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GEMINI VI

TECHNICAL DEBRIEFING

December 20, 1965

[redacted]

[redacted]

PREFACE

This preliminary transcript was made from voice tape recordings of the Gemini VI flight crew debriefing conducted December 17, - 18, 1965 at the Crew Quarters, Cape Kennedy, Florida.

Although all the material contained in this transcript has been rough edited, the urgent need for the preliminary transcript by mission analysis personnel precluded a final edit prior to its publication.

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1.0 COUNTDOWN

Schirra On the Dec. 12th countdown, the Sunday count, it was quite evident to all personnel involved, that the 25 minute hold at minus 3 minutes is not required. This hold was approached with about a 10 or 15 minute lead time. So, we were that much ahead of the count even then and could have easily forgotten the 25 minute hold. The philosophy of a hold is to pick up a pad if you have a problem, but you don't design a countdown for all problems. You run it down as best you well know. The 25 minute hold, I believe, didn't help us a bit. I think we should eliminate it from all future counts.

Stafford I had the same observation. The fact is that the whole net, the MOP system, became completely quiet between 10 and 20 minutes prior to reaching a hold. There was practically no activity. The white room was always cleared early, and, in fact, both cases the erector came down. It started down approximately 5 to 8 minutes before the programmed time. And before the erector even started down, there was a quiet time in there. So there was plenty of slack in the previous count which had astronaut insertion at 95 minutes with no hold to take care of any major problems of this nature.

Schirra We have in the rendezvous mission optimized for the rendezvous, be it Agena or Spacecraft 7 in our case, the

launch window is for the unpredicted hold. As a result, in both counts we were off on an M-4 launch. Therefore, if we are going to have a built in hold the window is almost redundant. I think we should take advantage of the windows rather than having us sit there, strapped in for another 25 minutes in a crew insertion count. That is why launch windows were conceived in the first place. So let's bear that point in mind as well.

Now to continue through from T minus three to about T plus two seconds on the Dec. 12th. As we approached engine ignition communications were perfect. There were no anomalies that we could see; it looked like we were going to launch exactly on time, the T zero would occur when we wanted T zero to occur. This was a concern we had, of course, as the result of seeing 7's launch. We did not want to have that 3.7 second delay just to be a little bit more pure. I think we could have made it up on a burn. At the call out for ignition, we had just that. We had ignition. We did not hear one word from Stoney which is exactly what it should be. It was very well done by Allen Bean. I had, as we approached ignition, all three engine lights on. The fuel levels, meaning the fuel and oxidizer pressures on both stages were nominal. The ignition point occured, the clock started

shortly and the sub-assembly light flickered out and then came back on again.

There was no perceptive physiological cue to lift-off. The engine noise came up to a fairly high crescendo and diminished almost as rapidly as it came up. It was sort of a one peak of a sign wave. The attitude ball did not move, the rate needles did not move, no indication of motion was apparent. I think all of these cues added together replaced the false cue of the clock starting which was legislated out from the failure, and that was a dirty cue. This was stressing us pretty hard. Fortunately I did not punch out, but I do believe if I had I don't think that anybody would have blamed us.

In any case we did not punch out. No Sunday punch. The essence of this though is that we had never seen this type of failure before. We had discussed it over a year ago prior to preping up on GT-3. At that point it was precisely stated that this failure could not happen, that we could not get a lift-off without having in fact a lift-off.

Sometime subsequent to the shut down the IVI started counting up, which gave me another momentary pause. I sat

there considering this, realizing that no events could happen much as they had in MR-1 where all the rest of the pyro-technics started going as if the spacecraft had realized a flight. I can only state right here that this is the proper way to design a launch abort system, to have man in the loop to access all these cues, and not react as a machine system might. If this was Apollo or Mercury we would have a flying spacecraft, but not a lifted off booster.

Shepard Do you remember some seconds after the shutdown, did you hear a call over UHF report a hold kill?

Schirra Vaguely, I think I said that this is a hold kill. I also said "clock started." I also heard "programmer reset" which made me feel very good because I knew then that the booster couldn't go through the various events that it would normally go through if it had picked up logic that said it was in flight. We were very well briefed subsequent to the hold kill. We were well aware within I'd say about five or six seconds of what was going on. But the cues that added up called for a response in about 1½ to 2 seconds, and, we rejected that response and just sat tight. I was particularly concerned whether we had to maintain hot seats or not. Never did get a precise answer so we maintained hot seats until we were finished with the erector coming up. As far

as the delay in the erector we understand all that, and, this will be cleaned up so there is no sense in belaboring that issue.

Stafford My cues that engine ignition had started up, like Wally describes the sign wave, but on the level of noise build up there is a definite pulsation. It is a low frequency pulsation and you feel it in your back. It is in synchronization with the head sets and it built up.

My technique is, when they say ignition I punch manual clock, I time with the count, 1001, 1002, 1003 and lift-off should occur. I saw it build up to a peak and I said 1002 and I started to say 1 on that 1003 and the noise started to die down right away. So, by the time I had reached 3 seconds the noise level had gone down and you could tell that there was a definite curve off; whereas, in the DCPS trainer when you have a hold kill it quits just like that. So I could ascertain that there was no cliff where it came off; it tapered off. At the same instant, when I had my thumb on there, I could see the clock running. I knew in my own mind though that there was no lift-off, from previous briefings, and also the engine hadn't fired long enough to go through the sequence for the bolts. I monitored the needles which I had on Computer and Attitude, and there was no deviation at

all whatsoever, in the needles. I knew in my own mind that we had not lifted off and that we had a hold kill.

Schirra This was very good discipline for Tom because it was, of course, my choice. All the command pilots had stated that they are the ones that will punch out under these situations. It was a rough task for the poor pilot to go through. He reacted as he should have.

Stafford I made my separate analysis. The first words I remember hearing, I heard the word "shut down" and then followed by, "programmer reset." I remember the word "shutdown." I don't know who said it, but, I then heard reset the programmer.

Schirra The response from the launch crew was beautiful. We were very well briefed during these critical seconds after we had reacted properly. Our only complaint was the fact that we were waiting for the erector unduly long. I think that we can cut that down. To my knowledge right now, having gone over this with Frank Terry and Kenny Sites, the two men who are responsible for this routine, it will take one hour under similar circumstances to get the erector up. This was a very careful analysis that they made because they knew that we were pretty well chapped about it. In our case, it took I think 99 minutes. It's not something you would expect to see happen in a hurry. I do believe that this

requires another review; this was strictly a Martin analysis and pad safety analysis. This was not the understanding we had; our understanding, and I even called down to Al Bean at that point, the Stoney, and said, "How about reading the egress manuel to us. We have time to kill." My understanding was that if we could not solve the situation within 15 minutes, we would have to punch out. It was a critical situation. If we had more than 15 minutes, the erector would come up. It doesn't really state that the erector will come up in 15 minutes. These are the things that should be gone over by the Getlock group again. I definitely want to see some follow-up action on this particular area. That is why we wanted to go over that as a countdown.

1.1 Crew Insertion

Schirra On the crew insertion for the final Gemini 6 countdown, I was informed by Gus and John that we were again well ahead of the count by 15 minutes. They sat up there waiting and we weren't coming up early. We put our foot over the sill, I believe about 1 minute early as far as insertion time went. I was fighting with Wendt on this but finally succumbed to his wishes, climbed in. This was just a nit pick between us. I wanted to get in on the second.

Again we completed a flawless count. We were completely briefed, up-dated and slept through another 25 minute hold. We were again well ahead of the count and it only substantiates that we did not need the 25 minute hold.

1.2 Communications

Schirra The communications were excellent. We participated as called out in the countdown SEDR. There were no problems with the SEDR. I think it was very clean. The only problem area that we found in both countdowns was the liberal use by the test conductor, actually the spacecraft test conductor, of the push to talk mode, which make it difficult for the crew to communicate in that we don't have intercom at this point. This is something that should be looked at more carefully. It was a problem in this particular pair of countdowns in that the range was picking up the side tones as well as trying to work Spacecraft 7. I could understand that, but we should be able to clean up the communications loop so that the range in Houston doesn't complain about side tones from us when we want to be in continuous intercom.

Shepard You can't talk back and forth with your visors open after cabin purge ?

Schirra Yes, you can, but you have to yell - its awkward. That's what the interphone was put in there for, so that we could

talk without all of this problem.

Schirra I think that there is a problem also, under the catagory of communications, of not having a good private loop. That doesn't seem to be clean. I'm not sure what the problem is here but I think it should be straightened out.

1.3 Comfort

Schirra I had the G3C suit with the 1 zipper and was comfortable throughout the count except for the obviously long two hours, and even then I started feeling some back discomfort from being in this position all of this time.

Stafford The suit I was wearing was a G4C that had the double zipper. From what we learned from previous countdowns and positions, I had a foam rubber pad installed that went completely the distance of my back. This starts out very comfortable but after approximately 1 hour to an hour 15 minutes this roll that is up on your spinal column starts to be felt in increasing proportion to the amount of time you are there. By the time you reach an hour and a half you start to get a few pains up and down the whole length of your back. After two hours in that position the pain is about constant and it stays that way and is very uncomfortable. In fact, I had to continue to reach hold of the hatch closing strap and the ingress bar and pull myself up and down and continue

motion and flex my back muscles to stand it.

Schirra This is going to be a continuing problem. That's why I wanted Tom to bring it up, because I'll probably have the only G3C suit in Gemini left.

1.4 ECS

Schirra The environmental control system gave us no problems. We switched to single fan operation for a period of time. We did work with the recirc. valve. We did repress on occasion to keep the cabin pressure above ambient so that we would not have any inflow of ambient air. And this does require some attention from the crew. We did do this, in fact we never got a call out from the ECS monitor. I think it might be worthwhile for him to keep an eye on that in case we miss watching the cabin pressure go lower than ambient. This would be something worthwhile to bring up to the ECS console man.

1.5 Sounds and vibrations

Schirra The sounds and vibrations from prevalve engine gimbaling and erector we are quite well briefed on now. The only sound level I think that was something more than I was prepared for was the second stage prevalve. That was quite noisy. I think its sufficient to bring that one out for future crews.

Stafford Right. It's a very definite decibel level even over what I

had previously expected to hear and associated with it is a tremendous pogo along the longitudinal axis of the spacecraft. It persists for about 4 or 5 cycles and then you could feel it die out. But it is a tremendous noise and a pogo.

Schirra One other point. We were in a different configuration for our real launch in that we had a fully fueled system, as contrasted to the first countdown on December 12. Engine gimbaling was much more obvious to us with this fully loaded bird. We discussed this with Frank Terry and he agreed that was probably the reason for it. We had a stiffer bird with this full load on it. This is engine gimbaling early in the count and all the way through it.

The erector operated normally. One problem we did detect on the first countdown on December 12 was, when the canvas curtain was removed when white room breakup was started, black flakes, carbon like flakes drifted on the windows. This wasn't aggravating because we knew that it would blow off. But, it had rained that day and there was water trapped on the orange structure of the erector, in the rails. When the erectors were tilted back the water would drip off and came right on the windows. This glued these little black objects on there. Now they actually did come off during Max Q. I saw one go off, so, even then it didn't

seem to hurt us.

Stafford Well, I had several pieces of black particles and they were all gone after, first time I got a good look at them was after staging and they were gone.

Schirra Visual, controls-displays, azimuth update were all nominal.

2.0 POWERED FLIGHT

2.1 Lift-off

Schirra We heard lift-off from Stoney, a good count; there was a slight delay from his count of three, two, one, ignition -- about that type of a delay. This was not aggravating, but it sort of keyed us up a little bit again. But lift-off was very obvious to us.

Motion, vibration, noise, visual cues, cockpit displays were all very cumulative. The physical sense of lift-off was very evident. I am sure we were hypertuned to this, but we both felt not only the acceleration, eye-balls in, which is of course quite slight, but also a slight wiggly effect, sort of a shimmy effect, that was, oh, very short. But this step went out immediately. This was another cue that I frankly hadn't expected to feel.

Stafford My impressions were the same on that three, two, one, and I really anticipated the iginition it seemed for a little longer than possible, then once the roar started it was just identical to what we had on the twelfth.

Schirra Hold kill.

Stafford It would build up, but it would build up in pulses and the stabilized level that it reached was louder than it felt

like on the twelfth. Then when it sat there, I could feel in my back there was a slight lateral oscillation; you could f feel this lateral oscillation, and on lift-off, there was a definite drop in the noise level, and the pulsations smoothed out and there was a slight oscillation like Wally described. Also in my back, I could feel an almost imperceptible increase in pressure. It was just like you pull maybe a little up collective on a helicopter, only this is what you feel right on your back. It was very, very slight. But there was no doubt in your mind that all these things change at that time that you had lift-off, I noticed the computer and the attitude needles, the spacecraft pitch needle, which is booster-yaw needle, just flickered momentarily. It was just a minute flicker, and from the first ten seconds on, it looked like we had electric nul on all the needles. It was just completely steady.

Schirra Roll, pitch, aerodynamics, ECS, DCS updates, engine operation, acceleration, POGO, no POGO, BECO were nominal.

2.2 Roll program - Nominal.

2.3 Pitch program - Nominal.

2.4 Aerodynamic profile - Nominal.

2.5 ECS - Nominal.

2.6 DCS updates - Nominal.

2.7 Engine 1 operation - Nominal.

2.8 Engine 2 status - Nominal.

2.9 Acceleration - Nominal.

2.10 POGO - Nominal

2.11 BECO

Schirra At staging we both noticed a large, orange fire ball, that I even saw brown around the edges of, and immediately these clear windows, at least my clear window, became clouded. Now part of the reason we could see this was that the sunlight was already hitting us slightly obliquely, and you could see the clouding of the window right after staging. I'm absolutely convinced that staging is what's filming the window.

2.12 Staging

Stafford I was watching the inside of the cockpit completely. I couldn't help but occasionally glance one wink outside and see the way that the ocean was coming up, and again there was considerable cloud cover over the ocean. I noticed how white the clouds were, and then I was back in the cockpit at staging, I could see, out of the corner of my eye, I could see this orange-yellowish flash. It seemed like it started right at the periphery of the windshield and instantaneously swept forward like that ... and it had a brownish-black

edge to it. There was a band that was behind the orange, and we went right through it. It was just flashed and it was all instantaneous. We went through it.

Schirra We actually flew through it.

Stafford Yes, flew through it Flew right through a part of it, and it seemed like the orange part came around to nearly within thirty degrees of our longitudinal axis. It came around there and I could still see the brown part, the part that went forward to the zero position on the X-axis. It was just a flash and we were through it, and I was looking for Guidance Initiate. Then I looked up at the clouds; I noticed that the white clouds weren't as white as they were before staging. So that was my cue a comparison of the clouds. These white cumulus clouds and some of the low stratus below them out over the ocean.

2.13 Engine 2 ignition - Nominal.

2.14 RGS initiate - Nominal.

Schirra Guidance initiate was so smooth it was difficult to detect it, and I merely said Guidance Initiate. I did see some minor oscillation of the needle. I would say about half a degree to a quarter of a degree at the most in rates.

Stafford Computer attitudes just barely flickered at guidance initiate.

2.15 Steering

Schirra Steering was nominal all the way through insertion.

Stafford I think I called out two cases where it was absolute zero. In fact, it looked like we had a complete electrical null there. One case was at about three minutes and ten seconds, the next one was beyond four minutes. Occasionally it would just flicker off a little bit, but it was just on zero. It wasn't until SECO it walked off slightly, in booster yaw, but iw was still very low.

2.16 Go/No Go - Nominal

2.17 Systems status - Nominal

2.18 Acceleration

Stafford We had 6.8 g's.

2.19 SECO

Schirra 6.8 g's indicated on my accelerometer SECO, exactly as we practiced it; I noticed in the fore and aft windows a requirement for more forward velocity than I would apply, meaning that ten foot per second. And I know that I burned about two seconds longer than I should have at insertion. It didn't hurt us. It turned out we needed to pick that up anyway, but I can't excuse myself. I really

did burn about two seconds longer.

2.20 Communications

Schirra Communications were satisfactory. We could receive; apparently the ground did not hear us too well, having heard some of the ground tapes, but this is not something for us to judge. We received everything we needed to receive very clearly, very crisply. The window coating we've discussed completely.

3.0 INSERTION

Schirra Attitudes and rate damping were tight as a drum. There were no problems of an oscillatory nature at insertion. It was very smooth.

3.1 Post SECO

Stafford Immediately after SECO, I punched address 72 and that value I read out was 25,690, which showed me right away that we had a go and that the tail off would build this velocity up probably another 30 or 40 feet per second. I reached over and turned the attitude control switch to mode and separated the spacecraft right on time. Went right through the check list just as we practiced in simulator. Turned back and hit address 72 again after the thrusting stabilized out, and I read out

the velocity 25,729. I got address 94, which was 00025, which showed that gamma was close to zero or slightly positive and we were all set. The other values I read out at that time but I don't think we shouldgo into them here. Everything looked nominal.

Schirra I'd like to add one other thing. In the countdown it is called out to have IVI's zero, and I have trained to have at least one number appearing in each of the three read-outs, meaning one foot per second in fore-aft, one foot per second left-right, one foot per second up-down, which gives me an electronic SECO. And admittedly you can detect SECO when you terminate thrusting. But to get a time correlation for SECO when those lights go out, and you are in the cockpit, of course, in command pilot position, that helps you nail SECO down to the event timer so you can time your 20 seconds, and then time your 12 seconds worth of burn. And I think that's a technique that should be utilized.

3.2 SECO plus 20 seconds

Schirra The spacecraft separation was clean. We called fairing jettison, although we were requested to confirm that later. Everything was done nominally on time.

3.3 Insertion checklist

Schirra The insertion checklist was completed. We maintained attitude using the roll and yaw from the ball, and I checked roll and pitch from the horizon. I used computer and attitude for pitch, nulled the pitch needle, caged the platform SEF, and immediately went into SEF align, and used platform mode at this point, so that we could check out the spacecraft systems rather than fly it in pulse, to get a tight line. At SECO we observed, or at least I can say, I observed no debris. I'm afraid that if Tom observed any, he wasn't doing his job, and he was doing it. We were busy in the cockpit, so we did not have any observations of debris at SECO, or separation.

Stafford That's right. I finally had one good glance after we had completed the burn and separated everything, I looked out and the sky was completely clean. That was just one glance, at the end of it.

Schirra I have one comment. Gus remarked on a small flap on the white cover on the nose of the spacecraft that goes off at separation. That's the fairings. And this flap is right in line with the command pilot. It's a flap about the size of a pack of cigarettes. And I saw it vibrating at Max. q. It got my attention. It sucked me out of the cockpit. It's a white fairing object vibrating at a

very high frequency through max q. I, of course, was in the cockpit and I could see this motion out there which drew me out, and I saw the same thing that Gus described. It hasn't changed apparently since then. This was at max q.

Shepard Was it the scanner cover?

Schirra It's the white fairing cover up on the nose.

Schirra Insertion checklist was completed before LOS. We had checked the primary scanner and had already switched to secondary scanner for confirmation of its operation, and all control modes were go.

4.0 ORBITAL OPERATIONS

Schirra Platform alignment was absolutely nominal. The out-the-window view which we were well prepared for, from the display was exactly as I had anticipated seeing it. In addition, this same out-the-window view, we optimized on the docking trainer with the light bars on the floor, and that, too, substantiated the same view.

Shepard How about you, Tom, were you prepared for it?

Stafford Absolutely.

Stafford No difficulty.

Schirra This is of course to eliminate the requirement that Gordo put up in the visual display problem. Gordo didn't really have a good feeling for what insertion looked like.

Shepard Was this the best display you've had so far?

Schirra Oh, without a doubt. I'm only giving the visual display a big pat on the back because it's got to be used in the Apollo program. And I'd like to add, if this can't be used on the Apollo mission simulator it should be at least utilized as a Part Task Trainer.

Stafford Right away we got an update.

Schirra We had a seventeen minute update also.

Shepard You got a one alpha.

Schirra We had a one alpha update, and we were continually updated at this point and well aware of the situation. We got a go immediately after insertion it seemed.

Stafford In fact, it was before insertion plus 20 we got a go.

Schirra Before SECO plus 20. And that was good. That's the first time I've heard one that early.

Unstowage of photographic equipment and urine nozzle

Schirra We continued with the unstowage of photographic equipment and forgot the urine nozzle until after rendezvous.

Orbit parameters report

Schirra The orbit parameters were brought in first with the first cut of data updated with Bermuda data.

Communication systems check

Schirra We made communication systems checks on both UHF 1, which we went into orbit with, and UHF 2 and HF. All were satisfactory.

Scanner check

Schirra Scanner check, we have discussed. Both were good.

Shepard You reported both scanners were checked by ten minutes and 24 seconds.

Schirra We conducted the accelerometer bias check over Carnarvon, and we had some concern about this. Apparently we did have an accelerometer bias, and this apparently disappeared later in the mission. There is an unknown here. I talked to Cliff Charlesworth about this since the flight and he agrees with the same statement. It does deserve some attention. We should dig into this further. Do you have the IVI readouts or the accelerometer bias check, Tom?

Stafford It should have stayed zero, and it filled up to 1 in the fore aft window, and it filled up to 2 in the down window.

Schirra Right.

Stafford 002, and it should have stayed zero. It was a short period of time, within about three minutes, these numbers appeared, and the Carnarvon station right away obtained this data. When we came over the States, they updated our accelerometer bias with a DCS update.

Pass 1 at Carnarvon

Schirra The rest of the systems were nominal. We had GO on the radiator, time backs, Go, No Go for 16-1, and subsequent to the Go, No Go for 16-1, we removed our gloves and stowed them for the duration of the mission until preping for retrofire.

Stafford We also got the GO to turn off our secondary coolant loop at Carnarvon, which we did. Then due to the fact that our suit temperatures were still very warm, we turned them back on one revolution later and left them on until 19 hours. We had both coolant pumps operating full time.

Orbit Adjust Translations

Schirra The platform was aligned at least 15 to 20 minutes prior to every burn, and every burn was completed on time. All addresses of 80, 81, 82, were removed. We probably should record propellant quantity, but there should be no reason to go through a long discussion of those.

Stafford No, all this data is recorded and maintains, I think, that practically every burn was made in the Platform mode.

Schirra No. The out-of-plane burn was made in Rate Command.

Stafford The out-of-plane was made in Rate Command. All the rest were Platform. The times for burn duration agreed within one second of what we burned. The ground time shows that the staff support room is very good on figuring the time in case we would have to burn on time without use of a computer or platform, which I thought was very good. The Cap Com at Carnarvon told us he had our maneuvers when we were ready to copy. I acknowledged this, and then he started and read out every maneuver we would have, including the braking maneuver at rendezvous, and the GET's. This is completely uncalled for. Basically, all we wanted to know was general times and that the flight was progressing satisfactorily. As it turned out, every maneuver was changed by two or three seconds, and by maybe one to two three delta V, even after what we thought was a final information update. So, this huge mass of information that Carnarvon sent up to us was not required.

Schirra Well, I'll retract that, some of the impact of that. Obviously he was given that from Houston. The real problem was, he read it off so fast that we had trouble recording it. The fact that the time of the burn, meaning the GET of the burn, varies by two or three seconds is absolutely insignificant. These burns are not that critical. If they are close enough to a half a minute, they are good burns, meaning

when they occur. We burn them exactly on time, but a second in orbit isn't that critical for all of these burns. So, they were trying to bring us up to speed, but we had discussed this before, and so we didn't want all that jazz. We wanted the next burn, and that's about it. This is part of that no communications case, and I don't think we would have gone with this data. We said we got it, and we didn't really get all of it.

Stafford All right, as far as such detailed information at that time, I don't think that it was required.

Gemini VII acquisition (radar)

Schirra We had a data update on when we were to acquire Gemini VII with radar lock, and this was the 248 mile point. I believe Tom has that data.

Stafford We were informed that the 248 mile nautical range would be reached at approximately three hours and fifteen minutes GET. The radar was turned on at three hours and seven minutes GET. A lock on was obtained at approximately three hours and ten minutes.

Schirra That was a sporadic lock on. The light didn't stay on steady. It would come on and go off, come on and go off. This could be due to warm up time, but in addition we had a rather sinking feeling at this point, wondering if we were, in fact, going to have a good radar set. The typical sequence of events on the analog gauge--the range rate needles and the range needles started quivering back and forth which is normal. We were prepared for this. And I don't recall exactly when we got a good solid lock, but it wasn't out that far. We had it hopping in and out if you recall.

Stafford The first data point that the computer, address 69, gave was 248.66 nautical miles. It continued to give that as I interrogated it.

Rendezvous test

Stafford During the radar test prior to the NSR burn, we synched the radar in the rendezvous mode and obtained data points every one hundred seconds, so the synch and registers were valid. We checked that feature out. Before we went into this rendezvous mode test, though, before NSR, I did check the data start to decrease, and I did get a data point at 242.6 something nautical miles, and it was decreasing all the way down' so at this time we noticed that the yaw and pitch needles were very soft. By that they would have somewhat of the sinusoidal oscillations in both yaw and pitch, primarily pitch at that time. However, the range decreased right according to schedule. The range was in very firm once we reached the 248 nautical mile point coming down.

Schirra I think another point of observation there --when we started getting the V_T readouts on the IVI's, we were both concerned because they didn't seem normal, and this was because we had 180° wt in, and we hadn't changed it to 130. We became quite worried about that until later when we cleared the register and put in the proper wt. That was a nice revelation all of a sudden.

Stafford Right.

Schirra I guess it's worthwhile to remember this because other crews

will have the same point of consideration.

Stafford We were getting values of a V_T of approximately 570 feet per second to start with. At that range, using a wt. of 130, the values should be between 900 and 1000 for a wt of 130, but the value did decrease as it would for either a 180 or a 130, so we monitored it. Then after we did go into the rendezvous mode, as our procedures, we checked all the addresses.

Schirra Checking the poop sheet or the debriefing guide--attitude at lock on. Of course we were SEF, and we were still in platform align, SEF. We were willing to take the slight misalignment, and this is about 4 or 5 degrees, in that we were more interested in aligning prior to NSR than we were in the radar test. Once we started getting data, we were satisfied that we were going to have a radar run.

Stafford That's correct. The radar synched very well in the rendezvous mode in giving out range that was stored there for every 100 seconds, and the pitch angle was being given out constantly through address 59. The first angles that we obtained were approximately 5 degrees, between 4 and 5 degrees to start with.

Schirra This was subsequent to NSR?

Stafford This was before NSR. We were about in the ballpark of 4 to 5 degrees.

Schirra Going down the list--bore sighting. This might infer that we could see the target, and let's make it clear now, we did not see the target for a considerable amount of time. This will, of course, be explained. The updating of addresses 83 and 93, that we discussed. If we had done it before the radar test we would have felt much better about these V_T readouts. And we did not work up a delta V calculation at that point for transfer.

FCSD Rep You did not hit start comp at any time?

Schirra No.

Update for circularization translation

Schirra The burn was given to us with a set of numbers that were not too far off in pitch. I would like to have Tom quote those.

Stafford Alright. It was called up to us that the NRS maneuver would be performed at a GET of 03:47:37. The delta V total was 42.5; duration of burn was 53 seconds; and pitch down 2 degrees; yaw was zero.

Circularization translation

Schirra On this point--we had done this before in simulation--we elected not to go off axis for pitch. We made the NSR burn in platform mode SEF, that's platform attitude control, using aft-firing thrusters. Then I corrected out the balance on the IVI's with downward thrust to compensate for the downward component, which is a much more efficient way

of doing it than trying to hold a two degree angle which is almost impossible to read with the attitude ball presentation. The OAMS fuel prior to NSR maneuver was 74 percent, the OAMS fuel after NSR maneuver was 68 percent.

The circularization translation calls for a platform alignment. We had aligned, as we mentioned, all the way up to the NSR burn. The total delta V was added in. Attitude and rates--we mentioned that because the control mode was platform mode. The timing-IVI correlation, I assume, connotes how long we burned. Tom, do you have a number on that?

Stafford Right. We burned for 53 seconds. It was right on time.

Schirra Then zeroing of addresses 80, 81, and 82 were the final small burns where we cleared out that downward component that was required with this pitch of 2 degrees. The propellent quantity has been noted.

I would like to make an important point here. Tom spent two separate sessions, one before this flight, in the simulator, checking which direction to move for addresses 80, 81, and 82 corrections. This saved us a lot of difficulty during the flight in that the logic of these burns is not appropriate. It requires some practice. They are not in the right direction as one would interpret them.

Stafford That is correct. The navigation axis sign is different from the body axis sign for some of the addresses, so particularly if you are in odd positions, like out of plane or you are burning a retro grade maneuver while SEP, the logic is not the same. So you have to have in your mind both the body axes, the navigation axes, and the signs of each.

Schirra We had a couple of burns there where even then we were confused by them.

Stafford Right.

Schirra And this can cost not a lot of fuel, but it can cost you some you shouldn't have to expend. This should be brought to mind as well for future developments, not necessarily in turn for Gemini. We can learn how to take care of an existing problem. I think at this point that we should go on to the data collection points that Tom conducted. All I can say from this period of time up to the translation point is that I attempted to track the target with the radar elevation or pitch, radar azimuth or yaw needles, with as much accuracy as I could hold in the pulse attitude control mode. I might add, we did not do any aligning of the platform from the period of NSR to the transfer burn. One other point that we can discuss separately

I think, is the visual acquisition of Spacecraft 7, so, Tom, you, have the floor.

