NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY 2 TRANSCRIPT

JERRY L. ROSS
INTERVIEWED BY JENNIFER ROSS-NAZZAL
HOUSTON, TEXAS – 26 JANUARY 2004

ROSS-NAZZAL: Today is January 26, 2004. This oral history with Jerry Ross is being conducted for the Johnson Space Center Oral History Project in Houston, Texas. Jennifer Ross-Nazzal is the interviewer, and she is assisted by Sandra Johnson and Rebecca Wright.

Thank you for joining us again today.

ROSS: Good to be back.

ROSS-NAZZAL: Great. Before we started, you mentioned that we did not talk about your chase crew experience [in the first interview]. Would you like to talk about that?

ROSS: Yes, I was reading over my résumé so I'd kind of be a little bit refreshed on what we might be talking about today, and I noticed that that was one of the times that I don't think we talked about a last time, and it was kind of a unique period during the Shuttle.

For the first four flights at least of the Shuttle Program, we had T-38s that we used to join up with the Shuttle as it was coming down for the final approach, and we would chase right along beside it as a backup way to give air speed calls and altitude calls to the Shuttle, should its pitot-static air speed and altitude systems not be working properly. So I was put on the team for the third and fourth flights and got a chance to train for that. Literally, we would take our helmet

and parachutes and put them in the airplane and leave on a Monday to go to Vandenberg Air Force Base [California] or out to White Sands [Missile Range, White Sands], New Mexico, or Edwards Air Force Base [California], or even down to the Cape [Canaveral, Florida], and our chutes and helmets would stay in the airplane the entire week.

We'd normally get two, three, four flights a day, and that was to work with the ground controllers, we'd normally have one airplane that was simulating the Shuttle and it would fly a simulated approach, and then the ground controllers would give us heading vectors to allow us to join up properly and get on the wing of the Shuttle as it was coming down for the final approach into the landing runway. That was a great experience for me. It was a lot of fun to get all that flying time, but it also was very interesting to be involved in a very direct fashion in the very early parts of the Shuttle Program.

The guy in the back was to help the pilot, but also had a Hasselblad camera, and we were responsible for trying to get as many good pictures of the Orbiter as it was coming in for a landing as we could.

The third Space Shuttle flight, the Orbiter was supposed to land at White Sands, New Mexico, because Edwards' lakebeds were wet and we weren't yet ready to commit to a hard runway landing out at the Kennedy Space Center [Florida]. So the first day that they were supposed to land, the winds came up out there; I mean they were like 60-knot winds or so, the gypsum dust was blowing all over the White Sands facility, so they waved off for landing that day. And we were expecting them to have the same type of weather the subsequent day, and if that had been the case, then they were going to go ahead and land at the Kennedy Space Center.

So Guy [S.] Gardner, who I was teamed up with, and I took a T-38 out of El Paso [Texas] that afternoon and flew to Kennedy Space Center. We were excited, because we thought we

were going to be basically the only ones at the Cape when they landed down there. Of course, as it resulted, the winds did abate at the White Sands facility and they went ahead and landed the next day, and we were frustrated that we had to watch the landing on TV as opposed to right up and close and personal.

But we were very happy when they assigned us to be the lead airplane for the fourth landing, which was STS-4, back at the Edwards landing facilities on July 4th, '82. So we got to join up with *Columbia* and to get some great pictures of it coming down for the approach and landing, and just as it touched down, I got a really nice picture of it just as the main wheels are touching down and throwing up smoke on the runway.

Then we got coming back around and land and there was a tremendous crowd out there on the dry lakebed. I mean, there was a little city of RVs [Recreational Vehicles] and campers and stuff on the far side of the lakebed and a fairly large crowd there at Edwards proper, because President [Ronald W.] Reagan was out there for the landing. That's also the day that he announced that we were going to go build a space station, which we all thought was pretty cool. Of course, it took many years to finally get it done, or be in the process of doing it, but it still was a very exciting time for all of us that were in the program and looking forward to an exciting future.

I also got to meet Roy Rogers while I was out there, and Monty Montana, so that was pretty cool, too.

ROSS-NAZZAL: That sounds like fun. Did you get any training while you were working with the Hasselblad cameras?

ROSS: They taught us how to shoot the cameras. They gave us a special eyepiece. It was a 45-degree angle so that we could use it in the small confines of the cockpit. Basically, the same kind of camera that we use on the Space Shuttle. They also taught us how to reload the magazines of film when they were expended. And that's where I also got to know Ron [Ronald E.] McNair pretty well for the first time. Ron was in the back of the other plane that worked on STS-3 and –4, and being the two backseaters, we got to commiserate a lot and talk about our experiences and help each other load cameras with film and things like that. Then subsequently, after that, I got to be a support crewman for Ron on his first flight.

ROSS-NAZZAL: Let me ask you about STS 62-A, which was your Vandenberg flight, which didn't actually—

ROSS: The flight that never happened.

ROSS-NAZZAL: Never happened. I did have a couple of questions. We talked a little bit about it last time.

ROSS: Okay.

ROSS-NAZZAL: Since you were going to be launching out of the Vandenberg complex, did the Department of Defense have any influence over things that normally NASA would have control over, or any more clout than NASA did for this mission?

ROSS: Yes, they did. The launch complex, the vehicle processing, everything was going to be on the facilities out at Vandenberg. They had built an Orbiter processing facility and all the infrastructure. In fact, that hardware's been mostly transferred to the Kennedy Space Center now and is the guts of OPF-3, is what we call it down there, Orbiter Processing Facility 3.

The launch pad was what was called Old Slick 6 Facility, and it's what the Air Force was originally going to launch the MOL Program, the Manned Orbiting Laboratory, from Vandenberg, and when that program was cancelled, it was mothballed and then subsequently modified to take a Shuttle.

The other differences out there were that the stack was going to be built up on the launch pad itself, so the solid-rocket motors were going to be stacked up out at the pad, on the pad. The external tank would be mounted to those out at the pad, and then the Shuttle would be brought out on this multi-tiered carrier from its processing facility several miles away and taken out to the launch pad and put in place once everything else was ready. In fact, they had done that. They had done it once with the *Enterprise* and then they also had done it with—I believe it was *Discovery.* It was what we were supposed to fly on. And it had actually been out there, and I was out there once or twice to see the pad once it was pretty well configured and ready to go.

The entire launch stack could be enclosed in basically a rollaway hanger type of facility, and also the launch control center was basically underneath the pad. It was buried in the concrete, not directly underneath, but still right there contiguous to the launch pad itself. That should have been a fairly noisy place to operate out of.

We got pretty close. When I launched in November of 1985, the 62-A flight was currently scheduled to be launched in February of the next year. Now, we didn't believe that date, you know, it wasn't going to be feasible, but at the same time, we did expect to fly fairly

soon in ’86, and while I was up on that first flight in ’85, that flight, the Vandenberg flight, had been rescheduled I think to, like, July of ’86 and people thought that that was a fairly realistic date.

They had put in all the facilities. They’d put in crew facilities out there. In fact, I went out there once and they showed me a nice blue Air Force jacket with my name embroidered on it and everything else. Never did find out what happened to that jacket, by the way. It’s gone.

But it would have been a fascinating ride. We were going to go into a seventy-two-and-a-half-degree inclination orbit. I think the apogee was going to be something like 380 nautical miles with a perigee around 240 or so. It would have been dual shift. We would have had two Air Force payload specialists working with us. The crew was basically the same crew that I ended up flying with on STS-27, except Bob [Robert L.] Crippen, who would have been the commander on that flight, was replaced by [Robert L.] “Hoot” Gibson, after “Crip” went up to [NASA] Headquarters [Washington, D.C.] and worked after *Challenger*. And Dale [A.] Gardner was replaced by Bill [William M.] Shepherd. Dale basically left the office went into private industry at that point.

The payload specialist, [John] Brett Watterson—I’ve just been trying to make contact with him; I haven’t talked to him in years—was going to be one of the payload specialists, and the other one would have been Randy [T.] Odle, another Air Force officer, but Randy had been bumped by [Edward Cleveland] “Pete” Aldridge, who was Undersecretary of the Air Force, so that would have been some pretty high-power folks flying with us on the flight.

We had two main payloads. One was P-[88]8, I think was what it was called, and it was called Teal Ruby, and it was a prototype satellite that my understanding was, it was a staring

mosaic infrared sensor satellite that was trying to be able to detect low-flying air-breathing vehicles, things like cruise missiles, and a way to try to detect those approaching U.S. territories.

