I waited for impact. I had just made it--I may even have been doing something at impact--I'm not sure about this, but the impact was very gentle, but noticeable.

4.6.6.8 Could you estimate your horizontal speed at impact?: I don't think there was any horizontal speed at impact.

4.7 Post Landing

4.7.1 Astronaut Status

4.7.7.1 Comment on the period of time while you were waiting for recovery vessels or aircraft: My status was good. I think after impact that I looked at cabin temperature and it was 101 degrees. I don't remember being warm at all. I did take the helmet off but don't remember that this cooled me down a great deal. I had heard Gus. I called a number of people and nobody could hear me, but I did hear Gus say "estimate an hour" and that I was long.

[redacted]

That, coupled with the fact that we were listing and I saw some water inside, and I expected a heat pulse, made me decide it would be best to at least prepare an egress route. When I had gotten started I just went ahead with it. My status was very good but I was tired. I did not put the neck dam up until I got in the raft. The sea was quite calm except for periodic swells. The swells would increase periodically but it was not rocky and it was a very pleasant time on the water. I wrestled with the neck dam for three or four minutes after I was in the raft but I had forgotten to undo the little silver strap on it. I was trying to roll it up past that strap and couldn't do it and my hands got so tired I had to give up. I was just making no headway at all with it. Then I noticed this little tab from the strap, pulled it off, stuck it down inside the suit (saving everything), and rolled the neck dam up with no problem. I was comfortable as far as temperature was concerned. It's a job to climb out. To get everything up there with you is a problem. I did turn the squib switch off and I shut down ASCS. I think I caged the gyros but I'm not sure. I climbed out and slid the parachute canister out very easily. I had it two thirds of the way out and was actually working my legs up around underneath the panel, before I had to disconnect the suit hose. I did this but I didn't lock the valve either. I forgot to lock the valve. I've done that faithfully everytime I get out of the couch. I've locked that valve everytime I've removed that hose. There is available a self-locking, inlet fitting that I worked with in the water. It gives you maybe $\frac{1}{2}$ inch of water suit pressure drop

(increase in the suit pressure) but I think that we should have it--I think we need something to seal the suit. Well, I got out and then held on to the capsule and pulled the raft out and rested it in the recovery section and stuck the camera down in there where it was anchored pretty well. The raft was attached to the suit at this point. I found the toggle and pulled it and the raft partially inflated, just a little bit, and then it broke two of the snaps open. I think I pulled two or three snaps out, pulled the toggle again, and this time it inflated. I had just barely tapped the bottle the first time to start it out and then I undid a couple of the snaps and pulled it, and then it just filled right up. It went down on the water, and I climbed aboard and took stock of the situation. Then I realized that I was in the raft up-side-down! The raft was up-side-down! And so I went back to the capsule and held on, climbed out of the raft, held onto the capsule and turned the raft over and climbed back in. I felt very good during the period on the water after I had gotten all the equipment out. I drank a lot of water on the raft. The first thing I saw was some sea weed and the next thing I saw was a black fish that was just as friendly as he could be--right down by the raft. Then I heard some planes. The first thing I saw was a P2V and then a little Apachee. A Piper Apachee came on and I was surprised to see him. I understand from talking to somebody here last night that he violated an air-space restriction that's set up by ADIZ for this flight. And that when he landed back in Puerto Rico or wherever it was, they confiscated his film. He took a lot of pictures. Then I got the

the mirror out and used it. It was quite hazy though, and it was hard to find the little bright spot in the mirror. The survival kit was excellent. Everything was just exactly where it was supposed to be and I didn't lose anything. Everything was retained properly and it, it was a real jewell. After the swimmers got there I broke out the food and asked them if they wanted any, but they had finished lunch recently so they didn't take any. I ate one of the chocolate bars--that was good. I attached the raft to the line to the pie-shape marker. It dips in the water and there must have been a stream of dye marker 10 miles long in the water. It really works good! The next thing was that there were a lot of airplanes around and I had been watching them flying over. I was just sitting there minding my own business and pretty soon a fellow called to me from behind and here was a fellow swimming up and I didn't even know he was in the water! He had dropped from 1100 feet, he said. He had landed behind me and just swam up. So he climbed in his raft, and we attached the rafts together. He was tired. His drop had not been good. Neither was the second drop--he also had to swim a long way. But my status was real good. We had a pretty good time there. I kept watching the capsule though, because it seemed to me that the list was increasing slowly and that the water level was getting higher. I watched along the beacons. The beacons were just barely above the water and this is the way the capsule stayed.

[redacted]

4.7.2 Spacecraft Status

4.7.2.1 Comment on ECS cooling during the postimpact period: It was adequate throughout the time I was getting out. I wasn't warm, I don't remember being nearly as hot as I was on the second orbit.