Rendezvous terminal phase

Stafford After four minutes after the initiation of the NSR maneuver, we synched the clocks for four minutes from initiation and switched the computer into rendezvous mode. After going into the rendezvous mode, we checked the following noted addresses in sequence as we practiced; addresses 54, 53, 24, and 92 were exactly as prescribed. Address 83, the wt. for the target travel during the rendezvous, was 180 degrees. I reset this to 130 degrees. The delta wt was 60 degrees, which I reset to 48.2 degrees. We also noted that the computer, when it would give the change in the register for address 69 for stored range every 100 seconds, was slightly out of synch with our times. So we resynched the elapsed time from the start of NSR so it would synchronize with the computer. This changed approximately seven seconds, and as a reference data point, at a GET of 4 hours, 21 minutes, and 50 seconds, we had an elapsed time from NSR for our time correlation of 34 minutes. That wasa re-synch time of 34 minutes. AT 34 minutes on the re-synch time, our pitch angle was 5.5 degrees, our range was 120.81 nautical miles. Now throughout this time, I was

plotting the pitch and range on the target centered polar coordinate plots, and it was immediately evident that we had a very nominal trajectory with no ellipticity involved. I checked the delta delta R function, which is delta R actual minus delta R nominal for this height of 15 miles, and this showed only minor variations from zero. They went from , say, -.01 to -.03 at the most, to +.04 to .05; but most of the time they were 01 plus and minus, which showed that we were exactly on as far as height went. Now I made a notation that at approximately 49 minutes elpased time from NSR, the pitch needle on the radar and attitude mode damped down considerably. Now this was at 97.40 nautical miles from the target that this occurred, and there was a noticed decrease in the oscillations; the oscillations were not excessive at first they were probably plus or minus one and one-half degrees, but at that time the oscillations decreased from less than one-half a degree down to practically zero when we were 97.4 miles from the target.

Schirra I would like to interject one point here. We, almost at the last minute, developed an overlay for the 8-ball, and the

number Tom gave was derived from that. We had marked on this overlay not only bank angles for roll, but the degree markings from neutral or null, plus and minus, in pitch and yaw.

Stafford The computer solution for delta V_T and delta V_I agreed very closely with the nominal that we would expect from this trajectory, and as an example, on the data point where the pitch needle became very smooth and tracked steady at 49 minutes elapsed time, we had a pitch angle of 6.9 degrees, 97.40 nautical miles. We had a delta V_T of 414 feet per second. The nominal you would expect is 390 feet per second. The delta V_I to initiate that the computer gave us was 193.7. The nominal is 176.9. So in that period of time, the percentage error was very low. And as we approached the initiation point, the difference between the computer close loop solution and what had been predicted beforehand, became practically zero. As we progressed

on in, I made a note at 81.6 miles that the needles were very tight. So starting back there where I made the notation from where the waviness stopped at 97.40 miles, it noticeably decreased. It became very tight at 81.84 miles. This was at an elapsed time of 59 minutes from MSR. We continued to make the polar plots and take data. I computed the whole table out for delta delta R, for delta V_I actual, and delta V_T total from the computer while making the polar coordinate plot. Occasionally, I would check address 58 for yaw angle and the values I got out of that were at the most .10 degree, so we were in plane as far as our trajectory with respect to Spacecraft 7's trajectory.

Schirra This bears out the request from the ground. I forget which station it was but they were asking us for some numbers and I said, "In exchange, will you tell us our out-of-plane velocity?" We were updated and we had asked for this in simulations. The out-of-plane velocity was described as less than 2 feet per second, which is remarkable work from the ground team and gave us another real notch on the confidence curve.

MSC Rep While we are here, what was the value that the ground gave you for your transfer?

Stafford The value that the ground gave us for the transfer maneuver was 32.9 feet per second forward, 1.5 feet per second down and 1.5 feet per second left. The GET was 05 plus 16 plus 54 and the elapsed space time of 1 plus 29 plus 17. The total delta V of those summations was 33.0. As we continued on down prior to point A, we had a value of Theta of 19.2 degrees at 43.52 miles. At this time, we were going into sunset and before going into this data we would like to describe the way that Spacecraft 7 looked with respect to reflected light.

Schirra My first indication, of course, was with use of the optical sight, cross checking with the radar indication null and all of a sudden I said, "My gosh, there is a real bright star out there. That must be Sirius!" And it turned out, of course, as we saw more stars as it got darker that it was not a star or planet. There wasn't anything supposed to be in that position. It was in relation to our well known constellation Orion but it was much farther up in the sense of up and down. It was higher in the sky than where Sirius was. Looking at the constellations preceding Sirius and Orion there are no planets in that area and it had to be Spacecraft 7. This illumination, of course, was from the sunshine bouncing off it in the darkness on the other side of the terminator. It was very bright. At first we

described it, as we saw Sirius later, as brighter or at least as bright as Sirius. But in recollection I would say that it was much brighter than Sirius. It was more like Venus, I guess that would be a very good analogy as we have seen it in the last month in the skies locally. The shock was to realize that it really was Spacecraft 7, that we hadn't seen it until this point in time which is quite late, of course. The other shock was as soon as the spacecraft slid behind the terminator where the sun was no longer illuminating it, we could no longer see it. This at first concerned me terribly because naturally we were worried about our back-up techniques. The realization that the optical sight was boresighted close enough was also apparent to us in that it showed up one half degree to the right, on the reticle, and exactly on in pitch. Which is a pretty good mark for boresighting at those ranges. I would like to add a point here though. Prior to this time I had checked the optical sight..a crew check for boresight and in this sense is really not boresight. There are two knobs that affix the site to the window panel--the upper knob I tightened down finger tight and as I adjusted the tightness of the lower knob, I could vary a star motion with the spacecraft fixed as much as two or three degrees depending on the tightness of the lower knob. I assumed

that the McDonnell people were not heavyhanded , but that they did torque the lower knob down to a very tight position, and used that as my reference point. This is the position it was in when I acquired the target. This, by the way, shows up on the simulator and this is why I was prepared, I might add, for this event. Now the suggestion obviously should be, we would torque this lower knob in the actual spacecraft for boresighting and put a bench mark on the knob to match up with a mark on the sight head itself, so that we would know where we are boresighted.

FCSD Rep What were those ranges again where you had that visual?

Schirra This was just prior to transfer burn.

Stafford It was approximately 43 to 44 miles. I had been looking in the cockpit all the time taking care of the computer and all the functions involved in the data acquisition and computation and when I looked up, I too thought it was a bright star . It took just a couple of seconds to look up and it appeared to me that besides being bright it had a slightly, very slight orange cast to it.

Schirra I think we can explain that orange cast because I saw that frequently in the upper part of the window. It had more smoke on it from the second stage. We will develop this point when we go back to the launch-insertion phase. The

upper half of my window, as contrasted to the lower half, specifically above the lines that would give me zero pitch was much darker than the lower half. It was much like looking through the smoke glasses you use for looking at the sun where you can get it to go orangy. This is a perfect anology. In fact that was the very effect.

Stafford When you normally look at a star, it is white to possibly yellowish at times. I could see Sirius like this but the reflected sunlight off Spacecraft 7 at this time had a very, very slight orange tint to it.

Schirra You are disagreeing with what I said?

Stafford Well, not really, but compared to Sirius....it was a little more orange than Sirius. Sirius had a tinge to it, too.

Schirra Yes.

Stafford But this had a little color offset and when you looked at them closely you could tell between the colors. It was probably more like Aldebaran.

Schirra O.K., I'll buy that.

Stafford We're probably splitting hairs here.

Schirra At this point we would like to discuss the lighting techniques we used in the cockpit during this phase of rendezvous, where we were trying to acquire the

outside targets. On all three lights, we used white light. We dimmed the center station light down to an orange yellow. Just barely enough to illuminate the systems reference in the center pedestal. On the command pilot side the light is dimmed down almost to that same intensity in orange yellow. On the pilot's side where all the data collecting, bookeeping, data reducing is done we keep that light almost white, not bright, and we have a light shield, a piece of cardboard with Velcro on it, attached to prevent that light from bouncing across to the left side of the cockpit. As a result, the first acquisition of the target naturally would be expected from the left side, so we must assume that in this case I was better dark adapted for finding the dim light of the target after we lost it from the natural lighting. This was just to give that configuration.

Stafford O.K.. At this time when we were describing the light of the target we had passed the terminator on the earth but had not gone into complete darkness where the earth had shaded us. The sky was a light shade of gray and only the major stars were seen at this time. In these major stars we could see the reflected light off Spacecraft 7. This was at approximately 43 to 44 miles.

Schirra Once we got it beyond the reflected light, we couldn't see Spacecraft 7.

Stafford Yes, Spacecraft 7 disappeared for a while, but we had the position on radar.

Schirra First time on debriefing -- Thank God for radar!

Stafford The next part concerns the final data acquisition and computations prior to transfer. I could tell that we had good positioning as far as the NSR manuever with respect to sunset by looking out the window and also with respect to the range and pitch angle as we approached Point Alpha, which nominally is 20.1 degrees and 43.45 miles. We had a data point that occurred 82 minutes and 20 seconds which I labeled as 22 minutes and 20 seconds after NSR. This data point had a Theta of 19.2 degrees and a range of 43.52 nautical miles. The next data point was 20.8 degrees and 41.06 nautical miles. I chose the latter with the Theta of 20.8 degrees for Point Alpha and this was to ensure that we did not transfer early and at the end come out in sunlight, possibly facing the target. We transferred in this manner so that we would probably have the slight up thrust after transfer. We would come out and the sun would be behind our blunt end where we would be upside down and the

sun would be reflecting on Spacecraft 7. So, 20.8 isapproximately half way between nominal of 20.1 and 21.4

Schirra I think this is an interesting point to make at this point. Tom was so well up on his computations that he had time to discuss this with me and we knew which way to favor delaying this point and,as a result,we concurred on this and took the late side rather than the early side tc favor this maneuver which we had pushed for from the very beginning. I think it is appropriate to say that this set of points, meaning that we had the target at this point, for transfer in relation to day-night,and the target at the same lighting conditions practically for the final intercept is the only way to do it, in earth orbit. I may retract this in some other type orbit. But at this point in time, I would really hesitate to program the target to appear at the midpoint of darkness, at the final point of rendezvous.

Stafford As we progressed on, point B was 22.2 degrees, 38.62 nautical miles. Point C was 23.9 degrees and 36.20 miles. After reaching point C, I instructed Wally to push Start Comp and we obtained a solution. The solution that the closed loop gave us was 31 feet per second forward and 7 feet per second up which progressively decreased down to

the time of transfer to 4 feet per second up and 1 foot per second right. So for the transfer burn--we went closed loop--we had 31 feet per second forward and 4 up and 1 right. The back-up solution was computed on degrees. The angle changed from 20.8 to 23.9. Nominal would have been 23.8 and I computed 2 feet per second up. Now the range had a slight anomally in there. Normally it should be decreasing about 2.46 nautical miles per hundred second intervals. From Point A to Point B it decreased 2.44 and to the next one it decreased 2.42, which is slightly less than nominal. This gave my back-up solution of 23 feet per second. So just a variance of about 0.2 of a mile meant the difference of 32 feet per second and 23. If we would have been required to use the back-up solution I would have applied the normal along the line of sight due to the tracking information based on the trajectory plot, since it would have required 32 feet per second energy added to our orbit at that time to reach the next level. Had we been required to use the backup solution I would have had Wally apply 32 feet per second forward and 2 feet per second up. At this time again we noted that the yaw needle was steering exactly right on the center of the pitch gimbal of the FDI, which meant the yaw

error was practically zero or no out-of-plane velocity. It might be interesting to note the close tolerance we were dealing with--the fact that the closed loop gave us 1 foot per second right while the ground solution was 4 feet per second left. The total errors were in the accuracy of tracking as far as the two systems were involved.

Schirra Oh, wait, I would rather say that is kind of big.

Stafford We had 1 foot per second right. Now this built up later on in the other mid-course, but in this case, definitely with the small error involved, most of the time I was getting a tenth of a degree in yaw to zero degrees in yaw. At this time there is no doubt that the onboard was far more accurate than the ground as far as radar solution.

Schirra Well, that is why I interrupted. The ground solution was quite large, 4 feet per second. Now, there is a difference. The computer is working a closed loop solution to correct out-of-plane velocity to intercept with no crossing at target intercept. So it would generate a different solution, possibly, than the ground. So I'm not accusing the ground of giving us wrong data.

Stafford After transfer we had 62 percent CAMS fuel remaining. We had 68 percent after the NSR maneuver and we had still,

for all reading accuracy, 68 percent prior to the initiation of the transfer. The transfer burn cost us approximately 6 percent of fuel.

Schirra We had discussed platform align very often. People had been badgering us about platform align and I frankly did not want to do an alignment if all was nominal. As it was, in this case, we were tracking right on the polar coordinate plot. We did not have the variance in delta hor ellipticity; therefore, we would buy the platform. But prior to transfer, when I realized that there was an hour and a half from NSR to the transfer burn, I elected and stated to the range that I would align at transfer plus 5 minutes for that 5 minute period, which in fact we did do.

Let me just interject a point. This shows that with the amount of practice we had, judgment still comes in whether you make rules or not and in this case the proper judgment would be to do an alignment.

Stafford Again, our phase elapsed time for the transfer Point A occurred at 24 minutes, which I labeled as 24, but which was actually 84 minutes or one hour and 24 minutes. Point C was one hour and 27 minutes and 20 seconds and we reset on the time at one hour and 41 minutes and 50 seconds.

Schirra We almost ran out of data sheets in that we had gone that far from NSR.

Stafford I recognized this right away. To get all this data down I did not record all the early data because I knew we would be running out of room on the data sheet. Particularly, at the last, I began writing in double lines near the bottom, so we could get all the data on it.

Schirra This is important only in that we need to have an extra page in case you need it, which we did not have. The longest duration we practiced for an NSR was on the order of about an hour and 12 or 15 minutes. So we were stretched. Something that we should bring out for the command pilots of future flights--the little time card that I had made and placed over the fuel gauges of the MDS panel was invaluable. It was also used for reentry. I wrote my times on that by turning it over and affixing it there. We wrote in the burn times for that. My little reference gauge that I put on the clip to the left of the instrument panel was used continually through the mission, even though we knew this by rote, to time tag when I would take a data point. All this eliminated confusion.

On the bottom of the sheet--and I would like to add this for future flights--I wrote down the time of every burn we had to make because these times were spread out over a rather lengthy period. This is prior to NSR. I could continually remind myself when this burn time was coming

up in case Tom was busy collecting data.

Stafford The clock was reset at 31:50 and then I resynched with Wally and we also told Spacecraft 7 of our resynch time and he synched so he could go to his target centered coordinate plot from normal in case communications were lost and still give us the correct pitch angle versus time. We were calling down to the ground all the way through this data acquisition, transmitting on UHF, both range and pitch angle.

Schirra This is a good point to bring up. I don't know how frequently this type of mission will occur, but we had beautiful communications with 7. There is a point that is recorded on the range. By the time we got it we were over a station.

The time synchronization from MSF was conducted by voice loop. It was much like two aircraft in formation this way. The time synch subsequent to the transfer burn was also communicated over UHF. They were completely synchronized with us and Frank followed our pitch angles with his complementary angle and of course kept the transponder on us, which helped immeasureably.

Prior to the radar test we were talking to Spacecraft 7 and we did make some light tests then to see if we could acquire them. This is both the docking light and

acquisition lights. We did not see them. Subsequently, we acquired them optically with the sun reflection. When we lost them due to the terminator shadow we asked for lights again, and at this time we could just barely see the docking light, not the acquisition light. The reason for this is, of course, the docking light beam was pointed directly at us. If Frank held an attitude--a pitch angle Theta--for awhile, we could see the docking light, and then suddenly we would lose the docking light and just barely see the acquisition light. We would give them a new Theta, broadcasting it to him. Of course, we didn't do this every hundred seconds. Then he would come to this new angle and, BANG, there would come the docking light again. So the cone of view from it is important to note. This is how we could see the docking light. The acquisition lights for the Agena--as we had asked for them, we would have the Agena yaw 90 degrees so that the acquisition lights would be optimized. On Spacecraft 7 the acquisition lights for our observation were not optimized, in that we had the nose of 7 pointed at us.

The docking light was so far superior to the acquisition lights. In fact, the same realization occurred to us when we made our runs at night on the back road at MSC Houston, which is another test that should be performed

by rendezvous crews. We became aware of the value of the dock light then. The dock light is superior to the acquisition lights, particularly if pointed at you. It may be that we will have some trouble with these acquisition lights on the Agena as far as acquiring them at long ranges. We may need more intensity is what I am trying to say. We were well aware of what the acquisition lights were capable of doing. They were described to us as a third or fourth magnitude star at 34 miles and I'll guarantee you that is exactly what they were. No more.

Stafford We had a good test of this after transfer. That was about the first time we picked them up. It was at a range slightly greater than 30 miles. Later on after we separated from them we had them turn on the acquisition lights and again they appeared just about like a third magnitude star. At 20 miles they were more like a second magnitude star approaching zero. This was during sextant sightings.

Schirra I would like to retract what I said. I don't think I would dare to say the acquisition light is comparable to a third or fourth magnitude star. I would say more like a fifth or sixth magnitude. We were somewhat horrified about how dim they were.

Stafford Right. They were dim. During the sextant sightings, I had a telescope which helped amplify them.

Schirra Yes, but this you normally would not have for optical sighting from the left seat. I think we

better retract that statement. It is dimmer than third or fourth magnitude stars from 30 miles, because we had stars around Orion that are third and fourth magnitude stars. The Belt for example is, I believe, fourth magnitude, and the acquisition lights were not as bright as the Belt.

Stafford That is right.

Schirra You could check me on that--what the magnitude of the three stars of the Belt of Orion are. The acquisition lights were never as bright as the Belt. We feel this is a problem area.

Stafford That is correct.

Schirra We were synched in on time at five minutes when the computer light went out. I think we were off about five or six seconds on that synchronization, too.

Stafford After transfer we tracked on the target particularly, in the three to five minute period. The range at three minutes after the clock reset point was 24.92 miles, the radar analog meter gave us a range rate of 156 feet per second. I calculated from the next data point, at four minutes and a range of 23.36 miles, that we had a range rate of 160 feet per second. So the analog was very close. At five minutes we had a range of 24.19 nautical miles. I computed that we had a range rate of 155 feet per second. The analog showed that we had 152 feet per second. At five minutes we had a pitch angle of 38.3 degrees.

Schirra I would like to interject something here. The numbers we get from the analog range rate have been accused of being very inaccurate. They are until your eyeball is educated. We spent many hours looking at that instrument. Specifically I did, and learned how to read this thing around the marks that were placed on this meter. There are not enough indications on it. I do believe it is quite accurate. It is merely the presentation that is not, and if you learn how to calibrate your eyeballs to these increments, you can read this meter more accurately than many people have stated.

Stafford That is correct.

Schirra The next step, after the tight tracking from three minutes to five minutes subsequent to the transfer burn, was to accept the computer time frame for platform align. We mentioned that we were going to do that. I pitched down in the Direct mode using the rate needles, acquired the horizon, checked it at zero pitch on the ball, checked the attitude from the reticle versus the horizon, and I can say now the platform did not drift in pitch. We continued the platform align, milked the rates down to nothing, put the selector to platform and attitude, nulled the meters, switched over to SEF, and aligned in Pulse mode. To get a very tight alignment, it is not recommended for these short periods of five minutes to align in platform control mode. We can fly much tighter in pulse mode, and eliminate all the

minute errors. I should add that the needles were almost tight as a drum. We were not generating nor did we have many errors. Typically, you can see the needles start to hunt a little bit as the errors are being eliminated. In this case, I would say that the platform was as well aligned as it ever would be, prior to this alignment. But again, our concern was that we had waited along time and I still think this was a good procedure to follow.

When the computer light came back on, I pitched back up initially in Direct mode, to get one good pulse going. The radar lock never did break, which was a good feature. We know it shouldn't, but you never know until you are there. It did not break, which meant of course two things: one, that the radar will maintain lock , as we understand it, through a ninety degrees cone diameter, and, two, that Frank was pointing fairly close to use with the transponder aimed at us. We were quite fortunate to have the transponder aimed at us.

At the ten minute and twenty second point I pitched back-up, switched over to the RADAR and ATTITUDE on the FDM and FDI needles, and locked back on the target in time to acquire the next data point and then take the solution for the first mid-course. Obviously, with this technique, we eliminated the back up data points at seven minutes and nine minutes.

Therefore, we did not clear the core in addresses 25, 26, and 27.

Stafford The data point that was obtained for the final input for the first mid-course solution occurred at 11:40. It gave us a range of 13.06 nautical miles. We could not read Theta out of the computer at that time, but off the 8-ball I reported 55 degrees pitch angle. The first mid-course correction gave 7 feet per second forward, 7 feet per second up, and 5 left. We anticipated a forward and up because as we said, if anything, we wanted to transfer slightly later, to play it conservative for the lighting conditions on the end and make sure we came up in front of the target. The direction and somewhat the magnitude of the first correction was anticipated.

Schirra I think it is interesting to note that our onboard solution called for 5 feet per second left and the range solution, initially, for the terminal phase backup called for 4 feet per second left. Apparently, as I review it now, I see that their solution was quite accurate for the out-of-plane correction.

Stafford We had the tight track from 15 to 17 minutes. Our range at 15 minutes was 9.53 nautical miles. I computed

a range rate of 91 feet per second, and the meter read 90 feet per second. At 16 minutes we had a range of 8.62 nautical miles. At 17 minutes we had a range of 7.77 nautical miles and a pitch angle of 74.2 degrees. After the tight track at 17 minutes I zeroed addresses 25, 26, and 27 and completed a back-up solution. At 19 minutes we had a pitch angle of 80 degrees. At 22 minutes, we had a pitch angle of 94.3 degrees, which gave us a delta Theta for the three minute track of 14.3 degrees. The back-up solution that I computed was 6 feet per second up.

At the 23 minutes 40 seconds data point, the closed-loop solution gave us 7 feet per second up, 4 feet per second forward, and 6 feet per second to the right. So, at the time we could see that the closed loop was driving the out-of-plane to zero. We had a left correction to start with and we now had a right correction so that we would have a nodal crossing at the rendezvous point. The

closed loop solution was burned out at that time and the Computer Mode was switched into Catch Up.

As we continued in, the following pitch angles and ranges

were recorded; at 25 minutes we had a pitch angle of 110 degrees, a range of 2.77 nautical miles; at 27 minutes we had 117 degrees and 2.06 nautical miles; at 29 minutes we had a pitch angle of 125 degrees, 1.30 nautical miles. The pitch angle stayed very close to 125 degrees all the rest of the way in until braking. Starting with the 1.30 nautical miles at 29 minutes we had .74 nautical miles at 30 minutes and braking occurred at approximately 31 minutes. Again, the pitch angle stayed approximately constant throughout the rest of the maneuver. At 33 minutes we had a range of .20 nautical miles or 1200 feet. At that time, I called out every increment of a hundredth of a nautical mile and converted it into feet for a UHF transmission for both Spacecraft 6 and 7. We had .16 nautical miles or 1000 feet at 33 minutes and 30 seconds. We came to a complete stabilized stop of 120 feet exactly at 36 minutes. At this time we had 50 percent fuel remaining in the OAMS tank and the OAMS source pressure was 1800 psi. The braking maneuver total was 27 feet per second aft, 14 feet per second left, and approximately 7 feet per second down.

Schirra At the completion of the second mid-course burn,

the command pilot takes over and the technique that Tom and I worked out is that Tom continually monitors Theta and range and called these out to me. At the same time, I am rivited on the target and using the attitude ball as reference to check out of plane motion, and the radar needles as well for fixed line of sight on the ball. The target was readily visible at this point due to the docking light. The acq lights were diminished in intensity by the focused beam of the docking light. Although they too were visible, the docking light definitely was the dominant one and was overshadowing the acq lights. The optical sight showed the target to be again the same point, a half of a degree to the right and right on in pitch with the radar needles nulled. This is consoling in that we had wrestled so long with the Gemini Mission Simulator visual display where the visual target, would oscillate around the field of view of the optical sight. But here now, let's make it clear that the use of the visual display in the GMS was invaluable for this preparation. We had elected, in contrast to the advice that we received when we first started rendezvous training, to continue to use the attitude ball in lieu of caging it and then going to a free platform, maintaining inertial line of sight with the platform. This technique that we utilized,

I am convinced, is the proper technique. Ultimately, we will have to face another technique, I assume. But I am quite sure we could not have afforded it on this mission. This point will be developed. When the spacecraft was visible due to its lighting its internal lighting--adjacent to the optical sight, displaced about 10 to 15 degrees, were the two stars Castor and Pollux, the Gemini stars, on the same pitch line as the target vehicle.

So I had a very good roll and pitch reference at this point, if I had to go to that mode, assuming the radar might have failed from then on in. We naturally can find any motion in the star field more readily than we can using the platform and the radar needle excursion. In this case, I did not see any motion of the target in relation to the star field so I did not make any corrective burns. We felt from looking at the polar coordinate plot that we had faired our flight path into the nominal path. That we were coming tangent to this path and would be right on at intercept, meaning that point of final rendezvous, and this came to be true. The two stars, the reticle, and the target, all stayed in one common straight line. There were slight corrections made out of plane which finally totaled up to

the number that Tom gave. This, of course, was the number that is generated from the second mid-course to the final point where we were stopped in all motions, meaning attitude and rates. As we proceeded up the groove, as I would best describe it, as it was that, and reached .5 of a mile I applied the braking maneuver with the forward firing thrusters, and slowed down to where the analog gauge read about 10 feet per second and where I could just barely sneak a view at the needle that is hidden behind the vernier read out. We had perfected this technique on the GMS. We did not want to slow down to 4 feet per second as described by the initial briefings. We felt that we had rather keep the energy in just as long as we could knowing that we could always overcome this closing rate at the final point.

Shepard — During the braking maneuver did you have any trouble with the thrusters firing in maintaining visual acquisition with the 7 spacecraft?

Schirra — Yes, very good question. As you recall, I mentioned Castor and Pollox. I could not see them while braking. The forward-firing thrusters increased the lighting around Spacecraft 6, and it was interesting to hear the remarks from Spacecraft 7 at this point. They were really fascinated by this fireball.

We almost didn't have the guts to tell them that this would happen during the braking maneuver. But we felt that we better prior to their flight. We were, of course, associated with the crew prior to their launch and did mention this to them. But even then I think that they were somewhat dazzled by this display of fireworks as we went through this braking maneuver. They did not see us much before the braking maneuver, as I recall.

Stafford That's correct.

Schirra And I do recall Jim Lovell saying that he noticed a large plume from the lateral thrusters where I was correcting for out of plane velocities, and he described these as going out some 40 to 50 feet, as I recall, as a big ball plume. Of course, we saw many plumes subsequent to this time. As we tracked in the point was made abundantly clear that the technique of using an inertial line of sight and using stars was a fallacy The stars were almost completely obliterated by the tremendous blaze of light that occurred as the sunlight hit Spacecraft 7. It obscured every bit of the background; it was just sort of a gray void around it and this fantastically bright arc lamp effect at this range. This is now, of course, about 1500 to 1200 feet I would guess.

Stafford 1200 feet occurred at 33 minutes after the transfer burn.

Schirra And now I felt almost pained from this light. That's why I'd like to describe it as being so bright-- like looking into an arc lamp. Really brilliant. Then as we came in closer I kept modulating the velocity down as Tom called it, to where at his readout of 120 feet,which meant we were 120 feet or slightly more--he was reading .02,obviously, on address 69-- we had stopped all velocities in translation and had stopped all attitude motion. From this point on I maneuvered so that I would come up in an SEF position in relation to 7 and 7,in turn,pitched with me so that we were more or less on the same straight line. They could see us quite easily. We were now both in daylight, at this point where we were stationed at 120 feet.

Stafford Yes, we were both in daylight.

Schirra There are no external references until you get the horizon.

FCSD Rep As you completed your braking and came up to 120 feet what was your attitude with respect to 7, and were you behind him or in front of him?

Schirra Well, you can't tell because we were pointing at each other all the time. He's tracking me as well to keep the transponder on for our radar. And I might add, the radar was working beautifully and the needles were good right on down

to 60 feet. Their indications were valid, which I always wondered and worried about.

Stafford At 1200 feet, or .20 nautical miles, we were at a 125 degrees pitched up and he was pitched down -- inverted at the time. We remained at that essentially throughout the rest of the maneuver so when we arrived out in sunlight we were upside down at a total pitch angle of 125 degrees and he was pitched down at us. We continued to call out these angles. The angle progressed from 110 to about 125 and it stayed at a 125. It might have decreased a degree or so right at the last but it was close to 125 degrees at the very end when we came out in sunlight.

Schirra This is probably the best challenge of the whole rendezvous, at least for me, and that was to maintain this constant line of sight with what I had to work with. This, of course, was the ball in orbit rate, noting where the target was in relation to the reticle. The reticle was just merely an extension of my line of sight of the spacecraft. There was no background to work with. I managed to keep these down fairly small, alternating between Rate Command and Pulse, depending on how big a maneuver I needed to make. Finally, I brought the spacecraft up to the horizon in SEF, rolled around to

where we were then in the true SEF position in relation to Spacecraft 7. At that point, I closed in to about 20 or 20 feet and sat there in the SEF position, threw the platform to SEF and threw the control mode to platform control, and just sat there aligning without any problem at all. And again this was another satisfaction--that we could fly around the vehicle as we did.

To review the lighting of Spacecraft 7--as we came into the daylight illumination of Spacecraft 7, naturally the docking light and acquisition lights were on. They were insignificant in comparison to this brilliant blaze of light from the sun reflected, I recall quite well now that either Frank or Jim asked, "Do you still need the docking and acq lights?" I frankly think we had both forgotten about those. They were just like holding a match up in front of the sun. They are of no value at that point. Of course, they were no hinderance; they did not blind us nor did not bother us. The sunlight was of such great contrast.

Stafford Well, I'd like to point out from my view point -- starting at about half a mile when I gave instructions for the braking, I monitored out the window and inside,

particularly for the range and range rate. Outside, I noticed the lighting and it started to really grow in intensity at approximately half a mile. At one mile you could see a faint glow of the adapter,, looking from the inside to the outside. But at half a mile it started to glow and then really became bright as we got in there. But the

real brightness occurred just at the time we started to brake at a half a mile. It was really brilliant.