The other satellite eventually did fly on a military mission later on that Don [Donald R.] McMonagle I believe was the commander of. It had a series of different types of ultraviolet and infrared telescopes on it and basically was trying to get background information about the environment of space so that they could use it for information and designing maybe interceptor missiles, seekers and things like that in the future.

The other interesting thing of the Vandenberg flight was that we had filament-wound solid-rocket motors. That meant as opposed to solid-steel case segments of the solid-rocket motors, ours were going to be made out of a graphite epoxy type of material. They had the same joint design as the steel cases, and since the graphite ones would have been more flimsy, more flexible, we always were wondering what would have happened to us had we tried to launch with those, considering the *Challenger* accident and the gas seeping past at the seals in those joints. The reason for using the filament wound solids is because they were a lighter weight. That would give us more weight capability to orbit, since launching at a higher inclination you use less of the Earth's rotational velocity to help you get into orbit.

ROSS-NAZZAL: Did you or the crew have any concerns about launching out of Vandenberg? This would have been the first flight.

ROSS: No, I don't think we had any concerns per se about that. I think anytime you do something for the first time, there are some additional risks inherent in it, but also there's the big plus of doing something for the first time. And, certainly, having my second flight assigned to

me before I got a chance to even fly my first one, I was very excited about that and the fact that you're going to get to do something so unique like that for the very first time was fascinating to me.

ROSS-NAZZAL: When did you find out officially that this flight was cancelled?

ROSS: Well, I'm not sure where in the post-*Challenger* period that was actually decided, but I think it was relatively soon. The Air Force had kind of been forced to use the Shuttle system for launching its satellites, and it was looking for the first opportunity to get out of that deal, and since we knew we were not going to be flying for a while and they wanted to get their other satellites off the ground, important military satellites into space, they very quickly reclamored that forced marriage and went off and starting building their own rockets. It was fairly evident that we were not going to be launching out of Vandenberg anytime soon. In fact, as we went further and further and the joint design came into question and we had this large backlog of satellites that needed to be launched and we'd lost one of the orbiters, it was evident that we weren't going to be launching out of Vandenberg anytime soon. Where the official and final decision was made, I really don't remember.

But you also might recall that in the wake of *Challenger*, all the crew assignments and all the flight assignments were cancelled, so we were back to the drawing board, basically, and it wasn't until maybe late 1987, early 1988, that they put two crews together to start training with the flight control teams and doing simulations. What became the STS-26 crew was one of them. It was called the nonmilitary crew, and our crew was put together, with the two changes that we talked about earlier, to work as a military crew. Subsequently, then, further into the training flow

is when it was decided that the other guys would get [STS-] 26 and we were going to be the [STS-] 27 crew.

ROSS-NAZZAL: Let me take you back to *Challenger*. Do you remember where you were when the accident occurred?

ROSS: Sure do. I was out at Los Alamos [National] Labs [Laboratories] out in [Los Alamos] New Mexico, and we were being trained on some of the payloads that we were going to carry on that Vandenberg flight. We knew that there was supposed to be a Shuttle launch that day and we had a TV over in the corner. We turned it on and learned that the flight had been delayed, so we just left the TV on, but with the volume turned down as we continued our training on the—I think it was some telescopes that we were going to carry that they were involved in.

We were sitting there training, and I think it was Dale Gardner who was more facing the TVs than some of the other people, and he saw this image on the screen and he said, "What is that?" And we all turned around and each of us had this different impression of what we were seeing. I can remember debris flying everywhere and the two solid-rocket motors corkscrewing through the sky, and my first thought was, "They're doing a return-to-launch-site abort," an RTLS. Unfortunately, very soon after, I realized that wasn't the case, that it was something much more severe than that.

So we knocked off everything right away. We got on phones, talked to people, and we started making arrangements to fly back to Houston as soon as we could. Pete Aldridge had an Air Force business jet that was waiting for him down at Albuquerque [New Mexico] airport, and I had a head cold going at the time, so I opted to fly back on that pressurized airplane as opposed

to trying to fly back in a T-38, where I might have problems with my sinuses. So I can very vividly remember flying back on that airplane, a very quiet flight, a very somber flight, to get back home as soon as we could. Then I remember going out with my wife, out to the airport that evening to be there when the crews' families came back into Ellington Field [Houston, Texas].

ROSS-NAZZAL: What were you initial assignments after the *Challenger* accident?

ROSS: Well, I was really not assigned to do much of anything in the way of recovery efforts from *Challenger*, and I was pretty frustrated about it, but the group of people they assigned to do various different things was very small and it was very hush-hush, very quiet, a very closed group of people working it, much unlike what we did on the *Columbia* accident.

So since I wasn't involved directly and didn't have very many jobs at all in terms of doing any kind of support, I thought the best thing I could was to try to support the families, going over to visit the various different spouses and seeing what I could do, helping in any way I could, and then supporting by going to, in retrospect, way too many services and memorials and graveside types of things.

So I went to the Carolinas, I went to New Hampshire, I went to Washington. I got around quite a bit on quite a few of those different services, and it was tough, but at the same time, I think it was the kind of support that the families needed and appreciated, so that's what I did.

ROSS-NAZZAL: Can you give us a sense of what impact the accident had on the astronaut corps itself? You said, for instance, you were frustrated because you couldn't participate in the recovery efforts or the investigation.

ROSS: Yes.

ROSS-NAZZAL: What about the whole office?

ROSS: I think it was a very sobering time. I mean, we always knew that that was a possibility, that we would have such a catastrophic accident. I think there was a lot of frustration that we found out fairly soon afterwards that the finger was being pointed at the joint design and, in fact, that there had been quite a bit of evidence prior to the accident that that joint design was not totally satisfactory. Most of us had never heard that. We were very shocked, disappointed, mad that the system had not done a more professional job of raising those types of issues and appraising the Astronaut Office of those issues so that we could have the proper amount of information to work from and to maybe challenge the decisions being made.

There were quite a few people that left the office fairly soon after the accident. There were more people that left for various different reasons; some of them for frustration, some of them knowing that the preparations for flight were going to take longer; some of them responding to spouses' dictates or requests that they leave the program now that they'd actually had an accident. A little bit of everything.

I talked it over with my family. I had mixed feelings at first about wanting to continue to take the risk of flying in space, but at the same time, all of the NASA crew members on the

Shuttle were good friends of mine, and I felt that if I were to quit and everybody else were to quit, then they would have lost their lives for no good benefit or progress. If you reflect back on history, any great undertaking has had losses; you know, wagon trains going across the plains or ships coming across the ocean. I was just watching a TV show last night that said in the 1800s, one out of every six ships that went across—or one out of seven, maybe it was—that went across the ocean from Europe to here didn't make it. So there's risk involved in any type of new endeavor that's going on. And I got into the program with my eyes wide open, both for the excitement and the adventure of it, but also I felt very strongly that it was important that we do those kinds of things for the future of mankind and for the good of America.

So after getting through the shock and getting through the memorial services and all that, even though I was frustrated I wasn't getting a whole lot to do to help with the recovery effort, I was very determined that I was not going to leave, after talking with the family and getting their agreement, and that I was going to do whatever I could to help us get back to flying as soon as we could and to do it safer.

Also during that time frame was when we were starting to do the initial developmental work on Space Station, what was it going to look like, how were we going to do it. From my spacewalking background, I was natural to fit into that and to do some of the developmental work and some of the thought processes of how we were going to do all those things. That's when I came up with the CETA [Crew and Equipment Translation Aid] cart concept design that sold to the program and is now on board the Station.

We also put the time to good use, the down period to good use. Since I wasn't doing a whole lot of active things and since the office was pretty quiet, my family took two really great family vacations those two dry summers. We had bought a van prior to my flight, so we packed

up the family on the first summer and took a forty-five-day vacation where we went out to the East Coast, started basically at Kitty Hawk [North Carolina] and went up the entire East Coast, all the way up into Nova Scotia [Canada] until we couldn't go any further. Then we turned around and came back and went down the St. Lawrence River and back to Indiana and spent a week, week and a half with each set of parents back in Indiana and kind of cut the kids loose and let them run around. Tremendous vacation. The kids were at the right age for that kind of thing. We spent a lot of time in D.C. and Williamsburg [Virginia] and Gettysburg [Pennsylvania] and all the typical touristy kind of places, and we left early enough that basically all the schools were still in session out east, by the time we got through all the typical tourist places, and that was nice.