4.7.2.2 Did the spacecraft leak? Where? Did you try to stop it?: I do not know if the spacecraft leaked. I did not try to stop it. There was water inside.

4.7.2.3 What was the status of the beacons, dye marker and light?: The light was working. The beacons were operating. I heard the tone on the headset. The dye marker worked well.

4.7.2.4 How rapidly did battery voltages deplete after landing? How did current vary?: I didn't watch battery voltages for long. In flight the number two main battery was low. I made a comment on the tape about this. All the rest of them were up to twenty-four volts, but number two main was down to around twenty-two volts. I remember noticing it down only once. I also remember looking at it again and it was not down. I don't know whether this is possible.

4.7.2.5 Did the HF antenna erect? How could you tell?: The HF antenna did erect. I do not know how you can tell. I did not notice any sound thirty seconds after I went to Rescue Aids Manual.

4.7.2.6 Was steam noticeable at any time?: No. I thought for awhile that I was hearing sizzling from somewhere. I thought I heard sizzling both while I was inside and when I was outside.

[redacted]

The sound persisted for a long time and I finally realized that what I was hearing was the noise of the suit fan. I turned the cabin fan off. The suit fan is noisy intermittently and from outside this noise sounds like sizzling.

4.7.3 Egress

4.7.3.1 If used, did the explosive hatch function properly? Comment on its operation: I didn't use the explosive hatch.

4.7.3.2 Describe your egress from the spacecraft: I have described* all but the one period when I stowed the camera on top of the recovery section. I do not remember exactly how I got out, but I did not let go of the capsule and there was one period just as I was getting out that water ran up over the sill and went down inside, but there was just a little bit. I guarantee that sixty-five gallons did not get in at that time.

4.7.3.3 Do you recommend a change in the egress procedure you used?: I do not recommend any changes in egress procedures, except that we adopt the long hose which works very well. It stayed in place throughout the flight and the loop was retained by velcro which pulled loose very easily when I started out.

4.7.3.4 Did you encounter any hot spots on the spacecraft?: There were no hot spots.

4.7.3.5 What survival equipment did you use? Was it adequate?: I used the SARAH. I used the mirror and I ate the food and the water. The water was mighty handy to have. That was about all I used.

* See Shipboard Debriefing

4.7.3.6 Was your egress training sufficient, or was it deficient in any aspect?: Egress training was good, I'm glad I had all of it. It's interesting to note that I forgot to seal the suit. Everytime that I disconnected the hose in training I sealed that valve. But this time I did not. Perhaps this is because I had never done it standing up in the tower.

4.8 Recovery

4.8.1 Visual Sighting

4.8.1.1 Did you see any airborne or surface recovery forces during descent? After landing prior to egress?: I saw the P2V first and then there were a lot of airplanes. Two paramedics were dropped. The second was dropped too far away and he was exhausted by the time he got there. We all attached the rafts and talked about where we were and how long it was going to take to be recovered. The first thing that was dropped was something on a small red parachute that I think was a smoke bomb. But the next thing that was dropped was a twenty man life raft. The chute failed and it smacked the water with a trememdous impact and the case tore open. It was attached with a long line to something else which I think was the Stullken collar and it hit the water with a terrible bang too. One of the bottles was broken on impact so that only the top loop of the Stullken collar could be inflated. This took just a little of the list out of the capsule. There were also some other things dropped but they were all too far away to do us any good. The Stullken collar at first appeared to be drifting toward us so we decided that we'd let it get a little closer instead of swimming so far out to get it.

I kept watching it and it wasn't getting any closer but was getting farther away so I told the divers that we had better go and get it. So one of the divers started out to get it and one stayed with me. I told him that I was fine..that he probably should go help his buddy, so they both left. It took them a long time, swimming the sea, dragging a raft. Even under water with a snorkel it was a long job for them, even with the flippers. Then they had to get the Stullken collar, put it on a raft and tow it back. That took a long time. It's a good thing they went to get it when they did. They finally got back and wrapped it around the capsule and inflated it. Because of the angle, or list, or because of improper installation of the collar, the capsule appeared to be coming out of the collar and the list was increasing, so I told them to stop and to make sure that it was installed properly. They both went down and they did do something underneath. The capsule moved somewhat back into the collar, and then they inflated this one tube and the capsule righted itself somewhat. They had a strap which they put around the hatch just in case it blew. We also had two extra rafts that we stuck inside the collar. One was in the raft and one was over by the periscope. The periscope door was open and the capsule was oscillating and I was afraid that the door might wear a hole in the raft, so we put one down over the door. Then we just waited there for a long time. People would come over and drop smoke flares, but we needed a radio. I thought a little while of getting back in the capsule and using the radio to talk to the P2V and tell him what the status was and that we needed a radio to transmit with. The jumper had no radio.