I could hardly see any stars. Of course, I was not completely night adapted because I was in the cockpit even though we had a low lighting condition.

I'd look out and back and forth.

FCSD Rep Schirra: And during this period you had good communications with 7? Oh, excellent. I think that the point that Tom started to make is that we did not concentrate on the right seat man having a dark adapted set of eyeballs, as contrasted with the left. I was the outside man and he was the inside man in this case. The reason why the light probably bothered me so much is that I was switching from what amounted to the darkness of the night side with just the acq lights and docking light to this brilliant light, so my eyes were really blasted by this reflected light. I can only say that this was very, very bright and I'd like to stress that point.

Stafford: To indicate our position to 7 at one time when we had a slight lull in our data acquisition, we told 7 that we would turn on our dock light, which we did, and they acknowledged immediately that they had us in sight. To prevent any reflection from the nose section of the spacecraft from blocking our view, we then turned the dock light

off.

Schirra The point here, and that brings up another, is we didn't want to keep our docking light on for any period of time because it would diminish my dark adaption by lighting up the nose.

The other point that comes from this is that we had discussed this and would not deploy the docking bar until we were within range and this is a recommendation for any rendezvous mission. This point, do not deploy the docking bar until you are ready to dock. It can only hinder you on rendezvous and we subsequently found this to be true when we finally did put it out. It was a bright shaft of light reflecting the docking light and it would be a problem during the period of rendezvous. Subsequent to rendezvous this type of lighting condition would not bother you at all.

FCSD rep When did you put your bar out?

Schirra We put the bar out just before we left orbit.

Stafford Well, right. It was during the daylight pass going into night for retrofire, We extended the docking bar to check the function and then checked that it was jettisoned at retrojet.

Station-Keeping

Schirra I'd like to restate the first task that we accomplished after completing the rendezvous - that was to align the platform

while in station-keeping position. This is the first thing that was accomplished at this point. This came up as a requirement prior to docking with the Agena. This was to permit platform parallelism check of both spacecraft and Agena. This is not a difficult task once all of the velocities are brought to null--that includes attitude as well as translation velocities. We aligned for about 10 minutes, I'd say, to get the platform properly set up for any subsequent maneuvers.

Shepard Did you have a feeling the platform was too far out of alignment? Was it noticeably out of alignment once it stabilized?

Stafford No.

Schirra No, the platform was quite close to alignment. I merely wanted to try this as a task knowing that I was there and that this would be a requirement for subsequent missions. And I would state now that it was not a difficult task at all. It is quite easy in fact.

Stafford Our position at this time was out in front of the other spacecraft, BEF.

Schirra Spacecraft 7 was BEF and we were SEF. Frank was maintaining his attitude with his reticle above the horizon and I merely sat on his nose, I guess at about 15 or 20 feet in align and merely maintained position with the translation thrusters. We were in the complete SEF position, meaning 0 roll, 0 pitch, 0 yaw.

The question was asked, "Is it easier to tell if the platform is 'off' in pulse rather than platform attitude control mode?" In platform mode you really can't tell whether the platform is off because it runs through the excursions. I believe the textbook answer is plus or minus 1.1° per axes, and that is about the way it was flying. In Pulse mode we hold it down to decimal degrees per axis. The tighter you hold it the better the alignment, so at this point I was in platform mode and merely just gave the platform the full 10 minutes to take out all the errors. Typically, errors are still being smoothed as late as 5 to 7 minutes, so through a ten minute alignment period you give the platform all the alignment it needs.

The task of staying in this position was simplified, of course, by having the horizon and we, at this point, started our picture taking and we took a boat load of movie film and still pictures. Somewhere in this period of time we had the sunlight crossed my window. I think that

this point is very important to make. I could not see through the window at all while in formation. I asked Tom to keep an eye on the other spacecraft and finally asked him to get on the maneuver thrusters, if necessary, in case we had any velocities develop that I hadn't detected before I lost sight of the other spacecraft. Now think of this. This is a spacecraft some 20 or 30 feet away and I can't see it.

RCSD Rep Can you describe the sun angles at which this occurred, or did it occur at any time the sun was shining in the window?

Schirra The sun angle was the key, but I can't tell you what the angle is. It is an oblique line of sunlight across the plane of the window and this then picks up all the deposit of material that we are convinced came about due to staging. It's just like a carbon glass that you use--smoked glass is the term I'm searching for--just like smoked glass with a light across it at an oblique angle.

RCSD Rep Would it be fair to say that the closer the sun rays fall to the plane of the window, the --

Schirra That's correct. It would have to be. It is when it is almost parallel to the window.

Stafford In fact, it was so bright that I could see out of my left eye that that whole part of the cockpit was just completely

lit up--a tremendous lighting. I could see the tremendous white glare over on the left side of the cockpit from the right side.

Schirra This happened to us subsequently, depending on who was flying, everytime we got this angle. At times Tom, when he was making a maneuver had to give it back to me because I could see it but he couldn't. Now this only derived from the fact that the two windows are in different planes, at least as far as the sun line is concerned, which helped us in that sense. And this again goes back to when we, as not the only flight crew but as representatives of the whole flight crew team asked for a maneuver thruster controller on both seats. That helped us this time. It paid off very much, I'd say.

Stafford That's right.

Schirra So it turns out that another pilot input did work.

Stafford It was nearly identical to formation flying where, say one wingman is flying on the lead aircraft and the lead turns into the sun, you call him and say, "I lost you in the sun." Now this would work back and forth between Wally and myself, I'd say, 5 or 6 times in flight. We'd just hand the control off to the other individual who had visual contact with the other spacecraft.

Schirra During the first daylight period when in formation with Spacecraft 7 we were scheduled to do an in-plane fly around. Combining the final stage of rendezvous with the platform align period, which I felt was necessary, at least as a technique to prove that we could to this prior to effecting dock if we had an Agena, we noticed that time was going by quite rapidly. In fact, I think this might be appropriate to say now. We had lost all reference to day and night--where we were over the surface of the earth. We were so intensely concentrating on the target vehicle and the rendezvous itself that we could care less about anything but where that target vehicle was. So as we, in essence, regrouped while in station on 7 and noticed the wires or cables--as we now know probably the primer cord bundles--hanging from the aft section of 7, it was obvious that we were not going to complete an in-plane fly around on a daylight side prior to the night terminator arriving. I elected then not to do the in-plane fly around but to become more acclimated to station-keeping in case we had problems maintaining a formation or station-keeping position on 7 during the night side. My concern was disspelled rapidly when we found that the docking light--even the cabin lights alone from 7--was sufficient for station-keeping.

Station-keeping as an art can be practiced very readily with the GMS and the visual display system. Without it, this task would have been an unknown and probably a most difficult task. One of the problems we did find station-keeping in daylight was the intense brightness of the target vehicle in contrast to the lighted background above the surface of the earth. The contrast between the bright horizon and (this whole mission basically was VFR on top) the bright surface of the earth due to the tremendous cloud cover, made the transfer from outside the window to inside the cockpit most difficult. Our eyes were so narrowly pinpointed--our pupils were drawn to a point to accommodate for this brightness--as a result the instruments inside were quite difficult to read. We kept our lights full bright and just barely could read the instruments. Now, this could be a problem that could only be avoided by carrying proper equipment. I have one suggestion at this point that could probably be improved upon, but it is a varied filter system that could be worn much like the flying gogles we did use. But these would have rotating lenses with a polaroid effect so that as you looked out the window you could rotate to some degree of polarization then, when restoring your attention to the inside of the

spacecraft, you could rotate the lens to give you complete visibility inside the spacecraft. I would prefer not to recommend the polaroid filter that we had on the mission. We did utilize that at a later point to keep the light out during our sleep period. That did work by the way, very well, but this would limit your field of view while station-keeping to just the circle we used for the polaroid filter on this window device. I think we can develop this point in subsequent debriefings. On the night side, there was no difficulty in maintaining any position we wanted. Interestingly enough, if we were in plane, either ahead or behind the target vehicle, or out of plane at a 90° point, it was very simple to hold station. I feel we'll have no point whatsoever holding station with a man on the end of an umbilical between the two vehicles, in one case this would be, we hope, Spacecraft 8 and the Agena. I have no qualms whatsoever about this as a problem. But, in reservation, I would like to state one thing very important. Let's not schedule EVA very early in a rendezvous mission. We found that we were busy, completely wrapped up, working continuously, even though one man might be station-keeping, doing a fly around, photographing. We were continually busy. I guess the best description would be "exhausted" when we

finally separated from Spacecraft 7 and completed our sextant sightings. It wasn't a requirement for sleep--it was just a requirement for shutting down. Tom, you may have a comment here as well.

Stafford Right. In getting all the pictures that were required, acknowledging the ground messages, coordinating the messages between the two spacecrafts, and recording the data along with integrating the total crew in holding position was just a complete busy time. I've got a note in my log at a GMT of 6 hours and 34 minutes which says, "still busy trying to get pictures and keeping station and occasionally trying to get a meal in." In other words, it was a completely full job for two people. Trying to project this over into the Agena missions where we have the commands for the Agena and associated functions to do, I think adequate time must be allowed for each individual step. I think a time line constructed on the gound must be multiplied by a factor of two at the minimum for the required time to perform any function at this point.

Schirra We did manage, I suspect due to my concern from my Mercury flight, to drink water frequently prior to the actual terminal phase of rendezvous. We did get a meal out, one meal, and split that prior to rendezvous.

Stafford Right, and we only had the bite size items to eat. There

was not time to even think of reconstituting any of the other items in the meal.

Schirra It was a very busy period and we only can say that this is a very strong recommendation. I feel that we were the best prepared crew for this mission due to the long time that we have been associated with the Gemini Program, considering the training that we had with 3, and phasing that on into 6 immediately after 3 with no new requirements such as systems, briefings, etc. We merely picked up rendezvous as a new adjunct to our mission. We were, in our own minds, very interested in doing EVA on this mission after the turn around from the Agena loss. I think now it's quite fortunate we didn't have it booked in unless we had this capability on a second day. And that would be the time that I would recommend that EVA be considered. Start a whole new day with EVA as a separate exercise. Meaning by a whole new day - rendezvous, station keeping, docking finally, sleeping while docked as we had discussed it, and then doing EVA after this period of time. This, then would be an orderly progression of events. One other thing that gave us a problem, and this probably is appropriate now, was that we had a fully powered spacecraft almost continually through to the period when we went to

sleep. We were never comfortably cool. We were just barely tolerably hot. And this was with full flow with all systems running as cold as we could set them, with both fans running suit fans 1 and 2 and both pumps running. Until we had powered down the spacecraft for our sleep period, we did not start to get cool.

Stafford That's correct. Initially, we turned the one pump off, as has been donw on all the previous Gemini flights over Carnarvon, and within a rev and a half later we had to turn the second pump back on because with just one pump running, with the suit temperature full cold and all the other associated gear operating, we were perspiring freely and were very warm. Nearly to the exhausting point. The second pump did reduce our suit temperature. It went down to nearly 60 degrees. At one time we had an inlet temperature of 68 to 70 degrees.

Schirra This point has been lost since Gemini III. Tom and I recall very vividly that Gus and John said they were never comfortable. They were tolerating it, and, of course, Gemini III never did power down. Since that mission we've had long duration powered down flights, and that's when the crews finally became cool. Possibly in Ed White's case, where he had an exertion period during EVA, he became overheated, but they managed to cool off, because shortly after that they started to power down again for the duration of their mission. This point could be lost on future rendezvous missions if we don't make a big issue of it right now. We managed to minimize any physical chores that could be performed during this period where we were fully powered up. The meals that we ate were brought out of the side boxes. We tried not to do any-

thing but that. In fact, our initial stowage was aligned that way only for convenience. Now, we realize that is was quite fortunate that we aligned our equipment so we didn't have to go through extra work to get to it.

The night pass-- getting back to staion keeping--had no surprises, no new events for us. We maintained station, I would say, between 30 feet to possibly 40 or 50 feet at night. And felt free to let Spacecraft 7 move without holding attitude. Now, this in itself was a challenge that we hadn't really faced before, and readily accepted, it turned out. This came about, of course, due to the fact that Spacecraft 7 was worried about its electrical power supply and its total fuel budget. As a result, we let them act as if we weren't there. Those were the instructions I gave to Frank. O said, "Just ignore us and we'll hang around here as long as we can." It turned out we could have stayed there as longas we wanted to. We merely found that we needed to do other things. Station-keeping was then a proven facility from the training we'd had. It might be worthwhile to bring up something else that made station-keeping obvious to us. This was the old D-2 Experiment, where we did the in-plane fly-around. When we initially started, we tried it in Rate Command with the

maneuver thrusters to force us up and around in-plane. The first fuel budget was something like 54 pounds of fuel for a period of about 35 minutes. If the motions are kept down to a bare minimum, the problem of station-keeping is minimized and the fuel budget is minimized, which, of course, is our intent. I think we ended up doing what I had hoped to do after we'd finished the flight plan items. That is, we did our station-keeping on the first orbit, really, the first orbit after being in rendezvous. On the next day period there were two experiments that had to be conducted by 7, so we delayed doing anything while they performed these experiments. This was their D-4/D-7, I believe. Once they completed those experiments they maintained yaw reference. We did fly around a stable vehicle--the in-plane fly around. Now, we had turned the radar off shortly after maintaining the initial position in orbit with 7--did not use the radar again--and we turned the computer off. It had no function for us. We left the platform on all this time. On this next day pass after completing the test with 7 we commenced an in-plane fly-around with an eyeball ranging system. I let the spacecraft move out to about 100 to 200 feet -- this you can judge

quite readily from the optical sight and the size of the target vehicle. I would say at about one point we got out to 150 to 180 feet, somewhere in that order, and it was quite easy with these very slow moving rates to just tap the aft-firing thrusters and maneuver back in. This is a normal technique flying around in-plane. As you initially startfrom where we did, which was SEF, I started slight little blips up, which then, of course, caused us to go up and translate slightly. Then the radial velocity needed to be added continually as we came around through this circle of in-plane. All of this control is in Pulse mode. In fact, the whole station-keeping exercise, but for the initial platform align was in Pulse mode. We never did go back to Platform mode again after that. The problem in Pulse mode versus Plat mode is practically negligible if you once get everything stopped. And that is the key to station-keeping--it's not to pick up any large velocities. The translation velocities were very very slow. I think they can be better observed and documented by the movies that we took with the Maur camera which was at real time velocity, 16 frames per second. You can easily see that the rates were very very low, and that's that's the rule for station-keeping.

Shepard Did you notice the closing effect when firing the lateral thrusters?

Schirra Oh very readily. That's a good question to ask, Al. The effect of any translation thrusters, but the forward-firing thrusters, is to bring you closer to the target and you continually find you have to back off a bit--use a little blip once in awhile to back out. Also, I was concerned about whether the attitude thrusters would cause some unknown velocities. They were not discernible at all. I thought they might be. They are not. And I think this is due to the fact that they are such small pulses that even in accumulation they are masked within the other pulses for translation. Now, another interesting observation during the in-plane fly around--I stopped at the 180 point, which is basically BEF with heads down--and came in to look at the adapter section. I'm not sure whether I did it on this point or some other point, but the point that I am about to make is significant. We were looking at the adapter section and photographing it, and with these translations

that you just described--the lateral translations--this, of course, causes you to come closer. We were photographing away with movies and with stills. Tom would take some and I would take some, passing the camera back and forth. And trying to log these things is another chore, which we finally gave up doing. We figured all pictures of Spacecraft 7 are obvious so there is no reason to log them. The interesting observation was- we took movies of this, and I hope we see it--we blipped the forward firing thrusters to decelerate this closing rate that accumulated and watched this adapter go "POOF" and balloon around. It's quite a thing to see--the thermal blanket on the adapter. We asked the 7 crew if they felt this or not. They said they did not, but, of course, we were looking at a large area. This is a ten foot diameter circle with a relatively pliable covering. But it did move considerably, like a sail that just picked up the wind when you came into the wind, having tacked or come about. Real stiff plop on it. This in turn might very well blow your little EVA man around. I think we might watch our

step on thruster action against a man in EVA. I think it would probably move him.

Stafford One thing I noticed when we did this--we were at the time aligned with the horizon and with the forward-firing thrusters being along the center of our axis on both sides when we did this, you could detect this movement on the thermal blanket out to distances of 40 and 50 feet. When you'd see these little pops you'd see two fairly large indentations on both sides of the thermal curtain on 7 and it would go through kind of a POP motion and spring back out when we'd fire these forward firing thrusters.

Shepard Were your X-axis aligned?

Schirra We were aligned exactly with the other spacecraft.

Stafford ANd when we'd fire the forward-firing thrusters, you'd see two large circular instantaneous indents in the thermal curtain.

Schirra This confused us too, because we know they are centered 10° and 26°.

Shepard The plumes aren't supposed to do that.

Schirra I know they are not. That's why we are making this point.

Stafford In fact, I would estimate that the diameter of one of these instantaneous circles that you would see, one on each side of the thermal curtain,

encompassed nearly the radius of the thermal curtain. The thermal curtain is approximately 10 feet in diameter, and you'd see two circles of approximately 4 feet in diameter go "POOF" when you'd fire the forward-firing thrusters.

Schirra It surprised us. It's not supposed to happen.

Stafford It surprised us. It's two, not one. You'd see two circles.

Schirra These aren't big "POOFS" either. These are just little tiny decelerating maneuvers. So we took movies of this and we got it one time later in our time with Spacecraft 7 where we had the adapter lighted with the sunlight. It should be a spectacular picture if it isn't over exposed. You can see the thing really quiver. It's not a minor thing. And, of course, this is the other thing we were looking for. We didn't realize this would be the thing to show it with so we lucked out by being so fascinated with these cords that were hanging out and getting back to take a close look at them. At that point, when we were looking at the cords on the casing, we almost touched the darn things.

Shepard Did you notice any movement in those cords when you fired those thrusters?

Schirra Not as much. They did move though. We moved them.

Stafford The cords would move with them but the main thing that was so evident was these two big indentations in their thermal blanket.

Schirra We're covering a large area of loose material, Al, and that's possibly why we were so aware of it. But there was definite motion imparted to the blanket. Now how much of that would be added to the total mass of the spacecraft, of course, is dependent upon its mass as well. It's quite high, so it shouldn't have affected the whole spacecraft. They didn't feel it.

Stafford In fact, it was very amazing. Just after we noticed the first one Lovell made a joking comment to Frank he transmitted. He said, "Do you have the feeling somebody's back behind us?" This occurred right after the first time we noticed the "POOF" on the adapter. Right away, at that time we thought we pushed them.

Schirra The second daylight period I did the in-plane fly around--came back and pulled in to about 60 feet and said, "Tom it's all yours", and Tom did the out-of-plane fly around. Subsequent to that I did one as well. ANd we did many of them, really. We shared quite a bit of time. I'd like to say that the best way to fly around a spacecraft is out-of-plane. It's the easiest way because you have a horizon there all the time as an attitude reference, and you can't come into the cockpit. It's much like flying formation on another airplane. You don't get in the cockpit when you fly formation; you know, you very discreetly take a sneak in and check and see if the guy's flying thesame place you want to go, whether your fuel is all right, whether your engines are all right, and you rip rightback out again and eyeball that other vehicle. The same thing is applicable here.

FCSD Rep At about what range were you in your out-of-plane fly around? At about the same as in-plane fly around?

Schirra I would say that you could pick any range you want and you are safe at--you know, I had reservations about this. I said I was never going to go beyond 60 feet. I think that is probably a good place to call it for in-plane. That's a little hairy.

Stafford On the out-of-plane I think you can maintain attitude out there in a good stabilized position very easily at 100 feet

because you have the broad side view of the other spacecraft, and you can detect any relative motion instantaneously, and make a small minute correction to hold it. A so, you can traverse from one given point to another one very easily. The one thing that also helps you on the reference cues, particularly during daytime, is to see the horizon and the other spacecraft.

Schirra And of course he is above you if you are flat with him, tangent to the earth.

Stafford After Wally completed his in-plane fly around, to save fuel they went to the Horizon Scan mode and started to drift off. Now, when I performed my out-of-plane fly around, they had yawed nearly 180°. We talked about it, and we developed the technique of having our X-axis pointed toward their center of mass, around somewhere near the heat shield.

Schirra Remember we have talked about this before? It works.

Stafford So, they can be at any attitude. It is at times confusing because you will pick up a rotational rate on the target spacecraft as a translational velocity by your spacecraft. But if you aim at the center of mass, this will help greatly as far as any position going around.

Schirra There was one time when we had an illusion and it was really amazing. They were moving in yaw while we were stationary. Actually, it looked like they were flying right by us. It

looked like they were really "modocking". This is why I asked Frank before they launched to be in a fairly tight mode, because I didn't know how we would handle it until we tried it. But before we left them 7 had some problems with this dose of water that came out of Frank's inlet hose, and he was quite concerned about it. So they told him that on the next daylight pass to roll up at a rate of 10 degrees per second. We were still in formation with him and Frank asked me to move out a little bit, so I moved out about another 5 feet from about 10 feet. That is as far as you have to go. He started this roll rate and it was the most delightful think you ever saw in your life. This big--big, of course, to us at this range--this big object and you could see this thing starting to move around in roll, just gently rolling. Then you could see the whole thing couple. I would go into a pure roll maneuver, and then finally translate into pitch and yaw and all axes were just going. I guess it was at this point that we realized that station-keeping, no matter how this beauty was moving, was no problem at all. Just a piece of cake. We developed this technique as we went along. If I had come up there and saw something like that to begin with, I would have been horrified.

Shepard What would you judge the minimum distance to be on a random

drifting spacecraft?

Schirra As long as I know that it is not translating, which is the problem with tracking the booster, I would come in within 10 feet of its nearest part. Some part is going to come by. What really backed us away one time when I was fairly close, I would say maybe 2 or 3 feet as they yawed around, were the darn cords flying around out there. We both elected to back off a little bit so we wouldn't snag those things.

Shepard Suppose you had an Agena where you know it has no translation capacity because it has lost attitude control. Would you think with a slow rate like that you would want to go up and try to get into a target adapter?

Schirra You know, we heard about some studies that were done and I think the numbers I heard of were something like an object, meaning target vehicle in this sense, moving more that 2 degrees per second, or something like that, would be almost impossible to dock with. I dispute that. I can't claim that I could do it, of course, but we could move with any facility we wanted. For example, when they started this roll thing, I said, "Frank, you have got a big blob of water." They had this big suit inlet problem and the water boiler is on his side. A large, big blob of ice formed there and the best way to describe it by dimension and size and configuration is it looked like a coot, a small black duck local here

in F orida that we shot a boat load of recently. It was the same size, the same appearance, but solid white. I said, "Frank, you have a real blob out there and I want to look at it." I just flew around looking at it no matter where he was going. He was in a random motion. We just sat there and took pictures of it and felt quite blase about maintaining station on that part of his spacecraft.

Stafford One thing that we should bring up in answer to Al's hypothetical question, is that I thought that the torque to inertia ratios and the thrust levels for a maneuver that we have in Gemini is absolutely beautiful. I am looking forward for the command module trying to turn around and head for the transposition and docking on the LEM. The Apollo Command Module does not have these torque to inertia ratios that the Gemini has so it might be a difficult job trying to catch a cycling S4-B with a LEM in it compared with what we have in Gemini.

Schirra That is quite true. That is where this simulation may have come up with these answers. I think it was for that that the numbers like 2 degrees per second were deribed. The control system of Gemini is--all I can say is exquisite. I could only ask if I really had to ask for more, for a smaller pulse, and then when youwant more you can get it by going Direct and if you want positive control in all three axes

you can select a Rate Command which is a very, very expensive mode. I don't like to use it, but it is a very precise mode for burning.

Stafford I have some data on this in-plane fly-around. The one that Wally did started at 7 hours and 42 minutes GET and ended at 8 hours and 2 minutes. The out-of plane fly-around that I performed started at 8 hours and 10 minutes and was concluded at 8 hours and 21 minutes. The OAMS fuel at that time on Wally's start was approximately 45 percent. The OAMS fuel that I had to start with was approximately 44 percent and concluded at 43 percent so we can basically say that each maneuver required approximately 1 percent of our fuel. Now with this, we have to evaluate the reading accuracy of the gauge.

Schirra We are talking in terms of less than 10 pounds anyway. This was the other number we said we could accomplish, so we're quite satisfied with that.

FCSD Rep Could you give an estimate of the maximum range during this station-keeping period and where you spent most of the time?

Schirra This is going to be fun because I don't have to answer that. It can be answered by photography. I would like to find out myself. As I said, we killed the radar and killed the computer. We didn't need it and that was another nice feeling because

I was a little worried about doing this in-plane fly-around. I always felt from the simulation that it was more difficult than the out-of-plane fly-around. As a result of not knowing my range, I had to work a lot harder, but even then I was content to stop and take pictures and this stopped my rivited attention to the other spacecraft. And it wasn't an ordeal. You were busy. You had to be on your toes. You had to watch for an opening rate that was not acceptable. Why I was concerned was that even on the Agena, I didn't know whether I could keep radar working all the time, or whether I'd get spurious inputs as I changed through different antennas. This is no longer a problem either.

MSSD Rep Regardless of the range, there were no particular problems in closing, opening or whatever you chose to do.

Schirra No. I can only stress it--you have to practice it. You don't just go up and do it. We spent a lot of time at MAC doing this, really for the D-2 Experiment. We did it down here and we ultimately got some training out of the docking trainer, where we worked up the Pulse mode for this thing. It is the only control mode that is feasible for this and this requires minimum fuel and that is what you are after.

Stafford For all the subsequent Gemini missions, in which docking practice is done with the Agena there is

only one control mode to use and that is P-lse for the attitude control and real minute inputs to the maneuver thrusters.

Stafford The call-up we had for the D-8 Experiment was to be performed at 6 hours and 35 minutes GET and 8 hours and 10 minutes. During the first one at 6 hours and 35 minutes we were very busy station-keeping and performing tasks. At this time Wally was station-keeping and acknowledging transmissions. I performed the D-8 protion on my side and have logged the times down there. However, Wally did not take the cover off the sensor on his side due to the motions required in station-keeping and the associated times. For the D-8 I have these exact times in here. The Position 1 was performed exactly at 06:35:00; Position 2 at exactly 06:36; Position 3, 06:37; Position 4, 06:38; Position 5, 06:39; and Position 6 at 06:40. When it came to the second pass through the South Atlantic Anomaly at 08:10 we were both very busy station-keeping at that time and did not get the data performed. Approximately 30 minutes later I entered in my log that we were extremely busy keeping track of the cameras and also talking to the crew about the water that was venting from the water boiler.

Schirra I think there might be another point to make, here. An object that is included in an experiment such as D-8 on my side was very difficult to perform. I had to take this large cover off, which I did not do on this mission. And to take my attention away from the task that I was involved in was too big a penalty. Tom could do his side because his came out readily. I had this big massive cover to take off and really no place to put it. So I elected not to even try to accomplish that part of it.

Stafford In fact, we talked it over real fast and decided that we'd take the cover off on the second pass through there at 08:10 and we became so busy that we could not perform it at that time.

Schirra We were asked to comment on thruster observations. That is the thruster activity from 7 while we were station-keeping. All this time they were in Horizon Scan mode, at night that is, and I was quite surprised to see how long the plume was that came out in duration of burn as if they weren't efficient. Every once in a while you'd see a sort of bluish-orange color that wouldextend out 15 or 20 feet.

Stafford 20 feet. Right.

Schirra And then you'd see what looked like somebody took 3 or 4 hot rivets and shoved them out. Sort of an incomplete

combustion. Sort of a squirt of hot fire that want whipping out there and then the burn seemed to last as long as a second or two. It wasn't like a pulse mode burn which is what horizon scan is supposed to be. Now, this may have been the lead into their thruster problems or just inefficient burning. More likely inefficient burning for the short duration that's asked for in pulse mode.

Stafford I would describe the light as bright, but not blinding, that came from them, from the attitude thrusters that they were firing at this time.

Stafford Right. It was a soft bluish-orange light that would come out. You would see it flash for an instant and them it was gone, and then these follow-up red rivets, but it would not blind you at night, and this was in complete black darkness.

FCSD REP Did you see this from any one particular thruster or set, or was it—

Schirra It seemed to be almost all the thrusters.

Stafford All the thrusters because in Horizon Scan mode you have both the roll and pitch thrusters firing.

Schirra Well now, you realize they were not controlling yaw which, of course, is just coupling anyway, but they were in just random attitudes and did not bother us at all. Random in the yaw plane at least. This may be another reason why we said we don't mind station-keeping out-of-plane, because we could just let them pivot.

Shepard You may have already answered this, but did you do any night fly-arounds with your docking light off?

Schirra We did not do the actual fly-around. We station-kept on the cabin light. They had their cabin lights up full bright for our benefit. There was no problem at all and that was a perfectly acceptable level of light which I might add is dimmer than the docking cone light of the Agena, so we are not in any trouhle on that light level.

Shepard Do you think with their ACQ lights on and their docking light off, and your docking light off, that you could fly formation at night?

Schirra On the ACQ lights? I would not even try to do it.

Stafford The ACQ lights would be far too bright and blinding with their flash.

Schirra In order of priority of light utilization, I suppose if I were trying to conserve in a spacecraft I'd use the running lights we have on the Agena. They would be ideal. Then next, I would use the docking light on the spacecraft, and

probably the other would be just sit off the nose of the Agena and use the cone light and just maintain station on the Agena if it were stable. I would not use ACQ lights at any time for station-keeping. I have stood close enough to them to drive myself batty out in that back row in Houston.

FCSD REP Did you find that the platform was of any particular use to you in station-keeping?