The subsequent summer we went west and went through Painted Desert and Petrified Forest [National Park, Park, Arizona] and Grand Canyon [National Park, Grand Canyon, Arizona], Arches [National Park, Moab, Utah], Natural Bridges [National Monument, Lake Powell, Utah], Dinosaur [National Monument, Dinosaur, Colorado, and Jensen, Utah], [Grand] Teton [National Park, Moose, Wyoming], Yellowstone [National Park, Idaho, Montana, Wyoming], Glacier [National Park, West Glacier, Montana], back down through Custer Battleground [Little Bighorn Battlefield National Monument, Crow Agency, Montana], Devil's Tower [National Monument, Devil's Tower, Wyoming], and again back to Indiana for a week or so with each set of parents that summer, too.

Then that fall I signed up for an MBA [Master's in Business Administration] program here at University of Houston-Clear Lake [Houston, Texas], and just got started on those courses, the first couple of courses, when I was assigned to this military training team, which eventually led to STS-27.

ROSS-NAZZAL: Our research has shown that during this down time you did a lot of testing of spacesuits.

ROSS: Right.

ROSS-NAZZAL: For instance, you were working on the Mark 3 suit.

ROSS: Yes.

ROSS-NAZZAL: Can you talk to us about testing that suit?

ROSS: Yes. They were looking at a lot of designs of suits that would maybe be types of suits we might want to use on the Moon or Mars or maybe building a Space Station. We didn't know exactly at the time. Since I had been working in EVA [Extravehicular Activity] for quite a while and one of the few people still around the office who had actual EVA experience, we got to do quite a bit of testing on several different designs of suits and we even looked at an 8-psi [pounds per square inch] suit, which meant that you didn't have to do any pre-breathes from inside the Space Station or Shuttle until you went outside, so you'd basically get in a suit and after a very short period of time of being in there and checking out the suit, then you could go straight out the hatch and not have any concern about the bends.

Some of that testing was done by [Manley Lanier] "Sonny" Carter, some of it was done by Jeff [Jeffrey A.] Hoffman, and me. I think we were the three prime testers. It seemed like

maybe Dave [David C.] Hilmers did some of it also. But it was looking at different types of suits that could work at the higher pressures. Again, probably the hardest part of the suit design is the gloves, and trying to come up with a glove design that would work at 8-psi was fairly difficult and we never really got there.

We demonstrated that the suit components themselves probably was achievable, and we went through a fairly long series of comparisons between various different types of designs and components for the shoulders and knees and the waist and even the ankles, and did a lot of comparison work and came up to some fairly subjective answers. Some of that technology has actually been brought back into upgrades to the Shuttle suits.

ROSS-NAZZAL: How comfortable was that suit?

ROSS: It wasn't. It wasn't at all. I can remember one time they were designing the angles at which the bearings should be mounted into the shoulder part of the hard upper torso of the suit, and I probably got in and out of mockups that—maybe fifteen times over a day, day and a half. That weekend I had a public appearance up in Austin and I went up there, because it was summertime, in a short-sleeved shirt, and I didn't notice until I was getting dressed up for the appearance that the whole inside of my arms from basically just above the wrist all the way up to basically the armpit on both arms was just black and blue. I mean, it looked like somebody had been beating on me. So I kind of tried to keep my arms down and to my sides as best I could. But it was pretty impressive that just getting in and out of a suit that many times could make you all black and blue like that.

We did a lot of work in the water tank. We had this ergometer system that you could put in different types of forces and it would record the amount of effort that you were putting into it, and we were trying to quantify the capabilities of the suit through different types of motions and ranges of motions. And it was a real struggle. I'd come out of that thing hoarse, because it was kind of like—you see weight lifters yelling and screaming as they're lifting weights and stuff? Well, that's what I was doing. I'd come out of those runs basically hoarse because I was grunting. [Laughs]

ROSS-NAZZAL: Do you know are the still working on that suit?

ROSS: There are still components that they have, and you have to ask my daughter to know exactly, because she's the one that's working on advanced spacesuits right now. But there are still parts of that suit that are around and they're still working on some of those technologies.

ROSS-NAZZAL: We also found out that you became part of the Astronaut Science Support Group.

ROSS: Yes. Boy, you really did do some digging, didn't you? The idea was to have some experienced crew members that would be eligible or available to work with scientists as they were designing experiments, and to work with them in a very early period of their design process and give them clues, hints, helps, on the designing of the crew interfaces, the control panels, how you might change out the samples if there was some kind of experiment such as that. Basically, just trying to give some operational knowledge to pure scientists and engineers who really didn't

have a clue on how the operator needed or wanted to interface with the equipment that they might be designing and providing for a Spacelab mission or maybe for a Space Station some day. And we got to do varying different degrees of that kind of stuff. It was pretty fascinating work, actually.

ROSS-NAZZAL: Who did you work with most often in your fields?

ROSS: There were some material science people who just wanted to have some discussions. Basically, the way I would work it is they would come in and tell me what they wanted to do and then we would just kind of talk about, okay, how would we perform this experiment? What kind of indications will the experiment give to an operator? How would you want to present those? What would you do if you got certain types of indications? Basically, just kind of walking through an operational checklist of things of how you would support various different types of experiments. It wasn't an overly successful venture, I guess I'd say. We did have some contact with various experimenters, but there weren't that many that had money to build a whole lot of hardware at that point, so it was a good program, but it never had a whole lot of fruit.

ROSS-NAZZAL: As you mentioned, you were assigned to STS-27. Can you tell us a little bit about your training for that flight?

ROSS: Yes, I can. I flew on that flight as the middle seater, as the flight engineer, on the flight deck, so I worked with the commander, Hoot Gibson, and the pilot, Guy Gardner, on all the techniques and procedures for flying uphill and back down. I did some water training for

contingency EVAs for spacewalks for anything that had to do with malfunctions of the Orbiter. The typical normal training that we had. Beyond that I probably can't say a whole lot else. [Laughter]

ROSS-NAZZAL: What challenges did you face working on this mission? It was a classified mission.

ROSS: Yes.

ROSS-NAZZAL: You had worked previously on a mission just for NASA, which was quite open.

ROSS: Right. I also worked in the Air Force on classified missions, and one of the things we didn't talk about, but in addition to that payload support work that I did, I also worked on quite a few military payloads and helped them from an operational perspective, just like I had done in my payload officer days earlier. I was also assigned to work some of the military payloads as an astronaut during that down period as well.

The problem with working classified programs is you have to be very careful of who you share information with and how you do that. You have to work within secured facilities, facilities that are swept so that you don't have any inadvertent electronic signals or voice going outside it, so it constrains you significantly on how and where you can do your business. When we traveled, we traveled on basically classified orders. We couldn't tell people where we were going or why were going. I'd tell my wife I was leaving; I couldn't, in most cases, tell her when I was coming home. When we launched, I couldn't tell her what time of the day we were going

to launch; I couldn't tell her how many days we were going to be gone; I couldn't tell her what we were going to do. So it's kind of frustrating. I mean, when you do something that's really neat, you want to be able to come home and tell people what you did, and with the exception of the small community in which you work, you can't do that.

ROSS-NAZZAL: When you launched on this mission, did you have any concerns with the possibility that something might go wrong, having witnessed *Challenger?*

ROSS: I think I had the same concerns on that flight that I had on my first flight or any subsequent flights. There's always a possibility something can go wrong. I think in some ways it took a little bit more guts, if that's the right word, to get onto a vehicle and go launch the second time after we had a catastrophic accident because it still is very vivid in your mind exactly what can happen. I can certainly remember as we went through—I think it was eighty-one seconds or eighty-three seconds, where *Challenger* came apart—I can remember vividly that time in our launch coming and going and thinking, "Well, that's where their ride ended." But you put that behind you very quickly and you have to concentrate on what you're doing. Yes, we thought about that. No doubt about it. But I don't think it was that much different than any other flight before it or after it.

We flew with the orange launch and entry suits, which was different and certainly uncomfortable. I didn't like it a whole lot; I never have, but that's the way it is. One of the interesting thing is, those launch and entry suits do muffle the sensations that you get when you're launching. My first flight was just in a cloth flight suit with a little motorcycle helmet kind of device that was there in case we lost cabin pressure, and the noise and the vibration was

considerably, to my recollection, subdued on my second flight as it was compared to the first one. I think that's because of the large launch and entry suit that is a little bit pressurized at launch and muffles the sounds and the vibrations considerably.