However, I was afraid that if I climbed back in, even in the colar, there was danger of getting water in the small end again. So, I didn't do that. I really didn't feel that there was a need to have a radio to talk to them because they certainly knew where we were and they knew that our status was good. We were all waving to them. The divers wanted another twenty man raft but they never got that. The SA16 came over and made a low pass and pushed out a big yellow can, about a 10 gallon can, on a parachute. It was not very close. The diver had a long way to swim to get it. This was our radio. He swam back and sat up on the collar and opened the can and there was nothing inside but a battery! He was livid! He said a lot of words that I won't record. He said, "Who packed this?", "Who inspected it?" He had the name, of course, because it was on the inspection tag; so we let him turn the air blue for a little while and then we were back where we started from. The next thing that happened, I guess, was that the HSS appeared. I wondered for awhile whether he was going to sit down on the water but he didn't. He had the sling way down and he was way up in the air. I went back to the capsule and stood on the collar and got the camera. He made a beautiful approach and the collar dragged up very slowly to the raft. The diver helped me. I put it on, but I was on the wrong side of the capsule, so I took it off again. I didn't have the camera either and I wanted to take the camera with me, so I got out of the collar, walked around to the other side, grabbed the camera and put the collar on and motioned to him to go up and he began to take the tension up. When he was almost above me so that I felt that if I let go of the capsule I would be held sub-

stantially above the water, I did this. Either the helicopter settled or the wrinch operator pushed the wrong switch because I went down! There was one period there when I'm sure that nobody saw anything of me but a camera and a hand! But I looked at the camera when I got back up and it had just a few drops of water on it so I'm sure that it was not submerged. It may have been just the movement in the water--it got splashed, but I don't believe it had been submerged. It was a long lift. He was about fifty or sixty feet up in the air. But I got in with no problem and stowed the camera and took my gloves off. I took my left boot off and poked a hole in the toe and stuck my leg out the window and drained the water out. Then I lay down to get the water out of the right leg into the left leg. I had to lie down close by the relief tube so I just stuck the toe up over the relief tube and put the rest of the water from the suit out through the relief tube! That's about all. I saw nothing during descent and heard nothing during descent.

4.8.2. Communications

4.8.2.1 What recovery aircraft or vessel was first contacted? The first one I saw was the P2V. There were, I think, three separate P2V's, two C54's and an SA16 and a Piper Apache, blue and white.

4.8.2.2 Comment on the quality of communications with recovery. The Cape Cap Com was weak but readable while I was on the chute. I was aware that I was long, that the Cape Cap Com was transmitting blind, and that I should expect an hour recovery time. That's about what I got from the Cape. I also remember being told there

would be jumpers in the water.

4.8.2.3 Did you receive the information you desired at all times from reentry until completion of the recovery operation? I did not hear emergency voice during reentry, though I listened for it.

4.8.3 Pick Up

4.8.3.1 Did you experience any difficulties during the recovery operation? Describe. The only really difficult thing is getting out of the capsule, and that is difficult because it takes a long time and your movements are restricted in a space suit.

4.9 Sequencing Review

With reference to the sequence panel, note which functions were operated manually and which were automatic. Cover the entire flight and comment on each function:

4.9.1 Jett Tower - The tower jettison was right on time, automatically.

4.9.2 Sep Capsule - The capsule separated right on time, automatically.

4.9.3 Retro Seq - The retro sequence began right on time, automatically.

4.9.4 Retro Att - I don't know. I do not remember the flight being red but the warning lights were still on dim, and were not readily visible.

4.9.5 Fire Retro - Retro sequence was right on time with the clock and the count. At the California Cap Com's count for fire retro I did not get fire retro, but this count was one second early. I waited for the clock to get to twenty-nine. They still did not fire. I went immediately to the fire retro button and the retro rockets still did not fire. One or two seconds passed before I felt the first retro.

[redacted]

4.9.6 Jett Retro - The retro rockets jettisoned automatically right on time.

4.9.7 Retract Scope - The periscope retracted automatically right on time.

4.9.8 .05 g - I do not recall the .05 g light.

4.9.9 Drogue - The drogue was not deployed automatically. It was deployed manually.

4.9.10 Snorkel - The snorkel was opened automatically.

4.9.11 Main - The main chute was deployed manually.

4.9.12 Reserve - The reserve chute was not used. It was jettisoned automatically after landing.

4.9.13 Landing Bag - The landing bag was manually positioned to the automatic position, and the light went green immediately.