Schirra Yes, I did. I would say that when we became acclimated to station keeping, we ;fist stopped out of the Platform mode We used platform mode to feel our way along. The first maneuver, of course, was the in-plane fly around and you don't use the platform. Other than in this particular maneuver, I depended on the platform to stop me from moving out of plane. I flew around the pitch gimbal band of the ball and if I started sliding off, I would immediate ly correct for it much as I do from the second mid-course in. I would keep correcting out-of-plane velocities immediately, so that they don' t develop. They are very insidious and very hard to detect unless you have a good star background. That is another point to make. We did not use the star background for station-keeping.

We merely used eyeballs and distances that varied just due to whether we wanted to fly close or farther out or wanted to look at something on 7 more carefully. Seven had a limited fuel budget. Their cutoff, as I recall, was 11 percent OAMS fuel remaining. They had something like 14 or 15 percent both Frank and Jim did station-keep for, I would say a total of their time of about five minutes. We were in a fixed position, and I said, "OK, Frank, you've got it" and they started keeping station on us. We maintained our attitude in Platform mode for them. So we were quite stiff. They just moved around much as you would in the target docking trainer, which is a very good tool for this. Now to summarize station keeping.

Schirra I think starting out with devices we have available and taking the time to use them, station-keeping is not a major job. But when first there I would approach it with caution, remembering the rule of very slow motion. I would recommend, if you have everything working for you, to use your radar and platform. When you get your confidence up, kill the radar and fly in Pulse mode. You can ultimately kill the platform. In fact, it is a very simple mode. Just go into Horizon Scan mode, if you like, and use minute pulses that

don't overdrive the pulse mode logic of Horizon Scan. You can station-keep in that mode, which would be a pretty cheap mode. That is probably the key to it--that you don't make a thrust motion that is big enough to overdrive pulse attitude control.

Stafford With respect to training devices, I feel that the visual display that we had with the Gemini Mission Simulator was invaluable in so far as our training for station-keeping. In actual flight, once you were completely stabilized, it was a slight bit easier than on the GMS. I think this probably arrived from the fact that the pulse input on the spacecraft was a little bit less than what we had in the Gemini Mission Simulator, so we were working with a finer control mode.

Schirra To qualify that point further, because we have had a chance to think and to talk about it--the Pulse control mode in the RCS is almost exactly like the mission simulator, where I couldn't get the attitudes to really null out in the RCS. You could in the Pulse mode with the OAMS attitude control system.

Separation from Gemini VII

Schirra The separation maneuver was conducted to facilitate the Apollo sextant sightings and the burn was made to cause us to separate from Spacecraft 7 at 9 feet per second retrograde. This was done in BEF attitude, PLAT Mode, with forward-firing thrusters. The target was in sight almost continually through the separation period on the back side and, surprisingly, was in sight through a good part of the day side. This was interesting to see because, this was due to the sunlight bouncing off it. It finally got to the point where it was bright enough to be visible even through the smoky windows. In my particular case, it was visible through the lower half of the window but as my line of sight moved up the window, the target became totally obscured. I pitched up slightly to keep it in sight. Then on the second night side, we lost the target completely except for radar. Of course, this was not persuing any valid test but for the fact that the radar could still see Spacecraft 7 and we could not, visually. Tom should talk about this in that he took a great number of sextant sightings which were all logged and noted and I don't think it's worthwhile to repeat those on the tape.

Stafford Right. The separation occurred at a GET of 11 hours

14 minutes 29 seconds,--9 feet per second retrograde and burned for approximately 15 seconds with our forward-firing thrusters. We started obtaining data right away with the sextant and the star Sirius. At times, the flashing lights and the dock light would fade out. There was a big area in there which we did not cover since we had no reference. We had radar lockon practically continuously.

Schirra This was without their pointing at us.

Stafford To save fuel, Spacecraft 7 was in a random drifting mode but we had radar locked practically the full time. The ranges were very hard and the needles were very hard as far as track ...the needles were very hard as far as track.

Sextant Measurements (Sirius to Gemini VII)

Schirra We reacquired them frequently by looking at the radar, presentation of course. And this shakes me on that. I think there are visual problems. The radar was good on the second night side as well, and we just gave up using that gear and said, "OK, we've had it as far as this goes."

Stafford The best training device for the sextant sightings was the use of the sextant in the simulator here (Cape) with the flashing light we had simulated on the Agena, and the stars in orbital rate motion. I don't think you could

find a better training place. In fact....

Schirra Specifically, the one at Ames is not sufficient for the task.

Stafford We used the suggestion that Commander Lovell made as far as the simulator was concerned; also, the two very well experienced officers from Wright-Patterson who were navigators in their R&D lab who had used this instrument came down and trained with us at that time and I would estimate that we had probably put in a total of 30 hours using the sextant with sighting, the majority of which has been got in the simulator here. All readings were taken leading up to the sighting with a positive forward motion on the instrument knob so that the hysteresis would always be in the same way. And the TM of input for the photo event indicator was depressed at that time.

Schirra It will be interesting to note whether the time was accurate enough from voice communications. Tom would continually give me stand-bys, stand-bys, stand-bys, stand-bys, and mark; and I would read the time off the event timer which we had synched in to the nearest fifth of a second, which is the minimum display you can read on that timer. It clicks at a fifth of a second. I suspect the accuracy of the system is not very high with this type

of timing and I would be really curious--I won't say curious--I demand to see this data.

Stafford We also correlated our radar range with the sextant sightings when I gave Wally a mark, I would immediately push read-out on address 69, so we had radar range data to correlate with the optical data that we obtained.

Schirra Interestingly enough, when we first heard of this experiment, the experimenters said, "Oh, no, the platform and the radar are not required." I guess on a defensive basis so that their experiment wouldn't be dumped if we in turn had to use up electrical consumables. If we hadn't had the radar and platform on we would never have found the target again.

Stafford It's because the target would continually fade out and then fade back in, and when we would catch it coming back in, we know exactly where to look for our radar needles.

FCSD Rep You want to describe the technique you used in superimposing the two images?

Stafford Well, when we were separating, and as the angle increased, I would bring the spacecraft, pardon me, I would bring the 7 Spacecraft down to where it was below the star, and

with a positive motioning, and let the two track in together. When they were super-imposed upon each other, I would call mark and hit the photo-event indicator, and also the other one. At times we would achieve some angles that were very close to a zero change in the angle between the two; in that case I would bring the two together with a positive motion and stop it and mark the time.

FCSD Rep With respect to visual acquisition itself, and the ACQ lights at night, the docking light....at night, versus the sun light reflection in the day time at the same range, which would you say was better, the sun light bounce.....

Schirra Oh, the sunlight bounces.

Stafford The sunlight would be a factor, I would say a factor of....

Schirra Indefinite.

Stafford Ten or above.

Schirra There was no comparison. It was brighter than Venus, or at least as bright as Venus, compared to, I would conservatively say, at ranges less than 30 miles, a fifth or sixth magnitude star.

Stafford And if we both made the same comment on the air that we had a good comparison, and meanwhile Wally was more adapted to night than I was, when I looked out and I saw

it, there was no doubt that the reflected light off Spacecraft 7 was far brighter than Sirius.

Schirra I think the other point we should make out of this in that we are under the gun for a.....so called optical systems such as this and that it is a heck of a lot of work involved in taking these sextant sightings. The training, that's not the whole point. This particular experiment was conducted with the sole function focused on that alone. We did nothing else but that. There was no other activities going on. I was busy recording data continually and maintaining an attitude that would give Tom the best presentation for these two objects; one, the star, and the other, the spacecraft; and checking again and again for radar lock so we wouldn't lose it. It was a pretty busy session, in fact very busy was another way of saying it. Then to take all of this and generate a rendezvous out of it, unless you had a full computer system working for you, I defy a man to meet it; and defy computers to meet man on this as well.

Shepard Was the relative trajectory with respect to Spacecraft 7 the same as had been planned in preflight?

Stafford Yes, sir.

Schirra You mean at the separation?

Stafford With respect to the star too, and the angles. In fact, it worked out just exactly like we practiced it in the simulator here.

Schirra Before we separated I station-kept, knowing what time we would separate. This was a precise time to give us the lighting. I maintained station for about ten minutes, I'd say, and got the rates down to absolutely zero. We were right on their nose, very tight, and, as a result of the separation burn, we fought that right down to where there were zero residuals, even though we made only a 9 foot per second burn. We did not move out of plane noticeably at all, not a smidgen, even through the last sighting which was really during the daylight. The platform was on so you can always check that.

Shepard Did you ever get ahead of them relatively, as you came down in altitude?

Schirra Oh yes. We started out, of course, trailing them in orbit, thenwent all the way down underneath them and way out in front of them, leading them in orbit.

Stafford When we finally came around to the sunrise, we were inverted, pitched-up at approximately 20 degrees, so we traversed completely out in front of them.

FCSD Rep Just the way it was supposed to be.

Stafford Exactly what we practiced.

Schirra Right on the money.

FCSD Rep Tom, do you have anything in the way of comment on the use of the piece of equipment, other than what you've said so far?

Stafford No.

FCSD Rep A piece of flight gear?

Stafford Well, I would say as far as the experiment went, it was adequate for an experiment. As far as operational flight gear, it's too bulky, too big and bulky to be used for continual input as far as navigation. You'd like one, say approximately half that size; and another thing, you would like to have it mounted on the spacecraft.

FCSD Rep If it were mounted, it would be easier to handle.

Stafford Very definitely, it would be easier to handle.

Schirra Particularly in one "G" training, as well.

Crew Status Report

FCSD Rep Along in here, the Flight Plan called for a crew status report. Do you remember?

Schirra Oh, they got that.....

Stafford They got a crew status report. We were so busy. We had logged all our water, but it will take a little while to add up all the half ounce drinks, so we got all the data

recorded, but again, we were so busy that we did not give them that one. No, we gave them the blood pressure, and the blood pressure appeared satisfactory.

Schirra That's right. Your temperature probe, your oral temperature probe failed before lift off, so I had to give all the orals. We had no problem with the water system, either, by the way. It worked very well. Left the water bags right where they were at lift off, but they were there in case we did have a problem.

FCSD Rep Well do you have anything else to say on these sextant measurements?

Stafford No, I think we covered it. We obtained the data. The sextant is bulky to use in the spacecraft. The motions that are required in operation are satisfactory, and the readout was obtained fairly well, but it was a full, time-consuming job...for the two individuals.

Schirra I have something big to say about it. The damned sextant wasn't usable beyond about twenty miles range, and that's it. And you are not going to do anything with something that close. You have got to have it set in concrete before you get to twenty miles. We do have a major problem which is the visibility of another spacecraft or a target. You've got to see it at least fifty miles away,

if not farther. So we've got to get to work on abetter on brighter lighting system as the ACQ lights for a sure visual system.

Stafford The last data point that we obtained was 21.87 miles, and I had a four-power optical piece on the flashing lights, and I could barely see them. There was no doubt that Sirius was tremendously brighter than the ACQ lights there. There was no rule of comparison between Sirius and the ACQ lights. I had a hard time seeing them with the telescope.

Schirra What was the greatest range we recorded before we lost them?

Stafford 21.877 miles.

Schirra Uh, uh..oh, wait a minute. Sextant setting was taken at 9.70 miles. How does that grab you?

Stafford It was real hard to see at that point.

FCSD Rep You got no sextant settings at all during the day time?

Schirra No. There was no star.

Stafford There was no star.

Schirra OK, that's the big point to make--WE DID NOT SEE STAR ONE DURING THE DAY LIGHT SIDE; in any attitude, including when we were coming up in the terminal phase. Of course, at that point we were blinded by a spacecraft.

Stafford At the end of the first night separation, we were inverted,

and pitched up approximately 20 degrees above the night air glow layer, and coming out, we passed a terminator looking back into a gray sky, and again we could see this bright reflection off the target, Spacecraft 7....we looked around for stars. We could see no more than we saw upright to start with, and we purposely rolled to the right-side up position, pitched up to about 20 degrees, looking at it, and it had the same intensity of light whether we were upside down or right side up, and there was no increase in stars between the inverted position or the other position at this time.

Schirra I would say, if we didn't have the radar set, we wouldn't be sitting here with big smiles on our faces. Now you think about it.

Stafford I think the same thing exactly.

Schirra Scares me. For all that precise work we've done in simulation without radar, we always had those stars down here. Now that's a big change to the GMS. But whenever it becomes daylight, turn the stars off, and make these poor guys fly those rendezvouses without stars when there aren't any.

FCSD Rep That can be done manually.

Schirra Sure. Just turn it off. But we didn't do it enough.

Should have done it. I trained myself to do it that way by staying in the cockpit, if you recall, using the radar needles. The only way to do it is to turn the stars off and then see how they do. All right, that should be phased, so that the instructor consoler can just click, turn off stars; that's the point where the stars are no longer visible. That's the end of them. That was the flaw in Mac's training, and the flaw with this as well.

Posigrade Translation

Stafford The posigrade translation of nine feet per second forward was performed at a GET of 13 hours, 25 minutes and 52 seconds; the duration was eleven seconds.

FCSD Rep Take out the residuals?

Stafford Right.

Schirra Yeah.

Stafford Residuals were removed in all burns.

FCSD Rep Did you align before you burned?

Stafford Right. We aligned for a considerable period of time before we made the.....

Schirra I don't think we ever made a burn with less than about 15 to 20 minutes of alignment, other than the transfer burn, and I almost got myself trapped in the subsequent burn for rendezvous.

Power Down Spacecraft

Schirra On power down the spacecraft, we did this on our own without great reference to the flight plan as such. When got done with the appropriate piece of equipment, we turned it off. For example, when we completed the rendezvous, we turned the radar off, and then when we got done with the computer, we turned it off. After the second burn, where we burn in an equal period of orbit, we were about ready to secure the watch and get some sleep. We turned, of course, the radar off when we lost the target; as far as the sextant settings went, there was no use for it anymore. We turned the computer off shortly after that, always going to Prelaunch and then turning the computer off.

Stafford The platform and the IGS power supply were turned off at a GET of 13:55:00.

FCSD Rep Can you estimate how long after that before you started getting cooler, significantly cooler?

Stafford It was half way...at least half way into the sleep cycle before we'd cool off. I'd wake up approximately every one hour. I recorded here that Wally started to sleep- maybe got to sleep 20 minutes before I did and I started my sleep cycle around a GET of 15 hours. It wasn't till

around 17 or 18 hours did we start to cool off to a comfortable degree. And I noted at the GET of 19:10 we finally turned the secondary coolant pump off.

Schirra I might add that I, in addition, during the sleep period started bleeding off my suit flow valve. I brought it down about a third of the way. I was getting cold, then woke up in the morning with a real heavy head cold. I was blowing my nose for the last part of the mission all the way to retrofire, real thick mucus.

Shepard You had a slight cold before?

Schirra Pardon...Yeah, but I didn't feel it, Al, until after that night period. No, no sensation of nasal congestion at all, and that's why I, finally in the morning, said "Whoops! I've got to stuff one of these pills in me, so I can hack this thing for reentry." And it just did it just right. I knew it was a four hour pill, so I played it so I would get in the reentry here.

Rest Period

FCSD Rep Would you care to comment on sleep time that you got?

Schirra We had ample sleep time scheduled, and we cut it short. Something woke me up, I think they were talking to Spacecraft 7, and they gave them a GMT that was 14:33, as I remember. GMT? I wrote it down on the clock and

said, "Oh! That's interesting. We only have about six more hours. I think I'll stay awake."

Stafford We started all our activity around a GET of 19 hours. We did get the secondary coolant pump off, you know, right at the end of our sleep period, and at 19:12 we turned the IGS power on and the platform on.

Schirra By the way, we knew without a doubt that there wasn't anyone who was going to talk to us about running for two days because we had done everything, we had a limited amount of fuel, not fuel, we had plenty of fuel; limited amount of film left, and that's all we had to play with other than another D-8, and we felt we'd just as soon get out of there and take it easy, because Spacecraft 7 was beginning to get kind of spastic too, and typically this also was quite obvious to us. We were about ignored, and should have been, cause we had everything under control, and Spacecraft 7 needed help. They needed to talk to the range, and most of the passes when we were in mutual pass range, and of course we were all the time, was devoted to Spacecraft 7. And I wanted to call someone and say I wanted to take a pill, and I just couldn't find any time to get in, so I said, "To heck with it! I'm taking a pill." Which is, of course, is what the pill is there for,

and I had already had one before the flight to become calibrated so that it wouldn't bother me.

FCSD Rep Say, you did hear this transmission to Spacecraft 7, and you probably stayed awake after that? Is that true?

Schirra Yes, that woke me up, I think.

Stafford I would say the maximum sleep period I had was approximately 4 hours from a little after 15:00 to approximately 19:00 or a few minutes after 19:00. During that period I was still warm so I would doze off for 45 minutes to an hour and some slight noise would wake me up and then I would go back to sleep again for about an hour, wake up a little bit, then go back again and wake up.

FCSD Rep Are these noises about what you expected? Anything new?

Schirra We never used a silence switch either. Neither of us did. We never did make up our minds. We were so damn tired we just powered down what we thought was sufficient to power down, knowing we had more than enough electrical power for one day.

Stafford You want to talk about, while we are on the subject here, that as far as being busy, one thing is apparent to me, that when we launched I was dehydrated from a slight case of diahrrea before we left here, and even though I drank a lot of water just before launch, I still did not

generate very much urine and after about....

Schirra This was something.....yeah.....

Stafford We both decided before we got into the real critical phase of rendezvous that we would not remove our urine collection devices; even after four hours or so, or five hours, I still did not have any urge to urinate. Then, after approximately 7 or 8 hours, it became obvious that my UCD had slipped off, and by then we were still too busy station keeping, taking photos, taking updates from the flight plan, and I finally got around to performing a urination at approximately 12 hours after launch.

Schirra This guy was so dehydrated, he slapped on 6 pounds since we landed on the ship. That was the tote we had before they weighed him and the tote we had after the evening meal; he put on 6 pounds.

Shepard That was before supper, right?

Schirra Yes.

FCSD Rep Anything else on that sleep period?

Schirra Yes, I had always worried about my hands floating around the cockpit, so I stuck one hand underneath my hoses, my right hand, this is the suit hoses in the COMM Lead; my left hand over the top, and clasped them and they never came apart. They stayed together the whole damn time.

Stafford I did the same thing. I hooked one hand underneath my COMM Lead and the other hand underneath the suit hose, and they stayed there all the time. With respect to these meals and how busy we were, we split a meal at approximately 3 hours and 30 minutes, just bite size, as we brought out before. We did not have time to reconstitute any food, and by the time we had about 7 hours and 30 minutes, we were still in the station keeping mode. Then, we did not have time to really press on so we split a meal at about 7 hours and 38 minutes, and we finally got around to each one consuming a normal meal after the sextant sightings and this was 12 hours and 30 minutes.

Shepard Before you went to sleep?

Stafford Yes.

Schirra The other thing that is interesting even then with just this little activity, minimum activity, no UCD work, no connecting up any hardware which is a big problem, too. We felt that the cockpit was cluttered. Stuff all over the place, just to do the rendezvous. Charts and cameras and this kind of thing, and updates and experiment books; and everytime we wanted to take a drink of water, we very precisely recorded the readings and the damn counter was reading 63,000 something when we started with it so we had

to log that big number all the time. The point there, that I am trying to make is, that we were busy, just barely living and working. And the working is the point, and if you take all of this and all of a sudden you say: "Now we are going to do EVA", oh, my God.....you wouldn't have a prayer.

Schirra The bird cage, as we call the stowage section, we spent 20 minutes getting that thing latched together again after the sleep period, we had it tied together with a little string.

Stafford With respect to the A frame there that contained the two camera boxes. Evidently it became bent or there was some deformation in the metal during the launch phase because while it worked satisfactorily on the ground when we got the camera box out and tried to put it back in, the camera box fit alright but the bottom tray was completely bent out of shape. We went through a---so we tied the pin for the water gun around it to make a kinda jury rig to keep it shut; and then before retrofire it took a considerable amount of effort on both of us straining full effort and getting in various angles in the cockpit to...

Schirra Tom was completely to the left. I got out of my seat

and turned around completely. Just to lock that thing up.

Stafford We finally forced it into position in the rev before retrofire. It was a huge effort.

Schirra That was a...we were really worried about that thing.... a maximum effort. The other big crisis was hooking up that blasted adapter hose to the water management panel for the urine thing. I again got out of my seat and turned all the way around and it took both of us to get that out of there. This is a fitting that is built for 2,000 psi.

Stafford Hydraulic thing.. it is a regular quick disconnect and it...

Schirra We complained about this before and couldn't get it fixed in time.

Stafford I would say that this required 20-30 minutes to get the...

Schirra To get that hooked up.

Stafford To get the urine quick disconnect hose onto the recepticle in the spacecraft.

Schirra That was a real problem.

Crew Status Report

FCSD Rep While going on here, 19:28 normally in the flight plan there was another crew status report followed by...

Schirra That was the morning report?

FCSD Rep Yes.

Stafford We gave that. We gave that to the...

Schirra Then we gave the full water deal, as well as all of our meals. We each had three meals, and the third meal we both ate, I guess at my urging. I said to Tom, "We had better have a good meal before we get down" and I'll say it now, it was the smartest thing I ever suggested, because those doctors didn't feed us, and we had to fight to get food on that carrier after the mission was over.

Stafford The total water consumption recorded was 129 half-ounce drinks for the Command Pilot, and 163 for the Pilot. At 22:25 the total was 129 for the Command Pilot and 114 for the Pilot, and then the Pilot had 49 more at the area approximately of a GET of 24 hours. Approximately 1 hour and 15 minutes prior to retrofire.

Dim Light Photography

Stafford The dim light photography experiment was conducted and we used one complete Hasselblad back of the 2475 black and white film, and approximately 15 exposures on the second of the two total that we carried. The majority of the film was shot on night cloud cover due to the fact that the orbital path was nearly completely covered with clouds throughout the entire mission. The first that we did on the twilight bands, that was sequence 1, I shot a

complete sequence as outlined in our log and with this we made a kind of sweep of the horizon for approximately 6 to 8 exposures. Then as the moon came up it would be too much exposure there, we yawed left approximately 70° and I made a series of exposures while we were yawed left. From then on, we continued to take a series of the cloud cover and I exposed...finished exposure on the one Hasselblad back and continued on the second Hasselblad back. The first dim light photography was accomplished at approximately 20 hours and 23 minutes GET. I had the exposures from 7 through 11 on the camera straight ahead in SEF position, then as the moon came up, we yawed left and I made a series of exposures; this was of the night air air glow band on the horizon; from 8 through 17 exposure numbers.

S-5 and S-6 Experiment

The following exposures are from 17 through 21, were made looking down at a pitch angle of approximately 20° of the night cloud cover of the Pacific Ocean with the half moon illuminating the cloud cover. You could very definitely see the cloud cover and I took a series of different time exposures up and down so we could cover the complete spectrum as outlined. This is on the Pacific Ocean west of Mexico. This occurred at a GET of 20 hours 42 min.

At 20 hours and 46 min. again for sequence 2, night cloud cover, I made exposures 22 through 27 and then 28. We had a very interesting one as we approached, still on the same pass at night, on the YUCATAN Penninsula. The moon was still up so we could see the night cloud cover below, and I would estimate about 7/10 broken clouds and right through the holes in the cloud there was oil and gas fires. With that, I obtained sequence number 9 as outlined in our flight log which is artificial lighting. So the sequence...this occurred at a GET of 20 hours and 51 min. on the YUCATAN Penninsula. I had a series of exposures that had both the fire at night and night cloud cover. Those were exposures 28 through 33 on the first Hasselblad back of the 2475 black and white film. On the next night pass I made approximately 10 exposures of the night cloud cover at various points. At this time we started our PRE-RETRO stowage preparations, and completed stowing the cameras and that terminated the dim light photography. So in recapping we had 2 series of the night air glow at sunset and then after sunset, as the moon came up we yawed left 70°, made another series of exposures, and from there on we made a whole series of the night cloud covers - they should have

turned out very well--we had a half moon and you could look down and see the clouds over the ocean. I took a series of time exposures that was outlined in the log, and also we had some that had both the night cloud cover superimposed over artificial lighting which appeared to be oil and gas fires in Mexico.

The majority of the time that we were in daylight, you could see only cloud cover below us. In fact, I never saw the United States. The only land areas that we observed was after launch-was the African Desert and parts of Australia on the second morning. We also observed just a small part of the Himalayas and the other part was completely obscured with clouds. So with this type of weather phenomena, the majority of the pictures exposed were the S-6 weather experiment. In reference to the log, the first S-5 and S-6 experiments were obtained at approximately a GET of 20 hours and 10 min.; at this time we were pitched down 90° and I'd use the MAC movie camera on my side and the film pack was No. 6 at 6 frames a second and here we had the ocean and the coast line of West Australia. It was a scattered cloud cover to start with and increased to a broken cloud cover. We pitched

down 90° and I ran the camera full time. At that time I also made three exposures with a Hasselblad camera and a 250mm lens and this was at a GET of 20 hours and 10 min. The Hasselblad pack was No. B and I used exposures 33, 34 and 35.

This was 90° pitch down and the West coast of Australia. At a GET of 2100 we were pitched down, yawed left, and we had exposures 36 thru 43. This was primarily of weather pheomena, the S-6 over the Atlantic. At 21:04, we were approaching the Canaries. At 21:07 we were over the Canaries and I exposed the No. 43 thru 48 of the cloud cover and the ocean around the Canary Islands. On two of these frames the Canaries were definitely exposed. At a GET of 21:11, you could see definite fault lines and sand dunes. In this case I took a series of the S-5 experiments -- this was exposure Nos. 49 thru 55. At 21:14 I logged exposure No. 55, and it appeared to be like either a mud runs in the desert or igneous rock. At this time we were pitch down at 90° and exposure 55 showed a very vivid contrast between the yellowish sand dunes and the black and brownish black rock that was observed there. At 21:16, exposure 56 was of the desert. In this case this would be around in the Moroccan and Algerian deserts going into the Sahara. I also had the MAC movie camera using No. 6 magazine at 21:09 GET. We were pitch down 90° and we started on the west coast of Africa and continued on. Some more notes at 21:20; African desert, exposures

57 and 58,you could see two small craters that looked to be of volcanic nature and igneous rock flowing from these. It really contrasted with the sand. At 21:22, I made several exposures of a river in the desert leading down to a delta. At a GET of 21:24 we had exposure Nos. 60 and 61 on the Hasselblad camera,and this was again in Africa. At 21:26, we had worked up to exposure No. 63 on the Hasselblad camera which should be the end of back B, and this was the coast near the Indian Ocean. This was the east coast of Africa. From there, we passed on over toward north of Madagascar. Now at 21:28, there was a cyclonic weather observation made in the Indian Ocean; we were pointed SEF slightly below the horizon, and exposure Nos. 64 and 65 were made in the Indian Ocean. At 21:23 a series of small storms on the Indian Ocean were observed,and this completed the end of back B. At 21:35, Hasselblad back C was installed in the camera, we were SEF pitched slightly down,and we had another storm in the Indian Ocean. This I can remember very vividly. You could see a tremendous column; it looked like one huge cumulus column had built up in the center. It looked very close to the type of a formation you would have from a large nuclear weapon,but it was far greater in diameter. I would say the diameter would be nearly

70-100 miles. It was like a mushroom without too much at the top. Now this was in the Indian Ocean. I made exposures 0 thru 9 of this. At this time we also had tremendous areas of wide spread cloud cover over the Indian Ocean approaching Australia. These were covered in these exposures. At a GET of 22:42, we had again cloud covers on the African coast that was the Atlantic Ocean and the African Coast, and we went straight across Africa, and here I shot a whole series of Hasselblad exposures. Exposures Nos. 15 thru 45 were made. So we had a nearly continuous strip and we approached over to Lake Victoria so number 15 thru 45 went from the west African coast to Lake Victoria. At a GET of 22:59, we were at exposure No. 49 of Lake Victoria. At a GET of 23:02, we were at exposure No. 52 and these were the islands between the east African coast and Madagascar. At 23:03, we had exposure No. 53 and that was the end of back C. We started back D at a GET of 23:05 and made several exposures of cloud formations in the Indian Ocean. I had noted exposure Nos. 0 thru 4, and we continued on around. Finally at a GET of 24:09, we had cloud formations coming across the United States and were south of Houston at that time. That was exposure No. 15. At this

time we were approaching 1 hour from retrofire and the camera was stowed. With respect to up dates from the ground for S-5 and S-6; we received no up dates from the ground. I think this was probably due to the nature of our mission and the fact that we were so busily occupied up through the rendezvous, the station keeping, the exercises, and the sextent exercises thereafter. Then the required period for reorganizing the cockpit, the cabin, and mealtime. At that time we were ready to go to sleep so basically the only photography of the ground and the dim light phenomena was done after we had awakened in the morning at a GET of approximately 19 hours from there until we were ready to finish our RETRO check list stowage, which occurred at a GET of about 24 hours, most of the photography was done in that time. There were no up dates from the ground and the one predominant feature of all of the terrain that we saw was the fact that most of it was obscured by clouds. Again, recapping, the only major land masses that we observed that did not have a cloud cover over them was the African desert, a part of India, and a part of the west coast of Australia. A small portion of the Himalayas was visible, right at sunset at one time,

but the Himalayas had snow over them and there was a heavy stratus cloud cover leading up to the base of the Himalayas. Now that should be in some of the movie film and also the Hasselblad film just before we left Spacecraft 7 with our retro-grade maneuver. With respect to updates from the ground, we received no updates for S-5 and S-6 and I think this is certainly understandable in view of the type of mission that we performed and the time sequence that we experienced. All PLA updates were received satisfactorily and logged in our log. The final one for the 17-1 reentry was given to us in adequate time and the GETRC did not change from the one that was given us approximately 2 hours before retro. We also had a very clear picture of the weather in the recovery area as passed up by Carnarvon on the revolution prior to retrofire. I think the Control Center should be commended in the way that they handled the ground to air transmissions and holding just to the essential information to be passed up throughout the entire mission. The preretro DCS updates were received over the States and checked on the computer addresses. The capsule communicator called up to me the core addresses for cores 03 thru 11. I repeated these back to him; it was acknowledged, then I interrogated the computer and all the

PLA Updates

cores from 3 thru 11 were exactly as specified on the verbal communications. I thought this a very neat way to accomplish the checking of the computer and the verification of the update. The T_R was checked at 1 hour and did not change from there on until retrofire. We had another check of the T_R time over Carnarvon and it was exactly on. The last crew status report was given at a GET of 22:25 as the spacecraft passed over Cape Kennedy. At this time I gave the total water consumed as of that time and the meals eaten. Blood pressure was given for both the Command Pilot and Pilot and the communications indicated that they were completely satisfactory. So we had a total of 2 crew status reports and I think the coordination there went off very well.