ROSS-NAZZAL: Once you got up into orbit, I understand that the tiles had sustained quite a bit of damage.

ROSS: Yes, you're bringing back a lot of good things that I've almost forgotten. We knew that there was some tile damage on—I think it was the left OMS [Orbital Maneuvering System] pod that we could see some damage on it. Subsequently, after we got back on the ground, we found out there was a lot more damage on the underside of the Orbiter. In fact, one complete tile was missing and we had a near burn-through of the Orbiter's skin. In fact, that was the worst tile damage ever recorded on an Orbiter to date. We saw the damage on the OMS pod and we downlinked that video to the ground, and basically I think everybody got fairly comfortable pretty quickly that it wasn't that significant, but it was noticeable.

ROSS-NAZZAL: I read a story in the *Roundup* that your crew claimed to have the longest kickoff and return in football history. What do you remember about that event?

ROSS: Just shortly before we launched, they manifested a professional football to fly with us so that it could be returned to the Commissioner of Football, Pete Rozell, at the upcoming Super Bowl, which was in Miami [Florida] that next January. Since it had been manifested so late, they couldn't put it in a normal place where it would have been unreachable by us, so it ended up

being in one of the lockers where we could get to it pretty easily. It had been deflated and was basically flat, but we discovered that if you use one of the spare needles, which were on board for putting into the apparatus that rehydrates our food, we could basically kind of make the football look like it was inflated. So since we couldn't show anything in our public movie of what we'd done on orbit, we decided that we were going to do a bunch of basically stupid astronaut tricks that we would film and then bring back to be able to use for our post-flight video.

We filmed things like playing baseball with a little metal rod and some peanut M&Ms as the baseballs and then trying to catch them in your mouth after the guys had hit them. We did a good tour of the vehicle and showed where the potty was and where the vehicle was flown from, and the kitchen facilities and the exercise facilities and all that. We showed running around—if you're really good at it, on an open middeck, you can actually run across the floor, or make it look like you're running across the floor, walk up the wall, walk across the ceiling, come down the far wall, and then come back around. So we filmed that and did that.

Then we got this football out, and we decided we'd play some football with it. We figured that traveling at five miles a second, that if you kicked this football and it took a couple of seconds to float across and go through the uprights or to hit the far wall, that it would probably stand for a long time as the world's longest kickoff, or the longest pass completion or whatever you want to call it. So we filmed five guys playing football against this imaginary team, opponent, on the other side of the line of scrimmage, and I put to good use my high school training as a center on the football team and being able to snap the ball.

I'll never forget. We did everything with a 16-millimeter movie camera. We didn't have videocameras at that point yet. We'd have to set the thing up and start it going and then we'd get

into the huddle and everything. I'll never forget, we were huddled up one time and Hoot, the commander, was the quarterback of the team, obviously, and he was facing the camera as we were huddled up, and we were kind of down in a huddle and were talking about what we were going to do this play, and then he kind of pokes his head up like he's looking at what the other guys are doing and then he comes out after he breaks the huddle and he's trying to quiet the crowd so we can hear the count and all that stuff. It was great. It was really a lot of fun.

Then we got to take that football—we were the crew that was sent to the Super Bowl in January '89, I guess it was, and given the honor of returning the football to the Commissioner of Football, and we got to meet Frankie Avalon and Annette Funicello. Pretty cool. [Laughter]

ROSS-NAZZAL: Sounds like a fun flight.

ROSS: Sure. Yes. The crew was really a great crew to fly with. We had a lot of fun. There was four males, military background kind of guys, and didn't have to tell anybody what we were doing because we couldn't. It was a good time. [Laughter]

ROSS-NAZZAL: Did you work on any experiments that weren't classified that you recall?

ROSS: You know, I honestly don't recall. I think we may have had one or two small experiments that we had on the middeck, but I, frankly, don't remember what they were, and I don't remember if I could talk about them even if I did remember. [Laughs]

ROSS-NAZZAL: We don't want to get you in trouble. Let's talk about your next mission, which was STS-37.

ROSS: Okay.

ROSS-NAZZAL: That was the Gamma Ray Observatory [GRO]. I understand that initially the crew did some visits out to TRW [Thompson-Ramo-Woodridge, Inc.] and to Goddard Space Flight Center [Greenbelt, Maryland]. Did you get to go on these trips?

ROSS: Right. I don't remember going to Goddard all that much, but I do remember TRW very well. Jay Apt had worked on the Gamma Ray Observatory for some period prior to the time he got assigned to the flight, and he had worked with them to make sure that they had put some of the contingency EVA capabilities into the satellite that we ultimately ended up using. I think he'd worked Gamma Ray when he was in the payload officer position, even before he got into the Astronaut Office, so he'd been involved with them for quite a while.

In fact, I think that may have been the first time that I met Dan [Daniel S.] Goldin, because Dan Goldin was at TRW at about the time frame that we were out there. I seem to recollect that he was introduced to us at some point out there.

My first thought about the Gamma Ray Observatory when I saw it was that this thing looks like a diesel locomotive. I mean, the thing was huge. I mean, everything on it was real bulky, real thick, real heavy, and it was just very impressive of the stoutness of the satellite. Most times you go up to a satellite and you're almost afraid to breathe on it because it may fall apart on you. This thing was just—I mean, it had huge beams that were the center part of the

structure of it and several of the experiments were great big devices, pretty heavy devices and that's why they needed that much structure to it.

I can remember training in the water tank for these contingency spacewalks and I'm going, "Yeah, they'll never need any of these," but we ended up needing it.

I was the middle seater on this flight, too. I was the flight engineer on this one as well. I can remember—maybe I ought let you ask questions, but I'll go ahead and talk until you stop me. I can remember in the wake of the *Challenger* accident, we lost a good share of the EVA experience within the Astronaut Office. We lost a good share of our trainers and flight controllers who had things to do with spacewalks, and we lost quite a few of our senior design guys who had designed some of the earlier equipment that we had used for spacewalks or for contingency spacewalks for the Orbiter.

And coming up on getting ready to fly again and starting to look towards building the International Space Station, I had gone to the Shuttle Program and convinced them—Jay Apt and I, in fact, had worked together. He was working Station EVAs and I was working Orbiter EVA stuff. We'd gone to them and convinced them that we needed to start doing some EVA DTOs [Detailed Test Objectives], to conduct some actual EVAs to start building up that experience base again, both for our office and the flight controllers and hardware designers. I think Brewster [H.] Shaw was the Shuttle Program Manager at that point, and he agreed with us that that was probably a good idea that we needed to start doing that.

Then we had worked with the Station people and had agreed that probably the right experiment to do would be the CETA cart, and since I had been the guy that had gone off and proposed the CETA cart to the Station Program in the first place, I thought that that was pretty

cool to be able to propose something, get it accepted into the design, and then get it selected as the thing that we'd go ahead and do a flight test on orbit with.

Jay and I worked hard. We got them to agree to do the test. We got them to agree to what we were going to test and we got them to agree to what flight the experiment was going to be done on. And about a month or so after we got that all accomplished, both Jay and I were assigned to the flight, which just floored us. There was no way—everybody thought we had done that and we got this EVA all packaged and we were going to keep it, but it didn't happen that way. I don't know why they assigned both of us to it, but it worked out neat that way.

And, frankly, since I had done the last spacewalks, on the STS 61-B, that the Shuttle had done, I really expected that Steve [Steven R.] Nagel was going to probably choose Linda [M.] Godwin and Jay to be the EVA crew members on STS-37, so that we'd get more experience base within the Astronaut Office. But he thought about it and I told him that's what I expected him to do, but, I'd certainly love to do an EVA if they decided otherwise.

And he thought about it for quite a while and he came back to me and he says, "You know, I understand what you're saying and I think that's a good thing to consider, but I'd really look stupid if we had to do some kind of a contingency EVA on a primary payload and you weren't one of the two guys that was outside."

I said, "Okay. Sounds good to me." [Laughs] "I don't think it's going to happen, but, okay." So there I was. I got to sell the CETA cart to the program, got to convince them to do an EVA, decided it was going to be the CETA cart we were going to test, got it on the flight that I ended up getting assigned to, and then I got to help work with the engineers to design the hardware, design the techniques, and design the timelines of what we were going to do outside. Pretty cool stuff, and something that only happens once in a blue Moon.

So we got to put that experiment on there and we got to train for it and we got to train for all the contingency spacewalks for the Gamma Ray Observatory and, as I said, really didn't think anything would come out of that, except we were a little bit nervous about the solar array and how it deployed, and there was some possibility that it may be something we may have to actually do.

I'll never forget, we get onto orbit and the solar array comes out just fine, and Jay says, "Well, everything's downhill from here."

We all looked at him and said, "Jay, it's not all done yet. Be quiet." And, of course, the next thing to be deployed was the high-gain antenna and it didn't come out.

ROSS-NAZZAL: Why don't you walk us through what happened there. Linda Godwin's got the GRO. Are you guys down in the airlock preparing in case?

ROSS: Well, we had done a pre-breathe and a depressurization of the Orbiter the day before, down to 10.2-psi in preparation for a possible contingency spacewalk. I had been down in the airlock on a mask doing some preliminary checkouts of the spacesuits while Jay had been upstairs working with Linda on some of the preliminary checkouts of the Gamma Ray Observatory while we were doing this pre-breathe and depressurization of the cabin. Then we checked out the suits and had them prepped for the next day, and in fact, I think we went as far as getting our biomed [biomedical] sensors on and getting into our liquid-cooled vent garments so we were that much ahead if we had to go out on a spacewalk.

And I'll never forget, I was sitting up there in the pilot's seat. Steve Nagel was sitting over in his commander's seat and Ken [Kenneth D. Cameron] and Linda and Jay were in the

back, and when this antenna boom didn't come out the first time, there was a series of things we were supposed to do. One of them was to fire some thrusters to see if we could shake it loose. Another one, I think, was for Linda to shake the arm, which you don't do very aggressively with that heavy a payload on the end of it. We had put all those things in place with the flight directors, but we didn't think that any of them were going to work. So after about the second or third iteration of the things that we were trying in a sequence, I looked over at Steve, I took off my wedding band, and I said, "Steve, I'm going downstairs to get ready."

He said, "Yeah, I think that's probably the right thing to do." And it wasn't forty-five seconds later the ground called us and said, "Why don't you send Jerry and Jay downstairs and Ken can start suiting them up." [Laughs] Just a weird sensation.

I've never got excited or nervous about going outside like I did in this one, because I was afraid that this $630 million satellite or whatever it was—I didn't know what was wrong with it. I didn't know if we could fix it or not. And here we are, on the spot to try to go out and fix this thing, and if we can't, then we've got this great big lead weight that what are we going to do with it? We may not be able to bring it home because the solar array's already been deployed; the antenna's partly released. Oh, man.

So we got into the airlock and they gave us the go-ahead and depress and go on out, and I climbed out and started going down the starboard sill and I left Jay behind and he was going to bring out a bunch of tools and stuff. This was Jay's first time on a spacewalk and I hadn't done one for several years, so that was kind of cool. I asked Jay to bring out a bunch of stuff, tools and things, and put them along the port sill.

I climbed down the starboard side about half way back in the payload bay, and Linda moved the satellite just a little bit closer to me so I could go from the sill and grab onto the

satellite. I got up onto the satellite and kind of worked my way around to where I could get around to the backside. The antenna was on the backside facing the aft bulkhead of the Orbiter and the guys in the cockpit couldn't see it from the aft windows. I crawled around and I got back there and decided that I could get back to where I could reach the antenna boom.

In fact, we were going through an LOS at that point, a loss of signal. This is when we were still working without two complete TDRS [Tracking and Data Relay Satellite] systems. So while we were LOS, I went ahead and moved back there to where I could actually position myself, holding onto the antenna boom, and give myself a good support position to work from. And when we came back into communication with the ground then, I said, "Hey, I've been back there. I think I can give it a pretty good push if you want me to." And, of course, I had these great big hydrazine tanks right underneath my feet and knees down here. I didn't want to go dinging them and spraying hydrazine all over the place.

So they went ahead and said, "Okay, go ahead and see what you can do." I got back into position again, and the guys inside had positioned cameras where they could watch me as well, and it took some pretty good pushes on the boom. The first two had felt pretty solid, and then I could tell it was starting to loosen up a little bit. I was probably putting in, I don't know, forty-five, fifty pounds of force, is my recollection, and I could tell it was starting to walk out. Finally, it came free and swung out about thirty or forty degrees from the stowed position.

The agreement was, with the Flight Directors, that if we had to go out and do one of these contingency things, then we were going to complete it manually and not try to recommand it and drive it out and lock it in place. So as soon as that was done, I let out a war whoop, came back around, back down to the Orbiter and then up to the front and back around on the other side where Jay was at.

Then Jay and I worked ourselves down the port sill to where the satellite was at again, and I think Linda brought it over a little bit to that side then, and I climbed back up onto the satellite. We put a foot restraint into position and then I got into the foot restraint and got a tool that was required to lock the antenna boom into its deployed position, so I slowly maneuvered the boom up into position, held it in position, and then threw this bolt that locked it in place. And that was a pretty good feeling, I'll guarantee you. I felt that I'd probably earned my keep for that day, $630 million or whatever the satellite was worth.

And that was really a good feeling, demonstrating where the man in the loop can help a robotic system and let it go off and do some really great science, which it did for years before it finally got de-orbited.

We also had an agreement that there was going to be a period of time where the satellite was going to require a lot of checkout before it was ultimately released from the arm of the Orbiter. So during that period of time, Jay and I were allowed to stay outside on the spacewalk and to do a series of force measurements on an instrumented pallet, and I can't remember the name of that pallet. Maybe you've got it written down there.

ROSS-NAZZAL: The Crew Loads Instrumented Pallet.

ROSS: Yes, Crew Loads Instrumented [Pallet], CLIP, is that it?

ROSS-NAZZAL: Yes, CLIP.

ROSS: And we had to bring out a box that kind of looked like a shoe box and it had a pigtail that came out of it, and it basically was a tape recorder and it had some batteries in it that provided power to the instrumentation on this instrumented pallet. The idea was to try to understand what kind of loads a crew member could react when he was in a foot restraint and when he wasn't in a foot restraint, the basic data that we needed to know to be able to start putting together design requirements for a space station.

So we brought the box out, we hooked it up, we deployed the CLIP hardware, and then I went through a whole series of maneuvers of turning wrenches, turning handles, maneuvering myself, a whole series of things that we were recording the data on so that we could get more information. Pretty good workloads. I can remember working up a sweat and the sweat getting down into my eyes at one point. It was a pretty exhausting period of time.

I ended up later—all of us have ended up later living down that data, because I put in some pretty good forces into things and so they had to make those the design requirements for the Station, which requires to put in load alleviators and all these other things. They said, "Put the max amount in." If they'd have said, "Put a reasonable amount in," that would have been a totally different story. But sometimes you do things and regret later that you did them.

Anyhow, we got that data, which was, I think, very valuable information for the program to design to, and ultimately, Jay and I were both supposed to do that, but by the time I got done through the sequence, it was time to get back into the airlock getting ready for them to deploy the satellite. And, of course, we were supposed to be fully into the airlock, or pretty close to it and just kind of looking out the hatch. I think about the only thing that was still in the airlock when we released the satellite were our toenails. [Laughter] Jay and I were pretty well outside of the hatch when we released the satellite and then they fired the jets to move the Orbiter away from

the satellite. That was really cool. I think we were over North Africa at the time that we released it and we were above the satellite, looking down. That was a pretty awesome sight.

ROSS-NAZZAL: Cool.

ROSS: Yes. Yes, it was a pretty good feeling. Then after that, we just cleaned up and came back in. Then we did the planned spacewalk the next day. I think it's the only time we've done back-to-back spacewalks with the same guys on the Shuttle Program.

ROSS-NAZZAL: Did you have to make dinner that night? I know you said on your first spacewalk you came back in and you had to make dinner.

ROSS: I can't swear to it, but on most of my spacewalks, especially on the first couple of flights, the EVA guys ended up making the dinner after the spacewalks, because basically you get back inside, you get de-suited, you clean up things a little bit, and you start charging the batteries on the suits and some other things, and then normally the time line has the other people going away to do other things and that leaves us to get cleaned up and things like that, and get redressed into normal clothes. And that gives you the time, while you're doing that, to start pulling out the food and making the meals, so my bet is, my recollection is, is that we probably did go ahead and make the meal both those nights after the spacewalks as well.

ROSS-NAZZAL: Why don't you tell us about the second EVA that you participated in.