Crew Status Report (Medical)

Schirra You wanted us to pick up where we stowed the major equipment, is that correct?

Stowage

FCSD rep That's right.

Schirra The problem we discovered very early in the mission when we started taking equipment out of the center storage section was that we could not re-secure the A frame, as we describe it, that holds the upper center line and the lower center line stowage boxes. Apparently it was

warped or distorted during the booster flight. This is the only thing we can think of because we didn't have trouble with it prior to this point. Meaning that at one g, and during pad activities it always seemed to secure very easily. We flew with it, tethered in a sense, using the lanyard and pin that was normally used for the water gun, and managed to loop it around a part of it which just kept the equipment from floating out into the cockpit. When we finally faced up to reality we realized we weren't going to secure that thing until sometime late in the mission and this, of course, is the time we are talking about. I would say that it probably took us 25 to 30 minutes to get that thing secured. I finally got completely out of my seat and turned around and Tom was bending on one side and I was bending on the other and we finally just happened to get it to click in and we didn't move it an inch after that. So it was quite a critical problem and, of couse, a lot of heavy loose equipment could have been floating around in there.

Stafford The major trouble seemed to be that the bottom tray was bent down because there was a noticeable space between the bottom camera box and the top box. During "0" g you could place the bottom camera box up against top box and see a large area between the bottom box and this

cradle tray on the bottom of the section. So, during powered flight, evidently the bottom of the section got bent down towards the spacecraft. Both of us generated a large heat load from this effort to get it locked.

Schirra You did discuss the problem with the water management tubing? Or did we discuss that?

Schirra We really had no major problems with stowage that we hadn't anticipated. All the equipment went into the retro stowage areas except for the water bags. We called that down to the ground in ample time for them to recompute where that would be, and we basically left those where they were from the beginning of the flight. The lanyard technique I felt went very well for the box I worked with and, of course, that was the active box, I guess. And we managed to fit everything in the bags. I did use the rubber bands for one item, that was for the urine bags. We used them to reel those up. We did not use tape for anything on the mission, other than holding the orbital chart in the new position as we moved it with the updates on the longitude (nodul) crossings.

Stafford I used small strips of tape to secure nuts, bolts, washers, and rivets that were floating around the cockpit.

Schirra Yeah.

FCSD rep Do either one of you have any recommendations or changes to stowage or that you would like to see made if you went through this similar type mission again?

Schirra No. I think the only thing we would make off hand would be that the centerline structure probably wasn't beefy enough to take the loads and obviously had been warped by the booster flight. The bags and the lanyards worked well. Oh, wait, there is a comment. Every time we pulled a bag out with the equipment in it from the left aft box, my aft box, and opened the bag we got a lot of little debris, seemed like little bits of paper, lent, or fuzz, and we always seemed to have to close our visors to seal off the suit circuit for a while until the stuff settled out. We accumulated quite a bit of loose paper and cloth type material throughout the spacecraft. It really showed up during retrofire. The cockpit was just covered with all the stuff. As has been discussed in previous flights it seemed to settle out and probably accumulated in several locations, but then it was shaken loose again during retrofire.

Stafford I don't really know any way to beat the problem like that. Except try to keep the spacecraft as clean as possible during manufacture.

Schirra It came from within these gray bags we had the equipment in. Every time we opened a bag, I noticed we got floating gear out. Not gear in the sense of equipment, but loose particles.

FCSD rep Then, it actually came from the bags themselves?

Schirra Yes, I'm sure that's where it came from. Because every time we opened a bag that's when we got it. It may be that the way the seams are made inside the bag. The material in there is shredding. That would be my first guess. We should vacuum these bags before we pack them. Not vacuum pack them, but suck the interiors of the bags to make sure they are very clean. All right. I think that covers any problems and we really didn't have problems as far as unstowing or stowing go.
Other than the recap, something we have said, and that was we stowed to optimize our configuration all the way through rendezvous, and it worked out very well.

Stafford There was very little clutter in the cockpit up until that time.

FCSD rep Were you able to move around pretty well, and make any calculations? You didn't have to bother about equipment in your lap all around did you?

Schirra We made one modification that was Tom's idea and that

was to put some velcro on top of the chart board to hold his charts down.

Stafford Right; like the log book and was designed for the knee board. But when you had the big chart board out, there's no place to stick this. We had a piece of the pressure sensitive velcro, put this on the back of the chartboard to hold this down and the rendezvous charts and we placed some of the other type, the female type velcro on the back of the rendezvous charts.

Schirra This type of idea we used in other cases as well and it's very strongly recommended that small velcro pouches be put up forward by the circuit breaker panel. You have a strip of both male and female self-adhering velcro to stick on back. We used it on the orbital chart, and the star chart, to hold it in place somewhere. There was nothing on those, and we'd like to have them out so you can just pull them off another part of the spacecraft and you've got them right there in front of you. And then, by using the tape to hold them in the fixed position, they don't slide around when you move them and you have a nice fixed reference. And you just use your surgical scissors to cut off a piece to stick it on and you're off and running. The objects were large enough

that we could find them. We did have another problem, and that was at first we couldn't find the little overlay for the star chart. It just didn't appear and all of a sudden, I found it floating around the cockpit so it must have come out of somewhere, and we had it available to us.

FCSD rep I thought the overlay would be over the chart.

Schirra It was supposed to be in with the star chart, and we searched all over the place for it.

Stafford You mean the measuring device for degrees?

Schirra A little circular thing.

Stafford It was a little square thing for degrees.

Schirra Oh, a square, about 2 inches on the side with circles drawn in 2° increasing in diameter, so we could measure a star off our orbital track as far as yaw goes. We've got to do something more on the star charts; I know that comes up as a question.

FCSD rep That comes up later on.

Schirra Okay.

FCSD rep Okay. Tom's covered the update prior to retrofire and we stopped a moment ago with ready to talk about platform alignment.

Schirra This is prior to retro?

FCSD rep Yes. Prior to retrofire.

Schirra Well, shortly after our sleep period and I immediately realized when I was awakened by a call from Spacecraft 7 that they had asked when our GMT of retrofire was. That was the first time I really had an inkling of when it was. I swear, we were the most casual guys, you've ever heard of in orbit. Most of the time we didn't know where we were and could care less. This is, of course, up through rendezvous and station keeping. We were completely confident of the spacecraft and didn't need to know. You don't need to know. But I continually had some concern about when in the hell was I supposed to retrofire because I would like to have known that at least to optimize if we had lost communications.

FCSD rep Didn't you get a verbal update on retrofire?

Schirra We didn't get it until the second day. I don't recall ever writing down...

FCSD rep You should have gotten an update at 19:28.

Stafford Okay. That was about when we started coming in. We had a series of updates we copied down for 11-2, 12-2, and then, we finally - it was around 20 hours that we finally got a confirmation The first we heard was about 17-1 was when Spacecraft 7 asked when we were going in.

Schirra Yeah. That's what woke us up. I realized we only had 6 hours left, which is 4 orbits.

Stafford That was about 19 hours.

Schirra So, we awakened as a result of this, and we powered up the platform. We didn't power up the computer. Subsequent to that and that's another point, by the way, we were asked to power up the radar. Someone wanted us to give them radar ranges every 5 or 10 minutes on the way into a stateside pass and then to the pitch angle, and I was very much disturbed about that, because this is the time I wanted to get the platform aligned and check the spacecraft out for reentry. And I couldn't understand why this test was called up to us as a test, which obviously it was. It was something we could do I admit, but we had done a lot of that already, and we had proven the radar was valid. We had turned the radar on again and proved again that we were capable of getting a radar lock, it did come up again after a day's quiet time, or almost a day's say 14 hrs. So there wasn't much sense in this test and it was interfering with our next mode of operations, which was preparing for reentry. And we didn't care to rush into reentry. We had booked up so we'd have time to play with the platform and the

spacecraft. We had the fuel. We were somewhat more refreshed than we were when we secured operations for a sleep period, and this seemed like an invalid request, because the data had already been ground out but good prior to this time, or we wouldn't have had the rendezvous. So, I was somewhat concerned about that. And in addition, Spacecraft 7 wasn't maintaining ATTITUDE so we weren't really giving the radar a fair wack at it. Meaning that their TRANSPONDER wasn't aimed at us, and so on. So, we had locks in and out, we picked them up---it didn't seem like a very professional requirement to us. So, we did not measure a theta for them. We were trying to get some stowage done at that point, as well, and I was aligning the platform for the new day.

FCSD Rep Let me back track and get into this, and go over 17-1 which was given at Carnarvon. On the first orbit. You didn't set a DCS load at that time?

Stafford We got a 16-1 DCS load at that time.

Schirra Yeah. Now that was our 16-1 not 17-1, so we didn't know anything about 17-1. We could have had it if we'd asked for it. That's the other point, I might add. Before I went to sleep I wanted to know what the heck retrofire time was so we could pace ourselves for the next day.

Because we had gone to sleep worried about the center line stowage section.

FCSD Rep I'm surprised when they gave you GO they didn't update then.

Schirra Well, they may have updated this, but they didn't verbally.

Stafford I checked the computer, I think the initial GO we had was 16-1. That was what was called...

FCSD Rep I would have thought they would have sent a load up.

Stafford They sent a DCS load on that one.

FCSD Rep So you could readout on that one?

Schirra We could always read out O_2, time to go to retrofire.

FCSD Rep OK

Schirra It wasn't a serious concern, I'm not trying to make a big flap about this.

FCSD Rep Well, no, I just want to see our procedural error.

Schirra Yeah. And continually we were pressing for numbers for right Ascensions and longitude for the nodal crossing. But whatever we asked for, we got it in apple pie order, so it's not a complaint. I'm just trying to show you the frame of mind we had. We felt very casual. Aligning the spacecraft was no problem at all. It turned out that we were almost in SEF at the time, so I just looked for SEF for a while. I wanted to first pick up SEF, pitch down and do this one frame a second photography.

FCSD Rep Did you get that done?

Schirra Got all pitched down, set up beautifully except I decided to do it in ORBIT RATE and I went down, of course, from SEF ALINE ORBIT RATE and got to pointing at the nadir, and I found it was so much easier to fly in PULSE mode than it would be in PLATFORM mode, that I just left it in ORBIT RATE, rather than caging and uncaging the platform in that position. And all set to shoot had a whole fresh load of film in the camera, punched the button and it didn't budge. That was when the MAURER camera failed at that point. It wouldn't pick up the next magazine. So, I had-I think it was about 2 full magazines and about 20 feet left; it indicated 20 feet left in the 3rd magazine. I stuck that one back in, knowing that it had run that far and it wouldn't run then. And then I checked and the circuit breaker popped, so I reset the circuit breaker and tried one more time and the circuit breaker popped and that was the last of the MAURER. I didn't want to knock off. I had a little tiny puff of smoke, I think, at least that was what I felt I saw out of the MAURER at the time that the circuit breaker popped the second time. It didn't feel hot to me and I was bare-handed at this point.

Power Up Spacecraft

Stafford Well, for time correlation we started to power up at a GET of 19:12. The IGS power supply came along and a platform came on. We had been on HORIZON SCAN mode prior to that.

Schirra That's right.

Stafford All during the sleep period we were in HORIZON SCAN.

Schirra Yeah.

FCSD Rep All right. About how long did you align prior to retrofire? Wally, do you remember?

Schirra Oh, probably almost an orbit. I'd like to go back a little bit. We did get this one frame a second idea accomplished at least, we shot it with Tom's camera unfortunately with the 25mm lens, the 75mm wasn't compatible to his camera. We took that as a gamble. I guess, recapping, we probably should have had a 75mm lens for your camera too.

Stafford Although, I never used a 75mm on mine, I might add, at all.

Schirra We got a cut at the western coast of Australia, as I remember. We got a real good cut at 6 frames a second with Tom's camera.

Stafford Across Africa.

Schirra Across Africa. We did not waste a lot of it on the middle.

of the desert because this was just an unchanging scene. So I hope we got something out of that one. So everything that we intended to do on the mission I think, we at least, got a good wack at. And I ended up, of course, with those two magazines and that extra 20 feet + left from Maurer camera, so even it did perform for what we brought it up there for.

Preretro Checklist

FCSD Rep Is there anything to be said about the preretro checklist Tom?

Schirra We did that first on our eyeballs just going around the cockpit and then we checked everything again on the list, so we were not rushed at all. In fact, obviously we were fairly casual because we had time to pull our jingle bells bit as we came across the States.

Stafford We went right down the checklist and checked off the data for each individual operation, and I think it's very satisfactory in the way it's set up.

FCSD Rep And the event timer started at T_R-20 minutes and moved straight forward?

Schirra Right.

FCSD Rep Do you remember how much time it took you for your preretro stowage?

Stafford An orbit or more.

Schirra Yeah. I wouldn't book up less than an orbit for it and I was going to say, just getting stuck with that center station took 25-30 minutes, right there. If we had got it click shut, we could have stowed it probably in about 25 minutes.

5.0 RETROFIRE

Schirra All checklists were completed as were published. We hadn't made any changes in those since early in October. The technique we used on Spacecraft 6, which differs from others, in fact Gus and John even do it differently, that differs from other checklists, at least is that T_R-30 seconds, we bring on the ARM AUTO RETRO and at T_R-10, I start bringing on the squibs one at a time. And this was easily accomplished and I got all four on at about $T_R$minus 7 seconds. I did them very slowly and precisely, and found no problem there. As we came down to T_R all timing systems were right on the money, we of course, heard a good count from the ground so we had that, which is always a consoling feeling, even from those stationed on ships out near Japan. And felt quite satisfied with the fact we were on...

Stafford Can I quote you?

Schrra That dig was for Alan Shepard who was on a ship out near Japan on the Mercury flight. At any rate the first retro fired exactly on time, the disturbances seemed to be fairly light, the control mode was RATE COMMAND, both rings, I did have to steer the spacecraft in a sense to keep it tight, and we fired on a 20° pitch ATTITUDE, which we had decided on long ago with a gang from FOD. This is

an easy index mark. I reject numbers like 19 and 22, you can fly the markings on the ball at 20, but the rest are approximations. The delays between the retro rockets, we've discussed, but not on tape and I think it's best to discuss those and probably I'll take my side and Tom can take his side of it. I felt that it was almost like four separate retrofire maneuvers. This might be a real good way of doing it if you had to do a retro in direct because you'd have time to regroup between them. But this wasn't what we'd ever seen before. So it did surprise us considerably. It was absolutely no overlap between them. And you're sitting there just really tight as a drum trying to catch the next one because you don't know what the disturbance will be. But we did get through all four retros, the IVIs settled out, and we have those numbers; the final numbers have been logged all over the place but I recall it was 310, 1 left and...

Stafford 310, 1 right, and 116 down.

Schirra 1 right that I didn't recall and 116 down. Initially the FORE-AFT window read 309. And I recall very well that number changed after jettison retro so we probably were in to the point where we were close to 310 and it took another little tiny impulse to knock it into the 310 readout

rather than the 309 readout. The retro-jettison light came on, I threw on the RETRO JETTISON ARM switch and I don't know whether I punched, I did punch it cause Tom was reading some of the other addresses at that point. The retro pack came off and there were, it appeared to me, there were sparks and other things I had not seen before. Of course this was at night and we had a very black sky, and I frankly don't recall ever seeing the horizon all the way into retro. I was looking for it. But of course, more concentrated on an IFR retro. This I think is the only way to do a night retro, that is, we had the cockpit full bright the same way we launched. All lights, white lights were on full bright. This may have disturbed my visual acuity as far as night adaptation outside. I think Tom can talk about this point when I get done. He may have seen something. When the RETRO PACK was jettisoned, I didn't see it of course as an object for a long time. Much later, but some time before 400,000 ft., I did see a bright lighted object as we came into daylight on my side, and it was probably about 15 degrees left of our yaw line. So that may have been Tom could not see, but I do recall saying "Did you see it, Tom?"

Schirra And I do not think you ever answeredme, because you did

not see it obviously. But I am quite sure that it was the RETRO PACK. If it was there Tom did not have a chance to see it during the reentry, and I did not of course, because I never looked out. The postretro jettison check list was accomplished, and we cleaned up all the squibs and Tom has some other items you can talk about. We checked the retro attitude. The first time we got BEF and it was not until after rendezvous. I checked the zero lines during the first orbit. They were fairly close. The optical sight was much better for that than the zero window markings. If I felt that I had a platform problem I had already planned to put the optical sight up for retrofire. Then removing it, within the 20 min. time period between RETRO and 400,000 ft. which should be no problem at all. I practiced stowing and unstowing that optical sight which is a difficult task, even at zero G. Something that other crews better remember; that it is a very difficult thing to get underneath a panel forward of the maneuver controller and find the slot to slide that open keyway in and then make up the one lug that remains on the optical sight. It is a satisfactory place, but it takes a little of practice to find your way in there.

FCSD Rep Maybe Tom better cover the retrofire...

Schirra Like to have Tom to go back and take his part of it, because we do have different tasks. That is why I would like to have both of us talk about it.

Stafford Alright, the Pilot's comments. We had the T_R-2 hours checklist performed as scheduled. We did receive our RETROFIRE time and our DCS update over the states. Prior to RETROFIRE, we checked all the addresses from cores 3 through 11 in the computer with a verbal callup from Houston. I acknowledged each one, got a re-verification, and then checked the cores in the computer and all were satisfactory. So the one DCS update took care of the reentry parameters into the computer. We exercised the docking bar in the last daylight pass prior to going into darkness before RETROFIRE to check the function and the docking bar extended exactly as prescribed in a real positive motion. We then....

Schirra About the docking bar, we should record this, we had decided and I actually had not had this thought till after the October 25th scrub, we decided not to extend the docking bar prior to being in station to dock. The reason for this is, we felt that it might bounce light off the docking light back into the Command Pilot's eyes. This would be a penalty that you did not need to suffer from until

Schirra you were ready to dock. This is the reason we wanted to get out into the daylight side, on the night side we did turn the docking light on and there was a shaft of light off it. The bar is silvery and there is a reflecting surface from the silvery bar, not shiny silver, but a flat, gray silver. Like a polished alluminum. And this could be a problem, I have already talked to Neal about this idea, and he understands what I am getting at. I told him I would give him a post flight report and I stick to my guns, I would not extend the bar till I was in position to dock. I would say that the light bounce from this is not severe enough to interfere with a night docking, nor any night exercise with the target, but if you are trying to acquire a target, for rendezvous, and the bar is out, we initially had it scheduled in our flight plans for the Agena flight, oh, before the transfer, burn and this could very well have been just that much more light to diminish your capabilities of seeing flashing light or star pattern. It was critical for the rendezvous. So, I definitely would discourage that deployment prior to being into position to dock. Then, you've acclimated to the target vehicle and this little added light reflection would not interfere with you at all.

Stafford As we continued on and completed the T_R-1 hour checklist, the major item was that all four batteries tested with good voltage and amperage and appeared GO for the retrofire maneuver. Passing over Carnarvon we got a hack on our TR in the computer which checked out to the second, also a GET which appeared very good, and a mark at T_R-20 minutes.

5.1 T_R -4:16 checklist

The TR - 4 minutes, and 16 seconds checklist was performed and as we placed the main batteries on the line, the main Bus voltage stabalized at approximately 23.5 to 23.6 volts.

5.2 T_R-1:00 checklist

The next sequence occurred at TR-1 minute and when it punched off the SEP OAMS, SEP ELEC AND SEP ADAPTER checklist. The SEP OAMS, was very audible, and there was no doubt that the pyro's had fired, SEP ELEC was the same way, however, the noise level was lower than the SEP OAMS. The SEP ADAPTER gave you a very definite slight acceleration that you could feel at that time, with a louder noise.

5.3 T_R-30

At TR-30 seconds when the amber light went on, we depressed, I mean I depressed the ARM AUTO RETRO sequence.

5.4 T_R-0

Then as Walley has described, each individual retro rocket went on. The rockets fired in the AUTO mode, I depressed the manual fire button, at TR + 2 seconds. The computer light went green at retrofire. I noticed as the first retro stopped firing, the forwardaft IVI counted up to 79 feet per second, and stopped. There was a noted period between the end of retro of the first retro rocket stop and the start of the 2nd one. In fact, it was such nature that I reached over and was getting ready to push the button when the 2nd one fired. The 2nd retro rocket fired, I noticed, at a number appeared in the fore aft window, it was in excess of 100 feet per second. I could read one, and the first digit and my hand was still over by the button when the retro rocket stopped firing and the IVI counted up and stopped. There was no noticeable delay there, and from there on, I pushed my finger on the button and held it down throughout the remainder of the retrofire sequence. Each retro rocket firing was a separate individual event, marked with a timed delay in between. I will estimate the time delay was probably in excess of one second or could be as high as two seconds. At the initiation of the retrojet sequence, a very loud, audible noise was heard, and sparks were seen off

the nose as the docking bar jettisoned.

FCSD rep That is what the sparks were, huh?

Stafford They went out radially from the nose section as the docking bar was jettisoned.

Schirra Tom, did you look at the window, here I am asking you, prior to retrofire? Did you see anything at all? I looked out at approximately at the T_R-5 minutes. I looked out and tried to pick up the horizon, I did not pick up the horizon and back in and had all the lights up and did not look out until after we jettisoned the retropack.

FCSD rep Then, I guess during retrofire was pretty well lit up out there then? So there was not much to see?

Stafford Well, I could tell that there was some yellow flames out the window, but I was not even concentrating looking out the window. Just in my peripheral vision, I could see some yellow flame, but I did not notice much about it. This completes the retro sequence. We had a update as we passed Hawaii, not an update, we had a check as we passed Hawaii as far as the check off on the sequence. Then later on, when we had acquisition with Guymas, we received a update as far as the bank left and the bank right and this changed one second.

Schirra I think another point I would like to add in here, that is

about retrofire. I noticed today as well as when we were hearing the 7 crew, come in, that the controller at Hawaii and Guymas both, ask for our attitudes. And you just cannot get a nominal retrofire in number that both 6 and 7 got without the attitudes being so tight you can't read numbers. Such as a deviation of attitude. This is sort of a redundant request and we were asked by both stations, before this. It is a reasonable request to make, I assume if people didn't know we were getting these numbers. Now the range should know that what the optimum retro IVI readings are. We know it, and we got it from the range. So they should not ask for this type of information. We will discuss that type of stuff as we go through the debriefing such as we are now.

6.0 REENTRY

6.1 Reentry update

FCSD rep Okay, we have up to 6.0 reentry, and I think Tom has already talked somewhat about 6.1 on reentry update. Is there anything to add there?

Schirra Yes, I would like to add something. Since we have been on the ground, exactly since we have been back here at the Cape, I heard this 47° bank angle, it never came to my attention. I see Tom has it written down. But I never heard, never in

my mind logged anything different than 55-55. It is not significant to the reentry, but it is significant, in that I did not get it into my mind. That is all I'm trying to say.

6.240OK feet

And all I did basically was to continue in the full lift attitude to 400,000 feet and that point, interestingly enough, is within a second or so of the time we had predicted. At that point, I went to the 55° bank angle. I believe that update came after the 400,000 feet...

Stafford The update came after 400,000 feet.

Schirra And, I am not sure whether it came prior to the 280,000 feet. It must have, because we received it. But at any rate, I held the 55° bank until we had guidance initiate. I did use the overlay to maintain a 55° bank angle. And I recommend it, but it is not the replacement for what I really recommend, and that is to remark the eight ball face inside of the glass, because there is so much parallexy with the device we used. In addition, the difference in the RCS system and the OAMS system, should be noted. The pulse mode and I know this is prior to retro, but it is applicable to talk about it now. Was very similar to the GMS here at the Cape, and also at Houston. It was, had more authority. We

noticed this also to be true in our thruster checks prior to retrofire that direct was pretty strong, the rate command was pretty strong, and obviously so was the pulse mode. It was very difficult to take little tiny pulses and put it where I was used to putting it, meaning the needles really nulled out on rates, as I had on the CAMS system. So there is that much more authority in the pulse mode on the RCS system. Approaching 400,000 feet the spacecraft seemed very easy to fly, although it took a little more activity, in pulse mode to keep a fairly stable attitude in that sense. When we got the 400,000 feet indication, the roll needle displaced fully to the right, asking really for a bank to the right. Of course, we take bank left as our initial bank and when we reached 280,000 feet the bank left was the proper bank, the cross range needle was deflected to the right, which really asked for a left bank. The down range needle, at this point, was about 2½° down, just below the W on the 8 ball. I had better back off. Before we got up to 400,000 feet we checked the computer presentation, by selecting computer and attitude on the mode select switches for the FDI needles and low and behold, the down range needle was just displaced below from my side, approximately 2½ needle widths from the horizon bar. We discussed this

quite thoroughly, and I elected to mark the face of the instrument with a Pentel Pen, bracketing where that needle was. There was no motion in the needle at this point and I assume that this was the electrical null for the reentry system. The reentry mode of the computer. This is the null I flew to, throughout the reentry. The cross range needle was right on the money, so there was no problem about marking it. If it had been displaced I would have also marked it. It was right down the middle. On ionization, which is Item 63. Tom can talk about that.

6.3 Ionization

Stafford Okay, I was looking out the window, the majority of the time, and at this time and since everything was pretty well squared away, I begin cross checking the computer displayed to the FDI needles. The first indication that Ionization came as a real light coppery colored cloud. It had the same color as a cloud that is put out from a commercial spray can. It was definitely a copper, a reddish copper, color, not a red but a copper color. It came on in little swirls and a puff, came on as puffs of clouds. At this time we were on a left bank and inverted position; this put me in a great view of the horizon and at the time we were coming across the Gulf and which was completely clouded in

and I could see the cummulus clouds dropping up and here I noticed a tremendous view of the speed we had, because you had, we had not started to accelerate and drop in low in towards the center of the earth, we were picking up velocity. We could also see our vertical velocity very evident. I could look down and see the cummulus clouds and their displacement above the regular stratus clouds. I could get a somewhat a relative idea of our dropping velocity. You could tell that we were really going down at a rapid rate and also we had a tremendous speed, because this is closer to any land mass or cloud mass than we had seen before at this velocity. This was right prior to the start of ionization, still see the white clouds that were down below. Then as we continued on into ionization and as g's started to build up, the cloud turned from a copper into more of a reddish color. This was interspersed with portions that looked like a copper stripping under heat when you see a greenish cloud, you see flashes of green into it every so often. It was ratios of about 1 to 3 coper flashes in with the green outside. And then you had the regular vortex right in behind it, but the vortex was not a steady vortex. It was a pulsing vortex as we descended on down. And at this time, the pieces of fiber glass around the RCS thruster

started turning white, turned it to a very white color and then on to a cherry red and the shingles in the back turned into a reddish color completely. The whole back end of the spacecraft was red at this time.

Schirra You mean the cylindrical section.

Stafford Right, the cylindrical section...

Schirra Back end and right.

Stafford Right.

Schirra The way we were going.

Stafford Right. Of course, red and this was interspersed with these flashes of greenish color that would occur at that time. This continued on through peak g and then started to die out rapidly after peak g. I think this is the description as far as any visional part in it. During this time I was also going down and check for cross range and down range on the computer, the solution out of the FDI needles. I tried to look back occasionally. I never could see any retro pack burning or anything, or objects burning that was trailing us. So all the phenomenon I observed was very close to the spacecraft.

Schirra I know this from the command pilot side, the film that was on the window peeling back like sunburned flesh had a dimension of thickness. You could actually see this peeling away

from about the center of the window near the upper half of the window in relation to my head and it looked just like a bad case of sunburn. It was really burning away. I was quite surprised how thick this film had to be to give me this sense of dimension. It was peeling off the outer surface of the outer pane. I looked at it long enough to detect that the window was then absolutely clear when this film came off, where it came off. It did not come off completely. There was still some of this film left after we were on the water. I did not have much time to observe this but it drew my attention, because it was a motion, that was occurring. You could actually see that stuff flaking away sort of like this still photography we take a sequence of pictures to see if we can get motion out of it. I am very convinced that this is why we don't see this same film after landing, that we have had in orbit. On the carrier, one of the technicians there did note that there was some of this film left, we did not have it rubbed off. I cautioned the skindivers that were along side not to touch that window. So, there is some of that film left up there at least. So, we may have some chemical analysis of the film.

Stafford On my side, I noticed that when it first started to burn off,

that it came as approximately around a little open area of about one square inch in the top center portion of the windshield and spread out radially from this. You could occasionally see small balls of this matter, little minute balls form, roll out, and disappear back. Occasionally, there'd be some pieces bigger than a ball that would flake off. They'd seem to curl back into little balls and flake off. It was a little darker around the very edge of the window.

Schirra It looked like it had lines. It wasn't a round spot burning. They were flaky lines much like a cracked window. Not that the window had cracked and these were jagged edges as it broke apart, rather than a smooth burning away. I would estimate its thickness was at least as thick as saran wrap . It definitely had a dimension of thickness.

FCSD rep As I recall, this is very close to the description John Young gave of his window.

Schirra Yes. I was looking for this as I had talked to some of the people in Houston about trying to document this kind of film. But you just can't document it, can't get this dimension of thickness. It definitely has that dimension.