ROSS: The second EVA was, in my recollection, a really neat one, because we were actually trying to understand things like what does it take to build structures in space and also trying to demonstrate this concept that I had come up with on transporting crew and equipment quickly up and down the face of the Station, the truss of the Station.

So we had two segments of truss that were launched in place on the forward part of the payload bay, because we needed the sills to be clear further aft for the Gamma Ray Observatory to be launched. Once it was out of the payload bay, then the aft area was clear and we could take one of the track segments that was probably twenty-five feet long, maybe a little bit more than that, twenty-six feet long, take it off its launch position, move it back, put it into position, and lock it down so that now we had both tracks end to end, and it basically went almost the entire length of the payload bay.

Then on top of the track, the forward piece of track, was mounted this little truck, or carrier. It was kind of like a little red wagon, but the rollers on it encapsulated both the top and bottom side of the rails so it couldn't come off and it would allow you to roll up and down the track.

And on top of that little bogie or truck, then, we had three different ways of propelling ourselves up and down the track. One of them was just to put a foot restraint into that little red wagon and then get into the foot restraint and just pull yourself up and down the track, pull or push yourself up or down the track. That was a concept that we liked and that's the one that we ultimately went with, because it's just easy to do and it's the least amount of overhead and the simplest. But the engineers in Engineering Directorate, because they wanted to build up their level of expertise and the experience requested in the program agreed that they could build a couple of different ways of propelling us up and down the track.

One of them was kind of like a mechanical handcart, kind of like the old handcars on a train, and basically that's what it looked like. And we tried that one. There was another one which was electrically powered. Basically, you stood up on it and you had a hand crank which was driving a generator. The generator fed electricity down to a motor which pushed you up and down the track. We tried the manual one first. That worked fine. Both Jay and I did that, and we also would climb onto the back of the other guy to add some additional mass to see if that had much difference, because a guy in a spacesuit weighs 350 pounds or so. So that was a way of adding some 350, 400 pounds, so that's a way of adding additional mass.

We also tried this railroad thing, and it was kind of a different way of supporting yourself. As opposed to your feet being in a foot restraint, you kind of straddled this thing and you put little pegs behind both knees, and that's the way you held yourself into position on that one. And it worked okay, too. Like I said, it was kind of like a hand crank kind of thing and then if you pulled the handle to a fully deployed position, it was your braking system as well.

The electrical cart was the one that gave me the biggest chuckle the whole flight, I think. In the water, the generator was not real, the motor was not real, and you would make the motion of turning the crank on a generator and the divers would drive you up and down the track. This mechanism also had a parking brake on it so that you could keep the thing from drifting away while you were not in it or while you were getting in and out of it.

Since the one in the water didn't work like the real one, you never worried about this parking brake. So I got into the real one on orbit, and I'm sitting there cranking it and it's not going anywhere. I'm going, "Man, these engineers. I told them this thing wouldn't work. It's a piece of junk." [Laughter] I said, "Hey, I got to give it a good old college try." So I said,

"Maybe it's just stuck or something. If I turn a little harder, it'll go." So I was cranking the thing for all it was worth.

And Linda Godwin told me afterwards, "Man, you were rocking the whole Orbiter, you were cranking so hard." [Laughter] So I literally tired myself out. I said, "Okay, let's stop for a second here." And while I'm taking this break and stopping and resting a little bit, I looked down and the parking brake was still on. And I wasn't quick enough to say, "Well, the parking brake works." [Laughter] So admitted that I had not released the parking brake, took it off, and then the cart worked very nicely, going up and down the track. Every once in a while you do something like that that you'll just never forget. So all three of those experiments worked pretty neat.

We also had a little tether shuttle, which was nothing more than a little knob mounted on a plate, and the plate had rollers that encompassed the sides of the tracks so that it couldn't come off. Basically, the concept for that was that you just tether yourself to that and now you can slide up and down the whole length of the track just by yourself, and that also worked nice. In fact, that design concept is also integrated into the current design that's on the International Space Station.

So we tested all those out, we deployed the mechanisms, we had to re-stow the mechanisms. We put the track back where it had launched and tied it down. And then we also had—I think it was the flight, where we—yes, this was the flight where we took the rope reel out and strung it across the middle of the payload bay and then used the rope as a way of translating around. Again, it was just a way of trying to understand what the Orbiter would allow you to do and what you couldn't do with it.

And also we had Linda bring the arm down into where I could reach it in the payload bay and I grabbed onto it to see if I could move it around manually. And it proved that I could move it some in direct directions, but I couldn't do any rotations of the end effector, and so that said that really that's probably not a really viable way of maneuvering the payload into position to attach it somewhere.

Jay also did some work on the end of the arm, using a fish scale to measure the loads that the Orbiter's arm could handle. I rode on the end of the arm a little bit with Linda driving the arm, basically at maximum rates up and down and left and right. That was trying to understand what kind of speeds the crew member could tolerate, riding on the end of the arm. Again, trying to feed knowledge back into the design and operational planning for building an International Space Station—or at that point Space Station Freedom, I think was the name we were working with at that point.

So we worked a full six hours on that spacewalk and, unfortunately, we had some orbital adjust burns or something that were coming up and so we couldn't extend the EVA that day.

Probably one of the more memorable things at the end of the second spacewalk was when Jay Apt was taking off his gloves. He had this great big bloody spot on one of his hands. I think it was his right hand, if I remember right. I'm going, "Wow, you had a blister and it broke. Wow, Jay, that was really tough on you."

We get back on the ground and come to find out that part of the glove mechanism that kind of keeps the palm configuration fixed is called a palm bar. It's kind of like a *C*, and one of those tips of the *C* had been turned in too much towards the hand and had actually punctured the bladder of the glove and was rubbing against his skin, and it was really the dried blood that sealed the glove so that it didn't leak. So that was kind of interesting.

ROSS-NAZZAL: How did you and Jay pass along these recommendations to the Crew Systems [Division]?

ROSS: We came back and had a very thorough debriefing. The data we got from the CLIP was passed on and reduced and is now the bible in terms of the crew loads that you can put into structures and what the crew can react loads for. I've continued to work EVA forever, basically, and have worked on the design of hardware for the Station throughout. We also debriefed the office and gave them as much knowledge as we could, as every spacewalking group does, both the lesson learned, what you did, what didn't work, you know, those types of things.

But more importantly, we debriefed the designers of the hardware so that they could know more about what worked and what didn't work, and ultimately, the choice we had of the manual CETA cart design, but the others did well as well.

ROSS-NAZZAL: Now on board this flight, I understand that all the crew members took part in the SAREX [Shuttle Amateur Radio Experiment].

ROSS: Yes.

ROSS-NAZZAL: Can you talk to us about that?

ROSS: Yes. SAREX is a amateur radio that was put on the Shuttle so that we could talk to various groups back here on the ground, and in most cases we tried to tie it in to schools so that

we could talk to kids directly from space and encourage them to study and to work hard and become scientists and engineers and some day maybe astronauts.

I'm not too much into amateur radios. I mean, it's not my thing, but Steve Nagel enjoyed them. Ken Cameron was big into them. Jay Apt was pretty big into them, and Linda Godwin was kind of like me, but she did some of it. And I was pretty busy preparing for this flight, because I was working part of the Gamma Ray stuff. I was doing the spacewalk stuff, both the contingency and the planned one. I was the middle seater on the crew, so I had all that stuff to work on, and Linda and I, we had two middeck experiments to work on, too. So I was pretty busy, and I didn't want to study the Morse code and all the other things I had to do to get my amateur radio license. So Ken Cameron would keep putting this stack of materials on my desk, you know, the application card and all the other things, and kept bugging me to do this, and I kept going, "No, Ken, I don't want to do this."

So finally, he came in one time and he put them back on my desk again and I said, "Ken, if we slip farther than *x* date, then I'll go ahead and do it." It was about three days later that we slipped again and I went, "Oh, no. Just what I want to do." [Laughter]

So I went ahead and studied up. He took me up to [George Bush] Intercontinental Airport [Houston, Texas], and took the exam, passed it, got my card, and then while we were on orbit, he had his little ham shack all set up over in his pilot seat and he was talking to people and everything else and making all these contacts on the ground, and I didn't want anything to do—I'd rather look out a window, take pictures, do other things, but not that.