6.4 Guidance

Schirra The area of 6.4 guidance under 1.) Roll Commands. I didn't pay too much attention to the roll needle. On about two or three occasions I noticed though, later in the profile it picked up the same technique I was. Very late in the profile it went off on its own and, I would say, was very confused. I would hesitate to say I could have followed that roll needle even with the later version of math flow 6 . Attitudes and rates were very stable . We started out with Ring A, Pulse Mode. When I picked up the first reverse bank, this was when the down range needle started coming up to where I was going up to the getlift line, meaning above the..never did get above the horizon bar or actually, I did not let it get above my Pentel marks, I could then afford to reverse bank and pick up the cross range needle. The cross range needle initially started out about one and a half degrees to the right. The range prediction was quite different from the ground than what we saw displayed but this is not unbelieveable in that they are looking at real time stuff while math flow six is taking errors and predicting. And they do differ because it smooths out and corrects it as part of the problem with the range predictor curve. So, there is no reason why they should be exactly alike. I'm

not sure what good the data from the fround really does us if we are trying to fly close loop. As the roll needle crossed, I reversed bank and reversed bank to the point where I needed the bank to arrest the down range needle and not let it move away from where I wanted it to. And favoring the cross range needle. The cross range needle came back cross center and went off the right again and I reversed bank to the right. I selected rate command, not reentry rate command, for these roll maneuvers and left it in rate command once I got to that point. I sort of regret not taking the time to put the attitude control in another mode because I didn't need rate command that long. The control authority of rate command was not required all the way through, but I became lazy and did not switch control modes. The acceleration started building very slowly and seemed to be quite similar to what we experienced in the GMS, although I cannot recall the sound effects of the GMS banks. That is quite a big cue and I became used to it and I was looking for the sound. I didn't hear it.

Stafford That is the same thing I noticed there was the air dynamic noise was real slight. It wasn't near as noticeable as what you get in the GMS. In fact, the largest noise you hear at this time are the thrusters firing.

Schirra That is exactly the cue I felt. We agree on that one hundred percent.

Stafford You hear the pop pop pop of the thrusters firing, but the noise was very, very low.

Schirra This cue in the GMS is valid because as you require control authority during certain regimes of the reentry, you hear the popping. When the popping dimenishes you know to go back to Pulse Mode again or direct because the thing is stable again. And we did hear this. That's the time I probably should have come out of rate command to save some fuel, but I did not.

FCSD rep Getting back to your roll command. Did you find this all the way, that your eight ball was helpful?

Schirra Very, very valuable. I would recommend that if you can't get the eight ball painted properly. I think we should talk about the eight ball as a separate item completely and we are lacking a lot of the information about the eight ball that is available to us. As we proceeded through the reentry, I was rolled right about, I'd say, 45° to 50° when Ring A was exhausted. I recall very vividly looking up and watching the ball rotating back to full lift. I said, "My gosh, I'm not doing that. What is doing it?" Then I looked out at the nose and I could see that the A ring was getting

cold. There was no heat on it. So I, as I hadn't rolled through full lift yet, but I was coming that way, I reached frantically, and was talking, but I guess that was the first time I beat Tom around the cockpit. But I beat him to ring B switch and he hit my hand as I was already moving the switch. We had an event later that we will discuss where he beat me again. So we got the second ring going and I did observe that thruster activity and the ring getting hot. What you would expect from this thruster activity - reestablish the bank angle I wanted and from then on, the cross range needle kept going off to the right. We could never suck it back in. But it did not seem to two block so I never selected high scale. We know where two block is as we practiced this on the various tests in the spacecraft on the pad. It came out to within about a half a degree of full scale, not mechanical stop, but full scale electrical on the pitch needle, which is the way you calibrate it. The pitch needle was locked on where I wanted it in Pentel markings so I didn't look to think, or even suspect, that I didn't have complete control of cross range. It stayed there for the rest of the reentry and I was favoring it all the way down to drogue chute, just kept it banked in that direction. Apparently, that is what drove us off in that we did go to

the south which is where we would have gone if I had banked that way. But the logic apparently was wrong. We could not understand why we had missed because that down range needle was really nailed right on. I think Tom might have some comments in the same area.

Stafford Right. The guidance initiate, I called it out, when I saw it on monitoring computer and attitude. Wall y had it at about the same time and say the needle was slightly to the right and down low. In fact, the least displacement that I've seen it of any simulations we've had. So right away Wall y went to it and it wasn't long until we had the down range coming right into close to the Pentel marking and the cross range come in and then we had the down range and the cross range completely wired and slowly went to the left side and come back just the way we had practiced it. Then it went over to the right and went right back with it. Meanwhile, the down range was just vary slightly oscillating above the Pentel mark and down below it. It stayed there for a while, and then just right close to the peakg period, then suddenly; it was very obvious where it had been within a half of a degree of either side of the cross range, it suddenly started walking off in steps right to the right and

then it went over right near the edge and stopped. You could see it walk off each... it was just a step.. step.. step... It walked right off and... but it didn't get to the edge and then; it stopped just before the electrical null stopped and Wally slowly added some bank to take care of it and it stayed all the rest of the way. At that point when it started walking we had the down range right on the Pentel and it would slightly go up maybe ½ a bar width up then down. Wally would would walk it back and forth coming into it. So the down range was wired coming in. Favored the cross range. That was the way we called them in at 100,000.

FCSD rep Could you tie down about when the stepping started?

Stafford It was right after Peak g.

Schirra We both know that and at the same time we ran out of the Ring B almost coincidental.

Stafford When you called, "give me ring B", I had my hand resting forward on the ejection seat on the console and I had my hand out of the way and he said, give me ring B and I reached up for it and I slapped his hand and his finger...

Schirra Well, it was the fastest flick from the hand controller to a switch. Of course, I had to come off the stick to get it. Tom was right on top of me!

Stafford At that time I noticed on the g's had let up considerably

and I would say we were down around 2 g just from the feel of the seat of my pants from around 2 g's left on the altimeter started to flicker over on his side.

Schirra It was about 1½ g when the altimeter came off the peg.

FCSD rep Do you remember what maximum bank angle you used when you attempted to pick up this cross range?

Schirra About 45° to 50° because I didn't want to let the down range go up.

Stafford The down range was about 50°. The down range would slowly go up and down and he would reduce them a little bit.

6.5 80K feet

Schirra Then the solution was terminated at 80,000 feet which was fairly close to the altimeter... I was quite surprised. That is where the needles go to a null and the presentation is gone so I then selected rates on the display since there is no sense flying the attitudes needles anymore.

6.6 50K feet

The rates were just about zero as we approached the drogue altitude of 50,000 feet. I punched the drogue off and right behind punching the drogue off I got the 40.6 lights so it was sometime between 50 and 40... I don't have complete confidence in that altimeter because there is a lot of lag in it, but I definitely am more confidence in the light.

Admittedly, it's the same source, but your winding needles in one case where in the other you are making up a switch so I would say we punched the drogue off somewhere around 45, 46,000 feet. When we got the drogue out, it came out without any problem at all and went through the typical throbing effect, but there wasn't the squidding effect from G. Cooper's flight and this would be natural in that we weren't deploying as high. The spacecraft started coming quite... not unstable, but it was surely oscilliatory and I recall Gus and John turning their control system back on and we did too, and damped it down and a little bit and then we killed it and then emptied the line. That reminds me we should go back.. this is not necessarily go back it is appli cable. The ground called up some crazy bit of information about how to do the reentry as far as draining the lines went and the way the message got to us was all wrong. I since have talked to Chris about and he said, "I wasn't changing anything." You would have done the same thing except they didn't want us to turn on ring B if we didn't need it which was what they thought we would do at 80,000 feet. If we never used ring B, ... what he was trying to get to us was don't turn on ring B. That's what he was trying to get to us. Leave the ring alone in other words.

Well, I don't understand the logic of that either because, you exercise both A and B prior to retro and during retro and after retro, of course, you just use the one ring. At any rate, this is a very confusing message, but I just told them that is what I was going to do and this is what we did. The very technique we described, so far. It was a lousy transmission to us. At 35,000 and 27,000 Tom ran the check list right on time and at 10,000...

Stafford Let me point out a couple of points to go back... things that I had observed. At a 100,000 feet when I felt my back it was around 2 g's or less at 100,000 feet I noticed the altimeter started to unwind and then as we came through fifty I noticed I was looking out the top and I noticed a contrail or something white was flashing. It seemed too high for a cloud but it seemed just like a contrail just flashing out there. This was up above 50,000. Just occasionally a white puff. White cloud effect, a puffing out there coming around us and then when we hit the drogues, like Wally described, the oscillations that we went through. I ball parked looked at the eight ball, a FDAI, we were going through plus or minus 30° oscillations each side.. it was a pretty sporty swing there. I then also very noticeably, at 35,000 feet the oscillations, right at

35,000, the oscillations decreased rapidly. Just a noticeable decrease of a few thousand feet. It really died down and the amplitude of the period was approximately the same, but the amplitude was greatly decreased.

Schirra I am sure that is when we had enough g · on the drogue to stabilize us.

6.7, 6.8 35K & 27K feet

Stafford And at 27,000, Wally gave me a mark I got the inlet open, pardon me, previous to that we turned back the valves to 35,000 we turned off the valves and drained the lines past the valves and at 27,000, had the inlet snorkle open and then the vent and continued down till we started on the main chute.

6.9 10.6K feet

Schirra At 10,600 indicated on the altimeter I punched the chute and the light came on almost exactly the same instant. They were really syncronized as you would expect, but it was very close... I could see both. And of course, I was looking out the window to look for the chute and the light is right there, so you see as I punched, I looked. There's nothing else to do. The chute came out and, of course, we saw the pilot chute come out, then drag the main out.. saw the main in the reef condition and it was acting beautifully

There seemed to be no problems with it and it dereefed. I could not see one break in that chute.. absolutely perfect. Not one little rip or one little line broken... nothing hanging loose. A perfect chute.

6.10 Single point release

Then as we stabilized on the chute dereefed, I announced to Tom stand by for 2 point suspension. I put my arm up on the window to protect myself and rested my head on the arm, and I am sure I had my visor on the wrist ring. I understand that I am the one who had the cracked visor and I think that is exactly how I did it. Was clanging the visor on the wrist ring. I now realize of course, that I should have had my arms displaced. But at this point, I don't really need a pressure suit anymore. So, I wasn't too conconcerned about the fact that I found it laying there broken although possibly, it would have been a problem if I had had to eject and use the suit for a buoyant system, which was the technique I had intended to use. The rate of descent was perfectly nominal in that we called out altitudes all the way down. We had.....

Stafford Let me put something else in here while we're still on our single point suspension. My impressions on the chute, particularly once the chute came out in the reefed position,

all oscillations stopped, you could feel a deceleration in the reef position and when it went open to the - to full open position it was a very nice, smooth deceleration like pulling a drag chute. And from there on down we braced for the single point. I had my head over to the side and probably my head down a little bit when we pushed the single point suspension. There was a fantastic forward acceleration. Just bang, like that. Immediately my head was jerked back and another one was not quite as bad as the first, but there was two really rapid forward accelerations. The first one by far the greatest and was popped back and the second time it persisted a couple of other minor oscillations. The first one was by far the largest and at that time the bulb on the D8 radiation experiment on the first one came sailing out of its housing - crashed against the panel and dropped down on the floor.

Schirra That was our only experiment failure. And, that, of course, is something to consider because that could have done a lot of damage. That is a pretty heavy mass and now at 1 g. The description that Tom gave I concur with completely on the transition from single point to two point. I don't think there's a reason to change a thing. Everybody should be briefed for it. We were prepared for it, but even then it

is worse than your worst thoughts. The chute itself is quite stable.. I didn't feel much motion. The films I had seen with boiler plates underneath the chute, the space-craft looked much like less stable, on the main chute than I felt. We were... we had very few oscillations on the main chute, once we were on 2 point. there was a slight oscillation and as we got lower-- I would say it was

after we made our 2,000 foot check for the cabin security, we were oscillating enough that we would back away from the chute in the pendulum motion, we could see the ocean, and it looked beautifully smooth. I counted down the altimeter for Tom just for the fun of getting ready to brace for impact. I said 200, before I could say 100 we hit the water so the altimeter is pretty darn close, which is pretty good testimony for that rig.

FCSD Rep What was your altimeter setting?

Stafford 30.16

Schirra 30.16, good

This is the point where Tom beat me. When we were on the water I wasn't in in any real rush, the water did surge up over my window, I am not sure if it did over yours or not.

Stafford I was looking out. When we hit the spacecraft dug in nose low and rolled over to the left window. At one instant I could see sunlight glaring through my window. I looked over and I could see green water through Wally's and bubbles down on his window. So, we hit and went nose forward and rolled over to the left. I would say a good 90 degrees.

Schirra I was shooting for the parachute jet and I hit Tom's hand. That just shows we were both working together very well.

Stafford Almost instantaneously the spacecraft righted itself and

went to a beautiful stable float.

6.11 Communications

Schirra As soon as we got to two point attitude we received and transmitted to the local recovery forces and immediately established communications on UHF. We tried HF a couple of times and had no luck with that. We maintained communications all the way down, I recall giving out altitudes to the Cape people I had acknowledgment from them. We lost UHF contact with the Cape subsequent to landing.

Stafford At 2,000 feet indicated pressure altitude the inlet snorkle was closed, the cabin vent was closed and the repress valve was open. We kept them in this configuration until after the chute was jettisoned. The water seal was also closed below at slightly below a thousand feet.

7.0 LANDING AND RECOVERY

7.1 Impact

Schirra Just prior to impact I called out our rate of descent and that was almost exactly 30 feet per second on the rate of descent indicator. I did not feel that the impact was severe at all, I have had much greater impacts on carrier landings. I don't feel any concern whatsoever about this landing in this spacecraft on water.

Stafford In fact I was impressed as how smooth it was. The only considerable motion was when we tilted forward and rolled over

The impact was very, very mild.

7.2 Postlanding Checklist

Schirra Tom called out the post landing checklist and that was as advertised. We went right on down through it, cleared up the cockpit.

7.3 Communications

Schirra We maintained UHF communications without any problem. There was one break in there when we couldn't re-establish UHF communications. We erected in this sense the HF antenna. It deployed very nicely and we watched it go up. The boot was all the way down to the stub, in other words, at the base of the antenna. Later the boot was pulled up, I noticed when we were trying to get it to come back in. The boot was afixed to the nose of the spacecraft at the cylindrical section, so it was right attached, which was something that people worried about so I want to make note of that.

I came up on HF and said "Any station, this is Gemini 6, do you read?" and bang "Hello Gemini 6, this is Cape Com Tech., hear you loud and clear." I said "Hello Murph, how are you?" It was that crisp, the most beautiful HF transmission I could ever ask for. Really, really a good piece of gear. I am all the more impressed with the fact that this would be good recovery equipment if we were in an inaccesible area in the

recovery. So let us not throw that point away, it was very good.

I came right off HF once having established that, and went back to UHF and established communications with the Air Boss and other associated personnel. We were all aware of the recovery posture. We first heard this 33 mile thing, and we were quite disheartened about that. Since recovery we know that was in error. They tracked a carrier aircraft and they thought that was us. This worked out, we were not concerned, although at that point I had considered getting out of our suits when I heard 33 miles. Then we heard we were some 12 miles away. We discussed our situation and decided to stay in the spacecraft.

7.4 Postlanding Spacecraft Status

We were quite comfortable and the spacecraft, I am convinced was at a higher relative altitude than sea level due to the fact that we hadn't brought enough air inside and the repress didn't charge it. The reason I am calibrated to that more is you will recall I was suffering from this head cold. I had to work all the way down from main chute relieving my ears with a valsalva maneuver. We heard this whistling and we were clearing up all our communications systems thinking that was the cause. There was this high pitched whistling and we could not figure out what it was.

We were quite concerned about it, and then we started to vent the cabin and the whistle stopped and we realized what it was. My ears popped again so, I knew then that we were still in a higher relative altitude or we had a lower pressure inside than we had outside. That was the whistling air trying to get in.

Stafford Even though we had the cabin vent at that time closed, the snorkel was closed, and the repress was open, this whistle kept building up and building. It was a very funny sound, it kept increasing in intensity and pitch.

Schirra It found a way of getting in. The spacecraft is built to keep inside and not to keep outside from getting in. I remember this because Pete Conrad and I had talked about this. The repress will not keep up with the rate of descent even though we are down low.

Stafford The cabin Delta P gauge as far the PSIG was showing zero. Which meant it was zero or below.

Schirra We were trying to avoid the RCS fumes. I did see nitrous oxide, I suspect that is what it was, little brown puffs off the RCS B ring. They disappeared fairly shortly. We could see the main chute right out in front of us. We could see the R & R can right out in front of us. All of it was right in a small circle, I would say less than 100 feet diameter

maybe 200 feet.

Air Boss one and I, and Tom as well, agreed it looked like the main chute was still attached. We saw some lines going off, the bridle lines going off the nose into the water. We thought the chute was in fact attached. The swimmers subsequently said it couldn't be, it was too far away by the time we were regrouped on the flotation collar.

Stafford I could look through Wally's window at an oblique angle and see a couple of shroud lines hanging in that area.

Schirra The window on my side was bathed with salt water, more so than Tom's side. The film I described earlier was still visible. It had changed then to a slightly pinkish hue, rather than a whitish brown hue. This same color existed until we were picked up by the crane. That is why the film should be left.

We had no leaks leaking in because actually we were trying to get air in rather than water. We had plenty of electrical power. We had plenty of oxygen. The hatches were tight and everything was in good shape.

Stafford Back on the RCS fumes, after we had been in this configuration, we heard the squeal build up, we then vented the cabin to ambient. We had this acid smelling fumes, which I think later turned out to be heat shield fumes.

Schirra I don't think that. I know that. I sniffed the heat shield later and it was exactly the same.

Stafford It wasn't the snell of N204, UDMH. We shut the inlet snorkel closed ourselves up in the suit loops for awhile. We tried again, we did this twice and it wasn't nearly as bad. The third time we left the inlet snorkel open.

7.5 Postlanding Electrical Systems Test

Stafford I checked the electric power, we had everything powered down. We did give a blood pressure check for the pilot and the command pilot. After that we turned off the biomedical recorders and powered the spacecraft down except for recovery gear. We were operating both suit fans one and two throughout reentry and on the water to try to keep us cool.

We had four amps on section one and four amps on section two. There was slight oscillation on the amp meters, I noticed the waves, the oscillations were exactly in synchronization with the waves. When there was no waves there were no oscillations. The amount of oscillations up and down on the amp meter was probably plus and minus an amp at the most. Both section one and section two went up and down and synchronous with the waves. I am sure this is what has been giving us the oscillation afterwards. I timed the period and it was about 1.3 to 2.0 seconds between the peaks and the

oscillations. At times this would vary but again this would be exactly in synchronization with the wave height.

Schirra I think this eliminates the requirement for post landing electrical and systems test and should not be required in subsequent Gemini flights.

7.6 Comfort

Schirra When we were checking the environment, meaning the air in the spacecraft, whenever we got an acid odor we would shut our visors, regroup, wait a little bit longer and go ahead and crack it again. Finally we found the air was tolerable, opened the visors and were basically prepared for pickup at any time. Sea condition was, I would describe as calm. I had been on Clear Lake when it had been rougher than that. So we had an optimal recovery situation there.

Stafford Right.

7.7 Recovery Team

Schirra The recovery team was deployed in rapid order, deployed the flotation collar. We could hear the collar inflate and, of course, we could feel the spacecraft become more stable. The only oscillations we had as far as stability oscillations were in pitch and roll, yaw of course, was negilible. The swim team leaders, Swim one I believe his name was, plugged in the Walt Williams telephone, and we established

communications. I didn't realize this was a hot line communications. We had never practiced this one before. I kept depressing the mike button to talk to him and, of course, I would broadcast. Then I had to knock off that conversation and get it all stablized again. This is something to remember, that the telephone plug in is a hot line, not a mike depress system. Just like the mops interphone system. I just didn't know that.

We discussed over this period of time whether we would want to get out of the spacecraft or stay in it. Once upon the flotation collar we realized, as the recovery posture improved, that the ship was getting closer and closer but it was taking longer than we had expected. It was supposed to pick us up on the hour and I think we were picked up some 20 or 30 minutes after the hour. As a result, once up on the collar, I elected to open my hatch just to get some fresh air and keep us cooler.

7.8 Crew Egress

We kept our helmets on, we took our gloves off and released all straps and harnesses, including taking off our parachute harness. We helped each other in releasing the helmet tie-down wire connectors in the back and took our harnesses off and stowed those in the footwell, just left them there. We

stood up; I stood up in my side and then I looked over on Tom's side to see how his hatch line was in relation to the water line. Itlooked like it was fairly safe to open it, so we started to open Tom's side and paused until he re-rigged or rigged his splash curtain. Tom had his splash curtain rigged. When Tom had his splash curtain rigged, we opened up his hatch as well. This merely helped us become a little more aclimated to the surface environment. I think it did help us keep cool. I never did feel hot at all. I felt warm, but never hot.

Stafford I had the same experience, I was perspiring but I wasn't uncomfortably hot. Just warm.

Schirra I managed to actually stand up in my seat, turn around, and look over the heatshield and sniffed it then to check this odor. And that was the very odor we smelled coming into the spacecraft when we were buttoned up. There is no doubt in my mind it was the heatshield, and this was, of course, that near the event that I am positive of this odor.

While standing up, I looked back and saw the carrier coming in sight. We discussed with the carrier the fact that we would re-secure the spacecraft, which we did when they were coming up alongside. Neither of us had trouble with either opening or closing the hatches other than, of course, lifting

the hatches which were very, very heavy, particularly with the stubborn hydraulic action on it.

7 9 Crew Pickup

Schirra Pickup went very smoothly. The spacecraft and the crew pick-up was accomplished, of course, by the carrier. We came up on the carrier on the number three elevator and we could see out, see the crew, and could even see the line fired from the carrier across our bow. We could see the bobbin with the bob floating and watch the whole recovery exercise. As we were hoisted up to the cradle, we knew we were safely on board. I asked Tom to completely power down the spacecraft, which we did. At the same time we saw one of the, I believe it was a map technician, checking the power circuits to be sure they were all safe. Then as we were lowered to the cradle, we started opening the hatches and performed the normal egress.

Stafford The splash curtain performed very satisfactorily and the only trouble I had at the end was, when I wanted to disengage it from the inboard side of the spacecraft, the spring part of the hook was bent and so I had extreme difficulty in detaching it.

Schirra This problem is only aggravated by the fact that the television world could not get Tom out as soon as I did.

8.0 SYSTEMS OPERATIONS

8.1 Platform

Schirra Platform alignment day and night, no problem. Modes, all, no problem. Display FDI, zero position of needles prior to 400 K. We've discussed our reentry. Window markings are acceptable. I prefer to use the optical sight to back up these window markings. I feel that's much more accurate. The controls of the platform, acceptable, no problem. Accelerometer bias check, we discussed that, no problem.

8.2 OAMS

Schirra Operational checks on the pad and inflight. The only thing I noticed on the pad was that the pitch down thruster was the last to come on the line. It took about three actuations on December 12, and they were crisp on launch day. System monitoring, no problems. Monitoring of OAM's propellant remaining, onboard information, no problem. Ground information, we were updated once, where I think I said I had something like 43 and they said 49.

Schirra So, we had more than the onboard indicator stated. No problem on selector controls and switches, attitude control, maneuver, controller, inflight malfunctions, none. Attitude control modes; Rate Command, very crisp; Reentry Rate Command was never evaluated. Direct was much more precise; the description given by Gordon Cooper is exactly the same as I saw it. Direct is a much easier control mode than the GMS, as is Rate Command, as is Pulse. The Pulse, again, is just about like the Translation and Docking Trainer. Horizon scan, the same; Platform mode is an excellent control mode; and and varied, just as technically described to us areound 1.1 degrees oscillation about all three axis.

8.3 RCS

Schirra We had one RCS heater light come on.

Stafford Right. I turned the RCS heater switch on, approximately 30 minutes later I turned it off. It stayed off for ten minutes. It came back on. I turned the RCS heater switch on. I left it on for the rest of the mission, and I checked

it one time right after waking up. Right away the light came on, and I left it on the rest of the time.

Schirra Do you have it logged when it first came on?

Stafford The RCS heater warning light came on, the best I can remember, at approximately three hours. It was left on for the rest of the mission. An occasional test, and the light would illuminate, so we left the heater switch off.

Schirra I would like to make note of something, because it is a valid and good cockpit display. This light, when it came on, was immediately noticed by both crew members, which means that it was located in the right place, got our attention. I think this is significant for future cockpit design. RCS operational checks, monitoring, all nominal. Control modes, Rate Command was stronger and had more authority than Rate Command on the OAMS. Reentry Rate Command was not utilized. Direct was stronger. Pulse was stronger. The heaters have been discussed. Systems shutdown has been discussed. Fumes have been discussed.

8.4 ECS

Schirra Mobility was satisfactory. Pressure was not utilized. Temperature under suit can be improved only by improving the ECS. The ECS never did have us sufficiently cool during fully powered operations. Humidity, we'll have to discuss that under experiments, I believe, with the humidity senser. CO_2 never

saw the needle move. Comfort was reasonable, but I would recommend for future flights that all crew consider removing their helmet on a 16 - 1 go.

Stafford That is right. As soon as possible get the helmet off. One thing on the suit temperature, it will be without TM data, but right away after we were going into the second orbit, out suit temperature inlet was over 60 degrees.

Schirra In the first orbit.

Stafford Yes, at the end of the first orbit. It was about 68 degrees.

Schirra It was knocking on 70 degrees.

Stafford It was real close to 70 degrees. We were both perspiring freely and we were hot.

Schirra That is not the suit's fault. It is the ECS's fault. ECS was running on design limit. The only time that I moved my suit flow lever down, we never readjusted. The suit circuit temperature control was during the sleep period, I did back down on my suit flow to about one third, I should say two thirds flow. Backed it down one third.

Schirra The oxygen demand regulator under suits, no problems. The umbilical, on the December 12 check we had a problem with the communications pigtail on my side. Had it plugged in, and it looked like it was going to be alright for GO so we stuck with it. This was changed during the 3 day recycle and we could not get it to lock in prior to launch. We were

about to tape it but the communications and the bimedical parameters were functioning properly, so, we let it go as it was. It did come loose, not completely loose, but I lost communications for about a split second. I refastened it and I never did get it to lock. So that connector never did make up in the lock position. We had no problem with it, it stayed where it belonged. Under cabin, all items were normal. Tom took the humidity readings and we should record those now.

Stafford Right. The various locations were noted as identified in the check list. The reading was taken at a GET of 19:25 to 19:36. This was after both crewmen had awakened. The right instrument panel had a dry bulb temperature of 80 degrees, a wet bulb of 70 degrees for a relative humidity of 69%. Near the helmet the dry bulb was 80 degrees, the wet bulb was 72 degrees, for a humidity of 75%. The footwell had 79 degrees dry bulb, a wet bulb of 71 degrees. We will get the humidity of that in a minute. The overhead cabin circuit breaker panel had a dry bulb of 81, a wet bulb of 72. The suit inlet hose had a dry buld of 76 and a wet bulb of 72. Again the suit inlet hoses; it was very hard to get that air in there to the sensor to hold for a long period of time.

Several wall temperatures were taken. I make 3 hatch temperature measurements at the best place I could. I got 76 degrees as an average on the hatch temperature and the right

wall temperature was 77 degree.

Schirra With those numbers anybody can see that we donot need to sit here and do that. Did you note all the times: It was in the framework of 19+25 to 19+36.

Stafford Right, I have them down for each minute.

Schirra Temperature, day and night powered up, bad. Powered down, satisfactory. And this is the problem with the Gemini S/C. This is the first time since S/C 3 that we have had the Spacecraft powered up for this long a time, and it is not meeting the heat load. Cabin fan, no problem. Relief valve, regulator vent valve, repressurization valve, inlet, reset valve, no problem.

Stafford The cabin pressure held very steady throughout the whole mission, between 4.9 and 5.0 psi.

Schirra That was interesting. Even during the sleep period we sneaked a look, unbeknownst to each other, whenever we awakened. I got my little pen light out and sat there and said Aaah, it is okay, and plop I went back to sleep. Tom must have done the same. We have discussed it since the flight.

Stafford It was holding right there steady and I could never notice any pressure variation.

Schirra It was a pretty dark cabin. I think that probably helped us on remaining cool during the sleep period. We had both polaroid filters on the windows and the polaroid segment

rotated to full dark, as much dark as we could get. We never did use the blue visor covers that we brought along for the sleep period. We both slept with gloves off and visor open.

Stafford It was readily noticeable, that in daytime when the sun would come in the cabin window, you could feel your face instantaneously get hot. There was a tremendous amount of heat that comes in.

Schirra With the polaroid filter on?

Stafford No.

Schirra Without the polaroid filter on the window we felt this heat. With the polaroid there was no evident sun shafting heat. We were pretty well bushed when we were sleeping anyway. It would have taken a lot to get us awake. Primary O_2, no problems, secondary O_2, no problems.

Stafford Very satisfactory

Schirra CO_2, no problems.

Stafford Coolant, we had the normal radiator functions at approximately 50 minutes when we went to flow on the radiator. The radiator was operating satisfactory as far as inlet and outlet delta T's go, so we can start the coolant cycling. We went to one coolant loop. This did not furnish the necessary coolant for the complete system. So we went back to the second coolant loop. We left the second coolant loop on until 19 hours. At that time we turned it off and approxi-

mately two hours prior to retro we turned the second loop back on. So, essentially the second loop was on for the majority of the flight.

The evaporator operation appeared satisfactory when it was required. This system is very marginal for a completely powered up spacecraft. For my own personal comfort evaluation, only about half way through the sleep cycle did I start to become somewhat comfortable.

Schirra The water management panel accessibility, miserable, bad, is that needs to be translated. It was very difficult to get the water gun unstowed. We spent about 15 minutes on that, getting this teflon pin out. The only good use for the teflon pin was to hold the A frame down when it would not reengage. We could not find a place to stow the water gun except back in the holster, and of course, we never did put the pin back in until retro stowage. The U shaped clip device on the water gun was too large for the circuit breaker guard clipping. We had it fixed for a bar that was on previously for the blub stowage. That bar was removed, so, we had no place for the water gun other than in the holster. It did, fortunately, with tension on the coiled hose and the bungee cord that was running through it, pretty well float itself right back to the water management panel, so we always could find it. We had to dash around for a while to get it out. We had to bounce it and let it bounce

it's way out and then grab it and use it.

The valve useage was very complicated for dumping the dump valve and the pre-heat switch. The dump switch, meaning that the same switch was cycled. This was very difficult to utilize in that you had to practically unstrap and get back there to get to it. The water dispenser was very cleverly started out at 63,000 something, 63,070, I think is the first reading we had on it.

Stafford Right.

Schirra So we had a lot of fun logging all of those clicks starting at 63,070. Obviously if this is to be used in a practical nature, it should be started at zero.

The urine system assembly and operation was our first nightmare. The hose connected to the water management panel is cleverly designed for hydraulic fittings on aircraft landing systems and not for penal pressure. As a result we had to unstrap, I unstrapped completely, turned around in the seat, and Tom and I both forced this on and left it on for the duration of the flight. As far as I know it is still connected to the spacecraft.

Stafford I would estimate that the force required to seat the quick disconnect was probably in excess of 40 to 50 pounds.

Schirra I would say it was more than that Tom.

Stafford I said in excess of.

Schirra I would say more like about 70 - 80 pounds.

Stafford A tremendous force was required. It took Wally turning around, kneeling down, and myself on his hand to help guide and force it to get it in.

Schirra We did not think we would get it connected. That is how difficult it was.

Stafford It required nearly 30 minutes of flight time to perform this one item, and we both generated a tremendous heat load.

Schirra Adding to this complication, when the urine receiver was plugged in, we could get enough mechanical advantage there to make up the quick disconnect there, we found that the system would not meet with the body interface. So, we had to make and break this disconnection every time we used the urine receiver. It was not long enough to make a loop around in front of the body and back to the penis. So, we had to make and break this connection every time.

The urine system did function properly. We both had cut the safety strap that is built into the suit at the zipper the furtherest travel up point towards the navel. I recommend this for all pilots. It is impossible to find that little goody down there for that strapping place.

Stafford The operation of the humidity sensor was completely satisfactory.

8.5 COMMUNICATIONS

Schirra Inter-phone operation, satisfactory. Quality, satisfactory, from our standpoint. UHF receive, all modes satisfactory. HF performance; orbit, we made our HF check at Canaries and after that we didn't really utilize HF. I did hear a "Taste of Honey" during the sleep period. I did not hear "Goodnight Irene." We did detect the music played but it was not as good as I am sure they heard it on the ground.
HF performance on recovery was absolutely outstanding, and I can only say that is good gear for recovery. UHF was by no means that good. We could not communicate with the carrier UHF until they were fairly close to us. We could communicate with the recovery aircraft. I believe we should have the recovery forces capable of giving this HF. The aircraft are not, I talked to Dave Bardsdale, the air group commander who was Air Boss, they do not monitor this HF. Nor did the ship.

Schirra If we had failed UHF we could not have talked to them even when they were close. At least the ship should have HF on it, and they didn't respond. As I said to Cape Comm. Tech. the voice tape recorder was a total loss. We believe we got one cartrige through and that was all.

Stafford Right. The warning light came on at approximately 2 hrs. 50 minutes. We changed the tape.

Schirra That's 2 hrs. 50 minutes elapsed time. We did turn it off frequently.

Stafford .... A new tape was inserted and time of removal was noted on the first tape. We ran continuously from NSR maneuver, well, not continuously....when it got close to the transfer, we recorded that up to the NSR from transfer on in, we ran it continuously. We started to wonder when it would be finished. We noticed we never got a yellow light, so I removed the cartridge and inspected it and found that probably only an inch or two had run. I tried 3 other cartridges in the recorder for a run and they did not work, so the basic recorder evidently failed.

Schirra I think it is about time that we recognized this voice tape recorder as a major deficiency for the Gemini flights. We should go into a crash program to initiate an acceptable voice tape recorder. We have this particular device all the chances it deserves and we can not afford to lose this valuable piece of equipment. When we were at McDonnell checking the voice tape recorder, we realized that there was no way of checking it and I had an engineering study performed inhouse to determine if there was any way possible to make an access hole so that we could see the tape cartridge in motion. Of course,

I mean the tape in the tape cartridge in motion. This apparently is not capable of being accomplished. This is a very sore point with me. I came off a Mercury flight with a perfect onboard tape and had no problem debriefing. This caused us probably more concern than any other item on the whole mission including malfunctions with the stowage equipment, malfunctions with the urine system. This was probably the most critical item to us. We didn't have time to take notes on these trying circumstances. We were working very rapidly and real time, and I cannot stress this point enough and I will make this evident to management as well.

Schirra Digital Command System, no problem.

Stafford All DCS updates worked very well, not a problem in the whole flight.

Schirra Communications Controls and switches, no problems. The HF antenna for recovery deployed normally. It did return to stowed position but it needed help. I had the hatch open and there was salt spray on it, and I could feel it on my hands, and this may have hindered its retract cycle. I am not willing to bet that this would retract in orbit, so, I suspect our philosophy of not deploying this orbit is a sound one.

8.6 Electrical

Schirra No problems.

Stafford Everything was very nominal.

8.7 Onboard computer

Schirra No problems.

8.8 Radar

Schirra No problems. In fact, I would like to say it another way. The radar was absolutely fantastic, particularly when we were tracking Spacecraft 7 after we had left them and they were in a drifting mode we had almost continuous lock for almost unbelievable periods of time when the transponder couldn't possibly have been looking directly at us. This was an outstanding piece of equipment.

8.9 Crew stations

Schirra We had better go down this one. Telelights, go; Event Timer, go; Digital clock, go; Digital clock, go; IVI, go. An overlay is a very good way of taking care of a problem that cannot be fixed due to lack of interest by management in optimizing the 8-ball.

I would like to speak just a little more succinctly if possible, or at least more reasonably: Throughout the prep period for the rendezvous mission we became more and more aware of the value of the 8-ball. The 8-ball reproduces

the very information that the platform has available. So, if the 8-ball as a servo to the platform, were optimized with markings we could use the 8-ball if we had a computer failure, and read angles such as Theta with enough accuracy to continue a rendezvous mission without reading Theta out of the computer. In addition with the proper markings on it, we could control our bank angle for reentry to the accuracy that we would like to. The change at the last minute for this flight to a reentry bank angle of 55° in lieu of 60° caused me enough concern that I then forced the overlay as an added item to the cockpit.

Stafford I would like to bring up a point on the FDI. The type of markings that we need, particularly for the rendezvous, are continuous markings around the pitch gimbal. Now, above 60°, it is completly vacant until you reach 60° on the opposite side. You have to extrapulate. We need continuous markings. The 5° marks could be reduced slightly in thickness, since they are fairly gross and heavy, and instead have fine line marks at 1° increments. Very fine line marks.

Schirra I think you are asking too much there. I would rather not change what is on the ball, but add markings, that's

feasible. If you change the markings on the ball, that is a big project.

Stafford Well, reduce the width of them.

Schirra We are aware of the fact that the ball has to be sent back to the manufacturer for these markings, we looked into this quite carefully. An ECPS has been submitted, and the last knowledge I have of action on it is that it may be too expensive. If that is the solution, that's a very very faulty one and should be fixed. I will not buy off on the overlay as the proper way of fixing this problem.

Range and rate, no problem. It worked exactly as we were briefed. We saw a glitch at 30,000 ft. and 3,000 ft. on the range rate, which I predicted. The instrument read accurately and the presentation was sufficient to where we could use it and check it against the computer readouts and the computations by Tom. I would like to see the range rate indicator, this again is not a requirement for future flights, I would like to have the vernier readout opened up enough so I could read 10 ft. per second on it. That's a nit, it's something I would call highly desirable, so it probably won't ever be done.

The MDS panel, very good. Altimeter track, we got that, rate of descent, got that, accelerometer is satisfactory, switches, mirrors, swizzle stick all satisfactory. Lighting was satisfactory. We used white light, and we did not use any red light. We became much more acclimated to the auxiliary receptable light. We did not break any lenses due to the care in removing them from the bracket. We did have the new brackets installed.

Shepard Was there any part of the panel you had trouble in seeing?

Schirra No. We used the flood light when we were inside. During the rendezvous we used the white lights for each panel and had the center console light dimmed down to an orange-yellow. And my white light on my panel side was dimmed down to an orange-yellow. Tom's was white. I used the pen light frequently, particularly to look at the magazine of the movie camera to read the feet traversal so I didn't run out if I had something critical going on. I also used it during the sleep period so I wouldn't have to brighten the cockpit up to read the center station systems readouts.

I did not use the finger tip lights at all, I think we can dispense with those if you are working without gloves. The fingertip lights probably would be worth

while if you had to work in a hard suit, I better retract that statement. I think I would just as soon use the portable pen light. We stuck it on the velcro and just left it there.

Shepard Did you have fingertip lights on both gloves?

Schirra Yes, never used them because they were stowed. The outside lighting on the docking light was excellent. I might add it did not affect the 7 crew and we used it even on 9 head on nose to nose configuration because they had their cockpit up full bright. We could use their cockpit interior illumination for night station keeping as well. And at that time, when I was nose to nose, I would kill the docking light just to not blast them with it. I could station keep off their interior lights.

Shepard Could you do a backup alignment inside the Command Module for a LEM active docking?

Schirra Yes.

Shepard Do you feel that you could see inside their windows fairly well, and could you have used this type of device?

Schirra To look into the Command Module from the LEM?

Shepard No. Say you are coming up on the LEM and you have a lighted standoff cross inside the window...

Shepard — Inside the window of the Command Module.

Schirra — You're in the LEM looking into the Command Module? You can see it.

Shepard — Okay.

Schirra — What distance are you talking about?

Shepard — We are talking about 10 or 12 feet.

Schirra — No problem at all.

Shepard — You could recognize things inside?

Schirra — I could very easily see that Frank Borman didn't have a beard, which you saw this morning, and that Jim Lovell did. It was that easy to see. I could see what camera Jim Lovell had in his hand.

Schirra — Onboard data, flight plan book. We didn't use it very much. Preparation was good, availability was good, management poor. We didn't need it is really what we are getting at.

Shepard — Qualify that, because you guys were so darn well trained on the part of the mission?

Schirra — That is quite true.

Stafford — It was a short mission..

Shepard — It was a major part of the mission, plus the sleep period you had no need to refer to it.

Schirra I do think that there were some items in there that we had a problem with, and that was the two pages that Tom needed for the retro LVI match up. We took those out and kept those out and stowed the flight plan book, it was there if we needed it. I used it frequently for AOS and LOS times. That was about all I used it for. I'm not trying to throw it out. I would still take it if I had to do it all over again.

Stafford It is far more valuable on a long duration mission.

Shepard Would you say we maybe need to tailor the flight plan book a little more to the type of flight?

Schirra Exactly right. This was sort of tailored as the result of 4 and 5, and we went along with it. This is true of the tremendous quantity of the checklist items, they're there if you need them. So I still don't think we should change them. They are good.

Shepard It is pretty hard to tell ahead of time what you are going to forget.

Schirra That is right. Checklist cards were satisfactory. There were no problems with them. I wouldn't change them. We basically disposed of items, for example, the launch cards, I just rolled up into a ball and put them into the trash once they were done, rather than trying to

keep them in the cockpit.

Schirra Maps and overlays. The orbital chart, I don't think we are on the right path with that. That's probably the easiest way for long duration missions. But for the mission we had to work too hard, I think, during the little time we had to grab it and find out where we were and get back again because you throw in this node point, get the GE time of the node, and you try to figure out what you GET time is, you can see that and you sit there and you subtract and you count your way around it, try to find out where you are. It took me about 2 minutes or more to figure out what was going on as far as what our orbital track was. And this is a little too difficult. I do not know how to get around this, but I think someone should look into it for this type of mission. Because you would like to know your ACQ and LOS times from a chart. I think I will just sit down and talk to the chart boys about it. You look at the one we flew You will see I have pencil marks all over that beauty. Sitting there doing arithmetic and adding and subtracting type stuff. The setting up I can do almost instantaneously.

Shepard It is just a matter of correlating times in between?

Schirra Yes, I get GET when it is effective, I take another GET and I have to sit there and sit there and do mental arithmetic is what I am getting at. It is awkward. I have to sit there and pencil mark my way along and try to figure out where the heck we are.

It was very useful. It was the only thing we had, in fact, I could not find it one time. I was looking all over the place for it. I did add, at one other time, that we did put a piece of self-adhering velcro on there, and that helped us considerably.

Stafford One of the best indications I had to correlate with the orbital map chart was the fact that the station would call up, it may be any message, but they would call if they had acquisition of signal.

Schirra You know when we got that the most? We would hear Tananavere Remote and we would know we were over Tananavere.

Stafford Right.

Schirra We talked about this a little bit. I believe that it would be worthwhile for each station on this type of mission, where you are really busy in the cockpit on rendezvous for the station to come up say in the blind, "Carnarvon acquisition", then you know you are there,

rather than trying to keep track of where you are.

Stafford It is a simple word and there is no acknowledgement to the transmission.

Schirra I heard them say, for example, Carnarvon LOS before we had voice LOS, so that is all we need from them. Then we know we have that station below us and we can babble all the way through to get that dope onto the ground. This would help us considerably.

Shepard We want to refer back to this piece of the tape when we get over to the mission control area.

Schirra Yes. This is part of that same problem.

Shepard It would get to be a little boring on a long mission.

Schirra No, I am talking about this mission specifically. We do not have many long ones.

Stafford For the rest of the Gemini Missions for the rendezvous.

Schirra For the real fast time stuff. You can sit down when you are plodding along, the next morning, we did this, we knew where we were all the time.

Stafford Rendezvous data book preparation, it required approximately one year as far as the total revisions and time lines. I think the way we have it today is very satisfactory. Availability of the information you want

to obtain is good for both failures and any sequence and for computations. The management of it is very good. Usefulness, outstanding.

Schirra If Tom did not say that he would be in hot water because he had a lot to do with it. But, I agree, I would like to add to that the fact that I could look at it even when Tom was working with it and become updated almost immediately. I must stress, and I as a command pilot should stress it, the nominal relative motion trajectory should be kept by the pilot. The trajectory permits the command pilot to have a complete picture of the status of the rendezvous all the way in to where he then takes over on eyeballs after a second mid course trajectory. I had a complete awareness of how the problem was going from NSR through second mid course. At that point Tom is continuing plotting his points for his own information to call out to me what might be developing as we proceed on into the fixed point of keeping.

Stafford The general data book I thought was very satisfactory. We did not have a piece of velcro to start with in the use of operation with the plotboard, then after we put a piece of velcro on the plotboard, this was readily taken care of. One thing that was a problem and should

be looked into is, when you have the back stick down through the plotboard all the leaves float open. You want to go back from one place to another. So maybe a series of rubber bands or minor clips on there to change off blocks of pages might be required That was the only trouble, the whole thing tended to float up with all the pages opening at times.

Schirra Looked like a Japanese fan, all splayed out, that was my problem too, and I stopped using it. We both had these books, is the point. I had to use it one time, the book I had, and that was to take a sextant sighting data for Tom.

Stafford I thought the retrofire data book was completely satisfactory and it contains adequate pages and it contains all the information you need to have updates for planned or contingency landing areas. Satisfactory.

Schirra Star charts. They are not satisfactory. The reason I wanted star charts on-board was to determine attitude, particularly yaw at night, from a known star. They are difficult to work with and very difficult to maintain in a fixed position. The index lines tend to slide off the center line of the plastic overlay, and they have to be taped down to stay there once you get a

setting for your right ascension. But, even then you can not read the number of degrees that a star is off your yaw line to determine yaw. In Mercury, I used a different type of star chart and I could find yaw with a known star within 1 degree, which is what we are using the star charts for. They are not for observation, they are to be used for getting attitude. We made a last minute change, which was this little overlay that we could lay on top of the star chart with circles increasing in diameter by 2 degrees per circle. This would help at least and is still a very crude way of using this equipment.

To go to the other extreme, of the sliding hootenanny, I do not think that is the right way either. But this does bear further study and optomization.

Stowage belts, harness, no problem. Life vests, I noted early in the flight that Tom's life vest, his starboard life vest in this sense, had to re-do that to be assured that his vest would be affixed to his harness.

Stafford It looked satisfactory for astronaut insertion, and it appeared that it was during powered flight or SECO when the strap came loose. We noticed it right away on our insertion check list.

Schirra Going back to stowage, our philosophy was to stow everything up forward that we needed prior to rendezvous, except for adding film, we did have to go back to my aft box to get more film out. This was not a critical problem, we had enough film up front in this sense, to take care of the first part of rendezvous and station keeping. While station keeping, Tom would be station keeping, I was hauling out more film to replenish our film supply. Other than that, I think stowage was most satisfactory.

Stafford It was real adequate for the mission that we had to accomplish.

Schirra Waste disposal. Again we found a problem for disposing of small items. These are loose objects that cannot be completely removed from the spacecraft. Even as carefully as the spacecraft was prepared, we had various small bits and pieces, such as nuts and washers and bits of material that we would stuff into a pocket. Finally Tom stuck it to the little pieces of tape that we had precut on the V shaped box above the right and left circuit breaker panel. This permitted us to get rid of most of it, but this problem probably could be solved with a little pouch that had a rubber slit

diaphragm that you could punch it through and have it stay inside.

Stafford That would be the ideal thing to do, take all these little items and hardware that float around the spacecraft.

8.10 Biomedical

Schirra Crew Stations, no problem. The oral temperature failed on Tom's side prior to insertion,

actually during insertion. We made another check during the 25-minute hold and the word was passed around the range and he was never requested to give it. Blood pressure, no problem until post landing. We deliberated very seriously whether we would go for the blood pressure reprograming adapter, which was stowed way aft in the right aft extension box. Tom finally volunteered to dig it out, and we both did give the Sir Johns their final blood pressure.

Food and waste evaluation. No problem. We eliminated the problem of body waste or defecation by a low residue diet. I recommend this for this type of mission for subsequent flights. We had one sleep period and went into it completely exhausted. So there was no problem about maintaining it.

Stafford Hot and exhausted.

Schirra We did have one occasion where we interrupted 7's sleep period. I wanted some information, and in turn they interrupted our sleep period when they wanted some information. In fact, their interruption was to ask for our retro time and that is what awakened us. Actually, I am quite pleased that they did because that is about the time I wanted to wake up anyway.

Comfort, no problem. Configuration, we both ended up with our hands looped underneath the hoses or communication leads, with our hands clasped. We had no problem with our hands floating around the cockpit.

9.0 VISUAL SIGHTINGS

9.1 Countdown. Schirra. None.

Stafford We had a U-2 on the first one.

Schirra That was on the Dec. 12th.

Stafford On the static firing, we had a U-2.

Schirra Which was supposed to be there?

9.2 Powered Flight

Schirra Staging, we discussed. Horizon view, Tom discussed the horizon view as a result of a clouding of the window. Fairing Jettison, I did not see it.

9.3 Orbital Flight

Schirra Man-made objects in orbits. Gemini Seven, nothing else. I might retract that in that at one point I felt I saw a meteor.

Stafford I saw the same thing and it was passing from our left to our right descending.

Schirra Yes, that is the only one.

Stafford When you said meteor, I looked out, and I saw one flash of light and that was all.

Schirra Geographical. We really did not have a feel for geographical reference, at least, I can say this, until I saw Gemini 7 over the Himalayas and I took movies of it.

Stafford I got stills.

Schirra That is fairly late in the flight.

Stafford Once we started into the phase adjust maneuvers, the only way I could tell where I was, going around the earth was I would hear these sites come up like "Carnarvon has acquisition", and I knew I was over Carnarvon. The whole world in our latitudes were completely covered with clouds. There were no coast lines wither at night or out in bright daytime, with clouds below. That is all we had.

Schirra Later, we did see Africa. We saw the West Coast of Australia. And that is just about it.

Stafford That was about all the land we saw in the whole mission.

Schirra Otherwise, it was night or cloudy.

Stafford We never saw the United States. Well you might have seen Florida, I did not see it. I was busy in the cockpit.

Schirra I never saw Florida, I never saw the Gulf Coast. I do not even remember seeing the West Coast. We saw an island off the West Coast. That was on reentry.

Stafford Right, we saw an island down by Mexico. It was somewhere we saw one little island down there and from there on, it was white clouds.

Schirra I did see Bermuda once.

Stafford I did not see it. It was on your side.

Schirra I saw Bermuda.

Stafford I saw the Canaries through the overcast.

Schirra We saw that and took photographs of that. We did see Madagascar. This is all on the morning of the reentry.

Stafford I recorded this on these S-5 experiments and time correlation.

Schirra I did take a series of pictures to show we had some real spotty cues. And had Tom run his MAC camera 6 frames a second, I think we can show how clouds really look for yaw references. We pitched down to the nadir and took these. I maintained zero yaw and this should help us a lot for these visual displays.

Schirra Celestial. I saw two stars in the triangle of Denebula, tail of Regulus. Tom, I believe saw three. That is not counting the three stars of the triangle. This is when we optomized for sighting with the lights out, except for red lights on the FDI's.

Stafford We turned everything out and I saw, two bright and the thrid one real faint.

Schirra The triangle of Denebula.

Stafford We saw the big triangle, but inside that triangle Wally saw two dim ones, and I saw two bright ones, plus a real faint one.

Schirra This really surprised me when we really ran the lights way down on the bottom half of my window I could see the milky-way, which I could not see in Mercury trying my darndest. So even with this film on the window, we had that much benefit.

Stafford You know how at times when the night is completely dark, and you cannot see it, well, just turn your cabin lights up, and then you look out, just the major stars shine. It is then real easy to identify the constellation.

Schirra It is a pretty good trick, really. We did not see any dim light phenomena as far as celestial observation goes. I did not see the Schirra Arcs or whatever they are called. I was looking for them, when we came over the Indian Ocean. This was the sighting I had from Mercury.

During rendezvous phase, the good old constellation Orion, the prophetic Gemini 6 patch was right there. We acquired Sp cecraft 7 and I though it was Sirius, and it was not Sirius. It was very delightful. And then subsequently we did see Sirius. This, of course, is before the star field became as clear, because this was their terminator reflected light. Or the light reflected before the terminator.

I think we did discuss the stars, how they did aid us. Particularly, C stor and Pollus forming a roll axis line, also a yaw axis line and a pitch axis line.

So I could have used them beautifully for a backup for pl tform if required. That is what I was searching for all the way up through the final phase of the rendezvous, was a good star pattern, and I had plenty.

The stars disappeared quite rapidly after sunrise.

When we were trying to do some Apollo sextant sightings, the only thing we could see after sunrise was Spacecraft 7 with reflected sunlight. All the stars disappeared immediately. As a result, we could not use stars as a function to detect any angular measurements. This was a combination of two things. I believe...one was the completely clouded atmosphere below us and the other, the fogged-over windows.

The star pattern just seemed to arrive exactly the time that it became night. We never did see a star during daylight, and we tried for them particularly during the final phase of rendezvous. At the point where I might very well have seen them optimize for this particular viewing, which is pointed straight up, with the sun at our belly, and the Spacecraft 7 above us, soon as it became brightly lighted due to the sunlight, BOOM - the whole celestial sphere was gone

Stafford Yes, disappeared. Up to the time it turned bl ck there is a definite shift from black into a gray. Right at that time, the only thing that was left was just your first magnitude stars and brighter. They stayed for awhile and then as you come out into sunlight, it all disappears.

Schirra The last thing I saw, every sunrise was Jupiter, and then the Spacecraft 7 lingered on. Jupiter did not last very long, a few seconds.

Other observations, I have none. I am very disappointed in this film on the window, frankly. Cloud coverage, a batch. I think we have discussed this sufficiently. Where we did not have cloud coverage, we took pictures.

Stafford We got pictures of most terrain that we did not have cloud coverage through S-5 and S-6.

Schirra I can really understand why Gordo flipped over the Himalyas. We had one pass and... Oh Man! That was spectacular. If you look at that big map up there, you can see how much area is involved. It is as big as the whole country of India.

Stafford Down the southeast edge of the Himalayas there is a tremendous stratus deck, which overcovered Thialand, China and forked its way through the Himalayas.

The central portions were covered with snow. As it came down over the desert of Pakistan and India, it was red sand going into the browns.

Schirra Remember those pictures that Pete and Gordo came

back with ,those little red sand dunes? They are just unbelievable. They travel for hundreds and hundreds of miles, really a spectacular sight. Geologically, of interest and they were beautifully photographed on 5, and we took some shots just to join the club. Again, the long duration missions did a much better job than we could afford to even try to do on this one. I thought we could do well, but we just did not have enough terrain visible. We saw the same four different colored lakes, and I took a picture of those that Pete took. It should be interesting to see how we got one and to see if they have changed.

Stafford And I said, "There is Petes lake."

Schirra We really got excited about that. The horizon that is something else that has been brought up by the other crews and I do not recall this from Mercury. The transition from day to night really surprised me on this mission. I have heard it described as a sort of a fuzzy, gray, blob. There is no sharp horizon at this point. That really did surprise me. You cannot use the horizon, is what I am getting at. Typically, you get a scanner light, because it was searching for something too.

Stafford One thing I noticed as we went from daytime into darkness, it appeared at least out of my window, we had the blue and the air glow layer down here and darkness the black part up here with green in between, but it seemed to funnel down in towards the center of the spacecraft. Just like you are going into the overhang of a thunderstorm, how it is dark in here. There was definite layer, it started out horizontal to the horizon out to my far right. Then as we got right near the center of my wind screen, it started to bend down. This was black here, bend down and towards the center, looked like it was going into a big funnel. As you progressed into it, the whole thing shifted down and then it was dark. Something like we flew into a funnel.

Schirra I think we had about maybe 3 or 4 sunsets. I would not change that drawing I made of sunsets from Mercury. Even the ragged bottom of the black is sort of like the bottom of a raincloud. I got that down pretty good. We measured the height of the air glow with the optical sight. I think Tom said it looks about 2.80 degrees and what did I say it was, 2.75? That is from the earth's horizon. We just guessed at it. We talked

about this from previous flights. But using the optical sight, zero roll, and measuring right off the reticle, no problem at all. I put it back up again for this purpose. It was 2.75 degrees through a span where you could see it and I covered about 90 degrees. I just yawed around tracking it. It did not vary a tenth of a degree. So it is a good number. We measured the thickness of the layer from the surface of the earth to where it is black - to the absence of light - with the optical sight.

Schirra Thruster firings, I assume this means looking at 7. We've discussed that already.

Shepard What about your thruster firings?

Schirra Everytime we fired an OAMS thruster, be it attitude or maneuvers, there was sort of a bluish white glow around us at night. Daylight, I never saw a thruster.

Shepard Did you check the RCS thruster plumes during reentry?

Schirra I was too trapped inside.

Stafford You could occasionally see RCS on reentry in the day time.

Schirra Oh. I saw it. When I checked them out I looked for them and I could see the gas flow. I did not really see a color. We checked the RCS rings, both of them,

during daylight, just the way the timing went, and I could see each thruster that was visible to me expell the gas.

Schirra Reentry. Okay. We discussed all of that. It's all covered.

10.0 EXPERIMENTS

10.1 Radiation Experiment (D-8)

Stafford They called us two updates. I have this one at 06:35 and the other one was at 8:10 GET.

Schirra We discussed that. As you recall, I did state that at those times I was much too busy and I was practically not able to turn around in my seat to get this cover off. I really wanted to do it, but I had to judge one against the other, and just unfortunately decide against doing it.

Shepard And we've already discussed the D-8 equipment that came loose on Tom's side...

Schirra Going from single-point to two-point.

10.2 Synoptic Weather and Terrain Photography Experiment (S-5/S-6)

Schirra We've covered S-5 and S-6.

11.0 PREMISSION PLANNING

11.1 Mission Plan

Schirra Pre-mission Planning. I guess I can't really nit pick this, but somehow or the other I was struggling to get the same sense of preparedness I had for October 25th. I knew exactly where we were going. I had the MPAD document. Remember I was floundering around there at the last, Al? know that this is awful hard to update that. I do feel as we were prepped for October 25th, we had all the stuff we needed. Now we cycled around much too much, much too fast, to get all of this stuff in. I was sort of struggling to find out where we were going. And, if you recall, it was the afternoon before launch that we finally got the feel for where we were going to fly on that mission, which admittedly was pressing the people. Their excuse was they were busy working out sightings for 7 and all sorts of stuff, but I didn't h ve a real good sense of assurance that I was going to be prepared for this. They finally came through.

Shepard You're talking specifically here about the geographical location of the various burns?

Schirra Right. And what orbit we'd be in. This is not a good

valid complaint because we were very well prepared for October 25th. We were quite well prepared for December 12th. And we were poorly prepared for December 15th with respect to this one item. It wasn't critical. It was just a little thing I wanted to have because I had a great feeling for it before the 25th of October when people could focus on us completely. I really would like to have those charts we had. Before we ended up flying that type of shot, we never used them because they were all out of whack.

Shepard It may very well be that if you have a good ground rotary of tracks with the rotating band around it, the overlay around it, the overlay around it, that would have been easy to update if we just changed the format around some. If you guys had gone for an M = 6. What you'd learn for M = 4, you see, would have to be adjusted. Maybe for future rendezvous missions, if anybody is interested in connecting geographical locations, then we can take a look at this orbital track with the overlay and make that easy to use. Use that rather than the MPAD document.