So finally, at one point, he says, "Come on. You got your license. You've got to at least talk one time." So I talked to somebody on the ground, I forget who it was, and said, "Hi," and that was it. That satisfied him and that was one of my few contacts using the amateur radio

system. I can honestly say I'm the only person who has only talked from space to the ground using an amateur radio system. I've never used one physically on the ground to talk to anybody else. [Laughs]

I used it again on STS-55 and I actually got a chance to be bridged to a school system where I talked to my nephew and I also got to talk to my folks at home, which was pretty cool.

ROSS-NAZZAL: Do you remember what your call sign was?

ROSS: N5SCW. It's no longer my call sign, since I let the license lapse.

ROSS-NAZZAL: Are there any other memories of this flight that you'd like to share with us?

ROSS: Can't think of any right now. It was a very busy flight, and we worked well together as a crew. I guess the one thing I do recall in hindsight is the fact that Steve and Linda both got married to each other later on. So I accuse them, in hindsight, of supposed hanky-panky during their flight, but there was none of that going on. I did end up being their best man at their wedding, so that was another nice side benefit of the flight.

ROSS-NAZZAL: That's great.

ROSS: Steve and I had known each other for quite a few years out of Edwards before we came here, and since he went to the University of Illinois [Urbana-Champaign, Illinois] and I went to Purdue [University, West Lafayette, Indiana], we harassed each other quite often.

ROSS-NAZZAL: He did make it a point, when we interviewed him, to point out that he and Linda had no connection there during that mission.

ROSS: After you turn off the camera and recorder, I'll tell you the real story.

ROSS-NAZZAL: Oh, all right. [Laughs]

Your next mission was STS-55. That was an entirely different mission for you. That was an international mission, and you also served as the payload commander for that mission. Can you tell us what your duties were as the payload commander?

ROSS: Yes. It was a very demanding flight for me. The payload commander is the guy that's responsible basically for interfacing with the payload sponsors and the crew to make sure that what the payload sponsors want to have happen on orbit is things that the crew can physically do, both from just the interfaces to the payloads, the checklists, the time line, all those types of things. Dan [Daniel C.] Brandenstein, who was then head of the Astronaut Office, called me when I was in quarantine, getting ready to go fly STS-37 and said, "We want you to be the payload commander for STS-55, Spacelab mission D-2."

I said, "Dan, you want a scientist for that. You don't want me, an old engineer."

And he said, "No, we want you. We want somebody that will work well with the Germans and make the whole flight get pulled together."

I said, "Well, give me some time to think about it. I'd really rather stay in the EVA area and continue working on Station assembly and all that kind of stuff." So he called me back a day

later and I said, "Okay, I'll do it." So, again, before I flew a flight, I already knew that I had another flight waiting for me, which was pretty nice. I mean, it's a nice way to do business.

So literally, I think it was less than two weeks after I got down from STS-37, I was announced as the payload commander for STS-55, and I didn't do a lot of the normal post-flight activities on STS-37 because I went to Germany probably within three weeks or so of landing, to start working on STS-55.

I went over, and the Germans at DLR [German Aerospace Center, Germany], at Porz-Wahn, between Bonn and Cologne, sat me down and ran through basically all the experiments that they were planning on doing on the flight and the proposed training for each of those experiments, and I brought all that knowledge back home and worked with the training people here, finding out what I was going to have to do in terms of Spacelab training and the other training that I was going to have to do here, and then started working out a plan of how we were going to get that all done. I also got a chance to meet the four pending German payload specialists for the flight while I was over there, which was really a big plus.

After looking at it for a while and understanding exactly what was required in the training, I was able to get the Germans to offload some of the training back here to the [United] States, especially in the life sciences and medical training areas, things like being able to put in a catheter, draw blood, give shots, those types of things, take pulses and respiratory rates and other basic medical kinds of capabilities. They allowed me to offload most of that training here and then just do a little bit over there to demonstrate that I'd got what they needed in the way of training. I also tried to consolidate the amount of training that we were doing over there so that we didn't have to travel to Europe any more than was required.

I came back and talked to Steve Nagel, who was then the acting head of the Astronaut Office. I think he'd been the pilot on D-1. Yes, he was the pilot on D-1, and they were hoping that he'd come back and fly again on D-2. I was also hoping that he may come back and we could fly together again, so I could harass him some more. So he came back later on and said, yes, that the system thought that that would be a good thing to do to have that kind of continuity, and he would be coming back as commander, but I couldn't tell the Germans yet. So that worked out pretty well.

But, basically, once we started into training, shortly thereafter, I'd say a month or so after I'd started working the flight, Bernard [A.] Harris was assigned as my other mission specialist. It was his first flight, and being a medical doctor—the Germans had requested a medical doctor mission specialist, and since I wasn't one, they were certainly hoping the next one would be. While I didn't personally think that a medical doctor was mandatory, I did think that it was not a bad idea, because probably over 50 percent of the work we were going to do was life sciences, human research type of experiments.

So Bernard and I went back and forth. Basically, we would spend three to four weeks in Germany and then three to four weeks back here, and we did that for basically a year, going back and forth, doing most of the payload-specific training in Germany and then coming back here and continuing to do training on Spacelab systems and other things and working the details of the flight.

One of the things I learned fairly late in the training flow was the fact that D-1 and D-2 Spacelab missions were the only flights flown that did not have a NASA mission manager. They had German mission managers, and since they were the prime sponsors, NASA chose not to have their own mission manager. I figured that out. I wondered why I was struggling so hard

and having to do so many things myself, and it didn't hit me until fairly late in the preparations for flight that that was why; I didn't have a NASA mission manager. I had to do all the coordination, all the dealings, everything, all the dealings with the safety community, with the medical community, with the science community, I had to work all that in addition to trying to get three rookies ready to go fly on ninety different, very complex experiments. So it was probably, from that perspective, the most challenging flight I had, because of not only the flight crew requirements, but also some very heavy management type of necessities that I had to do.

And it wasn't always easy, because the way the flight was set out, the Germans bought the flight, but to offset their expenses, they had sold back a lot of the research time and space to the U.S. and they'd also sold quite a bit of it to ESA [European Space Agency], but yet they wanted to do all the things that they decided that they wanted to do in the first place. So the flight was well overbooked in terms of the number of experiments and the number of hours required and it was, at times, more of an adversary type of arrangement than I wanted it to be, but sometimes I had to take the attitude that I'm not going to let the crew fail.

So there were times when I said, "No, that experiment is too late. We've not trained on it. The procedures are not ready. It's not been adequately safety-reviewed. It's not going to fly." And that was very tough for me, because I like to work as a team. I'm always a positive kind of guy and want to make things happen, but at the same time, there was a couple of points in there where we just had to lay down the law and say, "That's not going to happen."

Another time was when one of the experimenters, I thought, was very incompetent, and we had to go through a baseline series of tests, which took basically an entire week, where we had very strict foods that we could eat, we had to measure all our intake, and we had to collect

much of the outtake for an entire week. And the first time we did it, they came back later on and said, "We messed up the protocol."

So I said, "Okay. We've got one more try, right?"

They said, "Right." So we did the second preflight protocol and about, I would say, maybe two months before flight, they came back and said they'd messed that one up as well. Well, they came back and said they wanted to add another one.

And I kept going, "No, we've messed up the first one. We did the second one. That's all we've got time for. Can't do it."

They said, "Well, how about if we add it after the flight?"

I said, "No, there's no reason to do that. You know the protocol's there. You'll just have to take the one." Then they had to admit, finally, that the one protocol, the second protocol, had been messed up as well. I never got into the details of it. I said, "That's it. I'm not going to do this test. That's it. The other guys can do it if they want to; I'm not. That's it."

So there were a lot of problem childs, a lot of areas in which we had difficulties. A lot of the experiments came with not very complete or adequate operational procedures, and so while we were training, we were developing the procedures at the same time. And basically we wrote the whole flight data file ourselves. A lot of the experiments were very complex, very challenging to do, and they required a lot more time to do than what had been allocated, so we forced them to make cuts and make decisions on where we were going to delete repetitive tries of certain experiments or things, to kind of try to get everything to fit into a box. We also hoped that if we launched on time the first day that we'd have enough cryogenics to allow us to stay on orbit for a tenth day so that we could get more time to do some of the experiments.

The one other thing that I can remember that I encouraged the Germans to do right away was, even though I hadn't flown on any Spacelab missions, I had been tracking what was going on and I found out that the refrigerators or freezers that we were carrying on a lot of those flights were failing at a fairly rapid clip. It became apparent to me that probably 40 or 50 percent of the science that we were going to do on the flight was counting on that freezer working and bringing back those samples that we collected over the ten days on orbit.