Schirra Well, what the MPAD document did for me though, was give me a feeling for sunset and sunrise. Of course, I could

have been called that. I ended up working it out myself and it turned out when we hit the bottom of the orbit, basically at 29 degrees south going south -- BOOM! It was sunset. Then coming up to about 16 to 17 degrees north, it was sunrise. This, I worked out myself and I was really frantically trying to get that. It was a good feeling to know that because you can then sit there and figure out where you are and what is going on. It is sort of a sense of where you are. I guess that is about it. This should not have happened, but I am not bl ming anybody. It's just a case of pushing the mission pretty hard.

11.2 Flight Plan

Schirra Flight Plan, no problems.

11.3 Spacecraft Changes

Schirra We fought spacecraft changes all the way down the wire on October 25th. But for these delays, I would have made a real big scene debriefing right now on this. I feel very strongly about the changes that were made to Spacecraft 6 after it left St. Louis. I, at that point and time, was embarrassed in a management meeting by hearing the statement made by one of the management personnel that "Oh, you guys can make changes at the

Cape all the time, so you shouldn't talk about this here in St. Louis." We made no changes in that spacecraft except for a scotch tape overlay on the instrument panel. The changes that were made by management to Spacecraft 6 are as follows: urine system, water management system, water gun. A new item was added under the title of operational test--the sextant. This caused us great concern, and we would not have been prepared to do the job as we did do it on this flight if we had gone on October 25th. This was thrown at us in a very haphazard fashion without proper briefing, and without proper time to train for it. We had one change that we agreed to. That was trying to take photographs of Spacecraft 7's thrusters. As a result of carrying this dim light film, dim light photography was added as a requirement to this mission. We accepted this as a requirement but with the proviso that we would do it if we were capable and not rushed. It would not interfere with any other item. As a result, whatever we got was done during the last two night passes prior to retro. The other item that was added, at one time and removed was dim light film at the last minute to take some photographs of a comet. This comet was of interest to both

of us and it became quite a flap. We were quite aware of the fact we were going to be SEF all the way up to rendezvous and we could have taken pictures of it. So that was no problem, but it was another item that was added. In a sense, that one being added is responding operationally. I don't mind that one. It's the hardware changes that cuased the problem. These hardware changes in turn turned out to be major problems to us in orbit. We had difficulty with the urine system, mating it up with the spacecraft. We had difficulty with the A-frame or center stowage compartment--getting it to work. Those were the results of these changes. We restowed the center line boxes about three or four times to accommodate the sextant and the D-2 Experiment going in and coming out. This could not have been responded to as well as it has with an October 25th launch. Another item that was added that was not stowed in St. Louis was the humidity sensor. That was a last minute piece of equipment, and we did manage to get some good readings on that with the quiet time we had the morning of the reentry period. This was some nineteen hours. I've tried to state that the crew needs to have equipment to work with, to train with, in ample time. The reason we asked for the freeze on

the spacecraft at St. Louis is to give that ample time. Now our training had to be focused on rendezvous and all these little adjuncts to normal living in a spacecraft were the ones that pertubated us the most. I can only stress that this is not the right way to do business.

11.4 Mission Rules

Schirra We had ample time to go over those and we were completely satisfied with all the Mission Rules.

Stafford Yes, the final rule that they came up with as to whether we'd go closed loop or open loop on the rendezvous portion of the mission we agreed with completely. Originally, we disagreed with some of the values they had. But I think the final one they came up with was real good.

11.5 Experiments

Schirra Under the category of experiments---we did minimize the added experiments to this spacecraft and I think it was a valuable technique. I might add, this might be the time to talk about whether we would do or not do EVA on Spacecraft 6. I can always say that it's fortunate that EVA was cancelled out on the second go-around in that we probably could not have accomplished EVA while in the vicinity of Spacecraft 7 without a real nightmare developing. When we shut down, we were absolutely exhausted.

Shepard You're assuming a one day mission now?

Schirra Agreed. But I don't think we could have stayed with Spacecraft 7 for a two day mission. Now, if you had an Agena where you could dock, and stay there docked and sleep overnight, which is what we had planned on doing with the Agena, this would not have been a constraint. The postflight report from Gemini IV stated they needed at least an orbit, and more likely two orbits, to regroup to do EVA. If you go through the full rendezvous mission as we did with an M-4, which is really optimizing it---the best you can do is possibly move it up to M-3---you would run yourself

through about a fourteen hour day, counting wake up time to when you finally accomplish this. This is not the time to start the physical exertion restowing the cockpit that was required to be unstowed for rendezvous. Restowing the cockpit, regrouping, and then commencing EVA. It should be done after a sleep period, ideally after docking. EVA is a necessary technique to be performed. I'm not talking EVA out of the picture. I believed in EVA and wanted it on this mission, but I am very pleased that we did not have it. We could not have done EVA with Spacecraft 7. There is another reason for this; if Spacecraft 7 had had sufficient fuel to station-keep on us, we possibly could have gone to sleep and let Spacecraft 7 stay awake and maintain the station. That would have been another way of playing the game, but I suspect we would have flopped on EVA.

Shepard Of course, you had enough fuel for another rendezvous. You could have re-rendezvoused at the start of a second day.

Schirra That would be depending upon everything being optimum. That's true, we could have.

Shepard You could have moved out and moved back in again.

Schirra That would have been a way to catch up on our sleep. And that is probably another way of doing it if you couldn't sleep on the Agena while docked.

Stafford Move out to about a thousand feet or so and station keep the best you can. Then just come back from there, or you could go through a whole complete sequence again.

11.6 Training Activities

Schirra The first thing I did when we picked up Spacecraft 6 was to sit down with Joe Stegall and lay out the rules for pre-mission planning and the training activities. We blocked out all of those items we felt we had to accomplished, and I basically deputized Joe at that point to take care of all of our training activities. Naturally, we worked closely on what we could don, when and where, but this is part of what I call forming a staff of people who could take care of all the activities. I would like to expand this slightly. It may not be some place else. This includes people such as Dock Hudson, Jim Lewis, and Joe Stegall to cover the whole area that we could not cover, and drop the nit picking items that we typically had done as flight crews in the past. This staff technique, as we neared launch when we picked up the Flight Crew Director at the Cape, and made the task completely simple for the crew. The crew, in turn, could then concentrate on their own personal training as far as GMS work, and

attending the appropriate meetings that they could attend. We were completely updated on the spacecraft status, both by the McDonnell Spacecraft Manager and by Dock Hudson and Jim Lewis. Stowage was considered in the same category; so all of the side effects were taken care of way back when we picked up the mission. I recommend this technique to any future crews.

12.0 MISSION CONTROL

12.1 GO/NO GO'S

Schirra Mission Control - Go/No Go's. No Problems.

12.2, 12.3, 12.4 - PLA and CLA Updates, Consumables, Flight Plan Changes

Schirra PLA and CLA updates, no problem. We discussed the boat load out of Canavaron and I think that is sufficient on that. Consumables, no problem. Flight plan changes--- the only change that we had that we did not know about was the radar test. After a night's sleep I did attempt to do what was asked for, but we were doing other things at this time, and that was aligning the platform, and I felt that this was an uncalled for test. I may have to retract that, but I can't understand way. The experiment real-time updates were sufficient. I believe on the fast-time phases of the mission, as each subsequent rendezvous mission will be, it is worthwhile for the stations to come up and say "Spacecraft Acquisition" and, later, "Spacecraft LOS". This then gives the crew a chance to know that they are over a station. This could then help up to transmit to the ground to update them on the status of the rendezvous. I agree that we need not have this later when we are in what I would call slow time work. During EVA I think would be

Another case where you would want to do this. If you are hard-suited, both men obviously are, again act and LOS times would help. Just say that and that is all; we know then where we are. One other item we brought up earlier on ground control was the asking for information that was not required subsequent to retrofire. That was attitudes. I don't think that was necessary. It was almost an insult after the IVI readings were called out.

Shepard Yes, I think that it was superfluous here. If you don't get good IVI's or the IVI's are off nominal, it helps them if you can give them some idea of what your average vector was. But I think in this case since the IVI's were in one foot per second of being nominal it was probably superfluous.

Schirra They asked it if was an automatic or manual retrofire. That is understandable and good enough to ask. But, "Did all four retros burn?", that is redundant and that was asked on both 6 and 7. You can't get those IVI readings if you don't burn all four. We did call out retro jettison, and they asked us if we jettisoned retros. I belive that was probably because we had poor voice transmission. Apparently, we did not transmit too well to the ground. Our voice did

not get through too well.

Stafford We called retro jet over Canton and then Hawaii. Came up when we got acquisition and requested if we had jettisoned our retros already.

13.0 TRAINING

13.1 Gemini Mission Simulator

Schirra Starting with the Gemini Mission Simulator. Looking over these various categories I see no problems with procedures, systems, training, launch, orbit. Rendezvous---we fought like mad to keep it going. And we did have trouble getting the star field updated to the launch date. We did have it updated at one time, we thought, but we never did really get a good look at October 25th. Nor did we get a good look at December 12th. And I am concerned about that because it would have made it a lot easier for us if we had gone nominal, as we did go, and we could have been well aware of the star

pattern. That is probably why I said something earlier about worrying about where I was, and that is an example of it. My retrofire did not occur as we expected it to occur and now I am not sure that this is an odd ball case or not; this bears more study, but there was a big delay between retro rockets. We have discussed that. I have never seen that before. Reentry---we were disturbed about the reentry, and I always have been on the GMS. About the last three or four days we finally got the simulator solutions that were like what we expected to see, but for awhile I didn't think I couldn't get any closer than about 12 to 15 miles. Maybe it would have been best to leave me that way, and I would have been happy with what we got.

Schirra The crew station---I thought that they did an outstanding job of keeping it up to date, particularly with all the changes we made recycling and everything else.

Stafford That fast turn around after 7 to 6 was---

Schirra That boy Herman deserves a big pat on the back for the outstanding job he does down there. He is a real can-do man. He deserves to be patted on the back for the kind of work he does. Very good.

13.2 Launch Abort Training

Schirra Launch abort training was sufficient except for December 12th. I would like to discuss that some other way.

13.3 McDonnell Engineering Simulators

Schirra Without the rendezvous and reentry simulators at MAC we could not have accomplished the mission on October 25th and more than likely would not have been prepared by December 15th. That is how important they were to us and I would like to stress this point, directly to Neil Armstrong on 8. I cannot overemphasize it. Their hybrid simulation at MAC is what brought us on the road for rendezvous, and I don't know what the status of the GMS in Houston is, but I suspect that it will be down for awhile. I particularly feel for Dave Scott at this point of time picking up three things---Gemini, EVA, and rendezvous. All three are major tasks, and they are going to have to use anything they can get. When they are at MAC with any quiet time at all, they should utilize the equipment.

The only reason I can say that rendezvous looked easy is because we spent an exhaustive amount of time rehearsing this role. At this point in time I am aware of what a great entertainer is. It is one who has really rehearsed and rehearsed so it does look easy. It is fantastic the amount of rehearsal, and that is exactly what we did on rendezvous.

FCSD Rep Do you think it is a good plan for the crew to go to the contractor simulation facilities at this end of development phases to check procedures and to check simulations?

Schirra So strongly, that as soon as I can get on the Apollo rendezvous simulation I will get on it. At that point in time you can find out if the contractor is off base; we saw the contractor off base at MAC. We saw that the math flow had some problems in it which could not be changed in time. For example, 100 second radar points was a mistake. It should have been one minute. It would have been a lot easier for bookkeeping, a lot easier to work with. The fact that he programmed in two platform aligns was all right in a sense. We could ignore them and we learned how to get around them, and get some backup data. In fact, they did

not have an align between NSR and transcribe, which probably should be programmed in. These things you learn through experience. You can not make the system reflect it fast enough, but if you get there early enough, and I am talking about earlier than when you are actually a crew, you might do some good.

Stafford One of the things for the rest of the Gemini flights--- I feel that both the prime and backup crews should have about one week of concentrated simulations on the MAC rendezvous simulator, just to get the real rock knocking sessions in and get the real hard points ironed out as far as crew training and coordination. After that, the way the GMS situation is now, the GMS can suffice. As far as the initial first look, where they have fast reset points, you can get the procedures and techniques down and work two shifts a day on it. I would say about one week would be adequate, working two shifts a day.

Schirra The real key to the MAC Engineering Simulator for rendezvous is, that those people who are capable of helping you train for this can stand along side, and watch, and spoon-feed you, where you can't go this in the GMS. You are buttoned in on the GMS, and the elephant's over you, and you are not able to talk with anybody about the data

points you are collecting, or what you are seeing and get corrected; so this particular device that we used at MAC is what really brought the contractor's ideas of how to do rendezvous right in the cockpit with us, as well as the experts we worked with and found in the NASA community. That consisted of about two. This only adds up to one thing. We have got to have continuity in this training and this is why I made such an issue about Dean Grimm. I think he is the one who can provide the continuity from crew to crew.

13.4 Translation and Docking Trainer

Schirra Translation and Docking Trainer---it is an excellent piece of equipment. I scheduled myself back to that less than ten days before launch of the Agena and again utilized it even for the station-keeping exercises when we were in Houston before we came down here for the long pull That was used right up to the last minute. It is probably one of the best dynamic devices we will ever find for this type of mission planning and training.

13.5 Planetarium

Schirra We finally got off the hook on that. I almost am willing to make the statement

that we do not need to go the planetarium any more, due to the accuracy and completeness of the visual display that we have of the Farand system. I am very impressed with it. I.....

Shepard May I ask you a specific question?

Schirra Yes.

Shepard Let us assume that you are faced with the problem of training new astronauts in star recognition. Would you send them to the GMS or would you send them to the planetarium?

Schirra I would send them to the planetarium. You have to fly the GMS and that can only train two people at a time. I am sorry. I was focusing my attention on a flight crew selected for a mission. Good point.

13.6 Systems Briefings

Schirra I think the technique that we followed, which has been documented, is the ideal way to do it. As we come closer to launch we use the best experts at the Cape to bring us up to date on the latest changes. We started out way back in 3, so it is sort of old stuff for the 6 crew. But if you start with a new crew fresh from scratch, such as we are doing with the third generation of our group, they, in turn, I believe, can get something out of the systems trainers. I do believe they help you get an initial foot in the door on the systems. Ultimately, you must go to drawings---flight handbook type material to dig it out, but they take a lot of time to dig out and you can get a quick visualization of how the systems fall in place with these systems trainers. I am not a great fan of systems trainers but they pay for themselves in more ways than just flight crew training. They help controllers and other people. As we progressed, we generally got up-dated by the experts that we could find, either at the plant in St. Louis, which we utilized, and also here at the Cape where these particular technicians were working with the spacecraft and could bring us up to date continually. This has to be backed by people such as Doc Hudson, who saw changes in systems and came

up immediately and briefed us on it. If we were still a bit in the void on it we would start grabbing more people to fill us out. This is exemplified by such things as water management systems, the water gun, and other last minute changes.

13.7 Flight Experiments Training

We had sufficient briefings on it. The photographic equipment, I thought, was pretty skoash. We had a lot of time to get use to it. The Hasselblad, for example---there was nothing odd about that camera, and we have seen it for almost two years and I had seen it for another year or so on top of that. The Maurer camera was just stretched to the limit, I admit, to make this flight. As it was, it just stretched itself to the limit to perform. It was in short supply and we did not have much opportunity to work with it. It is a simple piece of equipment with a lot of versatility, and we do need them for crew utilization. The spot meter that I insisted on having on this flight, I am sure that both Tom and I agree, gave us the accurate light readings that gave us the photography we ended up having. We used that all the time. I think this is particularly true when you have something to look at in space that has never been looked at before. Now, I think maybe people will be aware of the fact that it is intensely bright. We ran

almost full scale on that spotmeter...that is 17 to 18, and it knocks out at 19, as I remember.

Stafford Full scale deflection.

Schirra That is full scale deflection. Now, no one gave us those numbers. They all said f11 and 250. We were shooting 22nd. So, we could have clobbered some of those shots. f11 and 250 would not have done it on some of those.

Stafford It was important going into darkness. I am sure we got a lot of great shots.

Schirra We were changing when I was taking movies. I was changing f stops even while I was taking them. As Tom called spot meter readings I'd go click, click, just to give you an example of how valuable that piece of equipment was. And we can't use what I call canned solutions for light values. That is a mistake.

13.8 Spacecraft Systems Tests

We minimized these and this was because we picked up a new function. If we minimize these, I don't know what the heck is going to happen on rapid turnarounds once we pick up the rendezvous mission again with the Agena coming down the road. The tests were looked at very carefully, basically to see what we could get out of it, not build up our confidence, which was what we used to do in the past---but to participate in as many of the tests as we could with the luxury, in a

sense, of getting another spacecraft where you might throw a switch once per half hour, just lying around in the cockpit basically. This we couldn't afford and we went very lightly on that.

Stafford I think the main items to cover here is to really cut down considerably from Spacecraft 3 to 6. Just a few series and the System Assurance Test at McDonnell, the SIM flight and altitude chamber, and then down here at the Cape, we had a little bit of Joint Systems test and SIM flight. And that was about it.

Schirra Basically, we participated in tests where we could help speed up the tests. Where we were more proficient.

Stafford Usually down in the simulator...

Schirra I don't think you could afford to spend four hours in the spacecraft, the actual spacecraft, getting a half an hour's worth of experience as far as switchmanship goes. You can get so much more than that in the GMS if it is maintained in configuration.

Shepard Of course, on basic difference between Gemini III and VI was, the mission in 3 was basically a check-out of the systems.

Schirra Right, so we were very well up on it.

Shepard There was very little else involved in that. In other words, this flight of 6 had a decidedly different objective.

Schirra Yes. But as a result of prepping...

FCSD Rep Plus the fact that you had time on Gemini 3.

Schirra But as a result of prepping for 3, we were very systems conscious because there were new systems to be evaluated so we went into them in greater depth. And we had a lot of time. I don't think that where we first picked up this mission, I had much assurance that we'd have time to train for rendezvous, if you recall way back. I was kind of worried about what equipment would come on the line in time for us to really be prepared for the rendezvous mission. As a result, I practically dropped the spacecraft real early in the game and concentrated on the rendezvous simulator at MAC and grabbed it any time I could grab it. I grabbed it for reentry, because it was a new reentry mode as compared to Spacecraft 3. So I can only say that this part of how we lucked out. We had been prepared, we knew the spacecraft; we hadn't changed it, it was a battery-powered spacecraft, as Spacecraft 3 was; so this helped us considerably.

FCSD Rep What would you say of the minimum systems test that a crew ought to participate in? Or would you like to express that?

Schirra I would like to sit down and work on that a little bit longer. I would like to be jigged on doing just that.

13.9 Egress Training (Pad and Water)

Egress training pad and water, satisfactory, but for hold kill, we really didn't have...

Shepard Where do you think your training fell down in the hold kill?

Schirra I don't think I had a sufficient awareness of how to get out of the spacecraft if it was still on the pad. I had a general picture of it.

Shepard You had done it before.

Schirra Oh, I'm sorry, what I'm getting at is things varied, for example, when we got out of the spacecraft on the Agena scrub, the White Room was there. The erector was brought up again, and we got our disconnects out and we got out and went on down; this was a perfectly safe environment..you see what I am getting at. Now in the hold kill environment we were on the bomb. That is just the way I thought of it. And the splash-suit men came up and made sniff checks and we opened the hatch. We played it exactly the way it should have been played, but I think we sort of felt our way along. This was all right, we had good communications and everything else. So again, we lucked out. But what I am saying as crew training, I guess I am saying as a total posture, the whole launch crew was not really as well prepared as I thought they should have been. For what I call downstream hold kill activities; everybody responded beautifully for the first five or ten minutes. Beautifully, exquisitely, then we went downstream, it was a little harder to regroup. I recall for example, that the Spacecraft Test Conductor called up to

find out when we had switched over to external power. We knew it; they didn't. This kind of stuff was a little sloppy, that's what i am getting at so if I am talking about training, it was the total package, not just the flight crew. We went through a pretty big study up here trying to figure out how soon we could get the erector up and no one really laid down the law on that. I think this gap will be filled now as a result of having had it.

13.10 Parachute Training

Parachute training, I can recall very vividly the one exercise I had, and I feel that every crewman who hasn't had it should have it, but we don't have to push it right down to the wire. It is something you remember. It should be done with a suit and with all the configuration as we have done it with the parasail chute.

FCSD Rep Do you feel once having had it you need not to repeat it?

Schirra That is correct. And for example, if a back-up crew has done an egres I don't see that they should go through it again. Unless they feel like it. Or parachute training.

13.11 Launch Simulations

Launch simulations...Are you inferring that this is with MCC Houston.

FCSD Rep Yes.

Schirra It is very valuable, it is one of the best we got.

13.12 Network Simulations

And Network Sims. I wouldn't even schedule those in again. I wouldn't even waste my time giving them a lift-off through LOS. It ties up the simulator too much. You have lost the simulator for crew training. All you do in a network SIM is climb in, get it through LOS and then you dump it because the tapes are a little out of range. As you recall we didn't even participate in the network SIMS towards the end. We did a couple earlier and it really messed us up because you are in there with a can solution anyway, you have got to go into orbit if that is what the simulation calls for; so you can't respond to some of the problems that might come up. In fact, one time I said something that screwed up the whole simulation, because it wasn't supposed to happen. It is something I saw happen, but it wasn't supposed to. So I think that we just as soon leave us out of that.

13.13 Reentry Simulations

Boy, oh boy, and if you've never done one you'd better have them. I think that the best way to say that is go all the way back to where you get your updates, check your updates and everything else. And those were very valuable to us. Except for one thing, they shouldn't screw around with them as much as they do.

Stafford Oh boy.

Schirra Oh, they had some failures in there that were unbelievable. Some that worked out as failures on top of failures but there were some over designed failures in there. We could train for that kind of stuff on our own, but when you start working with the flight controllers, you shouldn't put the crew in that kind of awkward position. I believe...maybe I didn't mean it that way. What I'd like to say is that all simulations of failures that we could possible consider within a degree of depth, not 99 failures in one simulation but those that are reasonable to expect should be simulated early enough so that the crew can go back and practice them. You don't throw them in the last week during the time when you are trying to perform with another group such as the flight controllers. I practically feel that when we work with the flight controllers, that we as a crew should be testing the flight controllers rather than the flight controllers testing the crew. We're being tested along through training and when I get in the simulator and something is going on, I try to press the flight controllers to bring in the information, because I want them to bring it up to me, to back us up...that is what they are there for. Under these considerations the whole range network should back us up, to help us out and they should respond to these problems, and this is typical of what is done on Spacecrafts 5 and 7.

13.14 Simulated Network Simulations

Schirra I would suggest that the crew concentrate completely on supporting these. On the rendezvous mission there are periods of time when you can make the burn and get back out again, so it is not necessarily as in our case where we were running form lift-off to rendezvous--a total of five hours and some odd minutes, oh say six hours steady work in the simulator. You can get in and get out for the burns, and this is a real good technique. You get used to doing updates, how to log them and responding to them and carrying it through, we hope eventually to rendezvous. The GMS was never capable of doing this and I hope it will be with the new math flow. It may not be then either. These are probably the most valuable simulations we participated in. Including even spacecraft simulations.

13.15 Zero "G" Flights

Zero G flights for EVA; there is just no other path to follow. They are mandatory for both crew members. When we first looked at Spacecraft 6, both Tom and John Young went out and developed their techniques for the EVA side, and as we were to progress down stream we were booked in to put the command pilot into the loop on Zero G flights in the mock-up in the Zero G aircraft to practice this procedure, and I am sure this requires some great concentration, and so

these must be followed. And I'm assuming that all subsequent flights are EVA flights, I can only answer by the way we were booked up to do it, and at this point in time, I suspect it may not be true even now, but up until October 25, Stafford and Young were the best prepared for EVA of the whole group including the subsequent flights other than possibly Ed White.

14.0 CONCLUDING REMARKS

Shepard Let me ask you a question here that is not on this list. You did not have centrifuge training during essentially the six months period prior to the flight. Did you feel anything other than a familiarization run with the hardware sometime prior to crew selection is necessary?

Schirra That is sufficient.

Stafford Plenty.

Schirra Going back in history to the kind of centrifuge training we had back in Mercury days, this probably was good at that time. We didn't know how we'd stand up under it.

Shepard It was research.

Schirra That was more of research. I think that there is no requirement to have acceleration runs made with a hand controller and a suit on and all the equipment on. Merely a shirtsleeve environment is sufficient to become acclimated to the effects of accelerations and be aware of what is involved. I made

one change in real time though that surprised me. I threw the elbow guard up, not the arm restraint, but the elbow block up for reentry. I don't know why I did it, but Tommy looked at me surprised when I did it. Thr reason I did that was on boosted flight I had it up and I was leaning on it and I could keep my hand on the stick because I used the mike button on the stick, so recalling that from accelerated flight on boost I knew I would probably need it on reentry if we got into a high G reentry. As it was, we had less than 5 g's, I think it was about 4.6...

Stafford 4.3 was what we got..Chris said 4.8 by the way.

Schirra Yes, I know.

Stafford I think that our G meter was probably a little bit low, of course it is a gross indicator anyway.

Schirra Yes. Because normally the Titan pulls about 7.7 G's at SECO and we only showed 6.8.

Stafford 6.8.

Schirra So it was probably a little bit low.

Stafford Yes.

Shepard You weren't running a V-g plot on reentry anyway.

Schirra No. You do have an awareness of G but this is developed from the mission simulator watching the Accelerometer work and it should be working everytime you practice reentry. It is a very important cue.

Stafford Yes. We had a total of a half a day before GT3; it was the last centrifuge training either one of us had, and I think it was completely adequate.

Shepard Yes, I think we ran a year back.

Schirra Yes. I think that we were completely trained in all areas that were involved in the mission other than the last minute changes that were brought in. We went to extra effort, particularly Tom did, on preparing himself for the sextant sightings and this was uncalled for, but Tom, on his own, in that sense went to great extremes to get a complete grasp of what was involved in these sextant sightings with obviously good help the people came down from Wright-Pat and as a result Tom, I think, probably did as good a job as anybody will ever do checking these sextant sightings. That is a good example of what can happen to you though. We didn't have that time prior to October 25, and I don't think that we would have anywhere near the kind of data that we both feel is good data from these sextant sightings.

Stafford All this data was good and the coordination of the crew was very good, that is, it came off according to Hoyle. And one thing about anything like this..it should be practiced in the total environment and this is how I came up with the idea of using the neck dam and the lightweight headset because it

was in the GMS, with the star field that progressed in orbital rate and a flashing light from the Agena that would be the orbital mechanics with respect to the celestial sphere, and so right then we knew exactly how we thought the angle would decrease and then come back and increase in the rotation of the knobs and everything.

Schirra This subject is going to be brought up in the Management debriefing and I'm realling going to clobber these people from other parts of MSC who feel that they are capable of telling us what training requirements are for the equipment that they throw at us. I am particularly perturbed about this so called Ames deal, and this will not lie dormant. There is one more comment that I'd like to bring out and that is we had probably the worst prepared spacecraft for equipment, stowed equipment, that ever left St. Louis. We were caught between a major program on Spacecraft 5 and the first incentive contract on Spacecraft 7. An all the equipment we were to work with on Spacecraft 6 in any manner or form was not ready for us to work with at St. Louis, and we finally grabbed off pieces and bits and parts while here at the Cape. But for these delays in launch, we would have been very badly prepared but for the spacecraft and the mission itself. All the side tricks such as photography, equipment was miserably set up for the spacecraft; as we set up the rule to have it

ready in St. Louis prior to spacecraft ship.

Stafford In fact, at the altitude chamber, the majority of the items we had were blocks of wood mocked up.

Schirra I can point my finger at every component of MSC, Houston, and blame these people for not meeting the schedule and if anyone wants to play games with that one, I'll lay it out.

Schirra We retraced our footsteps on our target that we initially had which was Agena. We had gone to great lengths to block out time at Lockheed. We were up there twice; the first was the exposure to Agena and basically it was a goodwill trip. At that time we hadn't been assigned to Gemini VI. This was with the Gemini III crew. I was very concerned about their casual attitude about Agena. We went back a second time specifically then assigned to GTA 6 and sat down and asked some very specific questions about the capability of sleeping while docked on the Agena, of making an SPS burn, of making a PPS burn. We came away from there having asked very candidly as those who were about to use this vehicle, "Do you have any reservations about these three items?" No reservations about sleeping while docked. No reservations about SPS. Then about three weeks before the flight in Houston a big meeting occurs and everybody is up in arms about the fact that we were sleeping on the Agena including Lockheed. And up in arms about the SPS burn; the PPS already

it; meaning running lights on the Atlas and the cone lights and ACQ lights on the TDA. With these I believe that there should be no problem with rendezvous and docking no matter what attitude the Atlas is in. This should be continued as a backup, a cheap backup in relation to the time lost waiting for another Gemini if we have another bomb out.

Stafford Let me hit one thing...I'd like to bring up some specific facts with respect to the terminal phase of the rendezvous. On this mission, everything went very nominal and as we pointed out before we decided to select a conservative approach as far as transfer, to insure we would have the proper lighting conditions. The terminal phase and the burns leading up to the terminal phase for both the plane and phase keep the crew completely occupied full time. And if the crew is not adequately trained to where they have nearly every angle and position nearly memorized or be able to derive it shortly and run into any trouble, then the probability of completing the rendezvous is greatly lowered; and I think that the crew should be able to instantaneously change over from a closed loop to an open loop with any type of failures that would persist at any time and in this, it takes a great amount of training and no other activities should be scheduled in the over-all flight plan that would have training that would detract

from the prime object of rendezvous on these subsequent Gemini missions and it also should be brought out very specifically in the Apollo project with the LEM rendezvous. This should have the number one priority by far, because I have seen cases in missions where certain minor items such as scientific experiments would get a lot of emphasis and the training would not be available for the real prime item to the degree which it should be. I somehow have the feeling that the people at MSC and possibly the American public now think that rendezvous is really a piece of cake and I'd say we had very great circumstances there and everything worked properly. The main thing that occurs is that if everything does not work properly, there is a good probability that the rendezvous cannot be completed....