So I suggested that they decide to carry a second freezer as a backup and forfeit those two lockers of space that were required to fly that second freezer, because of the fact that we'd had this record and if we had a freezer break, we'd be out of luck. Well, wouldn't you know it, the freezer that was powered up to launch failed by the time we got to orbit and never did come back to life, so the other one that was our spare was the one we used throughout the entire flight, and we did all kinds of things to try to nurse it along. We've got these plastic bags that are about this big in diameter [demonstrates] and they're about, I don't know, three feet long and they're sealed at one end, and that's where we put our wet trash into. Then we'd tie them up and tape them up so they don't smell, and we put them into our wet trash area to bring them home. We took several of those and cut out the sealed end and taped them together and ducted cold air coming out of one of the vents in the Orbiter and put it right in to the intake fan of the freezer so that we could give it additional help to keep itself cool. We were doing everything we could to keep that thing going and it made it.

The other thing was, just as a sidelight, there was a possibility that we were going to have to wave off the day because the weather was not good at the Cape on landing day. Even though all of our families were there, the program decided they were going to land us that day no matter what, so we ended up landing at Edwards, with all our families at the Cape, because they wanted

to make sure the science got back on the ground and was well taken care of. That was a trade that they made, and I think it was a good one.

Okay, what was your question? [Laughter]

ROSS-NAZZAL: Second question. Let me just ask you a clarifying question. Did you know German? Is that why you were appointed payload commander?

ROSS: No. No, in fact, after the fact, I found out there were quite a few people in the office that were fluent in German, but none of them had stepped up to the plate to volunteer that this was something they wanted to do. I was not fluent in German. I'm not fluent in German. Fortunately, most of the international science people work in the language of English anyhow, because you've got all the other languages in Europe that they have to find some common language and, fortunately, that's it. I did try. I got some of the tapes. I tried to learn some German and I did learn some, but I'm not good in foreign languages to start with, and trying to do all the other things I was doing, there wasn't time to learn much German.

ROSS-NAZZAL: You told us that you did some training in Europe and some training over here. Could you compare and contrast what training is like over in Europe compared to training here at the Johnson Space Center?

ROSS: They tried to make it as close to the training that we have here as they could. They had a Spacelab simulator that's relatively close to ours, and so they tried to do things about at the same. We did do a lot of traveling early on to many of the principal investigators' laboratories,

universities, or companies around Europe, to visit their prototype hardware, to understand the basic science of what they were trying to do, and to see experiments done on their prototype hardware. And that was very beneficial very early to establish that working relationship.

Also, it gave me a chance to see my prospective payload specialists, how they would operate, what kind of questions they would ask, what were their strengths, what were their weaknesses, traveling some weird hours and some long days, how would they respond to that. So it was kind of nice to see all those things as a byproduct of the training we were doing as well.

ROSS-NAZZAL: What was it like working on a mission where Crew A and Crew B [were] working twenty-four hours a day?

ROSS: Yes, that, plus there was a Crew C, which was the Shuttle crew. So you basically had three different teams that were working. I always tried to have a tag-up at each shift handover so that we could tell the oncoming crew where we were at, what we got done, any problems that were going on, a summary of all the flight notes that had been sent up and everything else, so that we made sure we had good, clean handovers. I think a couple of times during the flight I gave little pep talks like, "I know we're all tired, but you guys are doing great and we're getting a lot of good science here, and we've got to keep going," and everything.

And also make sure that they'd go to sleep on time so that they'd get the right amount of rest, even though I wasn't. I probably didn't get more than five hours of sleep a night for the whole time we were up there, and when I got back on the ground, I was just flat wiped out. That's all there was to it. Part of it was because I was working extra time in the lab to try to make sure that we kept up with the time lines. Part of it was that I don't sleep well in the sleep

bunks that we had. I mean, the bunks are like coffins. I mean, they're really small. You can't even roll—my shoulders—I couldn't even roll over, turn over in them. And there's still an ambient noise of people working out there, getting their food and eating, and knocking around and stuff, and my brain was going a million miles an hour. I was thinking about all we'd done that day and what we needed to do the next day. I'm kind of that way. I'm kind of hyper. So it was a very fatiguing flight for a lot of different reasons. And I hardly ever got to look out the windows. There weren't any windows in the Spacelab, and they kept giving me a bad time about that.

Oh, I've got a story, by the way. Write down "story," so I don't forget it.

ROSS-NAZZAL: Okay. You pointed out that you had some trouble with the fridge on board. There was also a problem with the flash evaporator system. Do you remember what problems that caused for you?

ROSS: It wasn't the flash evaporator system, was it? What I remember was the waste tank developed a leak in it, is what I remember. If there was a FES problem, I don't remember that. Maybe it was the tank problem that caused the FES problem, but I don't remember for sure.

At one point, I don't remember exactly how we noticed it, but we found out that we had—let's see. Is this the right flight? Yes, I guess.

ROSS-NAZZAL: We can always correct the transcript.

ROSS: We found out that we had a wastewater tank that was not working properly, so we had to use one of these big burlap rubber-lined bags to collect the urine. Then every once in a while we'd have to sit there and squeeze this bag to shoot the urine back out the side of the Orbiter into space, and that was a delightful thing to do.

The FES, I don't remember what the problem was there. Like I say, I didn't get into the Orbiter a whole lot, other than to eat and sleep and go to the bathroom, and that was about it.

ROSS-NAZZAL: When you came back, did you do any PR [Public Relations] trips to Germany?

ROSS: We did. We had like fourteen days of post-flight medical experiments they did on our bodies. We were really human guinea pigs on this flight. I mean, we had needles stuck in us all the time and we did all kinds of weird stuff. So we had like fourteen days of almost nonstop testing we did.

Then I'd say a month and a half or so after the flight, we went over to Germany and we had a real nonstop touring for two and a half or three weeks. I guess two and a half weeks, where we were in a new city basically every day; you were going until ten, eleven o'clock night, crash, get up at six o'clock in the morning, pack and leave and go someplace else and do things all over again, and that was a real whirlwind kind of thing. Enjoyable, but at the same time, very fatiguing, and it was one of the hottest summers that they'd had in Europe to date, and not many places have air-conditioning over there, so it was kind of tough to get to sleep when you're sitting there with sweat dripping off of you in the middle of the night.

ROSS-NAZZAL: What was the reaction of German crowds to the introduction of astronauts?

ROSS: They were very excited about it, especially the university crowds. They were very excited about the science, especially if that university had sponsored some of the experiments that we were doing. We were well received everywhere, had a lot of fun. They sure know how to throw parties. It was a great time. It really was.

ROSS-NAZZAL: Before we stop, you mentioned that you had a story you wanted to tell.

ROSS: Yes. Steve Nagel thought it was great fun that I was going to be back in the laboratory being a human guinea pig for the whole time and I wasn't going to get much of a chance to look out the window and take pictures of the Earth, which is my passion to do. He had arranged with some of the vehicle integration test team guys to take a large-sized picture of what he had taken of me looking in one of the rear windows of the Orbiter on STS-37. I don't know if you've seen the picture, but it's my smiling face in my spacesuit, looking in the window, and he's taking a picture of me looking in.

Well, he had arranged to have one of those pictures cut out so it fit perfectly into one of those windows, and that window was covered up by a cardboard closeout for launch, so that dirt and stuff doesn't get under the windows. And he knew that I was going to be the guy taking that closeout panel off so that I could look out the window to help set up cameras and things for opening up the payload bay doors after we got onto orbit.

So there I am, I'm pulling this thing off and I'm looking at this thing in the window and it's me looking at myself, and I just started laughing. I thought it was so hilarious. I just started laughing. And the other three, Charlie [Charles J.] Precourt and Steve and Tom [Terence T.

Henricks] were up in the front and they were getting ready for an OMS burn or doing some checklist procedures and stuff, and they thought Ross had lost it back there. I was just laughing hilariously. Then they turned around and saw the picture up there, and Steve had actually forgot that they were going to put that thing in there. But it was great.

So later on in the flight, since we didn't have any windows in the laboratory, as I told you earlier, Steve brought this thing back and pasted it on the aft end cone so it looked like I was outside having a good time throughout the flight.

ROSS-NAZZAL: Disappointing.

ROSS: It's hard to get even.

ROSS-NAZZAL: I think this would be a good place for us to stop.

[End of interview]